Sä Dena Hes Mine

Volume 3: Aquatic Ecological Risk Assessment

Prepared for:

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EXECUTIVE SUMMARY

Project History and Objectives

Azimuth Consulting Group Partnership (Azimuth) was commissioned by Teck Resources Limited (Teck) to conduct a Human Health Risk Assessment (HHRA) and terrestrial and aquatic Ecological Risk Assessments (ERA) for the Sä Dena Hes Mine (the Site) near Watson Lake, Yukon Territory (YT). The Site was a zinc-lead mine that operated for 16 months between August 1991 and December 1992. The Site has a number of mine-related Areas of Environmental Concern (AECs) described in detail in site assessment documents (Golder 2015a). The Site was kept in a state of temporary closure until January 2013 when Teck began implementing the Detailed Decommissioning and Reclamation Plan (DDRP) in support of permanent closure. As one of the early steps in the ERA process, Azimuth prepared a Draft Problem Formulation (PF) for the Site (Azimuth 2013), and since then has submitted several risk assessment reports. The ERA for the Site is organized into three main Volumes:

- Volume 1: Updated PF
- Volume 2: Terrestrial Ecological Risk Assessment (TERA)
- Volume 3: Aquatic Ecological Risk Assessment (AERA) (this report)

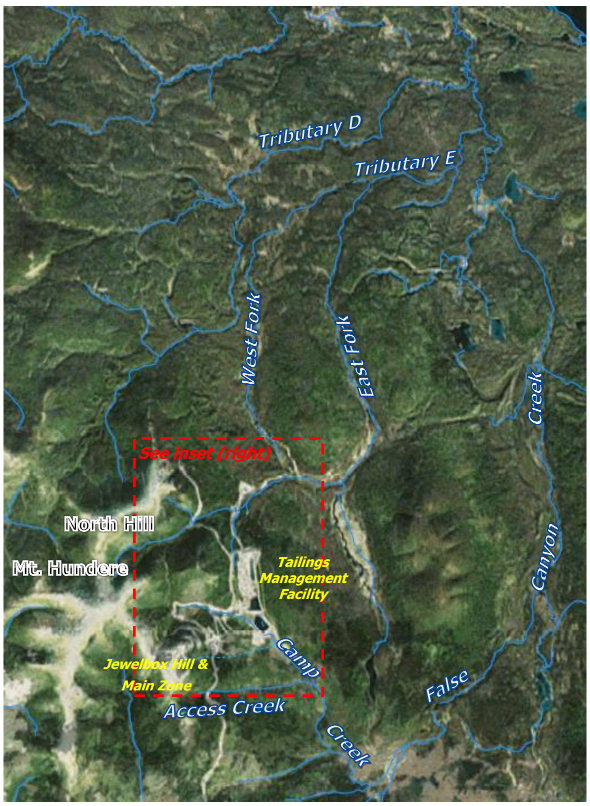
The primary objective of the AERA (Volume 3) was to assess potential risks to ecological receptors (i.e., aquatic plants, aquatic invertebrates, fish, and amphibians) from exposure to mine-related contaminants/stressors in the aquatic environment. Potential risks to amphibians from contaminants in the terrestrial environment are also assessed in this report. Unlike the TERA, which was a significant driver for closure planning and regulatory approvals with respect to the terrestrial environment, the AERA had a lower profile role; the main driver for decisions about post-closure aquatic monitoring fell within the purview of the Yukon Territory water licence process.

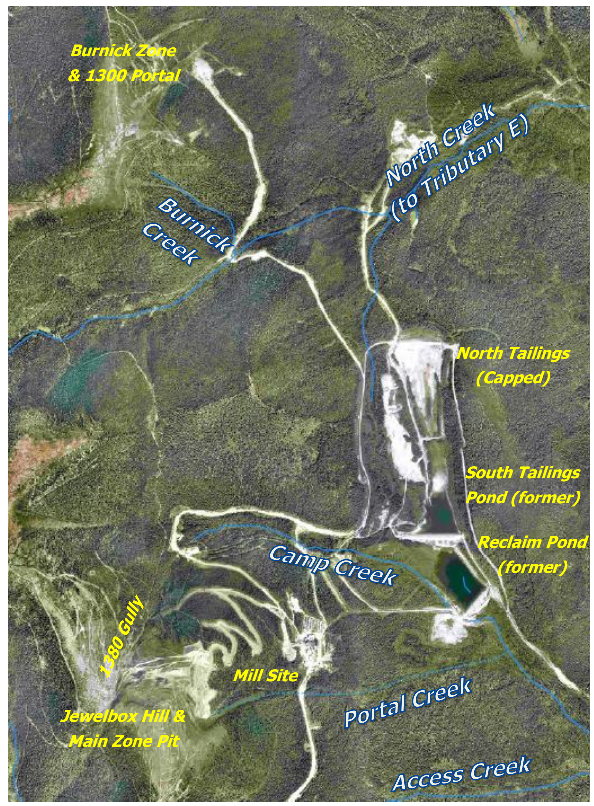
Aquatic Environment

False Canyon Creek is the main catchment for the Site, receiving drainage from two near-field receiving environments: the Camp Creek drainage (including Portal Creek and Access Creek) and the Tributary E drainage (including North Creek and Burnick Creek). Camp Creek drains the area east and south of Mt. Hundere, including the Jewelbox Hill, Main Zone, 1250 Portal, and 1380 Gully (AECs 1 and 9), the Mill

Site (AEC 3), portions of the Tailings Management Facility (TMF; AEC 8), as well as large tracts of undisturbed forest to the south of Access Creek. As laid out in the DDRP, the upper reach of Camp Creek underwent significant modification. Camp Creek was realigned to its original flow path following the dewatering and decommissioning of the Reclaim and South Tailings dams.

The main catchment for the northern portion of the Site is Tributary E. Burnick Creek and North Creek drain the area south of the North Hill, as well as the North Tailings area of the Tailings Management Facility. North Creek merges with the East Fork of Tributary E and flows northeast, joining with the West Fork of Tributary E, the catchment for surface water and groundwater flowing east from the Burnick Zone and 1300 Portal areas. Tributary E was not initially considered a receiving environment in the Updated PF (Azimuth 2014d; SRK 2014d). After the Updated PF was issued, a decision was made to include Tributary E in the formal risk assessment for completeness and transparency.





Approach

The AERA evaluated risks to aquatic receptors separately for (1) near-field Camp Creek, (2) near-field Tributary E[1] and (3) far-field False Canyon Creek environments. Somewhat less emphasis was placed on evaluating Tributary E because loading assessments (SRK Engineering, 2014d) indicate that metals

[1] The AERA focused on the upstream receiving environment in North Creek.

originating from both the Burnick Zone and North Tailings seepage are unlikely to affect water quality in in this drainage. Under Water License monitoring, there was a large water quality monitoring dataset available for most aquatic receiving environments dating back to 1999. Similarly, other types of data were available for False Canyon Creek, specifically, sediment quality, benthic invertebrate community, and fish information every two years since 1992. By comparison, the only information on biological communities in the near-field receiving environments prior to 2014 was collected in support of the baseline Initial Environmental Evaluation (IEE; SRK 1990). The data gaps in near-field sediment chemistry and biological community measures were identified in the PF (Azimuth 2013). Therefore, in 2014 a field program was conducted to assess the presence and health of aquatic receptors in receiving environments immediately downstream from the Site.

Using all of this information, the AERA evaluated risks and associated uncertainties for each receptor group by receiving environment using a weight of evidence (WOE) approach. Individual lines of evidence (LOEs – i.e., analytical tools and information) are collectively assessed to form an overall risk characterization rating. Individual LOEs are evaluated for relevance to the receptor, effect size (or degree of contamination), causal linkage to contamination, and uncertainty in the assessment. In general, risk ratings were based on the following effect size categories and examination of causal linkages:

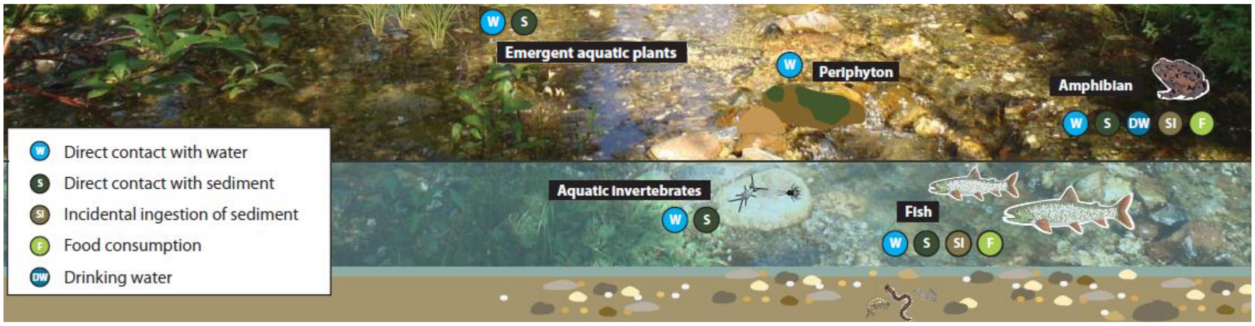
- Negligible – concentrations are below standards, no adverse effects are observed/predicted in toxicity tests, and/or no differences in receptor community metrics are observed between reference and exposure areas.
- Low – concentrations are 1-3 times above standards, low-level (e.g., 10-20%) sublethal effects in toxicity tests are observed/predicted, and/or low-level (i.e., 10-20%) changes in key receptor community metrics in exposure areas relative to reference.
- Moderate – concentrations are 3-10 times above standards, moderate-level (e.g., 20-50%) sublethal effects are observed/predicted in toxicity tests, and/or moderate-level (i.e., 20-50%) changes in key receptor community metrics in exposure areas relative to reference.
- High – concentrations are more than 10 times above standards, high-level (>50%) effects are observed/predicted in toxicity tests, and/or high-level (>50%) changes in key receptor community metrics in exposure areas relative to reference.

Uncertainty in risk conclusions are rated as low, moderate or high and consider several factors including sensitivity and specificity of the tool to contaminants, confounding variables such as habitat, level of resolution of the tool, data quality, spatial and temporal representativeness of the data, and natural variability.

Risk estimates are based on current conditions because monitoring shows long-term consistency in water quality data. In addition, an adaptive management plan is being developed under the Water Licence to monitor water quality and other parameters into the future.

Receptors of Concern and Lines of Evidence

The AERA for the Sä Dena Hes Mine evaluated potential risks to plants, invertebrates, fish and amphibians from metals in the waters of Camp Creek, Tributary E, and False Canyon Creek (and terrestrial environments for some amphibians). A generalized conceptual exposure model is shown below, followed by a description of each receptor group and LOEs evaluated in the AERA:



- Aquatic Plants – This receptor group is comprised of rooted aquatic plants (known as macrophytes), and periphyton [a complex assemblage of algae (unicellular, colonial, or filamentous), heterotrophic microbes, cyanobacteria, and detritus found attached to submerged substrates]. Macrophytes and periphyton communities are an important source of food and habitat for aquatic invertebrates, amphibians, and some fish species, and can be exposed to contaminants in the surface water and sediment. Risks to aquatic plant communities were evaluated at the community level by examining the available water and sediment chemistry data, water-based toxicity testing results on a freshwater algal species, and a qualitative survey of macrophyte presence/absence.

- Aquatic Invertebrates – The aquatic invertebrate community in stream environments is typically dominated by species that live in/on the bottom substrate, known as benthic invertebrates. These organisms can be exposed to contaminants in the surface water, sediment, and, for contaminants that bioaccumulate, their food. This receptor group was evaluated at the community level by assessing the structure and ecological function of the aquatic invertebrate community as food for higher trophic level consumers (e.g., fish). Risks to aquatic invertebrates were evaluated by examining metal concentrations in surface water and sediment, acute and chronic toxicity tests on a freshwater aquatic invertebrate, and information on the abundance and richness of various taxa from available benthic invertebrate community field surveys.


Benthic Invertebrate Community Sampling

- Fish – The AERA assessed the presence and viability of fish communities downstream from the Site. An evaluation of available information on fish presence / absence and habitat data (e.g., presence of fish barriers, available cover, etc.) indicated that the near field environments (Camp Creek and North Creek) were unlikely to support viable fish populations, due to their headwater nature and the presence of fish barriers. This was supported by the absence of fish detected in these creeks in the 2014 electrofishing survey. These environments were conservatively included in the AERA for fish, should fish presence change in the future. Bi-annual fish population monitoring under the Water Licence was conducted at three stations in False Canyon Creek. These data showed that slimy sculpin is the most abundant and widely distributed species in False Canyon Creek. Other species, including Arctic grayling, burbot, whitefish, and char have also been reported, but their presence in upstream False Canyon Creek is limited. Risks to fish from exposure to metals were evaluated by examining metal concentrations in surface water and sediment, quarterly acute toxicity test results for rainbow trout exposed to water from the Reclaim Pond, tissue chemistry results (where available), and the presence of a functional aquatic plant and invertebrate community.

Fish Community Survey - Electrofishing

- Amphibians – Two species of amphibian were identified as receptors: the wood frog (common species, so need to protect local populations), which prefers aquatic habitats and the western toad (listed species[2], protect individual frogs), which prefers terrestrial habitats (Azimuth 2013). Risks to amphibians preferring aquatic habitats were evaluated by comparing water chemistry to available amphibian toxicity thresholds, sediment chemistry relative to available guidelines, and the presence of a functional aquatic invertebrate community.

  The western toad prefers terrestrial habitat. Risks were evaluated under post-closure conditions within the boundaries of AECs defined in the. Two LOEs were used: the presence of a functional soil invertebrate community as food, and soil chemistry compared to available effects thresholds for amphibians.

Key Findings of the AERA

Key findings of the AERA are presented below for receptors in each of the drainages downstream from the Site.

[2] Species At Risk Act Status: Schedule 1, Special Concern (Link to Species at Risk Public Registry)

Camp Creek

The highest concentrations of metals (less than 10 times the standards) in surface water and sediment samples downstream from the Site are found in Camp Creek, particularly in the lower portion of Camp Creek downstream from the former Reclaim Pond. Risks to aquatic receptors in Camp Creek were found to be:

- Aquatic Plants
  - Lower Camp Creek – Moderate with high uncertainty,
  - Upper Camp Creek – Low with low uncertainty
- Low for aquatic invertebrates (with moderate uncertainty),
- Negligible for fish (with low uncertainty), and
- Low-to-moderate for amphibians (with high uncertainty).

The moderate risk rating for aquatic plants in lower Camp Creek is based primarily on toxicity tests, which showed adverse effects to algal growth at the 95th percentile concentration of zinc at one downstream Camp Creek station. The highest risk ratings were predicted for the winter months when metals concentrations are highest in lower Camp Creek; however, after freshet in June, the predicted risks range from negligible-to-moderate during the spring, summer, and fall months. Farther upstream, near the headwaters of Camp Creek, the toxicity test results indicated negligible-to-low risks to algal cell growth. Low effects to species richness and chlorophyll-*a* production were predicted for lower Camp Creek when comparing the 95th percentile site-specific water quality data to literature-based toxicity thresholds for periphyton. However, the diverse and relatively abundant benthic invertebrate community along the length of Camp Creek suggests that there is a functionally intact primary producer community in Camp Creek. Aquatic macrophytes were not observed during the field survey, and based on the habitat characteristics of Camp Creek, were not expected to be present. Uncertainty is considered high, because there is high likelihood that additional data (e.g., quantitative periphyton survey) could change the overall risk rating for aquatic plants.

The benthic invertebrate community in Camp Creek appears healthy based on the presence of several sensitive taxa, primarily mayflies, stoneflies, and caddisflies (taxa known to be sensitive). Some reduced total abundance was observed at two stations immediately downstream of the former Reclaim Dam in the 2014 survey, but similar proportions of sensitive taxa compared to the reference area suggests the lower abundance is not likely due to contaminants. Toxicity testing on a freshwater invertebrate indicates that upper limit (95th percentile) zinc concentrations in lower Camp Creek *may* have the potential to cause effects to reproduction, and possibly survival. Overall, the field survey was given more weight than the toxicity testing LOE, because the field survey provided direct evidence of the health of the Camp Creek benthic invertebrate community (i.e., presence of sensitive taxa).

No fish were captured at any of the sampling locations along Camp Creek in 2014, consistent with findings from the baseline work done in 1989, prior to mine development. Poor habitat quality in the form of limited cover, absence of deep pools for overwintering, and numerous downstream barriers to fish migration, are the primarily factors impeding fish colonization in Camp Creek. Even if fish migrate into Camp Creek in the future, risks are considered negligible (with low uncertainty), in part, because no adverse effects have been reported in any of the quarterly Water Licence toxicity tests measuring rainbow trout mortality exposed to water from the Reclaim Dam.

Wood frogs were previously observed in two marshy areas within the Tailings Management Facility in 2012, but with dewatering of the Tailings Ponds in 2013/4, ponded amphibian habitat on-Site is now limited to a small area upstream of the Camp Creek realignment in the area of the former South Tailings Pond. If amphibians are present on-Site and/or in Camp Creek, they likely occur in low abundance. Risks to amphibians were considered low to moderate (with high uncertainty) based on water and sediment concentrations exceeding generic guidelines at some Camp Creek stations. A comparison of surface water metals concentrations with water-based amphibian thresholds indicate effects to amphibians in Camp Creek are unlikely, with the exception of lower Camp Creek where effects were considered possible for lead.

False Canyon Creek

The risk of contaminant-related effects to receptors in False Canyon Creek was considered:

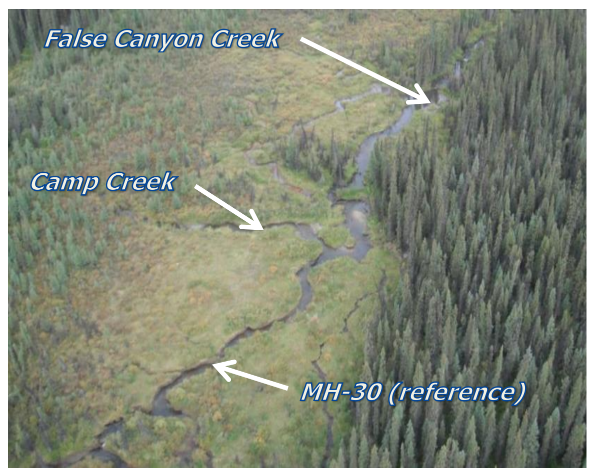
- Negligible for aquatic plants (with low uncertainty)
- Low for aquatic invertebrates (with moderate uncertainty),
- Low for fish (with moderate uncertainty), and
- Low for amphibians (with moderate uncertainty).

The negligible risk rating for aquatic plants was driven primarily by the results of the toxicity tests on algae where the effects concentrations in the test were higher than the upper 95th percentile of metals concentrations measured in False Canyon Creek dating back to 2004. The presence of a relatively stable and abundant benthic invertebrate community provided secondary support that the lower trophic level is functionally intact.

The long-term benthic invertebrate community data shows some variability in the abundance and richness metrics between sampling periods, but no apparent temporal trends indicating adverse effects. There are lower numbers of sensitive taxa upstream in False Canyon Creek relative to downstream, but

variability in the upstream benthic data and the water and sediment concentrations compared to guidelines suggest contaminants are not the cause. Multiple years of data, combined with knowledge of the habitat conditions (i.e., stream characteristics at the upstream station are highly variable), strongly suggest that any reduction in the number of sensitive taxa upstream compared to downstream are habitat-related.

Several years of fish community data provide good evidence to support the conclusion that habitat is the primary determinant of fish distribution in False Canyon Creek. The most prevalent fish species within the study area is slimy sculpin, and they are distributed along the length of False Canyon Creek (up to where Camp Creek merges with False Canyon Creek) and the reference tributary MH-30. Arctic grayling are recorded in False Canyon Creek dating back to 1992, but only as far as Station MH-16 located approximately 22 km downstream from the Site. Numerous barriers to fish migration are thought to impede upstream migration of most species.



Risks to fish in False Canyon Creek were considered low (with moderate uncertainty) primarily based on the long-term fish community dataset that shows relatively consistent species presence at the Water Licence monitoring locations. Some differences in abundance have been noted between years, but the overall distribution of species along the length of False Canyon Creek has remained consistent since 1992. A comparison of the long-term surface water chemistry in False Canyon Creek to the rainbow trout toxicity testing monitoring location implies there is negligible risk of effects to fish. Whole-body slimy sculpin collected in 2014 at the Confluence of Camp Creek and False Canyon Creek show elevated concentrations of some metals (e.g., lead) relative to slimy sculpin captured 22 km downstream at

Station MH-16. While this indicates elevated exposure for fish living closer to the Site, it is unknown if there are associated adverse effects to the slimy sculpin population in this upstream area of False Canyon Creek. The elevated tissue concentrations for some metals resulted in the moderate uncertainty rating, but overall the risk to fish in False Canyon Creek is considered low in light of the other LOEs.

No amphibian surveys have been completed in False Canyon Creek, but comparing surface water chemistry to available effects thresholds for amphibians suggests there is negligible risk for this receptor group.

Tributary E

As previously noted, Tributary E was a lower priority in the AERA and there are fewer data available for assessing the health of aquatic receptors. One sentinel biological monitoring station was sampled in the 2014 field survey for assessing the health of aquatic receptors in Tributary E. Other locations have been monitored for water quality; however, with the exception of Burnick Creek, sampling is limited to 2013 and 2014.

The WOE evaluation resulted in risk ratings of:

- Low for aquatic plants (with low uncertainty),
- Low for aquatic invertebrates (with moderate uncertainty),
- Negligible for fish (with low uncertainty), and
- Low for amphibians (with high uncertainty).

No aquatic macrophytes were present in the vicinity of North Creek in the 2014 survey, consistent with the riffle habitat along this stretch of North Creek, but lower reaches of Tributary E likely support macrophyte colonization in areas of suitable habitat (e.g., ponded wetlands with stagnant flow). Upstream in North Creek, periphyton growth was visible on cobble and large gravel, and the presence of an abundant and diverse benthic invertebrate community implies little, if any, effects to primary producers at this location. Results of the algal toxicity tests showed potentially low-level effects to growth (10-20%) at zinc concentrations corresponding to the upper 95th percentile in Burnick Creek water. Farther downstream in North Creek, the risk of effects to aquatic plants was considered negligible.

The benthic invertebrate survey showed some reduction in the number of sensitive species and the proportion of individuals from sensitive species relative to the reference area (Access Creek) in 2014. However, the total invertebrate abundance at this location was highest among all the near-field stations sampled in 2014 because of a large number of midge larvae (dipterans). Water quality data from Burnick Creek and North Creek compared to the toxicity testing benchmarks in invertebrate toxicity tests indicate negligible-to-low risks for aquatic invertebrates in this drainage, and substantiate the conclusion that the overall risk to aquatic invertebrates in Tributary E are low.

No fish were captured in the vicinity of the North Creek sampling station during the 2014 survey. Pre-mine development, fish were documented in lower portions of Tributary E (SRK 1990), but the habitat farther upstream in North Creek is not considered suitable for supporting fish communities. Regardless of the habitat suitability, risks to fish *potentially* residing in North Creek under future conditions are negligible when comparing the long-term water chemistry data in North Creek against the available rainbow trout toxicity testing results from exposure to water from the Reclaim Pond.

Amphibian surveys have not been completed in North Creek and Tributary E, but comparing surface water chemistry to available effects thresholds for amphibians suggests there is negligible risk for this receptor group.

Terrestrial Amphibians

Potential risks to amphibians in most AECs were considered negligible or low (with high uncertainty), risks to terrestrial amphibians in Jewelbox/Main Zone were considered high with high uncertainty, based on toxicity-based soil screening thresholds from the literature. This risk finding for the Jewelbox/Main Zone AEC is unlikely to change risk management decisions for the terrestrial environment, as amphibian risk rating results are similar to those obtained for some species of birds and mammals in the TERA (readers are referred to Azimuth 2015b for further information).

Summary of Findings

Teck undertook this AERA for due diligence purposes by building on years of water quality data and existing aquatic environmental effects studies. Augmented with some 2014 on-site data, this information was used to describe any aquatic risks and, if elevated risks with reliable certainty were identified, to consider options for managing those risks.

The data and assumptions the risk conclusions are based upon are clearly stated in the report. The table below summarizes the high-level findings for risks to aquatic receptors from exposures to metals expected to be similar to future conditions.

Receptor	**Camp Creek**		**False Canyon Creek**		**Tributary E**	
	Risk	(Uncertainty)	Risk	(Uncertainty)	Risk	(Uncertainty)
Aquatic plants	Upper Camp Creek: Low	(Low)	Negligible	(Low)	Low	(Low)
	Lower Camp Creek: Moderate	(High)				
Aquatic invertebrates	Low	(Moderate)	Low	(Moderate)	Low	(Moderate)
Fish	Negligible	(Low)	Low	(Moderate)	Negligible	(Low)
Amphibians (aquatic)	Low-to-moderate	(High)	Low	(Moderate)	Low	(High)

Through the Yukon Water Board, an adaptive management plan will monitor post-reclamation surface water and groundwater quality. In that Plan, thresholds triggering responses (e.g., risk management) are linked to trend analysis and comparison with water quality limits specified in the Water Licence. Ultimately, the findings of this risk assessment will be evaluated/verified through ongoing monitoring.

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ACKNOWLEDGEMENTS

This report was authored by Cheryl Mackintosh, Eric Franz, Laura Bekar, and Randy Baker with contributions and technical peer-review from Alena Fikart and Beth Power (Azimuth Consulting Group Partnership, "Azimuth"). Project management was provided by Randy Baker and Beth Power (Azimuth). Eric Franz, Randy Baker, and Andrew MacPhail (Access Consulting Group) conducted field sampling with assistance from Liard First Nation (LFN) field assistants. Water data were provided by SRK Consulting (SRK). Sediment and biological data from routine monitoring programs in False Canyon Creek were provided by Laberge. Maps and GIS inputs were provided by Jason Shaw of Caslys Consulting.

This report was prepared for Michelle Unger and Bruce Donald of Teck Resources Limited, who provided substantial input closure plans and scenarios for the Site.

We recognize the input that the LFN has made to this work. From providing field support to learning from elders about the site and its history - this work has benefited from their insights. In particular, Sarah Newton and Shelia Caesar are recognized for organizing inputs from LFN community members.

NOTICE TO READERS

The ecological risk assessment (ERA) for the Sä Dena Hes Mine, Yukon Territory is reported in the following volumes:

- Volume 1 – Problem Formulation for the Ecological Risk Assessment (PF): An Updated PF was prepared in September 2014 (Azimuth 2014d), which replaced the Draft PF prepared in June 2013. As part of 2015 ERA deliverables for the Site, an Addendum to the PF (Azimuth 2015a) has been issued, which updates the September 2014 Updated PF with site conditions and data collected in 2014. The Addendum to the PF (Volume 1A [Azimuth 2015a]) is considered a companion document to the September 2014 Updated PF which contains supporting information and data that was collected after Volume 1 was issued.
- Volume 2 – Ecological Risk Assessment for the Terrestrial Environment (TERA): A Draft TERA was prepared in September 2014 (Azimuth 2014e), which relies on food chain model results presented in an Interim ERA (Azimuth, 2014c). Additionally, a TERA Addendum has been issued (Azimuth 2015b), which updates risk conclusions for terrestrial receptors based on site conditions and data collected in 2014. The Draft TERA and Interim ERA contain supporting information and are considered companion documents to the TERA Addendum.
- Volume 3 – Ecological Risk Assessment for the Aquatic Environment (AERA): This document (Azimuth 2015c) provides risk assessment results for aquatic receptors and relies on studies conducted in aquatic receiving environments in 2014 and historical monitoring data collected and reported in compliance with the Water Licence between 1992 and 2014.

Readers are referred to these documents for information on each topic.

USE & LIMITATIONS OF THIS REPORT

This report has been prepared by Azimuth Consulting Group Partnership (Azimuth) for the use of Teck Resources Limited (Teck; the Client), the Liard First Nation, and the Yukon Government (Departments of Energy Mines and Resources (EMR) and Environment Yukon (EY)) and reviewers under contract to EMR. This report is intended to provide information to Teck to assist with making decisions regarding management options with respect to closure of the Sä Dena Hes Mine. The Client has been party to the development of the scope of work for the subject project and understands its limitations.

In providing this report and performing the services in preparation of this report Azimuth accepts no responsibility in respect of the Site described in this report or for any business decisions relating to the Site, including decisions in respect of the management, purchase, sale or investment in the Site.

This report and the assessments and recommendations contained in it are intended for the sole and exclusive use of the Client, the Liard First Nation, and the Yukon Government (EMR and EY), and reviewers under contract to EMR.

Any use of, reliance on, or decision made by a third party based on this report, or the services performed by Azimuth in preparation of this report is expressly prohibited, without prior written authorization from Azimuth. Without such prior written authorization, Azimuth accepts no liability or responsibility for any loss, damage, or liability of any kind that may be suffered or incurred by any third party as a result of that third party's use of, reliance on, or any decision made based on this report or the services performed by Azimuth in preparation of this report.

The findings contained in this report are based, in part, upon information provided by others. In preparing this report, Azimuth has assumed that the data or other information provided by others is factual and accurate. If any of the information is inaccurate, site conditions change, new information is discovered, and/or unexpected conditions are encountered in future work, then modifications by Azimuth to the findings, conclusions and recommendations of this report may be necessary.

In addition, the conclusions and recommendations of this report are based upon applicable legislation existing at the time the report was drafted. Changes to legislation, such as an alteration in acceptable limits of contamination, may alter conclusions and recommendations.

This report is time-sensitive and pertains to a specific site and a specific scope of work. It is not applicable to any other site, development or remediation other than that to which it specifically refers. Any change in the Site, remediation or proposed development may necessitate a supplementary investigation and assessment.

ACRONYMS

AEC	Area of environmental concern
AEL	Acceptable effect level
AERA	Aquatic ecological risk assessment
AMP	Adaptive management plan
APEC	Area of potential environmental concern
CABIN	Canadian Aquatic Biomonitoring Network
CCME	Canadian Council of Ministers of the Environment
COPC	Contaminants of potential concern
CRR	Concentration response relationship
CSR	Contaminated sites regulations
DDRP	Detailed decommissioning and reclamation plan
DL	Detection limit
DW	Dry weight
ECxx	Effects concentration
EMR	Yukon Government Department of Energy Mines and Resources
EPT	Ephemeroptera, plecoptera, and trichoptera (benthic invertebrate taxa orders)
ERA	Ecological risk assessment
ESA	Environmental site assessment
EY	Yukon Government Ministry of Environment (i.e., Environment Yukon)
FCSAP	Federal Contaminated Sites Action Plan
HHRA	Human health risk assessment
ICxx	Inhibitory concentration
IEE	Initial Environmental Evaluation (for the Mt. Hundere Joint Venture)
LCxx	Lethal concentration
LFN	Liard First Nation
LOE	Line of evidence
NOAEL	No observed adverse effect level
PEL	Probable effect level (CCME sediment screening criteria)
PF	Problem formulation
QA/QC	Quality assurance/quality control
ROC	Receptor of concern
SD	Standard deviation
SDHOC	Sä Dena Hes Operating Corporation

SQG	Sediment quality guideline
SSWQO	Site specific water quality objectives
TERA	Terrestrial ecological risk assessment
TMF	Tailings Management Facility
WER	Water effect ratio (toxicity test)
WOE	Weight of evidence
WQG	Water quality guidelines
WW	Wet weight
XRF	X-ray fluorescence
YT	Yukon Territory

1. INTRODUCTION

1.1. Background

Azimuth Consulting Group Partnership (Azimuth) was commissioned by Teck Resources Limited (Teck) to conduct a Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the Sä Dena Hes Mine (the Site) near Watson Lake, Yukon Territory (YT). Sä Dena Hes was operated by Curragh Resources Incorporated as a zinc-lead mine for 16 months between August 1991 and December 1992. Mining operations were suspended in December 1992 in response to low metals prices, at which point the Site was put into a state of care and maintenance and has not operated since. In April 1994, the Site was purchased by the Sä Dena Hes Operating Corporation (SDHOC), a Joint Venture between Teck Resources Limited (25% ownership), Teck Metals Limited (25% ownership) and Korea Zinc (50% ownership), continuing in a state of care and maintenance due to the continued low market demand for zinc. In 2013, Teck reorganized some of its assets and this resulted in the joint venture being owned 50% by Korea Zinc and 50% by Teck Resources Limited. Finally, due to a limited resource and low market demand for metals, a formal decision was made to temporary close the mine in 2000 and a formal decision to permanently close the mine was made in 2012.

The Sä Dena Hes Mine is permitted under a Yukon Quartz Mining Production Licence (QML-0004) regulated by Yukon Energy Mines and Resources "EMR" and a Type A Water Use Licence (QZ99-045)[3] regulated by the Yukon Water Board, both of which expire at the end of 2015. Teck submitted a Detailed Decommissioning and Reclamation Plan (DDRP) in 2000 and updated versions have been submitted as required between then and August 2015 when the final version was delivered (Teck 2015). Teck completed closure activities at the end of 2015 and, as part of a separate and parallel permitting process, they are renewing the Type A Water Licence, for January 2016. Teck and the LFN have cooperatively developed an ongoing engagement process to involve the LFN in mine closure.

Implementation of the DDRP involved the following reclamation/management actions: sealing portals; grading steep slopes; draining, covering and re-vegetating the Tailings Management Facility (TMF); covering discrete areas of the Mill Site, Borrow Areas, and Jewelbox; risk managing hydrocarbon contaminated areas; removing contaminated soils from discrete areas (e.g., settling ponds) and in some cases, depositing contaminated soils in mine shafts; diverting Camp Creek back to its previous location (through the Reclaim Pond); and removing mine site buildings. Closure activities were initiated in 2013 when draining of the ponds was started and building demolition began. The bulk of the physical work was conducted in 2014, with reclamation being the focus of 2015. DDRP activities are discussed further in the Updated PF (Volume 1, Section 2.3).

Environmental investigations have been ongoing at the Site since the 1990s. SRK Inc. (SRK) conducted initial environmental evaluations for the Mt. Hundere Joint Venture in 1989. From the time when the

[3] Referred to throughout the document as "the Water Licence."

SDHOC acquired the Site in 1994, Teck has been conducting water monitoring on Site in compliance with the Water Licence. Water, sediment, and biological monitoring has been also been conducted every two years dating back to 1992 in the downstream environment as per the Water Licence (see Laberge 2012 and 2015). Golder Associates Ltd. (Golder) and Access Consulting Group (Access) have conducted environmental site assessment work (ESA) (Golder 2013, 2014a; Access 2012) and hydrogeological assessment work (Golder 2014b). During preparation of the DDRP and with review of groundwater monitoring results by EMR and Environment Yukon (EY), Teck made a decision to risk manage hydrocarbons *in situ* and areas of stockpiled contaminated soils were backfilled in September 2013 (Access 2013).

ERA studies and related work are described in more detail below and are shown, along with the overall risk assessment process, in **Table 1–1**.

1.2. Environmental Setting for the Aquatic Environment

The Site straddles a drainage divide between the False Canyon Creek and Tom Creek catchments, both of which ultimately drain into the Liard River (**Figure 1–1**). False Canyon Creek is the main catchment for the Site, which drains an area of 492 km^2. False Canyon Creek flows into the Frances River which ultimately flows into the Liard River, 55 km downstream from the confluence with False Canyon Creek. Tom Creek receives water from the southern portion of the Site away from any potential contamination sources and ultimately drains into the Liard River (SRK 1990). There is no surface water connection between False Canyon Creek and the Stuart River drainage to the east.

The AERA evaluates risks to aquatic receptors in near-field Camp Creek and North Creek[4] and far-field False Canyon Creek environments separately. A general description of each of the receiving environments is provided in the following sections.

1.2.1. Camp Creek (Near-field)

A detailed description of the Camp Creek monitoring stations was provided in Volume 1 (Azimuth 2014d). A general discussion of the water course and associated stations is provided below.

Camp Creek originates from two groundwater springs in close proximity to each other just above (CC-1) and just below (PH-1) one of the mine access roads (**Figure 1–2**). Area CC-1 drains a small valley on the southern flank of Mt. Hundere that has not been disturbed or affected by mine activity. PH-1 (originating from a large spring where an old pumphouse was situated) also gathers water from near Mt. Hundere but lies below land on the north flank of the Jewelbox and Main Zone pits. The area upgradient/

[4] North Creek was previously determined to be unimpacted by contamination from the Site in the PF (see Section 6.2.2.2 in Azimuth 2014d) based on information in the draft version of SRK (2014d) issued in May 2014. The decision to include Tributary E as a downstream receiving environment was made because of the potential loading from MH-02 to North Creek. SRK did conclude that the load from MH-02 is "so small that it does not affect downgradient surface water quality" (SRK 2014d), but in absence of definitive evidence that the load is attenuated *before* reaching North Creek, the Tributary E drainage was kept in the AERA.

southwest of PH-1 is known as the 1380 Gully (see red outlined AEC upgradient/southwest of MW-13-13 on **Figure 1–2** or Figure 2-1 in the PF Addendum [Volume 1A]). There is no surface water connection between the gully and the origin of the spring at PH-1. Upgradient of the road near MH13-01 on **Figure 1–2** for at least 300 – 400 m the landscape consists of intact forest moss and lichen with no evidence of surface water flow. While metals from the Jewelbox and Main Zone mine workings are presumed to travel via groundwater to PH-1, SRK has documented attenuation of metals by marbled waste rock and native soil and there is currently no evidence that water quality at PH-1 has been adversely affected. Recent groundwater monitoring has not identified any influence on metals concentrations at PH-1 (Golder 2015a). Nevertheless, given that PH-1 is downgradient of mine source areas, and there is some uncertainty about the mine influence on this spring water, PH-1 cannot technically be designated as a background station for water quality or sediment. The two springs (CC-1 and PH-1) drain adjacent, but different watersheds and the chemical characteristics differ slightly from each other. Both streams meet within 100 m of their origin and flow downstream, past the Tailings Management Facility (TMF) and Mill Site.

Station MH-04 is the furthest upstream, long-term water quality monitoring station on Camp Creek. Because PH-1 and MH-04 are downgradient from disturbed lands (the 1380 adit and waste rock pile), MH-04 has been classified as an "exposure" station (Golder 2015a). However, given the absence of upgradient influence of metals at this station, it is considered an "upstream comparator" station, to compare against water quality and other data from Camp Creek stations further downstream that collect water drainage across the entire Mine Site.

As Camp Creek moves downstream it gathers surface water from local runoff, especially during freshet and snowmelt in May through early July, contributions from discrete sources (e.g., seeps, streams [Access and Portal creeks] and groundwater. Portal Creek receives intermittent, ephemeral surface runoff from the east slope of Jewelbox during freshet and joins with Camp Creek approximately 250 m downstream from the Reclaim Pond. Access Creek, which is located south of the Mine Site, drains an area west of the ERA reference station FF-Ref-2 (near MW13-04 on **Figure 1–2**; see also Figure 2-7 in the PF Addendum [Volume 1A]). MH-29 was established in 2013 on Access Creek, just upstream of the confluence with Camp Creek. Access Creek is not considered to be under mine influence, and for the purpose of the AERA was regarded as a reference creek in the 2014 sampling program.

The last point of long-term water quality monitoring in Camp Creek before joining with False Canyon Creek is MH-11, located approximately 3 km downstream from the Reclaim Pond. As part of the AERA sampling program in 2014, a sampling station was established at the confluence of Camp Creek and False Canyon Creek (CC-Confl). This location represents the total of the source loading and background contributions to water quality within the Camp Creek catchment area.

1.2.2. False Canyon Creek (Far-field)

There are three downstream monitoring locations on the main stem of False Canyon Creek for monitoring sediment quality, benthic invertebrate communities, and fish populations: MH-13, MH-16, and MH-20. MH-13 is approximately 10 km downstream of the Reclaim Pond and is the first station that has been monitored for sediment composition, benthic community and fish presence by Laberge and Can-Nic-A-Nick (2012). MH-14 was the original monitoring location stated in the Water Licence, but its location in a beaver/wetland complex caused flooding of the original site in 1996, and necessitated the relocation of the monitoring location 2 km downstream to MH-16. The area around MH-14 is no longer flooded, but in the pursuit of data consistency between years, sediment, benthic invertebrate and fish monitoring has continued at MH-16. Quarterly water quality sampling is, however, still undertaken at MH-14. The furthest sediment, benthic invertebrate, and fish monitoring location on False Canyon Creek is MH-20, located approximately 33 km downstream from the Reclaim Pond. **Figure 1–3** shows the locations of the water quality, sediment quality, benthic invertebrate, and fish monitoring locations downstream from the Mine Site.

1.2.3. Tributary E

Tributary E is the main catchment for water originating from the northern portion of the Mine Site, specifically the Burnick Zone and North Dam of the TMF. Water leaving the Burnick Zone goes to ground in close proximity to the discharge point. According to SRK (2014d) the general flow direction for water from the Burnick Zone is east-northeast towards the West Fork of Tributary E. Three water quality monitoring stations are located along the length of the West Fork: TRIBEWF01, TRIBEWF02, and MH-15. As described in the Initial Environmental Evaluation (IEE), the West Fork of Tributary E is characterized by a series of long slow glides with old beaver dams. The stream gradient was low with few riffle areas, and the substrate was noted as predominately comprised of fine sediment, with occasional patches of heavily silted cobble (SRK 1990).

Seepage / runoff from the North Dam enters a wetland area to the north and is inferred to travel as groundwater toward North Creek, which eventually merges with the north-flowing East Fork of Tributary E. Another small creek (Burnick Creek) drains the south facing slope of the North Hill area before merging with North Creek northwest of TMF. There are two long-term water quality monitoring locations for the East Fork of Tributary E drainage: MH-08 on Burnick Creek and MH-12 on North Creek. The baseline IEE reported that much of the Eastern Fork of Tributary E was a small glide-like channel approximately 1 to 2 m across flowing through a drowned marsh (SRK 1990). The survey of North Creek completed in 2014 as part of the near-field sampling program confirmed that much of the lower reach of North Creek near MH-12 still exists as a drown marsh.

1.3. Objectives

In general, ERA is a process that evaluates the likelihood and magnitude of adverse effects to ecological resources (e.g., plants, invertebrates, fish, and wildlife), as a result of exposure to one or more stressors (i.e., usually chemicals but may also include physical stressors). The ultimate goal of this AERA is to support risk management decision-making for the Sä Dena Hes site. With this in mind, specific objectives of this report are to:

1. Assess potential risks to ecological receptors (i.e., aquatic plants, aquatic invertebrates, fish, and amphibians) from exposure to mine-related contaminants/stressors in the aquatic environment and the terrestrial environment for some amphibians.
2. Support risk management planning by identifying any remaining gaps for the AERA and options for additional study or risk management to reduce uncertainty and/or risks from contaminants in the aquatic environment, if warranted.

Importantly we note that the PF and ERA have been advanced alongside site investigation work and mine closure activities. While this can result in additional uncertainty in the process, there was a need to compress timelines for site evaluation and regulatory approvals.

1.4. Document Organization

The AERA (**Volume 3**, this report) presents aquatic risk predictions, the rationale behind those predictions and implications for risk management. This Draft AERA is organized as follows:

Section 1: Introduction

- Provides background, objectives and the general approach for the Updated PF and AERA.

Section 2: Approach and Assumptions

- Summarizes the ERA approach and assumptions that are important for understanding the ERA process and findings.

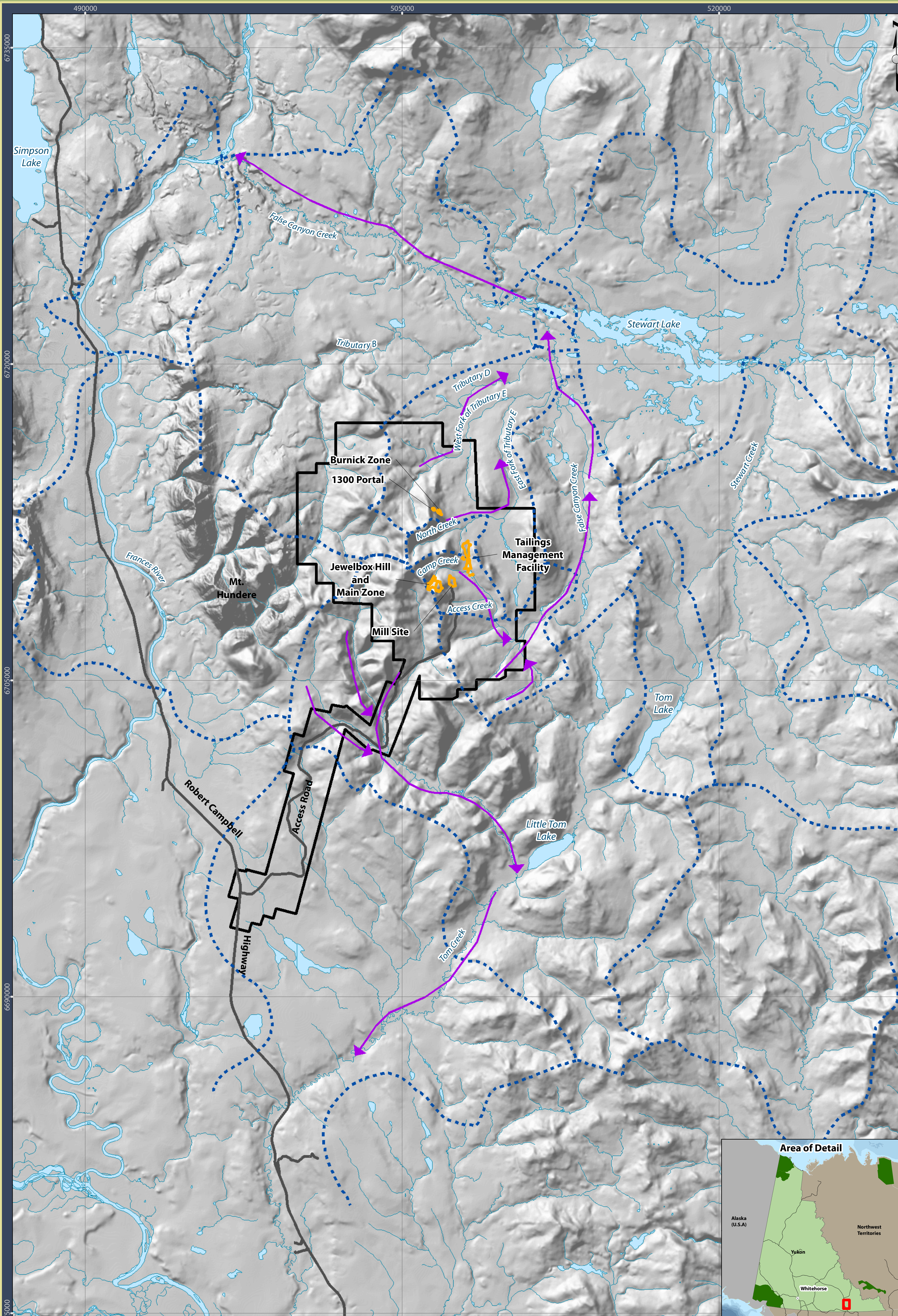
Section 3: Risk Characterization for the AERA

- Documents risks by AEC and by receptor group for aquatic plants/macrophytes, aquatic invertebrates, fish, and amphibians. Birds and mammals as receptor groups were addressed in Volume 2 and are not included in the AERA. Qualitative risk ratings (negligible, low, moderate, high) and associated uncertainty are provided based on a WOE assessment of the LOEs evaluated for each ROC group. An LOE technical appendix (**Appendix A**) documents the derivation of risk and uncertainty ratings.

Section 4: Implications for Risk Management

- Discusses role of the AERA relative to the Water Licence.

As described in the Notice to Readers, readers are referred to the Volume 1 PF (Azimuth 2014d) PF Addendum (Azimuth 2015a), Volume 2 TERA (Azimuth 2014e), and TERA Addendum (Azimuth 2015b) for further information on the Site, ERA history, and risks to terrestrial ecological receptors.



Legend

- Area of Environmental Concern (AEC)
- Water Flow Direction
- Catchment Areas
- Road
- Claim Boundary
- River/Stream
- Water

0 2 4 6
Kilometres

Projection: UTM Zone 9 NAD83

Data Sources:
Natural Resources Canada, GeoBase®
Teck Metals Ltd., Azimuth Consulting Group,

Figure 1-1: Watershed Boundaries and Flow Direction Sä Dena Hes Mine Site, Yukon Territory

Sä Dena Hes

Prepared for: AZIMUTH

By: CASLYS CONSULTING

June 9, 2015

Figure 1-2: Near-field Monitoring Locations for the Aquatic ERA at Sä Dena Hes Mine, Yukon Territory.

Sä Dena Hes

Prepared for: AZIMUTH

By: CASLYS CONSULTING

July 8, 2015

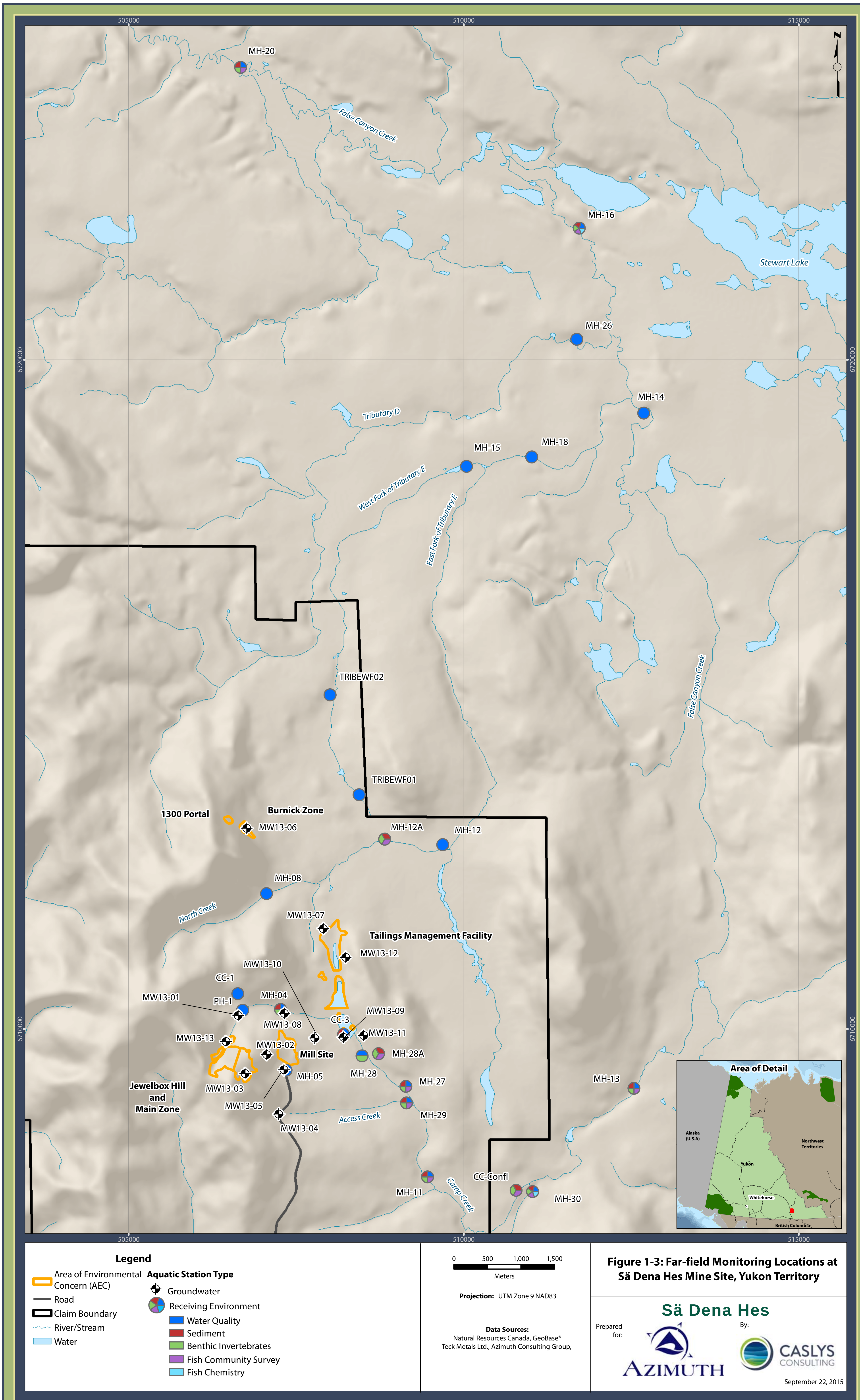
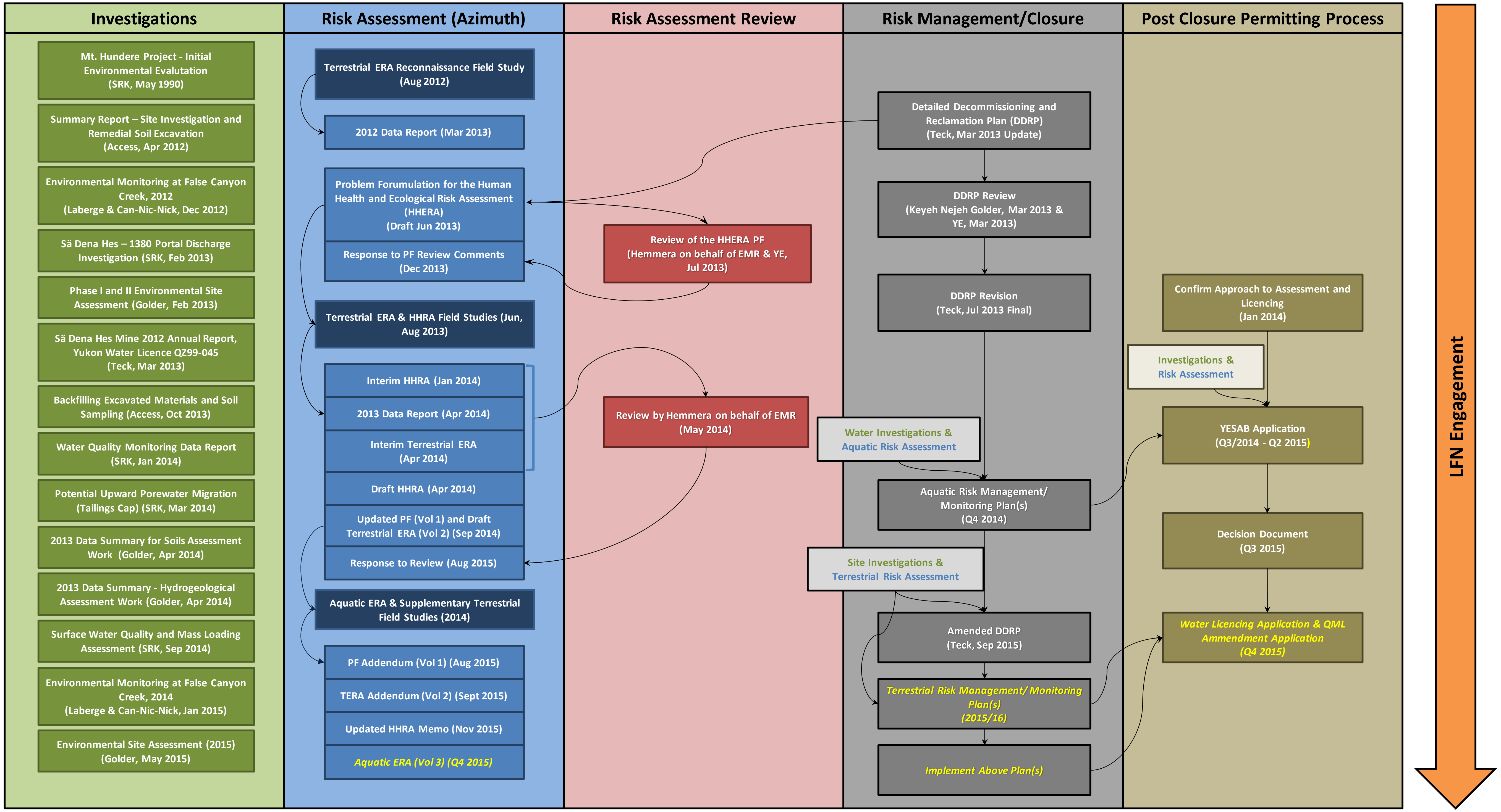


Figure 1-3: Far-field Monitoring Locations at Sä Dena Hes Mine Site, Yukon Territory

Table 1–1. Overall site closure process for the Sä Dena Hes mine, Yukon Territory with emphasis on environmental requirements and human health and ecological risk assessment (HHERA) process.



Notes

Items in white font have been completed.

Items in yellow font represent scheduled deliverables/activites, but have not yet been completed.

Dashed arrows represent anticipated items, but need to be determined pending current work.

Azimuth, November 19, 2015

2. APPROACH & ASSUMPTIONS

This section provides a summary of the approach and assumptions that are important for understanding the ERA process and findings.

2.1. General Approach

The approach taken for this Draft AERA relies on a formal risk assessment framework consistent with guidance from EY (2011), Environment Canada (EC 2012), and the Canadian Council of Ministers of the Environment (CCME 1996, 1997). In addition, guidance from other jurisdictions (i.e., British Columbia [SAB, 2008, 2010], and the US [USEPA 1998, 2007]), and from the scientific literature is relied upon where appropriate.

An Addendum to the PF, with supporting information, is reported as Volume 1A (Azimuth 2015a), and lays out the general approach for the AERA. The site-specific strategy and ERA components are described in **Section 2.2**. A key step of the ERA involved the detailed analysis of each LOE using the attributes and WOE criteria identified in Tables 5-2, and 5-3 of Volume 1, respectively (Azimuth 2014d). The methods, analyses, and results of all LOEs are provided in **Appendix A** of this document. The LOE results are then compiled into a summary table to help visualize findings by ROC and receiving environment in **Table 3–1** and **Table 3–2** for amphibians in terrestrial environments).

The main components for the ERA are shown below:

Subject	Location
LOE technical analysis	**Appendix A**
WOE risk characterization – Camp Creek, False Canyon Creek, and Tributary E	**Table 3–1**
WOE risk characterization – Terrestrial Environment for Amphibians	**Table 3–2**

Formal protection goals for the ERA were not identified *a priori*. Rather, the ERA attempts to characterize risks with all judgments of acceptability being made as part of a consultative process after the ERA is completed (as per EC 2012). That said, our risk predictions often implicitly consider protection goals typically associated for the receptors assessed herein (i.e., acceptable effect level [AEL] of 20% for common aquatic receptors and 10% for listed receptors). Our objective is to provide a thorough description of risk predictions and their uncertainties to support the risk management decision-making process.

2.2. Site-specific Strategy

In this section, we describe the strategy used for the AERA at Sä Dena Hes. The absence of near-field aquatic monitoring data, particularly for Camp Creek, was identified as a data gap in the Draft PF (Azimuth 2013). To address this data gap, the 2014 program was designed primarily to provide information on the spatial distribution of metals concentrations in sediment, the abundance and diversity of the benthic invertebrate community, and the presence of fish in near-field Camp Creek and North Creek, and augment historical information further downstream in False Canyon Creek. As well, a survey on amphibians was conducted but did not detect their presence. The AERA made use of existing data from various monitoring programs to the extent possible.

The general strategy for the AERA was:

1. Conduct a field program in 2014 to collect sediment, benthic invertebrate community samples, perform an aquatic habitat survey, determine fish presence/absence and collect fish tissue (if present) from various near-field Camp Creek water quality monitoring locations. Near-field Camp Creek stations were sampled by Azimuth personnel on June 24th – 25th, 2014. Water samples were also collected during this field program for use in toxicity tests with aquatic invertebrates and algae. A second field program was completed by Laberge in late August to gather data from lower Camp Creek, the headwaters of False Canyon Creek, and an additional reference location (see below for information on the stations).
2. Incorporate data on water and sediment chemistry, benthic invertebrate community, and fish community (1992 – 2014) from False Canyon Creek into the AERA.
3. Assess information from the individual studies/LOEs based on field surveys, chemistry data, toxicity testing and other tools to assess potential effects and causal relationships (**Appendix A**).
4. Characterize risks by receptor group/assessment endpoint. Risk conclusions are derived for Camp Creek, North Creek/Tributary E, and False Canyon Creek receiving environments.

   The locations of each station, downstream to False Canyon Creek are shown in **Figure 1–2** (near-field) and **Figure 1–3** (overview/far-field). **Table 2–1** presents the list of stations included in the AERA, a short description of the station, and the LOEs assessed at each location. A more detailed description of the physical habitat, including photographs from the stations sampled in 2014 is provided in **Appendix B**:

   - Reference Areas: MH-29 (Access Creek); MH-30 (unnamed reference tributary), CC-1 (reference stream on Mt Hundere); MH-26 (Tributary D)
   - Camp Creek & Portal Creek:
     - Camp Creek: PH-1, MH-04, CC-3, MH-28A, MH-27, MH-11, and the confluence of Camp Creek and False Canyon Creek (i.e., CC-Confl)
     - Portal Creek: MH-05, MH-28
   - North Creek & Tributary E: MH-12, MH-12A, TRIBEWF01, TRIBEWF02,
   - Far-field False Canyon Creek: MH-13, MH-14, MH-16, MH-20

- Terrestrial Areas of Environmental Concern (AECs): For amphibians specifically, risks are evaluated for aquatic environments (above), but also for terrestrial portions of the Site[5] including: Burnick/1300 Portal (AEC 2), Jewelbox/Main Zone/1380 Gully/1250 portal (AEC 1/9), Mill Site (AEC 3) and Tailings Management Facility (AEC 8). Readers are referred to Azimuth 2015a and 2015b for further information on the terrestrial environment.

5. Risks to aquatic receptors are assessed under current conditions based on the assumption that current water quality, which has been fairly consistent over many years of monitoring, is likely representative of future conditions in the downstream receiving environment (Section 6.9, in the PF [Azimuth 2014d]); long-term monitoring will be in place under the Water Licence to detect any changes in the future.

2.3. Receptors, Endpoints and Lines of Evidence (LOEs)

Assessment endpoints for the AERA remain unchanged from the Updated PF, and include\ the following for each receptor group:

- Aquatic Plants: Structure and ecological function (i.e., food and habitat for invertebrates, fish and wildlife) of vegetation communities are assessed by considering presence, percent cover and growth. The entity is assumed to be represented by the entire creek for Camp Creek, North Creek, and False Canyon Creek.
- Aquatic Invertebrates: Structure and ecological function (i.e., food for fish and wildlife) of invertebrate communities are assessed by considering abundance, richness, and biomass of aquatic invertebrate communities. The entity is assumed to be represented by the entire creek for Camp Creek, North Creek, and False Canyon Creek.
- Fish: Viability[6] of local fish populations[7] (for common species). The entity is assumed to be represented by the entire creek for Camp Creek, North Creek, and False Canyon Creek.
- Amphibians: Viability of local amphibian populations (for common species), and survival, reproduction, growth, and deformities of individual organisms[8] (for listed species).

[5] Note that amphibians may be exposed to contamination in both aquatic and terrestrial environments; results for all amphibian LOEs are reported in this document.

[6] We define viability as the ability of a population to sustain itself over the long term. We assume that assessing organism level attributes will be protective of population attributes.

[7] The assessment population consists of a group of conspecific organisms occupying a defined area that has been selected to serve as an assessment endpoint entity for the ERA (Barnthouse et al. 2008). The assessment population is operationally defined in the ERA as the local population, which consists of all organisms exposed to, or indirectly affected by, contaminants at the Site.

[8] The measurement endpoint is based on an average individual within a test population.

Below is a list of the LOEs for the AERA that were updated in Volume 1A (Azimuth 2015a, Table 3-4) to reflect changes that were made after the Updated PF was issued (Azimuth 2014d). Refer to **Appendix A** for analysis of LOEs that were included in the ERA for the aquatic environment.

- **Water chemistry** – The water chemistry LOE compares surface water chemistry data to CCME WQG and Yukon CSR standards for the protection of aquatic life. The data is evaluated for potential spatial gradients and extent of contamination patterns (if present) downstream of the Site. This LOE is used for aquatic plants, aquatic invertebrates, fish, and amphibians.
- **Sediment chemistry** – Compares the available sediment chemistry data against sediment criteria for the protection of aquatic life. The data is evaluated for potential spatial gradients and extent of contamination patterns downstream of the Site. This LOE is used for aquatic plants, aquatic invertebrates, fish, and amphibians
- **Amphibian soil screening benchmarks** – Soil chemistry data for lead is compared to amphibian-based toxicity values derived from the literature.
- **Aquatic habitat survey –** a field assessment of the suitability of aquatic habitat from a hydraulic (discharge, velocity, stream channel profile) and ecological perspective (sediment grain size and distribution, stability, barriers, etc.). This was not used as an LOE on its own but provided context for interpreting the fish and benthic invertebrate surveys; reported in **Appendix B**.
- **Field surveys** – surveys of the periphyton/macrophytes, benthic invertebrate, fish, and amphibian communities/populations:
  - **Periphyton/aquatic plant survey**: A qualitative assessment of the presence of aquatic plants and periphyton communities was made for stations in Camp Creek and North Creek. This LOE does not provide quantitative ratings for effect size and other metrics and is presented as a narrative in the WOE assessment.
  - **Benthic invertebrate community**: The benthic invertebrate field survey LOEs (Camp Creek/North Creek and False Canyon Creek) compares the abundance and richness of the benthic invertebrate community, with a focus on sensitive taxa, for assessing the structure and ecological function of the benthic invertebrate community. Additionally, any observed effects on benthic invertebrate community were qualitatively compared to water and sediment chemistry patterns to determine if effects are mine related.
  - **Fish population**: Comparison of total and relative abundance of fish species collected from stations in Camp Creek, North Creek, and False Canyon Creek. This LOE is presented as a narrative and does not provide quantitative ratings for effect size and other metrics.
  - **Amphibian survey**: The amphibian survey LOE was intended to compare species presence, abundance, condition and other endpoints in relation to habitat quality and COPC gradients in soil. However, as no amphibians were located during the survey, it did not inform on these metrics.

- **Tissue chemistry** – Fish tissue chemistry (sculpin) was measured at two stations: near the confluence of MH-30 and False Canyon Creek, and MH-16 (far-field exposure). Metal concentrations were compared between areas; no reference data are available.
- **Water toxicity testing - Acute** – Two acute toxicity tests were carried out on the aquatic invertebrate *Ceriodaphnia dubia*:
  - **Water Effect Ratio (WER) Testing**: WER testing was conducted to develop site-specific water quality objectives (SSWQO) for potential use in renewal of the Water Licence (see **Section 1.1**). The test endpoint was *Ceriodaphnia dubia* survival in the 48-hr tests on different concentration of aluminum, cadmium, chromium, copper, iron, lead, and zinc.
  - **Dilution Series Testing**: Two dilution series tests on MH-04 site water and a mixture of MH-04 and MH-25 (1380 Portal) were conducted to evaluate *C. dubia* survival over 7 days of exposure. Toxicity test results (and associated effects concentrations) were compared with concentrations at selected stations within Camp Creek, False Canyon Creek, and Tributary E to determine if metal concentrations associated with effects in the tests are reflective of water chemistry data downstream from the Site.
- **Water toxicity testing – Chronic** – The same dilution series tests mentioned above were conducted to evaluate the chronic response of 7-day *C. dubia* reproduction and 72-h *P. subcapitata* growth inhibition (cell yield) to different concentrations (dilutions) of site water.

Table 2-1. Receiving environment monitoring stations and lines of evidence (LOE) used in the aquatic ERA.

Station Code	Station Description	Water Chemistry	Sediment Chemistry	Benthic Invertebrate Community	Fish Tissue Chemistry	Fish Survey	Qualitative Habitat Survey (observations of aquatic plants)	Dilution Series Toxicity Testing[1]	Literature-based periphyton effects concentrations	WER Tests[1]
		Line of Evidence available for each Station								
Reference										
PH-1	Sampling location near the Pump House located upstream from MH-04. Considered the headwaters of Camp Creek	●								
CC-1	Small creek upstream of the confluence with Camp Creek that is unaffected by runoff from the 1380 Gully area	●								
MH-26[2]	Tributary D, upstream of confluence with False Canyon Creek	●								
MH-29	Located on Access Creek, upstream of Camp Creek	●	●	●		●	●			
MH-30	Reference station located on an unnamed tributary to FCC, approximately 3 km downstream from the Reclaim Pond	●	●	●	●	●	●			
Camp Creek										
MH-04	Camp Creek located immediately above the West Interceptor Ditch sample	●	●	●		●	●	●		●
CC-3	Downstream from MH-04 and upstream of the tailings area	●	●	●		●	●			
MH-28A	Downstream from MH-27 on Camp Creek, and just upstream of the confluence with Portal Creek		●	●		●	●			
MH-05	A small intermittent stream that drains the east side of the Jewelbox Hill	●								
MH-28	Located on Portal Creek upstream from the confluence with Camp Creek	●		●		●	●			
MH-27	Located downstream of the Reclaim Pond on Camp Creek, upstream from the confluence with Access Creek	●	●	●		●	●	●		●
MH-11	Camp Creek located approximately 3 km downstream of the tailing management facility	●	●	●		●	●	●	●	●
CC-Confl	Located at the downstream extent of Camp Creek where it joins with False Canyon Creek		●	●	●*	●	●			
False Canyon Creek										
MH-13	The main channel of False Canyon Creek, approximately 10 kilometres downstream of the reclaim pond	●	●	●		●	●	●	●	●
MH-14	The main channel of False Canyon Creek, approximately 20 kilometres downstream of the Reclaim Pond just upstream of the confluence with Tributary E	●								

Table 2-1. Receiving environment monitoring stations and lines of evidence (LOE) used in the aquatic ERA.

Station Code	Station Description	Line of Evidence available for each Station: Water Chemistry	Sediment Chemistry	Benthic Invertebrate Community	Fish Tissue Chemistry	Fish Survey	Qualitative Habitat Survey (observations of aquatic plants)	Dilution Series Toxicity Testing[1]	Literature-based periphyton effects concentrations	WER Tests[1]
False Canyon Creek										
MH-16	The main channel of False Canyon Creek, downstream of the confluence of Tributary D, approximately 22 kilometres downstream of the reclaim pond	●	●	●	●	●	●	●		●
MH-20	The main channel of False Canyon Creek, approximately 13 kilometres upstream of the mouth and immediately above the Tributary B confluence	●	●	●		●	●			
Tributary E										
MH-08	A small intermittent drainage south of the Burnick pit and portal sites which will consolidate drainage within a sediment pond from those sites as well as Burnick pit access road runoff; the drainage contributes to the upper end of Tributary E, east fork, of False Canyon Creek	●						●	●	●
MH-12 and MH-12A	Approximately 2 km downstream from the North Dam. **NOTE**: MH-12A was established as an ERA station upstream of MH-12 in 2014 in suitable habitat for stream sampling	●	●	●		●	●	●		●
TRIBEWF01	West Fork of Tributary E, upstream from TRIBEWF02	●								
TRIBEWF02	West Fork of Tributary E, downstream from the confluence with flow from SDH-BD-01	●								
MH-15	Upstream of the confluence with the east fork of Tributary E	●								
MH-18	Main stem of Tributary E, downstream from the confluence of the East Fork and West Fork, and approximately 1 km upstream from the confluence with False Canyon Creek									

Notes:

[1] Results from the dilution series and water effect ratio (WER) toxicity tests were compared to a subset of stations within each drainage.

[2] MH-26 has been monitored as MH-20 since 2010. MH-20 station name changed to MH-26 for data collected since 2010.

* Field staff (Laberge) noted that some fish were collected from the CC-Confl location near MH-30. Reference/exposure comparisons for the Fish Tissue LOE are not part of the AERA.

3. RISK CHARACTERIZATION AND UNCERTAINTY ASSESSMENT

3.1. Risk Predictions and Uncertainties

3.1.1. Aquatic Plant Communities

The assessment endpoint for aquatic plant communities is structure and ecological function and the entity (spatial scale) is assumed to be represented by the entire creek (i.e. Camp Creek, False Canyon Creek, and Tributary E). This assessment endpoint was evaluated using four LOEs (see Table 3–4 in Volume 1A [Azimuth 2015a]):

- **LOE 1 – Water chemistry:** Compare water chemistry to guidelines for protection of aquatic life. Evaluate spatial gradients and extent of contamination patterns.
- **LOE 2 – Sediment chemistry:** Compare sediment chemistry data to criteria and guidelines for protection of aquatic life. Evaluate spatial gradients and extent of contamination patterns.
- **LOE 3 – Qualitative periphyton/aquatic plant survey:** Qualitative documentation of presence, and percent composition of the macrophyte community in relation to habitat/stream variables and water quality (COPC gradient).
- **LOE 4 – Water toxicity testing:** Compare growth in 72-hr *Pseudokirchneriella subcapitata* test across a gradient of COPC exposure in water (dilution series compared to upstream water and laboratory control).
- **LOE 5 – Literature-derived effects thresholds for periphyton:** Compare zinc concentrations at selected locations downstream from the Site to concentration-response relationships derived from Hill et al., 2000 for various periphyton endpoints in a field study.

Evaluation of these LOEs was conducted in detail in **Appendix A**. Overall risk conclusions for this receptor group were based on a WOE evaluation of the five LOEs (see **Table 3–1**); the water toxicity testing LOE (LOE 4) was given the highest LOE weighting particularly given the limited application of the field survey (LOE 3).

Camp Creek – Potential risks to aquatic plant communities are considered low-to-moderate (based on location) with a high degree of uncertainty based on the following LOE findings and WOE assessment:

- Camp Creek was rated moderate for water and sediment contaminant exposure, with the highest concentrations of COPCs reported downstream from the former Reclaim Pond at MH-11.
- Effects to aquatic plant communities were undetermined the qualitative habitat survey. No rooted aquatic macrophytes were observed throughout Camp Creek, consistent with the habitat characteristics of lotic environments (see **Appendix B** for photographs of the habitat). However, the presence of a diverse benthic invertebrate community throughout Camp Creek (see **Section 3.1.2**) suggests that there is likely a functional primary producer community (i.e., periphyton) present; uncertainty is considered moderate because this is not a direct assessment of the plants themselves.

- Effects concentrations for *P. subcapitata* cell yield in the mixture toxicity test compared to the 95th percentile COPC concentrations at the Camp Creek stations indicate there is the potential for adverse effects to aquatic primary producers in some reaches of Camp Creek. The highest effects were predicted for lower Camp Creek (MH-11) in the winter months (December to May) prior to freshet (**Figure A11-5**). After freshet (June), the concentrations of zinc decrease, resulting in generally negligible-to-moderate predicted effects to *P. subcapitata* cell yield. Farther upstream at MH-04 (referred to as Upper Camp Creek) zinc concentrations were in the negligible-to-low effect range for most months from 2013 dating back to 1999. There is a moderate degree of uncertainty associated with this LOE because of the unknown species sensitivity of *P. subcapitata* compared with the resident periphyton community in Camp Creek.
- Zinc concentrations at MH-11 compared to the effects thresholds from the periphyton field study by Hill et al.,2000 indicate that there is the potential for low level (10% to 20%) reductions of chlorophyll-a (functional change) and species richness (structural change). There is a high degree of uncertainty for this LOE because the effects thresholds were derived from the literature and it is unknown whether the periphyton communities downstream of Sä Dena Hes have similar sensitivity.
- WOE Integration – The risk characterization presented in **Table 3–1** for the Camp Creek aquatic primary producer receptor group is separated into Upper and Lower Camp Creek because of the spatial-differences in risk ratings concluded in the WOE assessment. Zinc concentrations were high enough downstream from the Site at MH-11 during the winter months (2007 to 2013) to potentially cause a high level of adverse effects on cell yield. However, during key summer algal growing months, potential effects at MH-11 were in the negligible-to-moderate category. While weighted the highest, the toxicity LOE is associated with a moderate level of uncertainty when extrapolating from the laboratory to the field (i.e., uncertainty regarding the sensitivity of *P. subcapitata* compared to the resident periphyton community). Compared with literature-based effects thresholds, the zinc concentrations at MH-11 were predicted to have only low (10-20%) reductions in chlorophyll-*a* production and species richness. These results are in line with the results of the toxicity tests that predict the possibility of reduced *P. subcapitata* cell yield at MH-11. The presence of a diverse benthic invertebrate community (i.e., numerous sensitive taxa) in Camp Creek provides evidence of functional primary producer community in Camp Creek, but was not a direct measure of aquatic plants. Overall, risks were rated as moderate and uncertainty is considered high for lower Camp Creek, because there is high likelihood that additional data (e.g., quantitative periphyton survey) could change the overall risk rating for aquatic plants. Risks to aquatic plant communities in Upper Camp Creek (MH-04) are considered negligible to low.

False Canyon Creek – Potential risks to aquatic plant communities are considered negligible with a low degree of uncertainty based on the following LOE findings and WOE assessment:

- Chemistry LOEs in False Canyon Creek were rated as moderate for water and low for sediment, with the highest COPC concentrations reported for MH-13.

- The qualitative aquatic plant survey was not completed in the False Canyon Creek drainage. While benthic invertebrate results are more uncertain, the presence of a fairly diverse benthic invertebrate community in False Canyon Creek (see **Section 3.1.2**) suggests that there is likely a functional primary producer community (i.e., periphyton) present; uncertainty is considered moderate because this is not a direct assessment of the plants themselves.
- Effects concentrations for *P. subcapitata* cell yield in the mixture toxicity test were higher than the 95th percentile COPC concentrations at the False Canyon Creek stations, indicating there is a limited (negligible) potential for adverse effects to aquatic primary producers in False Canyon Creek. While general uncertainty associated with this LOE is considered moderate, this LOE tends to be conservative because laboratory organisms are typically more sensitive than resident organisms that have been acclimated to higher metals concentrations in the field. Therefore, the likelihood that potential effects have been missed under field conditions is considered low.
- Zinc concentrations at MH-13 are well below the concentrations shown to cause effects to periphyton biomass, chlorophyll-a production, autotrophic index, and species richness in the survey published by Hill et al. (2000). A negligible magnitude rating was applied to the aquatic plant receptor group in False Canyon Creek, with moderate uncertainty for reasons described previously in the Camp Creek aquatic plant summary.
- WOE Integration – 95th percentile COPC concentrations (specifically zinc) in the water samples from False Canyon Creek were below the concentrations shown to cause effects in the mixture toxicity test and the literature-based endpoints; this resulted in a negligible rating of risk. Uncertainty was considered low because the laboratory-based toxicity LOE tends to be a conservative measure of potential effects in the field. The toxicity LOE was weighted higher than the surface water and sediment chemistry LOEs in the overall WOE assessment for potential effects to aquatic plant communities in False Canyon Creek. The presence of a fairly diverse and abundant benthic invertebrate community in False Canyon Creek also suggests a functional primary producer community is present.

Tributary E – Potential risks to aquatic plant communities are considered low with a moderate degree of uncertainty based on the following LOE findings and WOE assessment:

- The exposure assessment in Tributary E was moderate for water and low for sediment.
- The qualitative aquatic plant survey was completed in North Creek at MH-12A where the benthic invertebrate sample was collected. Similar to Camp Creek, there were no rooted aquatic macrophytes, as was expected for this drainage. The substrate at MH-12A was primarily cobble and gravel, and there was visual evidence of a periphyton community present along the length of the reach (see **Appendix B,** Photo 17). The presence of a diverse and abundant benthic invertebrate provides supporting evidence of a functional aquatic primary producer community in North Creek; uncertainty is considered moderate because this is not a direct assessment of the plants themselves.

- Mixture toxicity test results indicated that 95th percentile zinc concentrations at MH-08 in Burnick Creek were within the low effects range for reduced *P. subcapitata* cell yield. Using monthly historic water quality (199-2013), potential effect-sizes range from negligible-to-high, but appear to be lower (negligible) in recent years (**Figure A11-5**). At the next closest station on North Creek (MH-12), the risk was considered negligible, suggesting that any potential adverse effect to aquatic plant communities is limited in spatial extent. There is a moderate degree of uncertainty associated with this LOE because of the unknown species sensitivity of *P. subcapitata* compared with a possible resident periphyton community in Tributary E.

- Zinc concentrations at MH-08 are well below the concentrations shown to cause effects to periphyton biomass, chlorophyll-*a* production, autotrophic index, and species richness in the survey published by Hill et al. (2000). MH-08 is the farthest upstream station in the Tributary E drainage and has the highest metals concentrations in Tributary E, so potential effects further downstream in Tributary E are considered unlikely.

- WOE Integration – Tributary E aquatic plant communities are at low risk (with moderate uncertainty) of effects based on the WOE assessment. The toxicity testing LOE indicated a low potential risk to aquatic plants, with a small spatial extent limited to Burnick Creek. Zinc concentrations were below effects thresholds for periphyton based on the literature study. Furthermore, the presence of a fairly diverse and abundance benthic invertebrate community in North Creek, and visual observations of periphyton, imply minimal (if any) effects from the mine on primary producers in this drainage.

3.1.2. Aquatic Invertebrates

The assessment endpoint for aquatic invertebrates is structure and ecological function of the benthic invertebrate communities. The spatial scale/entity are the receiving environments downstream from the mine: Camp Creek, False Canyon Creek, and Tributary E. This assessment endpoint was evaluated using five LOEs (see Table 3–4 in Volume 1A [Azimuth 2015a]):

- **LOE 1 – Water chemistry:** Compare water chemistry to guidelines for protection of aquatic life. Evaluate spatial gradients and extent of contamination patterns.

- **LOE 2 – Sediment chemistry:** Compare sediment chemistry data to criteria and guidelines for protection of aquatic life. Evaluate spatial gradients and extent of contamination patterns.

- **LOE 3 – Benthic invertebrate survey:** Quantitative evaluation of the benthic invertebrate community assemblages downstream from the mine site.

- **LOE 4 – Water effects ratio (WER) testing:** Comparison of acute toxicity testing endpoints for *Ceriodaphnia dubia* from parallel toxicity tests using laboratory water and site water to determine whether the site water characteristics modify contaminant bioavailability and potential toxicity.

- **LOE 5 – Water toxicity testing – chronic:** Comparison of 7-day *Ceriodaphnia dubia* survival and reproduction across a gradient of COPC exposure in water (dilution series compared to upstream water and laboratory control; acclimation included in study design).

Evaluation of each of these LOEs was conducted in detail in **Appendix A**. Overall risk conclusions for this receptor group were based on a WOE evaluation of the five LOEs (see Table 3–1). The benthic invertebrate survey LOE (LOE 3) was generally considered to have the highest LOE weighting, with consideration of toxicity-based LOEs 4 and 5.

Camp Creek – Potential risks to aquatic invertebrates from mine related impacts are considered low with a moderate degree of uncertainty based on the following LOE findings and WOE assessment:

- Camp Creek was rated moderate for water and sediment contaminant exposure, with the highest concentrations of COPCs reported downstream from the former Reclaim Pond.
- Effects to benthic invertebrates based on the 2014 data were considered negligible to low (depending on the station) with high uncertainty. Reduced benthic invertebrate total abundance relative to reference was observed in the downstream portion of Camp Creek from below the former Reclaim Dam at MH-28A to MH-11; however, the reduced abundance was not observed in EPT taxa, suggesting the effect is likely due to habitat suitability and/or modified flow due to annual dewatering of the Reclaim Pond.
- Mixture toxicity test results on *C. dubia* indicate there is potential for low level effects to survival downstream from the Site at MH-11. Zinc was identified as the likely cause of the observed toxicity in the mixture test, and low effects concentration (10-20% reduction in survival) was similar to the 95th percentile zinc concentration reported at MH-11 (0.14 mg/L). This concentration of zinc also corresponded to a high effect (>50%) on *C. dubia* reproduction. Farther upstream at MH-04 and MH-27, the effect was negligible on survival, and low for reproduction. Uncertainty for this LOE was considered moderate.
- WOE Integration – The benthic invertebrate community LOE assessment provides the strongest evidence of a relatively functional and diverse aquatic invertebrate community in Camp Creek (negligible to low effects with high uncertainty). Toxicity test results on *C. dubia* indicated the *potential* for adverse effects to aquatic invertebrates, but the spatial scale was limited primarily to lower Camp Creek (MH-11) and extrapolating laboratory results to the field is considered to have higher uncertainty than direct field measurements. Overall risks are considered low with moderate uncertainty.

False Canyon Creek – Potential risks to benthic invertebrates in False Canyon Creek are considered low with a moderate degree of uncertainty based on the following WOE assessment:

- There is an upstream to downstream trend in water and sediment chemistry in False Canyon Creek. MH-13 had higher metals concentrations than MH-16 and MH-20 and was rated as "moderate" for water chemistry and "low" for sediment chemistry.

- Effects to benthic invertebrates determined from the long-term field monitoring program (Laberge 2015) were considered moderate with high uncertainty based on lower EPT/sensitive taxa metrics at MH-13 versus downstream stations. Qualitative comparisons to Camp Creek stations (MH-11/CC-Confl and the MH-30 reference) did not indicate impairment at MH-13. Importantly, Laberge (2015) documents important habitat/physical stream characteristics that explain the differences in benthic invertebrate assemblages between the three monitoring stations. Based primarily on habitat and comparisons to water toxicity thresholds (next bullets), the relationship between effects (difference in EPT) and metals chemistry is not considered causal in the False Canyon Creek study. Data supporting stronger comparisons to Camp Creek stations and an outside reference would reduce uncertainty in risk ratings.
- Dilution toxicity test results on *C. dubia* indicate there is negligible potential for effects (with moderate uncertainty) to survival or reproduction at MH-13 and further downstream in False Canyon Creek. Similarly, the WER toxicity testing results on *C. dubia* indicate water chemistry at MH-13 and further downstream in False Canyon Creek is in the "no-effect" range; indicating negligible potential for effects to invertebrates in False Canyon Creek.
- WOE Integration – The benthic invertebrate community LOE indicated that there are lower EPT/sensitive taxa indices at MH-13 relative to the downstream locations, but there is a high degree of uncertainty regarding the cause of the reduced number of sensitive taxa. Water quality data compared to the toxicity testing benchmarks suggest there is likely no effect on the False Canyon Creek benthic invertebrate community due to metals in the surface water. Multiple years of data, combined with knowledge of the habitat conditions, strongly suggest that any difference in the number of sensitive taxa or EPT indices at MH-13 is due to the habitat and stream characteristics at this location.

Tributary E – Potential risks to benthic invertebrates in Tributary E are considered low with a moderate degree of uncertainty based on the following WOE assessment:

- Tributary E was rated moderate for water chemistry and low for sediment contaminant exposure. Burnick Creek (MH-08) was the station responsible for the moderate exposure rating for water chemistry. The two other stations in Tributary E had surface water COPC concentrations that were rated negligible-to-low for exposure (based on the 95^{th} percentile), but data are limited (**Appendix A**).
- Effects to benthic invertebrates based on the 2014 field survey were considered moderate with high uncertainty. The highest abundance was observed at MH-12A in North Creek in the June 2014 survey, but the abundance of EPT individuals and the number of EPT taxa were lower relative to the reference location. A high level of uncertainty was associated with the LOE rating because of the limited dataset (1 year) and uncertainty about the suitability of comparing the benthic invertebrate community at MH-12A with the reference location MH-29 on Access Creek due to potential confounding effects of habitat differences between the two locations.

- Results of the Dilution and WER toxicity tests on *C. dubia* indicate there is negligible to low risk (with moderate uncertainty) of effects to aquatic invertebrates in North Creek, and by extension, farther downstream in Tributary E. No effects were observed in the WER tests at concentrations corresponding to the 95th percentile at MH-08 or the maximum concentration at MH-12. Low level effects were predicted for *C. dubia* reproduction at MH-08 when compared to the zinc concentration that caused adverse effects in the Mixture test. Downstream at MH-12, the zinc concentration was within the negligible effects range (i.e., no effects on *C. dubia* reproduction relative to the control).
- WOE Integration – With the exception of Burnick Creek, the available chemistry data in Tributary E indicated low risk of exposure with moderate uncertainty. Reduced EPT abundance relative to the reference areas was observed in the single sample collected from MH-12A on North Creek in 2014, but water quality data from Burnick Creek (MH-08) and North Creek (MH-12) compared to the toxicity testing benchmarks in the Dilution and WER tests indicate negligible-to-low risks for aquatic invertebrates in this drainage. Overall, the low risk rating (with moderate uncertainty) was considered appropriate given the inconsistency in effects ratings between the benthic invertebrate community and toxicity testing LOEs.

3.1.3. Fish

The assessment endpoint for fish is viability of local fish populations. This assessment endpoint was evaluated using six LOEs as follows (see Table 3–4 in Volume 1A [Azimuth 2015a]):

- **LOE 1 – Water chemistry:** Compare water chemistry to guidelines for protection of aquatic life. Evaluate spatial gradients and extent of contamination patterns.
- **LOE 2 – Sediment chemistry:** Compare sediment chemistry data to criteria and guidelines for protection of aquatic life. Evaluate spatial gradients and extent of contamination patterns.
- **LOE 3 – Fish tissue chemistry:** Compare near-field vs far-field site fish tissue chemistry data.
- **LOE 4 – Water toxicity testing (acute):** Survival of rainbow trout (96-hr static test using rainbow trout (*O. mykiss*) exposed to mine site source water (MH-06A or MH-06B) collected as part of Teck's Water License program.
- **LOE 5 – Fish habitat survey:** Comparison of total and relative abundance of fish species collected from stations in relation to habitat/stream variables and water quality (COPC gradient) in Camp Creek and False Canyon Creek.
- **LOE 6 – Aquatic plant and invertebrate LOEs:** See LOEs for aquatic plants and invertebrates; fish are also assessed indirectly via health of benthic communities upon which they rely for food.

Evaluation of each LOE was conducted in detail in **Appendix A**, and considered the risk-characterization stage attributes (Table 5-2 in the Volume 1 [Azimuth 2014d]). Overall risk conclusions and uncertainties were obtained by integrating all six LOEs (provided below and in **Table 3–1**); the fish habitat survey

(LOE 5) was generally considered to have the highest LOE weighting, with consideration of fish tissue chemistry (LOE 3) and toxicity testing (LOE 4).

Camp Creek – Potential risks to fish are considered negligible with a low degree of uncertainty based on the following LOE findings and WOE assessment:

- Fish are not expected to be present in Camp Creek due to a lack of suitable habitat and barriers to fish access. No fish were captured from Camp Creek during the June 2014 survey between MH-04 to MH-11. Historic fish data from Camp Creek is limited to one location sampled in the Baseline IEE completed by SRK in the fall and spring of 1989, and no fish were captured. Fish have been recorded as far upstream as the confluence of Camp Creek and False Canyon Creek, but based on the available surveys and knowledge of the habitat in Camp Creek and False Canyon Creek, it is unlikely that Camp Creek would support a permanent fish community (see **Appendix B** [this report], SRK 1990, and Laberge 2015).
- Even if fish were present in Camp Creek, the quarterly rainbow trout LC50 toxicity tests suggest negligible potential effects (but high uncertainty). No mortalities have been observed in the on whole-effluent tests from the Reclaim Pond (MH-06A) dating back to 2002. However, extrapolating the LC50 results from MH-06A to Camp Creek has high uncertainty for MH-11, because surface water concentrations are higher than at MH-06A; other stations (MH-04) are more similar to MH-06A.
- Camp Creek was rated moderate for water and sediment contaminant exposure, with the highest concentrations of COPCs reported downstream from the former Reclaim Pond.
- We note that near-field tissue concentrations (from the confluence of Camp Creek with False Canyon Creek) were considered to be highly elevated relative to far-field tissues, with lead concentrations in near-field fish approximately 10 times higher than in far-field fish. (This LOE is included under False Canyon Creek, but is mentioned here for context).
- Aquatic invertebrate LOEs suggest low potential risks with moderate uncertainty for COPC-related impacts to fish food in Camp Creek. There was some reduced total abundance in the downstream portion of Camp Creek relative to reference areas that were attributed to habitat or stream characteristics.
- WOE Integration – The absence of fish from Camp Creek in 2014 is consistent with findings from the baseline IEE (SRK 1990) and with known habitat preferences for the various species found farther downstream (e.g., slimy sculpin, Arctic grayling). It is not expected that Camp Creek would support a permanent fish community, largely due to the absence of cover and suitable areas to overwinter. Furthermore, there are numerous barriers to fish migration in the upper reaches of False Canyon Creek that likely impede fish migration (Laberge 2015). As a result, risks to fish in Camp Creek are considered negligible with low uncertainty.

  If fish populations were to be present in the system in the future, contaminant-related effects are still considered unlikely and based on available information risks would be rated low with moderate uncertainty in light of the LC50 toxicity test results compared to the surface water chemistry in Camp Creek, and expected elevations in tissue concentrations of metals.

False Canyon Creek – Potential risks to fish are considered low with a moderate degree of uncertainty based on the following LOE findings and WOE assessment:

- False Canyon Creek was rated moderate for water chemistry and low for sediment contaminant exposure.
- Near-field tissue concentrations (Camp Creek and False Canyon Creek confluence) were considered to be highly elevated relative to far-field tissues, with lead concentrations in near-field fish approximately 10 times higher than in far-field fish. This LOE has moderate uncertainty for extrapolating to a measure of effects.
- As discussed above, no mortalities have been observed in the quarterly rainbow trout LC50 toxicity tests on whole-effluent from the Reclaim Pond (MH-06A) dating back to 2002. Extrapolating the LC50 results from MH-06A to False Canyon Creek has moderate uncertainty, but long-term surface water concentrations (95^{th} percentile) for most COPCs at the farthest upstream location MH-13 are similar to MH-06A (see **Appendix A**, **Section 11.2.4**). Only iron was elevated at MH-13 relative to concentrations at MH-06A.
- Fish community data (species presence / absence) shows similar species are present in False Canyon Creek. The absolute number of individual fish captured has varied over-time, but the catch data show a relatively stable fish community is present in False Canyon Creek as far as MH-13.
- Aquatic invertebrate LOEs suggest low potential risks with moderate uncertainty for COPC-related impacts to fish food in False Canyon Creek.
- WOE Integration – Fish species presence / absence in False Canyon Creek has been relatively consistent dating back to 1992. The overall numbers of each species at the monitoring locations varies among years, but there do not appear to be long-term trends in reduced catch for the various species at MH-13, MH-16, or MH-20. Year-over-year differences in the absolute number of fish captured seem to be primarily due to changes in water levels, particularly for MH-13. No toxicity testing has been carried out on fish using water from False Canyon Creek, but a comparison of the long-term surface water chemistry in False Canyon Creek to the LC50 monitoring location at the former Reclaim Pond implies effects to fish are unlikely. Overall, risks were considered low (rather than negligible) with moderate uncertainty because near-field tissues were 10 times higher in lead than far-field fish.

Tributary E – Potential risks to fish are considered negligible with a low degree of uncertainty based on the following LOE findings and WOE assessment:

- No fish were captured from North Creek during the June 2014 survey. Historic fish data from 1989 reported in the Baseline IEE documents fish presence downstream in Tributary E. Based on the available surveys and knowledge of the habitat in Camp Creek and False Canyon Creek, it is unlikely that North Creek would support a permanent fish community (see **Appendix B** [this report], SRK 1990, and Laberge 2015).

- As discussed above, no mortalities have been observed in the quarterly rainbow trout LC50 toxicity tests on whole-effluent from the Reclaim Pond (MH-06A) dating back to 2002. Extrapolating the LC50 results from MH-06A to stations in Tributary E has moderate uncertainty, but long-term surface water concentrations (95th percentile) for most COPCs at MH-08 (Burnick Creek) are similar to MH-06A. Aluminum, chromium, and iron are historically higher at MH-08 relative to MH-06A (see **Appendix A** [Section 11]), but this location represents the "worst-case" station in the Tributary E drainage; water quality improves farther downstream at MH-12 (Table A2-2; **Appendix A**).
- Tributary E was rated moderate for water chemistry and low for sediment contaminant exposure.
- Aquatic invertebrate LOEs suggest low potential risks with moderate uncertainty for COPC-related impacts to fish food in Tributary E.
- WOE Integration – No fish were captured from North Creek in 2014. It is not expected that the upstream portion of North Creek would support a stable fish community, but baseline information in the IEE (SRK 1990) shows the downstream Tributary E environment is fish bearing. Risks to fish under current conditions are considered negligible with a low degree.

  If fish populations were to be present in the system in the future, contaminant-related effects are still considered unlikely and based on available information risks would be rated low with moderate uncertainty in light of the LC50 toxicity test results compared to the surface water chemistry in Burnick Creek, North Creek and Tributary E.

3.1.4. Amphibians

The assessment endpoint for common amphibian species is viability[9] of local amphibian populations[10]. For listed species, the assessment endpoints are survival, reproduction, growth, and deformities of individual organisms[11]. There were two amphibian ROCs identified in the PF – the wood frog, which prefers aquatic habitats and the western toad, which prefers terrestrial habitats. Wood frogs were observed in the Tailings Ponds in 2013, but with the draining of the ponds for closure, amphibians are now more likely present in on-Site marshy areas and terrestrial AECs (rather than creeks). However, to be conservative, and because ponded wetland beaver habitats may occur downstream of the Site (and locations may vary

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[9] We define viability as the ability of a population to sustain itself over the long term. We assume that assessing organism level attributes (e.g., growth and fecundity) will be protective of population level attributes (e.g. abundance).

[10] The assessment population consists of a group of conspecific organisms occupying a defined area that has been selected to serve as an assessment endpoint entity for the ERA (Barnthouse et al. 2008). The assessment population is operationally defined in the ERA as the local population, which consists of all organisms exposed to, or indirectly affected by, contaminants at the Site.

[11] The measurement endpoint is based on an average individual within a test population.

overtime), we have included an assessment of amphibians in creeks downstream of the Site in the AERA. The assessment, however, relies on chemistry LOEs and invertebrate food sources for amphibians, with high uncertainty in risk conclusions. Risk management decision-making in the aquatic environment is assumed to be driven by the other ROCs. More emphasis was placed on assessing amphibians (western toad) in 'terrestrial' portions of the site (see LOEs 3, 4 and 5 below). The Site is at the northern edge of the western toad's range and it has not been documented on-Site. However, if it is present on-Site, the toad may inhabit many terrestrial habitats, including the subalpine and alpine areas (COSEWIC, 2012). The spatial scale/entity is assumed to be represented by the creeks and terrestrial AECs (Volume 1A [Azimuth 2015a]).

This assessment endpoint was evaluated using three LOEs for aquatic amphibians/life stages, and three LOEs for terrestrial amphibians/life stages considering current and future conditions as appropriate (see Table 3–4 in Volume 1A [Azimuth 2015a]):

- **Aquatic Amphibians/Life-stages**
    - **LOE 1 – Water chemistry:** Compare water chemistry to guidelines for protection of aquatic life. Evaluate spatial gradients and extent of contamination patterns. We also bring in information from a recent meta-analysis of amphibian water-based toxicity data (Liu 2015).
    - **LOE 2 – Sediment chemistry:** Compare sediment chemistry data to criteria and guidelines for protection of aquatic life. Evaluate spatial gradients and extent of contamination patterns.
    - **LOE 4 – Aquatic invertebrate LOEs:** See LOEs for aquatic and soil invertebrates; amphibians are also assessed indirectly via health of invertebrate communities upon which they rely for food.
- **Terrestrial Amphibians/Life-stages**
    - **LOE 3 – Soil-based effects thresholds for amphibians compared with soil chemistry:** Compare soil lead concentrations from the Site to effects-based amphibian thresholds from the literature.
    - **LOE 4 –Terrestrial invertebrate LOEs:** See LOEs for aquatic and soil invertebrates; amphibians are also assessed indirectly via health of invertebrate communities upon which they rely for food.
    - **LOE 5 – Qualitative amphibian survey:** The intention was to compare species presence, abundance, condition and other endpoints in relation to habitat quality and COPC gradients in soil, water and/or sediment. However, no amphibians were observed during the survey, likely due to low abundance and/or survey timing; but they are expected to be present on-Site. As a result, this LOE is included only qualitatively.

Evaluation of each of these LOEs was conducted in detail in **Appendix A** and considered the risk-characterization stage attributes (Table 5-2 in the Volume 1 [Azimuth 2014d]). Updated risk predictions and uncertainties obtained by integrating the appropriate LOEs for aquatic and terrestrial amphibians/life stages are provided below (see also **Table 3–1** [aquatic], and **Table 3–2** [terrestrial]). For aquatic amphibians, more weighting was placed on the chemistry LOEs, including recent information from a study on water-based amphibian toxicity thresholds for three of the main aquatic COPCs at the site – cadmium, lead and zinc (see below). For terrestrial amphibians, results of the comparison of soil chemistry to soil-based effects thresholds was given the most weight in the WOE risk characterization.

3.1.4.1. Aquatic Amphibians/Life-stages

Camp Creek – Potential risks to aquatic amphibians/life stages are considered to range from low to moderate, with a high degree of uncertainty, based on the following WOE assessment:

- Water and sediment chemistry were evaluated for this receiving environment and both media were considered to be moderately elevated above CCME guidelines and CSR standards (particularly for cadmium, lead, and zinc). We note that a recent study compiled literature on amphibian water-based toxicity tests to develop concentration-response relationships for cadmium, lead, mercury and zinc. The amphibian data compilation included studies evaluating malformation and mortality endpoints. While considered preliminary, this study suggests that, based on available information, generic water quality guidelines are generally conservative, relative to effects "thresholds"[12] for amphibians (Liu 2015). Comparing amphibian "thresholds" for cadmium (0.010 mg/L), lead (0.030 mg/L) and zinc[10] (0.56 mg/L) to concentrations in receiving water suggests effects to amphibians are unlikely, with the possible exception of lead at MH-11 (95th percentile of 0.046 mg/L):

COPC	Amphibian "Thresholds" (mg/L)	95th Percentile Concentration in Receiving Environment Stations (mg/L)			
		MH-04 Upper Camp Creek	**MH-11** Lower Camp Creek	**MH-08** Burnick Creek	**MH-13** False Canyon Creek
Cadmium	0.010	0.00038	0.00075	0.00017	0.00028
Lead	0.030	0.020	0.046	0.0063	0.0069
Zinc	0.56	0.032	0.14	0.024	0.013

- Aquatic invertebrate LOEs suggest low potential risks with moderate uncertainty for COPC-related impacts to amphibian food (i.e., abundance of invertebrates is not impaired).

[12] Thresholds were set by Azimuth based on the Liu 2015 data, as the concentration below which the bulk of data did not show effect sizes above 20%, and above which, the bulk of data showed effect sizes above a 20% level. We note that for zinc, there were two studies (with a total of four treatments) showing 50% effect sizes at concentrations between 0.01 and 0.08 mg/L zinc. However, the vast majority of treatment concentrations associated with toxicological responses above a 20% effect size were above 0.56 mg/L zinc, which was selected here as the "threshold".

False Canyon Creek – Potential risks to aquatic amphibians/life stages are considered low, with a high degree of uncertainty, based on the following WOE assessment:

- The water chemistry LOE was rated as moderate (for upstream MH-13) to low (for downstream MH-16 and MH-20), based on exceedances of iron, lead, aluminum, chromium, copper and selenium. However, amphibian thresholds for cadmium, lead and zinc (see above) were higher than 95th percentile concentrations in False Canyon Creek receiving water, suggesting effects to amphibians are unlikely.
- Sediment chemistry was rated as low, based on exceedances of arsenic, cadmium, lead, zinc.
- Aquatic invertebrate LOEs suggest low potential risks with moderate uncertainty for COPC-related impacts to amphibian food (i.e., abundance of invertebrates is not impaired).

Tributary E – Potential risks to aquatic amphibians/life stages are considered low, with a high degree of uncertainty, based on the following WOE assessment:

- Water and sediment chemistry LOEs were evaluated for this receiving environment. While water and sediment chemistry COPCs were mostly rated as low (water: copper, iron, lead, selenium; sediment: arsenic), some water COPCs were moderately elevated above CCME guidelines and CSR standards (aluminum and chromium) at MH-08. However, amphibian thresholds for cadmium, lead and zinc (see above) were higher than 95th percentile concentrations in Burnick Creek receiving water, suggesting effects to amphibians are unlikely.
- Aquatic invertebrate LOEs suggest low potential risks with moderate uncertainty for COPC-related impacts to amphibian food (i.e., abundance of invertebrates is not impaired).

Because the water and sediment quality guidelines are not specific to amphibians, the recent meta-analysis has not been formally published/reported, and no site-specific information on resident organisms has been collected, potential risks ranged from low to moderate with a high level of uncertainty. It is assumed that risk management (and water permitting) decisions for the aquatic environment will be driven by other ROCs with more robust information and confirmed presence. More detailed assessment or other LOEs would be required to reduce uncertainty in risks to amphibians in aquatic receiving environments.

3.1.4.2. Terrestrial Amphibians/Life-stages

Burnick Zone (AEC 2) – Potential risks to amphibians at this AEC are considered negligible-to-low with high uncertainty, based on the following WOE assessment:

- The amphibian survey did not specifically target the Burnick area (targeted lower elevations and areas with nearby aquatic habitat).
- The soil toxicity thresholds derived from the literature for lead, suggest negligible (1300 Portal) or low (Burnick) potential effect sizes and localized spatial extent (only 1 sample exceeded); uncertainty in this LOE was considered high.

- Terrestrial invertebrate LOEs suggest negligible potential risks with moderate uncertainty for COPC-related impacts to amphibian food (i.e., biomass and abundance of invertebrates were not impaired).

Jewelbox/Main Zone (AEC 1/9) – Potential risks to amphibians at this AEC are considered high with high uncertainty, based on the following WOE assessment:

- The amphibian survey did not specifically target the Jewelbox/Main Zone area (lower elevations and areas with nearby aquatic habitat were targeted).
- The soil toxicity thresholds derived from the literature for lead, suggest high potential effect sizes and spatial extent is considered moderate under post-closure conditions (i.e., with application of a soil cover on the re-contoured area of the Jewelbox bench); uncertainty in this LOE was considered high.
- Terrestrial invertebrate LOEs suggest negligible potential effects with moderate uncertainty for COPC-related impacts to amphibian food (i.e., biomass and abundance of invertebrates were not impaired).
- Further site-specific information or other LOE tools would be required to reduce uncertainty in the assessment of potential risks to amphibians at this AEC. Although potentially elevated risks to amphibians are present in the Jewelbox/Main Zone AEC, this finding is unlikely to change risk management decisions, as amphibian risk rating results are similar to those obtained for some species of birds and mammals in the TERA (readers are referred to Azimuth 2015b for further information).

Mill Site (AEC 3) - Overall, potential risks to amphibians at this AEC are considered negligible to low with high uncertainty, based on the following WOE assessment:

- The amphibian survey targeted the Mill Site; however no amphibians were observed from any location on-Site or at reference locations.
- The soil toxicity thresholds derived from the literature for lead, suggest, after completion of the 2015 soil cover, negligible (Haul Road) or low (Mill Site) potential effects and limited spatial extent; uncertainty in this LOE was considered high.
- Terrestrial invertebrate LOEs suggest negligible potential risks with moderate uncertainty for COPC-related impacts to amphibian food (i.e., biomass and abundance of invertebrates is not impaired). Overall, potential risks to amphibians at this AEC are considered low with moderate uncertainty.

Tailings Management Facility (AEC 8) - Overall, potential risks to amphibians at this AEC are considered low with high uncertainty, based on the following WOE assessment:

- The amphibian survey targeted several areas in this AEC; however no amphibians were observed from any location on-Site or at reference locations.

- The soil toxicity thresholds derived from the literature for lead, suggest, after completion of the 2014 soil cover, low potential effects and limited spatial extent; uncertainty in this LOE was considered high.
- Terrestrial invertebrate LOEs suggest negligible potential risks with moderate uncertainty for COPC-related impacts to amphibian food (i.e., biomass and abundance of invertebrates is not impaired).

3.2. General Considerations in the ERA

Overall, a combination of conservative and realistic decisions was made in the face of uncertainty in this risk assessment; generally, there is a greater chance of making a Type I error (false positive) than a Type II error (false negative). While risk conclusions are considered robust, they inherently reflect a considerable degree of professional judgment and expert opinion. Our goal was to be as transparent as possible in the risk assessment process.

The findings contained in this report are based, in part, upon information provided by others. In preparing this report, Azimuth assumed that the data or other information provided by others is factual and accurate. If any of the information is inaccurate, site conditions change, new information is discovered, and/or unexpected conditions are encountered in future work, then modifications by Azimuth to the findings, conclusions and recommendations of this report may be necessary.

In addition, the conclusions and recommendations of this report are based upon applicable legislation existing at the time the report was drafted. Changes to legislation, such as an alteration in acceptable limits of contamination, may alter conclusions and recommendations.

This report is time-sensitive and pertains to a specific site and a specific scope of work. It is not applicable to any other site, development or remediation other than that to which it specifically refers. Any change in the Site, remediation or proposed development may necessitate a supplementary investigation and assessment.

ERA is an iterative process where results from initial phases are used to identify uncertainties in risk predictions and inform the need for further studies. The strategy of conducting the ERA in parallel with site investigation work, as well as concurrently with closure/remediation activities, and the Water Licence permitting process, there can lead to greater uncertainty in the ERA.

Table 3-1: WOE risk characterization summary for Sä Dena Hes aquatic ERA.

Receptor Group	LOE #	LOE Category (Tool)	All Drainage Basins: Data Quality[1]	All Drainage Basins: Ecological Relevance	All Drainage Basins: LOE Weighting[2]	Camp Creek: Magnitude[3] Rating	Camp Creek: Magnitude[3] Uncertainty	Camp Creek: Causality[4] Summary	Camp Creek: Causality[4] Uncertainty	Camp Creek: Risk Characterization[5]	False Canyon Creek: Magnitude[3] Rating	False Canyon Creek: Magnitude[3] Uncertainty	False Canyon Creek: Causality[4] Summary	False Canyon Creek: Causality[4] Uncertainty	False Canyon Creek: Risk Characterization[5]	Tributary E: Magnitude[3] Rating	Tributary E: Magnitude[3] Uncertainty	Tributary E: Causality[4] Summary	Tributary E: Causality[4] Uncertainty	Tributary E: Risk Characterization[5]
	1	Water chemistry	✓	Low	+	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Upper Camp Creek - Low Risk with Low Uncertainty:** Water toxicity test results predicted negligible-to-low risks of effects to algae in Upper Camp Creek. Zinc concentrations were below literature-based effects thresholds for structure and function of periphyton communities. Uncertainty was considered low because the laboratory toxicity LOE tends to be a conservative measure of potential effects in the field.	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Negligible Risk with Low Uncertainty:** The qualitative plant survey was not completed at stations in the False Canyon Creek drainage. 95th percentile COPC concentrations (specifically zinc) in the water samples from False Canyon Creek were below the concentrations shown to cause effects in the mixture toxicity test. Uncertainty was considered low because the laboratory-based toxicity LOE tends to be a conservative measure of potential effects in the field. A functionally intact aquatic primary producer community is inferred based on a diverse and abundant benthic invertebrate community in False Canyon Creek.	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Low Risk with Low Uncertainty:** A visually noticeable periphyton community was present in North Creek in 2014 in areas of predominantly cobble/gravel substrate and continuous flow at MH-12A. The toxicity testing LOE indicated a low risk to aquatic plants, with a small spatial extent limited to Burnick Creek. Uncertainty was considered low because the laboratory-based toxicity LOE tends to be a conservative measure of potential effects in the field. Furthermore, the presence of a diverse and abundant benthic invertebrate community in North Creek implies the minimal (if any) effects of the mine on primary producers in this drainage.
	2	Sediment chemistry	✓	Low	+	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High		Low and Isolated (exp)	High (eff)	N/A; Plausible	High		Low (exp)	High (eff)	N/A; Plausible	High	
Aquatic Plants	3	Qualitative periphyton/aquatic plant survey[7]	✓	High	+	Narrative assessment: No evidence of in-stream plant community, which could be explained by the timing of the survey (early in the growing season), creek characteristics, or limited nutrients (groundwater fed system).				**Lower Camp Creek - Moderate Risk with High Uncertainty:** Water toxicity testing results indicate the potential for adverse effects to algal growth in Lower Camp Creek; results vary from negligible-to-high effects in winter, but post-freshet months are given greater emphasis (negligible to moderate). The literature based LOE suggested "low" effects to some periphyton endpoints. The qualitative plant survey was of limited use; however, the presence of a diverse benthic invertebrate community in Camp Creek provides supporting evidence of a functional primary producer community in this drainage. Uncertainty is high, because there is high likelihood that additional data (e.g., quantitative periphyton survey) could change the overall risk rating for aquatic plants. Additional assessment would be required to reduce uncertainty.	N/A: No survey completed.					Narrative assessment: Visual evidence of a periphyton community was observed in June 2014 survey. Limited plant community could be explained by the timing of the survey (early in the growing season), creek characteristics or limited nutrients (i.e., groundwater fed system).				
	4	Water toxicity testing	✓	Moderate	++	Upper CC: Neg-low (eff) Lower CC: Neg-high (eff)	Moderate (eff)	High; N/A	Moderate		Negligible (eff)	Low (eff)	High; N/A	Moderate		Low and Limited Spatial Scale (eff)	Low (eff)	High; N/A	Moderate	
	5*	Literature-based periphyton effects concentrations	✓	Moderate	+	Low and isolated (eff)	High (eff)	N/A; Plausible	High		Negligible (eff)	High (eff)	N/A; Plausible	High		Negligible (eff)	High (eff)	N/A; Plausible	High	
	1	Water chemistry	✓	Low	+	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Low Risk with Moderate Uncertainty:** The benthic invertebrate community LOE assessment provides the strongest evidence of a relatively functional and diverse aquatic invertebrate community in Camp Creek (negligible to low effects). Toxicity test results on *C. dubia* indicated the potential for adverse effects to aquatic invertebrates, but the spatial scale was limited primarily to lower Camp Creek (MH-11) and was based on comparing the exposure concentrations (zinc) in the toxicity tests to the 95th percentile of the long-term water quality data at MH-11. The field survey was weighted more heavily than laboratory toxicity testing results.	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Low Risk with Moderate Uncertainty:** The benthic invertebrate community LOE indicated that there are lower EPT/sensitive taxa indices at MH-13 relative to the downstream locations, but there is a high degree of uncertainty regarding the cause of the reduced number of sensitive taxa. Water quality data compared to the toxicity testing benchmarks suggest there is likely no effect on the False Canyon Creek benthic invertebrate community due to metals in the surface water. Multiple years of data, combined with knowledge of the habitat conditions, strongly suggest that any difference in the number of sensitive taxa or EPT indices at MH-13 is due to the habitat and stream characteristics at this location.	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Low Risk with Moderate Uncertainty:** With the exception of Burnick Creek, the available chemistry data in Tributary E indicated low risk of exposure with moderate uncertainty. Reduced EPT abundance relative to the reference areas was observed at MH-12A on North Creek in 2014, but water quality data from Burnick Creek (MH-08) and North Creek (MH-12) compared to the toxicity testing benchmarks in the Dilution and WER tests indicate negligible-to-low risks for aquatic invertebrates in this drainage. Overall, the low risk rating was considered appropriate given the inconsistency in effects ratings between the benthic invertebrate community and toxicity testing LOEs.
	2	Sediment chemistry	✓	Low	+	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High		Low and Isolated (exp)	High (eff)	N/A; Plausible	High		Low (exp)	High (eff)	N/A; Plausible	High	
Aquatic Invertebrates	3	Benthic invertebrate community survey	✓	High	+++	Negligible to Low (eff)	High (eff)	Weak, Positive; N/A	Moderate		Moderate (eff)	High (eff)	None; N/A	Moderate		Moderate (eff)	High (eff)	None; N/A	Moderate	
	4	Water toxicity testing - acute[8]	✓	Moderate	++	Low (Limited Spatial Scale) (eff)	Moderate (eff)	High, Positive	Moderate		Negligible (eff)	Moderate (eff)	High, Positive	Moderate		Negligible (eff)	Moderate (eff)	High, Positive	Moderate	
	5	Water toxicity testing - chronic	✓	Moderate	++	High (Limited Spatial Scale) (eff)	Moderate (eff)	High, Positive	Moderate		Negligible (eff)	Moderate (eff)	High, Positive	Moderate		Low (Limited Spatial Scale) (eff)	Moderate (eff)	High, Positive	Moderate	

Table 3-1: WOE risk characterization summary for Sä Dena Hes aquatic ERA.

Receptor Group	LOE #	LOE Category (Tool)	Data Quality[1]	Ecological Relevance	LOE Weighting[2]	Camp Creek: Magnitude[3] Rating	Camp Creek: Magnitude[3] Uncertainty	Camp Creek: Causality[4] Summary	Camp Creek: Causality[4] Uncertainty	Camp Creek: Risk Characterization[5]	False Canyon Creek: Magnitude[3] Rating	False Canyon Creek: Magnitude[3] Uncertainty	False Canyon Creek: Causality[4] Summary	False Canyon Creek: Causality[4] Uncertainty	False Canyon Creek: Risk Characterization[5]	Tributary E: Magnitude[3] Rating	Tributary E: Magnitude[3] Uncertainty	Tributary E: Causality[4] Summary	Tributary E: Causality[4] Uncertainty	Tributary E: Risk Characterization[5]
Fish[6]	1	Water chemistry	✓	Low	+	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Negligible Risk with Low Uncertainty**; Based on the 2014 survey and historical data, Camp Creek is unlikely fish-bearing due to habitat limitations. Even if fish are present under future conditions, the available toxicity testing data suggest negligible potential effects. However, there is uncertainty because the full concentration range of receiving water in Camp Creek (MH-11) was not represented by the LC50 monitoring location, and the test was acute rather than sublethal.	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Low Risk with Moderate Uncertainty:** Fish species presence in False Canyon Creek has been relatively consistent dating back to 1992. Species abundance varies among years, likely due to water levels particularly for MH-13. A comparison of the long-term surface water chemistry in False Canyon Creek to the LC50 monitoring location implies there is negligible risk of effects to fish; uncertainty was rated moderate because the toxicity tests were acute, rather than sublethal. Overall, risks were considered low (rather than negligible) because near-field tissues were 10 times higher in lead than far-field fish.	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Negligible Risk with Low Uncertainty:** No fish were captured from North Creek in 2014, which is expected for the upstream portion of North Creek. Even if fish are present under future conditions, the available LC50 toxicity testing data suggest risks of contaminant-related effects to potential fish populations in North Creek and Tributary E are unlikely, but there is uncertainty because the testing was acute rather than sublethal.
	2	Sediment chemistry	✓	Low	+	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High		Low and Isolated (exp)	High (eff)	N/A; Plausible	High		Low (exp)	High (eff)	N/A; Plausible	High	
	3	Fish tissue	✓	Moderate	++	N/A	N/A	N/A	N/A		High (exp)	High (eff)	N/A	N/A		N/A	N/A	N/A	N/A	
	4	Water toxicity testing (acute)	✓	Moderate	++	Negligible (eff)	High (eff)	N/A	N/A		Negligible (eff)	Moderate (eff)	N/A	N/A		Negligible (eff)	Moderate (eff)	N/A	N/A	
	5	Fish survey[7]	✓	High	++	Narrative assessment: Based on 2014 survey and historical data, Camp Creek does not appear to be fish bearing likely due to lack of suitable habitat and barriers to fish access.					Narrative assessment: Long-term monitoring and 2014 survey document several species in False Canyon Creek; slimy sculpin present as far upstream as confluence with Camp Creek.					Narrative assessment: Based on 2014 survey fish were not present in North Creek; historically present downstream in Tributary E.				
	6	Aquatic plant and invertebrate LOEs	✓	Low	+	Low (eff)	Moderate (eff)	N/A	N/A		Low (eff)	Moderate (eff)	N/A	N/A		Low (eff)	Moderate (eff)	N/A	N/A	
Amphibians - Aquatic (see also Table 3-2 for terrestrial amphibians/life stages)	1	Water chemistry and amphibian toxicity thresholds	✓	Low	++	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Low to Moderate Risk with High Uncertainty:** Water and sediment concentrations exceed guidelines. Water-based amphibian thresholds suggests effects to amphibians are unlikely in most of Camp Creek, with the exception of lead at MH-11. Uncertainty is considered high as no site-specific information on resident organisms has been collected. Additional assessment would be required to reduce uncertainty.	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Low Risk with High Uncertainty:** Water and sediment concentrations exceed guidelines. Water-based amphibian thresholds suggests effects to amphibians are unlikely in False Canyon Creek. Uncertainty is considered high as no site-specific information on resident organisms has been collected. Additional assessment would be required to reduce uncertainty.	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High	**Low Risk with High Uncertainty:** Water and sediment concentrations exceed guidelines. Water-based amphibian thresholds suggests effects to amphibians are unlikely in the Tributary E drainage. Uncertainty is considered high as no site-specific information on resident organisms has been collected. Additional assessment would be required to reduce uncertainty.
	2	Sediment chemistry	✓	Low	+	Moderate and Widespread (exp)	High (eff)	N/A; Plausible	High		Low and Isolated (exp)	High (eff)	N/A; Plausible	High		Low (exp)	High (eff)	N/A; Plausible	High	
	4	Aquatic invertebrate LOEs	✓	Low	+	Low (eff)	Moderate (eff)	N/A	N/A		Low (eff)	Moderate (eff)	N/A	N/A		Low (eff)	Moderate (eff)	N/A	N/A	

Notes:

[1] Data quality - a check mark indicates acceptable data quality; and an "x" indicates unacceptable data quality.

[2] LOE weighting - greater number of '+' signs indicates greater weighting on this LOE. Weightings range from '+' to '+++'.

[3] Magnitude considers degree of contamination (exposure "exp") or effect size (effects "eff"), as well as spatial extent and temporal representativeness.

[4] Causality considers strength of correlation and supporting evidence.

[5] Risk characterization considers concordance among LOEs and provides an overall risk and uncertainty rating. See Section 3 for risk and uncertainty ratings by ROC.

[6] No fish were found at the sampling locations in Camp Creek or Tributary E in 2014.

[7] No formal magnitude and causality ratings were derived for the Qualitative Aquatic Plant Survey and Fish Survey. A narrative assessment of the available information was provided in Appendix A for the Risk Characterization.

[8] The LOE for Water Toxicity Testing - Acute combines the survival results for *C. dubia* from the WER test and the Mixture Dilution Tests. These tests were previously classified as separate LOEs in Table 3-4 of Volume 1A Problem Formulation (Azimuth 2015a).

Risk Ratings (See Section 3 for risk and uncertainty ratings):

- Negligible-Low Risk
- Moderate Risk
- High Risk

N/A = not assessed. In the case of the fish tissue LOE in Camp Creek and Tributary E, N/A was applied because no fish were captured during the survey.

"-" LOE not used

* LOE added to the aquatic plant WOE evaluation after the Updated PF was issued (Azimuth 2014d)

Table 3-2. WOE risk characterization summary for amphibians in the terrestrial environment, post-closure conditions, Sä Dena Hes Mine Site. (For aquatic amphibians/lifetages, see Table 3-1).

			All AECs			Burnick Zone - Post-closure					Jewelbox/Main Zone - Post-closure					Mill Site - Post-closure					Tailings Management Facility - Current/Post-closure					Other Areas (Boneyard, Outside AEC, Outside AEC 1 & 9, and Reference; see Section 10 of Appendix A)				
Receptor Group	LOE #	LOE Category (Tool)	Data Quality[1]	Eco Relevance	LOE Weighting[2]	Magnitude[3]	Uncertainty	Causality[4]	Uncertainty	Risk Characterization[5]	Magnitude[3]	Uncertainty	Causality[4]	Uncertainty	Risk Characterization[5]	Magnitude[3]	Uncertainty	Causality[4]	Uncertainty	Risk Characterization[5]	Magnitude[3]	Uncertainty	Causality[4]	Uncertainty	Risk Characterization[5]	Magnitude[3]	Uncertainty	Causality[4]	Uncertainty	Risk Characterization[5]
Amphibians - Terrestrial	3	Soil Invertebrate LOEs (as food source)[6]	✓	Low	+	Negligible	Moderate	N/A	N/A	**Negligible (1300 Portal) to Low (Burnick) Risk with High Uncertainty:** Risks based primarily on soil toxicity thresholds and suggest negligible to low effects/localized spatial extent. Terrestrial invertebrate LOEs indicate negligible effects to the amphibian food source. Amphibian survey was not conducted in this AEC. Site at northern extent of Western Toad distribution.	Negligible	Moderate	N/A	N/A	**Negligible Risk with High Uncertainty (1250 Portal).**	Negligible	Moderate	N/A	N/A	**Negligible (Haul Road) to Low (Mill Site) Risk with High Uncertainty:** An amphibian survey was conducted in this AEC, however no amphibians were observed. Soil toxicity thresholds and terrestrial invertebrate LOEs suggest low potential effects/limited spatial extent post reclamation. Terrestrial invertebrate LOEs indicate negligible effects to the amphibian food source. Site at northern extent of Western Toad distribution.	Negligible	Moderate	N/A	N/A	**Low Risk with High Uncertainty:** An amphibian survey was conducted in this AEC, however no amphibians were observed. Soil toxicity thresholds and terrestrial invertebrate LOEs suggest low potential effects/limited spatial extent. Terrestrial invertebrate LOEs indicate negligible effects to the amphibian food source. Site at northern extent of Western Toad distribution.	Negligible	Moderate	N/A	N/A	**Negligible Risk with High Uncertainty:** An amphibian survey was conducted in some reference areas, however no amphibians were observed. Soil toxicity thresholds and terrestrial invertebrate LOEs suggest negligible potential effects (all samples below 'low' threshold, except one). Terrestrial invertebrate LOEs indicate negligible effects to the amphibian food source. Site at northern extent of Western Toad distribution.
	4	Soil-based effects thresholds for amphibians	✓	Moderate	++	Negligible (1300 Portal) Low (Burnick)	High	N/A; Plausible	High		High (all except) Negligible (1250 Portal)	High	N/A; Plausible	High	**High Risk with High Uncertainty:** Risks based primarily on soil toxicity thresholds derived from the literature for lead, which indicate potentially high effect size and widespread spatial extent for some portions of this AEC. Amphibian survey was not conducted in this AEC. Site at northern extent of Western Toad distribution.	Negligible (Haul Road) Low (Mill Site)	High	N/A; Plausible	High		Low	High	N/A; Plausible	High		Negligible	High	N/A; Plausible	High	
	5	Qualitative Survey	× (no amphibians located)	N/A	-	N/A (survey not conducted at Burnick)					N/A (survey not conducted at Jewelbox)					N/A: No amphibians encountered in 2014 survey possibly due to low abundance or timing of survey.					N/A: No amphibians encountered in 2014 survey possibly due to low abundance or timing of survey.					N/A: No amphibians encountered in 2014 survey possibly due to low abundance or timing of survey.				

Notes:

[1] Data quality - a check mark indicates acceptable data quality; and an "x" indicates unacceptable data quality.

[2] LOE weighting - greater number of '+' signs indicates greater weighting on this LOE. Weightings range from '+' to '+++'.

[3] Magnitude considers degree of contamination (exposure "exp") or effect size (effects "eff"), as well as spatial extent and temporal representativeness.

[4] Causality considers strength of correlation and supporting evidence.

[5] Risk characterization considers concordance among LOEs and provides an overall risk and uncertainty rating. See Section 3 for risk and uncertainty ratings by ROC.

[6] See WOE Table 3-1 in the Addendum to the Terrestrial ERA (Azimuth 2015b).

Risk Ratings (See Section 3 for risk and uncertainty ratings):

- Negligible-Low Risk
- Moderate Risk
- High Risk

N/A = not assessed. In the case of the amphibian survey, N/A was applied because no amphibians were encountered during the survey.

"-" LOE not used

4. IMPLICATIONS FOR RISK MANAGEMENT

As described in **Section 3** and **Table 3–1** and **Table 3–2** , the AERA found that potential risks to most receptor groups in most receiving environments (or AECs for amphibians) are currently negligible or low (uncertainty varied by ROC and environment). Where potentially elevated risks were identified, they were accompanied by a high degree of uncertainty. ROCs with potentially elevated risks included:

- The aquatic plant community in lower (but not upper) Camp Creek (moderate risk with high uncertainty), based primarily on the toxicity testing LOE, and secondarily, information from the literature on zinc effects to periphyton. A quantitative assessment of plants (e.g., periphyton survey) was not conducted in the AERA, leading to higher uncertainty about actual effects in the field.
- Aquatic amphibians in Camp Creek (low-moderate risks with high uncertainty), based on a preliminary screening of water chemistry data and information from the literature on amphibian toxicity thresholds.
- Terrestrial amphibians in Jewelbox/Main Zone (AEC 1/9), based on toxicity-based soil screening thresholds from the literature. We note that this finding is unlikely to change risk management decisions for the terrestrial environment, as amphibian risk rating results are similar to those obtained for some species of birds and mammals in the TERA (readers are referred to Azimuth 2015b for further information).

If uncertainties in risk findings are considered too high to support Site management needs and decisions, further assessment could be conducted to reduce uncertainty.

Unlike the TERA, which was a significant driver for closure planning due to soil contamination, the AERA had a lower profile role. The long-term water quality dataset for the vicinity of the mine identified metals exceeding standards in a pattern that suggests it is mine-related; however, exceedances were typically in the low-moderate range (<10 fold above standards), in some cases related to turbidity, and intermittent for some COPCs. While the aquatic risk assessment results have been used to provide input into the permitting process and adaptive management plan (AMP), the Yukon's water license process was the main driver for decisions about post-closure water quality monitoring.

Teck undertook the AERA for due diligence purposes by building on years of water quality data and existing aquatic environmental effects studies. Augmented with some 2014 on-site data, this information was used to describe any aquatic risks and, if elevated risks with reliable certainty were identified, to consider options for managing those risks.

We understand that Teck is developing an AMP that will monitor post-reclamation surface water and groundwater quality. Thresholds triggering responses are linked to trend analysis and comparison with water quality limits specified in the Water Licence. Long-term monitoring and trend analysis can provide information to allow the development of appropriate responses which are based on a 'weight of evidence' and not solely a limited number of data points. Responses to such triggers could also include expansion of the aquatic resource monitoring network, adjustments to the frequency or intensity of monitoring efforts, or both. These requirements will be determined on a case basis and will be dependent on the nature of the trigger. In addition to water quality, Teck plans to monitor sediment quality, benthic communities, and continue fish monitoring as per the previous Water Licence.

In summary, risk management for aquatic receptors is being delivered through the Water Licence and AMP.

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APPENDIX A

Risk Analysis by Lines of Evidence (LOEs) for the Sä Dena Hes AERA

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1. INTRODUCTION

1.1. Overview

This appendix provides detailed information for each line of evidence (LOE) used in evaluating potential risks and associated uncertainties for the ecological risk assessment (ERA) of aquatic receptors at the Sä Dena Hes Mine Site. The aquatic receptor groups considered in the aquatic ERA (AERA) include the following:

- Aquatic Plants
- Aquatic Invertebrates
- Fish
- Amphibians

LOEs for these receptor groups were initially identified during the Draft Problem Formulation (Azimuth 2013a) and have been updated in the Updated Problem Formulation (see Table 6-11 in Section 6 of Volume 1).During the risk characterization process, each LOE is evaluated according to a series of attributes that represent data quality, ecological relevance, magnitude, and evidence for causality; see detailed criteria in Tables5-2 and 5-3 of Volume 1. This approach to risk characterization is consistent with recent ERA guidance from Environment Canada (2012) and the Science Advisory Board for Contaminated Sites in British Columbia (SAB 2008, 2010).

Generally, each LOE used in an ERA links information or assumptions about exposure and effects, and considers causality. In some cases an LOE is limited to evaluating exposure only (e.g., LOEs such as surface water or sediment); for tissue chemistry, evaluation is limited to evaluating changes along a spatial gradient. While most LOEs are evaluated quantitatively, some LOEs (LOEs 5 and 9) are qualitative and/or data is limited. These qualitative LOEs are reported in a narrative fashion.

The detailed LOE assessment presented in this appendix "builds the case "for the weight-of-evidence (WOE) evaluation. Results of individual LOEs are integrated in Section 2 of Volume 3 to reach a conclusion regarding potential risks for a specified receptor group/assessment endpoint.

In the Sä Dena Hes AERA, we provide risk conclusions for current conditions, which are assumed to be representative of post-closure conditions. Assumptions are documented in Section 2.3and Table 2-1of Volume 3.

1.2. Datasets

The data analyses conducted for each LOE in each section as appropriate, but for many of the LOEs, analyses have been reported previously in separate documents and readers are referred to other sources for more detailed information. The datasets and/or reports used to support the LOE assessment include the following:

- A review of the major supporting studies provided in Section 4 of the Volume 1 Updated PF (Azimuth 2014d)
- Volume 3 Main AERA Report (cited as Volume 3)
- Volume 1 Updated PF (cited as Volume 1, Azimuth 2014d)
- Volume 1 Addendum PF (cited as Volume 1A, Azimuth 2015a)
- Azimuth Data Report for 2012 and 2013 programs (cited as Azimuth 2014a)
- Environmental Monitoring Reports by Laberge Environmental Services and Can Nic-A-Nick (cited as Laberge 2012 and 2015 [provided as Appendix E in this AERA])
- The baseline Initial Environmental Evaluation (IEE) Report by SRK (cited as SRK 1990)

References are provided in the Volume 3 main report.

1.3. Appendix Organization

Each of the following sections describes LOEs used in the aquatic ERA for the Sä Dena Hes ERA. The general LOE categories include:

- Water chemistry for aquatic plants, aquatic invertebrates, fish and amphibians
- Sediment chemistry for aquatic plants, aquatic invertebrates, fish and amphibians
- Fish tissue chemistry as measures of COPC exposure to fish,
- Field surveys for plants (qualitative), benthic invertebrates (semi-quantitative), fish (presence/absence) and amphibians (timed survey)
- Water-based toxicity testing for aquatic plants and aquatic invertebrates (including water effects ratio)and fish

For each LOE, we describe specifically how the exposure and effects information is used to inform the LOE, the data analysis that underpins the LOE, and the risk characterization stage attributes.

2. WATER CHEMISTRY

2.1. LOE Description

The water chemistry LOE compares surface water chemistry data to CCME WQG and Yukon CSR standards for the protection of aquatic life. The data is evaluated for potential spatial gradients and extent of contamination patterns (if present) downstream of the Site.

This LOE is applicable to aquatic plants, invertebrates, fish and amphibians.

2.2. Data Analysis

2.2.1. Overview

Water chemistry data for screening was provided by SRK (Microsoft Access database). The data set is comprised of quarterly and monthly samples collected in accordance with the Water Use Licence (QZ99-045), as well as water samples collected for various other monitoring programs. Water quality data has been collected from 1991 to 2014 at various locations including receiving environments but also seeps and adits/portals. For the purpose of the AERA, only monitoring locations identified as potential aquatic habitat were assessed (see Table 2-1 in Volume 3 for a list of monitoring locations used in the AERA and in this LOE). Portal and seep monitoring locations are not considered aquatic habitat and were excluded from assessment in the AERA[1]. Additionally, for the purpose of screening, only water samples collected between 1999 and December 2013 were carried forward in this assessment (see Volume 1, Azimuth 2014d). The water quality stations assessed include:

- **Reference**
    - o CC-1 (reference, drains the southern slope of Mt. Hundere)
    - o Access Creek: MH-29 (considered reference and confirmed by SRK)
    - o Tributary D: MH-26
    - o Unknown Tributary to False Canyon Creek: MH-30 (reference)
- **Camp Creek**
    - o Camp Creek: PH-01, MH-04, CC-3, MH-27, MH-11
    - o Portal Creek: MH-05, MH-28

[1]Refer to Section 6.2 of Volume 1 for a discussion of the portal and seep monitoring locations. Screening results for the portal and seep stations compared against the matrix numerical standard for groundwater flow to surface water used by aquatic life (EY 2002) are presented in Section 6.3.3 of Volume 1

- **False Canyon Creek: MH-13, MH-14, MH-16**
- **Tributary E**2
  - Burnick Creek: MH-08
  - North Creek: MH-12
  - Tributary E: TRIBEWF01, TRIBEWF02, MH-15

Tributary E receives drainage from two potential sources: North Tailings Dam seepage and the Burnick Zone (SRK 2014d). The water quality dataset is limited for Tributary E, particularly for the downstream locations MH-12 and MH-15. MH-08, located on-Site in Burnick Creek, is the only aquatic receiving environment station[3] that has been routinely sampled dating back to 1999.

2.2.2. Methods

Section 6 of the Volume 1 (Azimuth 2014d) describes the screening process and benchmarks used to identify contaminants of potential concern (COPCs) for the aquatic environment (see Appendix A). Water quality data from 1999 to 2013[4] were screened against the following:

- Yukon CSR aquatic life standards (Schedule 3; EY 2002), which are divided by the 10-fold safety factor to compare with water chemistry data from receiving aquatic habitats (*Protocol 6* of the Yukon CSR, EY 2012).
- CCME WQG for the Protection of Aquatic Life (CCME 2014a).

Data were screened in using R (v 2.15.2) software to identify COPCs by station using exceedance ratios (i.e., the concentration in the sample divided by the standard). The CCME and Yukon CSR screening criteria are presented in Table 6-2 of Volume 1 (Azimuth 2014d).

2.2.3. Results

Exceedance ratios using the Yukon CSR aquatic life standards and the CCME aquatic life criteria are presented in **Table A2-1** on a station by station basis**.** COPCs include aluminum, cadmium, chromium, copper, iron, lead, selenium, and zinc.

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[2] Tributary E drainage is not considered impacted by source loading from the Burnick Zone [see Section 6.2.2.2 of Volume 1], but is included in AERA based on source loading from seepage from the North Tailings Dam (MH-02) to North Creek, and ultimately to the East Fork of Tributary E.

[3]Stations MH-02 (North Dam seep) and MH-22 (Burnick Zone portal) have been monitored more frequently, but these are not considered aquatic habitat and are therefore excluded from the AERA. Refer to Volume 1 Appendix A for information on the COPC screening specific to source water (portals and seeps) on-Site.

[4] COPC screening for receiving water was not updated with 2014 data in the 2015 PF Addendum because reclamation work was in progress in 2014 (e.g., draining of the tailings ponds), which may have temporarily altered water quality at the Site; see Azimuth 2015a for further information.

Water chemistry results are discussed in Section 6.3.5 and Appendix A of Volume 1 (Azimuth 2014d, Figures A-1 to A-15). Figure A-7 (CCME time series plot) and Figure A-15 show the exceedance ratios for cadmium, copper, iron, lead, selenium, and zinc at MH-30 (reference) relative to the False Canyon Creek stations; the results suggest that concentrations in False Canyon Creek may be within the range of reference/background concentrations in the area.

2.3. LOE Attributes

2.3.1. Data Quality

Acceptable –The following step-wise approach was taken to assessing the quality of the dataset prior to screening:

1. Data where the detection limit was greater than the screening criteria were omitted from the dataset (e.g., chromium had several non-detect measurements in the dataset that were above the screening criteria, particularly for historical data collected between 2004 and 2007).
2. Data were plotted by station to determine if there are potential outliers in the dataset. Outliers were visually examined on a station-by-station basis, and isolated for further investigation. If the outliers were from samples collected prior to 2004, they were considered unrepresentative of current conditions and removed from the dataset.
3. Samples were distinguished between newer water quality data (2004 – 2013) and older data (1999 – 2003). If a COPC exceedance was observed in the older dataset at a given station, but no exceedances were observed since 2004, then the COPC was not carried forward in the AERA.
4. Samples with TSS concentrations > 50 mg/L were flagged in the screening process, and the results were compared with samples where TSS was < 50 mg/L before carrying COPCs forward in the AERA. This ensured that observed total metal concentrations were not artificially biased high because of sediment entrained in the water sample.

The step-wise data quality assessment for the water COPC screening was described in more detail in Appendix A of Volume 1 (Detailed Soil and Water COPC Screening Methods and Results).

2.3.2. Ecological Relevance

Low – Comparisons of water chemistry data to various benchmarks are considered to have low ecological relevance for predicting risks to aquatic receptors. The LOE does not incorporate any site-specific information on effects to receptor communities themselves. The water chemistry information does provide important context (i.e., contaminant exposure) for establishing exposure levels and interpreting other LOEs.

2.3.3. Magnitude

Magnitude Interpretive Framework

The interpretive framework applied to assess the degree of contamination on a creek-by-creek basis for Camp Creek, False Canyon Creek, and Tributary E (North Creek) receiving environments is based on: (1) the magnitude of exceedance: (2) the number of samples exceeding; and (3) the spatial extent of exceedances.

The magnitude of exceedance was calculated based on exceedance ratios (see **Section 2.2.2**); and the CCME WQG were used instead of the YK CSR standards when defining the magnitude of exceedance. The CCME WQGs are considered more relevant than the 2002 Schedule 3 aquatic life standard in the YK CSR.

The interpretive framework is as follows:

- Magnitude (based on the 95th percentile concentration exceedance ratio at the worst case station in each receiving environment between 2004 and 2013[5]):
    - Below Guidelines (Negligible)= the same or lower than screening guidelines
    - Above Guidelines
        - Low = exceedance ratios of 1 to 3
        - Moderate = exceedance ratios of 3 to 10
        - High = exceedance ratios greater than 10
- Spatial Scale:
    - Isolated = exceedances at only 1 station within the receiving environment
    - Limited = exceedances at 2 stations
    - Widespread = exceedances at more than 2 sampling stations
- Frequency of Exceedance:
    - Rare = exceedance rate < 5%
    - Limited = exceedance rate between 5 and 20 %
    - Consistently = exceedance rate > 20%

Ratings are summarized in **Table A2-2** by receiving environment. Overall spatial and temporal trends are assessed in **Section 2.3.3.2.**

[5]The 95th percentile was chosen to for defining the magnitude of the CCME WQG exceedances because of the large dataset.

Magnitude Rating

Camp Creek

- **Magnitude – Above Benchmarks; Moderate** (cadmium, lead, zinc); **Low** (aluminum, chromium, iron, selenium)
- **Spatial Scale – Widespread** for most COPCs, with increasing concentrations of cadmium, lead, and zinc downstream at MH-11 relative to the upstream comparator station MH-04.
- **Frequency – Consistently above guidelines**

False Canyon Creek

- **Magnitude – Above Benchmarks; Moderate** (Iron, lead); **Low** (aluminum, chromium, copper, selenium)
- **Spatial Scale – Widespread**, with an overall improvement of water quality from MH-13 to MH-16 (see Figure A-7 in Azimuth 2014d).
- **Frequency – Consistently above guidelines for iron**

With the exception of iron, COPCs identified in the False Canyon Creek stations were based on less than 5 exceedances dating back to 2004. The magnitude rating of moderate for iron and lead was based on exceedance ratios of 3 to 5 at the worst case station MH-13.

Tributary E

- **Magnitude– Above Benchmarks; Moderate** (Aluminum, chromium); **Low** (copper, iron, lead, selenium)
- **Spatial Scale – Widespread**
- **Frequency – Consistently above guidelines**

Cadmium exceeds only the YK CSR standard, and consistent with the framework outlined above, was not carried forward in the LOE assessment.

Overall Spatial and Temporal Trends

Spatial – Spatial extent of contamination is widespread in Camp Creek (up to MH-11 [2 km downstream] for most COPCs, and up to MH-13 [10 km downstream] for lead).

There appears to be a spatial gradient of higher COPC concentrations in Camp Creek relative to downgradient stations in False Canyon Creek; concentrations increase from MH-04 to MH-11 in Camp Creek, and then decrease from MH-11 in Camp Creek to MH-13, MH-14, and MH-16 in False Canyon Creek. Cadmium and zinc, identified as COPCs in Camp Creek, occur below the screening criteria at the 95th percentile concentration at all of the False Canyon Creek stations (**Table A2-2**). As discussed in **Section 2.2.3**, concentrations in False Canyon Creek may be within the range of reference/background concentrations in the area.

Temporal - Concentrations in Camp Creek and False Canyon Creek are expected to follow the seasonal trend observed since 1999; key COPCs (cadmium, lead, and zinc) are typically higher during base-flow (October to April) when surface flow is primarily from groundwater compared to freshet (late May to June) when surface water is primarily from snow melt (SRK 2014d). Overall, there is no evidence of an increasing long-term trend in the concentration of COPCs in Camp Creek (SRK 2014a). Current water quality is considered representative of the likely long-term concentrations at Camp Creek and False Canyon Creek locations, provided the attenuation capacity of the waste rock and soils in contact with the source water on-Site is not exhausted (SRK 2014d).

Concentrations in the Tributary E drainage in the future are expected to remain consistent with current water quality data. The recent loadings assessment report by SRK (2014d) indicates water quality concentrations in Tributary E are expected to remain elevated well into the future. Attenuation experiments using downgradient soils from the Burnick Zone indicate zinc in the loading from the Burnick Portal (MH-22) is precipitating on contact, and the attenuation mechanism will effectively continue for more than 200 years. Attenuation of the metals from the seepage from the North Tailings Dam has not been evaluated, but according to SRK, the load does not affect downgradient surface water quality (SRK 2014d).

Uncertainty About Magnitude

Moderate for Exposure; High for Effects – For this LOE we consider uncertainty related to the magnitude of exposure to be moderate. The exposure site dataset is long-term, but the reference dataset is limited. There is also uncertainty about the long-term water quality, as SRK has indicated there is potential for exhaustion of the attenuation capacity of soils downgradient from the MH-25. Uncertainty related to extrapolating this LOE to effects to aquatic receptors is considered high because it does not incorporate any site-specific information on water characteristics or the aquatic receptors themselves. Note, uncertainty related to effects is provided in Table 3–1.

2.3.4. Causality

Causality - Strength of Correlation

Correlation (N/A); Supporting Evidence (Plausible) – This LOE is limited to evaluating exposure relative to effects-based benchmarks/standards. Because the standards are effects-based, they provide plausible supporting evidence for potential toxicity. However, because standards are usually derived to be conservative for multiple sites/environments, exceedance of a standard only indicates the possibility for an effect. This LOE does not provide evidence of causality for actual effects.

Uncertainty Related to Causality

High – While the mechanism of action is supported by the data underlying the water standards, this LOE does not incorporate site-specific information on effects to assess strength of relationships/causality.

Table A2-1. Water quality screening results for COPCs identified during in the Problem Formulation[1] for the Sä Dena Hes mine site AERA.

Drainage Area	Station	COPC	CCME Chronic WQG – Data Summary: N	N < MDL	N > WQG	CCME Exceedance Ratio Stats: Min	Mean	Median	95th%ile	Max	Yukon CSR aquatic life standards – Data Summary: N	N < MDL	N > WQG	Yukon Exceedance Ratio Stats: Min	Mean	Median	95th%ile	Max	Concentrations (mg/L): Min	Mean	Median	95th%ile	Max
Reference	CC-1	Cadmium	2	0	0	0.44				0.45	2	0	2	1.6				1.7	0.00008				0.00009
	MH-30	Cadmium	2	0	1	0.39				1.2	2	0	2	1.2				4.8	0.00006				0.00024
		Iron	2	0	2	1.0				1.3	2	0	0						0.31				0.40
		Lead	2	0	1	0.12				1.1	2	0	0	0.083				0.83	0.00033				0.0050
	MH-29	Cadmium	2	0	0	0.28				0.84	2	0	2	1.3				3.6	0.00008				0.00018
	MH-26†	Cadmium	10	7	0	0.049	0.38	0.42	0.56	0.62	10	7	8	0.20	1.6	1.7	2.3	2.6	0.00001	0.00009	0.00010	0.00014	0.00016
		Copper	10	4	1	0.15	0.50	0.30	1.4	2.0	10	4	1	0.078	0.26	0.15	0.74	1.1	0.00047	0.0018	0.0010	0.0052	0.0076
		Iron	10	0	4	0.66	0.94	0.96	1.2	1.2	10	0	0						0.20	0.28	0.29	0.35	0.36
		Lead	10	1	1	0.029	0.27	0.095	1.0	1.4	10	1	1	0.018	0.26	0.088	0.99	1.4	0.00020	0.0016	0.00053	0.0060	0.0085
Camp Creek	PH-1	Cadmium	3	0	3	2.9	3.0	2.9	3.2	3.2	3	0	3	12	13	12	14	14	0.00062	0.00067	0.00069	0.00070	0.00071
		Selenium	3	0	3	1.0	1.2	1.1	1.5	1.6	3	0	3	1.0	1.2	1.1	1.5	1.6	0.0010	0.0012	0.0011	0.0015	0.0016
	MH-04	Aluminum	21	3	2	0.050	0.42	0.23	1.2	1.9	21	3	0						0.0050	0.042	0.023	0.12	0.19
		Cadmium	45	0	31	0.20	31	1.1	1.5	1342	45	0	44	1.0	131	4.5	6.3	5667	0.00004	0.0078	0.00026	0.00038	0.34
		Copper	33	7	1	0.056	0.27	0.16	0.43	3.1	33	7	1	0.029	0.14	0.086	0.24	1.6	0.00020	0.0009	0.00056	0.0017	0.011
		Iron	46	1	1	0.017	0.18	0.068	0.66	1.4	46	1	0						0.0050	0.055	0.021	0.20	0.41
		Lead	45	0	5	0.020	18	0.12	3.3	790	45	0	5	0.021	20	0.12	3.3	860	0.00013	0.12	0.00070	0.020	5.2
		Selenium	33	5	1	0.30	0.74	0.80	0.99	1.1	33	5	1	0.30	0.74	0.80	0.99	1.1	0.00030	0.00074	0.00080	0.0010	0.0011
		Zinc	46	12	3	0.17	0.36	0.27	1.1	1.9	46	12	0	0.030	0.14	0.089	0.60	0.93	0.0050	0.011	0.0080	0.032	0.057
	CC-3	Cadmium	1	0	0					0.78	1	0	1					2.9					0.00018
	MH-05	Cadmium	4	0	2	0.92	1.1	0.98	1.3	1.4	4	0	4	3.7	4.7	4.3	6.0	6.3	0.00022	0.00028	0.00026	0.00036	0.00038
		Lead	10	0	5	0.37	0.53	0.43	0.84	0.90	4	0	1	0.42	0.59	0.45	0.96	1.1	0.0025	0.0035	0.0027	0.0058	0.0063
		Selenium	2	0	2	2.5				2.6	2	0	2	2.5				2.6	0.0025				0.0026
		Zinc	4	0	1	0.17	0.70	0.62	1.3	1.4	4	0	0	0.057	0.21	0.16	0.43	0.47	0.0051	0.021	0.019	0.039	0.042
	MH-28	Cadmium	4	0	1	0.19	0.51	0.32	1.1	1.2	4	0	3	0.92	2.2	1.4	4.6	5.2	0.00006	0.00013	0.00009	0.00028	0.00031
		Iron	4	1	1	0.017	0.39	0.074	1.2	1.4	4	1	0						0.0050	0.12	0.022	0.36	0.42
		Lead	4	1	1	0.029	0.32	0.069	0.95	1.1	4	1	1	0.018	0.34	0.060	1.0	1.2	0.00020	0.0021	0.00046	0.0063	0.0073
		Selenium	4	0	1	0.55	0.81	0.76	1.2	1.2	4	0	1	0.55	0.81	0.76	1.2	1.2	0.00055	0.00081	0.00076	0.0012	0.0012
	MH-27	Cadmium	10	0	0	0.41	0.65	0.67	0.90	0.97	10	0	10	1.9	2.7	2.8	3.6	3.9	0.00011	0.00016	0.00017	0.00022	0.00024
		Lead	10	0	1	0.27	1.4	0.55	5.7	9.6	10	0	1	0.32	1.4	0.56	5.8	9.8	0.0019	0.0086	0.0033	0.035	0.059
		Selenium	10	0	1	0.54	0.82	0.82	1.0	1.1	10	0	1	0.54	0.82	0.82	1.0	1.1	0.00054	0.00082	0.00082	0.0010	0.0011
		Zinc	10	0	1	0.35	0.60	0.59	0.94	1.1	10	0	0	0.12	0.20	0.20	0.31	0.37	0.011	0.018	0.018	0.028	0.033
	MH-11	Aluminum	68	15	6	0.010	0.42	0.20	1.5	4.6	68	15	0						0.0010	0.042	0.020	0.15	0.46
		Cadmium	104	3	31	0.22	5.6	0.74	3.2	479	104	3	104	1.2	29	3.2	15	2500	0.00007	0.0017	0.00019	0.00075	0.15
		Chromium	3	0	1	1.0	1.2	1.0	1.5	1.5	3	0	1	1.0	1.2	1.0	1.5	1.5	0.0010	0.0012	0.0010	0.0015	0.0015
		Copper	69	11	3	0.050	0.32	0.23	0.85	2.7	69	11	1	0.022	0.16	0.11	0.38	1.6	0.00020	0.0012	0.00085	0.0034	0.0065
		Iron	109	5	8	0.017	0.33	0.16	1.4	2.8	109	5	0						0.0050	0.099	0.048	0.42	0.84
		Lead	104	1	28	0.039	5.3	0.35	6.6	426	104	1	25	0.031	3.8	0.34	5.2	271	0.00027	0.037	0.0022	0.046	3.0
		Silver	54	48	2	0.20	0.26	0.20	0.38	2.0	54	48	0						0.00002	0.00003	0.00002	0.00004	0.00020
		Zinc	109	6	27	0.17	1.2	0.50	4.6	11	109	6	6	0.030	0.32	0.13	1.4	2.9	0.0050	0.035	0.015	0.14	0.34
False Canyon Creek	MH-13	Aluminum	21	3	1	0.050	0.37	0.28	0.77	1.7	21	3	0						0.0050	0.037	0.028	0.077	0.17
		Cadmium	39	8	4	0.034	3.6	0.27	1.7	120	39	8	22	0.18	19	1.6	7.2	667	0.00001	0.0011	0.00008	0.00028	0.040
		Copper	25	2	2	0.075	0.38	0.28	1.1	1.3	25	2	0	0.033	0.19	0.13	0.55	0.66	0.00030	0.0015	0.0010	0.0043	0.0053
		Iron	39	0	13	0.027	1.0	0.73	3.1	4.1	39	0	0						0.0080	0.31	0.22	0.93	1.2
		Lead	39	2	2	0.0043	4.9	0.12	4.8	141	39	2	2	0.0050	2.7	0.11	1.2	90	0.00003	0.027	0.00077	0.0069	0.99
		Selenium	25	6	3	0.50	0.76	0.70	1.4	1.7	25	6	3	0.50	0.76	0.70	1.4	1.7	0.00050	0.00076	0.00070	0.0014	0.0017
		Zinc	39	21	1	0.063	0.29	0.20	0.44	1.6	39	21	1	0.021	0.23	0.056	0.14	6.4	0.0019	0.0088	0.0060	0.013	0.048

Table A2-1. Water quality screening results for COPCs identified during in the Problem Formulation[1] for the Sä Dena Hes mine site AERA.

Drainage Area	Station	COPC	CCME Chronic WQG – Data Summary			CCME Chronic WQG – Exceedance Ratio Stats					Yukon CSR aquatic life standards – Data Summary			Yukon CSR aquatic life standards – Exceedance Ratio Stats					Concentrations (mg/L)				
			N	N < MDL	N > WQG	Min	Mean	Median	95th%ile	Max	N	N < MDL	N > WQG	Min	Mean	Median	95th%ile	Max	Min	Mean	Median	95th%ile	Max
False Canyon Creek (con't)	MH-14	Aluminum	21	5	4	0.16	1.1	0.26	2.2	14	21	5	0						0.016	0.11	0.026	0.22	1.4
		Cadmium	39	10	1	0.046	4.5	0.24	0.61	165	39	10	22	0.23	23	1.3	2.9	833	0.00001	0.0014	0.00008	0.00017	0.050
		Chromium	4	1	1	0.10	1.3	1.0	2.7	3.0	4	1	1	0.10	1.3	1.0	2.7	3.0	0.00010	0.0013	0.0010	0.0027	0.0030
		Copper	25	5	1	0.075	0.35	0.25	0.84	2.1	25	5	0	0.033	0.16	0.13	0.37	0.92	0.00030	0.0014	0.0010	0.0034	0.0083
		Iron	39	0	15	0.030	1.1	0.93	2.0	9.2	39	0	0						0.0090	0.33	0.28	0.59	2.8
		Lead	39	3	1	0.010	3.4	0.10	0.89	126	39	3	2	0.0064	2.2	0.083	0.62	80	0.00007	0.024	0.00061	0.0062	0.88
		Selenium	25	2	3	0.40	0.82	0.85	1.1	1.1	25	2	3	0.40	0.82	0.85	1.1	1.1	0.00040	0.00082	0.00085	0.0011	0.0011
	MH-16	Aluminum	17	4	1	0.10	0.54	0.20	1.7	4.7	17	4	0						0.010	0.054	0.020	0.17	0.47
		Cadmium	32	11	1	0.033	2.2	0.18	0.43	65	32	11	14	0.17	11	0.81	1.7	333	0.00001	0.00068	0.00005	0.00010	0.020
		Iron	32	0	3	0.29	0.85	0.61	2.8	4.0	32	0	0						0.088	0.26	0.18	0.85	1.2
		Lead	32	4	2	0.0051	0.63	0.051	1.6	14	32	4	2	0.0033	0.42	0.040	1.0	9.1	0.00004	0.0041	0.00034	0.0070	0.10
		Zinc	32	28	1	0.17	0.25	0.17	0.33	1.4	32	28	0	0.030	0.066	0.043	0.11	0.46	0.0050	0.0075	0.0050	0.010	0.041
Tributary E	MH-08	Aluminum	73	20	7	0.010	0.86	0.20	4.5	20	73	20	0						0.0010	0.086	0.020	0.45	2.0
		Cadmium	109	18	5	0.049	3.9	0.27	0.80	382	109	18	57	0.20	16	1.1	3.4	1600	0.00001	0.00083	0.00006	0.00017	0.080
		Chromium	7	0	3	0.41	2.9	1.0	8.1	9.0	7	0	3	0.41	2.9	1.0	8.1	9.0	0.00041	0.0029	0.0010	0.0081	0.0090
		Copper	75	16	6	0.057	0.43	0.23	1.2	6.0	75	16	2	0.029	0.22	0.12	0.61	3.0	0.00020	0.0015	0.00080	0.0043	0.021
		Iron	114	8	9	0.017	0.43	0.11	1.3	12	114	8	0						0.0050	0.13	0.033	0.38	3.7
		Lead	109	15	6	0.0041	0.59	0.065	1.1	37	109	15	6	0.0032	0.51	0.063	1.1	30	0.00002	0.0031	0.00038	0.0063	0.18
		Selenium	72	19	7	0.10	0.74	0.70	1.7	2.0	72	19	7	0.10	0.74	0.70	1.7	2.0	0.00010	0.00074	0.00070	0.0017	0.0020
		Zinc	114	70	4	0.17	0.37	0.20	0.81	4.1	114	70	2	0.056	0.12	0.066	0.27	1.4	0.0050	0.011	0.0060	0.024	0.12
	TRIBEWF01	Cadmium	1	0	0					0.84	1	0	1					3.2					0.00019
		Iron	1	0	1					2.8	1	0	0										0.85
		Zinc	1	0	1					1.1	1	0	0	0.36	0.36	0.36	0.36	0.36					0.032
	MH-12	Cadmium	2	0	0	0.17				0.37	2	0	1	0.72				1.5	0.00004				0.00008
		Iron	2	0	1	0.089				1.1	2	0	0						0.027				0.32

Notes:

No screening criteria are available for aluminum and iron in the YK CSR Schedule 3 generic numerical water standards.

Concentration data are shown as the maximum if only one data point was available at a given station for a particular COPC. If two data points are available, the minimum value is also presented.

[1] The dataset was limited to recent data (2004-2013) with TSS concentrations < 50 mg/L, consistent with the approach used for screening the water quality data for the Problem Formulation (refer to Table 6-3 and Table 6-4 in Volume 1).

Exceedance ratings are applied to the various stats as:

Low	1 to 3 times the water quality screening criteria
Moderate	3 to 10 times the water quality screening criteria
High	> 10 times the water quality screening criteria

* Data are presented for the Tributary E drainage, but are not discussed in the context of the AERA as outlined in the Problem Formulation (see Section 6.2.2.2 of Volume 1).

† Station MH-26 is considered a far-field reference location on Tributary D, which flows into False Canyon Creek downstream from Tributary E.

Table A2-2. Water quality screening summary for the Camp Creek, False Canyon Creek, and Tributary E receiving environments[1].

COPC	Summary[2]	Camp Creek (PH-01, MH-04, CC-3, MH-28A, MH-28, MH-27, MH-11)	False Canyon Creek (MH-13, MH-14, MH-16)	Tributary E (MH-08, MH-12, TRIBEWF01, TRIBEWF02, MH-15)
Aluminum	Magnitude[3]	Low (MH-11)	Low (MH-14)	Moderate (MH-08)
	Spatial Scale[4]	Limited (MH-04 and MH-11)	Widespread (All stations)	Isolated (MH-08)
	Frequency[5]	Limited (9%)	Limited (10%)	Limited (10%)
Cadmium	Magnitude	Moderate (MH-11)	Negligible	Negligible
	Spatial Scale	Widespread (All stations)	Widespread (All stations)	Widespread (MH-08, TRIBEWF01, MH-12)
	Frequency	Consistently (40%)	Limited (5% CCME)	Limited (4%)
Chromium[6]	Magnitude	Low (MH-11)	Low (MH-14)	Moderate (MH-08)
	Spatial Scale	Isolated (MH-11)	Isolated (MH-14)	Isolated (MH-08)
	Frequency	Limited (17%)	Limited (15%)	Consistently (33%)
Copper	Magnitude	Negligible	Low (MH-13)	Low (MH-08)
	Spatial Scale	Limited (MH-04, MH-11)	Isolated (MH-13, MH-14)	Isolated (MH-08)
	Frequency	Rare (3%)	Rare (4%)	Rare (4%)
Iron	Magnitude	Low (MH-11)	Moderate (MH-13)	Low (MH-08)
	Spatial Scale	Widespread (MH-04, MH-28, MH-11)	Widespread (All stations)	Widespread (MH-08, TRIBEWF01, MH-12)
	Frequency	Limited (6%)	Consistently (28%)	Limited (9%)
Lead	Magnitude	Moderate (MH-11)	Moderate (MH-13)	Low (MH-08)
	Spatial Scale	Widespread (Most stations)	Widespread (All stations)	Isolated (MH-08)
	Frequency	Consistently (20%)	Rare (4.5%)	Limited (5.2%)
Selenium	Magnitude	Low (MH-28)	Low (MH-13)	Low (MH-08)
	Spatial Scale	Widespread (Most stations)	Limited (MH-13, MH-14)	Isolated (MH-08)
	Frequency	Limited (7%)	Limited (9%)	Limited (9%)
Zinc	Magnitude	Moderate (MH-11)	Negligible	Negligible
	Spatial Scale	Widespread (Most stations)	Limited (MH-13, MH-16)	Limited (MH-08, TRIBEWF01)
	Frequency	Limited (18%)	Rare (1.8%)	Rare (4.1%)

Notes:

[1] Refer to **Appendix A Table A2-1** for the screening summary for each monitoring station.

[2] Summary:

[3] Magnitude: COPCs by drainage are highlighted according to the CCME WQGs based on the 95th percentile concentration at the worst case station in each drainage:

Negligible	Not a COPC (i.e. less than the screening criteria)
Low	SQ of 1 to 3
Moderate	SQ of 3 to 10
High	SQ > 10

[4] Spatial Scale: Isolated = exceedances at only 1 station; Limited = exceedances at 2 stations; Widespread = exceedances at more than 2 stations.

[5] Frequency of exceedance for all samples within the drainage: Rare = exceedance rate < 5%; Limited = exceedance rate between 5 and 20%; Consistently = exceedance rate > 20%.

[6] The majority of the chromium data from 2004 to 2013 had non-detects above the CCME and CSR WQG, and were not included in the screening summary.

3. SEDIMENT CHEMISTRY

3.1. LOE Description

The sediment chemistry LOE compares the available chemistry data against sediment criteria for the protection of aquatic life. The data is evaluated for potential spatial gradients and extent of contamination patterns downstream of the Site.

This LOE is applicable to aquatic plants, invertebrates, fish and amphibians.

3.2. Data Analysis

3.2.1. Overview

The following sediment data were used for this LOE:

- Azimuth collected two sediment samples were collected from near-field locations in Camp Creek, one upstream at station MH-04 and one downstream at MH-27 in 2013.
- A near-field sediment sample program was completed by Azimuth as part of the AERA in June and August 2014; including the following samples (a total of nine stations, see Figure 1–2 of Volume 3 for locations):
    - Six locations were sampled in Camp Creek (upstream to downstream): MH-04, CC-3, MH-28A, MH-27, MH-11 and CC-Confl (the confluence of Camp Creek and False Canyon Creek)
    - Two reference/background locations were sampled, one in Access Creek (MH-29, presumed to be within the mineralized zone of Sä Dena Hes) and another in a tributary of False Canyon Creek (MH-30) downstream from MH-11.
    - One sediment sample (MH-12A) was collected near water quality station MH-12 in North Creek (within Tributary E).
- Routine sediment samples were collected every two years in False Canyon Creek (stations MH-13, MH-16, MH-20, considered far-field) from 1992 to 2014 as part of the Water Licence. Data collected after 2000 was considered sufficient for assessing the sediment quality for the LOE. Prior to 2000, only a few analytes were analyzed (arsenic, cadmium, copper, lead, and zinc. The 1992-1998 data is reported in Laberge (2015).
- Laberge also collected a sediment sample at MH-30 (reference) in 2014.

3.2.2. Methods

Collection Methods

Near-field and reference sediments were sampled by Azimuth using a Beckson Pump (Guzzler method) that targets fine sediments from the hyporheic zone of the stream (see Azimuth 2014a for a detailed description of sediment collection and processing methods for near-field and reference sediments). Sediment was collected from the middle of the stream, away from the edges or bottom of the stream bank to target fine sediment. The Guzzler method is generally used in high-gradient streams where sediment is rarely deposited more than a few mm in thickness and where grab samplers would be ineffective for collection. The Guzzler method gathers a grain size consisting of fine sand or smaller, usually achieving a consistency in grain size and minimizing differences in metals concentrations due to different grain size materials. Sediment samples were analyzed for grain size, total metals (mg/kg dw), pH and organic carbon content (%) by ALS, Burnaby BC.

Far-field sediments in False Canyon Creek were collected by Laberge as part of a routine monitoring program from 1992 to 2014 collection of sediment using a hand trowel. Sediment was collected from near the stream bank, within what appeared to be depositional areas. Several trowel scoops were collected, composited and homogenized before passing through a 100 um sieve. These samples were also analyzed for total metals, but not grain size or TOC. Laberge also collected a sample at MH-30 using the hand trowel method.

To support the AERA, Laberge collected replicate samples from MH-30, MH-11 and the confluence of False Canyon Creek and Camp Creek using both the trowel and Guzzler methods to determine if the two collection methods produce similar chemistry results. Of note is that laboratory analyses for metals are routinely completed on the < 2 mm fraction (sand, silt and clay) for either field collection method as part of standard laboratory procedures. Sediment chemistry results from the trowel and guzzler methods are presented in Table 3-2 of Volume 1A (Azimuth 2015a). The two methods differed slightly in the results, notably for lead and zinc, with concentrations higher in the trowel method than the Guzzler method. This is likely due to different habitats sampled within each station, but without replication, it’s unknown whether the results are statistically “different”. For the purpose of the AERA, the Guzzler chemistry data collected by Laberge from MH-30, MH-11, and CC-Confl was used in the LOE assessment for consistency with the other near-field stations sampled in June.

Data Handling and Analysis

The Camp Creek, North Creek, and False Canyon Creek sediment chemistry data were tabulated and screened in Microsoft Excel. Plots of the chemistry data were generated using R software. Sediment metals data are compared to the BC Contaminated Sites Regulation (CSR) ‘sensitive’ ($SedQC_{SCS}$) and ‘typical’ (sediment quality ($SedQC_{TCS}$) criteria as well as the CCME probable effects levels (CCME 2015b).

3.2.3. Results

Sediment chemistry results up to and including 2013 has been previously summarized in: the Data Report (Azimuth 2014a), Volume 1 (Azimuth 2014d); 2014 sediment data is provided in Volume 1A (Azimuth 2015a). Arsenic, cadmium, lead, and zinc were identified as COPCs in both Camp Creek and False Canyon Creek receiving environments based on single-sample exceedances in the updated screening (see Volume 1A).

Sediment data relevant to this LOE (for COPCs identified above) are provided as follows:

- The 2014 near-field sediment chemistry data have not previously been reported, so a high-level summary of the sediment chemistry sampled specifically for the AERA in 2014 is provided below and in **Table A3-1** and **Figure A3-1**.
- Far-field sediment data from False Canyon Creek used in this LOE (2000 to 2014) are summarized in **Table A3-2** and shown in **Figure A3-2.** A narrative discussion of the sediment chemistry data collected in 2014 from False Canyon Creek is provided in the environmental monitoring report completed by Laberge (2015).

2014 Reference Stations (MH-30 and MH-29)

- **Conventional Parameters** –Sediment pH was consistently around 8.0 at all stations (including exposure), with a total organic carbon concentration of 2.7% and 6.6% at MH-29 and MH-30. Sediment grain size at MH-29 was dominated by silt (77%) with a small proportion of sand (14%). MH-30 was 61% sand and 30% silt.
- **Metals** – There were no exceedances of the sediment quality criteria at MH-30, possibly because of coarse grain size and/or the watershed south of Sä Dena being relatively less mineralized. Metals concentrations in sediments at MH-29 in Access Creek were more similar to concentrations in downstream exposure stations, possibly due to similarities in grain size. Arsenic, cadmium, lead and zinc exceeded the $SedQC_{TCS}$ at this reference station.

2014 Near-field Stations (Camp Creek and North Creek)

- **Conventional Parameters** – Sediment pH was near 8.0 and TOC ranged from 1.5 to 4%. Sediment grain size was dominated by silt/clay (41 – 78%) at all stations except at MH-11 (77% sand).
- **Metals** – Cadmium, lead and zinc exceeded the $SedQC_{TCS}$ at all Camp Creek stations; arsenic exceeded at least the $SedQC_{TCS}$ at all Camp Creek stations. The North Creek station (MH-12A) had no exceedances above applicable criteria with the exception of arsenic which exceeded the $SedQC_{SCS}$. Specifically:
    - **Arsenic** –All Camp Creek stations exceeded at least the $SedQC_{SCS}$; overall there appears to be a slight decrease in arsenic from upstream (MH-04) to downstream (MH-11).
    - **Cadmium** – Concentrations of cadmium decreased slightly from upstream to downstream on Camp Creek. Cadmium concentration was highest at MH-04, and was lowest at MH-11.
    - **Lead and Zinc** – These two metals have similar spatial patterns of concentrations within and between stations, from up to downstream. Information on the soil geochemistry of the Site indicates that these metals co-occur (Golder 2015b). Lead and zinc concentrations exceeded the $SedQC_{TCS}$ at MH-04, concentrations of these two metals then increase with increasing distance downstream of MH-04 to CC-3 (adjacent to the Reclaim Pond), to reach highest concentrations at MH-28A (just upstream of Portal Creek) and MH-27, just downstream from here (Note that the relative magnitude of difference between lead and zinc

was similar within stations, both from the guzzler samples as well as the trowel-collected samples.

3.3. LOE Attributes

3.3.1. Data Quality

Acceptable – Standard field and laboratory practices and QAQC procedures were applied for collection of sediment chemistry data. Data were then inspected by plotting the data and examining the variability within a station when multiple replicate samples were collected. No samples were excluded based on this assessment. Two different sampling methods have been used to collect sediments - the Guzzler was used in the near-field program whereas the trowel was used for the False Canyon Creek routing monitoring program. Because sampling methods were consistent within a waterbody and also because the comparison of replicate samples using the two methods showed both provided comparable metals chemistry, both methods are considered useful and acceptable for the LOE assessment.

3.3.2. Ecological Relevance

Low – Comparisons of sediment chemistry data to various benchmarks are considered to have low ecological relevance for predicting risks to aquatic receptors for the following reasons: (1) the LOE does not incorporate any site-specific information on effects to receptor communities themselves; (2) sediment deposits in the creeks are limited and are unlikely to be a key exposure media for aquatic receptors (only form a small part of contaminant exposure; (3) both the Guzzler sampling method and laboratory analysis (standard analysis is on the < 2.0 mm fraction) specifically targets the fine sediment fraction often associated with elevated metals concentrations, thus potentially overestimating bulk sediment concentrations.

3.3.3. Magnitude

Magnitude Interpretive Framework

The interpretive framework applied to assess the degree of contamination on a creek-by-creek basis for Camp Creek, False Canyon Creek, and Tributary E (North Creek) receiving environments is based on: (1) the magnitude of exceedance relative to the $SedQC_{SCS}$(2) the number of samples exceeding; and (3) the spatial extent of exceedances. The interpretive framework as follows:

- Magnitude:
  - Below Criteria (Negligible) = the same or lower than screening criteria
  - Above Criteria
    - Low = 1 to 3 times above screening criteria
    - Moderate = 3 to 10 times above screening criteria
    - High = Greater than 10 times above screening criteria

- Spatial Scale:
  - Isolated = exceedances at only 1 station within the receiving environment
  - Limited = exceedances at 2 stations
  - Widespread = exceedances at more than 2 sampling stations
- Frequency of Exceedance:
  - Rare = exceedance rate < 5%
  - Limited = exceedance rate between 5 and 20 %
  - Consistently = exceedance rate > 20%

The magnitude of exceedance was calculated as follows:

- Sediment chemistry data from Camp Creek and North Creek (collected with the Guzzler) is limited (2013 and 2014 only), so magnitude ratings are applied to each individual sample (**Table A3-1**). The worst-case magnitude of exceedance at any given station was applied to the entire sediment chemistry LOE for Camp Creek and North Creek.
- As there is long-term sediment chemistry data for False Canyon Creek stations (collected by hand trowel), magnitude ratings were applied to the 90th percentile concentration (2000 to 2014) at each False Canyon Creek station. The worst case magnitude of exceedance for a given COPC at the 90th percentile concentration was applied as the LOE rating.

Magnitude Rating

Camp Creek

- **Magnitude** – **Moderate** (cadmium, lead, zinc), **Low** (arsenic)
- **Spatial Scale – Widespread** sediment chemistry exceedances
- **Frequency – Consistently above criteria**

False Canyon Creek

- **Magnitude – Low** (arsenic, cadmium, lead, zinc)
- **Spatial Scale – Isolated** exceedances at MH-13, with concentrations below screening criteria at MH-16 and MH-20 (**Figure A3-2**).
- **Frequency – Consistently above criteria** at MH13 for arsenic, cadmium, lead, and zinc.

Tributary E

- **Magnitude – Low** (arsenic)
- **Spatial Scale – Unknown** (only 1 station)
- **Frequency – Unknown** (only 1 sample)

Overall Spatial Trends Relative to Reference

Patterns of metals (**Figure A3-1** and **A3-2**) indicate that arsenic and cadmium concentrations are elevated relative to sediment criteria throughout the Camp Creek watershed, including the reference location downstream at Access Creek (MH-29) and the farthest upstream station MH-04 (e.g., MH-29 has the highest concentrations of arsenic and lead). These data suggest that arsenic and cadmium in sediments may be naturally elevated above BC CSR and the CCME PEL.

Lead and zinc concentrations are somewhat elevated relative to criteria at the near-field reference station in Access Creek, but increase in Camp Creek sediments to reach highest concentrations a few hundred meters downgradient of the Mine Site at MH-28A and MH-27. The concentration pattern of these metals suggests that there has been enrichment of lead and zinc in sediment from groundwater and surface water sources beginning at the Mine Site (CC-3) and increasing downstream of the Tailings Facility at MH-28A and MH-27 and diminishing from MH-11 downstream. The relative contributions via surface water runoff (e.g., roads, disturbed soils) or groundwater is not known. It is possible that inputs from naturally mineralized soils along the flowpath of the stream, may contribute to the spatial gradient of lead and zinc in sediment. Golder's technical analysis of background vs mining-related soil metals concentrations indicated "*soil concentrations outside the areas directly impacted by mining can be naturally occurring; they would be related to the natural geological metal dispersion halo surrounding a zinc-lead skarn deposit*" (see Golder 2015b [Appendix C of the Volume 2 Addendum]).

Uncertainty About Magnitude

Camp Creek and North Creek – High for Exposure and Effects – A high uncertainty rating for the magnitude of exposure is applied for the near-field sediment data from Camp Creek and North Creek for the following reasons: (1) the limited amount of data available for analysis; and (2) dewatering activities were on-going during the sampling program in 2014 (i.e., the affect dewatering may have had on near-field sediment quality at MH-28A and MH-27 downstream from the Site is unknown).

False Canyon Creek – Low for Exposure; High for Effects – We consider uncertainty related to the magnitude of exposure to be low for the sediment chemistry LOE for False Canyon Creek because of the long-term dataset.

For all receiving environments, uncertainty related to extrapolating this LOE to effects to aquatic receptors is considered high because it does not incorporate any site-specific information on sediment characteristics or the aquatic receptors themselves. Note, uncertainty related to effects is provided in Table 3-1.

3.3.4. Causality

Causality - Strength of Correlation

Correlation (N/A); Supporting Evidence (Plausible) – This LOE identifies elevated sediment concentrations relative to effects-based benchmarks/standards. Because the standards are effects-based, they provide plausible supporting evidence for potential toxicity. However, because standards are derived to be conservative for multiple sites/environments, exceedance of a standard only indicates the *possibility* for an effect.

Uncertainty Related to Causality

High – While the mechanism of action is supported by the data underlying the sediment standards, this LOE does not incorporate site-specific information on effects to assess strength of relationships/causality.

Figure A3-1. Metals concentrations in sediment from near-field stations in Camp Creek and North Creek in 2013 and 2014.

Note: Only metals identified as COPCs for the Camp Creek stations were plotted against the BC CSR (sensitive and typical) and CCME (probable effect level [PEL]) sediment quality guidelines.

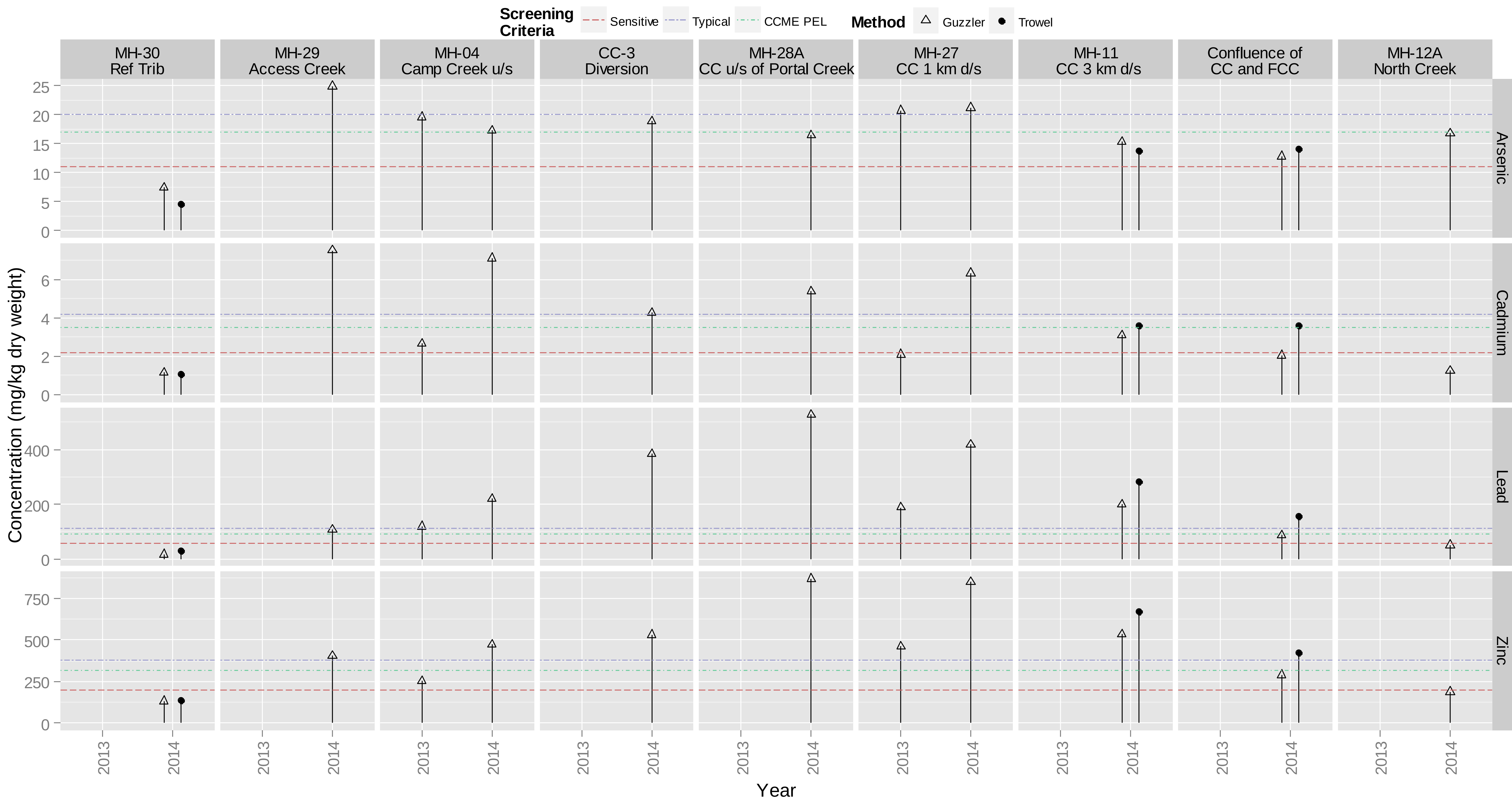

Figure A3-2. Sediment chemistry data for far-field monitoring locations in False Canyon Creek (2000-2014).

Notes: Only metals identified as COPCs for the False Canyon Creek stations were plotted against the BC CSR (sensitive and typical) and CCME (probable effect level [PEL]) sediment quality guidelines.

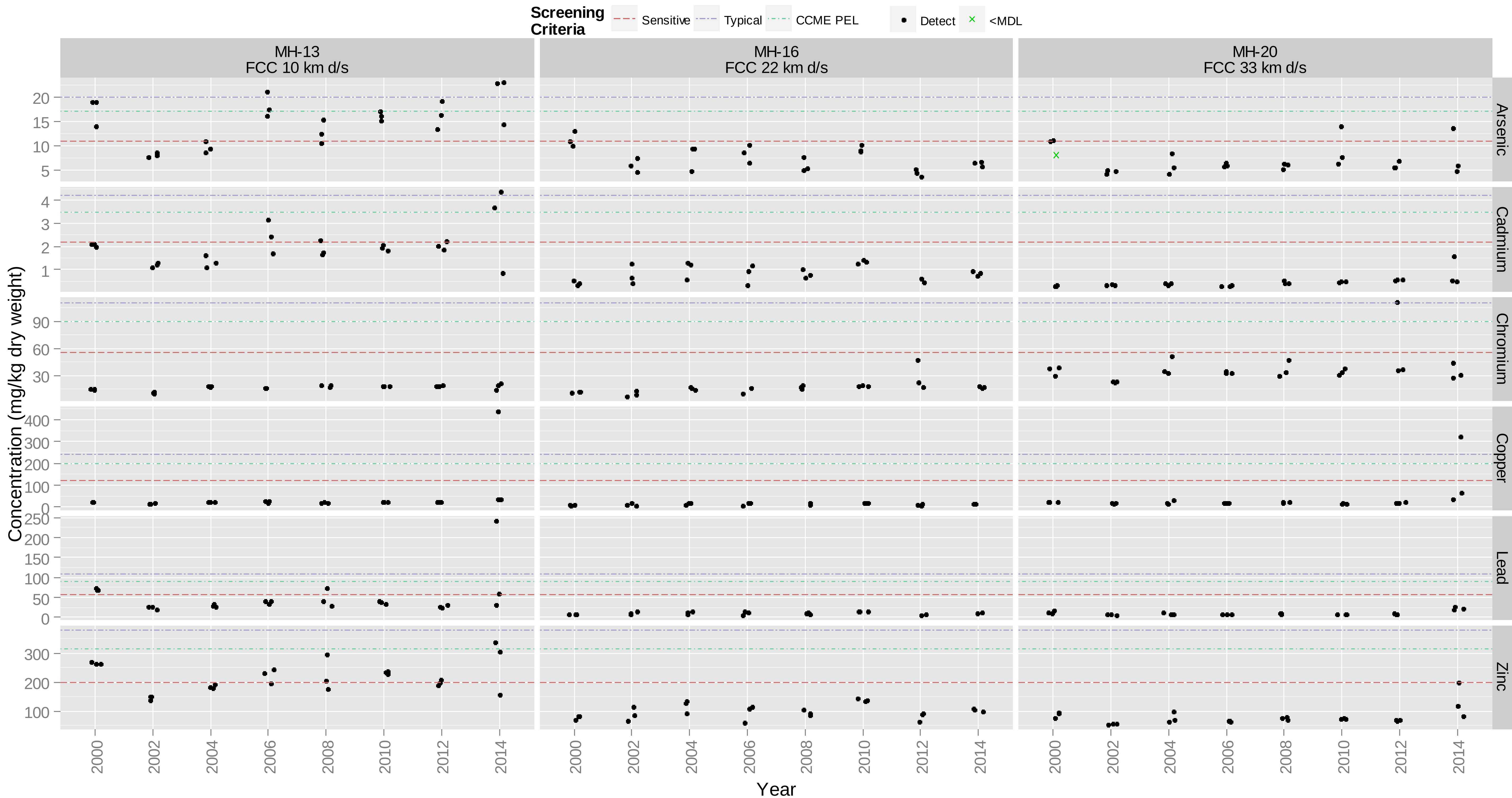

Table A3-1. Metals concentrations in sediment from the near-field monitoring stations in 2013 and 2014.

Sample ID / Location	Sediment Screening Criteria BC CSR[3] Sensitive[4]	Sediment Screening Criteria BC CSR[3] Typical[5]	CCME[1] PEL[2]	Reference: Unnamed Tributary to FCC	Reference: Access Creek	Average Reference	Camp Creek (2013): Camp Creek Upstream	Camp Creek (2013): Camp Creek u/s from Access Creek	Camp Creek (2014): Camp Creek Upstream	Camp Creek (2014): Camp Creek Diversion	Camp Creek (2014): Camp Creek u/s from Portal Creek	Camp Creek (2014): Camp Creek u/s from Access Creek	Camp Creek (2014): Camp Creek (2 km d/s)	Camp Creek (2014): Camp Creek u/s from the FCC Confluence	North Creek (2014)
Site Code				MH-30	MH-29		MH-04	MH-27	MH-04	CC-3	MH-28A	MH-27	MH-11	CC-Confl	MH-12A
Ref / Exp				Reference	Reference		Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure	Exposure
Date				23-Aug-14	25-Jun-14		27-Jun-13	27-Jun-13	24-Jun-14	24-Jun-14	25-Jun-14	25-Jun-14	23-Aug-14	23-Aug-14	24-Jun-14
Method				Guzzler	Guzzler		Guzzler	Guzzler	Guzzler	Guzzler	Guzzler	Guzzler	Guzzler	Guzzler	Guzzler
Physical Properties															
Moisture				47.5									36.7	36.2	
pH				7.6	8.05		8.07	8.24	7.96	8.08	8.09	8.07	8.25	8.27	8.12
Gravel				1.92	<0.10		9.19	15.8	<0.10	<0.10	<0.10	<0.10	2.48	2.58	<0.10
Sand				60.7	14.6		71.6	80.9	46.4	37.8	59	21.3	77.1	77.4	63.8
Silt				33.2	77.4		16.5	2.82	49	52.6	36.6	67.7	18.4	17.3	32.6
Clay				4.2	8		2.66	0.51	4.65	9.61	4.41	11	2	2.71	3.61
TOC				2.67	6.61		1.35	0.24	4.07	2.7	1.65	3.82	1.45	1.36	1.58
Total Metals (mg/kg dry weight)															
Arsenic	11	20	17	7.41	24.9	16.2	19.6	20.7	17.3	18.9	16.5	21.2	***15.3***	***12.8***	16.8
Cadmium	2.2	4.2	3.5	1.14	7.51	4.33	***2.67***	***2.1***	7.11	***4.27***	5.38	6.33	***3.11***	***2.05***	***1.26***
Chromium	56	110	90	15.8	32	23.9	***22.1***	***23.0***	28.3	25.6	25.3	23.9	***18.4***	***16.2***	24.1
Copper	120	240	197	15.8	30.9	23.4	***17.9***	***19.6***	25.7	25.1	***18.6***	***23.0***	***15.4***	***18.2***	***16.9***
Lead	57	110	91.3	15.7	107	61	119	188	219	384	527	418	200	87	***50***
Mercury	0.3	0.58	0.486	0.072	0.053	0.063	***0.0216***	***0.0143***	<0.050	***0.055***	<0.050	<0.050	***0.0189***	***0.0363***	<0.050
Zinc	200	380	315	132	406	269	***252***	462	473	530	867	848	533	289	***187***

Notes:

[1] CCME (2014b) Canadian Sediment Quality Guidelines for the Protection of Aquatic Life - Summary Tables.

[2] PEL - probable effect level.

[3] BC MOE (2011) CSR Schedule 9: Generic numerical sediment criteria. BC Reg 375/96. May 31, 2011.

[4] Sensitive Contaminated Sites Guideline.

[5] Typical Contaminated Sites Guideline.

COPCs by are highlighted according to the magnitude of exceedance of the BC Sensitive Contaminated Site Guideline:

Low	1 to 3 times the guideline
Moderate	3 to 10 times the guideline
High	> 10 times the guideline
Bold, italics	Concentration is ***less than*** the average reference sediment concentration from MH-29 and MH-30 (Guzzler samples only).

Table A3-2. Summary of metals concentrations in sediment from the monitoring stations in False Canyon Creek, 2000-2014[1].

Parameter	CCME[2] PEL[3]	BC CSR[4] Sensitive[5]	BC CSR[4] Typical[6]	Reference[7] (MH-30)	N	N > SQG	% > SQG	Min	Mean	90th%ile	Max
MH-13 (10 km downstream)											
Arsenic	17.0	11.0	20.0	4.6	24	17	71%	7.7	14.8	20.4	23.0
Cadmium	3.5	2.2	4.2	1.07	24	5	21%	***0.86***	2.0	3.0	4.3
Chromium	90	56	110	18.3	24	0	0%	***10.2***	***16.7***	19.2	21.9
Copper	197	120	240	19.0	24	1	4%	***15.4***	41.1	32.6	439
Lead	91.3	57	110	30.8	24	6	25%	***18.9***	48.5	72	243
Mercury	0.486	0.3	0.58	0.052	18	0	0%	0.070	0.089	0.10	0.13
Zinc	315	200	380	139	24	14	58%	139	218	288	338
MH-16 (22 km downstream)											
Arsenic	17.0	11.0	20.0	4.61	24	2	8%	***3.5***	7.4	10.2	13.0
Cadmium	3.5	2.2	4.2	1.070	24	0	0%	***0.30***	***0.82***	1.3	1.4
Chromium	90	56	110	18.3	24	0	0%	***7.4***	***16.6***	19.0	47.6
Copper	197	120	240	19.0	24	0	0%	***7.5***	***14.3***	19.9	21.1
Lead	91.3	57	110	30.8	24	0	0%	***6.2***	***11.1***	***14.9***	***15.6***
Mercury	0.486	0.3	0.58	0.052	18	0	0%	***0.050***	0.062	0.080	0.090
Zinc	315	200	380	139	24	0	0%	***60***	***100***	***134***	144
MH-20 (33 km downstream)											
Arsenic	17.0	11.0	20.0	4.6	23	4	17%	***4.1***	6.9	11.0	14.0
Cadmium	3.5	2.2	4.2	1.07	24	0	0%	***0.27***	***0.46***	***0.55***	1.6
Chromium	90	56	110	18.3	24	1	4%	22.4	37.4	46.3	112
Copper	197	120	240	19.0	24	0	0%	***11.5***	20.3	23.4	37.2
Lead	91.3	57	110	30.8	24	0	0%	***6.7***	***11.1***	***19.0***	***27.7***
Mercury	0.486	0.3	0.58	0.052	18	0	0%	***0.050***	0.063	0.074	0.20
Zinc	315	200	380	139	24	1	4%	***55***	***80***	***99***	200

Notes:

[1] Sediment collected between 2000 and 2014 by Laberge using a hand trowel. Refer to Table 3-3 in Volume 1A (Azimuth 2015a) for the complete dataset.

[2] CCME (2014b) Canadian Sediment Quality Guidelines for the Protection of Aquatic Life - Summary Tables.

[3] PEL - probable effect level.

[4] BC MOE (2011) CSR Schedule 9: Generic numerical sediment criteria. BC Reg 375/96. May 31, 2011.

[5] Sensitive Contaminated Sites Guideline.

[6] Typical Contaminated Sites Guideline.

[7] Trowel sample collected at MH-30 in 2014.

[8] Data Summary:

COPCs by are highlighted according to the exceedance of the BC Sensitive Contaminated Site Guideline:

Low	1 to 3 times the guideline
Moderate	3 to 10 times the guideline
High	> 10 times the guideline
Bold, italics	Concentration is ***less than*** the reference sediment concentration MH-30 (2014 trowel sample).

4. FISH TISSUE CHEMISTRY

4.1. LOE Description

This LOE relies primarily on fish tissue chemistry data collected for slimy sculpin from two sampling areas by Laberge during the August 2014 survey. Historical data from 1992 is presented for comparative purposes, but the results are not integrated into the LOE assessment because of uncertainty regarding the data quality and elevated detection limits for some COPCs[6].

4.2. Data Analysis

4.2.1. Overview

The 2014 fish tissue component of the AERA was conducted in light of the lack of available information on the level of metals exposure for fish residing downstream from the Site. The intent of the program was to collect replicate fish from the reference location (MH-30) and the nearest exposure station (MH-13) where slimy sculpin have been recorded in previous years. Poor catch success at MH-13 in 2014 meant the exposure location was changed to MH-16 where catch success was higher. MH-30 is considered a reference location for other LOEs of the AERA; however, slimy sculpin collected at MH-30 were captured at or within approximately 100 m of the confluence to False Canyon Creek (CC-Confl), an exposure location. Fish movement between MH-30 and CC-Confl is likely, precluding reference/exposure comparison of metals concentrations for this LOE. As such, CC-Confl / MH-30 and MH-16 are considered to represent near-field and far-field exposure sites, respectively. Data have been organized as follows:

- **Near-field Exposure:**
  - MH-30 (unnamed tributary to False Canyon Creek) and CC-Confl (the confluence of Camp Creek and False Canyon Creek)
- **Far-field Exposure**:
  - MH-16 (on the mainstem of False Canyon Creek, approximately 22 km downstream of the reclaim pond)

Prior to 2014, the only available fish tissue chemistry results were from an August 1992 survey of False Canyon Creek completed by P.A. Harder and Associates. This program captured slimy sculpin from four locations on the mainstem of False Canyon Creek: MH-13, MH-14, MH-19, and MH-20. Arctic grayling and a single round whitefish were also captured from the lower False Canyon Creek at the confluence of the

[6] Bonnie Burns (Laberge Environmental Services) provided scanned pages showing the tabulated concentrations of some metals, but maps showing sampling locations, sampling methods, and complete laboratory results were not available for review.

Frances River (Harder, 1992), but for the purpose of the AERA, only the slimy sculpin data from 1992 are shown here given the 2014 tissue chemistry program was limited to this species.

4.2.2. Methods

Collection Methods

Laberge collected fish for lethal sampling using a Smith Route model LR24 battery powered electro-fisher was used for fish capture. Captures were identified and measured for length (± 1mm) and weight (± 0.1gm). Five slimy sculpin from MH-30 and five slimy sculpin from MH-16 were retained for tissue chemistry analysis. Fish retained for chemistry analysis were submitted frozen to ALS Laboratories in Whitehorse. Whole-body metals concentrations were analyzed at the ALS laboratory in Burnaby, BC (refer to **Appendix C** for the ALS report). Tissues were analyzed by ICP-MS (inductively coupled mass spectrometry) for total metals and reported in dry weight. Percent moisture was reported for each sample to allow conversion to wet weight concentrations.

The methods section in the Harder (1992) report was not available for review, so the fish collection method(s) used in this survey is not known. Metals analysis was carried out using inductively coupled argon plasma (ICAP), and fish were treated as composite whole tissue samples for each location. The ICAP analysis included 33 elements, but only arsenic, cadmium, chromium, copper, lead, manganese, nickel, and zinc were provided in the main report. The full list of results is in an appendix that was not available for review.

Data Handling and Analysis

The fish tissue chemistry data were tabulated and screened in Microsoft Excel. Plots of the chemistry data were generated using R. Tissue metals data are qualitatively compared between near-field and far-field exposure sites. No statistical comparisons were made due to the low sample size. Metal concentrations in near-field samples that were more than two fold above the average far-field sample concentration were bolded, concentrations more than 10 times the maximum far-field sample concentration were shadowed.

4.2.3. Results

Slimy sculpin tissue chemistry data from near-field exposure and far-field exposure samples are presented in **Table A4-1** and plotted in **Figure A4-1**. Fish from near-field and far-field stations had similar weight (2.2 – 15.6 g) and length (7.6 – 11.5 cm) ranges. The moisture content was between 72 and 83% (**Table A4-1**).

As there are no relevant screening values for tissue chemistry, the assessment focused on the AERA COPCs for water (aluminum, cadmium, chromium, copper, lead, iron, selenium, zinc) and sediment (arsenic, cadmium, lead, zinc). COPC concentrations in fish tissue (with the exception of selenium and copper) tended to be elevated in near-field samples relative to far-field (generally less than 2 times the average far-field concentration). Lead concentrations in three near-field samples were greater than 10-fold higher than the average far-field concentrations.

The 1992 slimy sculpin chemistry data (dry weight) are shown in **Table A4-2** alongside the average concentrations for slimy sculpin collected in 2014. The results are shown to allow for a rough comparison of how concentrations in far-field False Canyon Creek stations compare between 1992 and 2014. Conclusions about temporal changes in tissue concentrations should be avoided based on the limited amount of data combined with advances in the analytical methods between 1992 and 2014.

The 1992 tissue chemistry results for aluminum, iron, and selenium were not shown in the main report that was available for review, so it's unknown if the concentrations are similar to those reported for slimy sculpin in the 2014 survey. In the case of arsenic and lead, elevated detection limits in 1992 (10 µg/g for arsenic and 2 µg/g for lead) preclude any meaningful comparison of the results. Of the remaining COPCs reported in 1992, concentrations are within the range reported in 2014 for cadmium and copper, and slightly lower than the 2014 concentrations for zinc (**Table A4-2**).

4.3. LOE Attributes

4.3.1. Data Quality

Acceptable – Data quality of fish tissue data from 2014 is considered acceptable based on standard field and laboratory QA/QC measures that were used. No data quality issues have been identified. The 1992 tissue chemistry data is present for comparison, but the quality of the data is unknown because the full report was not available for review.

4.3.2. Ecological Relevance

Low–Tissue samples collected from the site represent site-specific exposures, but effects are not directly assessed. As a result, this LOE is considered to have low ecological relevance for predicting risks to fish.

4.3.3. Magnitude

Magnitude Interpretive Framework

Degree of contamination ratings for near-field tissue concentrations, relative to far-field, was based generally on the following categories:

- Negligible– similar or lower than far-field concentrations
- Low = less than 2 times above far-field
- Moderate = 2 to 10 times above far-field
- High = Greater than 10 times above far-field

The magnitude of exceedance, but also the frequency of near-field samples exceeding far-field sample concentrations was considered in the degree of contamination ratings.

- Negligible = no samples at least 2 times average far-field
- Low = up to 2 of 5 samples at least 2 times average far-field

- Moderate = 3 of 5 samples times at least 2 times average far-field
- High = 4 or more samples at least 2 times average far-field

Magnitude Rating

The magnitude ratings for near-field exposure when compared to far-field exposure are as follows:

- **Magnitude – High** (lead), **Moderate** (arsenic, aluminum, cadmium, chromium, iron), Low (copper, selenium, zinc)
- **Frequency – High** (lead), **Moderate** (cadmium), **Low** (aluminum, arsenic, chromium, iron), **Negligible** (copper, selenium, zinc)

Uncertainty About Magnitude

High for Exposure and Effects – For this LOE we consider uncertainty related to the magnitude of exposure to be high due to the relatively low number of sample locations and the uncertain movement patterns and spatial exposure for fish (i.e., possibility that fish collected at the near-field exposure site may have been not been exposed to mine influence if they have resided at MH-30 for their entire life history). Uncertainty related to extrapolating this LOE to effects to fish is considered high because it is a measure of exposure only and effects information is not considered.

4.3.4. Causality

Causality - Strength of Correlation

N/A – Causality not assessed.

Uncertainty Related to Causality

N/A – Causality not assessed.

Figure A4-1. Slimy sculpin (*Cottus cognatus*) tissue chemistry, 2014.

Notes: Near-field refers to the area where Camp Creek, False Canyon Creek and MH-30 (reference) converge. Far-field refers to station MH-16 which is located 22 km downstream of the Site on False Canyon Creek. Green symbol = detection limit (raised in this sample).

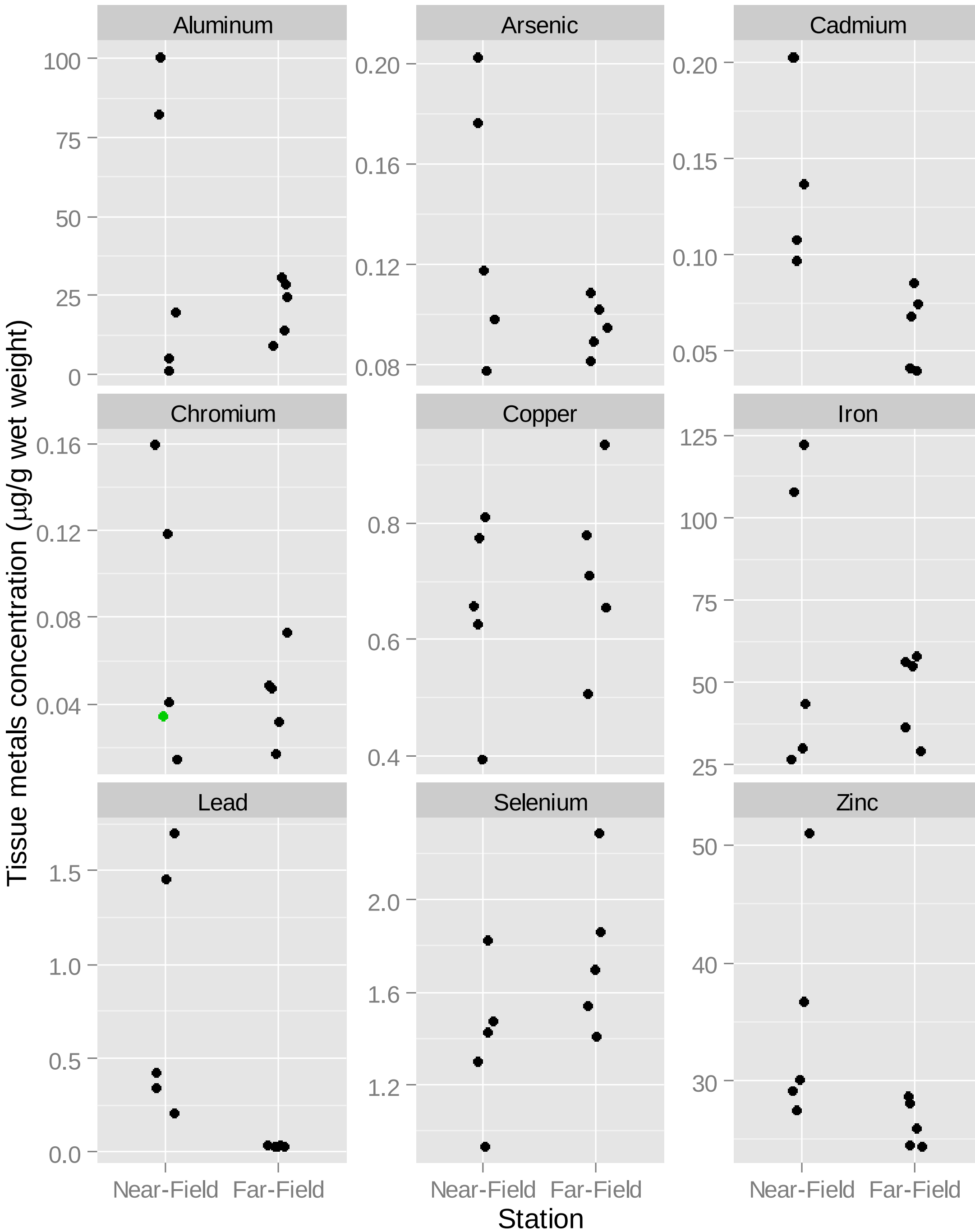

Table A4-1. Whole-body metals concentrations (µg/g wet weight) in slimy sculpin (*Cottus cognatus*) from False Canyon Creek, 2014.

	Far-Field Exposure (MH-16)						Near-Field Exposure (CC-Confl / MH-30)				
Site Code	False Canyon Creek (22 km downstream)						Confluence of Camp Creek and False Canyon Creek				
Replicate	1	2	3	4	5	**Average**	1	2	3	4	5
Weight, Length, and Moisture											
Weight (g)	15.6	7.1	6.3	4.4	4.8	7.64	12.1	11.8	11.1	6.2	2.2
Length (cm)	11.5	8.8	8.1	7.6	7.6	8.72	9.8	10.1	9.8	8	6.6
Moisture (%)	79.2	79.2	77.8	77.4	75.7	77.9	79	76.3	77.6	72.1	82.8
Total Metals (µg/g wet weight)[1]											
Aluminum	9.13	24.8	28.6	30.7	14.2	21.5	82.3	5.4	19.9	100.7	1.4
Arsenic	0.090	0.082	0.103	0.109	0.095	0.096	0.203	0.078	0.118	0.176	0.098
Cadmium	0.040	0.041	0.085	0.075	0.068	0.062	0.203	0.098	0.108	0.203	0.138
Chromium	0.017	0.047	0.049	0.073	0.032	0.044	0.119	0.015	0.041	0.160	<0.0344
Copper	0.508	0.655	0.935	0.780	0.712	0.718	0.811	0.628	0.659	0.776	0.396
Iron	29.3	55.3	56.4	58.1	36.5	47.1	107.9	30.3	43.9	122.2	27.0
Lead	0.030	0.037	0.032	0.038	0.041	0.035	1.701	0.214	0.347	1.456	0.427
Selenium	1.41	2.29	1.70	1.86	1.55	1.762	1.306	1.429	1.481	1.825	0.934
Zinc	28.1	24.5	26.0	24.4	28.7	26.3	51.0	29.2	27.6	30.1	36.8

Notes:

[1] Results were reported by ALS as dry weight concentrations. Results were converted to wet weight with the following equation:

wet weight concentration = (dry weight concentration) * [1 - (% Moisture/100)]

[2] Detection limit was raised due to detection of the analyte at comparable levels in the method blank.

< 2 fold > than average far-field
2 - 10 fold > than average far-field
> 10 fold average far-field

Table A4-2. Whole-body metals concentrations (µg/g dry weight) in slimy sculpin (*Cottus cognatus*) from False Canyon Creek, 1992 compared to 2014.

Study	Environmental Assessment of False Canyon Creek, 1992 Study[1]				2014 AERA[2]	
Site Code	MH-13	MH-14	MH-19	MH-20	MH-16	CC-Confl / MH-30
Total Metals (µg/g dry weight)						
Aluminum[3]	-	-	-	-	97.3	175
Arsenic	<10	<10	<10	<10	0.43	0.60
Cadmium	0.4	0.2	0.3	0.4	0.28	0.68
Chromium	3.7	3.9	4.6	4.3	0.20	0.32
Copper	3.6	3.0	3.6	3.5	3.24	2.91
Iron[3]	-	-	-	-	214	287
Lead	<2	<2	<2	<2	0.16	3.65
Selenium[3]	-	-	-	-	8.01	6.17
Zinc	88.1	85.8	106	93.4	119	162

Notes:

[1] 1992 fish tissue concentrations were reported in dry weight by P.A. Harder & Associates Ltd. (1992).

[2] The 2014 chemistry data are shown in dry weight (average) to allow for comparison with the 1992 data.

[3] Results for these metals were contained in an appendix that was not available for review.

5. QUALITATIVE FIELD SURVEY OF AQUATIC PLANTS

5.1. LOE Description

This LOE provides qualitative documentation of presence, and relative composition of the macrophyte community. This LOE does not provide quantitative ratings for effect size and other metrics and is presented as a narrative.

This LOE is used for aquatic plant communities.

5.2. Narrative Summary

Habitat and plant presence information was collected during a site visit in June 2014.

Camp Creek is a moderate to high energy stream with a 2 – 3 % gradient, moderate flow velocity (>0.5 m/s) and tightly packed, heterogeneous bottom substrate. Upstream areas of the stream are quite typical, with a shallow profile, cobble/gravel substrate and a riparian cover that does not encroach within the stream. Downstream of the Tailings Facility the stream becomes increasingly confined, with near vertical sides of the stream and flat bottom, resembling a U-shaped trench. The stream flows around and between willow roots, suggesting the stream may recently have altered its course.

In Camp Creek and upper False Canyon Creek there appears to be little evidence of in-stream plant community. While riparian vegetation was abundant at all sampling locations, with the exception of North Creek where it was sparse, rooted macrophytes were absent during the June survey. Lack of emergent or submerged macrophytes could be explained by the creek characteristics: shallow profile, moderate velocity, steep gradient in some sections, and limited depositional areas. Additionally, the creek bed path changes from year-to-year in some areas. Early stages of periphyton colonization were observed at some locations (i.e., M-12A in North Creek) in June (early in growing season). No samples were collected for periphyton as the substrate was not suited to the preferred sampling technique. The lower reaches of False Canyon Creek are larger water bodies that likely better supports aquatic growth.

Benthic invertebrates rely on healthy phytoplankton/periphyton communities. The benthic invertebrate community in Camp Creek and upper False Canyon Creek is generally healthy (see **Sections 6** and **7**) both in richness and abundance) giving possible indication that aquatic plant community is healthy.

6. BENTHIC INVERTEBRATE FIELD SURVEY – NEAR-FIELD STATIONS

6.1. LOE Description

The benthic invertebrate field survey LOE quantitatively compares the total abundance and richness of the benthic invertebrate community, with a focus on sensitive taxa, for assessing the structure and ecological function of the benthic invertebrate community in Camp Creek and Tributary E. The Camp Creek and Tributary E sampling stations are compared to reference stations sampled at the same time. Additionally, any observed effects on benthic invertebrate community were qualitatively compared to water and sediment chemistry patterns to determine if effects are potentially mine related.

This LOE assessment is applicable to the benthic invertebrate community in the Camp Creek and North Creek (Tributary E) receiving environments.

> The benthic invertebrate field assessment LOEs are reported separately by receiving environment in this Appendix. These LOEs have been separated because the underlying study methods/designs are different, which led to different LOE assessment approaches:
>
> - The near-field program was a one-time study (2014) based on a "CABIN" protocol using a 400 µm mesh kick-net, which incorporated two local reference stations (Section 6).
> - The far-field LOE used data from a long-term (1992-2014) monitoring program in False Canyon Creek conducted by Laberge, which uses a Surber sampler with a 300 µm mesh net and has a gradient design (upstream with higher exposure versus downstream) (Section 7). The intent was to use the metrics and information provided by Laberge for this receiving environment.

6.2. Data Analysis

6.2.1. Overview

This LOE analyzes the benthic invertebrate community data that was collected from near-field locations (Camp Creek and North Creek) in 2014. Sampling was conducted at stations along length of Camp Creek, as well as in Portal Creek, North Creek, and two reference areas to assess the overall health of the benthic invertebrate community near the Site. Benthic invertebrate samples were collected from the following locations (see also Table 2-1 and Figure 1-3 in the Volume 3 main report):

- **Camp Creek**
    - Camp Creek: MH-04, CC-3, MH-28A, , MH-27, MH-11, CC-Confl
    - Portal Creek: MH-28
- **Tributary E**
    - North Creek: MH-12A
- **Reference**
    - Access Creek: MH-29

  - Unknown Tributary to False Canyon Creek: MH-30 (reference)

The program was completed in two sampling events:

- The first sampling event was completed by Azimuth between June 22nd and 27th, 2014. Samples were collected from MH-04 to MH-27 along Camp Creek, MH-28 in Portal Creek, MH-12A in North Creek, and MH-29 in Access Creek.
- The second survey was completed by Laberge at MH-11, MH-30, and CC-Confl between August 23rd and 25th, 2014 at the same time as the benthic invertebrate community sampling program in False Canyon Creek (see **Section 7** of this appendix), due to the need for helicopter access at MH-11 and CC-Confl.

The same sampling protocol was used in both the June and August sampling events to allow for qualitative comparison of the benthic invertebrate community data despite the surveys being completed in different seasons.

The sampling station MH-12A receives potential source loading from the North Tailings Dam seep, although SRK has concluded the load is so small that it does not affect downgradient surface water quality (SRK 2014d). Nonetheless, this location can be considered a "worst case" monitoring location for the benthic invertebrate community in Tributary E, as the station is situated closest to the source in an area that is suitable for benthic invertebrate sampling.

6.2.2. Methods

Collection Methods

Benthic invertebrate community samples were collected using travelling kick-net protocol described in (Environment Canada 2012b, Canadian Aquatic Biomonitoring Network [CABIN] protocols) by both Azimuth and Laberge. The method involves walking backwards upstream over a 3 minute period while disturbing the substrate by foot, allowing the current to wash dislodged benthic invertebrates into the kick-net (400 µm mesh). The end of the net is fitted with a cod-end that allows water to flow through, but retain the organisms and debris. Under optimal conditions, the person sampling walks backwards in a zigzag pattern across the width of the stream to integrate benthic invertebrates from various stream microhabitats within the erosional zone (for example, areas around large boulders, riffle, runs, bank overhang) in proportion to their occurrence in a sample reach.

Marginal habitat conditions at some stations led to some modifications to the sampling protocol (see **Appendix B** for photographs and general habitat descriptions for each station). Sampling locations were preferentially chosen in areas of the reach with riffle/run, and where the depth of water was at least 15 cm (Environment Canada 2012b); however, at MH-28, MH-27, and MH-29, the narrow stream width confined the sampling efforts to defined areas in the creeks. In the event that obstructions were encountered, or the depth of the creek became too shallow, the sampling time was paused and the kick-net was removed from the water column. The timer was restarted once the sampler had relocated and resumed sampling. Heavy amounts of in-stream debris impeded continuous sampling at MH-28, MH-27, and MH-29, as did the overgrowth of willow at the stations. In the case of MH-28 and MH-29, the suitable habitat for a 3 minute kick sample could not be found. Two minute kick times were used at both locations (see below for a discussion of the data handling).

After the sample was collected, the kick-net was removed from the water column and inspected for benthic invertebrates adhered to the mesh and seams inside of the kick-net. A squirt bottle was used to rinse these organisms to the cod-end, and then into pre-labeled 500 mL plastic containers. A considerable amount of debris (sand, wood, small cobble) was accumulated in the net during sampling at some of the stations. In such cases, the kick-net was periodically emptied into a 20 L bucket before resuming sampling. The bucket swirling method described in Environment Canada (2012b) was used to elutriate the benthic invertebrate from the debris once the kick-time was completed. Benthic invertebrates were poured back into the kick-net and then transferred to the 500 mL container as a way of reducing the volume of debris in the sample. Each sample was preserved using 10% buffered formalin and shipped to Biologica Environmental (Victoria, BC) for taxonomic identification.

Benthic invertebrate samples were processed following the CABIN Laboratory Protocol (Environment Canada, 2012b). Taxonomic identification was completed to the lowest practical level (species where possible). Details of the sorting procedure, identification, and QA measures used by Biologica are provided in **Appendix D**.

Data Handling and Analysis

Benthic invertebrate taxonomy results from 2014 were compiled into a MS Access database by Biologica. Raw taxonomic data was entered as the total abundance of each taxon at the lowest practical level of identification. In the case of MH-28 and MH-29, only 2 minute kicks were completed, so the taxon abundance was multiplied by 1.5 to standardize all the stations to a 3 minute kick time. Within the database, an exclusion filter was applied to remove specific taxa from the data set. Consistent with CABIN methods (Environment Canada 2012c), this filter was used to remove ostracods, cladocerans, rotifers, copepods, sponges, nematodes, flat worms, vertebrates, and non-aquatic taxa. Filtered raw data were imported to R (v 2.15.2) where the following metrics were calculated for each sample (all are based on a 3 minute kick time):

- Total abundance (number of individuals)
- Richness (total number of different taxonomic groups) by major taxa group (crustacea, diptera, ephemeroptera, plecoptera, trichoptera, and other taxa).
- EPT (ephemeroptera, plecoptera, trichoptera) taxa metrics - Abundance and richness of EPT taxa expressed as totals and percentages of each sample. The percentage of each benthic sample comprised of organisms from the EPT taxa is a good indicator of overall benthic invertebrate community health given the sensitivity of these taxa to metals and environmental changes.

Quantitative analysis of the results for the LOE assessment (**Section 6.3.3**) were made using the reference data paired with exposure stations sampled during the same survey. Near-field exposure stations sampled in June were compared against the MH-29 benthic invertebrate community and MH-11 and CC-Confl sampled in August were compared against the MH-30 benthic invertebrate community. MH-11 was compared to the MH-30 reference due to the timing of the survey; however, MH-29 is also a suitable reference spatially. Due to this ambiguity, MH-11 was compared to both reference stations.

While the CABIN protocol described in Environment Canada 2012b was used for sampling and laboratory methodology, data analyses did not include comparisons to the reference dataset as described in the CABIN protocols.

6.2.3. Results

Plots of the benthic invertebrate community metrics are presented in **Figure A6-1** to **Figure A6-3**. Total abundance and richness is plotted in **Figure A6-1** alongside the abundance and richness of the EPT taxa (ephemeroptera, plecoptera, and trichoptera). **Figure A6-2** shows the absolute number of individuals (abundance) and taxa (richness) in each sample for the major taxonomic groups. **Figure A6-3** shows the relative abundance and richness in each sample. The abundance and richness data are presented in **Table A6-1**. Discussion of the benthic invertebrate community is presented below in **Section 6.3**.

6.3. LOE Attributes

6.3.1. Data Quality

Acceptable –Standard procedures were applied to the degree possible to ensure consistency when counting and weighing organisms, including reviewing taxonomy relative to invertebrate guide books and having two staff involved with taking measurements as a QA check. No data quality issues were identified.

6.3.2. Ecological Relevance

High– The field measurements target the assessment endpoint for benthic invertebrates, specifically the structure and ecological function of the invertebrate community.

6.3.3. Magnitude

Approach

The focus of the effects assessment was on changes to the benthic invertebrate community, relative to reference stations sampled in the study, as a result of COPC exposure downstream of the Site rather than differences caused by habitat/physical characteristics.

Effects related to COPCs are expected to manifest as reduced abundance and richness in sensitive EPT taxa (Rosenberg and Resh 1993). A generalized response pattern would include reduced EPT taxa abundance and richness accompanied by increased dipteran (chironomids) taxa abundance and richness with increasing metals. Among the EPT taxa, mayfly larvae (ephemeropterans) are particularly sensitive (Clements et al. 2000; Kiffney and Clements 2003). Reduced benthic invertebrate abundance in the absence of reductions in the number of EPT individuals or EPT taxa was considered evidence in support of habitat/physical stressors as the probable cause of the observed difference between reference and exposure stations rather than exposure to COPCs in water and/or sediment.

Magnitude Interpretive Framework

Two steps were used to determine derive a magnitude of effect rating; the second step emphasizes changes to the benthic invertebrate community that may be attributable to COPCs:

1. Total abundance, richness and EPT metrics (percent EPT abundance and EPT richness) were assessed for each station relative to the appropriate reference location[7]. If no difference (< 10%) in these metrics was observed at the exposure stations, then potential effects were considered negligible for that location.

    - Negligible = No difference (<10%) in total abundance, richness, EPT richness or percent EPT abundance, relative to the reference.

    Stations where there was a reduction in one of these metrics relative to reference were carried forward to the second step to determine the magnitude of effects rating.

2. In the second step, the community composition metrics (specifically the EPT percent abundance and richness) at the exposure stations relative to reference, were used to determine the magnitude of the effect ratings (regardless of effect sizes based on total abundance and richness) according to:

    - Negligible = Difference (>10%) in total abundance or richness, but no difference (<10%) in EPT richness or percent EPT abundance, relative to the reference.
    - Low = between 10% and 20% reduction in number of EPT taxa or percent EPT abundance relevant to the reference.
    - Moderate = between 20% reduction in number of EPT taxa or percent EPT abundance relevant to the reference.
    - High = greater than 50% reduction in number of EPT taxa or percent EPT abundance relevant to the reference.

[7]The near-field Camp Creek and Portal Creek stations sampled in June (MH-04, CC-3, MH-28A, MH-28, and MH-27) were compared with the reference station MH-29 on Access Creek, while the downstream stations in Camp Creek sampled in August (MH-11, CC-Confl) were compared to MH-30 to account for potential effects of seasonality in the analysis.

Magnitude Rating

Camp Creek

- **Magnitude of Effect**:
    - **Low** – at MH-04, MH-28, and MH-27
    - **Negligible** – at CC-3, MH-28A, CC-Confl and MH-11 (relative to both references)

A low magnitude of effects rating was applied to MH-04 (upstream Camp Creek) based on slightly lower total richness (11%, Step 1) as well as lower EPT richness and percent EPT abundance relative to the reference area MH-29.

Total abundance was more than 50% lower at MH-28A and MH-27 relative to the abundance at the reference location MH-29 (**Table A6-1**). Both stations had similar numbers of EPT taxa relative to reference (17 EPT taxa at MH-28A, 19 at MH-27, 18 at MH-29), and Station MH-28A percent EPT abundance was not considered different from reference (negligible effects). A slight reduction in the percent EPT abundance at MH-27 compared to reference resulted in the low risk rating for this station.

There were no differences in total abundance or richness at CC-Confl relative to reference (MH-30). Total abundance was lower at MH-11 relative to reference MH-30 (Step 1); however, there was no difference in EPT richness or percent EPT abundance (Step 2). Comparison of MH-11 to MH-29 would also result in a negligible rating.

The overall effect rating for magnitude in Camp Creek is negligible to low. The farthest downstream Camp Creek station (CC-Confl) had negligible effects, suggesting the potential effects may not extend past MH-27 in Camp Creek.

Tributary E

- **Magnitude of Effect**: **Moderate** at MH-12A

Total richness at MH-12A was slightly lower at MH-12A relative to the reference MH-29, and the percentage of EPT abundance in the sample was reduced by 21% relative to MH-29 corresponding to a moderate effect rating (20-50%) (**Table A6-1**). There was also a slight reduction (low effect rating) in the number of EPT taxa at MH-12A (15) compared to MH-29 (18).

Overall Spatial Trends in Camp Creek

In summary, there is no clear spatial trend in reduced richness or abundance related to COPCs over the length of Camp Creek, with effects ranging from negligible to low. Low effects ratings do tend to be concentrated in the upper portion of Camp Creek at MH-04, MH-27 and MH-28 (**Table A6-1**).

Uncertainty About Magnitude

High – A high level of uncertainty is attached to the magnitude of effect rating in Camp Creek and Tributary E stations. The uncertainty is related to seasonal differences in invertebrate collection; only one year of data, use of different reference stations, dewatering in 2014 done as part of decommissioning activities and use of the CABIN protocol for sampling methodology but without the use of the CABIN reference dataset.

6.3.4. Causality

In addition to using EPT metrics as a possible signal of effects due to metals contamination, causality was assessed by comparing the magnitude of effects determined above to water and sediment chemistry and water toxicity test information for COPCs at each station where data were available. Magnitude ratings are provided in **Table A6-1** based on:

- Water chemistry at each station versus guidelines (**Section 2** above)
- Water chemistry at each station versus toxicity benchmarks, i.e., a concentration-response relationship developed on a mixture of site/creek water and water effects ratio tests conducted in the laboratory using (**Section 11** below)
- Sediment chemistry at each station versus guidelines (**Section 3** above)

Upstream-to-downstream patterns in the above three LOEs are used to assess the strength of correlation with the benthic invertebrate study results according to the criteria presented in Table 5-3 of the Updated PF (Azimuth 2014e). We note that the 'strength of correlation' analysis is qualitative; statistical analyses were not conducted.

Causality - Strength of Correlation

Camp Creek: Correlation (Weak, Positive); Supporting Evidence (N/A) – There was no obvious association between magnitude of effects and water or sediment quality. Station MH-11 had some of the highest concentrations for lead and zinc, but had negligible effects on benthos while MH12A had moderate effects on benthos but no correspondingly elevated chemistry or toxicity predictions. However, low effects ratings do tend to be concentrated in the upper portion of Camp Creek at MH-04, MH-27 and MH-28. Spatial trends for sediment data (see **Section 3.3.3.2**) suggest that there has been enrichment of lead and zinc in sediment from groundwater and surface water sources beginning at the Mine Site (CC-3) and increasing downstream of the Tailings Facility at MH-28A and MH-27 and diminishing from MH-11 downstream. It is also possible that inputs from naturally mineralized soils along the flowpath of the stream, may contribute to the spatial gradient of lead and zinc in sediment. Both these factors may contribute to the effects ratings observed at MH-27 and MH28, (although likely not at MH-04); however, dewatering activities in 2014, which coincided with benthic sampling may also be a significant factor.

Tributary E: Correlation (None); Supporting Evidence (N/A) – MH-12A had a moderate effect rating primarily due to reduced percent EPT abundance relative to reference.; however, neither water or sediment chemistry data for North Creek are particularly elevated relative to reference or other stations. Metals from the mine site are not considered to be the cause of the moderate effect rating.

Uncertainty About Causality

Moderate –The level of uncertainty about causality is considered moderate for the following reasons: The uncertainty is related to seasonal differences in invertebrate collection; only one year of data, use of different reference stations, dewatering in 2014 done as part of decommissioning activities and use of the CABIN protocol for sampling methodology but without the use of the CABIN reference dataset. Despite these uncertainties, it is not likely that major effects on the benthic community related to the mine were missed.

Figure A6-1. Benthic invertebrate abundance and richness at near-field sampling stations in 2014.

Notes: Abundance measures are for a 3 minute kick-net sample.

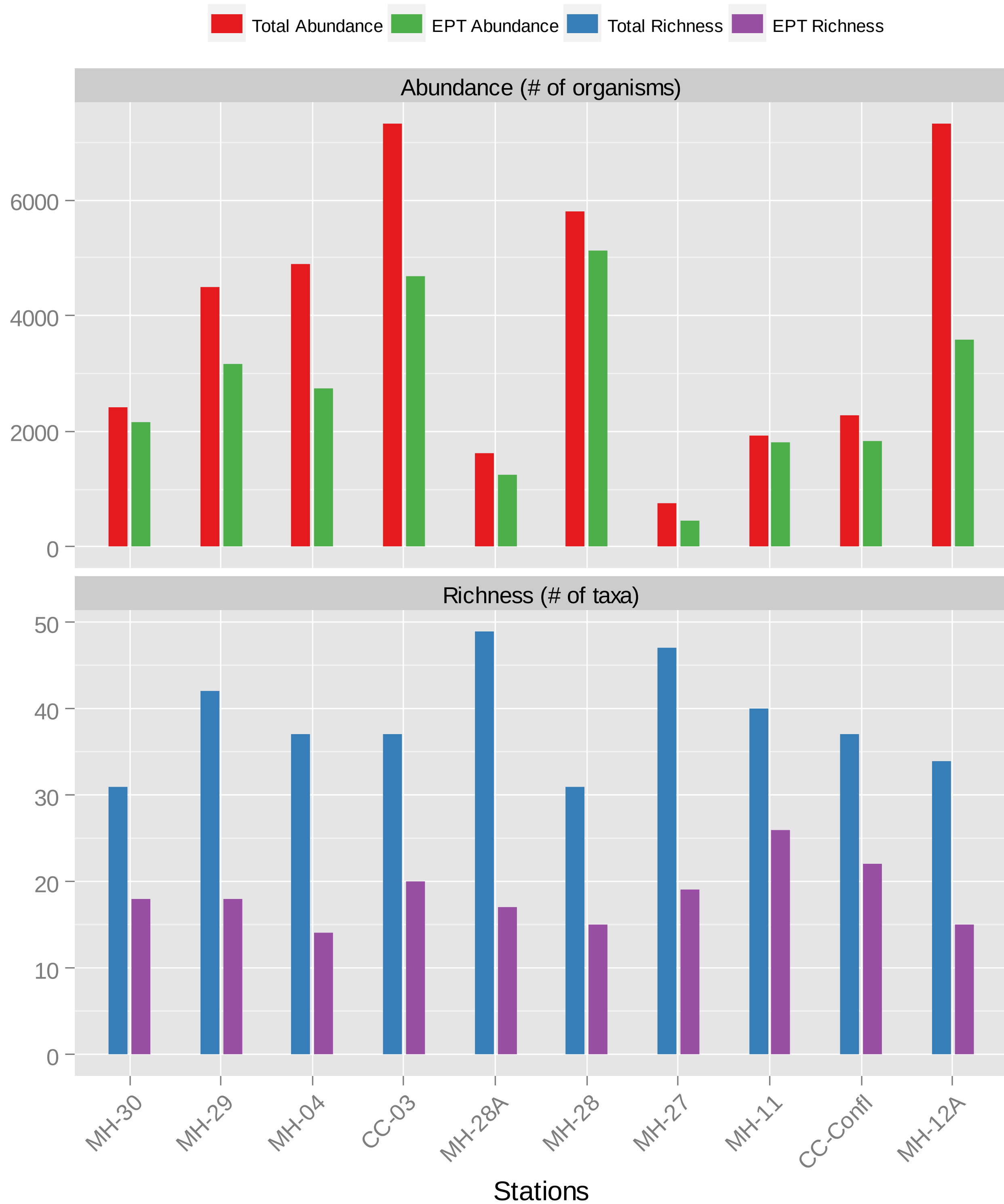

Figure A6-2. Abundance and richness by taxa group for near-field stations sampled in 2014.

Notes: Abundance measures are for a 3 minute kick-net sample.

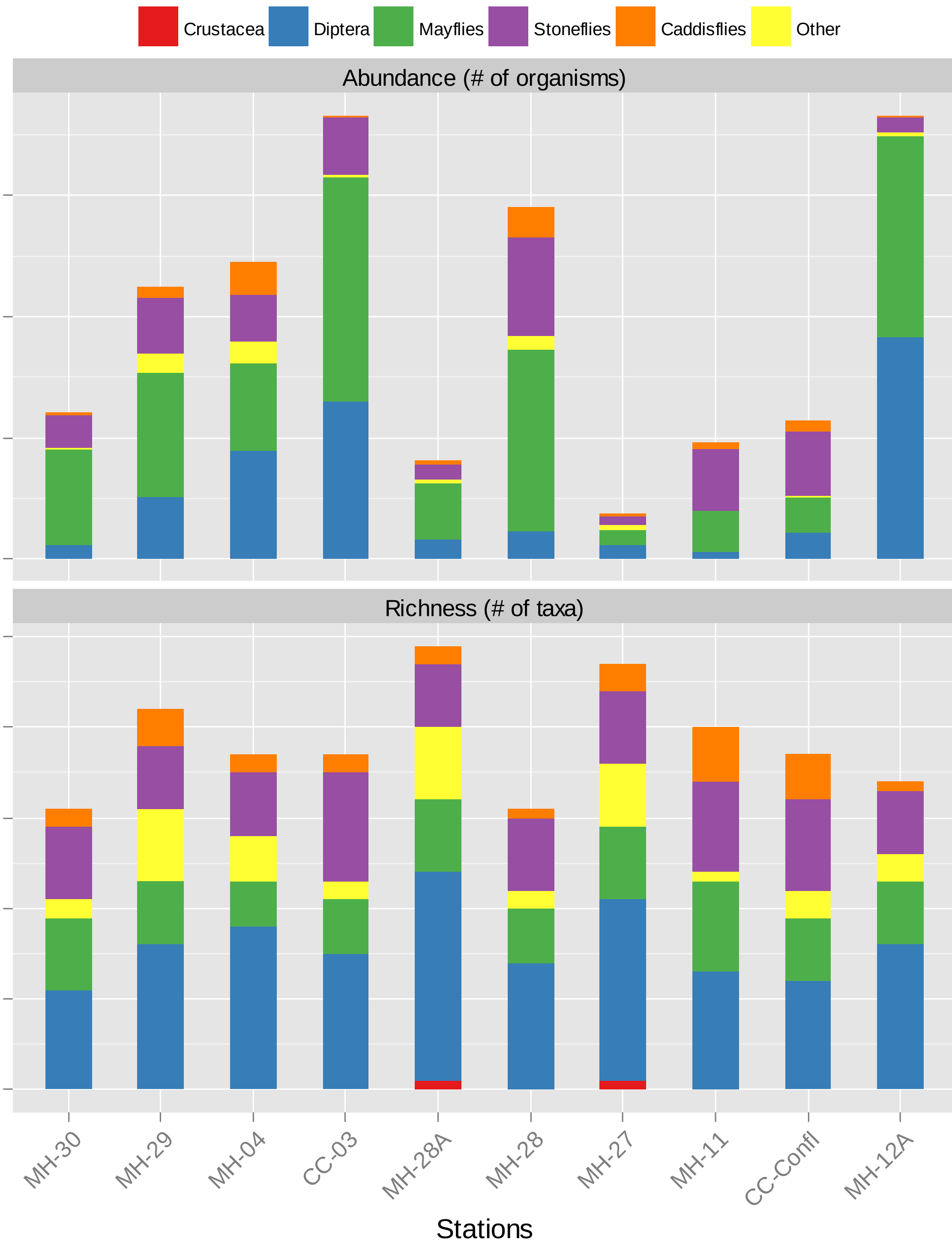

Figure A6-3. Relative abundance and richness by taxa group for near-field stations sampled in 2014.

Notes: Abundance measures are for a 3 minute kick-net sample.

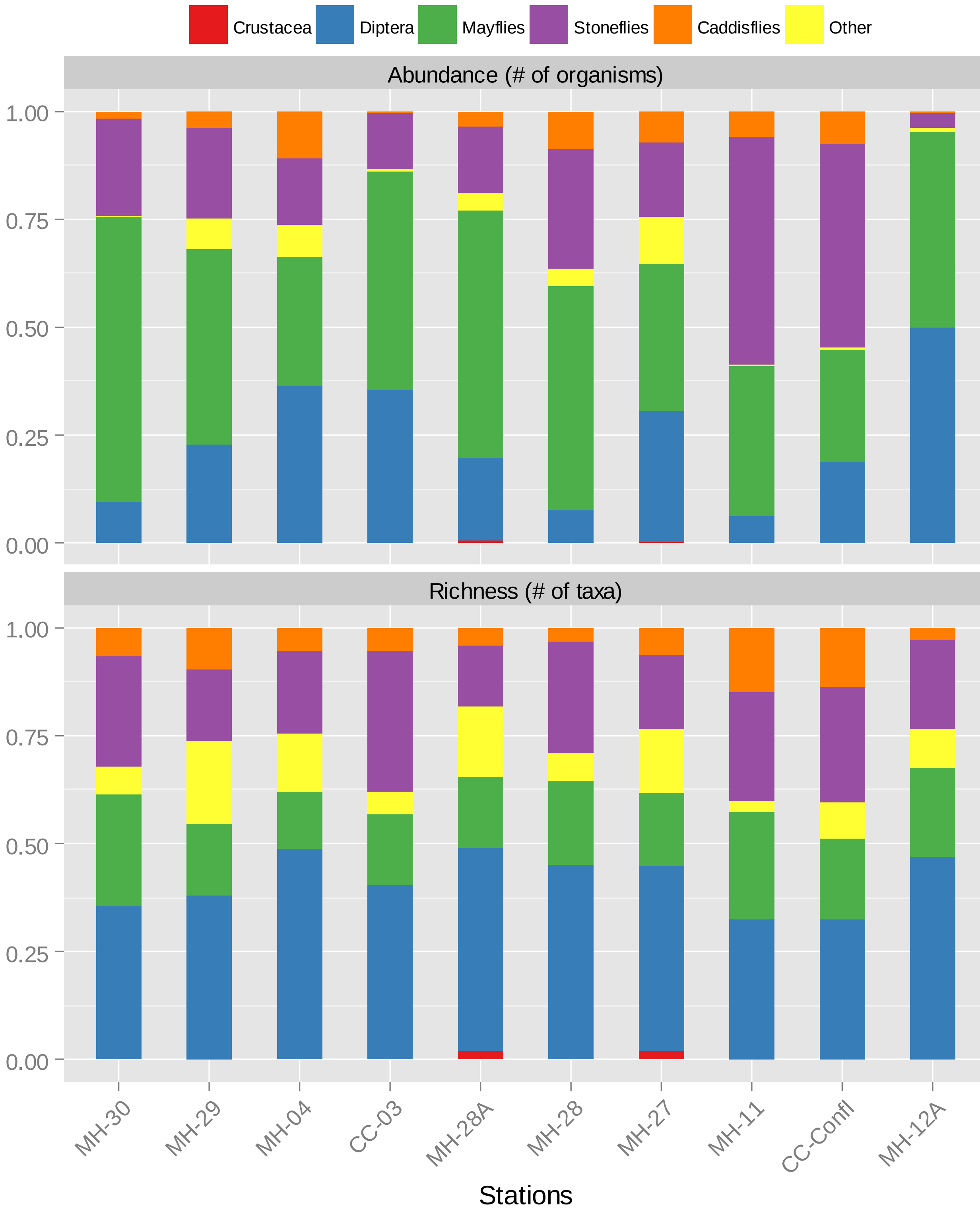

Table A6-1. Benthic invertebrate community effects assessment for the 2014 near-field sampling program.

	June Sampling Event (Azimuth)							August Sampling Event (Laberge)		
	Reference	Exposure						Reference	Exposure	
	Access Creek	Camp Creek Upstream	Camp Creek Diversion	Camp Creek u/s from Portal Creek	Portal Creek	Camp Creek u/s from Access Creek	North Creek	Unnamed Tributary to FCC	Camp Creek (2 km downstream)	Camp Creek u/s from the Confluence
Metrics[1]	**MH-29**	**MH-04**	**CC-3**	**MH-28A**	**MH-28**	**MH-27**	**MH-12A**	**MH-30**	**MH-11**	**CC-Confl**
Abundance										
Total Abundance	4500	4895	7328	1628	5814	749	7329	2412	1929	2282
Crustacea	0	0	0	12	0	2	0	0	0	0
Diptera	1032	1788	2604	308	450	227	3672	234	120	432
Ephemeroptera	2040	1452	3696	937	3006	256	3312	1584	672	588
Plecoptera	936	767	956	252	1620	130	249	540	1014	1074
Trichoptera	180	528	24	57	504	54	24	42	117	170
Other taxa organisms	312	360	48	62	234	80	72	12	6	18
Number of EPT organisms	3156	2747	4676	1246	5130	440	3585	2166	1803	1832
Percent EPT Abundance	70.13%	56.12%	63.81%	76.54%	88.24%	58.74%	48.92%	89.80%	93.47%	80.28%
Richness										
Total Richness	42	37	37	49	31	47	34	31	40	37
Crustacea	0	0	0	1	0	1	0	0	0	0
Diptera	16	18	15	23	14	20	16	11	13	12
Ephemeroptera	7	5	6	8	6	8	7	8	10	7
Plecoptera	7	7	12	7	8	8	7	8	10	10
Trichoptera	4	2	2	2	1	3	1	2	6	5
Other Taxa	8	5	2	8	2	7	3	2	1	3
Number of EPT Taxa	18	14	20	17	15	19	15	18	26	22
Percent EPT Taxa	42.86%	37.84%	54.05%	34.69%	48.39%	40.43%	44.12%	58.06%	65.00%	59.46%
Overall Effect Rating[2]		Low	Negligible	Negligible	Low	Low	Moderate		Negligible	Negligible
Supporting Information for Assessing Causality										
Water Chemistry versus Guidelines[3]	No COPCs	Moderate (Pb) Low (Al, Cd, Zn)	No COPCs	No data	Low (Cd, Fe, Se)	Moderate (Pb) Low (Se)	Low (Fe)	Low (Cd, Fe, Pb)	Moderate (Cd, Pb, Zn) Low (Al, Cr, Fe)	No data
Sediment Chemistry versus Guidelines[4]	Moderate (Cd) Low (As, Pb, Zn)	Moderate (Cr, Pb) Low (Cd, Zn)	Moderate (Pb) Low (Cd, Cr, Zn)	Moderate (Pb, Zn) Low (Cd, Cr, Zn)	No data	Moderate (Pb, Zn) Low (As, Cd)	Low (As)	No COPCs	Moderate (Pb) Low (As, Cd, Zn)	Low (As, Pb, Zn)
Water Chemistry versus Toxicity Tests[5]	N/A	Negligible / no-effects range	N/A	N/A	N/A	Negligible / no-effects range	Negligible effects	N/A	Low (survival) / High (reproduction) effects	N/A

Notes:

[1] Benthic invertebrate metrics for June samples were compared against MH-29, and August samples were compared against MH-30. This was done to account for seasonality.

Abundance measures are standardized to a 3 minute kick time. Richness is expressed as the number of taxa identified at the lowest practical level within each major taxonomic group.

[2] Overall effect rating (for exposure stations) takes into account the abundance and diversity of sensitive taxa (EPT) at stations where differences in total abundance or total richness were observed.

Negligible effect	<10% reduction relative to reference
Low effect	10-20% reduction to reference
Moderate effect	20-50% reduction to reference
High effect	>50% reduction to reference

[3] Based on Water Chemistry LOE (see Section 2 of the LOE Appendix A; also Azimuth 2014d). A low rating means the concentration (95th%ile or maximum depending on the sample size) is 1-3 fold above guidelines, and moderate is 3-10 fold above guidelines.

[4] Based on Sediment Chemistry LOE (see Section 3 of this LOE Appendix A). A low rating means 95%ile concentration is between 1-3 fold above guidelines.

[5] Based on Water-Based Toxicity Testing LOE (see Section 11 of this LOE Appendix A; also Azimuth 2014d).

N/A = Water chemistry data were not compared to the results in the Toxicity Testing LOE.

7. BENTHIC INVERTEBRATE FIELD SURVEY – FALSE CANYON CREEK

7.1. LOE Description

The benthic invertebrate field survey LOE quantitatively compares total abundance and richness of the benthic invertebrate community, with a focus on sensitive taxa, for assessing the structure and ecological function of the benthic invertebrate community in False Canyon Creek. The False Canyon Creek sampling stations are located along an upstream to downstream gradient, with upstream being closer to the mine site and expected to have higher metals exposure concentrations in water and sediment. Additionally, any observed effects on benthic invertebrate community were qualitatively compared to water and sediment chemistry and habitat conditions to determine whether differences may be mine related, and/or explained by other variables.

As stated in the text box in Section 6, the False Canyon Creek benthic invertebrate LOE is reported separately from Camp Creek because of underlying differences between the programs. Notwithstanding, we do qualitatively compare the 2014 sensitive EPT results in False Canyon Creek (MH-13) to stations in Camp Creek[8] sampled at the same time (the MH-30 reference station, MH-11 and CC-Confl) to determine any large scale differences.

7.2. Data Analysis

7.2.1. Overview

This LOE relies on field work and data analysis conducted by Laberge Environmental Services (Laberge) and Can-Nic-A-Nick Environmental Sciences (Can-Nic-A-Nick) primarily in the 2012 and 2014 programs (Laberge 2012, 2015, respectively). The report on the 2014 program (Laberge 2015) is included as **Appendix E**.

Environmental monitoring in False Canyon Creek is conducted every two years (starting in 1992) in compliance with Water Licence QZ99-045, and includes water quality, sediment quality, benthic invertebrate community, and fish community monitoring. Monitoring stations prescribed in the Water Licence include (see also Table 2-1 and Figure 1-3 in the Volume 3 main report):

- MH-13 - is located on the mainstem of False Canyon Creek in a beaver/wetland complex approximately 10 km downstream of the Reclaim Pond (Laberge 2012). Laberge (2015) notes that the water levels here were higher in 2014 than any previous sampling event and the regular

[8] We note that all Camp Creek stations were included in the sensitive taxa analysis to look at overall trends; however, emphasis was placed on comparing MH-13 results to the MH-30 reference station, and the two nearest Camp Creek stations MH-11 and CC-Confl to determine comparability between the receiving environments (see **Section 7.2.3** for details).

sampling area could not be accessed; as such, one small section of running water was sampled for benthic invertebrates in 2014.

- MH-16 - is located on the mainstem of False Canyon Creek approximately 22 km downstream of the Reclaim Pond. The channel is moderately well confined and appears stable with well-vegetated banks. This site has changed very little over time since being included as an alternate sampling location for MH-14. Laberge (2015) notes that the water was slightly turbid at this station in 2014.
- MH-18, MH-19 and MH-24 - although prescribed in the Water Licence, these stations have never been sampled due to lack of access.
- MH-20 - is located on the mainstem of False Canyon Creek, 33 km downstream of the Reclaim Pond and 13 km upstream of the confluence with the Frances River. The physical characteristics of this station have remained unchanged since the monitoring program commenced in 1992, with the exception that several downed trees fell into the stream in 2008 and most of the woody debris had been washed away in 2014. The regular site was inaccessible for helicopter landing in 2014 due to high water; the site was re-located approximately 75 m upstream, which had the same physical characteristics as the original site.

Benthic data were available for MH-13, MH-16 and MH-20, and were therefore used in this LOE.

7.2.2. Methods

Collection Methods and Laboratory Methods

The 2014 environmental monitoring program was conducted on August 23rd and 24th, 2014; all sites were accessed by helicopter. Laberge (2015) describes the field collection and laboratory methods, which have been consistent over the many years of sampling:

"*Benthic invertebrates were sampled at three similar locations per site and labeled A, B and C. The samples were collected from an undisturbed, fast flowing, gravel strewn riffle habitat at each of the sites where possible. Collections were made with a Surber sampler (area = 0.0929 m^2) which had a 300 [9]micron mesh net. The bed material within the frame was cleaned and washed by hand, with the fast flowing current carrying the disturbed bottom fauna and detritus into the collection bag. The level of effort for each sample and at each site was comparable. The captured invertebrates and detritus were placed in one-litre Nalgene bottles, preserved in 10% formalin, and shipped to Cordillera Consulting in Summerland, B.C., for sorting, identification and enumeration.*"

As well, Laberge (2015) reports the following summary on laboratory methods:

[9] Camp Creek sampling was conducted with a 400 µm mesh kick-net.

"*At the lab, all samples were washed through two screens with mesh sizes 1 millimetre and 180 microns. All of the organisms retained by the coarse screen were counted and identified, whereas the organisms on the 180 micron screen were subsampled as necessary. A Folsom plankton splitter was used for the subsampling. The majority of the benthos was identified to the genus level.*"

Data Handling and Analysis

The following metrics are reported in Laberge (2015) for each sampling station and are used for this LOE:

- Total abundance (number of individuals in all three replicate samples[10,11]) at the three monitoring locations overtime (1992-2014).
- Richness (reported as 'diversity' in the Laberge report; number of different taxonomic groups identified in all three replicate samples) at the three monitoring locations overtime (1992-2014).
- Total number of "sensitive" EPT taxa at the three monitoring locations overtime (1992-2014) "Sensitive" EPT represent only a portion of the total EPT groups. Specifically, Laberge has identified a total of 19 EPT taxa that are particularly sensitive to, or have a low tolerance for, chemical pollution based on Lehmkuhl, 1979[12]. This metric was used specifically for the False Canyon Creek LOE (not Camp Creek) because this metric had been calculated by Laberge for the monitoring program (other more common EPT metrics were only calculated for 2014; see below).
- EPT taxa metrics - EPT abundance, richness and the percentage of EPT organisms in the benthic community (based on abundance) at the three monitoring locations in the 2014 program specifically[13]. The Camp Creek benthic LOE also emphasized EPT indices because they provide a good indication of overall benthic invertebrate community health, given their sensitivity to metals and environmental changes.

Analysis of results were based on a gradient design, where the upstream station (MH-13), which is closer to the mine site and expected to have higher concentrations of metals in water and sediment, is compared to the downstream stations (MH-16 and MH-20), which have lower exposure concentrations.

Azimuth has used the benthic invertebrate community data as reported by Laberge (2015), and did not quantify any additional metrics for LOE analysis, with the exception of preparing a table showing the presence/absence of sensitive EPT taxa in False Canyon Creek compared to Camp Creek and reference stations.

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[10] A, B and C replicate data are in Appendix C of the Laberge (2015) report (see **Appendix E**).

[11] Density was also reported as number of individuals per m^2 and followed the same trend as abundance.

[12] Refer to **Table A7-2** for further details on taxonomic groups.

[13] These EPT metrics have not been calculated by Laberge for previous sampling events.

7.2.3. Results

Laberge (2015) provides results of the 2014 program; trends in some of the metrics are provided in Section 4.3.4 of their report (**Appendix E**). Laberge reports that due to precipitation events prior to sampling in 2014, water levels at all sites in 2014 were somewhat higher than experienced during past surveys. Surface water at MH-13 and MH-20 stations was clear, whereas MH-16 had turbid waters, which may be attributable to surface runoff. Key results are shown in the following:

- **Figure A7-1** (below) shows abundance, richness and total number of sensitive EPT taxa over time (based on Table 10 from Laberge, 2015)
- **Figure A7-2** (below) shows *average* abundance, richness, sensitive taxa in the three monitoring stations overtime, and EPT richness and EPT percentage of total abundance for 2014 only. These benthic data are also summarized in **Table A7-1** along with supporting information to assess LOE attributes (see further description in **Section 7.3.3** below).
- **Table A7-2** compares presence and absence of the sensitive EPT taxa (Lehmkuhl 1979) in False Canyon Creek stations (particularly MH-13) and Camp Creek stations (particularly MH-11, and CC-Confl, located upstream of MH-13) and a nearby reference station (MH-30). These three comparator stations in Camp Creek were sampled at the same time as the False Canyon Creek stations, also by Laberge, but using the kick-net method (400 µm mesh size) as opposed to the Surber (300 µm mesh size). This was done to allow for comparison with the Camp Creek stations that were sampled in June (**Section 6.2.2**).
- Figure 7 in Section 4.3.2 of Laberge (2015; **Appendix E**) shows distributions of the major taxonomic groups at the three stations (results summarized in text below).

We have summarized the findings and overall trends of the Laberge's benthic invertebrate community study, based on Azimuth's interpretation and additional analyses, below[14]:

- Total abundance in 2014 and overtime is highest at MH-16 (middle station), closely followed by MH-13 (upstream) and quite a bit lower at MH-20 (downstream).
- Total richness (in 2014 and over time) is highest at MH-16, and slightly lower, but similar, at MH-13 and MH-20.
- Temporal trends in the number of sensitive taxa and EPT indices from 2014 are highest at MH-16 and MH-20 and lowest at MH-13 (**Table A7-1**). In other words, the sampling stations farthest downstream (MH-16 and MH-20) are dominated by sensitive EPT taxa, compared to the sampling station furthest upstream (MH-13). MH-13 is dominated by crustaceans (i.e., copepods and

[14] We note that this section has more detail than other LOE results sections in this appendix largely because results are not reported or interpreted previously in any of the ERA reports.

ostracods; seed shrimp), which tend to be more pelagic, preferring ponds and lakes; a large amount of ponded habitat is present at MH-13.

- EPT richness (2014 data) was similar at MH-13 (17 taxonomic groups, **Table A7-1**) in False Canyon Creek and MH-30 (18; reference), and lower than MH-11 (26) and CC-Confl (22) in Camp Creek (see **Table A6-1** for reference and Camp Creek EPT richness). We note that caution should be applied when making this comparison because different sampling methodologies were applied. However, on a gross scale, these data show that MH-13 has comparable EPT richness to the MH-30 reference station. MH-13 did have lower EPT richness than MH-11 (and CC-Confl), but water and sediment chemistry are lower at MH-13 than MH-11, so the difference is unlikely chemistry-related.
- A basic comparison of the presence and absence of 19 total sensitive EPT taxa between MH-13 and MH-11/CC-Confl/MH-30 showed similar results to the EPT richness comparison (**Table A7-2**). In general, there was agreement or "overlap"[15] in the presence/absence of 17 out of 19 taxa (89%) between the results for MH-13 and the results for at least one of the MH-11/CC-Confl/MH-30 comparator stations. There were only two taxa that were not present at MH-13, but were at the comparator stations (i.e., chlorperlidae and rhyacophilidae); however, both had been found at MH-13 in previous recent programs (2008-2012) and there did not appear to be a site-related upstream to downstream trend in presence/absence. Based on this qualitative evaluation of presence/absence, the only note-worthy results were for:
    - Rhrithrogena sp. (Heptageniidae) – this species was not detected at MH-13 or anywhere upstream in Camp Creek, but was present at MH-16 and MH-20. This group was also not present at MH-13 in recent (2008-2012) programs. However, this species was also not detected in 2014 at the MH-30 (or MH-29) reference stations, so the trend is unlikely site or chemistry-related.
    - Perlodidae – this taxon was detected everywhere except MH-28 and MH-11 (water chemistry is highest at MH-11). It is possible but uncertain whether this trend is site-related (taxon is present at stations between MH-28 and MH-11); however, if site-related this trend does not extend to False Canyon Creek as this taxon is present at MH-13, MH-16 and MH-20.
    - Brachycentridiidae – this taxon was not detected at MH-13, was present at CC-Confl, but no further upstream in Camp Creek; it was present at MH-16 and MH-20. The group was

[15] "Overlap" was based on a comparison of the presence/absence of a sensitive taxon at MH-13, relative to the presence/absence of this taxon at the Camp Creek (MH-11, and CC-Confl) and reference (MH-30) comparator stations. For example, Ephemerellidae was present at MH-13, as well as MH-11, CC-Confl, MH-30; this is considered an 'overlap'. Chloroperlidae was not present at MH-13, but was at MH-11, CC-Confl and MH-30; these results do not 'overlap'. To overlap, MH-13 results need to match only one of the comparator stations. See **Table A7-2** for more details.

detected at MH-13 in 2012. However, this species was also not detected at the MH-30 (or MH-29) reference stations, so the trend is unlikely site or chemistry-related.

In general, there is much more variability overtime in metrics such as abundance and total number of sensitive EPT taxa at the MH-13 station, relative to MH-16 and MH-20. In some years (e.g., 2008) the number of sensitive EPT taxa at MH-13 matches that of MH-16 and MH-20, but in other years (e.g., 2010) this metric is much lower at MH-13 than the downstream stations. We note that water chemistry has been fairly consistent at these stations overtime (Figure A-9 in Azimuth 2014d), so the variability in EPT does not appear related to metals exposure from the Site. Benthic invertebrates have frequently been difficult to sample at MH-13 due to unconfined channels, deep pools, and altered watercourses due to beaver activity (Laberge, 2012 and 2015). The authors attribute the variation in abundance and the number of sensitive taxa across years at MH-13 to fluctuations in the stream habitat characteristics along this reach of the stream and the lack of clean washed gravel with high velocity flow that is considered suitable habitat for EPT taxa. In contrast, the physical characteristics and benthic communities at MH-16 and MH-20 have been stable overtime (Laberge, 2012).

7.3. LOE Attributes

7.3.1. Data Quality

Acceptable – Standard procedures were applied to the degree possible to ensure consistency when counting and weighing organisms, including reviewing taxonomy relative to invertebrate guide books and having two staff involved with taking measurements as a QA check. No data quality issues were identified. There has been consistency overtime with the sampling and laboratory methods for the False Canyon Creek stations (MH-13, MH-16, and MH-20), as well as sampling personnel and analytical laboratory. As mentioned above, caution should be applied when comparing the False Canyon Creek benthic invertebrate community data with samples collected in 2014 from Camp Creek because of differences in collection methods and mesh sizes.

7.3.2. Ecological Relevance

High – The field measurements target the assessment endpoint for benthic invertebrates, specifically the structure and ecological function of the invertebrate community.

7.3.3. Magnitude

Approach

The approach of the effects assessment for False Canyon Creek differed somewhat from the Camp Creek study, because of the gradient design (i.e., the higher exposure upstream was compared to downstream stations, rather than reference). Like the Camp Creek study however, there was a focus on assessing changes to the benthic invertebrate community that may be a result of COPC exposure from the Site, rather than differences caused by habitat/physical characteristics. To this end, emphasis was placed on EPT taxa metrics (see **Section 6.3.3**).

The benthic invertebrate data described above in **Section 7.2.3** were summarized along with supporting information that evaluates causality (water and sediment chemistry, and habitat characteristics) in **Table A7-1**; and presence of sensitive EPT taxa was compared between False Canyon Creek and Camp Creek in **Table A7-2.** These two tables were used to complete the LOE analysis of magnitude and causality (**Table A7-3**).

Magnitude Interpretive Framework

Table A7-3 rates magnitude of potential effects based on three comparisons, as follows:

1. Upstream (MH-13) versus downstream (MH-16 and MH-20) trends in total abundance, richness and EPT metrics (number of sensitive EPT taxa, EPT richness and percent EPT abundance). If no difference (< 10%) in these metrics was observed at the upstream station, relative to downstream then potential effects were considered negligible:
   - Negligible = No difference (<10%) in total abundance, richness, EPT richness or percent EPT abundance, relative to the reference.

   If there was a reduction in one of these metrics, the next step was used to determine the magnitude of effects rating.
2. In the second step, the community composition metrics (specifically sensitive EPT taxa, EPT percent abundance, and EPT richness) were used to determine the magnitude of the effect ratings (regardless of effect sizes based on total abundance and richness) according to:
   - Negligible = Difference (>10%) in total abundance or richness, but no difference (<10%) in number of sensitive EPT taxa, EPT richness or percent EPT abundance at MH-13 relative to MH-16 and MH-20.
   - Low = MH-13 is between 10% and 20% lower in EPT metrics, relative to MH-16 and MH-20.
   - Moderate = MH-13 is between 20% and 50% lower in EPT metrics, relative to MH-16 and MH-20.
   - High = MH-13 is greater than 50% lower in EPT metrics, relative to MH-16 and MH-20.

   The third comparison is more qualitative and was used as secondary supporting information for the magnitude rating. The comparison was intended to link results from the False Canyon Creek study to the Camp Creek study using a metrics (EPT richness and sensitive taxa presence) that were considered reasonably comparable between the two studies, which used different sampling methods.
3. Qualitative/semi-quantitative comparison of EPT richness and sensitive EPT taxa presence in MH-13 (False Canyon Creek) to results in Camp Creek, with particular emphasis on MH-30 (reference sampled at the same time as False Canyon Creek) and MH-11 and CC-Confl, (nearest stations to MH-13 in Camp Creek). Ratings were assigned according to:

- Negligible = EPT richness at MH-13 is similar to MH-30/MH-11/CC-Confl; there is good agreement/overlap[16] (≥80%) of presence of sensitive EPT taxa between MH-13 and MH-30/MH-11/CC-Confl.
- Somewhat Different = EPT richness at MH-13 is lower than MH-30/MH-11/CC-Confl; there is moderate overlap (50-80%) in the presence of sensitive EPT taxa between MH-13 and MH-30/MH-11/CC-Confl.
- Different = EPT richness at MH-13 is lower than to MH-30/MH-11/CC-Confl; there is limited overlap (<50%) in the presence of sensitive EPT taxa between MH-13 and MH-30/MH-11/CC-Confl.

The integration of the results from these three comparisons is described in **Table A7-3** and below in *Magnitude Rating*.

Magnitude Rating

Moderate – Total abundance and richness of benthic invertebrates are similar or higher at MH-13, relative to MH-16 and MH-20. However, EPT richness/percent abundance and sensitive taxa richness at MH-13 are lower than farther downstream in False Canyon Creek (MH-16 and MH-20); differences were in the moderate and high categories. The pattern for sensitive EPT taxa is based on long-term monitoring data since 1992, although there is some year-to-year variability in results for MH-13. A qualitative comparison between MH-13 and Camp Creek (MH-11/CC-Confl) and the MH-30 reference station, based on EPT richness and presence of sensitive EPT taxa, suggests MH-13 is not impaired relative to Camp Creek or the MH-30 reference. Because of the different methods, and the single sampling event for Camp Creek/MH-30, there is more uncertainty in this comparison. Overall, the various comparisons used to assess magnitude did not provide consistent results. While we recognize the there is some incongruity in the benthic invertebrate study results for False Canyon Creek (possible impairment observed) and Camp Creek (no impairment observed), the overall magnitude of effects for False Canyon Creek (MH-13) was rated as moderate, because there was a definite trend of lower EPT taxa in upstream versus downstream False Canyon Creek, which was given more weight than the more qualitative comparisons to Camp Creek.

Uncertainty About Magnitude

High – Although the False Canyon Creek study has a long-term data set, and the upstream to downstream trends have been fairly consistent overtime, there is high uncertainty in this assessment of magnitude, because (1) an outside reference is not included in the False Canyon Creek study; (2) comparisons to upstream Camp Creek and the MH-30 reference suggested that MH-13 is not impaired but were only qualitative because of the different methods used for sampling (i.e., kick net 'CABIN' protocol in Camp Creek, and Surber method in False Canyon Creek); and (3) effects to the benthic

[16] See footnote 15 and **Table A7-2** for more details.

invertebrate community in Camp Creek were considered negligible to low at all stations (see **Section 6**), therefore effects due to metals further downstream of Camp Creek in False Canyon Creek are unlikely. Overall, there is a high likelihood that with additional data, or stronger comparisons with Camp Creek and/or an outside reference, the magnitude of effects rating for benthic invertebrates in False Canyon Creek, based on MH-13, would be lower (i.e., negligible to low).

7.3.4. Causality

Causality in the False Canyon Creek benthic invertebrate analysis was assessed in the same manner as the Camp Creek study (i.e., using upstream to downstream patterns in water chemistry exceedances, sediment chemistry exceedances and water toxicity information for each False Canyon Creek station; see ratings in **Table A7-1** and further explanation in **Section 6.3.4** above). In addition, this False Canyon Creek study evaluated differences in habitat characteristics between the three stations that may confound results or explain any trends in benthic invertebrate metrics (as reported by Laberge, 2015). **Table A7-3** summarizes causality (strength of correlation) evaluations.

Causality - Strength of Correlation

Correlation (None); Supporting Evidence (N/A) – While there was an upstream to downstream trend in water and sediment chemistry (MH-13 had higher metals concentrations than the downstream stations [MH-16 and MH-20]), comparisons to water toxicity thresholds developed in the AERA suggest that concentrations of metals in water at MH-13 are in the "no-effect" range. Exceedances of guidelines were considered moderate for water and only low for sediment at MH-13; these comparisons were given less weight than comparisons to the toxicity benchmarks. Most importantly, Laberge (2015) document differences in habitat and physical stream characteristics between MH-13 and the downstream stations that are the most likely causes of differences in species composition between the study stations (i.e., lower EPT at MH-13).

Uncertainty About Causality

Moderate – Although the False Canyon Creek study is long-term, and upstream to downstream trends in benthic invertebrate metrics have been consistent overtime and are considered likely the result of habitat differences between MH-13 and the downstream stations (MH-16, MH-20), uncertainty in the assessment of causality is considered moderate, because (1) an outside reference is not included in the False Canyon Creek study; (2) trends in upstream to downstream water and sediment quality exist and could be contributing factors to differences in benthic invertebrate communities. Data enabling stronger comparisons to Camp Creek and/or an outside reference station (see *Uncertainty About Magnitude* above) would reduce uncertainty in assessment of potential risks to benthic invertebrates in False Canyon Creek.

Figure A7-1. Benthic invertebrate abundance, richness, and number of sensitive taxa in False Canyon Creek, 1992-2014.

Note: Abundance (# of organisms) is the sum of three replicates per station. The richness is the total number of taxa identified among the three replicates per station. Sensitive taxa are those with a pollution tolerance score of 0-1.5 according to Lehmkuhl (1979; taxa list adapted from Hilsenhoff [1977]). Sampling was not completed at MH-16 in 1992, 1994, or 1996. The benthic invertebrate data are shown in Laberge (2015; Table 10).

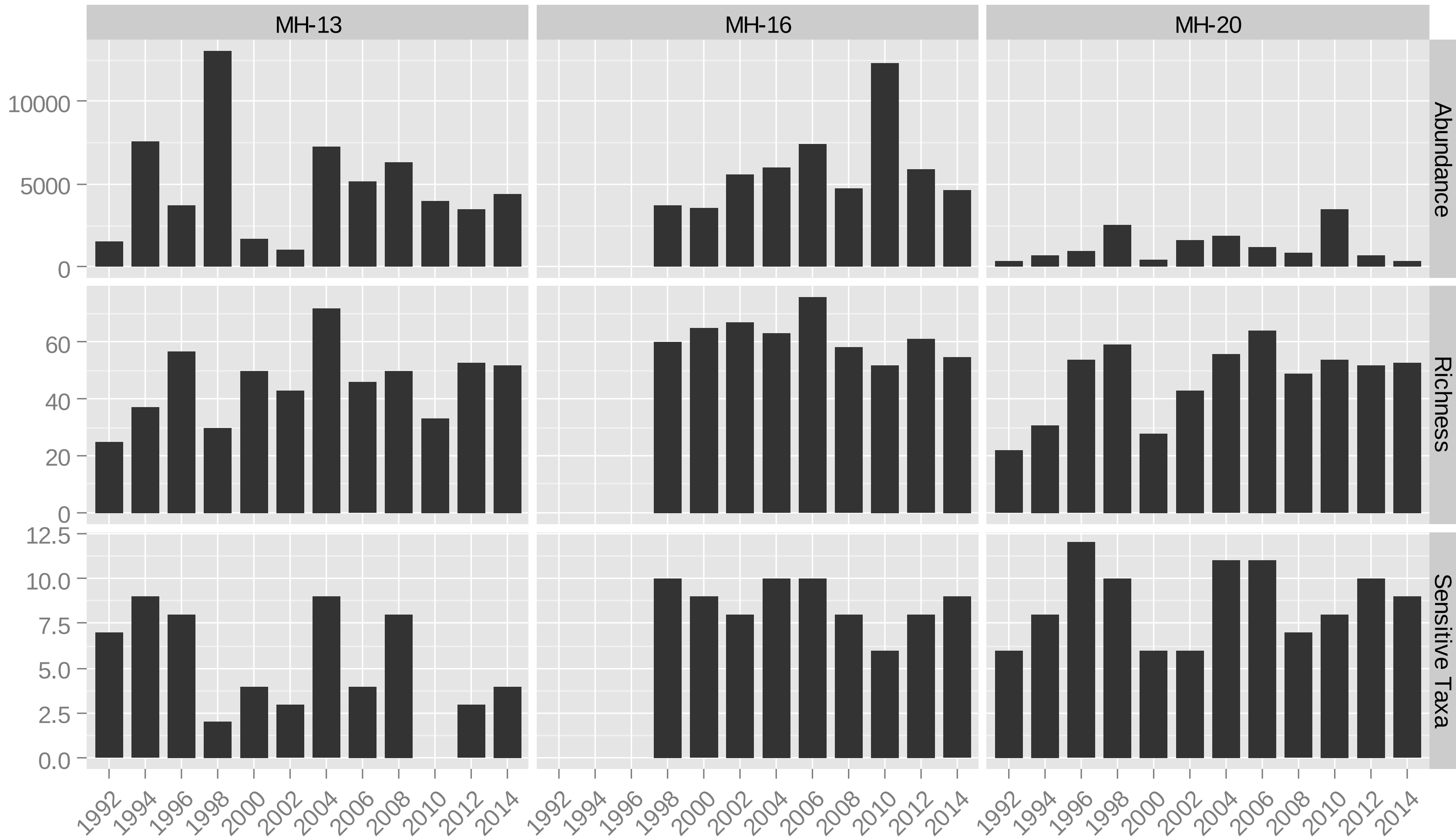

Figure A7-2. Benthic invertebrate metrics in False Canyon Creek monitoring stations, 1998 to 2014[1].

Note: The mean ± 1 standard deviation is shown for abundance, richness, and number of sensitive taxa. Refer to **Figure A7-1** for a description of the abundance, richness, and sensitive taxa metrics. % EPT abundance is the proportion of each sample comprised of individuals from the orders ephemeroptera, plecoptera, and trichoptera. ETP richness is the number of taxa belonging to the orders ephemeroptera, plecoptera, and trichoptera (results are presented in Laberge [2015]).

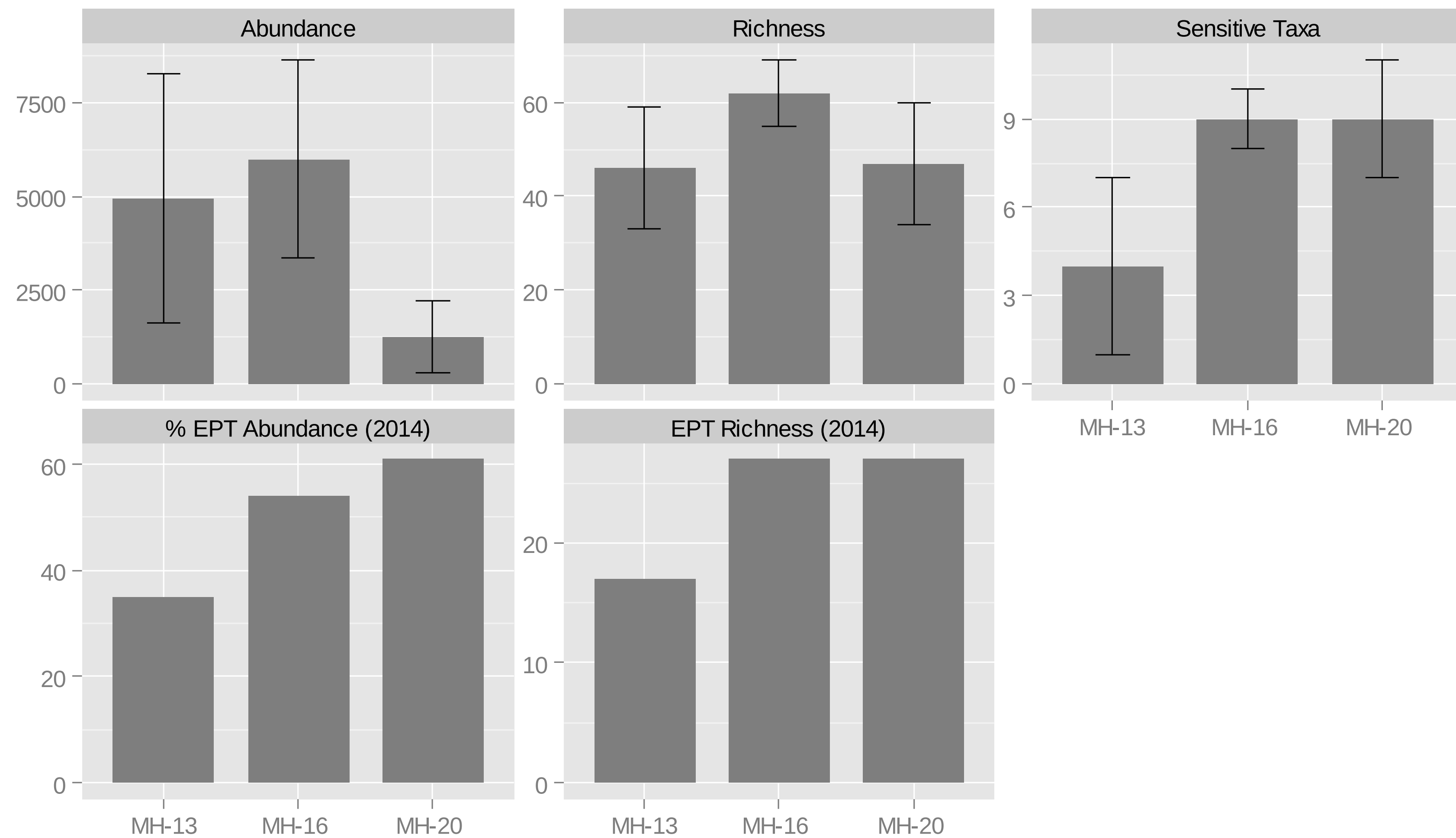

Table A7-1. Average benthic invertebrate metrics and supporting information in False Canyon Creek monitoring stations, 1998 to 2014[1].

Station	Average Benthic Invertebrate Metrics for Supporting Magnitude					Supporting Information for Assessing Causality			
	Total Abundance[2] Mean (Stdev)	Richness[3] Mean (Stdev)	Sensitive Taxa[4] Mean (Stdev)	EPT Richness[5] 2014 only	% EPT[6] 2014 only	Water Chemistry versus Guidelines[7] 95% Percentile	Water Chemistry versus Toxicity[8] 95% Percentile	Sediment Chemistry versus Guidelines[9] 95% Percentile	Habitat Characteristics[10]
MH-13	4,940 (3336)	46 (13)	4 (3)	17	34.7	Moderate (Fe, Pb); Low (Al, Cd, Cr, Se)	Negligible/no-effects range (Figure A11-1, and Table A11-2 and A11-4 this appendix)	Low (As, Cd, Pb, Zn)	- Less conducive to EPT (lack of gravels, sluggish flow, proximity of beaver dams) - Ponded areas preferable for copepods, which were dominant - Fluctuations in the stream habitat characteristics overtime
MH-16	5,997 (2639)	62 (7)	9 (1)	27	53.6	Low (Al, Fe, Pb)	Negligible/no-effects range (Figure A11-1, and Table A11-2 and A11-4 this appendix)	Negligible	- Habitat conducive to EPT, dipterans - Stable channel/stream characteristics overtime
MH-20	1,252 (965)	47 (13)	9 (2)	27	60.6	Negligible (Figure A-9 Azimuth 2014d)	Negligible/ no-effects range (Figure A-9 Azimuth 2014d)	Negligible	- Habitat conducive to EPT, dipterans - High water levels may have created bed scour - Wash out of large in-stream woody debris - Stable stream characteristics overtime

Notes:

[1] MH-13 and MH-20 were monitored since 1992 (see Appendix E for data); however averages are based on 1998-2014 to be consistent between all three stations.

[2] Total abundance = the combined abundance (number of organisms) from three replicate surber samples per station; mean and standard deviation of 1998-2014.

[3] Total number of taxa in three replicates surber samples per station; mean and standard deviation of 1998-2014.

[4] Total number of sensitive taxa; based on specific taxa from the orders ephemeroptera, plecoptera, and trichoptera (based on Lehmkuhl [1979], as reported in Laberge [2015]); mean and standard deviation of 1998-2014.

[5] Total number of EPT taxa, based on 2014 program only (statistics for previous years have not been calculated by Laberge).

[6] Percent EPT abundance relative to overall benthic community (number of EPT/total number of organisms), based on 2014 program only (statistics for previous years have not been calculated by Laberge).

[7] Based on Water Chemistry LOE (see **Section 2** of the LOE Appendix A; also Azimuth 2014d). A low rating means 95%ile concentration is between 1-3 fold above guidelines, and moderate is 3-10 fold above guidelines.

[8] Based on Water-Based Toxicity Testing LOE (see **Section 11** of this LOE Appendix A; also Azimuth 2014d).

[9] Based on Sediment Chemistry LOE (see **Section 3** of this LOE Appendix A). A low rating means 95%ile concentration is between 1-3 fold above guidelines.

[10] Key habitat and species preference information, as reported in Laberge (2015).

Table A7-2. Presence/absence of sensitive benthic invertebrates from the ephemeroptera, plecoptera, and trichoptera (EPT) taxon groups[1], in Camp Creek and False Canyon Creek (2014) and comparison to recent years (August 2008-2012) data for MH-13 (False Canyon Creek).

	2014 Data													Past Years	Site-related trends and MH-13 overlap with Camp Creek (MH-11, CC-Confl) and reference (MH-30)		
	Camp Creek						REF	Camp Creek		REF	False Canyon Creek			FCC			
	MH-04	MH-12	MH-27	MH-28	MH-28A	CC-03	MH-29	CC-Confl	MH-11	MH-30	MH-13	MH-16	MH-20	MH-13			
TAXON[1]	Jun 2014	Jun 2014	Jun 2014	Jun 2014	Jun 2014	Jun 2014	Jun 2014	Aug 2014	Aug 2014	Aug 2014	Aug 2014	Aug 2014	Aug 2014	2008-2012	Overlap	Trend	Comments
Ephemeroptera																	
Ephemerellidae	-	-	+	-	+	-	-	+	+	+	+	+	+	Yes	Yes	No	Present at MH-13, MH-30, MH-11, CC-Confl
Ephemeridae	-	-	-	-	-	-	-	-	-	-	-	-	-	No	Yes	No	Not present at any stations
Epeorus (Heptageniidae)	-	+	+	-	+	-	+	+	+	-	-	-	+	No	Yes	No	Not present at MH-13, MH-30; present at MH-11, CC-Confl; trend does not appear site-related
Rhrithrogena sp. (Heptageniidae)	-	-	-	-	-	-	-	-	-	-	-	+	+	No	Yes	POSSIBLE but not at reference	Not present at MH-13, MH-30, MH-11, CC-Confl; possible trend associated with site, but not detected at reference
Paraleptophlebia (Leptophlebiidae)	-	-	-	-	-	-	-	-	-	-	-	-	-	No	Yes	No	Not present at any stations
Polymitarcidae (Ephoron)	-	-	-	-	-	-	-	-	-	-	-	-	-	No	Yes	No	Not present at any stations
Plecoptera																	
Capniidae	-	-	-	-	-	-	-	-	+	-	+	+	+	Yes	Yes	No	Present at MH-13, MH-11; not present at CC-Confl, MH-30
Chloroperlidae	+	+	+	+	+	+	+	+	+	+	-	+	+	Yes	NO	No	Not present only at MH-13; present at MH-11, CC-Confl, MH-30; present in recent years at MH-13; trend does not appear site-related
Leuctridae	+	+	-	+	-	+	+	-	+	-	-	-	-	Yes	Yes	No	Not present at MH-13, MH-30, CC-Confl; present MH-11; more prevalent upstream in Camp Creek; trend does not appear site related
Nemouridae	+	+	+	+	+	+	+	+	+	+	+	+	+	Yes	Yes	No	Present at all stations
Perlidae	-	-	-	-	-	-	-	-	-	-	-	-	-	Yes	Yes	No	Not present at any stations (detected previously at MH-13)
Perlodidae	+	+	+	-	+	+	+	+	-	+	+	+	+	No	Yes	POSSIBLE for MH-11	Present at all stations except MH-28 and MH-11
Pteronarcidae	-	-	-	-	-	-	-	-	-	-	-	-	-	No	Yes	No	Not present at any stations
Taeniopterygidae	-	-	-	-	-	-	-	-	-	-	-	+	-	Yes	Yes	No	Present at all stations except MH-16; present previously at MH-13
Trichoptera																	
Brachycentridiidae	-	-	-	-	-	-	-	+	-	-	-	+	+	Yes	Yes	POSSIBLE but not at reference	Not present at MH-13, CC-Confl, MH-30; present at MH-11; present in recent years at MH-13; possible trend associated with site, but not detected at reference
Helicopsychidae	-	-	-	-	-	-	-	-	-	-	-	-	-	No	Yes	No	Not present at any stations
Molannidae	-	-	-	-	-	-	-	-	-	-	-	-	-	No	Yes	No	Not present at any stations
Philopotamidae	-	-	-	-	-	-	-	-	-	-	-	-	-	No	Yes	No	Not present at any stations
Rhyacophilidae	-	+	+	+	+	-	+	+	+	+	-	+	+	Yes	NO	No	Not present at MH-13; present in MH-11, CC-Confl, MH-30; present in recent years at MH-13; trend does not appear site-related
Total # of sensitive EPT taxa (of 19 total):	**4**	**6**	**6**	**4**	**6**	**4**	**6**	**7**	**7**	**5**	**4**	**9**	**9**	**9**	**17 of 19 (89%)**		

Notes:

[1] A total of 19 EPT taxa are selected by Laberge as having with a low tolerance to chemical pollution based on Lehmkuhl, 1979. These taxa are those with low scores (0 to 1.5) in Table 4 of the Lehmkuhl reference. EPT taxa in Table 4 with scores of 2 or higher are not included in the "sensitive" group and include Baetidae, Baetiscidae, Caenidae, Stenonoma sp, Heptagenia sp, Leptophlebia sp, Siphlonuridae, Tricorythidae, Hydroptilidae, Hydropsychidae, Polycentropodidae.

"Overlap" was based on a comparison of the presence/absence of a sensitive taxon at MH-13, relative to the presence/absence of this taxon at the Camp Creek (MH-11, and CC-Confl) and reference (MH-30) comparator stations. For example, Ephemerellidae was present at MH-13, as well as MH-11, CC-Confl, MH-30; this is considered an 'overlap'. Chloroperlidae was not present at MH-13, but was at MH-11, CC-Confl and MH-30; these results do not 'overlap'. To overlap, MH-13 results need to match only one of the comparator stations.

Table A7-3. False Canyon Creek benthic invertebrate LOE - assessment of magnitude and causality.

Metrics[1]	Effects Assessment: False Canyon Creek Upstream to Downstream Trends[2]	Effects Assessment: Qualitative Comparison to Camp Creek Benthic Invertebrate Study[4]	Exposure/Causality Assessment: Water Chemistry versus Guidelines and Toxicity Benchmarks[5]	Exposure/Causality Assessment: Sediment Chemistry versus Guidelines[6]	Exposure/Causality Assessment: Habitat and Stream Characteristics[7]
Total Abundance	Negligible	**Negligible** - Specific metrics are not directly comparable due to different sampling methods; - EPT richness was similar at MH-13 and MH-30 (reference), slightly lower than MH-11/CC-Confl (but MH-13 has lower metals concentrations than MH-11); - There was 89% overlap in presence of EPT sensitive taxa between MH-13 and MH-11/CC-Confl/MH-11; overall trends in presence/absence did not appear site-related; - Effects to the benthic invertebrate community in Camp Creek were considered negligible to low at all stations (therefore effects due to metals in False Canyon Creek are considered unlikely)	**None** - There is an upstream to downstream trend in water quality in False Canyon Creek; (MH-13 is highest in metals and was rated as 'moderate' relative to guidelines). - However, based on the toxicity benchmarks from laboratory testing conducted for the AERA using site/creek water, water concentrations of metals are in the "no-effect/negligible" range, and are not expected to cause effects to invertebrates in False Canyon Creek.	**Weak, Positive** - There is an upstream to downstream trend in sediment chemistry. - Sediment chemistry was rated "low" at MH-13, based on exceedances of 1-3 fold above guidelines.	**Explanatory** - Differences in habitat between MH-13 and the downstream stations (MH-16 and MH-20) can explain differences in benthic invertebrate communities and composition, and are considered the likely explanatory variable (not metals), based on Laberge (2015).
Richness	Negligible				
Sensitive Taxa	High (MH-13 is 53% lower than MH-16 and MH-20)				
EPT Richness	Moderate (MH-13 is 37% lower than MH-16/20)				
% EPT Abundance	Moderate (MH-13 is 22% lower than MH-16/20)				
Overall Rating	**Moderate (with high uncertainty)** EPT/sensitive taxa metrics are lower at MH-13 than downstream stations in False Canyon Creek. Comparisons to the Camp Creek study suggest MH-13 is not impaired relative to the reference station, but this comparison was qualitative and given less weighting.		**None (with moderate uncertainty)** While there was an upstream to downstream trend in water and sediment chemistry (MH-13 had higher metals than downstream), comparisons to water toxicity thresholds developed in the AERA suggest that concentrations are in the "no-effect" range. Sediment exceedances were slightly above guidelines. Most importantly, Laberge (2015) document differences in habitat and physical stream characteristics between MH-13 and the downstream stations that are the most likely causes of differences in species composition between the study stations (i.e., lower EPT at MH-13).		

Notes:

[1] See Table A7-1 for explanation of metrics.

[2] MH-13 (upstream) versus the average of MH-16 and MH-20 (downstream).

[3] Based on Laberge, 2015.

[4] See LOE Appendix Section 6; emphasis is placed on comparisons of EPT richness and presence of sensitive EPT taxa in MH-13 to MH-11 (nearest station in Camp Creek), and MH-30 (nearby reference station). Both of these stations (MH-11 and MH-30) were sampled at the same time as False Canyon Creek, but the comparison is qualitative due to differences in sampling protocols in Camp Creek and False Canyon Creek (see text for details).

[5] Based on Water Chemistry LOE (see Section 2) and Water-Based Toxicity Testing LOE (see Section 11); summarized in Table A7-1.

[6] Based on Sediment Chemistry LOE (see Section 3 of this LOE Appendix A). A low rating means 95%ile concentration is between 1-3 fold above guidelines.

[7] See Table A7-1 for key habitat and species preference information, as reported in Laberge (2015).

8. FISH POPULATION SURVEY

8.1. LOE Description

Comparison of total and relative abundance of fish species collected from stations in Camp Creek, North Creek, and False Canyon Creek. This LOE is presented as a narrative and does not provide quantitative ratings for effect size and other metrics.

8.2. Narrative Summary

8.2.1. Overview

This LOE relies on the following data:

- Fish community surveys conducted by Azimuth in Camp Creek between stations MH-04 and MH-27 in late June 2014.
- Fish community surveys conducted by Laberge in the lower reaches of Camp Creek at MH-11 and False Canyon Creek at MH-13, MH-16, MH-20, and MH-30 in late August 2014.
- Historical fish community data collected at MH-13, MH-16, and MH-20 are assessed biennially by Laberge as a component of the routine monitoring program.
- Baseline fish presence/absence data from the Mt. Hundere Project IEE (SRK 1990). Spring and fall surveys were completed to assess the distribution and abundance of fish species in watercourses in the region surrounding the Site. Stations in close proximity to the AERA and Laberge monitoring stations were singled out for comparison.

While MH-29 and MH-30 are considered reference stations for exposure variables (water, sediment), they are not considered reference locations for fish populations. These stations are in close proximity to exposure locations and fish movement between these two areas cannot be discounted.

This LOE is considered qualitative and provides information on presence/absence of fish at the various sampling locations from upstream Camp Creek to downstream False Canyon Creek. General information on abundance at each area is provided but with variability in catch effort and timing, direct quantitative comparisons are not appropriate. Fish community characterized in previous years is used to assess temporal variability at some stations as part of routine monitoring.

8.2.2. Methods

Collection Methods

AERA / Monitoring Programs

A Smith Route model LR24 battery powered electro-fisher was the primary method used for determining fish presence. Shocking time (seconds) and settings used to collect fish were recorded for each sampling

Site. Angling (fishing rod with small spinner), G-minnow trapping (baited overnight), and seining (1.5 x 7 m seine net with 6.3 mm mesh size set in shallow water) were also employed as fish capture methods by Laberge at the far-field stations in False Canyon Creek (MH-13, MH-16, and MH-20) with limited success. Fishing method and effort are provided in **Table A8-1**. Suitable habitat was not identified at Access Creek (MH-29) and Portal Creek (MH-28) during the June 2014 survey by Azimuth, and as such, these stations were not shocked.

Captures were identified and measured for length (± 1mm) and weight (± 0.1gm). Weight was determined using an Ohaus Scout II digital scale. All fish were live released at site of capture except for five slimy sculpin from MH-30 and five slimy sculpin from MH-16, which were retained for tissue chemistry analysis. Fish tissue chemistry falls under a separate LOE and is presented in **Section 4**.

Baseline IEE (1989)

The spring fish population survey was completed June 27th to 29th, and focused on the distribution and abundance of recently emerged spring spawners (i.e., Arctic grayling). Fall sampling was completed in early September and focused on the location of fall spawning species (Dolly varden and whitefish). Sampling was done over approximately 50 m of stream reach at each station using a gas powered electroshocker. Fish were enumerated and identified in the field prior to release. The sampling efforts and catch results for each location are shown in Tables 2.19 and 2.20 of Volume IV of the IEE (SRK, 1990).

Of the stations sampled in the baseline survey, E4, E5, D4, and C1 were singled out for comparison with the current (2014) and long-term fish population data (from Laberge) based on their proximity to existing monitoring locations. According to the map provided in Volume IV (see Figure 2.18; SRK, 1990), station E4 corresponds to MH-04 on Camp Creek, E5 is near MH-13 on False Canyon Creek, D4 is near MH-16, and C1 is in the vicinity of MH-20.

Habitat Descriptions

Habitat was characterized at all near-field stations where fish populations were assessed in 2014. Habitat descriptions with site pictures can be viewed in **Appendix B** of the main report. Information on the habitat of the far-field False Canyon Creek station sampled by Laberge is contained in the various monitoring program reports (refer to Laberge 2008, 2010, 2012, and 2014 for more information). Lastly, habitat descriptions of False Canyon Creek and some tributaries were provided in Volume IV (Biophysical Evaluation of the Project Site) of the IEE (SRK, 1990). The available habitat information was used to provide context to the fish catch results, particularly in instances where no fish were captured.

8.2.3. Results

Catch results for the 2014 surveys (June and August) are presented in **Table A8-1**. Long-term average catch results for 1992 – 2012 compared to the 2014 and baseline IEE surveys are shown in **Table A8-2**.

Baseline Data (Initial Environmental Evaluation, 1989)

No fish were captured from E4 (upper Camp Creek) and E5 (~MH-13 on False Canyon Creek) in the June and September surveys. Overall, baseline fish catch results for slimy sculpin are lower relative to the average catch results from the long-term monitoring data collected by Laberge (**Table A8-2**). At MH-13 for example, the long-term average catch of slimy sculpin is 21.7 fish while the baseline survey catch of slimy sculpin at approximately the same location (E5) was 0 in the spring and fall surveys in 1989. Arctic grayling were prevalent in the lower reaches of False Canyon Creek, primarily in backwaters and eddies during the June survey, but upstream of MH-20 the catch was lower, with some small schools observed feeding at D4 (~MH-16). The catch/observation data for Arctic Grayling in the baseline IEE is similar to the long-term fish community data from Laberge dating back to 1992 (see Laberge 2015).

Fish catch in Tributary E during the IEE was limited to slimy sculpin in the June and September 1989 surveys. Five locations were sampled, two on the East Fork (E1 and E2), two on the West Fork (D1 and D2), and one the mainstem (D3) of Tributary E downstream from where the two branches join. No fish were captured on either of the West Fork stations in June or September, but slimy sculpin were captured from both stations on the East Fork in June and September. E1, the farthest upstream location, is situated in the area of the water quality station MH-12 based on the map provided in the SRK report (SRK 1990). Arctic grayling and sculpin were captured on the mainstem of Tributary E.

Azimuth June 2014 Survey – Camp Creek and North Creek

No fish were captured in the June survey conducted by Azimuth in Camp Creek or in North Creek at MH-12A. The absence of catch in Camp Creek is attributed mainly to habitat. As mentioned in the IEE, the upper reach of False Canyon Creek is characterized by meandering shallow glides and riffles, with relatively few pools of sufficient depth to provide cover (SRK, 1990). There are also numerous barriers to fish migration in False Canyon Creek, particularly near MH-13 (Laberge 2008). These observations are consistent with the habitat observed at location in upper and lower Camp Creek in 2014.

Slimy sculpin are known to rely on unembedded cobble and the surrounding interstitial spaces for cover (survival) and nesting sites (reproduction) (Edwards and Cunjak, 2007; Arciszewski et al., 2010). Unembedded cobble habitat was not observed at any of the stations in upper or lower Camp Creek. Furthermore, the downstream reach of Camp Creek (MH-28A to MH-27) is situated within a flat valley bottom and it appears that the stream is vulnerable to migration and streambed scour, a factor that can negatively affect the distribution and abundance of slimy sculpin (Edwards and Cunjak, 2007). The absence of slimy sculpin from Camp Creek in 2014 is consistent with the habitat preference of this species.

Artic Grayling are not expected to reside in Camp Creek, based on the IEE (SRK 1990) and long-term monitoring (Laberge 2015).

Laberge Survey Data – False Canyon Creek

Results from the August 2014 program at MH-13, MH-16 and MH-20 were generally consistent with previous monitoring programs at these locations (see Laberge 2014 for more information). Fish density was low at these three stations, as follows:

- Only four species were captured, including slimy sculpin, artic grayling, burbot and whitefish.
- Slimy sculpin were the dominant species present at all sampling locations. MH-13 only had one sculpin captured (and no other species) indicating extremely low densities at this site, and is lower than catch in recent years. Sculpin catch at MH-16 and MH-20 was similar to the historical average for these locations.
- Arctic grayling were caught at MH-16 and MH-20 by angling and electrofishing. Only one individual was caught per site by angling but numerous "strikes" were recorded.
- Two burbot were caught at MH-16, a species that has been documented in low numbers at MH-16 and MH-20 historically.
- Six whitefish were caught at MH-20, a higher density than in past years at this station.

Water levels at MH-13 were higher in 2014 compared to any of the previous surveys, and the ponds where the fisheries assessments have previously been completed were deeper and larger (Laberge 2015). In contrast to 2014, water levels in 2008 were noted as being "abnormally low" relative to previous years, which according to the authors, contributed to the capture of large numbers of sculpin (see Section 4.4.2 of Laberge [2015]). It's apparent that year-over-year changes in water levels at MH-13 are an important determinant of the sculpin catch. By comparison, sculpin catch was higher at MH-16 (13 fish) and MH-20 (11 fish) compared to MH-13, and near historic averages. Water levels at both locations were also noted as being higher in 2014 relative to previous years, but these areas of False Canyon Creek have more optimal habitat for fish colonization (i.e., good cover in the form of deep pools, overhanging vegetation, and accumulations of woody debris [Laberge 2015]). Overall, fish distribution and catch comparisons sampled in 2014 generally indicate little to no change in the dominant fish types or their relative abundance when compared to historic surveys.

MH-30/CC-Confl and MH-11 were sampled by Laberge for fish for the first time in 2014. Five slimy sculpin were caught by electroshocker at MH-30[17]. No other species were caught and no other capture methods were employed at this site. MH-30 is the furthest upstream station to be confirmed as fish-bearing. No fish were captured at MH-11. The habitat at MH-11 is similar to the stations sampled by Azimuth in June 2014 where no sculpin were observed (**Appendix B**; Photos 13 and 14). Poor habitat quality for slimy sculpin is likely the reason for the absence of fish at this location.

[17]As discussed in Section 4, some fish caught at MH-30 were captured closer to the confluence of Camp Creek and False Canyon Creek (station CC-Confl).

8.2.4. Summary

Camp Creek and North Creek – The upper reaches of Camp Creek and North Creek do not appear to be fish-bearing, as there was no catch during the 2014 survey. The baseline IEE survey in 1989 also failed to document fish presence in upper Camp Creek, likely due to lack of suitable habitat. Station MH-30/CC-Confl (start of False Canyon Creek) appears to be the furthest upstream fish-bearing site. Fish were document downstream in Tributary E during the baseline survey, but there are no operation fisheries data available for comparison.

False Canyon Creek – Several fish species are present in False Canyon Creek. While the absolute number of captured fish varies from year to year, the species composition continues to be consistent and indicative of a stable fish community. Low density populations of slimy sculpin are supported at all sites as far upstream on False Canyon Creek as MH-30/CC-Confl.

This LOE is included qualitatively in the WOE risk characterization (see Table 3-2 and Section 3.1.3 in the Main Report).

Table A8-1. Fish catch data for the 2014 program in Camp Creek and False Canyon Creek.

	Site	Method [1]	Effort	Catch: Arctic Grayling	Catch: Burbot	Catch: Slimy Sculpin	Catch: Whitefish	Observations[2]	Total Catch per Station
Azimuth Program (June 2014)	MH-04	Electro	111 sec	0	0	0	0		0
	CC-3	Electro	158 sec	0	0	0	0		0
	MH-28A	Electro	120 sec	0	0	0	0		0
	MH-27	Electro	74 sec	0	0	0	0		0
	MH-12	Electro	185 sec	0	0	0	0		0
Laberge Program (August 2014)	MH11	Electro	327 sec	0	0	0	0		0
	MH13	MNT	21.0 hrs	0	0	0	0		1
		Electro	766 sec	0	0	1	0		
	MH16	MNT	21.0 hrs	0	1	0	0		17
		Electro	627 sec	1	1	13	0	6 sculpin + fry	
		Angling	15 min	1	0	0	0	4 grayling strikes	
	MH20	MNT	20.5 hrs	0	0	0	0		18
		Electro	723 sec	1	0	11	1	6 sculpin + fry	
		Seine	30 m2	0	0	0	5		
		Angling	20 min	0	0	0	0	3 grayling strikes	
	MH30	Electro	723 sec	0	0	5	0		5

[1]Electro = electrofishing, MNT = minnow trap

[2]Fish observed visually or by fishing rod strike, but not captured

Table A8-2. Fish catch data from the baseline investigation relative to the operational/closure phase.

	Operational/Closure Period[1]			Baseline (1989)[3]		
Species	Licence Station	1992 to 2012[2] (Average)	2014 (Total)	IEE Sample Station[4]	Spring Sampling (June 27-28)	Fall Sampling (Sept 8-9)
Slimy sculpin	MH13	21.7	1	E5	0	0
	MH16	12.1	13	D4	0	1
	MH20	14.7	11	C1	1	2
Arctic grayling	MH13	0	0	E5	0	0
	MH16	3.3	2	D4	Obs[5]	1
	MH20	4.3	1	C1	1	6
Burbot	MH13	0	0	E5	0	0
	MH16	0.9	2	D4	0	0
	MH20	0.8	0	C1	0	0
Whitefish sp.	MH13	0	0	E5		
	MH16	0	0	D4	NR[6]	NR
	MH20	0.7	6	C1		
Lake chub	MH13	0	0	E5		
	MH16	0	0	D4	NR	NR
	MH20	0.1	0	C1		
Char sp.	MH13	0	0	E5	0	0
	MH16	0	0	D4	0	0
	MH20	0.1	0	C1	0	0

Notes:

[1] Presented in Laberge (2015; Table 13)

[2] Note that site MH16 was not sampled during the 1992, 1994 and 1996 surveys.

[3] Presented in SRK (1990; Volume 4, Table 2.19).

[4] Stations in the Initial Environmental Evaluation (IEE) correspond approximately to the monitoring locations in the Water Licence:
E5 = MH-13; D4 = MH-16; C1 = MH-20

[5] Obs = species observed, but not captured

[6] NR = species not reported

9. AMPHIBIAN SURVEY

9.1. LOE Description

The amphibian survey LOE was intended to compare species presence, abundance, condition and other endpoints in relation to habitat quality and COPC gradients in soil. However, as no amphibians were located during the survey, it did not inform on these metrics.

This LOE applies to amphibians.

9.2. Data Analysis

This LOE is based on a field survey conducted by Martin Gebauer in August 2014 (Gebauer 2014, included as Appendix B of Azimuth 2015b):

The two amphibian species on the list of ecological receptors of concern at the Sä Dena Hes Site are Wood Frog (Rana sylvatica) and Western Toad (Anaxyrus boreas; listed). Potential habitats for Wood Frog include wetland habitats such as marshes, creeks, and riparian areas, while Western Toad could occur anywhere on the Site, including terrestrial habitats. Wood Frogs have only been observed incidentally in 2012 in the north tailings pond and between the north and south tailings ponds. No other amphibians were observed, despite extensive informal presence over a wide area at site in 2013 and 2014.

Time-constrained surveys were conducted by one or two observers at several [terrestrial] locations at the Sä Dena Hes Mine in 2014 to further determine if amphibians are present and in what abundance (see Figure 2-10 in Volume 1 PF Addendum [Azimuth 2015a]). Sampling locations were targeted based on availability of amphibian habitat (e.g., lower elevation areas on-Site and areas with marshy or nearby aquatic habitats). Searches were time-constrained (i.e., not area-constrained) and involved walking slowly through potentially suitable habitat at a target site, and where appropriate, turning over cover objects such as rocks and coarse woody debris. Rocks and wood were returned to their original location.

Amphibians were not observed on any of the encounter surveys (see **Table A9-1**), *but the August timing may not have been ideal for encountering amphibians. This is consistent with results of informal surveys in 2012 and 2013. Overall, the lack of amphibians observed suggests that if they are present, they occur in low abundance or are more easily observed in other seasons or habitats.*

9.3. Narrative Interpretation

Overall, the field survey did not locate any amphibians on-Site, nor provide any quantitative information to evaluate this LOE. Based on information from the wildlife biologist, the expectation is that amphibians would be present on-Site (possibly at low abundance), but likely were not observed due to the timing of the field survey. This LOE is included qualitatively in the WOE risk characterization (Table 3-2 in main Volume 3 report).

Table A9-1. Results of Amphibian Encounter Surveys Conducted at the Sä Dena Hes Mine, August 2014.

Date	Location[1]	Survey Length (man hours)	Results
06 Aug 2014	1 - TPN	2	No amphibians
06 Aug 2014	2 - Between former north tailings and south tailings ponds	1	No amphibians
07 Aug 2014	3 - North of TPN	1	No amphibians
07 Aug 2014	4 - Mill Site	0.5	No amphibians
07 Aug 2014	5 - NC-Ref	1	No amphibians
07 Aug 2014	6 - FF-Ref1	0.25	No amphibians

[1]See Figure 2-10 in Volume 1 PF Addendum (Azimuth 2015a).

10. AMPHIBIAN SOIL TOXICITY THRESHOLDS

10.1. LOE Description

This LOE compares soil lead concentrations from the Site to effects-based amphibian thresholds from the literature.

This LOE applies to amphibians.

10.2. Data Analysis

This LOE relies on the following data:

- Soil-based toxicity tests using lead conducted on red-backed salamander (*Plethodon cinereus*) reported in Bazar et al., 2010 were used to derive effect-size ratings (amphibian benchmarks).
- Soil data for terrestrial Areas of Environmental Concern (AECs; see Azimuth 2015a and 2015b) provided by Golder based on 2014 site conditions (Golder, 2015a) were screened into various effect-size rating categories based on lead concentrations. Soil data are reported in Golder 2015a and discussed in more detail in Azimuth 2015a and 2015b[18].

10.2.1. Literature Search

A literature search on the effects to amphibians from exposure to key COPCs (lead and zinc) in soil at the Sä Dena Hes Mine was conducted using Google Scholar and TOXLINE (part of TOXNET) databases on September 4, 2014. Searches were conducted using a combination of key words: "amphibians" and "lead" or "zinc" and "soil". The first two pages of results for Google Scholar and approximately 43 results from TOXLINE were reviewed for relevance; abstracts from 15 papers were reviewed in more detail. Overall, most articles were not considered relevant, many experiments were done on water-based exposures to amphibian larvae/tadpoles, others reported on exposure (tissue based concentrations), but not corresponding effects. In the end, only one study, Bazar et al., 2010, which explored potential toxicity to red-backed salamanders from lead contaminated soils, was considered relevant for assessing potential risks to amphibians from soil contamination at the Site, and is used as the basis for this LOE. Other studies of note include:

- Bazar et al., 2009 was a soil-exposure study that explored toxicity from copper. Although copper was a COPC at Sä Dena Hes Mine, soil concentrations of copper were much lower relative to standards than lead; so the lead study was used as the LOE and provides a more conservative assessment of potential risks.

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[18] Reclamation activities (i.e., capping and recontouring) were carried out within the Mill Site, Jewelbox Hill, Boneyard, and TMF AECs in 2015. Soil lead concentrations used in the LOE are reflective of conditions prior to completing capping in these areas.

- Salice et al., 2009 was a feeding study exploring lead toxicity in lizards. However, reptiles are not present at the Site due to its Northern location.

10.2.2. Surrogate Receptor

Soil data for the Site were compared to literature-based toxicity values for the red-backed salamander. The red-backed salamander is used as a surrogate for the terrestrial life stage of the western toad (a species considered to be potentially present on-Site). Western toad was identified as a ROC in the PF, and although it has not been confirmed on-Site, wood frogs were observed on-Site in the Tailings Ponds in 2013. The Site is at the northern edge of the western toad's range, but if present on-Site, the toad may inhabit many terrestrial habitats, including the subalpine and alpine areas (COSEWIC, 2012). The red-backed salamander is exclusively terrestrial, primarily resides in soil, preys on soil invertebrates, and has a small home range, relatively long life span, and thin integument (skin), and was considered a suitable surrogate for the western toad.

10.2.3. Toxicity Test Methods

Salamanders were exposed to lead contaminated soils (or control soils) for 28 days with a 4 week acclimatization period. Soils included laboratory soils amended with lead acetate, or field collected soils from arms and skeet ranges. Of importance, this study exposed salamanders to contaminated soil only (exposure via dermal absorption); salamanders were fed uncontaminated food (wingless fruitflies). Toxicity testing studies for other soil COPCs at the Sä Dena Hes Site were not found in the literature (a similar study was conducted using copper, which was not a COPC in soil).

10.2.4. Toxicity Test Results

Table A10-1 summarizes the results of the study. For lead amended soils, the following effects were observed:

- 15% mortality, inappetence (i.e., lack of appetite), and 32% reduction in white blood cell count (WBC) was observed at 4,700 mg/kg dw lead
- 80% mortality (as well as overt signs of toxicity), inappetence, 15% lower body weight gain (relative to control), and 22% reduction in WBC was observed at the 9,167 mg/kg dw treatment level.
- The authors report the 1,700 mg/kg dw lead treatment level as a no-observed-adverse-effect-level (NOAEL) (the 11% reduction in WBC was not significant, although this is an endpoint that is not usually considered in ERA, the authors suggest that large reductions in WBC could have adverse health effects).

For the field soils contaminated by lead shot, minor effects were only observed at the 16,967 mg/kg dw lead treatment level (7.4% lower growth over 28 weeks and soil avoidance). The authors attribute the difference between treatment types to reduced bioavailability in the arms and skeet range soils.

10.3. LOE Attributes

10.3.1. Data Quality

Acceptable – Soil data used for screening against effect-size ratings were provided by Golder (2015a) and data quality is considered acceptable based on QA/QC measures that were in place during site characterization. Samples for which data quality was questionable were excluded from the data set (XRF data for some COPCs [see Azimuth 2015a for details] and 2012 duplicate data for the NC-Ref sample [see Azimuth 2014a]). The literature study is considered to have acceptable data quality – it had multiple treatments, a control for each soil exposure type, a sufficient number of organisms for each treatment (10-20), evaluated relevant toxicity endpoints, and was published in a peer reviewed journal.

10.3.2. Ecological Relevance

Moderate – Soil samples are collected from the site and represent site-specific exposures. Potential effect levels are inferred based on benchmarks from laboratory toxicity tests specific to amphibians (so has higher relevance than chemistry LOEs based on generic soil standards), but effects are not directly assessed (e.g., so has lower ecological relevance than a field survey). Overall, this LOE is considered to have moderate ecological relevance for predicting risks to amphibians.

10.3.3. Magnitude

10.3.3.1. *Degree of Contamination/Effects and Spatial/Temporal Scale*

Ratings were based on the following general categories used in the Interim ERA (Azimuth 2014c).

- Negligible (<10% sublethal effect size)
- Low (10-20% sublethal effect size)
- Moderate (20-50% sublethal effect size)
- High (>50% sublethal effect size or >20% lethal effect size)

Based on the results of laboratory toxicity tests conducted by Bazar et al., 2010, and the general effects categories listed above, we have applied the following effect-size ratings to lead concentrations in soil for rating magnitude for terrestrial amphibians:

- Negligible Effects: Less than 1700 mg/kg dw lead in soil
- Low Effects: 1700 to 4700 mg/kg dw lead in soil (11% reduction in WBC)
- Moderate Effects: 4700 to 9167 mg/kg dw lead in soil (15% mortality; 32% reduction in WBC)
- High Effects: Above 9167 mg/kg dw lead in soil (80% mortality; 15% lower body weight gain)

Figure A10-1 shows individual soil samples screened into various effect-size rating categories based on lead soil concentrations. Overall effect-size ratings by AEC are provided in **Table A10-2**, and summarized below.

- **Burnick Zone (AEC 2): Current and Post-reclamation: Low potential effect-size and localized spatial extent –** Most samples were below 1,700 mg/kg dw lead; only one exceeded. All soil samples in the 1300 Portal were below 1,700 mg/kg (low level) benchmark; potential effects here would be considered negligible. These ratings apply to current and post-reclamation conditions (no further remediation planned in this AEC).
- **Jewelbox / Main Zone (AEC 1 / 9)**
  - **Current: High potential effect-size and widespread spatial extent –** The Jewelbox, Main Zone and 1380 Gully sub-AECs had maximum and 95% upper confidence limit of the mean (UCLM) lead concentrations above 9,167 mg/kg dw lead (except Jewelbox, the 95% UCLM was 3,258 mg/kg dw in the low range). All soil samples in the 1250 Portal were below 1,700 mg/kg (low level) benchmark; potential effects here would be considered negligible. Based on **Figure A10-1**, the overall extent of contamination in AEC 1/9 is considered widespread.
  - **Post-reclamation: High potential effect-size and moderate spatial extent –** Remediation of the Jewelbox waste rock bench and portion of the Main Zone bench (i.e., application of a soil cover over the re-contoured area; see Figure 1-3 in Azimuth 2015a) is expected to improve lead concentrations in soil under post-reclamation conditions. However, some residual contamination is expected to remain on the periphery of the Jewelbox AEC (downgradient of the waste rock piles) and in the Main Zone and 1380 Gully AECs. Under post-reclamation, potential effect-sizes are still considered high, but spatial extent would be reduced and is considered moderate. There is some uncertainty with this rating, based on predicting future conditions.
- **Mill Site (AEC 3)**
  - **Current: Moderate potential effect-size and moderate spatial extent –** Although two samples (maximum 18,018 mg/kg were above 9,167 mg/kg dw lead [high]), the 95% UCLM was in the "low" category. Based on **Figure A10-1**, extent of contamination is considered moderate within the AEC. The haul road sub-AEC is in the 'negligible' category.
  - **Post-reclamation: Low potential effect-size and limited spatial extent –** Completion of a soil cover over soils from the Mill Site disturbed area is underway. Based on **Figure A10-1**, this would result in concentrations of lead in almost all soils to drop below the 1,700 mg/kg dw "low" threshold, so potential effects are considered low under post-reclamation conditions.
- **Tailings Management Facility (AEC 8)**
  - **Current and Post-reclamation: Low potential effect-size and limited spatial extent –** Most of the Tailings Management Facility disturbed area was covered with clean till in 2014 (not TPN, TPN-West Berm, and the marsh area) (**Figure A10-1**). Concentrations of lead in most soils are below the 1,700 mg/kg dw "low" threshold, with a few minor exceedances.
- **Other areas: Negligible potential effect-size with no exceedances** – This rating applies to the boneyard, Outside AEC, Outside AEC 1 & 9, and Reference categories. Although there was one exceedance of the 'low' threshold in the Outside AEC 1 & 9 area, the remaining soil samples

were in the negligible category. All other areas had no exceedances of the 1700 mg/kg dw 'low' benchmark.

Temporal extent of contamination is long-term – With the exception of areas identified as undergoing further remediation/reclamation, soil data collected between 2012 and 2014 are considered representative of long-term conditions (without active remediation). Information documented in Azimuth 2014d and 2015a suggests the terrestrial environment is fairly stable. Post-closure soil chemistry in the AECs is anticipated to improve where remedial works are planned, according to the information and assumptions provided above.

Uncertainty About Magnitude

High – Uncertainty related to extrapolating this LOE to effects to amphibians at the Site is considered high because it does not incorporate multiple COPCs, cumulative (e.g., dietary) exposures (see below) nor assess direct measures of effects to the amphibian species themselves (i.e., based on field studies). However, it does target one of two main COPCs in the terrestrial environment at the Site – lead, and is based on amphibian-specific toxicity information.

One major source of uncertainty is that this LOE only addresses toxicity from direct soil contact (dermal absorption); potential risks from the food chain pathway are not addressed. This uncertainty could underestimate overall exposure and risks to amphibians because a key exposure pathway is not covered (i.e., invertebrates and plants at the Site have higher levels of lead than reference areas, so amphibians feeding on-Site would be exposed to additional lead). Based on the search conducted for this LOE, we did not find any literature looking at dosing amphibians lead through the dietary route (which could be used to develop a TRV for the food chain model).

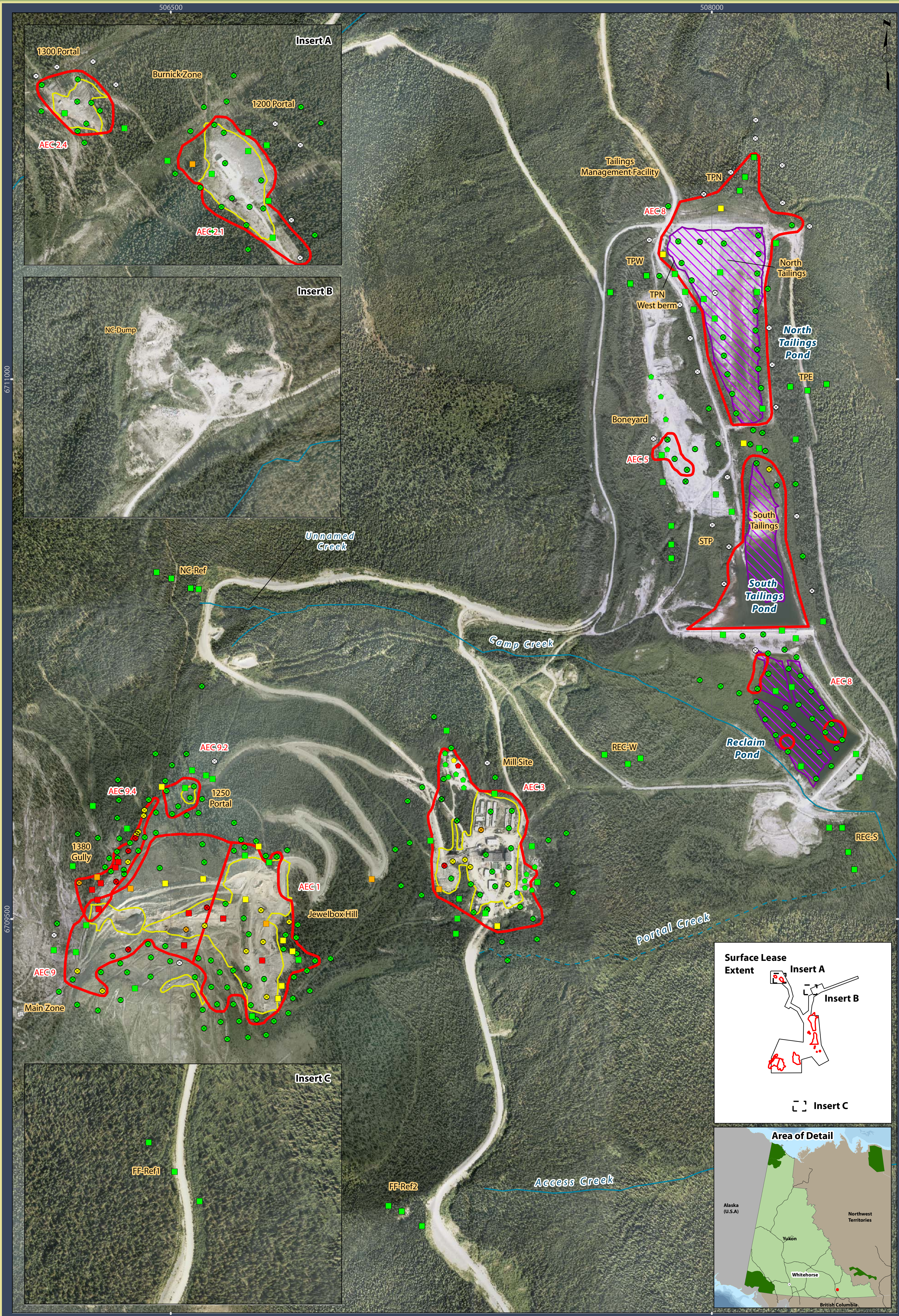
10.3.4. Causality

Causality - Strength of Correlation

Correlation (N/A); Supporting Evidence (Plausible) – This LOE identifies elevated exposure at three AECs relative to effects-based benchmarks from a toxicity study reported in the literature. Because the underlying study is effects-based, it provides plausible supporting evidence for potential toxicity. However, this LOE does not provide evidence of causality for actual effects.

Uncertainty Related to Causality

High – While the mechanism of action is supported by the soil benchmark, this LOE does not incorporate site-specific information on effects to assess strength of relationships/causality.



Legend

- River/Creek
- Ephemeral stream
- Area of Environmental Concern (AEC)
- Recontoured areas
- Tailings Pond Capped Areas

Soil Collection Method

- Surface Soil
- Test Pit
- XRF Soil

Note: Soil data shown here are representative of conditions in 2014, prior to completion of reclamation efforts at the Mill Site, Jewelbox Hill, Burnick Zone, Boneyard, and portions of the TMF.

Note: soil stations are labelled on a separate map.

Symbol color legend

Green: Negligible effects (less than 1700 mg/kg dw)

Yellow: Low effects (between 1700 and 4700 mg/kg dw)

Orange: Moderate effects (between 4700 and 9167 mg/kg dw)

Red: High effects (greater than 9167 mg/kg dw)

0 100 200 300

Metres

Projection: UTM Zone 9 NAD83

Data Sources:
Natural Resources Canada, GeoBase®
Teck Metals Ltd.
Azimuth Consulting Group

Figure A10-1

Lead Concentrations in Soils (mg/kg dw) Compared to Amphibian Toxicity Benchmarks

Sä Dena Hes

Prepared for: AZIMUTH

By: CASLYS CONSULTING

July 23, 2015

Table A10-1: Summary of salamander 28-day soil toxicity testing reported in Bazar et al., 2010.

Soil Type/ Treatment	Lead Soil Concentration (mg/kg dw)	No. Per Treatment Group	Day 28 Body Weight (Percent Change from Day 0)	Body Weight (Difference from Control)	% Mortality	Signs of Lead Toxicity/Soil Avoidance	Inappetence	Reduction in White Blood Cell Count (WBC), Relative to Control	Notes
Lead Amended[1] Laboratory Soils									
Control	14	20	12.6	n/a	~0%	None	Not observed	~0%	Exact mortality not reported
500	553	20	13.4	n/a	~0%	None	Not observed	7%	Exact mortality not reported
1500	1,700	20	15.0	n/a	~0%	None	Not observed	11%	Exact mortality not reported; WBC not statistically significant
4500	4,700	20	10.8	n/a	15%	None	Observed	32%	Mortality not statistically significant
9000	9,167	20	-2.3	15%	80%	Lethargy, un-responsiveness to touch, inability to right	Observed	22%	WBC not statistically significant
Field Collected Soils (Arms and Skeet Ranges)									
TAFB 1 (REF)	11	10	2.3	n/a	0%	Not observed	Not observed	n/a	
TAFB 2	1,430	10	-1.9	n/a	0%	Not observed	Not observed	n/a	
TAFB 3	2,710	10	3.4	n/a	0%	Not observed	Not observed	n/a	
APG 1 (REF)	28	10	0.8	n/a	0%	Not observed	Not observed	n/a	
APG 2	260	10	-0.3	n/a	0%	Not observed	Not observed	n/a	
APG 3	16,967	10	-6.6	7.4%	0%	Soil avoidance	Not observed	n/a	

Notes:

[1] Amended with lead acetate, but concentrations reported based on elemental lead.

Effects less than 10% or secondary endpoint (e.g., WBC count)

Effects above 10% for primary endpoints

Table A10-2: Lead concentrations in soils from AECs, relative to amphibian benchmark screening levels.

AEC	Area	*n*	Lead Concentration in Soil (mg/kg dw)		Spatial Extent
			Maximum	Upper 95% UCLM	
AEC 1	Jewelbox	*59*	22,200	3,258	Moderate extent
AEC 2.1	Burnick Waste Rock Pile	*18*	7,460	1,751	Localized
AEC 2.4	1300 Portal	*9*	1,247	829	No exceedances
AEC 3	Mill Site	*66*	18,018	2,031	Moderate extent
AEC 3.9	Haul Road	*20*	1,690	599	No exceedances
AEC 5	Boneyard	*8*	47	37	No exceedances
AEC 8	Tailings and Reclaim Ponds	*107*	3,180	311	Limited extent
AEC 9.0	Main Zone Waste Rock Dump	*24*	42,600	11,457	Widespread
AEC 9.2	1250 Portal	*7*	1,122	855	No exceedances
AEC 9.4	1380 Gully	*35*	45,700	12,818	Widespread
N/A	Outside AEC	*124*	617	84	No exceedances
N/A	Outside AECs 1 & 9	*90*	4,089	487	Limited extent
N/A	Reference	*24*	569	195	No exceedances

Notes:
UCLM = Upper confidence limit of the mean

Effect-size Ratings:

Negligible	Less than 1700 mg/kg dw lead is considered negligible; Spatial extent=no exceedances
Low; Localized	1700 mg/kg dw to 4700 mg/kg dw is considered low; Spatial extent=limited or localized exceedances
Moderate; Moderate	4700 mg/kg dw to 9167 mg/kg dw is considered moderate; Spatial extent=moderate
High; Widespread	Above 9167 mg/kg dw is considered high; Spatial extent=widespread

11. WATER-BASED TOXICITY TESTING

11.1. LOE Description

This LOE compares the water-based toxicity test results for aquatic plants, aquatic invertebrates and fish against the available water chemistry data from selected stations downstream of the Site.

This LOE assessment is applicable to aquatic plants, invertebrates, and fish.

11.2. Data Analysis

11.2.1. Overview

The following toxicity test data are available for use in the LOE assessment of each receptor group:

- **Aquatic Plants**
    - Dilution Series: Comparison of growth in 72-hr *Pseudokirchneriella subcapitata across* a gradient of COPC exposure in water (dilution series compared to upstream water and laboratory control).
- **Aquatic Invertebrates**
    - Dilution Series: Comparison of 7-day *Ceriodaphnia dubia* survival and reproduction across a gradient of COPC exposure in water (dilution series compared to upstream water and laboratory control; acclimation included in study design).
    - Water effect ratio (WER): Comparison of acute toxicity testing endpoints for *C. dubia* between parallel toxicity tests using laboratory water and site water to determine whether the site water characteristics modify contaminant bioavailability and potential toxicity.
- **Fish**
    - Quarterly Rainbow Trout Test: Survival of rainbow trout (96-hr static test using rainbow trout [*O. mykiss*]) exposed to Mine Site source water (MH-6A or MH-6B) collected as part of Teck's Water License.

Toxicity test results for the *P. subcapitata* and *C. dubia* tests were compared to water quality data either collected synoptically with the toxicity test samples or measured during toxicity testing (**Table A11-1** [Dilution Tests]; **Table A11-4** [WER Test]). To our knowledge, there are no synoptic water chemistry data available for the rainbow trout LC50 tests carried out as part of the Water Licence. Water chemistry data from the Reclaim Pond (MH-06A) are summarized (95^{th} percentile 2004-2013) in **Section 11.2.4** and compared to the long-term water quality results from MH-11 over the same time period to provide context to the toxicity test results. MH-11 was chosen for comparison because the results at this station tended to be the most conservative (**Table A11-2**).

The toxicity test results were also compared with predicted future concentrations of cadmium, lead, and zinc developed by SRK for expected and conservative scenarios (SRK 2014d). SRK generated model predictions for each metal by month (SRK 2014d), but for the purpose of comparison with the site-specific chemistry results, the concentrations shown in the tables listed above are those for the worst case month for each station and COPC combination. Toxicity test results (response and concentrations) are shown for available stations and relevant COPCs in **Table A11-2** (*C. dubia* Dilution Tests), **Table A11-3** (*P. subcapitata* Dilution Tests), and **Table A11-4** (*C. dubia* WER test).

Laboratory reports from Nautilus Environmental for the dilution series and WER toxicity tests are provided in **Appendix F**. Quarterly rainbow trout toxicity test results are included each year with the annual report for the Water Licence, and the most recent LC50 toxicity test results are presented in SRK (2014d).

Specifics of the Dilution Series, WER, and rainbow trout LC50 tests, including methods and data analysis and handling, are provided in the following sections.

11.2.2. Dilution Series Toxicity Test (Aquatic Plants and Invertebrates)

Test Method

Two dilution series tests were conducted to evaluate the response of 7-day *C. dubia* (survival and reproduction) and 72-h *P. subcapitata* growth inhibition (cell yield) to different concentrations (dilutions) of site water:

1. **MH-04 Dilution Series**: Water collected from MH-04 in Camp Creek to assess the potential toxicity of up-gradient water on-Site. There are some exceedances of guidelines at this station, and it is downgradient of mine waste (Main Zone pit/1380 Gully; see Section 6.2.1.1 of Volume 1 [Azimuth 2014d]).

   Three MH-04 concentrations were tested for their effect on the organism response: 10%, 50% and full-strength MH-04 surface water. The dilutions were prepared with laboratory control water diluted with Perrier water to achieve water hardness similar to the MH-04 sample (~160 mg/L as $CaCO_3$).

2. **Mixture Dilution Series**: Water collected from MH-25 (adit water) was mixed with water from MH-04 at varying concentrations to develop a "concentration-response relationship" or CRR by assessing the response of *C. dubia* and *P. subcapitata* over a concentration gradient that represents metals concentrations throughout Camp Creek, False Canyon Creek, and Tributary E based on 2004-2013 water quality data (see **Section 2.3.1** for information on the water quality data analysis).

   The full-strength mixture (i.e., 100% Mixture) was made up of 85% MH-04 and 15% MH-25, and was the highest concentration tested. The 100% Mixture was further diluted using MH-04 surface water to 30%, 10%, 3%, 1%, 0.3% and 0.1%, resulting in seven concentrations of the mixture. MH-04 (100% dilution) was also used as a site water control for this test.

Surface water from Camp Creek (MH-04) and site water from the 1380 Portal (MH-25, adit source) was collected by Azimuth during the June 2014 site visit. Twenty liters of unfiltered water from each station were collected into plastic carboys using an electric pump and submitted to Nautilus environmental for toxicity testing. Synoptic water samples were collected at each location and submitted to ALS for analysis of total and dissolved metals, anions and nutrients, organic carbon (total and dissolved), total suspended and dissolved solids, turbidity, and other physical tests (conductivity, pH, and hardness).

Data Handling and Analysis

Nominal metal concentrations were calculated for all dilution series treatments using data for MH-04 and MH-25 samples that were collected by Azimuth synoptically with the toxicity testing water[19]. Data were screened against the CCME guidelines and Yukon CSR aquatic life standards

Due to the different dilution waters (laboratory water for the MH-04 dilution series and MH-04 for the Mixture dilution series), the LC50 and ICxx toxicity test endpoints for the MH-04 and Mixture series were analyzed as independent datasets. The MH-04 dilution series was compared to the laboratory control (hardness-adjusted) while the test organism response in the Mixture dilution series was compared to the 100% MH-04 treatment.

Nominal metal concentrations in the Mixture and MH-04 tests were evaluated in each dilution (%v/v) to identify the list of metal(s) of interest to carry forward when assessing causality for reduced *C. dubia* survival and reproduction and *P. subcapitata* cell yield in the various tests. These metal(s) of interest were then compared against the water quality data (95th percentile [**Table A2-1**]) for selected stations within Camp Creek, False Canyon Creek, and Tributary E to determine if metal concentrations associated with effects in the tests are reflective of water chemistry data downstream from the Site. The predicted concentrations from SRK were also evaluated relative to the Dilution series tests.

Results

The following metal(s) of interest were identified in the nominal water quality screening data shown in **Table A11-1** for the *C. dubia* and *P. subcapitata* tests:

- Cadmium and zinc exceeded screening criteria in a number of dilutions; however, cadmium exceedances did not correspond with the response in the toxicity tests for both test organisms. For this reason, and based on correspondence with Nautilus, cadmium was not carried forward into a more detailed examination of causality and comparison against the site-specific water quality data and predicted concentrations from SRK.

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[19] Nautilus also collected water from the dilution series and submitted these samples to ALS Laboratories for analysis. However detection limits (DL) were elevated in the Nautilus samples relative to the water quality screening criteria, resulting in "less than DL" concentration results for many metals, except zinc. Hardness-adjusted control water re-submitted by Nautilus for low-detection limit analysis was used in the nominal water concentration calculation for the dilution series treatments.

- Zinc concentrations were observed to be associated with adverse effects in the Mixture toxicity tests, and zinc was carried forward for more detailed analysis in the Nautilus report [**Appendix F**]).

Toxicity test response results for *C. dubia* and *P. subcapitata* are presented in **Table A11-2** and **Table A11-3**, respectively. The tabulated results show the endpoint(s) for each test organism relative to the concentration of zinc in each treatment. The MH-04 and Mixture dilution series test results are shown in **Figure A11-1** for the *C. dubia* and **Figure A11-2** for *P. subcapitata*[20].

Discussion of the dilution series toxicity test results as a LOE in the AERA is presented in **Section 11.3.3** below.

11.2.3. WER Toxicity Test (aquatic invertebrates)

WER testing was conducted to develop site-specific water quality objectives (SSWQO) for potential use in renewal of the Water Licence (see Section 1.1 of Volume 3). Site specific objectives are meant to account for: (1) the physico-chemical properties of the site water that may alter the toxicity of the chemical; or (1) the differences in biological communities between the site and those used to derive the CCME guidelines or CSR aquatic life standards.

In the case of WER testing, the test procedure provides a direct means of modifying generic water quality guidelines/standards to account for the unique characteristics of the site (BC MOE 2013). WER tests were conducted on seven metals identified as COPCs at the Site for which WER testing was considered potentially beneficial for developing SSWQO (see Azimuth 2014f): aluminum, cadmium, chromium, copper, iron, lead, and zinc. Selenium was not considered a candidate COPC for WER testing because dietary exposure, not direct surface water contact, is the primary exposure pathway for sensitive ROCs (i.e., egg laying vertebrates).

Test Method

Surface water was collected from MH-04 on June 27th, 2014 and shipped to Nautilus for toxicity testing using the *C. dubia* 48-hr acute test method. Tests were conducted as follows:

- Seven metal treatments were prepared with MH-04 water spiked with each of the seven metals. Five concentrations were tested in each treatment, plus a control. Subsamples of each concentration were collected at test initiation for measurement of the spiked metal (total and

[20] The *P. subcapitata* MH-04 dilution test exhibited decreased cell yield in the MH-04 dilution series relative to the hardness adjusted control; however, the laboratory reported that relative to the normal laboratory control treatment, there was no effect on growth in any of the MH-04 dilutions. The hardness-adjusted water appears to have had a stimulatory effect on the control treatment, with a mean cell yield of 359 x 10^4 cells/mL compared to 55 x 10^4 cells/mL in the standard laboratory control water. A similar stimulatory effect was noted for all MH-04 dilution concentrations relative to the normal laboratory control (**Figure A11-2**; refer to the Nautilus report in **Appendix F** for more information).

dissolved). Subsamples were also collected at the end of the test for measurement of the total metals concentration.

- Laboratory controls were run concurrently with each treatment. The control water was modified to match the hardness of MH-04 (approximately 140 mg/L).
- Toxicity test end-points (LC50 and WER) were calculated on the basis of measured total metal concentration, with the exception of aluminum, which was calculated based on the concentration of dissolved metal (**Table A11-4**).

The WER was calculated by dividing the LC50 in each treatment by the LC50 in the laboratory control treatment.

- WER > 1: increased survival in site water relative to the laboratory control
- WER ≈ 1: no ameliorating effect of site water on survival
- WER < 1: reduced survival in the site water relative to the laboratory control

A full description of the WER test method is provided in the Nautilus laboratory report in **Appendix F**.

Data Handling and Analysis

The WER concentrations were compared against the water quality data (95th percentile) for selected stations within Camp Creek, False Canyon Creek, and Tributary E to determine whether concentrations associated with effects in the treatments are similar to water chemistry data downstream from the Site (**Table A11-4**). Predicted future concentrations for expected and conservative scenarios are also shown in this table for cadmium, lead, and zinc (SRK 2014d).

Results

Survival results, test endpoints (LC50 and WER) and measured metals concentrations are shown in **Table A11-4**. Measured concentrations in the Site receiving water were compared to the WER toxicity tests results, and zinc at MH-11 was the only metal that occurred at concentrations reported to cause effects in the test.

Discussion of the WER toxicity test results as a LOE in the AERA is presented in **Section 11.3.3** below.

11.2.4. Quarterly Rainbow Trout Toxicity Testing

Quarterly rainbow trout toxicity tests are required for discharge to False Canyon Creek as specified in the Effluent Quality Standards (Part D) of the Water Licence. The Water Licence requires that any water discharged into False Canyon Creek must meet an LC50 value of 100% effluent concentration. Tests are conducted on water samples taken from the Reclaim Pond at either MH-06A during discharge or MH-06B when there is no discharge from the Reclaim Pond.

The most recent rainbow trout toxicity testing results for 2014 are presented in SRK (2014d). No effects on trout survival have been recorded in any of the quarterly tests dating back to 2002 (refer to Section

4.2.2 of Volume 1 (Azimuth 2014d). For comparative purposes, the 95th percentile (mg/L) of the water quality data from the LC50 sampling location at the Reclaim Pond is shown relative to MH-04, MH-11, MH-08, and MH-13 for the 2004-2013 dataset:

COPC	**MH-06A** Reclaim Pond Outflow	**MH-04** Upper Camp Creek	**MH-11** Lower Camp Creek	**MH-08** Burnick Creek / Tributary E	**MH-13** False Canyon Creek
Aluminum	0.060	0.11	0.15	0.45	0.077
Cadmium	0.00025	0.00038	0.00075	0.000172	0.00028
Chromium	0.0010 (max)	0.001	0.0015 (max)	0.0081	0.0010
Copper	0.0029	0.0017	0.0034	0.0043	0.0043
Iron	0.18	0.20	0.42	0.38	0.93
Lead	0.0054	0.020	0.046	0.0063	0.0069
Selenium	0.0014	0.0010	0.0009	0.0017	0.00142
Silver	0.00002	0.00002	0.00004	0.00002	0.00002
Zinc	0.046	0.032	0.14	0.024	0.013

Notes:
The following formatting was used to compare the surface water concentrations at MH-06A where LC50 samples are collected to concentrations in stations representative of Camp Creek, Tributary E, and False Canyon Creek:

No fill	< 2 fold higher than the MH-06A concentration
	2-5 fold greater than the MH-06A concentration
	> 5 fold the MH-06 concentration

To our knowledge, water chemistry data has not been collected synoptically with the LC50 tests, so it is unknown where in the distribution of concentrations that the LC50 water samples fit relative to the long-term dataset for MH-06A. The 95th percentile concentrations reported at MH-11 are generally higher than those at MH-06A, but with the exception of lead, the concentrations at MH-06A are within a factor of 5 of those at MH-11. MH-04, MH-08, and MH-13 water quality data is similar to MH-06A for most COPCs. The absence of any reported effects precludes a more formal LOE assessment, and as such, the risks to fish based on the toxicity testing LOE are considered "negligible" for all receiving environments. There is uncertainty whether the results from MH-06A can be extrapolated to other locations downstream from the Site: uncertainty is considered high for Camp Creek because concentrations of metals such as lead and zinc at MH-11 are higher than MH-06A; uncertainty is considered moderate for False Canyon Creek and Tributary E based water chemistry that is more similar to MH-06A. The uncertainty ratings also incorporate extrapolating this acute lethality test to chronic exposures and sublethal endpoints. Because there was no toxicity in the MH-06A location, it is likely that LC50 tests on water from North Creek, and False Canyon Creek would produce similar no-effect results, and possible, but more uncertain, for Camp Creek (MH-11).

11.3. LOE Attributes

This section applies to aquatic plants and invertebrates. Based on information presented in **Section 11.3.3** risks to fish based on toxicity testing are considered "negligible" and are not assessed further.

11.3.1. Data Quality

Acceptable – Dilution and WER tests were conducted by in accordance with standard test methods, and Nautilus has indicated tests met all control acceptability criteria. The 72-hr holding time was exceeded for the dilution toxicity tests due to logistical challenges of collecting and shipping samples from Site. Any potential effects on the results were considered minor and there are no issues with the results that negatively affect the quality of the data (**Appendix B**). Raw data reports for the 96-hr acute rainbow trout tests were not available for review; however, the data quality is inferred as acceptable given the results have been previously reported in compliance with Water Licence.

11.3.2. Ecological Relevance

Moderate – The organisms used in the toxicity tests are considered broadly representative of the diversity of taxa that may be exposed in receiving environments downstream from the Site. Some resident species could be more sensitive to metals than the organisms used in the toxicity tests; however, adaptation and site-specific variables that affect exposure can mean that organisms at the Site may be less sensitive than the laboratory organisms used in the toxicity tests. The use of Site water in the dilution and WER tests incorporates some of the site-specific water quality characteristics in the exposure assessment. Overall, the toxicity tests are considered a moderately sensitive LOE.

11.3.3. Magnitude

Magnitude Interpretive Framework

An effect size ratings for each station in Camp Creek (MH-04, MH-27, MH-11), False Canyon Creek (MH-13, MH-16), and Tributary E (MH-08, MH-12) was assigned based on results of the dilution and WER toxicity tests. The dilution series was relevant for determining effect sizes to all stations for both aquatic plants and invertebrates; the WER tests are only applicable to the aquatic invertebrate receptor group.

Magnitude of effect ratings were assigned to each stations as follows:

Step 1: a rating was applied to each dilution in the tests (see **Table A11-2** [*C. dubia*], **Table A11-3** [*P. subcapitata*], and **Table A11-4** [*C. dubia* WER]) based on the following framework:

- Negligible = < 10% reduction in the measurement endpoint
- Low = between 10% and 20% reduction in the measurement endpoint
- Moderate = between 20% to 50% reduction in reduction in the measurement endpoint
- High = greater than 50% reduction in the measurement endpoint

Step 2: As zinc was identified as a potential cause of toxicity in the toxicity tests (see Results in **Section 11.2.2**), the station-specific water chemistry data (95th percentile or maximum concentration) was compared to the test concentrations in both WER and dilution toxicity tests to determine the appropriate magnitude of effect rating (same as above) to apply at each station, for each test endpoint.

Step 3: A more in-depth analysis of the CRRs was undertaken *if* moderate to high effects were predicted at the 95th percentile concentrations for a given station. The analysis involved determining the proportion of water samples at a given site that correspond to each risk rating (i.e., negligible, low, moderate, and high), and then examining temporal and seasonal distribution of the risk ratings.

The spatial extent of the potential effect(s) for each receptor group was qualitatively defined by assessing the effects ratings at each station relative to other stations within each receiving environment.

Magnitude of effects ratings are summarized below for each receptor group by receiving environment.

Camp Creek

- **Fish Survival – Negligible effect** (see **Section 11.2.4** above).
- **Aquatic Invertebrates**
  - **Survival – Low effect (Mixture Dilution test); Limited Spatial Scale** – MH-11 was the only location in the Camp Creek receiving environment where inferred effects on survival were greater than negligible or low based on the results of the toxicity tests. Based on the WER test, the magnitude of effect was considered high (> than 50% reduction in survival) for MH-11. The magnitude of effect for MH-11 in the mixture dilution test was considered low. For the overall magnitude rating, the results from the Mixture dilution test were weighted higher because the test was more ecologically relevant (i.e., the mixture dilution test was based on dilutions of MH-25 and MH-04 site water compared with the WER tests where MH-04 was spiked with increasing concentrations of zinc).
  - **Reproduction – High effect (Mixture Dilution test); Limited Spatial Scale** – MH-11 was the only location in the Camp Creek receiving environment where inferred effects on reproduction were greater than negligible (rated as high) based on the results of the toxicity tests.
- **Aquatic Plants**
  - **Upper Camp Creek: Negligible-to-low effect; limited spatial scale** – Moderate-level effects to algal cell growth were predicted based on comparing the 95th percentile zinc concentration at MH-04 to the CCR developed from the Mixture dilution toxicity test (**Figure A11-3**). The 95th percentile concentration slightly exceeds the IC20 concentration (moderate), and a comparison of the water quality data from 1999 to 2014 shows that 96% of the samples collected from MH-04 have zinc concentrations in the negligible-to-low effects range for predicted effects to *P. subcapitata* cell growth (**Table A11-5**; **Figure A11-4**). In total, four of 66 samples have zinc concentrations that exceed the negligible risk rating at MH-04 dating back to 1999 (**Figure A11-5**). Seasonal analysis of the results substantiates the conclusion that zinc concentrations pose negligible-to-low risks to algae in Upper Camp Creek.

- **Lower Camp Creek: Negligible-to-high effect; Limited Spatial Scale** – Adverse effects to cell yield were predicted as high at MH-11 and low at MH-27 when the 95th percentile concentrations were compared against the CCR (**Table A11-3** and **Figure A11-3**). A more detailed examination of the risk ratings by season shows higher concentrations of zinc in the winter months are primarily responsible for the high risk ratings predicted at MH-11 (**Figure A11-5**). After freshet in June, the predicted risks are within the negligible-to-moderate range; a high proportion of the samples are predicted as having negligible risk to algal cell growth. Ecologically, the post-freshet season is considered most critical for algal growth. A magnitude rating encompassing the range of data at MH-11 (negligible-to-high) was applied; the highest risk prediction for the growing season (post-freshet) was used (i.e., moderate potential effects in the WOE risk characterization (**Section 3.1.1** of the Main Report).

False Canyon Creek

- **Fish – Negligible effect** (see **Section 11.2.4** above).
- **Aquatic Invertebrates – Negligible Effect** – no adverse effects to aquatic invertebrates were determined based on the survival or reproduction results from the mixture toxicity tests compared to the site-specific water quality data for MH-13 and MH-16. Similarly, no adverse effects were reported in the WER tests at concentrations corresponding to the 95th percentile at MH-13 and MH-16.
- **Aquatic Plants – Negligible Effect** – no adverse effects to aquatic plants were determined based on the cell yield response results from the Mixture tests on *P. subcapitata* compared to the site-specific water quality data for MH-13 and MH-16.

Tributary E

- **Fish – Negligible effect** (see **Section 11.2.4** above).
- **Aquatic Invertebrates**
  - **Survival – Negligible Effect** – no adverse effects to aquatic invertebrates were determined for MH-08 and MH-12 based on the survival endpoint in the mixture dilution test or WER tests.
  - **Reproduction – Low Effect (Mixture Dilution test); Limited Spatial Scale** – Effects on *C. dubia* reproduction were rated low at MH-08 (Burnick Creek). A negligible effect rating was applied to MH-12 on North Creek based on the available water quality data relative to the Mixture test.
- **Aquatic Plants – Low Effect; Limited Spatial Scale** – The magnitude of effect on aquatic plants at MH-08 was considered low, as the concentration was less than IC25. The magnitude of effect at MH-12 indicated negligible risk to aquatic plants, so the spatial scale of the potential effect is considered limited.

Uncertainty About Magnitude

Most receptors, receiving environments and endpoints - Moderate – Uncertainty about magnitude is considered moderate as toxicity tests are not always representative of conditions in site receiving environments for the following reasons: some of the species used in the toxicity tests (*C. dubia*) would not necessarily be found in streams; laboratory organisms are often bred in water with very low metal concentrations and are often more sensitive to metals such as zinc than organisms in the field which can be acclimated to higher metals concentrations. Additionally, effects at each station were inferred from toxicity tests.

Aquatic Plants in False Canyon Creek and Tributary E - Low – In cases where negligible or low effects are predicted using the toxicity testing LOE, uncertainty was considered low because the laboratory-based toxicity LOE tends to be a conservative measure of potential effects in the field due to the higher sensitivity of laboratory reared organisms to metals. Therefore, it is unlikely that potential effects in the field would be underestimated based on this LOE.

Fish in Camp Creek - High – Uncertainty is considered high for Camp Creek because concentrations of metals such as lead and zinc at MH-11 are higher than the MH-06A LC50 monitoring location.

11.3.4. Causality

Causality - Strength of Correlation

Plants and Invertebrates - Correlation (High, Positive) – The CCR for zinc provides convincing evidence that zinc is responsible for the observed effects in the toxicity tests on *P. subcapitata* and *C. dubia.*

Fish - Correlation (N/A) – Effects were not observed in the acute fish toxicity tests; causality is not applicable.

Uncertainty Related to Causality

Plants and Invertebrates - Moderate – Consultation with Nautilus confirmed the likelihood that zinc is the cause of the observed effects in the toxicity tests (Dilution series [Mixture] and WER test). However, extrapolating these results to the field is considered to have moderate uncertainty.

Fish - N/A – Effects were not observed in the acute fish toxicity tests; causality is not applicable.

Figure A11-1. *Ceriodaphnia dubia* survival and reproduction test results from the MH-04 and Mixture dilution toxicity tests.

Notes: Refer to the text and **Table A11-1** for information on the dilution concentrations for each test.

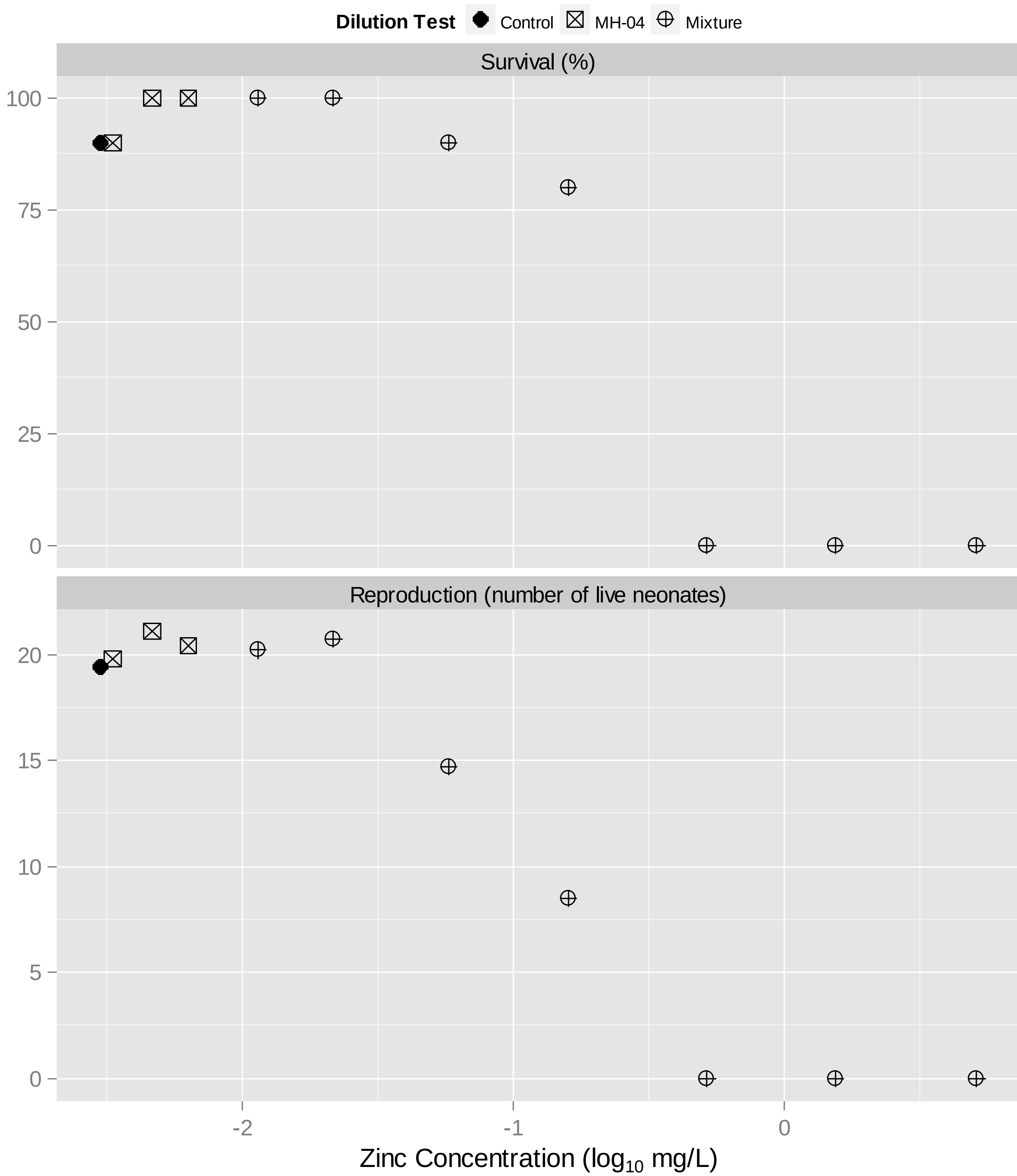


Figure A11-2. *Pseudokirchneriella subcapitata* toxicity test results from the MH-04 and mixture dilution toxicity tests.

Notes: Refer to the text and **Table A11-1** for information on the dilution concentrations for each test.

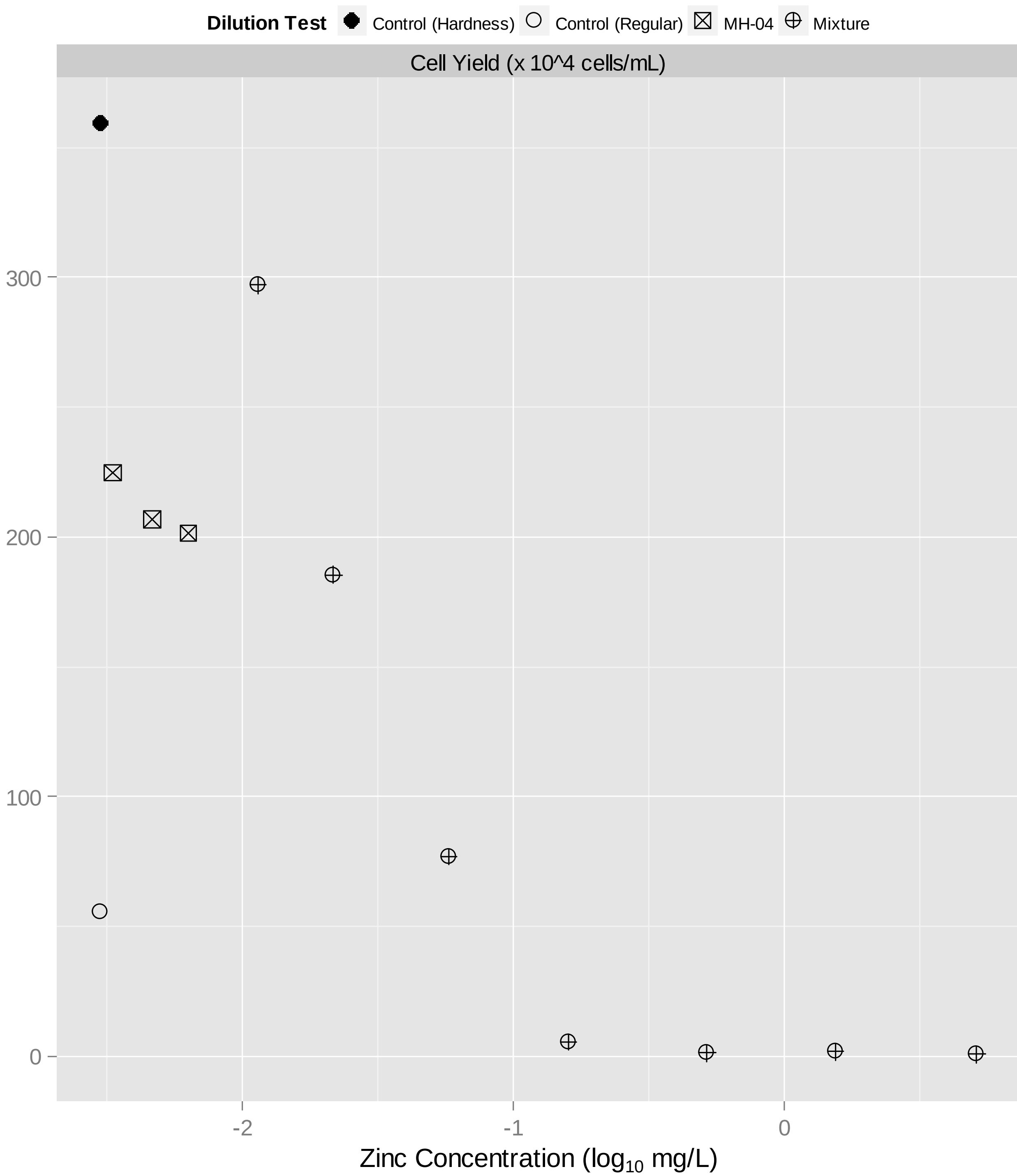


Figure A11-3. Normalized response results for *C. dubia* (survival and reproduction) and *P. subcapitata* (cell yield) in the mixture dilution toxicity test.

Notes: Results are normalized to the 100% MH-04 dilution as the ñcontrolò for the Mixture dilution toxicity test. Effects concentrations (EC) are defined as Negligible (<EC10), Low (EC10 to EC20), Moderate (EC20 to EC50) and High (>EC50). Vertical dashed lines represent the 95th percentile zinc concentration for samples collected between 2004 and 2013 at each station (maximum concentration for MH-12).

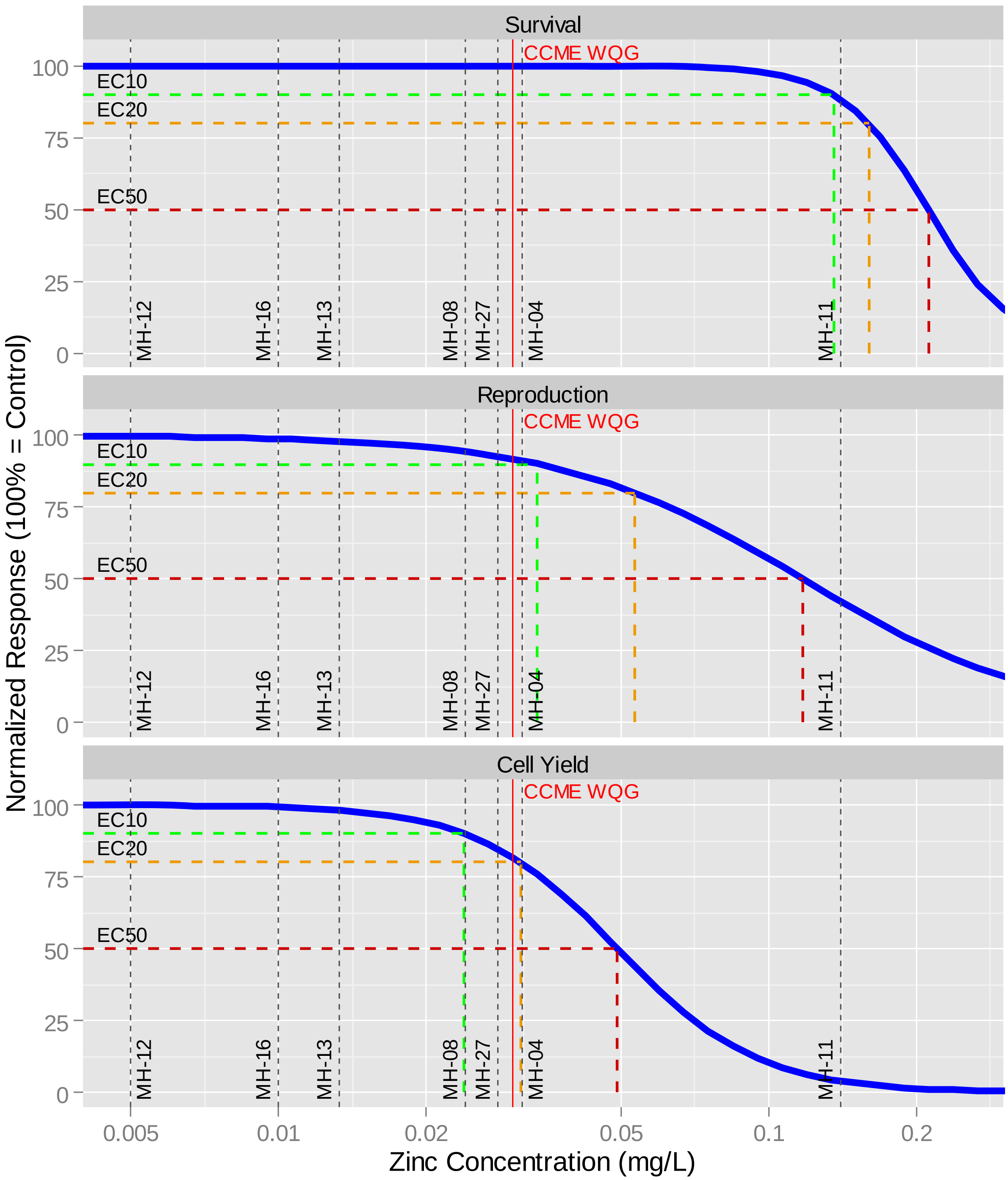


Figure A11-4. Proportion of water quality samples assigned to each risk category when comparing the site-specific zinc concentration against the *P. subcapitata* mixture dilution toxicity test concentration response relationship.

Notes: See **Figure A11-3** for information on the risk categories.

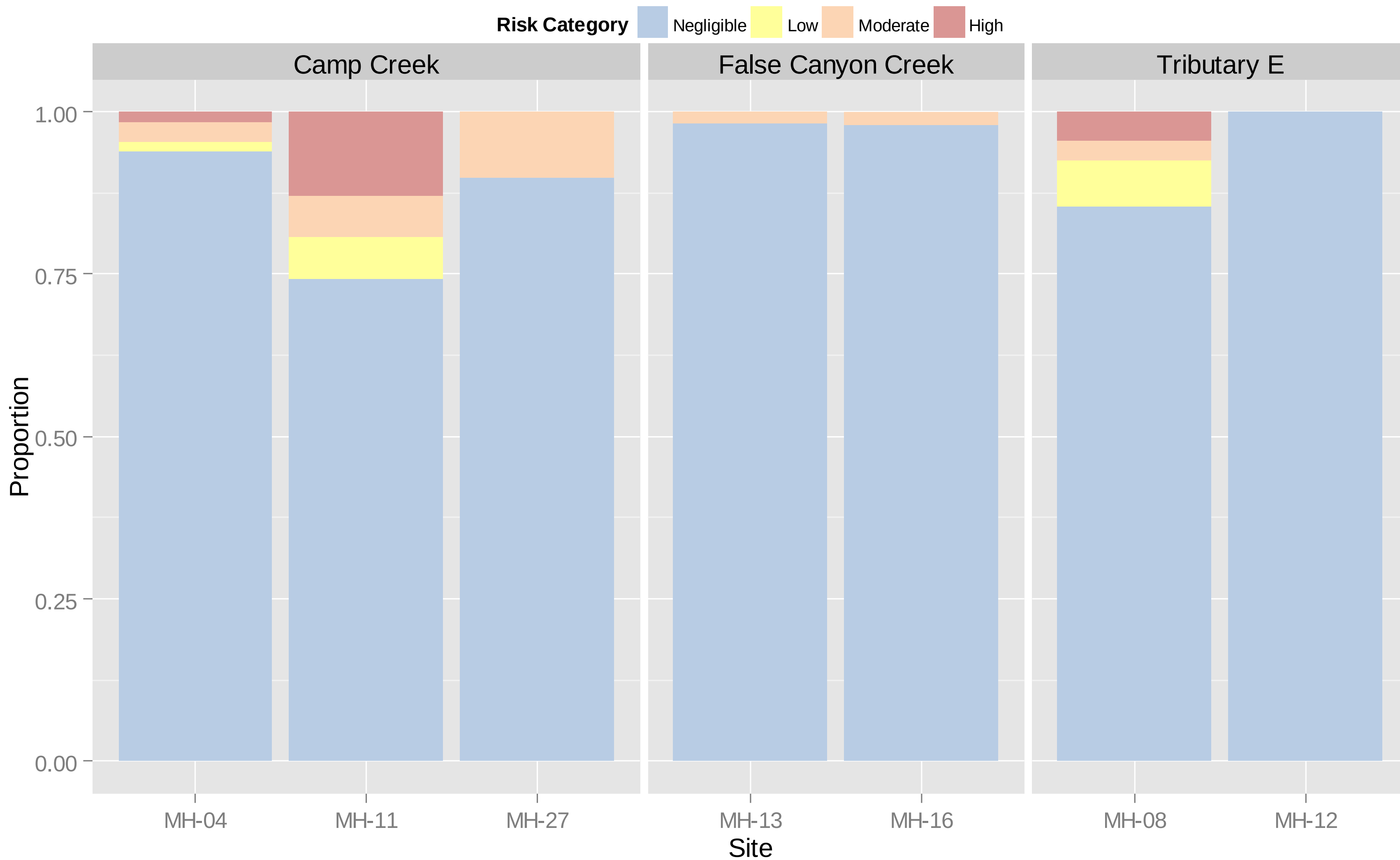


Figure A11-5. Predicted effects to *P. subcapitata* cell yield based on site-specific zinc concentrations, 1999-2013.

Notes: Predicted temporal (year) and seasonal (month) effects based on the dose-response for cell yield and zinc concentration in the Mixture dilution toxicity test.

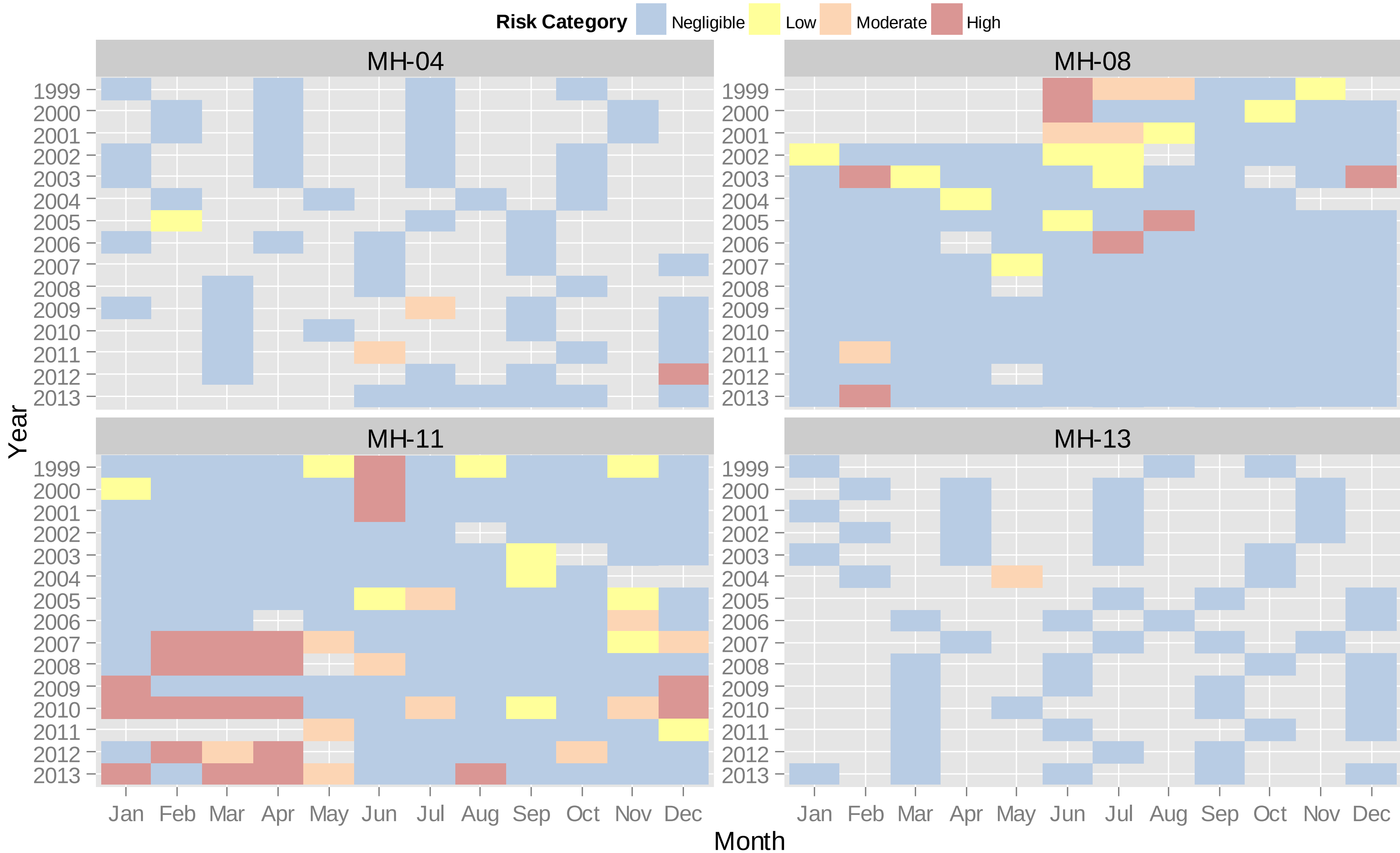


Table A11-1. Toxicity test results and water quality data for the *C. dubia* and *P. subcapitata tests* compared against the CCME and YK CSR water quality screening criteria.

Parameter	Source Water, Dilution Water, and Mixture Water Concentrations: MH-25 (1380 Portal) Lab Results	MH-04 (Camp Creek) Lab Results	Lab Dilution Water[1] Lab Results	Mixture Water[2] (85% MH-04, 15% MH-25)	Screening Criteria[3]: Yukon CSR	Screening Criteria[3]: CCME	MH-04 Toxicity Test (nominal concentrations and tox results) – MH-04 Treatment Concentrations: 10% MH-04 90% Dilution	50% MH-04 50% Dilution	100% MH-04	*C. dubia* LC50 & IC25 / IC50 >100% MH-04	*P. subcapitata*[4] IC25 >10% MH-04	*P. subcapitata*[4] IC50 >100% MH-04
Physical Tests (mg/L)												
Conductivity	413	267	312	289			308	290	267	267	308	267
Hardness (as $CaCO_3$)	164	154	163	156			162	159	154	154	162	154
pH (units)	7.6	8.2	8.3	8.1		6.5 - 9.0	8.3	8.3	8.2	8.2	8.3	8.2
Total Suspended Solids	26.0	*<3.0*	*<3.0*	6.5			3.0	3.0	3.0	3.0	3.0	3.0
Total Dissolved Solids	294	158	198	178			194	178	158	158	194	158
Turbidity	4.5	0.21	0.97	0.85			0.89	0.59	0.21	0.21	0.89	0.21
Anions and Nutrients (mg/L)												
Alkalinity, Bicarbonate (as $CaCO_3$)	38.8	138	110	123			113	124	138	138	113	138
Alkalinity, Carbonate (as $CaCO_3$)	*<2.0*	*<2.0*	*<1.0*	2.0			1.1	1.5	2.0	2.0	1.1	2.0
Alkalinity, Hydroxide (as $CaCO_3$)	*<2.0*	*<2.0*	*<1.0*	2.0			1.1	1.5	2.0	2.0	1.1	2.0
Alkalinity, Total (as $CaCO_3$)	38.8	138	110	123			113	124	138	138	113	138
Ammonia (as N) (see footnote 4)	*<0.0050*	*<0.0050*	*<0.050*	0.005			0.046	0.028	0.005	0.005	0.046	0.005
Chloride (Cl)	*<0.50*	*<0.50*	10.5	0.50			9.5	5.5	0.50	0.50	9.5	0.50
Fluoride (F)	0.076	0.11	0.067	0.11	0.30	0.12	0.072	0.090	0.11	0.11	0.072	0.11
Nitrate (as N)	0.25	0.13	0.85	0.14		3.0	0.78	0.49	0.13	0.13	0.78	0.13
Nitrite (as N)	*<0.0010*	*<0.0010*	0.008	0.001	0.02 - 0.1	0.060	0.007	0.005	0.001	0.001	0.007	0.001
Total Kjeldahl Nitrogen	0.084	0.090	*<0.050*	0.089			0.054	0.070	0.090	0.090	0.054	0.090
Orthophosphate-Dissolved (as P)	*<0.0010*	0.002	*<0.0010*	0.002			0.001	0.001	0.002	0.002	0.001	0.002
Phosphorus (P)-Total Dissolved	*<0.0020*	*<0.0020*	0.003	0.002			0.003	0.002	0.002	0.002	0.003	0.002
Phosphorus (P)-Total	0.023	*<0.0020*	*<0.0020*	0.005			0.002	0.002	0.002	0.002	0.002	0.002
Silicate (as SiO_2)	5.9	5.1	4.8	5.2			4.8	5.0	5.1	5.1	4.8	5.1
Sulfate (SO_4)	168	10.6	15.7	34.2	100		15.2	13.2	10.6	10.6	15.2	10.6
Organic / Inorganic Carbon (mg/L)												
Dissolved Organic Carbon	*<0.50*	1.2	1.2	1.1			1.2	1.2	1.2	1.2	1.2	1.2
Total Organic Carbon	*<0.50*	1.6	1.7	1.5			1.7	1.7	1.6	1.6	1.7	1.6
Total Metals (mg/L)												
Aluminum (footnote 5)	0.22	0.010	0.003	0.041		0.10	0.004	0.006	0.010	0.010	0.004	0.010
Antimony	0.001	0.0001	*<0.00010*	0.0003	0.020		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Arsenic	0.0008	0.0003	*<0.00010*	0.0004	0.005	0.005	0.0001	0.0002	0.0003	0.0003	0.0001	0.0003
Barium	0.014	0.019	0.013	0.018	1.0		0.013	0.016	0.019	0.019	0.013	0.019
Beryllium	*<0.00050*	*<0.00010*	*<0.00010*	0.0002	0.005		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Bismuth	*<0.0025*	*<0.00050*	*<0.00050*	0.0008			0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Boron (footnote 6)	*<0.050*	*<0.010*	0.023	0.016		1.5	0.022	0.017	0.010	0.010	0.022	0.010
Cadmium (footnote 7)	0.36	0.0002	*<0.000010*	0.054	0.00006	0.00023 - 0.00024	0.00003	**0.0001**	**0.0002**	**0.0002**	0.00003	**0.0002**
Calcium	61.5	55.5	61.8	56.4			61.2	58.7	55.5	55.5	61.2	55.5
Chromium (footnote 8)	*<0.00050*	0.0002	0.0004	0.0003	0.001	0.001	0.0003	0.0003	0.0002	0.0002	0.0003	0.0002
Cobalt	0.005	*<0.00010*	*<0.00010*	0.0008	0.0009		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Copper (footnote 7)	0.003	*<0.00050*	*<0.00050*	0.0008	0.007		0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Iron	1.0	0.013	*<0.010*	0.16		0.30	0.010	0.012	0.013	0.013	0.010	0.013
Lead (footnote 7)	0.61	0.0005	0.00006	0.092	0.006	0.003 - 0.0036	0.0001	0.0003	0.0005	0.0005	0.0001	0.0005
Lithium	*<0.0025*	0.001	0.002	0.001			0.002	0.002	0.001	0.001	0.002	0.001
Magnesium	2.0	2.6	2.2	2.5			2.2	2.4	2.6	2.6	2.2	2.6
Manganese	0.18	0.0005	0.0001	0.028			0.0002	0.0003	0.0005	0.0005	0.0002	0.0005
Molybdenum	0.0004	0.0006	0.0005	0.0006	1.0	0.073	0.0005	0.0005	0.0006	0.0006	0.0005	0.0006
Nickel (footnote 7)	0.003	*<0.00050*	*<0.00050*	0.0008	0.11	0.133 - 0.138	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Phosphorus	*<0.050*	*<0.050*	*<0.050*	0.050			0.050	0.050	0.050	0.050	0.050	0.050
Potassium	0.49	0.39	0.37	0.41			0.37	0.38	0.39	0.39	0.37	0.39
Selenium	0.005	0.0005	0.003	0.001	0.001	0.001	**0.003**	**0.002**	0.0005	0.0005	**0.003**	0.0005
Silicon	4.3	2.7	2.2	2.9			2.2	2.4	2.7	2.7	2.2	2.7
Silver (footnote 7)	0.0004	*<0.000010*	*<0.000010*	0.00007	0.002	0.0001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Sodium	0.46	0.71	5.2	0.67			4.7	2.9	0.71	0.71	4.7	0.71
Strontium	0.065	0.18	0.29	0.16			0.28	0.23	0.18	0.18	0.28	0.18
Sulphur	59.2	3.9	5.2	12.2			5.1	4.5	3.9	3.9	5.1	3.9
Thallium	*<0.000050*	*<0.000010*	*<0.000010*	0.00002	0.0003	0.0008	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Tin	*<0.00050*	*<0.00010*	0.0006	0.0002			0.0006	0.0004	0.0001	0.0001	0.0006	0.0001
Titanium	*<0.050*	*<0.010*	*<0.010*	0.016	0.10		0.010	0.010	0.010	0.010	0.010	0.010
Uranium	0.00010	0.0006	0.001	0.0006	0.30	0.015	0.001	0.001	0.0006	0.0006	0.001	0.0006
Vanadium	*<0.0050*	*<0.0010*	*<0.0010*	0.002			0.001	0.001	0.001	0.001	0.001	0.001
Zinc (footnote 7)	34.2	0.006	*<0.0030*	5.1	0.090	0.030	0.003	0.005	0.006	0.006	0.003	0.006
Dissolved Metals (mg/L)												
Aluminum (footnote 5)	*<0.0050*	0.002	0.003	0.002		0.10	0.003	0.002	0.002	0.002	0.003	0.002
Antimony	*<0.00050*	0.0001	*<0.00010*	0.0002	0.020		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Arsenic	*<0.00050*	0.0003	*<0.00010*	0.0004	0.005	0.005	0.0001	0.0002	0.0003	0.0003	0.0001	0.0003
Barium	0.010	0.020	0.013	0.018	1.0		0.014	0.016	0.020	0.020	0.014	0.020
Beryllium	*<0.00050*	*<0.00010*	*<0.00010*	0.0002	0.005		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Bismuth	*<0.0025*	*<0.00050*	*<0.00050*	0.0008			0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Boron (footnote 6)	*<0.050*	*<0.010*	0.027	0.016		1.5	0.025	0.019	0.010	0.010	0.025	0.010
Cadmium (footnote 7)	0.33	0.0002	*<0.000010*	0.050	0.00006	0.00023 - 0.00024	0.00003	**0.0001**	**0.0002**	**0.0002**	0.00003	**0.0002**
Calcium	62.8	57.3	61.5	58.1			61.1	59.4	57.3	57.3	61.1	57.3
Chromium (footnote 8)	*<0.00050*	0.0001	0.0003	0.0002	0.001	0.001	0.0003	0.0002	0.0001	0.0001	0.0003	0.0001
Cobalt	0.004	*<0.00010*	*<0.00010*	0.0007	0.0009		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Parameter	Mixture Toxicity Tests (nominal concentrations) – Mixture Treatment Concentrations (MH-04 diltuion): 0.1% Mixture 99% MH-04	0.3% Mixture 99.7% MH-04	1% Mixture 99% MH-04	3% Mixture 97% MH-04	10% Mixture 90% MH-04	30% Mixture 70% MH-04	100% Mixture	*C. dubia* LC50 4.1% Mixture 95.6% MH-04	*C. dubia* IC25 0.9% Mixture 99.1% MH-04	*C. dubia* IC50 2.3% Mixture 97.7% MH-04	*P. subcapitata*[4] IC25 0.49% Mixture 95.1% MH-04	*P. subcapitata*[4] IC50 0.82% Mixture 99.18% MH-04
Physical Tests (mg/L)												
Conductivity	267	267	267	268	269	274	289	268	267	268	267	267
Hardness (as $CaCO_3$)	154	154	154	154	154	154	156	154	154	154	154	154
pH (units)	8.2	8.2	8.2	8.2	8.2	8.2	8.1	8.2	8.2	8.2	8.2	8.2
Total Suspended Solids	3.0	3.0	3.0	3.1	3.3	4.0	6.5	3.1	3.0	3.1	3.0	3.0
Total Dissolved Solids	158	158	158	159	160	164	178	159	158	158	158	158
Turbidity	0.21	0.21	0.22	0.23	0.27	0.40	0.85	0.24	0.22	0.22	0.21	0.22
Anions and Nutrients (mg/L)												
Alkalinity, Bicarbonate (as $CaCO_3$)	138	138	138	138	137	134	123	137	138	138	138	138
Alkalinity, Carbonate (as $CaCO_3$)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Alkalinity, Hydroxide (as $CaCO_3$)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Alkalinity, Total (as $CaCO_3$)	138	138	138	138	137	134	123	137	138	138	138	138
Ammonia (as N) (see footnote 4)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Chloride (Cl)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Fluoride (F)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Nitrate (as N)	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.13	0.13	0.13	0.13	0.13
Nitrite (as N)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Total Kjeldahl Nitrogen	0.090	0.090	0.090	0.090	0.090	0.090	0.089	0.090	0.090	0.090	0.090	0.090
Orthophosphate-Dissolved (as P)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Phosphorus (P)-Total Dissolved	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Phosphorus (P)-Total	0.002	0.002	0.002	0.002	0.002	0.003	0.005	0.002	0.002	0.002	0.002	0.002
Silicate (as SiO_2)	5.1	5.1	5.1	5.1	5.1	5.1	5.2	5.1	5.1	5.1	5.1	5.1
Sulfate (SO_4)	10.6	10.7	10.8	11.3	13.0	17.7	34.2	11.6	10.8	11.1	10.7	10.8
Organic / Inorganic Carbon (mg/L)												
Dissolved Organic Carbon	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.2	1.2	1.2	1.2	1.2
Total Organic Carbon	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.6	1.6	1.6	1.6	1.6
Total Metals (mg/L)												
Aluminum (footnote 5)	0.010	0.010	0.010	0.011	0.013	0.019	0.041	0.011	0.010	0.010	0.010	0.010
Antimony	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0003	0.0001	0.0001	0.0001	0.0001	0.0001
Arsenic	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003
Barium	0.019	0.019	0.019	0.019	0.019	0.019	0.018	0.019	0.019	0.019	0.019	0.019
Beryllium	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
Bismuth	0.0005	0.0005	0.0005	0.0005	0.0005	0.0006	0.0008	0.0005	0.0005	0.0005	0.0005	0.0005
Boron (footnote 6)	0.010	0.010	0.010	0.010	0.011	0.012	0.016	0.010	0.010	0.010	0.010	0.010
Cadmium (footnote 7)	**0.0003**	**0.0004**	**0.0008**	**0.002**	**0.006**	**0.016**	**0.054**	**0.002**	**0.0007**	**0.001**	**0.0005**	**0.0007**
Calcium	55.5	55.5	55.5	55.5	55.6	55.8	56.4	55.5	55.5	55.5	55.5	55.5
Chromium (footnote 8)	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002
Cobalt	0.0001	0.0001	0.0001	0.0001	0.0002	0.0003	0.0008	0.0001	0.0001	0.0001	0.0001	0.0001
Copper (footnote 7)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0006	0.0008	0.0005	0.0005	0.0005	0.0005	0.0005
Iron	0.013	0.013	0.015	0.018	0.028	0.058	0.16	0.019	0.014	0.016	0.014	0.014
Lead (footnote 7)	0.0006	0.0008	0.001	0.003	**0.010**	**0.028**	**0.092**	0.004	0.001	0.003	0.0010	0.001
Lithium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Magnesium	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.6	2.6	2.6	2.6	2.6
Manganese	0.0006	0.0006	0.0008	0.001	0.003	0.009	0.028	0.002	0.0008	0.001	0.0007	0.0008
Molybdenum	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
Nickel (footnote 7)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0006	0.0008	0.0005	0.0005	0.0005	0.0005	0.0005
Phosphorus	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Potassium	0.39	0.39	0.39	0.39	0.39	0.39	0.41	0.39	0.39	0.39	0.39	0.39
Selenium	0.0005	0.0005	0.0005	0.0005	0.0006	0.0007	**0.001**	0.0005	0.0005	0.0005	0.0005	0.0005
Silicon	2.7	2.7	2.7	2.7	2.7	2.8	2.9	2.7	2.7	2.7	2.7	2.7
Silver (footnote 7)	0.00001	0.00001	0.00001	0.00001	0.00002	0.00003	0.00007	0.00001	0.00001	0.00001	0.00001	0.00001
Sodium	0.71	0.71	0.71	0.71	0.71	0.70	0.67	0.71	0.71	0.71	0.71	0.71
Strontium	0.18	0.18	0.18	0.18	0.18	0.17	0.16	0.18	0.18	0.18	0.18	0.18
Sulphur	3.9	3.9	3.9	4.1	4.7	6.3	12.2	4.2	3.9	4.0	3.9	3.9
Thallium	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001
Tin	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
Titanium	0.010	0.010	0.010	0.010	0.011	0.012	0.016	0.010	0.010	0.010	0.010	0.010
Uranium	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
Vanadium	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001
Zinc (footnote 7)	0.011	0.022	0.058	**0.16**	**0.52**	**1.5**	**5.1**	**0.22**	0.052	**0.12**	0.031	0.048
Dissolved Metals (mg/L)												
Aluminum (footnote 5)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Antimony	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
Arsenic	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003
Barium	0.020	0.020	0.020	0.020	0.020	0.019	0.018	0.020	0.020	0.020	0.020	0.020
Beryllium	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
Bismuth	0.0005	0.0005	0.0005	0.0005	0.0005	0.0006	0.0008	0.0005	0.0005	0.0005	0.0005	0.0005
Boron (footnote 6)	0.010	0.010	0.010	0.010	0.011	0.012	0.016	0.010	0.010	0.010	0.010	0.010
Cadmium (footnote 7)	**0.0003**	**0.0004**	**0.0007**	**0.002**	**0.005**	**0.015**	**0.050**	**0.002**	**0.0007**	**0.001**	**0.0005**	**0.0006**
Calcium	57.3	57.3	57.3	57.3	57.4	57.5	58.1	57.3	57.3	57.3	57.3	57.3
Chromium (footnote 8)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
Cobalt	0.0001	0.0001	0.0001	0.0001	0.0002	0.0003	0.0007	0.0001	0.0001	0.0001	0.0001	0.0001

Table A11-1. Toxicity test results and water quality data for the *C. dubia* and *P. subcapitata tests* compared against the CCME and YK CSR water quality screening criteria.

	Source Water, Dilution Water, and Mixture Water Concentrations				Screening Criteria[3]		MH-04 Toxicity Test (nominal concentrations and tox results)					
	MH-25 (1380 Portal)	MH-04 (Camp Creek)	Lab Dilution Water[1]	Mixture Water[2]			MH-04 Treatment Concentrations			*C. dubia*	*P. subcapitata*[4]	
	Lab Results	Lab Results	Lab Results	(85% MH-04, 15% MH-25)	Yukon CSR	CCME	10% MH-04 90% Dilution	50% MH-04 50% Dilution	100% MH-04	**LC50 & IC25 / IC50** >100% MH-04	**IC25** >10% MH-04	**IC50** >100% MH-04
Copper (footnote 7)	*<0.0010*	*<0.00020*	0.0005	0.0003	0.007		0.0004	0.0003	0.0002	0.0002	0.0004	0.0002
Iron	*<0.010*	*<0.010*	*<0.010*	0.010		0.30	0.010	0.010	0.010	0.010	0.010	0.010
Lead (footnote 7)	0.047	0.0003	*<0.000050*	0.007	0.006	0.003 - 0.0036	0.00007	0.0002	0.0003	0.0003	0.00007	0.0003
Lithium	*<0.0025*	0.001	0.002	0.001			0.002	0.002	0.001	0.001	0.002	0.001
Magnesium	1.8	2.7	2.2	2.6			2.2	2.4	2.7	2.7	2.2	2.7
Manganese	0.092	0.0002	0.0001	0.014			0.0001	0.0002	0.0002	0.0002	0.0001	0.0002
Molybdenum	*<0.00025*	0.0006	0.0005	0.0006	1.0	0.073	0.0005	0.0005	0.0006	0.0006	0.0005	0.0006
Nickel (footnote 7)	*<0.0025*	*<0.00050*	*<0.00050*	0.0008	0.11	0.133 - 0.138	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Phosphorus	*<0.050*	*<0.050*	*<0.050*	0.050			0.050	0.050	0.050	0.050	0.050	0.050
Potassium	0.49	0.37	0.37	0.39			0.37	0.37	0.37	0.37	0.37	0.37
Selenium	0.005	0.0006	0.003	0.001	0.001	0.001	**0.003**	**0.002**	0.0006	0.0006	**0.003**	0.0006
Silicon	3.2	2.8	2.2	2.8			2.2	2.5	2.8	2.8	2.2	2.8
Silver (footnote 7)	*<0.000050*	*<0.000010*	*<0.000010*	0.00002	0.002	0.0001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Sodium	0.38	0.72	4.8	0.67			4.4	2.7	0.72	0.72	4.4	0.72
Strontium	0.061	0.18	0.29	0.16			0.28	0.24	0.18	0.18	0.28	0.18
Sulphur	58.1	3.9	5.2	12.0			5.0	4.5	3.9	3.9	5.0	3.9
Thallium	*<0.000050*	*<0.000010*	*<0.000010*	0.00002	0.0003	0.0008	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Tin	*<0.00050*	*<0.00010*	0.0006	0.0002			0.0005	0.0003	0.0001	0.0001	0.0005	0.0001
Titanium	*<0.050*	*<0.010*	*<0.010*	0.016	0.10		0.010	0.010	0.010	0.010	0.010	0.010
Uranium	*<0.000050*	0.0006	0.001	0.0005	0.30	0.015	0.001	0.001	0.0006	0.0006	0.001	0.0006
Vanadium	*<0.0050*	*<0.0010*	*<0.0010*	0.002			0.001	0.001	0.001	0.001	0.001	0.001
Zinc (footnote 7)	30.4	0.005	0.004	4.6	0.090	0.030	0.004	0.004	0.005	0.005	0.004	0.005

	Mixture Toxicity Tests (nominal concentrations)											
	Mixture Treatment Concentrations (MH-04 diltuion)							*C. dubia*			*P. subcapitata*[4]	
	0.1% Mixture 99% MH-04	0.3% Mixture 99.7% MH-04	1% Mixture 99% MH-04	3% Mixture 97% MH-04	10% Mixture 90% MH-04	30% Mixture 70% MH-04	100% Mixture	**LC50** 4.1% Mixture 95.6% MH-04	**IC25** 0.9% Mixture 99.1% MH-04	**IC50** 2.3% Mixture 97.7% MH-04	**IC25** 0.49% Mixture 95.1% MH-04	**IC50** 0.82% Mixture 99.18% MH-04
Copper (footnote 7)	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002
Iron	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Lead (footnote 7)	0.0003	0.0003	0.0003	0.0005	0.0010	0.002	**0.007**	0.0005	0.0003	0.0004	0.0003	0.0003
Lithium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Magnesium	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.7	2.7	2.7	2.7	2.7
Manganese	0.0002	0.0002	0.0003	0.0006	0.002	0.004	0.014	0.0008	0.0003	0.0005	0.0003	0.0003
Molybdenum	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
Nickel (footnote 7)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0006	0.0008	0.0005	0.0005	0.0005	0.0005	0.0005
Phosphorus	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Potassium	0.37	0.37	0.37	0.37	0.37	0.38	0.39	0.37	0.37	0.37	0.37	0.37
Selenium	0.0006	0.0006	0.0006	0.0006	0.0006	0.0008	**0.001**	0.0006	0.0006	0.0006	0.0006	0.0006
Silicon	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Silver (footnote 7)	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001
Sodium	0.72	0.72	0.72	0.72	0.72	0.71	0.67	0.72	0.72	0.72	0.72	0.72
Strontium	0.18	0.18	0.18	0.18	0.18	0.18	0.16	0.18	0.18	0.18	0.18	0.18
Sulphur	3.9	3.9	4.0	4.1	4.7	6.3	12.0	4.2	3.9	4.1	3.9	3.9
Thallium	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001
Tin	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
Titanium	0.010	0.010	0.010	0.010	0.011	0.012	0.016	0.010	0.010	0.010	0.010	0.010
Uranium	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006
Vanadium	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001
Zinc (footnote 7)	0.009	0.018	0.050	**0.14**	**0.46**	**1.4**	**4.6**	**0.19**	0.046	**0.11**	0.027	0.042

Notes:

1 Diluted Perrier water (hardness 160 mg/L $CaCO_3$) was used for in the toxicity tests.

2 Mixture concentrations reported here are based on nominal concentrations calculated using the chemistry data from MH-04 and MH-25 collected at the same time as the water for toxicity testing was collected.

Note: Analytes in MH-25 and MH-04 source water that were < DL were set = to the DL when calculating the concentration in the Mixture.

3 Screening criteria applied in the AERA are:

i) Yukon Contaminated Sites Regulation, Schedule 3 - Generic Numerical Water Standards. The Yukon CSR aquatic life standard assumes a minimum dilution factor of 1:10. The values shown here were derived by dividing the standards by 10 in accordance with Protocol 6 (Yukon CSR 2002).

ii) CCME (Canadian Council of Ministers of the Environment) Canadian Water Quality Guidelines for the Protection of Aquatic Life.

4 *P. subcapitata* growth inhibition (ICxx) was calculated using hardness adjusted control water.

5 The CCME Guideline and Yukon CSR Standard for ammonia is temperature and pH-dependent. Screening was done using a water temperature of 10°C.

6 The CCME aluminum guideline is pH-dependent.

7 The CCME boron guideline is applied seperately for short term exposure (29 mg/L) and long term exposure (1.5 mg/L). The long-term guideline was used fro screening in the AERA.

8 The CCME Guideline and Yukon CSR Standards are hardness dependent for the following metals: cadmium, copper, lead, nickel, silver (Yukon CSR only), and zinc (Yukon CSR only).

Note: the range (minimum and maximum) of the CCME hardness-dependent guideline values was derived using the nominal hardness values calculated for each toxicity test concentration.

9 Chromium guideline is for Cr(VI).

10 The CCME uranium guideline is applied seperately for short term exposure (0.033 mg/L) and long term exposure (0.015 mg/L). The long-term guideline was used fro screening in the AERA.

Bold values indicate the concentration exceeds the Yukon CSR Aquatic Life Standard.

Shaded cells indicate the concentration exceeds the CCME guideline value.

Table A11-2. *Ceriodaphnia dubia* effects sizes for the MH-04 and mixture dilution series toxicity tests.

Treatment	Test Endpoint[3] Survival (%)	Reproduction Mean	Reproduction SD	Nominal Zinc[4] (mg/L)
Laboratory Control	90	19.4	5.1	<0.003
MH-04 Dilution Series[1]				
10% MH-04	90	19.8	7.2	0.003
50% MH-04	100	21.1	2.1	0.005
100% MH-04	100	20.4	20.4	0.006
Mixture Dilution Series[2]				
0.1% mixture	100	20.2	20.2	0.011
0.3% mixture	100	20.7	20.7	0.022
1% mixture	90	14.7	14.7	0.058
3% mixture	80	8.5	8.5	0.16
10% mixture	0	0	0	0.52
30% mixture	0	0	0	1.5
100% mixture	0	0	0	5.1
Mixture Dilution Series Effects Concentrations (mg/L)[7]				
Survival (LC50)				0.22
Reproduction (IC25)				0.052
Reproduction (IC50)				0.12

Water Chemistry Data Compared to the Mixture Dilution Series Test Results

	Camp Creek MH-04	Camp Creek MH-27	Camp Creek MH-11	False Canyon Creek MH-13	False Canyon Creek MH-16	Tributary E MH-08	Tributary E MH-12
Measured Zinc Concentration (mg/L)[4]							
95th Percentile [Zn]	0.032	0.028	0.139	0.013	0.010	0.024	0.005 (max)
Mean [Zn]	0.011	0.018	0.035	0.0088	0.0075	0.011	0.005 (max)
SRK WQ Predictions for Zinc (mg/L)[5]							
Expected (average)[4]	0.016	N/A	0.039	0.011	0.006	0.006	0.007
Conservative[4]	0.115	N/A	0.061	0.017	0.009	N/A	0.023
Potential Effects?[6]							
Survival							
95th Percentile [Zn]	Negligible	Negligible	Low	Negligible	Negligible	Negligible	Negligible
Reproduction							
95th Percentile [Zn]	Negligible	Negligible	High	Negligible	Negligible	Negligible	Negligible

Notes:

[1] The MH-04 dilution series effects size are compared against the laboratory control (adjusted to MH-04 hardness).

[2] The Mixture dilutions series are compared against the 100% MH-04 treatment.

[3] The following effect size ratings were applied when interpreting the Mixture Dilution Series Testing results relative to the Laboratory Control:

Negligible effect	<10% reduction in survival or mean reproduction
Low effect	10-20% reduction in survival or mean reproduction
Moderate effect	20-50 % reduction in survival or mean reproduction
High effect	> 50 % reduction in survival or mean reproduction

[4] The following formatting was applied to the nominal (i.e., calculated) total zinc concentrations, the station-specific 95th percentile concentrations, and the SRK WQ predictions:

Regular text	concentration exceeds the CCME guideline value (0.03 mg/L).

[5] Post-closure water quality predictions were developed by SRK (2014d). Zinc concentrations shown for the expected and conservative case scenarios are for the worst-case month (i.e., highest concentration).

[6] Potential effects ratings are defined by comparing the site-specific water chemistry data (95th percentile and mean) at each station to the concentration-response relationship in the Mixture Dilution Series. The ratings listed above are then applied to the survival and reproduction endpoints for each Station.

[7] Presented in Table A11-1.

Table A11-3. *Pseudokirchneriella subcapitata* growth inhibition for the MH-04 and mixture dilution series toxicity tests.

Treatment	Test Endpoint[3] Cell Yield (x 10^4 cells/mL) Mean	SD	Nominal Zinc[4] (mg/L)
Laboratory Control	55	10.3	<0.003
Hardness-adjusted Control	359	36.5	<0.003
MH-04 Dilution Series[1]			
10% MH-04	225	12.0	0.003
50% MH-04	207	11.5	0.005
100% MH-04	202	25.2	0.006
Mixture Dilution Series[2]			
0.1% mixture	297	31.3	0.011
0.3% mixture	186	23.5	0.022
1% mixture	77	14.1	0.058
3% mixture	5.5	3.8	0.16
10% mixture	1.25	1.9	0.52
30% mixture	1.75	0.5	1.5
100% mixture	0.75	1.0	5.1
Mixture Dilution Series Effects Concentrations (mg/L)[8]			
Growth (IC25)			0.031
Growth (IC50)			0.048

Water Chemistry Data Compared to the Mixture Dilution Series Test Results

	Camp Creek MH-04	Camp Creek MH-27	Camp Creek MH-11	False Canyon Creek MH-13	False Canyon Creek MH-16	Tributary E MH-08	Tributary E MH-12
Measured Zinc Concentration (mg/L)[4]							
95th Percentile [Zn]	0.032	0.028	0.139	0.013	0.010	0.024	0.005 (max)
Mean [Zn]	0.011	0.018	0.035	0.0088	0.0075	0.011	0.005 (max)
SRK WQ Predictions[5]							
Expected (average)[4]	0.016	N/A	0.039	0.011	0.006	0.006	0.007
Conservative[4]	0.115	N/A	0.061	0.017	0.009	N/A	0.023
Potential Effects to Cell Yield?[6,7]							
95th Percentile [Zn]	Moderate	Low	High	Negligible	Negligible	Low	Negligible

Notes:

[1] The MH-04 dilution series effects size are compared against the hardness-adjusted laboratory control.

[2] The Mixture dilutions series are compared against the 100% MH-04 treatment.

[3] The following effect size ratings were applied when interpreting the Mixture Dilution Series Testing results relative to the Laboratory Control:

Negligible effect	<10% reduction in cell yield
Low effect	10-20% reduction in cell yield
Moderate effect	20-50 % reduction in cell yield
High effect	> 50 % reduction in cell yield

[4] The following formatting was applied to the nominal (i.e., calculated) total zinc concentrations, the station-specific concentrations (95th percentile and average), and the SRK WQ predictions:

Regular text	concentration exceeds the CCME guideline value (0.03 mg/L).

[5] Post-closure water quality predictions were developed by SRK (2014d). Zinc concentrations shown for the expected and conservative case scenarios are for the worst-case month (i.e., highest concentration).

[6] Potential effects? are defined based on a comparison of the site-specific water chemistry data (95th percentile and mean) at each station to the concentration-response relationship in the Mixture Dilution Series test.

[7] Refer to Table A11-5 for details on the percentage of data in the various effect size categories.

[8] Presented in Table A11-1.

Table A11-4. Water effect ratio (WER) test results for the 48-hr *Ceriodaphnia dubia* survival tests.

COPC	Laboratory Water: Concentration Nominal	Laboratory Water: Concentration Measured	Laboratory Water: Survival (%)	Site Water (MH-04): Concentration (µg/L) Nominal	Site Water (MH-04): Concentration (µg/L) Measured	Site Water (MH-04): Survival[3] (%)	Summary[1]	Camp Creek: MH-04	Camp Creek: MH-27	Camp Creek: MH-11	False Canyon Creek: MH-13	False Canyon Creek: MH-16	Tributary E: MH-08	Tributary E: MH-12
Aluminum (dissolved [µg/L])	Control	<200	100		1.6	100	**Measured Concentrations**							
	250	172	45		171	55	Concentration (Max)[2]	25.4	5.3	6.2	6.0	5.6	7.3	21.4
	500	301	0	Footnote 5	282	0	Potential effects[4]	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
	1000	312	0		329	0								
	2000	320	0		344	0								
	4000	344	0		399	0								
	LC50	**~ 172**		**LC50**	**~ 171**									
	WER			**~1.0**										
Cadmium (total [µg/L])	Control	<0.05	100	Control	0.2	90	**Measured Concentrations**							
	6.25	6	100	25	22.9	100	Concentration (95th)	0.38	0.22	0.74	0.28	0.17	0.17	0.074 (max)
	12.5	12.5	100	50	47.1	45	Potential effects	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
	25	23.1	20	100	95.5	0								
	50	46.5	0	200	192	0	**SRK WQ Predictions**[6]							
	100	87.3	0	400	387	0	Expected (average)	0.4	N/A	0.4	0.3	0.1	0.2	0.18
	LC50	**19.4 (17.2-21.9)**		**LC50**	**46.1 (39.3-54.0)**		Conservative	2.8	N/A	1.0	0.5	0.1	N/A	0.2
	WER			**2.4**										
Chromium (total [µg/L])	Control	<0.5	100		<0.5	100	**Measured Concentrations**							
	43.75	43	100		41.9	95	Concentration (95th)	1.0	0.10	1.5	0.95	0.10	8.1	0.36 (max)
	87.5	91.3	100	Footnote 5	91.3	5	Potential effects	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
	175	178.5	95		181	0								
	350	357.5	0		353	0								
	700	732.5	0		734	0								
	LC50	**244.1 (228.4 – 260.9)**		**LC50**	**61.8 (58.3 – 65.6)**									
	WER			**0.3**										
Copper (total [µg/L])	Control	<0.5	100		<0.5	100	**Measured Concentrations**							
	1.56	3.15	100		2.97	100	Concentration (95th)	1.7	1.7	3.4	4.3	1.5	4.3	0.82 (max)
	3.13	3.31	100	Footnote 5	4.7	100	Potential effects	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
	6.25	5.91	95		8.89	100								
	12.5	10.8	0		15.8	40								
	25	22.8	0		28.8	10								
	LC50	**7.8 (7.3 – 8.2)**		**LC50**	**15.2 (12.8 – 18.1)**									
	WER			**1.9**										
Iron (total [mg/L])	Control	0.05	100		0.02	90	**Measured Concentrations**							
	2.5	0.1	90		2.1	100	Concentration (95th)	0.2	0.16	0.42	0.93	0.85	0.38	0.30 (max)
	5	3.8	65	Footnote 5	4.9	65	Potential effects	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
	10	9.1	20		9.2	5								
	20	18.1	10		19.5	5								
	40	37	0		37.3	0								
	LC50	**4.6 (3.1 – 6.6)**		**LC50**	**5.7 (4.8 – 6.9)**									
	WER			**1.2**										

Table A11-4. Water effect ratio (WER) test results for the 48-hr *Ceriodaphnia dubia* survival tests.

COPC	Laboratory Water: Concentration Nominal	Laboratory Water: Concentration Measured	Laboratory Water: Survival (%)	Site Water (MH-04): Concentration (µg/L) Nominal	Site Water (MH-04): Concentration (µg/L) Measured	Site Water (MH-04): Survival[3] (%)	Summary[1]	Camp Creek: MH-04	Camp Creek: MH-27	Camp Creek: MH-11	False Canyon Creek: MH-13	False Canyon Creek: MH-16	Tributary E: MH-08	Tributary E: MH-12
	Control	<0.05	100		0.29	100	**Measured Concentrations**							
	62.5	28.6	100		40.5	100	Concentration (95th)	19.7	34.7	46.1	6.9	7.0	6.3	1.6 (max)
	125	61.8	100	Footnote 5	47.1	100	Potential effects	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Lead (total [µg/L])	250	133	100		188	100								
	500	301	85		244	70	**SRK WQ Predictions**							
	1000	329	0		623	0	Expected (average)	7.0	N/A	8.0	2.0	2.0	6.0	7.0
	LC50	**294 (273.5 – 316.1)**		**LC50**	**325.4 (287.8 – 367.9)**		Conservative	23	N/A	13	3.0	3.0	N/A	2.0
	WER			**1.1**										
	Control	<3.0	100		7.0	100	**Measured**							
	50	41.4	90		44.4	90	Concentration (95th)	31.5	28.1	139	13.3	10.0	24.4	5.0 (max)
	100	73.9	80	Footnote 5	81.2	65	Potential effects	Negligible	Negligible	High*	Negligible	Negligible	Negligible	Negligible
Zinc (total [µg/L])	200	158.5	40		152	20								
	400	332.5	25		330	0	**SRK WQ Predictions**							
	800	638.5	0		671.5	0	Expected (average)	16	N/A	39	11	6.0	6.0	7.0
	LC50	**146.7 (108.4 – 198.6)**		**LC50**	**97.7 (78.5 – 121.5)**		Conservative	115	N/A	61	17	9.0	N/A	23
	WER			**0.7**										

Notes:

LC50 = the concentration resulting 50% lethality in the test.

WER = Site Water LC50 ÷ Laboratory Water LC50

[1] The summary section outlines the concentration (µg/L) and statistic (Max or 95th percentile) used to compare against the results of the WER tests for each COPC.

[2] The maximum concentration was calculated for each site because of the limited amount of data (i.e., dissolved aluminum was only available for 2013).

[3] The following effect size ratings were applied when interpreting the survival data results relative to the control treatment for each COPC:

Negligible effect	<10% reduction in survival or mean reproduction
Low effect	10-20% reduction in survival or mean reproduction
Moderate effect	20-50 % reduction in survival or mean reproduction
High effect	> 50 % reduction in survival or mean reproduction

[4] Potential effects ratings are defined by comparing the site-specific water chemistry data at each station to the concentration-response relationship in the Site Water (MH-04) test. The ratings listed above are then applied to each station.

* The MH-11 zinc concentration is between a moderate and high effect rating, so the station concentration was compared to the zinc LC50 results to help inform the magnitude rating (>LC50 of 97.7 µg/L = "High effect").

[5] Nominal concentration same as the laboratory water test.

[6] Post-closure water quality predictions were developed by SRK (2014d) for cadmium, lead, and zinc. Concentrations shown for the expected and conservative case scenarios are for the worst-case month (i.e., highest concentration). N/A = no water quality predictions available for the station/COPC combination.

Table A11-5. Predicted risk ratings for site-specific water quality data compared to the concentration response relationship for effects to *P. subcapitata* cell yield from zinc.

			Risk Ratings[1]			
Drainage	**Station**	**N**	**Negligible**	**Low**	**Moderate**	**High**
Camp Creek	MH-04	66	94	2	3	2
	MH-27	10	90	0	10	0
	MH-11	171	74	6	6	13
False Canyon Creek	MH-13	58	98	0	2	0
	MH-16	52	98	0	2	0
Tributary E	MH-08	159	86	7	3	4
	MH-12	2	100	0	0	0

Notes:

[1] Water chemistry data from 1999 to 2013 compared to the CCR for the mixture dilution toxicity test.

12. PERIPHYTON COMMUNITY TOXICITY THRESHOLDS

12.1. LOE Description

This LOE compares surface water zinc concentrations from the Site to a literature-based concentration-response relationship for periphyton. It applies to the aquatic plant receptor group and was added to the WOE assessment after the Updated PF (Azimuth 2014d) was issued in September 2014. To support this LOE, Azimuth conducted a literature review on the effects of aqueous zinc exposure to periphyton communities. Similar to derivation procedures for guidelines, we evaluated the publications for ecological relevance, the range of exposure concentrations tested/measured, and data quality. Five studies[21] were identified in the literature review and carried forward for a more thorough analysis of their potential use in this LOE. Of 5 papers reviewed, Hill et al., 2000 was considered the most relevant for incorporating into the WOE assessment for the following reasons:

1. The study was conducted a watershed influenced by mining-related contamination in the Rock Mountains,
2. Effects endpoints were measured on the resident periphyton community inhabiting the stream (i.e., ecologically relevant receptor),
3. Zinc concentrations spanned the range of concentrations observed downstream from Sä Dena Hes, and
4. There was a dose-response relationship between zinc exposure and effects measured in the periphyton endpoints, meaning the study endpoints were sensitive enough to detect effects at concentrations representative of those observed downstream from Sä Dena Hes.

12.2. Data Analysis

This LOE relies on field data presented by Hill et al., 2000 on effects to the stream periphyton community in the Eagle River, a mining impacted river in central Colorado, USA. The periphyton community was assessed in 1991 and 1992 using assemblage information (taxa richness, community similarity) and other measures (biomass, chlorophyll-*a* autotrophic index[22]) from periphyton samples collected from artificial substrates at 12 locations, two upstream of mine influence and 10 downstream. Water chemistry data was collected from each of the locations and analyzed for dissolved metals and other routine water quality parameters.

Table A12-1 presents the periphyton endpoint results and dissolved metals concentrations from the Hill et al., 2000 study. The authors noted that dissolved cadmium, iron, manganese, and zinc showed clear

[21] Admiraal et al., 1999; Blanck et al., 2003; Hill et al., 2000; Pandy et al., 2015; Paulsson et al., 2000. The studies are listed in the reference section of the main report (**Volume 3**).

[22] The autotrophic index is the ratio of biomass: chlorophyll-*a.*

spatial trends in the study as the Eagle River flowed past mining-impacted areas. For the purpose of the AERA, metals showing an upstream to downstream increase in concentration were screened against the CCME WQG to determine which metals are likely linked to the effects observed in the periphyton endpoints. Cadmium and zinc consistently exceeded the CCME WQGs at the downstream locations in 1991, but only zinc was greater than 10-times the reported detection limits. In the 1992 study, the DL for cadmium dropped from 0.0003 mg/L to 0.0005 mg/L, and only two of the downstream stations had cadmium concentrations above the DL. Zinc exceed the CCME WQG at 9 of the 10 downstream locations in 1992, with concentrations ranging from <0.008 mg/L upstream of mine influence to 0.51 mg/L near the source (i.e., mine tailings). By comparison, the zinc concentrations (95th percentile) downstream from Sä Dena Hes are lower and range between 0.01 mg/L at MH-16 in False Canyon Creek to 0.14 mg/L at MH-11.

The spatial distribution of zinc exceedances reported in Hill et al., 2000 provide convincing evidence that any observed effects to the periphyton community in Eagle Creek were likely due zinc. For this reason, zinc was the only contaminant used to develop the CCR with the periphyton endpoints (i.e., any effects measured were attributed to zinc). The CCR between periphyton endpoints and zinc concentrations was developed in R using the drc package (Analysis of Dose-Response Curves [version 2.5-12]). The initial step in the analysis involved normalizing the downstream periphyton response data to the upstream reference results. Data were normalized by year using the lowest ash-free dry weight, chlorophyll-*a*, and autotrophic index and the highest richness of the two upstream reference locations. The normalized response data from 1991 and 1992 was then combined to develop the CCR for each endpoint shown in **Figure A12-1**. The two parameter log-logistic function from the drc package was used to fit the curve to each CCR. The slope and ICxx concentrations (mg/L) for each periphyton endpoint are shown below.

Endpoint	Slope	IC10	IC20	IC50
Ash-free dry wt	0.450	0.404	2.44	53.0
Autotrophic Index	2.022	0.305	0.455	0.903
Chlorophyll-*a*	1.859	0.113	0.174	0.368
Richness	0.524	0.078	0.365	5.2

12.3. LOE Attributes

12.3.1. Data Quality

Acceptable – The acceptability of the water chemistry data from the long-term dataset was discussed in **Section 2**. Water quality data and periphyton community data reported by Hill et al., 2000 was considered acceptable for use in developing CRRs.

12.3.2. Ecological Relevance

Moderate – Typically, a literature based LOE (including data supporting environmental quality guidelines) is given a "low" rating for ecological relevance. In this case, effect levels (ICxx) for the various periphyton endpoints are derived from a field survey where data were collected on the resident periphyton community; endpoints are highly ecologically relevant. However, because data are from the literature (another site) and not from the Sä Dena Hes receiving environment, an overall rating of moderate is considered appropriate for the ecological relevance of this LOE.

12.3.3. Magnitude

Magnitude Interpretive Framework

To be protective, the effect-size ratings shown below were applied to the monitoring station with the highest zinc concentration in each drainage (based on 95th percentile): MH-08 for Tributary E, MH-11 for Camp Creek, and MH-13 for False Canyon Creek. Zinc concentrations at each of these stations were then compared to the CCR developed from the Hill et al., 2000 study as described above in **Section 12.2**. Risk ratings for the various stations were based on comparison of site-specific zinc concentration data (95th percentile) to the most sensitive of the endpoints: chlorophyll-*a* and species richness.

- Negligible Effects: zinc concentration is less than the IC10 concentration.
- Low Effects: Zinc concentration is between the IC10 and IC20 effects range for the periphyton endpoints.
- Moderate Effects: Zinc concentration is between the IC20 and IC50 effects range for the periphyton endpoints.
- High Effects: Zinc concentration is greater than the IC50 effects range for the periphyton endpoints.

Figure A12-1 shows the zinc concentration at MH-08, MH-11, and MH-13 plotted on the dose-response curves for the different periphyton endpoints. Magnitude of effect ratings for the primary producer community is summarized below by drainage.

Camp Creek

- **Magnitude of Effect**:
  - o **Low** – at MH-11 (reduced chlorophyll-*a* and species richness)
  - o **Negligible** – all other stations

The 95th percentile zinc concentration at MH-11 of 0.14 mg/L (140 µg/L) was between the IC10 and IC20 effects range for reduced chlorophyll-*a* in the periphyton samples from the Hill et al., 2000 study. Low-level effects to species richness (structural changes) were also predicted for MH-11, which corresponds with the findings of the toxicity tests that showed reduced cell yield in *P. subcapitata* at zinc concentrations representative of MH-11 (**Section 11.3.3**). No effects to biomass (ash-free dry weight) were predicted at MH-11 or other locations in Camp Creek. The overall magnitude rating for this LOE assessing risks to periphyton communities in Camp Creek is considered low.

False Canyon Creek

- **Magnitude of Effect**:

  - **Negligible** – all stations

The conservative 95th percentile zinc concentration at MH-13 and MH-16 in False Canyon Creek are below the concentrations shown to cause effects to periphyton biomass, chlorophyll-*a* production, autotrophic index, and species richness in the Hill et al., 2000 study.

Tributary E

- **Magnitude of Effect**:
  - **Negligible** – all stations

The conservative 95th percentile zinc concentration at MH-08 and maximum concentration at MH-12 are below the concentrations shown to cause effects to periphyton biomass, chlorophyll-*a* production, autotrophic index, and species richness in the Hill et al., 2000 study.

Uncertainty About Magnitude

High for Effects – Uncertainty related to extrapolating this LOE to effects to aquatic plants at the Site is considered high because it does not incorporate any site-specific information on local water characteristics, the mixture of COPCs specific to the Site (e.g., lead), or resident aquatic plant species themselves. However, it does target zinc, which is considered the main COPC in the aquatic environment at the Site, and is based on plant-specific toxicity information.

12.3.4. Causality

Strength of Correlation and Supporting Evidence

Correlation (N/A); Supporting Evidence (Plausible) – This LOE identifies slightly elevated exposure at the worst case water quality station in Camp Creek (but not False Canyon Creek or Tributary E drainages) relative to concentrations associated with low-level (10-20%) effect-sizes from a field study reported in the literature. Because the underlying study is effects-based, it provides plausible supporting evidence for potential toxicity. However, this LOE does not provide evidence of causality for actual effects.

Uncertainty Related to Causality

High – While the mechanism of action is supported by the underlying study, this LOE does not incorporate site-specific information on effects to aquatic plants to assess strength of relationships/causality.

Figure A12-1. Concentration response relationship for periphyton indices and zinc concentrations from Hill et al., 2000.

Notes: ICxx = inhibitory concentration (% reduction relative to the upstream reference). Zinc concentrations at MH-08, MH-11, and MH-13 (vertical dashed lines) are the worst-case 95th percentile concentrations in Tributary E, Camp Creek, and False Canyon Creek, respectively.

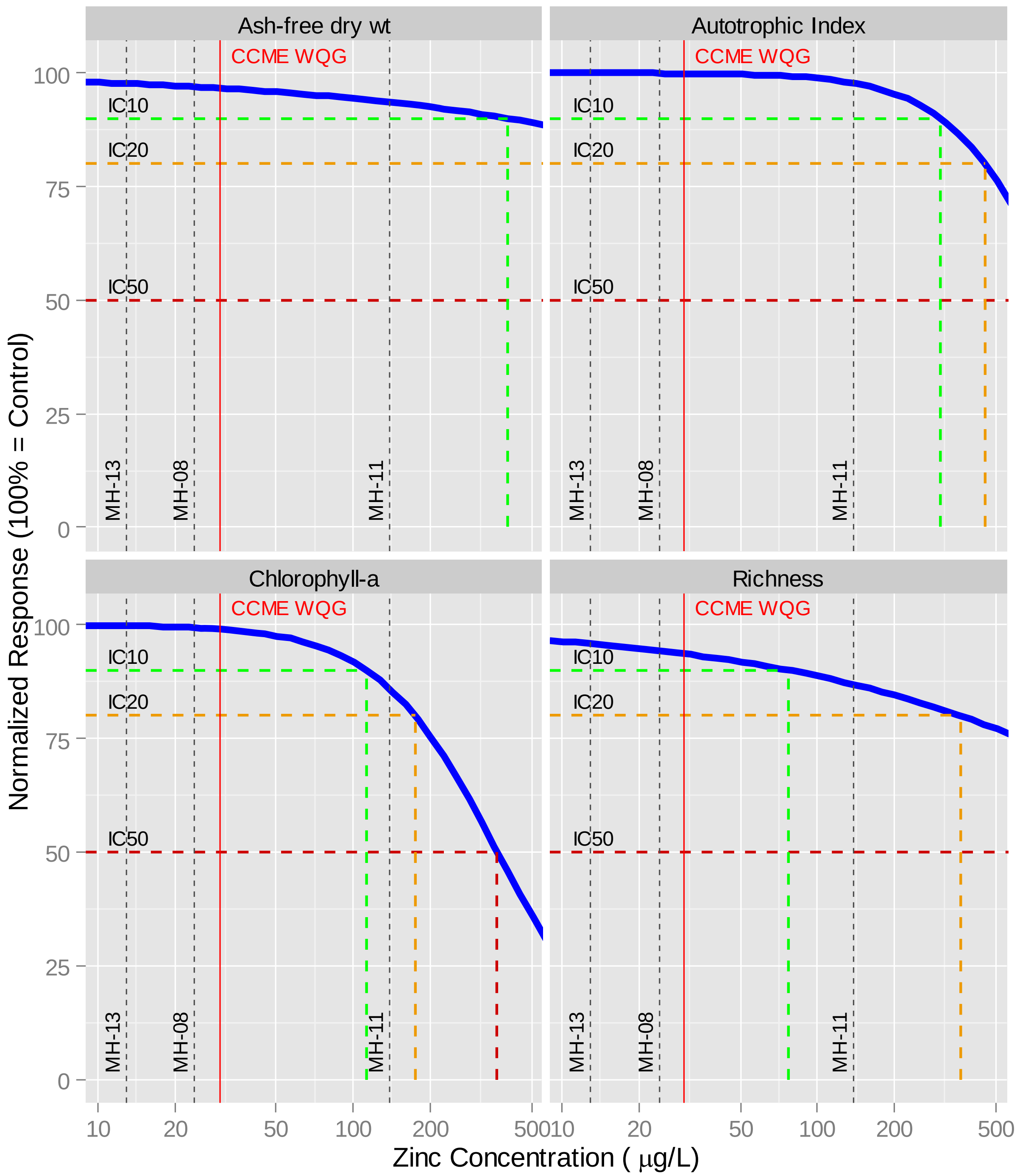


Table A12-1. Periphyton endpoints and metals concentrations reported in Hill et al., 2000.

	1991 Survey											
	Upstream (Reference)		Downstream (Exposure)									
Measurement	**E01A**	**E01**	**E03**	**E05**	**E10**	**E11**	**E12**	**E12A**	**E13**	**E13B**	**E20**	**E22**
Periphyton Endpoints												
Ash-free Dry Weight[1]	0.008	0.004	0.004	0.003	0.006	0.009	0.003	0.013	0.003	0.017	0.006	0.002
Chlorophyll-*a* [2]	0.107	0.091	0.135	0.068	0.082	0.046	0.021	0.058	0.043	0.024	0.064	0.059
Autotrophic Index[3]	71	48	33	85	72	191	172	216	82	1177	96	34
Richness[4]	10	12	11	13	12	ns	13	7	ns	2	17	15
Concentrations (mg/L)												
Hardness	138	83	94	92	80	86	98	101	118	181	95	101
Cadmium	*<0.0003*	*<0.0003*	*<0.0003*	*<0.0003*	**0.0003**	**0.0012**	**0.0012**	**0.0007**	**0.0007**	**0.0005**	**0.0003**	*<0.0003*
Iron	0.10	0.15	0.13	*<0.019*	0.15	0.49	0.16	0.18	0.03	0.19	0.02	*<0.019*
Manganese	0.004	0.017	0.034	0.20	0.17	0.92	1.1	0.51	1.3	2.6	1.4	1.2
Zinc	0.010	0.009	0.017	0.25	0.22	0.70	0.80	0.45	0.52	0.75	0.39	0.32

	1992 Survey											
	Upstream (Reference)		Downstream (Exposure)									
Measurement	**E01A**	**E01**	**E03**	**E05**	**E10**	**E11**	**E12**	**E12A**	**E13**	**E13B**	**E20**	**E22**
Periphyton Endpoints												
Ash-free Dry Weight[1]	0.011	ns	0.039	0.01	0.01	0.01	0.009	0.012	0.009	0.01	0.014	0.012
Chlorophyll-*a* [2]	0.232	ns	0.433	0.119	0.082	0.041	0	0.06	0.018	0	0.057	0.18
Autotrophic Index[3]	58	ns	89	101	149	312	nc	258	573	nc	247	118
Richness[4]	15	18	12	16	17	14	7	21	17	6	21	15
Concentrations (mg/L)												
Hardness	120	68	66	67	61	71	66	75	105	107	81	84
Cadmium	*<0.0005*	*<0.0005*	*<0.0005*	*<0.0005*	*<0.0005*	*<0.0005*	**0.0006**	*<0.0005*	**0.0006**	*<0.0005*	*<0.0005*	*<0.0005*
Iron	0.058	0.16	0.197	0.17	0.16	0.60	0.32	0.41	0.18	0.14	0.13	0.095
Manganese	0.007	0.015	0.027	0.097	0.095	0.615	0.391	0.543	0.771	1.745	0.852	0.719
Zinc	*<0.008*	*<0.008*	0.027	0.11	0.10	0.51	0.30	0.35	0.33	0.46	0.22	0.19

Notes:

1 (mg/cm^2).

2 Chlorophyll-*a* ($\mu g/cm^2$).

3 ash-free dry weight (mg/cm^2)/ chlorophyll-*a* Chl ($\mu g/cm^2$).

4 Taxa richness (No. of genera).

ns = not sampled or sample lost.

nc = not calculated because chlorophyll a was absent.

Italicized values = less than the detection limit

Formatting for exceedances of the CCME aquatic life water quality guidelines WQG. No guideline for manganese; hardness-dependent for cadmium.

Shaded values > the CCME WQG

Bold values > the CCME WQG, but < 10-times the detection limit.

13. REFERENCES

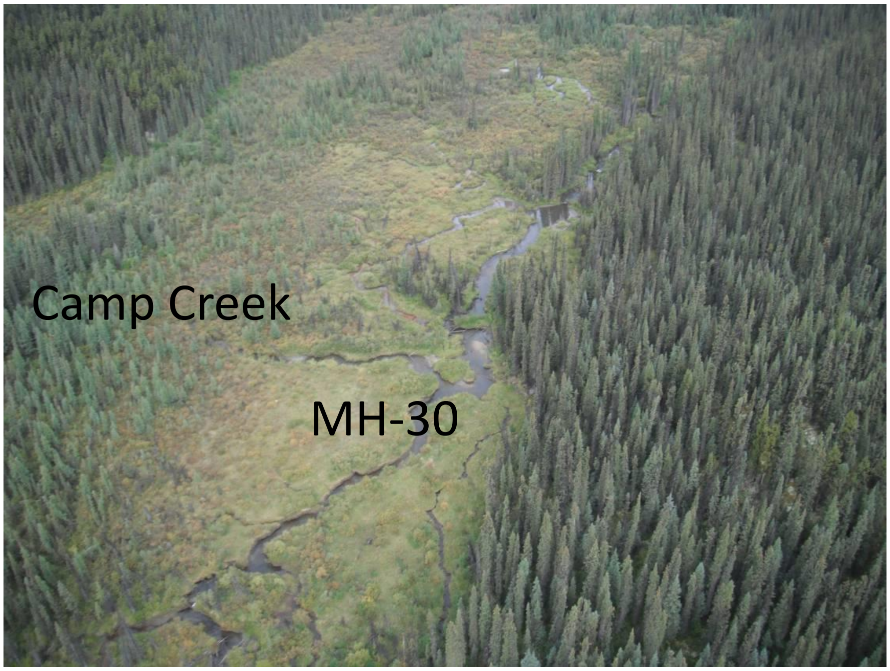
See Main Report.

APPENDIX B

Photos and Habitat Descriptions for the AERA

MH-30 – Downstream Reference Area

Photo 1. MH-30 confluence of CC with FCC

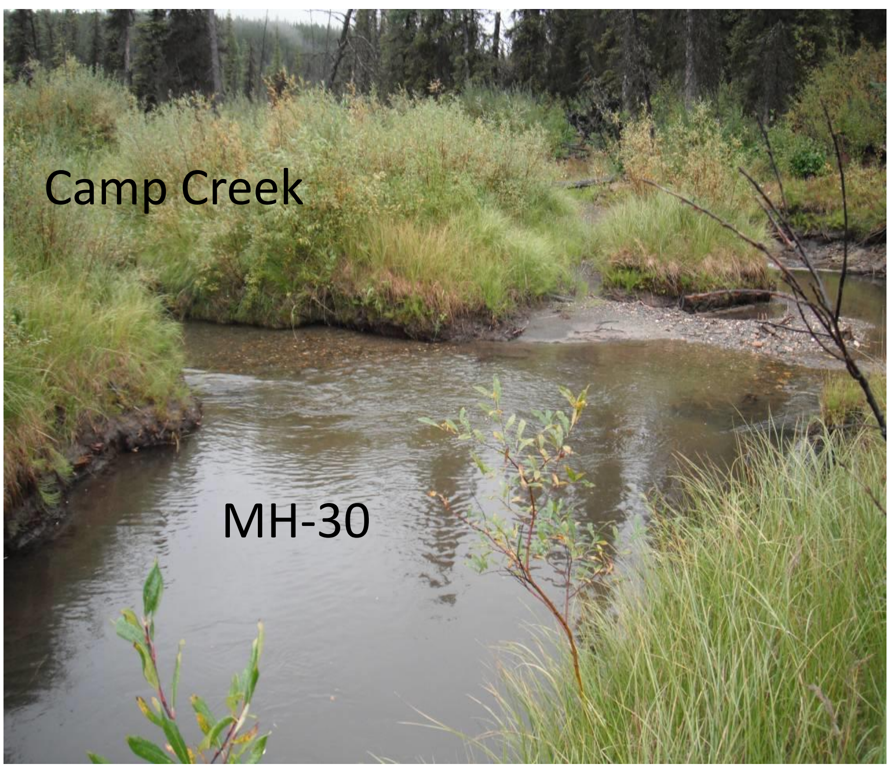


Site Information

Sampled Aug 23, 2015 by Laberge. This station is 4.5 km downstream of the Reclaim Pond at the juncture with MH-30, and just up stream of a beaver complex. Moderate flow, 1.5 m wide stable channel, sinuous slow flow drains reference area; joins Camp Creek and flows as False Canyon Creek downstream.

The stream is open, with stable banks and non-overhanging riparian vegetation here. Moving upstream, the channel is increasingly choked by willow and alder. Water velocity is moderate dominated by runs, with some riffle.

Photo 2. MH-30 looking downstream



Looking downstream from MH-30 to confluence with Camp Creek, east. Confluence station is just left of photo. Benthic invertebrates and sediment collected. Electrofishing completed for the fish community survey.

Bottom substrate consisted of fine gravel and sand with some cobble. No apparent barriers here at junction with MH-30. Fish were captured at this location, the furthest upstream that fish have been documented on False Canyon Creek.

MH-29 – Access Creek Near-field Reference Area

Photo 3. MH-29 Benthic sampling

Site Information

Sampled June 25, 2015 by Azimuth. Stream temperature was 4.1 C, pH 7.8, conductivity 285 µS/cm. Access Creek is a small tributary stream 1.2 km downstream of the TMF. The stream was sampled just upstream of its mouth at confluence with Camp Creek. Both streams are steep at this location with riffle/falls, 0.6 m wide and 0.5 – 0.7 m deep in a box-like profile, with steep, near-vertical sides. The stream flows through and around willow branches and roots and may have recently shifted within the valley bottom to establish itself here.

Photo 4. MH-29 Substrate

MH-29 substrate is dominated by compacted sand or silty/clay with woody debris, roots and 5-10% cobble. Channel is very narrow and confined, flowing tightly in and around willow riparian zone. Less than 1 m wetted width, moderate to high flow, non-depositional and variable flow path, both horizontally and vertically. Substrate and conditions are very heterogeneous; water quality was somewhat turbid at the time of sampling.

MH-04 – Camp Creek Upstream

Photo 5. MH-04 Substrate

Site Information

Sampled June 24, 2015 by Azimuth. Stream temperature was 2.8 C, pH 7.9, conductivity 266 µS/cm. MH-04 on Camp Creek is just downstream of CC-1 and PH-1, about 400 m from the stream origin via 2 springs. Stream width was about 2 m, 15 cm depth. Stable banks with willow riparian vegetation. Flow is ~0.8 m/s. Bottom substrate consists of cobble/gravel with embedded sand and silt.

Photo 6. MH-04 Benthic sampling

MH-04 channel is braided upstream of above photo. No evidence of macrophytes. Early in growing season for periphyton. Habitat was considered very good with abundance benthic invertebrates observed during kick-netting.

CC-3 – Camp Creek near Reclaim Pond

Photo 7. CC-3 Benthic sampling

Site Information

Sampled June 24, 2015 by Azimuth. Stream temperature was 4.4 C, pH 8.1, conductivity 287 µS/cm. CC-3 is on Camp Creek downstream of MH-04 opposite (west) of the Reclaim Pond. A half culvert lines the east side of the stream to prevent against encroachment into the Reclaim Pond. Sparse riparian vegetation, open with little cover, no woody debris. Bottom substrate consists of cobble/gravel with embedded sand and silt.

Photo 8. CC-3 Substrate

CC-3 channel is 1.5 m wide and 10 – 15 cm deep at this location, running south past the Reclaim Pond. Mostly riffle/run. Downstream of this point, the stream cascades down a steep rocky chute. No visual evidence of macrophytes. Substrate is heterogeneous. Abundant invertebrate community observed. Electrofishing took place at this location.

MH-28A – Camp Creek u/s Portal Creek

Photo 9. MH-28A

Site Information

Sampled June 25, 2015 by Azimuth. Stream temperature was 7.9 C, pH 8.2, conductivity 320 µS/cm. This station is immediately upstream of Portal Creek, just to the right of the photo, downstream of samplers. MH-28A is 1.5 m wide, stable banks, willow riparian and riffle/run flow with moderate, consistent gradient. Water clarity was higher in Portal Creek than in Camp Creek, reflecting influence of dewaterng activities at the TMF.

Photo 10. MH-28A Substrate

Bottom substrate consists of cobble/gravel with some embedded sand and silt. There is no instream woody debris, although instream organics were abundant. Moving upstream from here, the stream became increasingly choked by overhanging willow. Benthic sampling and electrofishing took place at this location.

MH-27 – Camp Creek 1 km downstream of TMF

Photo 11. MH-27

Site Information

Sampled June 25, 2015 by Azimuth. Stream temperature was 7.9 C and pH 8.2. This station is 1 km downstream of the Reclaim Pond and 2 km upstream of MH-11. The stream here is very narrow (<1 m) and confined with steep vertical sides and U shaped profile. Gradient is steep and uniformly riffle/rapid and non-depositional. There are numerous small falls and fish barriers. Flow is high enough that flows over banks here and there. Stream channel flows in and around willow and white spruce.

Photo 12. MH-27 Substrate and kick area

Bottom substrate consists of sandy / gravel, with a hard compact bottom that was difficult to penetrate with the sampler. No depositional areas present. Instream organics were retained during kick net sampling. Water clarity was somewhat impaired
Benthic sampling and electrofishing took place at this location.

MH-11 – Camp Creek 3 km downstream of TMF

Photo 13. MH-11 looking upstream

Site Information

Sampled August 25, 2015 by Laberge. Stream temperature was 6.9 C and pH 8.2 and conductivity was 390 µS/cm. This station is 3 km downstream of the Reclaim Pond and 2 km upstream of MH-11. About 1.5 km downstream of Access Creek (MH-29). Stream features at MH-11 are very similar to MH-27 with a narrow (<1 m), confined, U-shaped channel with steep sides and flat bottom. Gradient is steep and uniformly riffle with small barriers and falls. Discharge velocity is high with no depositional areas. Stream channel flows in and around willow and alder.

Photo 14. MH-11 looking downstream

Bottom substrate consisted of mobile fine sand with some interspersed gravel areas. Instream organics were retained during kick net sampling. Water clarity was somewhat impaired Benthic sampling and electrofishing took place at this location.

North Creek at MH-12A, 4.5 km downstream of TMF

Photo 15. North Creek at MH-12A looking downstream

Site Information

Sampled June 24, 2015 by Azimuth. Stream temperature was 5.3 C and pH 8.2 and conductivity was 261 µS/cm. This station is upstream from the water monitoring location MH-12 in suitable habitat for benthic invertebrate sampling. The sampling reach is open, with unstable banks and sparse stream-side vegetation. Water velocity is moderate dominated by riffle.

Photo 16. North Creek (MH-12A) substrate

Bottom substrate consisted of fine gravel and sand with some cobble. Benthic sampling and electrofishing took place at this location.

Photo 17. North Creek (MH-12A) periphyton

Visual evidence of green/brown periphyton colonization on cobble substrate.

APPENDIX C

ALS Laboratory Reports

AZIMUTH CONSULTING GROUP INC.
ATTN: Randy Baker
218 - 2902 West Broadway
Vancouver BC V6K 2G8

Date Received: 27-JUN-14
Report Date: 29-AUG-14 10:00 (MT)
Version: FINAL

Client Phone: 604-730-1220

Certificate of Analysis

Lab Work Order #: L1478487

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 10-219431, 10-219435
Legal Site Desc:

Brent Mack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1478487-3	L1478487-4	L1478487-5	L1478487-6	L1478487-7
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	24-JUN-14	25-JUN-14	25-JUN-14	24-JUN-14	24-JUN-14
	Sampled Time	09:00	09:00	09:00	09:00	09:00
	Client ID	MH-12	MH-28A	MH-29	MH-04	CC-3
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	8.12	8.09	8.05	7.96	8.08
Particle Size	% Gravel (>2mm) (%)	<0.10	<0.10	<0.10	<0.10	<0.10
	% Sand (2.0mm - 0.063mm) (%)	63.8	59.0	14.6	46.4	37.8
	% Silt (0.063mm - 4um) (%)	32.6	36.6	77.4	49.0	52.6
	% Clay (<4um) (%)	3.61	4.41	8.00	4.65	9.61
	Texture	Sandy loam	Sandy loam	Silt loam / Silt	Sandy loam	Silt loam
Organic / Inorganic Carbon	Total Organic Carbon (%)	1.58	1.65	6.61	4.07	2.70
Metals	Antimony (Sb) (mg/kg)	1.79	1.97	1.90	2.00	2.49
	Arsenic (As) (mg/kg)	16.8	16.5	24.9	17.3	18.9
	Barium (Ba) (mg/kg)	138	135	225	111	131
	Beryllium (Be) (mg/kg)	0.52	0.47	0.80	0.75	0.59
	Cadmium (Cd) (mg/kg)	1.26	5.38	7.51	7.11	4.27
	Chromium (Cr) (mg/kg)	24.1	25.3	32.0	28.3	25.6
	Cobalt (Co) (mg/kg)	7.45	8.55	11.3	10.7	9.89
	Copper (Cu) (mg/kg)	16.9	18.6	30.9	25.7	25.1
	Lead (Pb) (mg/kg)	50.4	527	107	219	384
	Mercury (Hg) (mg/kg)	<0.050	<0.050	0.053	<0.050	0.055
	Molybdenum (Mo) (mg/kg)	1.95	1.54	1.28	1.31	2.54
	Nickel (Ni) (mg/kg)	25.5	26.2	29.8	28.5	30.0
	Selenium (Se) (mg/kg)	0.61	0.74	2.22	1.25	1.26
	Silver (Ag) (mg/kg)	0.22	0.66	0.54	0.40	0.69
	Thallium (Tl) (mg/kg)	0.134	0.126	0.186	0.180	0.179
	Tin (Sn) (mg/kg)	2.2	2.1	2.1	<2.0	3.9
	Uranium (U) (mg/kg)	0.890	0.878	1.01	1.18	1.16
	Vanadium (V) (mg/kg)	39.0	37.4	31.3	35.5	46.7
	Zinc (Zn) (mg/kg)	187	867	406	473	530

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1478487-8				
	Description	Sediment				
	Sampled Date	25-JUN-14				
	Sampled Time	09:00				
	Client ID	MH-27				
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	8.07				
Particle Size	% Gravel (>2mm) (%)	<0.10				
	% Sand (2.0mm - 0.063mm) (%)	21.3				
	% Silt (0.063mm - 4um) (%)	67.7				
	% Clay (<4um) (%)	11.0				
	Texture	Silt loam				
Organic / Inorganic Carbon	Total Organic Carbon (%)	3.82				
Metals	Antimony (Sb) (mg/kg)	2.07				
	Arsenic (As) (mg/kg)	21.2				
	Barium (Ba) (mg/kg)	185				
	Beryllium (Be) (mg/kg)	0.55				
	Cadmium (Cd) (mg/kg)	6.33				
	Chromium (Cr) (mg/kg)	23.9				
	Cobalt (Co) (mg/kg)	10.5				
	Copper (Cu) (mg/kg)	23.0				
	Lead (Pb) (mg/kg)	418				
	Mercury (Hg) (mg/kg)	<0.050				
	Molybdenum (Mo) (mg/kg)	2.12				
	Nickel (Ni) (mg/kg)	29.9				
	Selenium (Se) (mg/kg)	1.34				
	Silver (Ag) (mg/kg)	0.72				
	Thallium (Tl) (mg/kg)	0.135				
	Tin (Sn) (mg/kg)	3.6				
	Uranium (U) (mg/kg)	0.949				
	Vanadium (V) (mg/kg)	38.8				
	Zinc (Zn) (mg/kg)	848				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1478487-1	L1478487-2	L1478487-9	L1478487-10	L1478487-11
	Description	Tissue	Tissue	Tissue	Tissue	Tissue
	Sampled Date	26-JUN-14	26-JUN-14	25-JUN-14	26-JUN-14	24-JUN-14
	Sampled Time	09:00	09:00	09:00	09:00	09:00
	Client ID	JBX PIT W/R INVERTEBRATES	1408 W/R INVERTEBRATES	JBX-RBV-1	JBX RBV-2	1408 - RBV-1
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	71.0	73.3	77.7	76.5	71.9
Metals	Aluminum (Al)-Total (mg/kg wwt)	140	83.8	22.9	23.8	48.9
	Antimony (Sb)-Total (mg/kg wwt)	0.0135	0.0622	0.0070	0.0165	0.0672
	Arsenic (As)-Total (mg/kg wwt)	0.122	0.194	0.0353	0.0384	0.302
	Barium (Ba)-Total (mg/kg wwt)	1.83	7.63	10.0	5.62	2.93
	Beryllium (Be)-Total (mg/kg wwt)	0.0043	0.0128	<0.0020	<0.0020	0.0062
	Bismuth (Bi)-Total (mg/kg wwt)	0.0033	0.0196	0.0030	0.0061	0.0347
	Boron (B)-Total (mg/kg wwt)	0.28	0.24	0.38	0.37	0.61
	Cadmium (Cd)-Total (mg/kg wwt)	1.90	7.03	0.383	0.209	0.868
	Calcium (Ca)-Total (mg/kg wwt)	339	565	9780	8340	8320
	Cesium (Cs)-Total (mg/kg wwt)	0.0955	0.155	0.307	0.203	0.495
	Chromium (Cr)-Total (mg/kg wwt)	0.403	0.251	1.91	0.253	0.175
	Cobalt (Co)-Total (mg/kg wwt)	0.0851	0.136	0.0988	0.0792	0.141
	Copper (Cu)-Total (mg/kg wwt)	14.3	19.4	2.10	1.60	1.64
	Iron (Fe)-Total (mg/kg wwt)	243	223	88.7	90.3	175
	Lead (Pb)-Total (mg/kg wwt)	3.91	133	10.4	15.9	103
	Lithium (Li)-Total (mg/kg wwt)	0.29	0.12	<0.10	<0.10	<0.10
	Magnesium (Mg)-Total (mg/kg wwt)	465	539	413	374	395
	Manganese (Mn)-Total (mg/kg wwt)	18.9	25.9	13.6	11.2	19.9
	Molybdenum (Mo)-Total (mg/kg wwt)	0.117	0.117	0.345	0.131	0.266
	Nickel (Ni)-Total (mg/kg wwt)	0.331	0.303	1.34	0.301	0.555
	Phosphorus (P)-Total (mg/kg wwt)	2160	2660	6990	6480	6410
	Potassium (K)-Total (mg/kg wwt)	2850	2770	3430	3630	3200
	Rubidium (Rb)-Total (mg/kg wwt)	5.57	7.56	11.7	6.92	19.2
	Selenium (Se)-Total (mg/kg wwt)	0.219	0.763	0.192	0.219	0.273
	Sodium (Na)-Total (mg/kg wwt)	696	1110	1280	1070	1340
	Strontium (Sr)-Total (mg/kg wwt)	0.708	1.28	4.11	4.30	3.36
	Tellurium (Te)-Total (mg/kg wwt)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Thallium (Tl)-Total (mg/kg wwt)	0.00910	0.00992	0.00378	0.00365	0.00410
	Tin (Sn)-Total (mg/kg wwt)	<0.020	<0.020	0.233	<0.020	<0.020
	Uranium (U)-Total (mg/kg wwt)	0.00611	0.0200	0.00171	0.00237	0.0813
	Vanadium (V)-Total (mg/kg wwt)	0.332	0.289	0.114	0.121	0.244
	Zinc (Zn)-Total (mg/kg wwt)	78.5	290	40.5	41.3	174
	Zirconium (Zr)-Total (mg/kg wwt)	0.061	0.043	<0.040	<0.040	<0.040

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1478487-12	L1478487-13	L1478487-14	L1478487-15	
	Description	Tissue	Tissue	Tissue	Tissue	
	Sampled Date	24-JUN-14	24-JUN-14	25-JUN-14	26-JUN-14	
	Sampled Time	09:00	09:00	09:00	09:00	
	Client ID	1408 - RBV-2	1408 - RBV-3	1408 - RBV-4	1408 - RBV-5	
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	73.7	77.1	75.2	71.1	
Metals	Aluminum (Al)-Total (mg/kg wwt)	33.8	18.0	20.1	19.9	
	Antimony (Sb)-Total (mg/kg wwt)	0.0468	0.0130	0.0246	0.0479	
	Arsenic (As)-Total (mg/kg wwt)	0.120	0.0974	0.102	0.127	
	Barium (Ba)-Total (mg/kg wwt)	8.45	4.72	2.44	6.48	
	Beryllium (Be)-Total (mg/kg wwt)	0.0031	<0.0020	<0.0020	<0.0020	
	Bismuth (Bi)-Total (mg/kg wwt)	0.0354	0.0090	0.0135	0.0241	
	Boron (B)-Total (mg/kg wwt)	0.30	<0.20	0.34	0.34	
	Cadmium (Cd)-Total (mg/kg wwt)	0.828	0.411	0.243	0.437	
	Calcium (Ca)-Total (mg/kg wwt)	10500	8630	11200	8820	
	Cesium (Cs)-Total (mg/kg wwt)	2.70	1.83	0.333	0.318	
	Chromium (Cr)-Total (mg/kg wwt)	0.141	0.101	0.830	0.081	
	Cobalt (Co)-Total (mg/kg wwt)	0.0985	0.0597	0.0851	0.0810	
	Copper (Cu)-Total (mg/kg wwt)	2.22	2.20	1.63	1.96	
	Iron (Fe)-Total (mg/kg wwt)	120	87.0	98.3	106	
	Lead (Pb)-Total (mg/kg wwt)	74.5	29.8	43.3	45.4	
	Lithium (Li)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	
	Magnesium (Mg)-Total (mg/kg wwt)	434	375	445	361	
	Manganese (Mn)-Total (mg/kg wwt)	24.6	9.32	9.04	9.13	
	Molybdenum (Mo)-Total (mg/kg wwt)	0.134	0.119	0.252	0.156	
	Nickel (Ni)-Total (mg/kg wwt)	0.294	0.209	0.768	0.268	
	Phosphorus (P)-Total (mg/kg wwt)	7360	6580	8390	6370	
	Potassium (K)-Total (mg/kg wwt)	3920	3600	2890	3650	
	Rubidium (Rb)-Total (mg/kg wwt)	63.9	49.2	17.2	17.9	
	Selenium (Se)-Total (mg/kg wwt)	0.329	0.307	0.241	0.374	
	Sodium (Na)-Total (mg/kg wwt)	1150	1220	1560	1120	
	Strontium (Sr)-Total (mg/kg wwt)	4.59	2.89	3.71	3.39	
	Tellurium (Te)-Total (mg/kg wwt)	<0.0040	<0.0040	<0.0040	<0.0040	
	Thallium (Tl)-Total (mg/kg wwt)	0.0136	0.00628	0.00195	0.00582	
	Tin (Sn)-Total (mg/kg wwt)	0.108	0.091	<0.020	0.088	
	Uranium (U)-Total (mg/kg wwt)	0.0114	0.00560	0.0272	0.0253	
	Vanadium (V)-Total (mg/kg wwt)	0.148	0.065	0.129	0.105	
	Zinc (Zn)-Total (mg/kg wwt)	81.4	40.9	64.7	57.1	
	Zirconium (Zr)-Total (mg/kg wwt)	<0.040	<0.040	<0.040	<0.040	

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Bismuth (Bi)-Total	DUP-H	L1478487-10, -11, -12, -13, -14, -15, -9
Duplicate	Chromium (Cr)-Total	DUP-H	L1478487-10, -11, -12, -13, -14, -15, -9
Duplicate	Tin (Sn)-Total	DUP-H	L1478487-10, -11, -12, -13, -14, -15, -9
Duplicate	Vanadium (V)-Total	DUP-H	L1478487-10, -11, -12, -13, -14, -15, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-ORG-LECO-SK	Soil	Organic Carbon by combustion method	SSSA (1996) p. 973

Total Organic Carbon (C-TOT-ORG-LECO-SK, C-TOT-ORG-SK)

Total C and inorganic C are determined on separate samples. The total C is determined by combustion and thermal conductivity detection, while inorganic C is determined by weight lass after addition of hydrochloric acid. Organic C is calculated by the difference between these two determinations.

Reference for Total C:
Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, organic carbon and organic matter. P. 961-1010 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

Reference for Inorganic C:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/245.7

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis of the digested extract is by collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-WET-CCMS-VA	Tissue	Metals in Tissue by CRC ICPMS (WET)	EPA 200.3/6020A

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-WET-MICR-HRMS-VA	Tissue	Metals in Tissue by HR-ICPMS Micro (WET)	EPA 200.3/200.8

Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on wet weight basis.

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

Reference Information

MOISTURE-TISS-VA	Tissue	% Moisture in Tissues	ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. 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. The pH of the solution is then measured using a standard pH probe.

PSA-PIPET+GRAVEL-SK	Soil	Particle size - Sieve and Pipette	SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

10-219431 10-219435

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

10- 219431

ALS Environmental

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Canada Toll Free: 1 8
www.alsglobal.

L1478487-COFC

Page 1 of 2

Report To

Company: Azimuth
Contact: Randy Baker
Address: 2~~0~~8 - 2902 West Broadway
Vancouver, BC V6K 2G8
Phone: 604 73~~2~~ 1220 Fax:

Invoice To Same as Report ? (circle) Yes or No (if No, provide details)
Copy of Invoice with Report? (circle) Yes or No

Company:
Contact:
Address:
Phone: Fax:

Lab Work Order # (lab use only)

Report Format / Distribution

Standard: X Other (specify):
Select: PDF X Excel X Digital Fax
Email 1: rbaker@azimuthgroup.ca
Email 2: efranz@azimuthgroup.ca

Client / Project Information

Job #:
PO / AFE:
LSD:
Quote #:
ALS Contact:
Sampler:

Service Request (Rush subject to availability - Contact ALS to confirm TAT)

- Regular (Standard Turnaround Times - Business Days)
- Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
- Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
- Same Day or Weekend Emergency - Contact ALS to confirm TAT

Analysis Request

(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total metals (dry)	Moisture	Total metals	TOC	Grain Size	pH							Number of Containers
	JBX Pit W/R Invertebrates	26-Jun-14		Tissue	X	X											1
	1408 W/R Invertebrates	26-Jun-14		Tissue	X	X											1
	MH-12	24-Jun-14		Sediment		X	X	X	X	X							2
	MH-28A	25-Jun-14		Sediment		X	X	X	X	X							2
	MH-29	25-Jun-14		Sediment		X	X	X	X	X							2
	MH-04	24-Jun-14		Sediment		X	X	X	X	X							2
	CC-3	24-Jun-14		Sediment		X	X	X	X	X							2
	MH-27	25-Jun-14		Sediment		X	X	X	X	X							2
	JBX-RBV-1	26-June-14		Tissue	X	X											1
	JBX-RBV-2	26-June-14		Tissue	X	X											1
	~~JBX-RBV-3~~			~~Tissue~~	~~X~~	~~X~~											~~1~~
	~~JBX-RBV-4~~			~~Tissue~~	~~X~~	~~X~~											~~1~~

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Contact Eric or Randy prior to analysis.

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.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: [signature]	Date: Jun 27	Time: 2:15 pm	Received by: [signature]	Date: 27-Jul-14	Time: 2:00	Temperature: 12.1 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY GENF 18.01 Front

ALS Environmental

Chain of Custody / Analytical Re[quest Form]
Canada Toll Free: 1 800 668[...]
www.alsglobal.com

L1478487-COFC

Report To	
Company:	Azimuth
Contact:	See page 1 for other info
Address:	
Phone:	Fax:
Invoice To	Same as Report ? (circle) Yes or No (if No, provide details)
	Copy of Invoice with Report? (circle) Yes or No
Company:	
Contact:	
Address:	
Phone:	Fax:
Lab Work Order # (lab use only)	

Report Format / Distribution	
Standard:	Other (specify):
Select: PDF Excel Digital Fax	
Email 1:	
Email 2:	
Client / Project Information	
Job #:	
PO / AFE:	
LSD:	
Quote #:	
ALS Contact:	**Sampler:**

Service Request (Rush ...) - Contact ALS to confirm TAT)	
	Regular (Standard Turnaround Times - Business Days)
	Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
	Same Day or Weekend Emergency - Contact ALS to confirm TAT

Analysis Request
(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total metals (dry)	Moisture											Number of Containers
	1408-RBV-1	24-Jun-14		Tissue	X	X											1
	1408-RBV-2	24-Jun-14		Tissue	X	X											1
	1408-RBV-3	24-Jun-14		Tissue	X	X											1
	1408-RBV-4	25-Jun-14		Tissue	X	X											1
	1408-RBV-5	26-Jun-14		Tissue	X	X											1

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

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.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date: 27 June ~~2014~~	Time: 2:05pm	Received by:	Date: 27-Jun-14.	Time: 2:00	Temperature: °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

AZIMUTH CONSULTING GROUP INC.
ATTN: Randy Baker
218 - 2902 West Broadway
Vancouver BC V6K 2G8

Date Received: 27-AUG-14
Report Date: 04-NOV-14 12:45 (MT)
Version: FINAL

Client Phone: 604-730-1220

Certificate of Analysis

Lab Work Order #: L1508860

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 1, 2
Legal Site Desc:

Brent Mack, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1508860-1	L1508860-2	L1508860-3		
	Description	Sediment	Sediment	Sediment		
	Sampled Date	23-AUG-14	23-AUG-14	23-AUG-14		
	Sampled Time	12:00	12:00	23:30		
	Client ID	MH30	CC U/S CONFLUENCE	MH-11		
SOIL						
Physical Tests	Moisture (%)	47.5	36.2	36.7		
	pH (1:2 soil:water) (pH)	7.60	8.27	8.25		
Particle Size	% Gravel (>2mm) (%)	1.92	2.58	2.48		
	% Sand (2.0mm - 0.063mm) (%)	60.7	77.4	77.1		
	% Silt (0.063mm - 4um) (%)	33.2	17.3	18.4		
	% Clay (<4um) (%)	4.20	2.71	2.00		
	Texture	Sandy loam	Loamy sand	Loamy sand		
Organic / Inorganic Carbon	Total Organic Carbon (%)	2.67	1.36	1.45		
Metals	Aluminum (Al) (mg/kg)	7860	8770	10200		
	Antimony (Sb) (mg/kg)	1.04	1.82	1.38		
	Arsenic (As) (mg/kg)	7.41	12.8	15.3		
	Barium (Ba) (mg/kg)	283	137	135		
	Beryllium (Be) (mg/kg)	0.31	0.34	0.41		
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20		
	Cadmium (Cd) (mg/kg)	1.14	2.05	3.11		
	Calcium (Ca) (mg/kg)	5890	10800	11200		
	Chromium (Cr) (mg/kg)	15.8	16.2	18.4		
	Cobalt (Co) (mg/kg)	6.31	7.14	8.28		
	Copper (Cu) (mg/kg)	15.8	18.2	15.4		
	Iron (Fe) (mg/kg)	18900	20800	22400		
	Lead (Pb) (mg/kg)	15.7	86.5	200		
	Lithium (Li) (mg/kg)	14.2	18.2	24.5		
	Magnesium (Mg) (mg/kg)	4660	7400	7900		
	Manganese (Mn) (mg/kg)	157	528	1510		
	Mercury (Hg) (mg/kg)	0.0720	0.0363	0.0189		
	Molybdenum (Mo) (mg/kg)	1.36	2.73	1.28		
	Nickel (Ni) (mg/kg)	24.1	25.1	23.2		
	Phosphorus (P) (mg/kg)	1130	1440	840		
	Potassium (K) (mg/kg)	580	540	490		
	Selenium (Se) (mg/kg)	1.42	1.18	0.88		
	Silver (Ag) (mg/kg)	0.29	0.42	0.27		
	Sodium (Na) (mg/kg)	<100	<100	<100		
	Strontium (Sr) (mg/kg)	29.1	48.8	44.1		
	Thallium (Tl) (mg/kg)	0.120	0.089	0.079		
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0		
	Titanium (Ti) (mg/kg)	68.3	148	286		
	Uranium (U) (mg/kg)	1.37	1.29	0.689		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1508860-1	L1508860-2	L1508860-3		
	Description	Sediment	Sediment	Sediment		
	Sampled Date	23-AUG-14	23-AUG-14	23-AUG-14		
	Sampled Time	12:00	12:00	23:30		
	Client ID	MH30	CC U/S CONFLUENCE	MH-11		
Grouping	**Analyte**					
SOIL						
Metals	Vanadium (V) (mg/kg)	23.6	27.5	25.9		
	Zinc (Zn) (mg/kg)	132	289	533		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1508860-4	L1508860-5	L1508860-6	L1508860-7	L1508860-8
	Description	Tissue	Tissue	Tissue	Tissue	Tissue
	Sampled Date	23-AUG-14	23-AUG-14	23-AUG-14	23-AUG-14	23-AUG-14
	Sampled Time					
	Client ID	MH-16-1	MH-16-2	MH-16-3	MH-16-4	MH-16-5
TISSUE						
Physical Tests	% Moisture (%)	79.2	79.2	77.8	77.4	75.7
Metals	Aluminum (Al)-Total (mg/kg)	43.9	119	129	136	58.5
	Antimony (Sb)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Arsenic (As)-Total (mg/kg)	0.432	0.393	0.462	0.481	0.391
	Barium (Ba)-Total (mg/kg)	21.4	24.6	32.2	23.1	28.6
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Boron (B)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cadmium (Cd)-Total (mg/kg)	0.193	0.199	0.385	0.330	0.280
	Calcium (Ca)-Total (mg/kg)	49800	62300	80900	52100	60200
	Cesium (Cs)-Total (mg/kg)	0.0092	0.0160	0.0249	0.0172	0.0112
	Chromium (Cr)-Total (mg/kg)	0.083	0.228	0.221	0.325	0.132
	Cobalt (Co)-Total (mg/kg)	0.118	0.137	0.187	0.170	0.117
	Copper (Cu)-Total (mg/kg)	2.44	3.15	4.21	3.45	2.93
	Iron (Fe)-Total (mg/kg)	141	266	254	257	150
	Lead (Pb)-Total (mg/kg)	0.145	0.177	0.142	0.166	0.169
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	1590	1910	2070	1520	1820
	Manganese (Mn)-Total (mg/kg)	39.8	69.6	71.9	54.4	49.8
	Molybdenum (Mo)-Total (mg/kg)	0.095	0.124	0.120	0.099	0.083
	Nickel (Ni)-Total (mg/kg)	0.30	0.30	0.37	0.33	0.30
	Phosphorus (P)-Total (mg/kg)	33400	42300	52100	34900	39900
	Potassium (K)-Total (mg/kg)	13600	14100	13400	12800	12500
	Rubidium (Rb)-Total (mg/kg)	6.20	7.24	8.90	7.55	6.17
	Selenium (Se)-Total (mg/kg)	6.79	11.0	7.67	8.23	6.36
	Sodium (Na)-Total (mg/kg)	5720	5440	5230	4460	4240
	Strontium (Sr)-Total (mg/kg)	42.1	59.6	67.9	45.8	52.4
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0111	0.0113	0.0173	0.0112	0.0100
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	0.0091	0.0141	0.0137	0.0133	0.0131
	Vanadium (V)-Total (mg/kg)	0.71	1.18	1.16	0.92	0.83
	Zinc (Zn)-Total (mg/kg)	135	118	117	108	118
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1508860-9 Tissue 23-AUG-14 MH30-1	L1508860-10 Tissue 23-AUG-14 MH30-2	L1508860-11 Tissue 23-AUG-14 MH30-3	L1508860-12 Tissue 23-AUG-14 MH30-4	L1508860-13 Tissue 23-AUG-14 MH30-5
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	79.0	76.3	77.6	72.1	82.8
Metals	Aluminum (Al)-Total (mg/kg)	392	22.8	89.0	361	8.1
	Antimony (Sb)-Total (mg/kg)	0.049	<0.010	0.012	0.036	0.011
	Arsenic (As)-Total (mg/kg)	0.965	0.329	0.525	0.632	0.572
	Barium (Ba)-Total (mg/kg)	28.7	16.4	20.3	12.3	27.7
	Beryllium (Be)-Total (mg/kg)	0.016	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Boron (B)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
	Cadmium (Cd)-Total (mg/kg)	0.968	0.412	0.483	0.729	0.800
	Calcium (Ca)-Total (mg/kg)	98600	27900	65000	17500	73400
	Cesium (Cs)-Total (mg/kg)	0.558	0.159	0.399	0.615	0.370
	Chromium (Cr)-Total (mg/kg)	0.565	0.063	0.183	0.572	<0.20
	Cobalt (Co)-Total (mg/kg)	0.252	0.115	0.114	0.139	0.076
	Copper (Cu)-Total (mg/kg)	3.86	2.65	2.94	2.78	2.30
	Iron (Fe)-Total (mg/kg)	514	128	196	438	157
	Lead (Pb)-Total (mg/kg)	8.10	0.904	1.55	5.22	2.48
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	2140	1280	1650	1070	2400
	Manganese (Mn)-Total (mg/kg)	64.5	12.8	20.4	33.3	34.3
	Molybdenum (Mo)-Total (mg/kg)	0.131	0.083	0.113	0.100	<0.070 DLB
	Nickel (Ni)-Total (mg/kg)	0.71	0.27	0.25	0.53	<0.50 DLB
	Phosphorus (P)-Total (mg/kg)	59900	21600	42500	14700	34900
	Potassium (K)-Total (mg/kg)	13900	11600	12800	10100	17000
	Rubidium (Rb)-Total (mg/kg)	16.1	8.42	12.9	16.6	15.2
	Selenium (Se)-Total (mg/kg)	6.22	6.03	6.61	6.54	5.43
	Sodium (Na)-Total (mg/kg)	6210	4360	4590	3340	6390
	Strontium (Sr)-Total (mg/kg)	85.1	20.9	52.7	15.8	73.7
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0271	0.0151	0.0217	0.0181	0.0137
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	0.0506	0.0147	0.0194	0.0211	0.0196
	Vanadium (V)-Total (mg/kg)	2.13	0.50	1.07	1.56	0.71
	Zinc (Zn)-Total (mg/kg)	243	123	123	108	214
	Zirconium (Zr)-Total (mg/kg)	0.26	<0.20	<0.20	0.24	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Chromium (Cr)-Total	DLB	L1508860-13
Duplicate	Molybdenum (Mo)-Total	DLB	L1508860-13
Duplicate	Nickel (Ni)-Total	DLB	L1508860-13
Duplicate	Aluminum (Al)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Barium (Ba)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Cadmium (Cd)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Calcium (Ca)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Chromium (Cr)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Cobalt (Co)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Iron (Fe)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Lead (Pb)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Manganese (Mn)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Molybdenum (Mo)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Phosphorus (P)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Strontium (Sr)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Uranium (U)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Vanadium (V)-Total	DUP-H	L1508860-10, -11, -12, -4, -5, -6, -7, -8, -9
Duplicate	Aluminum (Al)-Total	DUP-H	L1508860-13
Duplicate	Barium (Ba)-Total	DUP-H	L1508860-13
Duplicate	Calcium (Ca)-Total	DUP-H	L1508860-13
Duplicate	Iron (Fe)-Total	DUP-H	L1508860-13
Duplicate	Lead (Pb)-Total	DUP-H	L1508860-13
Duplicate	Manganese (Mn)-Total	DUP-H	L1508860-13
Duplicate	Phosphorus (P)-Total	DUP-H	L1508860-13
Duplicate	Strontium (Sr)-Total	DUP-H	L1508860-13
Duplicate	Uranium (U)-Total	DUP-H	L1508860-13
Duplicate	Vanadium (V)-Total	DUP-H	L1508860-13
Duplicate	Antimony (Sb)	DUP-H,J	L1508860-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection Limit was raised due to detection of analyte at comparable level in Method Blank.
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
DUP-H,J	Duplicate results outside ALS DQO, due to sample heterogeneity. Duplicate results and limits are expressed in terms of absolute difference.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-ORG-LECO-SK	Soil	Organic Carbon by combustion method	SSSA (1996) p. 973

Total Organic Carbon (C-TOT-ORG-LECO-SK, C-TOT-ORG-SK)

Total C and inorganic C are determined on separate samples. The total C is determined by combustion and thermal conductivity detection, while inorganic C is determined by weight lass after addition of hydrochloric acid. Organic C is calculated by the difference between these two determinations.

Reference for Total C:
Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, organic carbon and organic matter. P. 961-1010 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

Reference for Inorganic C:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/245.7

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is

Reference Information

weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MET-200.2-CCMS-VA Soil Metals in Soil by CRC ICPMS EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis of the digested extract is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MET-DRY-CCMS-VA Tissue Metals in Tissue by CRC ICPMS (DRY) EPA 200.3/6020A

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

MET-DRY-MICR-HRMS-VA Tissue Metals in Tissue by HR-ICPMS Micro (DRY) EPA 200.3/200.8

Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on dry weight basis.

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

MOISTURE-TISS-VA Tissue % Moisture in Tissues ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

MOISTURE-VA Soil Moisture content ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

PH-1:2-VA Soil pH in Soil (1:2 Soil:Water Extraction) BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. 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. The pH of the solution is then measured using a standard pH probe.

PSA-PIPET+GRAVEL-SK Soil Particle size - Sieve and Pipette SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

Chain of Custody Numbers:

1 2

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L1508860-COFC

COC Number: 14 -

Page 1 of 2

Report To
Company: Azimuth
Contact: Randy Baker
Address: 218-2902 West Broadway, Vancouver, BC V6K 2G8
Phone: 604-730-1220

Report Format / Distribution
Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ Yes ☐ No
☐ Criteria on Report - provide details below if box checked
Select Distribution: ☐ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax rbaker@azimuthgroup.ca
Email 2 efranz@azimuthgroup.ca

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
R ☑ Regular (Standard TAT if received by 3 pm - business days)
P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Specify Date Required for E2,E or P:

Invoice To
Same as Report To ☑ Yes ☐ No
Copy of Invoice with Report ☑ Yes ☐ No
Company:
Contact:

Invoice Distribution
Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax
Email 2

Project Information
ALS Quote #:
Job #:
PO / AFE:
LSD:
ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)
Approver ID: | Cost Center:
GL Account: | Routing Code:
Activity Code:
Location:
ALS Contact: | Sampler:

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

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	Total metals (dry)	Moisture	Total metals	TOC	Grain Size	pH	Number of Containers
	MH30	23-Aug-14	12:00	Sediment		R	R	R	R	R	3
	CC u/s confluence	23-Aug-14	12:00	Sediment		R	R	R	R	R	2
	MH-11	25-Aug-14	11:30	Sediment		R	R	R	R	R	1
	MH-16-1	23-Aug-14		Tissue	R	R					
	MH-16-2	23-Aug-14		Tissue	R	R					
	MH-16-3	23-Aug-14		Tissue	R	R					
	MH-16-4	23-Aug-14		Tissue	R	R					
	MH-16-5	23-Aug-14		Tissue	R	R					
	MH30-1	23-Aug-14		Tissue	R	R					
	MH30-2	23-Aug-14		Tissue	R	R					
	MH30-3	23-Aug-14		Tissue	R	R					
	MH30-4	23-Aug-14		Tissue	R	R					

Drinking Water (DW) Samples[1] (client use)
Are samples taken from a Regulated DW System? ☐ Yes ☑ No
Are samples for human drinking water use? ☐ Yes ☑ No

Special Instructions / Specify Criteria to add on report (client Use)
It won't let me put an X in the analysis cell so I've put R as just regular services is required.
Keep tissue samples frozen until analyzed.

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: -13.1 12.5
FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date: 27 Aug 14	Time: 11:00	Received by:	Date:	Time:

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 a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1508860-COFC

COC Number: 14 -

Report To	
Company:	Azimuth
Contact:	Randy Baker
Address:	218-2902 West Broadway Vancouver, BC V6K 2G8
Phone:	604-730-1220
Invoice To	Same as Report To
	Copy of Invoice with Report
Company:	
Contact:	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report

☐ Criteria on Report - provide details below if box checked

Select Distribution: ☐ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: rbaker@azimuthgroup.ca

Email 2: efranz@azimuthgroup.ca

Invoice Distribution

Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax:

Email 2:

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

R ☑ Regular (Standard TAT if received by 3 pm - business days)

P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT

E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT

E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge

Specify Date Required for E2,E or P:

Project Information

ALS Quote #:	
Job #:	
PO / AFE:	
LSD:	
ALS Lab Work Order # (lab use only)	

Oil and Gas Required Fields (client use)

Approver ID:	Cost Center:
GL Account:	Routing Code:
Activity Code:	
Location:	
ALS Contact:	Sampler:

Analysis Request

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

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	Total metals (dry)	Moisture	Total metals	TOC	Grain Size	pH	Number of Containers
	MH30-5	23-Aug-14		Tissue	R	R					

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

Are samples for human drinking water use?

Special Instructions / Specify Criteria to add on report (client Use)

It won't let me put an X in the analysis cell so I've put R as just regular services is required.
Keep tissue samples frozen until analyzed.

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

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:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

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

APPENDIX D

Camp Creek Benthic Invertebrates: Raw Data and Laboratory Methods, 2014

Biologica
Environmental Services Ltd
Marine & Fresh Water Taxonomy

Methods - Freshwater Benthos
Project: Sa Dena Hes
Client: Azimuth Consulting Group
Protocol: CABIN (modified)

Kicknet samples were collected June 24-25, 2014 (7 samples in 19 jars) and in August 2014 (3 samples in 4 jars) and field-screened to 0.5mm. These arrived at Biologica on July 3 and September 10 respectively. The chain of custody documents were checked and approved. Samples were immediately transferred from formalin into 70% ethanol on a 0.25mm screen to allow for tissue shrinkage in the preservative. These were stained with Rose Bengal to aid in sorting. Each sample was provided a unique identification number and placed in the queue for analysis.

Prior to subsampling, samples were elutriated where possible, and any organisms >1.5cm ("Macro" organisms) were removed from the whole sample prior to subsampling to ensure the density of large, rare taxa were enumerated accurately. Subsampling was done on Caton trays (12-and 24-Quadrat trays) (Caton, 1991), which is an acceptable alternative to the Marchant box when samples contain high debris volumes with dense vegetation and plant matter (S. Strachan, pers. comm.). Samples were sorted to a minimum 300-count, which does not include copepods, cladocerans, nematodes and other incidental organisms specified by CABIN (MacDermott *et al.* 2012).

All samples are sorted using a Meiji EMZ dissecting microscope at 10-40x magnification by trained personnel. All debris in the subsample was checked microscopically, including leaves, twigs, moss, elutriated gravel, and other large debris. This method assures 'clinger taxa' are recovered consistently from the samples. To minimize potential sorter bias, samples were distributed among technicians such that no person sorted all the replicates of a given sample.

To ensure the sorting efficiency was >95%, whole and/or partial subsamples were re-sorted. Sorting efficiency was calculated using the following equation:

$$\text{Sorting efficiency} = \frac{[\text{Total count} - (\text{\#recovered on re-sort})] \times 100\%}{\text{Total count}}$$

For the July samples, 50% of the debris for 4 of the 7 samples was re-sorted. The estimated efficiency was 98.2%. For the September samples, all samples were completely double-checked by a trained sorting technician during a training exercise and thus sorting efficiency is estimated to be 100% as all found organisms were retained.

Subsampling accuracy was assessed by comparing the percent differences in abundances among equivalent quadrats during sorting. Mean error among quadrats within a sample was 18.7%. Actual subsampling error is thus expected to be <20% from the larger reported subsamples.

All organisms are identified using a combination of dissecting (10-40x) and compound microscopes (100-1000X) and standard taxonomic keys (See Taxonomic References) to the lowest practicable level (species where possible). All chironomids were cleared and slide-mounted in a permanent mounting medium for optimal resolution of their head capsules. Specimens were identified by a SFS-certified taxonomist (EPT and Chironomidae, West) with 4 years of experience (Robynn Holma, B.Sc.). No new taxa were encountered or added the Biologica's reference collection during the course of this study. One sample for each time period was double-checked by a second internal taxonomist to ensure 100% internal agreement on all species-level identifications. All specimens were archived in air-tight glass vials with glycerin and 70% ethanol for long-term storage.

Taxonomic data were recorded on bench sheets as per CABIN guidelines. These data were entered into an excel spreadsheet and completely double-checked against bench sheets for entry errors. Data were delivered to the client electronically.

Methodological References:

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Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-01		
		No. of	MH-04		
TAXON	STAGE	individuals	1/12	Macro	Total
PLATYHELMINTHES					
Planariidae					
Polycelis sp.	A	24			
Polycelis sp.	J	12	1		12
ANNELIDA					
Oligochaeta					
Enchytraeidae					
Enchytraeidae indet.	A	13			
Enchytraeidae indet.	J	14			
ARTHROPODA					
ARACHNIDA					
Acari					
Acari indet.	L	4			
Oribatida					
Oribatida indet.	A	38			
Hydrozetidae					
Hydrozetes sp.	A	15			
Trombidiformes					
Hydrachnidiae					
Hydrachnidiae indet.	Deutonymph	22	1		12
Arrenuridae					
Arrenurus sp.	A	4			
Hydryphantidae					
Protzia sp.	A	96	8		96
Wandesia sp.	A	503	19		228
Aturidae					
Brachypoda sp.	A	24			
Lebertiidae					
Lebertia sp.	A	16	1		12
Sperchontidae					
Sperchon sp.	A	8			
Amphipoda					
Gammaridae					
Gammarus sp.	A	12			
Gammarus sp.	J	2			
INSECTA					
Coleoptera					
Coleoptera indet.	A	8			
Collembola					
Dicyrtomidae					
Dicyrtoma s.l. sp.	A	24			
Isotomidae					
Isotomidae indet.	A	65	1		12
Onychuridae					

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

TAXON	STAGE	No. of individuals	MH-04		
Biologica Sample #			14-19-01		
			1/12	Macro	Total
Onychuridae indet.	A	94			
Ephemeroptera					
Ephemeroptera indet.	N	132	11		132
Ameletidae					
Ameletus sp.	N	243			
Baetidae					
Baetidae indet.	N	1048	21		252
Baetis bicaudatus	N	7959	48		576
Baetis sp.	N	1560			
Ephemerellidae					
Drunella doddsii	N	3			
Drunella sp.	N	4			
Heptageniidae					
Heptageniidae indet.	N	977	31		372
Cinygma sp.	N	12			
Cinygmula sp.	N	849	10		120
Epeorus albertae	N	66			
Epeorus longimanus	N	32			
Epeorus sp.	N	132			
Lepidoptera					
Lepidoptera indet.	L	12			
Plecoptera					
Plecoptera indet.	N	362	13		156
Chloroperlidae					
Chloroperlidae indet.	N	129	3		36
Paraperla sp.	N	191			
Suwallia sp.	N	206	14		168
Sweltsa sp.	N	172			
Leuctridae					
Leuctridae indet.	N	156	1		12
Despaxia augusta	N	44			
Perlomyia sp.	N	24			
Nemouridae					
Nemouridae indet	N	180			
Visoka cataractae	N	306			
Zapada cinctipes	N	4			
Zapada columbiana	N	24			
Zapada oregonensis group sp.	N	1431	22		264
Zapada sp.	N	544			
Perlodidae					
Perlodidae indet	N	228	10		120
Megarcys sp.	N	57		11	11
Trichoptera					
Trichoptera indet.	L	14			
Apataniidae					
Allomyia sp.	L	516	43		516

Biologica Sample #			14-19-01		
TAXON	STAGE	No. of individuals	MH-04 1/12	MH-04 Macro	MH-04 Total
Glossosomatidae					
Glossosoma sp.	L	8			
Hydropsychidae					
Parapsyche sp.	L	11			
Limnephilidae					
Limnephilidae indet.	L	12	1		12
Chyranda sp.	L	16			
Philocasca sp.	L	8			
Rhyacophilidae					
Rhyacophila sp.	L	546			
Uenoidae					
Oligophlebodes sp.	L	12			
Diptera					
Diptera indet.	L	12			
Brachycera					
Brachycera indet.	P	12	1		12
Chaoboridae					
Chaoborus sp.	L	44			
Chironomidae					
Chironomidae indet.	L	650	20		240
Chironomidae indet.	P	360	2		24
Chironominae					
Tanytarsini					
Tanytarsini indet.	L	2			
Micropsectra/Tanytarsus sp. complex	L	129	6		72
Diamesinae					
Diamesinae indet.	L	110			
Diamesa sp.	L	372	1		12
Pagastia sp.	L	60			
Orthocladiinae					
Orthocladiinae indet.	L	1414	21		252
Brillia sp.	L	86	1		12
Corynoneura sp.	L	80	3		36
Cricotopus/Orthocladius sp. complex	L	856	5		60
Eukiefferiella sp.	L	1887	46		552
Heleniella sp.	L	24			
Heterotrissocladius sp.	L	24			
Parakiefferiella sp.	L	36	3		36
Parametriocnemus sp.	L	30			
Platysmittia sp.	L	24			
Rheocricotopus sp.	L	52			
Stilocladius sp.	L	10			
Synorthocladius sp.	L	204	1		12
Synorthocladius sp. (aberrant)	L	426	4		48
Thienemanniella sp.	L	189	2		24
Tvetenia sp.	L	760			

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

TAXON	STAGE	No. of individuals	MH-04 1/12	Macro	Total
Biologica Sample #				14-19-01	
Podonominae					
Boreochlus sp.	L	8			
Prodiamesinae					
Prodiamesinae indet.	L	12			
Tanypodinae					
Tanypodinae indet.	L	14			
Procladius sp.	L	6			
Psectrotanypus sp.	L	4			
Reomyia/Zavrelimyia sp. complex	L	8			
Dixidae					
Dixa sp.	L	4			
Empididae					
Empididae indet.	L	28			
Clinocera sp.	L	48	4		48
Neoplasta sp.	L	154			
Oreogeton sp.	L	951	24		288
Psychodidae					
Pericoma/Telmatoscopus sp.	L	16	1		12
Simuliidae					
Simuliidae indet.	L	58	3		36
Simuliidae indet.	P	19			
Prosimulium sp.	L	366			
Tipulidae					
Tipulidae indet.	L	8			
Antocha sp.	L	2			
Dicranota sp.	L	28	1		12
Total Number of Organisms		28820	408	11	4907
Total Number of Taxa		70			27
MEIOFAUNA					
Crustacea					
Cladocera indet.	A	*Present*			
Copepoda indet.	A	*Present*			
Ostracoda indet.	A	*Present*	P		P
Nematoda					
Nematoda indet.	A	*Present*			
MEMO					
Araneae indet. (spider)	A	*Present*			
Invertebrate indet.	eggs	*Present*			
Terrestrial insect	A	*Present*	P		P
Terrestrial gastropoda indet.					

Biologica Sample #			14-19-02		
		No. of	MH-12		
TAXON	STAGE	individuals	1/24	Macro	Total
PLATYHELMINTHES					
Planariidae					
Polycelis sp.	A	24			
Polycelis sp.	J	12			
ANNELIDA					
Oligochaeta					
Enchytraeidae					
Enchytraeidae indet.	A	13			
Enchytraeidae indet.	J	14			
ARTHROPODA					
ARACHNIDA					
Acari					
Acari indet.	L	4			
Oribatida					
Oribatida indet.	A	38			
Hydrozetidae					
Hydrozetes sp.	A	15			
Trombidiformes					
Hydrachnidiae					
Hydrachnidiae indet.	Deutonymph	22			
Arrenuridae					
Arrenurus sp.	A	4			
Hydryphantidae					
Protzia sp.	A	96			
Wandesia sp.	A	503			
Aturidae					
Brachypoda sp.	A	24	1		24
Lebertiidae					
Lebertia sp.	A	16			
Sperchontidae					
Sperchon sp.	A	8			
Amphipoda					
Gammaridae					
Gammarus sp.	A	12			
Gammarus sp.	J	2			
INSECTA					
Coleoptera					
Coleoptera indet.	A	8			
Collembola					
Dicyrtomidae					
Dicyrtoma s.l. sp.	A	24	1		24
Isotomidae					
Isotomidae indet.	A	65			
Onychuridae					

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-02		
TAXON	STAGE	No. of individuals	MH-12 1/24	MH-12 Macro	MH-12 Total
Onychuridae indet.	A	94			
Ephemeroptera					
Ephemeroptera indet.	N	132			
Ameletidae					
Ameletus sp.	N	243			
Baetidae					
Baetidae indet.	N	1048	7		168
Baetis bicaudatus	N	7959	110		2640
Baetis sp.	N	1560	7		168
Ephemerellidae					
Drunella doddsii	N	3			
Drunella sp.	N	4			
Heptageniidae					
Heptageniidae indet.	N	977	5		120
Cinygma sp.	N	12			
Cinygmula sp.	N	849	7		168
Epeorus albertae	N	66	1		24
Epeorus longimanus	N	32			
Epeorus sp.	N	132	1		24
Lepidoptera					
Lepidoptera indet.	L	12			
Plecoptera					
Plecoptera indet.	N	362			
Chloroperlidae					
Chloroperlidae indet.	N	129			
Paraperla sp.	N	191	3		72
Suwallia sp.	N	206			
Sweltsa sp.	N	172	1		24
Leuctridae					
Leuctridae indet.	N	156	1		24
Despaxia augusta	N	44			
Perlomyia sp.	N	24			
Nemouridae					
Nemouridae indet	N	180			
Visoka cataractae	N	306			
Zapada cinctipes	N	4			
Zapada columbiana	N	24			
Zapada oregonensis group sp.	N	1431	3		72
Zapada sp.	N	544			
Perlodidae					
Perlodidae indet	N	228	1		24
Megarcys sp.	N	57	1	9	33
Trichoptera					
Trichoptera indet.	L	14			
Apataniidae					
Allomyia sp.	L	516			

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

TAXON	STAGE	No. of individuals	MH-12 1/24	MH-12 Macro	MH-12 Total
Biologica Sample #				14-19-02	
Glossosomatidae					
Glossosoma sp.	L	8			
Hydropsychidae					
Parapsyche sp.	L	11			
Limnephilidae					
Limnephilidae indet.	L	12			
Chyranda sp.	L	16			
Philocasca sp.	L	8			
Rhyacophilidae					
Rhyacophila sp.	L	546	1		24
Uenoidae					
Oligophlebodes sp.	L	12			
Diptera					
Diptera indet.	L	12			
Brachycera					
Brachycera indet.	P	12			
Chaoboridae					
Chaoborus sp.	L	44			
Chironomidae					
Chironomidae indet.	L	650	12		288
Chironomidae indet.	P	360			
Chironominae					
Tanytarsini					
Tanytarsini indet.	L	2			
Micropsectra/Tanytarsus sp. complex	L	129			
Diamesinae					
Diamesinae indet.	L	110	4		96
Diamesa sp.	L	372	3		72
Pagastia sp.	L	60	2		48
Orthocladiinae					
Orthocladiinae indet.	L	1414	31		744
Brillia sp.	L	86	1		24
Corynoneura sp.	L	80			
Cricotopus/Orthocladius sp. complex	L	856	11		264
Eukiefferiella sp.	L	1887	47		1128
Heleniella sp.	L	24			
Heterotrissocladius sp.	L	24			
Parakiefferiella sp.	L	36			
Parametriocnemus sp.	L	30			
Platysmittia sp.	L	24	1		24
Rheocricotopus sp.	L	52			
Stilocladius sp.	L	10			
Synorthocladius sp.	L	204	3		72
Synorthocladius sp. (aberrant)	L	426	2		48
Thienemanniella sp.	L	189	6		144
Tvetenia sp.	L	760	27		648

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-02		
		No. of	MH-12		
TAXON	STAGE	individuals	1/24	Macro	Total
Podonominae					
Boreochlus sp.	L	8			
Prodiamesinae					
Prodiamesinae indet.	L	12			
Tanypodinae					
Tanypodinae indet.	L	14			
Procladius sp.	L	6			
Psectrotanypus sp.	L	4			
Reomyia/Zavrelimyia sp. complex	L	8			
Dixidae					
Dixa sp.	L	4			
Empididae					
Empididae indet.	L	28	1		24
Clinocera sp.	L	48			
Neoplasta sp.	L	154			
Oreogeton sp.	L	951	1		24
Psychodidae					
Pericoma/Telmatoscopus sp.	L	16			
Simuliidae					
Simuliidae indet.	L	58			
Simuliidae indet.	P	19			
Prosimulium sp.	L	366	1		24
Tipulidae					
Tipulidae indet.	L	8			
Antocha sp.	L	2			
Dicranota sp.	L	28			
Total Number of Organisms		28820	304	9	7305
Total Number of Taxa		70			22
MEIOFAUNA					
Crustacea					
Cladocera indet.	A	*Present*			
Copepoda indet.	A	*Present*			
Ostracoda indet.	A	*Present*			
Nematoda					
Nematoda indet.	A	*Present*			
MEMO					
Araneae indet. (spider)	A	*Present*			
Invertebrate indet.	eggs	*Present*	P		P
Terrestrial insect	A	*Present*	P		P
Terrestrial gastropoda indet.					

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-03		
TAXON	STAGE	No. of individuals	MH-27 5/12	MH-27 Macro	MH-27 Total
PLATYHELMINTHES					
Planariidae					
Polycelis sp.	A	24			
Polycelis sp.	J	12			
ANNELIDA					
Oligochaeta					
Enchytraeidae					
Enchytraeidae indet.	A	13	2		5
Enchytraeidae indet.	J	14	1		2
ARTHROPODA					
ARACHNIDA					
Acari					
Acari indet.	L	4			
Oribatida					
Oribatida indet.	A	38	1		2
Hydrozetidae					
Hydrozetes sp.	A	15	3		7
Trombidiformes					
Hydrachnidiae					
Hydrachnidiae indet.	Deutonymph	22	1		2
Arrenuridae					
Arrenurus sp.	A	4			
Hydryphantidae					
Protzia sp.	A	96			
Wandesia sp.	A	503	13		31
Aturidae					
Brachypoda sp.	A	24			
Lebertiidae					
Lebertia sp.	A	16			
Sperchontidae					
Sperchon sp.	A	8			
Amphipoda					
Gammaridae					
Gammarus sp.	A	12		2	2
Gammarus sp.	J	2			
INSECTA					
Coleoptera					
Coleoptera indet.	A	8			
Collembola					
Dicyrtomidae					
Dicyrtoma s.l. sp.	A	24			
Isotomidae					
Isotomidae indet.	A	65	7		17
Onychuridae					

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-03		
TAXON	STAGE	No. of individuals	MH-27 5/12	MH-27 Macro	MH-27 Total
Onychuridae indet.	A	94	6		14
Ephemeroptera					
Ephemeroptera indet.	N	132			
Ameletidae					
Ameletus sp.	N	243	3		7
Baetidae					
Baetidae indet.	N	1048	10		24
Baetis bicaudatus	N	7959	28		67
Baetis sp.	N	1560			
Ephemerellidae					
Drunella doddsii	N	3	1		2
Drunella sp.	N	4			
Heptageniidae					
Heptageniidae indet.	N	977	17		41
Cinygma sp.	N	12	5		12
Cinygmula sp.	N	849	27		65
Epeorus albertae	N	66	16		38
Epeorus longimanus	N	32			
Epeorus sp.	N	132			
Lepidoptera					
Lepidoptera indet.	L	12			
Plecoptera					
Plecoptera indet.	N	362	4		10
Chloroperlidae					
Chloroperlidae indet.	N	129	2		5
Paraperla sp.	N	191	3		7
Suwallia sp.	N	206	11		26
Sweltsa sp.	N	172	5		12
Leuctridae					
Leuctridae indet.	N	156			
Despaxia augusta	N	44			
Perlomyia sp.	N	24			
Nemouridae					
Nemouridae indet	N	180			
Visoka cataractae	N	306	1		2
Zapada cinctipes	N	4			
Zapada columbiana	N	24			
Zapada oregonensis group sp.	N	1431	28		67
Zapada sp.	N	544			
Perlodidae					
Perlodidae indet	N	228			
Megarcys sp.	N	57		1	1
Trichoptera					
Trichoptera indet.	L	14	1		2
Apataniidae					
Allomyia sp.	L	516			

Biologica Sample #			14-19-03		
		No. of	MH-27		
TAXON	STAGE	individuals	5/12	Macro	Total
Glossosomatidae					
Glossosoma sp.	L	8			
Hydropsychidae					
Parapsyche sp.	L	11	1		2
Limnephilidae					
Limnephilidae indet.	L	12			
Chyranda sp.	L	16			
Philocasca sp.	L	8			
Rhyacophilidae					
Rhyacophila sp.	L	546	21		50
Uenoidae					
Oligophlebodes sp.	L	12			
Diptera					
Diptera indet.	L	12			
Brachycera					
Brachycera indet.	P	12			
Chaoboridae					
Chaoborus sp.	L	44			
Chironomidae					
Chironomidae indet.	L	650	4		10
Chironomidae indet.	P	360	5		12
Chironominae					
Tanytarsini					
Tanytarsini indet.	L	2	1		2
Micropsectra/Tanytarsus sp. complex	L	129	2		5
Diamesinae					
Diamesinae indet.	L	110	1		2
Diamesa sp.	L	372			
Pagastia sp.	L	60			
Orthocladiinae					
Orthocladiinae indet.	L	1414	4		10
Brillia sp.	L	86	4		10
Corynoneura sp.	L	80			
Cricotopus/Orthocladius sp. complex	L	856	5		12
Eukiefferiella sp.	L	1887	3		7
Heleniella sp.	L	24			
Heterotrissocladius sp.	L	24			
Parakiefferiella sp.	L	36			
Parametriocnemus sp.	L	30	1		2
Platysmittia sp.	L	24			
Rheocricotopus sp.	L	52			
Stilocladius sp.	L	10	1		2
Synorthocladius sp.	L	204			
Synorthocladius sp. (aberrant)	L	426	1		2
Thienemanniella sp.	L	189	2		5
Tvetenia sp.	L	760	5		12

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Biologica Sample #			14-19-03		
		No. of	MH-27		
TAXON	STAGE	individuals	5/12	Macro	Total
Podonominae					
Boreochlus sp.	L	8			
Prodiamesinae					
Prodiamesinae indet.	L	12			
Tanypodinae					
Tanypodinae indet.	L	14	1		2
Procladius sp.	L	6	1		2
Psectrotanypus sp.	L	4			
Reomyia/Zavrelimyia sp. complex	L	8			
Dixidae					
Dixa sp.	L	4			
Empididae					
Empididae indet.	L	28			
Clinocera sp.	L	48			
Neoplasta sp.	L	154	4		10
Oreogeton sp.	L	951	3		7
Psychodidae					
Pericoma/Telmatoscopus sp.	L	16			
Simuliidae					
Simuliidae indet.	L	58	4		10
Simuliidae indet.	P	19	3		7
Prosimulium sp.	L	366	39		94
Tipulidae					
Tipulidae indet.	L	8			
Antocha sp.	L	2	1		2
Dicranota sp.	L	28			
Total Number of Organisms		28820	313	3	754
Total Number of Taxa		70			34
MEIOFAUNA					
Crustacea					
Cladocera indet.	A	*Present*	P		P
Copepoda indet.	A	*Present*	P		P
Ostracoda indet.	A	*Present*			
Nematoda					
Nematoda indet.	A	*Present*	P		P
MEMO					
Araneae indet. (spider)	A	*Present*			
Invertebrate indet.	eggs	*Present*	P		P
Terrestrial insect	A	*Present*	P		P
Terrestrial gastropoda indet.			P		P

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-04	
		No. of	MH-28	
TAXON	STAGE	individuals	1/12	Total
PLATYHELMINTHES				
Planariidae				
Polycelis sp.	A	24	2	24
Polycelis sp.	J	12		
ANNELIDA				
Oligochaeta				
Enchytraeidae				
Enchytraeidae indet.	A	13		
Enchytraeidae indet.	J	14		
ARTHROPODA				
ARACHNIDA				
Acari				
Acari indet.	L	4		
Oribatida				
Oribatida indet.	A	38		
Hydrozetidae				
Hydrozetes sp.	A	15		
Trombidiformes				
Hydrachnidiae				
Hydrachnidiae indet.	Deutonymph	22		
Arrenuridae				
Arrenurus sp.	A	4		
Hydryphantidae				
Protzia sp.	A	96		
Wandesia sp.	A	503	12	144
Aturidae				
Brachypoda sp.	A	24		
Lebertiidae				
Lebertia sp.	A	16		
Sperchontidae				
Sperchon sp.	A	8		
Amphipoda				
Gammaridae				
Gammarus sp.	A	12		
Gammarus sp.	J	2		
INSECTA				
Coleoptera				
Coleoptera indet.	A	8		
Collembola				
Dicyrtomidae				
Dicyrtoma s.l. sp.	A	24		
Isotomidae				
Isotomidae indet.	A	65		
Onychuridae				

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-04	
		No. of	MH-28	
TAXON	**STAGE**	**individuals**	**1/12**	**Total**
Onychuridae indet.	A	94	1	12
Ephemeroptera				
Ephemeroptera indet.	N	132		
Ameletidae				
Ameletus sp.	N	243	8	96
Baetidae				
Baetidae indet.	N	1048	7	84
Baetis bicaudatus	N	7959	109	1308
Baetis sp.	N	1560	40	480
Ephemerellidae				
Drunella doddsii	N	3		
Drunella sp.	N	4		
Heptageniidae				
Heptageniidae indet.	N	977	1	12
Cinygma sp.	N	12		
Cinygmula sp.	N	849	2	24
Epeorus albertae	N	66		
Epeorus longimanus	N	32		
Epeorus sp.	N	132		
Lepidoptera				
Lepidoptera indet.	L	12		
Plecoptera				
Plecoptera indet.	N	362		
Chloroperlidae				
Chloroperlidae indet.	N	129		
Paraperla sp.	N	191		
Suwallia sp.	N	206		
Sweltsa sp.	N	172	6	72
Leuctridae				
Leuctridae indet.	N	156	8	96
Despaxia augusta	N	44	3	36
Perlomyia sp.	N	24		
Nemouridae				
Nemouridae indet	N	180	5	60
Visoka cataractae	N	306	20	240
Zapada cinctipes	N	4		
Zapada columbiana	N	24	2	24
Zapada oregonensis group sp.	N	1431	42	504
Zapada sp.	N	544	4	48
Perlodidae				
Perlodidae indet	N	228		
Megarcys sp.	N	57		
Trichoptera				
Trichoptera indet.	L	14		
Apataniidae				
Allomyia sp.	L	516		

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-04	
			MH-28	
TAXON	STAGE	No. of individuals	1/12	Total
Glossosomatidae				
Glossosoma sp.	L	8		
Hydropsychidae				
Parapsyche sp.	L	11		
Limnephilidae				
Limnephilidae indet.	L	12		
Chyranda sp.	L	16		
Philocasca sp.	L	8		
Rhyacophilidae				
Rhyacophila sp.	L	546	28	336
Uenoidae				
Oligophlebodes sp.	L	12		
Diptera				
Diptera indet.	L	12		
Brachycera				
Brachycera indet.	P	12		
Chaoboridae				
Chaoborus sp.	L	44		
Chironomidae				
Chironomidae indet.	L	650	1	12
Chironomidae indet.	P	360	4	48
Chironominae				
Tanytarsini				
Tanytarsini indet.	L	2		
Micropsectra/Tanytarsus sp. complex	L	129		
Diamesinae				
Diamesinae indet.	L	110	1	12
Diamesa sp.	L	372		
Pagastia sp.	L	60	1	12
Orthocladiinae				
Orthocladiinae indet.	L	1414	4	48
Brillia sp.	L	86	2	24
Corynoneura sp.	L	80	1	12
Cricotopus/Orthocladius sp. complex	L	856		
Eukiefferiella sp.	L	1887	1	12
Heleniella sp.	L	24		
Heterotrissocladius sp.	L	24		
Parakiefferiella sp.	L	36		
Parametriocnemus sp.	L	30	1	12
Platysmittia sp.	L	24		
Rheocricotopus sp.	L	52		
Stilocladius sp.	L	10		
Synorthocladius sp.	L	204		
Synorthocladius sp. (aberrant)	L	426		
Thienemanniella sp.	L	189	1	12
Tvetenia sp.	L	760	1	12

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-04	
		No. of	MH-28	
TAXON	**STAGE**	**individuals**	**1/12**	**Total**
Podonominae				
Boreochlus sp.	L	8		
Prodiamesinae				
Prodiamesinae indet.	L	12		
Tanypodinae				
Tanypodinae indet.	L	14	1	12
Procladius sp.	L	6		
Psectrotanypus sp.	L	4		
Reomyia/Zavrelimyia sp. complex	L	8		
Dixidae				
Dixa sp.	L	4		
Empididae				
Empididae indet.	L	28		
Clinocera sp.	L	48		
Neoplasta sp.	L	154		
Oreogeton sp.	L	951	1	12
Psychodidae				
Pericoma/Telmatoscopus sp.	L	16		
Simuliidae				
Simuliidae indet.	L	58	1	12
Simuliidae indet.	P	19		
Prosimulium sp.	L	366	4	48
Tipulidae				
Tipulidae indet.	L	8		
Antocha sp.	L	2		
Dicranota sp.	L	28		
Total Number of Organisms		28820	325	3900
Total Number of Taxa		70		22
MEIOFAUNA				
Crustacea				
Cladocera indet.	A	*Present*		
Copepoda indet.	A	*Present*	P	P
Ostracoda indet.	A	*Present*	P	P
Nematoda				
Nematoda indet.	A	*Present*	P	P
MEMO				
Araneae indet. (spider)	A	*Present*		
Invertebrate indet.	eggs	*Present*		
Terrestrial insect	A	*Present*	P	P
Terrestrial gastropoda indet.				

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

TAXON	STAGE	No. of individuals	MH-28A 1/4	MH-28A Macro	MH-28A Total
Biologica Sample #				14-19-05	
PLATYHELMINTHES					
Planariidae					
Polycelis sp.	A	24			
Polycelis sp.	J	12			
ANNELIDA					
Oligochaeta					
Enchytraeidae					
Enchytraeidae indet.	A	13			
Enchytraeidae indet.	J	14	1		4
ARTHROPODA					
ARACHNIDA					
Acari					
Acari indet.	L	4	1		4
Oribatida					
Oribatida indet.	A	38	5		20
Hydrozetidae					
Hydrozetes sp.	A	15	2		8
Trombidiformes					
Hydrachnidiae					
Hydrachnidiae indet.	Deutonymph	22			
Arrenuridae					
Arrenurus sp.	A	4	1		4
Hydryphantidae					
Protzia sp.	A	96			
Wandesia sp.	A	503			
Aturidae					
Brachypoda sp.	A	24			
Lebertiidae					
Lebertia sp.	A	16	1		4
Sperchontidae					
Sperchon sp.	A	8			
Amphipoda					
Gammaridae					
Gammarus sp.	A	12		10	10
Gammarus sp.	J	2		2	2
INSECTA					
Coleoptera					
Coleoptera indet.	A	8			
Collembola					
Dicyrtomidae					
Dicyrtoma s.l. sp.	A	24			
Isotomidae					
Isotomidae indet.	A	65	1		4
Onychuridae					

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

TAXON	STAGE	No. of individuals	MH-28A		
Biologica Sample #			14-19-05		
			1/4	Macro	Total
Onychuridae indet.	A	94	3		12
Ephemeroptera					
Ephemeroptera indet.	N	132			
Ameletidae					
Ameletus sp.	N	243			
Baetidae					
Baetidae indet.	N	1048	49		196
Baetis bicaudatus	N	7959	109		436
Baetis sp.	N	1560			
Ephemerellidae					
Drunella doddsii	N	3		1	1
Drunella sp.	N	4	1		4
Heptageniidae					
Heptageniidae indet.	N	977	32		128
Cinygma sp.	N	12			
Cinygmula sp.	N	849	23		92
Epeorus albertae	N	66	1		4
Epeorus longimanus	N	32			
Epeorus sp.	N	132	19		76
Lepidoptera					
Lepidoptera indet.	L	12			
Plecoptera					
Plecoptera indet.	N	362	15		60
Chloroperlidae					
Chloroperlidae indet.	N	129			
Paraperla sp.	N	191	13		52
Suwallia sp.	N	206			
Sweltsa sp.	N	172	3		12
Leuctridae					
Leuctridae indet.	N	156			
Despaxia augusta	N	44			
Perlomyia sp.	N	24			
Nemouridae					
Nemouridae indet	N	180			
Visoka cataractae	N	306			
Zapada cinctipes	N	4	1		4
Zapada columbiana	N	24			
Zapada oregonensis group sp.	N	1431	23		92
Zapada sp.	N	544			
Perlodidae					
Perlodidae indet	N	228	7		28
Megarcys sp.	N	57		4	4
Trichoptera					
Trichoptera indet.	L	14			
Apataniidae					
Allomyia sp.	L	516			

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-05		
TAXON	**STAGE**	**No. of individuals**	**MH-28A**		
			1/4	**Macro**	**Total**
Glossosomatidae					
Glossosoma sp.	L	8			
Hydropsychidae					
Parapsyche sp.	L	11	2	1	9
Limnephilidae					
Limnephilidae indet.	L	12			
Chyranda sp.	L	16			
Philocasca sp.	L	8			
Rhyacophilidae					
Rhyacophila sp.	L	546	12		48
Uenoidae					
Oligophlebodes sp.	L	12			
Diptera					
Diptera indet.	L	12	3		12
Brachycera					
Brachycera indet.	P	12			
Chaoboridae					
Chaoborus sp.	L	44	11		44
Chironomidae					
Chironomidae indet.	L	650	2		8
Chironomidae indet.	P	360	6		24
Chironominae					
Tanytarsini					
Tanytarsini indet.	L	2			
Micropsectra/Tanytarsus sp. complex	L	129			
Diamesinae					
Diamesinae indet.	L	110			
Diamesa sp.	L	372			
Pagastia sp.	L	60			
Orthocladiinae					
Orthocladiinae indet.	L	1414	2		8
Brillia sp.	L	86			
Corynoneura sp.	L	80	8		32
Cricotopus/Orthocladius sp. complex	L	856	7		28
Eukiefferiella sp.	L	1887	2		8
Heleniella sp.	L	24			
Heterotrissocladius sp.	L	24			
Parakiefferiella sp.	L	36			
Parametriocnemus sp.	L	30	1		4
Platysmittia sp.	L	24			
Rheocricotopus sp.	L	52	3		12
Stilocladius sp.	L	10			
Synorthocladius sp.	L	204			
Synorthocladius sp. (aberrant)	L	426	1		4
Thienemanniella sp.	L	189	1		4
Tvetenia sp.	L	760	10		40

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-05		
		No. of	MH-28A		
TAXON	STAGE	individuals	1/4	Macro	Total
Podonominae					
Boreochlus sp.	L	8			
Prodiamesinae					
Prodiamesinae indet.	L	12	1		4
Tanypodinae					
Tanypodinae indet.	L	14			
Procladius sp.	L	6	1		4
Psectrotanypus sp.	L	4	1		4
Reomyia/Zavrelimyia sp. complex	L	8			
Dixidae					
Dixa sp.	L	4	1		4
Empididae					
Empididae indet.	L	28	1		4
Clinocera sp.	L	48			
Neoplasta sp.	L	154	1		4
Oreogeton sp.	L	951	1		4
Psychodidae					
Pericoma/Telmatoscopus sp.	L	16	1		4
Simuliidae					
Simuliidae indet.	L	58			
Simuliidae indet.	P	19	1		4
Prosimulium sp.	L	366	10		40
Tipulidae					
Tipulidae indet.	L	8			
Antocha sp.	L	2			
Dicranota sp.	L	28	1		4
Total Number of Organisms		28820	402	18	1626
Total Number of Taxa		70			37
MEIOFAUNA					
Crustacea					
Cladocera indet.	A	*Present*	P		P
Copepoda indet.	A	*Present*	P		P
Ostracoda indet.	A	*Present*	P		P
Nematoda					
Nematoda indet.	A	*Present*	P		P
MEMO					
Araneae indet. (spider)	A	*Present*	P		P
Invertebrate indet.	eggs	*Present*	P		P
Terrestrial insect	A	*Present*	P		P
Terrestrial gastropoda indet.			P		P

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-06	
TAXON	STAGE	No. of individuals	MH-29	
			1/8	Total
PLATYHELMINTHES				
Planariidae				
Polycelis sp.	A	24		
Polycelis sp.	J	12		
ANNELIDA				
Oligochaeta				
Enchytraeidae				
Enchytraeidae indet.	A	13	1	8
Enchytraeidae indet.	J	14	1	8
ARTHROPODA				
ARACHNIDA				
Acari				
Acari indet.	L	4		
Oribatida				
Oribatida indet.	A	38	2	16
Hydrozetidae				
Hydrozetes sp.	A	15		
Trombidiformes				
Hydrachnidiae				
Hydrachnidiae indet.	Deutonymph	22	1	8
Arrenuridae				
Arrenurus sp.	A	4		
Hydryphantidae				
Protzia sp.	A	96		
Wandesia sp.	A	503	8	64
Aturidae				
Brachypoda sp.	A	24		
Lebertiidae				
Lebertia sp.	A	16		
Sperchontidae				
Sperchon sp.	A	8	1	8
Amphipoda				
Gammaridae				
Gammarus sp.	A	12		
Gammarus sp.	J	2		
INSECTA				
Coleoptera				
Coleoptera indet.	A	8	1	8
Collembola				
Dicyrtomidae				
Dicyrtoma s.l. sp.	A	24		
Isotomidae				
Isotomidae indet.	A	65	4	32
Onychuridae				

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-06	
		No. of	MH-29	
TAXON	STAGE	individuals	1/8	Total
Onychuridae indet.	A	94	7	56
Ephemeroptera				
Ephemeroptera indet.	N	132		
Ameletidae				
Ameletus sp.	N	243	16	128
Baetidae				
Baetidae indet.	N	1048	24	192
Baetis bicaudatus	N	7959	89	712
Baetis sp.	N	1560		
Ephemerellidae				
Drunella doddsii	N	3		
Drunella sp.	N	4		
Heptageniidae				
Heptageniidae indet.	N	977	8	64
Cinygma sp.	N	12		
Cinygmula sp.	N	849	25	200
Epeorus albertae	N	66		
Epeorus longimanus	N	32	4	32
Epeorus sp.	N	132	4	32
Lepidoptera				
Lepidoptera indet.	L	12		
Plecoptera				
Plecoptera indet.	N	362	8	64
Chloroperlidae				
Chloroperlidae indet.	N	129	2	16
Paraperla sp.	N	191		
Suwallia sp.	N	206		
Sweltsa sp.	N	172	2	16
Leuctridae				
Leuctridae indet.	N	156		
Despaxia augusta	N	44	1	8
Perlomyia sp.	N	24		
Nemouridae				
Nemouridae indet	N	180		
Visoka cataractae	N	306	8	64
Zapada cinctipes	N	4		
Zapada columbiana	N	24		
Zapada oregonensis group sp.	N	1431		
Zapada sp.	N	544	53	424
Perlodidae				
Perlodidae indet	N	228	4	32
Megarcys sp.	N	57		
Trichoptera				
Trichoptera indet.	L	14		
Apataniidae				
Allomyia sp.	L	516		

Biologica Sample #			14-19-06	
			MH-29	
TAXON	STAGE	No. of individuals	1/8	Total
Glossosomatidae				
Glossosoma sp.	L	8	1	8
Hydropsychidae				
Parapsyche sp.	L	11		
Limnephilidae				
Limnephilidae indet.	L	12		
Chyranda sp.	L	16	2	16
Philocasca sp.	L	8	1	8
Rhyacophilidae				
Rhyacophila sp.	L	546	11	88
Uenoidae				
Oligophlebodes sp.	L	12		
Diptera				
Diptera indet.	L	12		
Brachycera				
Brachycera indet.	P	12		
Chaoboridae				
Chaoborus sp.	L	44		
Chironomidae				
Chironomidae indet.	L	650	4	32
Chironomidae indet.	P	360	27	216
Chironominae				
Tanytarsini				
Tanytarsini indet.	L	2		
Micropsectra/Tanytarsus sp. complex	L	129	2	16
Diamesinae				
Diamesinae indet.	L	110		
Diamesa sp.	L	372		
Pagastia sp.	L	60		
Orthocladiinae				
Orthocladiinae indet.	L	1414	2	16
Brillia sp.	L	86	2	16
Corynoneura sp.	L	80		
Cricotopus/Orthocladius sp. complex	L	856		
Eukiefferiella sp.	L	1887	3	24
Heleniella sp.	L	24	3	24
Heterotrissocladius sp.	L	24		
Parakiefferiella sp.	L	36		
Parametriocnemus sp.	L	30		
Platysmittia sp.	L	24		
Rheocricotopus sp.	L	52	2	16
Stilocladius sp.	L	10	1	8
Synorthocladius sp.	L	204		
Synorthocladius sp. (aberrant)	L	426		
Thienemanniella sp.	L	189		
Tvetenia sp.	L	760		

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-06	
		No. of	MH-29	
TAXON	STAGE	individuals	1/8	Total
Podonominae				
Boreochlus sp.	L	8	1	8
Prodiamesinae				
Prodiamesinae indet.	L	12	1	8
Tanypodinae				
Tanypodinae indet.	L	14		
Procladius sp.	L	6		
Psectrotanypus sp.	L	4		
Reomyia/Zavrelimyia sp. complex	L	8	1	8
Dixidae				
Dixa sp.	L	4		
Empididae				
Empididae indet.	L	28		
Clinocera sp.	L	48		
Neoplasta sp.	L	154	1	8
Oreogeton sp.	L	951	14	112
Psychodidae				
Pericoma/Telmatoscopus sp.	L	16		
Simuliidae				
Simuliidae indet.	L	58		
Simuliidae indet.	P	19	1	8
Prosimulium sp.	L	366	20	160
Tipulidae				
Tipulidae indet.	L	8	1	8
Antocha sp.	L	2		
Dicranota sp.	L	28		
Total Number of Organisms		28820	375	3000
Total Number of Taxa		70		33
MEIOFAUNA				
Crustacea				
Cladocera indet.	A	*Present*		
Copepoda indet.	A	*Present*		
Ostracoda indet.	A	*Present*	P	P
Nematoda				
Nematoda indet.	A	*Present*	P	P
MEMO				
Araneae indet. (spider)	A	*Present*	P	P
Invertebrate indet.	eggs	*Present*	P	P
Terrestrial insect	A	*Present*	P	P
Terrestrial gastropoda indet.				

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

Biologica Sample #			14-19-07		
		No. of	CC-03		
TAXON	**STAGE**	**individuals**	**1/12**	**Macro**	**Total**
PLATYHELMINTHES					
Planariidae					
Polycelis sp.	A	24			
Polycelis sp.	J	12			
ANNELIDA					
Oligochaeta					
Enchytraeidae					
Enchytraeidae indet.	A	13			
Enchytraeidae indet.	J	14			
ARTHROPODA					
ARACHNIDA					
Acari					
Acari indet.	L	4			
Oribatida					
Oribatida indet.	A	38			
Hydrozetidae					
Hydrozetes sp.	A	15			
Trombidiformes					
Hydrachnidiae					
Hydrachnidiae indet.	Deutonymph	22			
Arrenuridae					
Arrenurus sp.	A	4			
Hydryphantidae					
Protzia sp.	A	96			
Wandesia sp.	A	503	3		36
Aturidae					
Brachypoda sp.	A	24			
Lebertiidae					
Lebertia sp.	A	16			
Sperchontidae					
Sperchon sp.	A	8			
Amphipoda					
Gammaridae					
Gammarus sp.	A	12			
Gammarus sp.	J	2			
INSECTA					
Coleoptera					
Coleoptera indet.	A	8			
Collembola					
Dicyrtomidae					
Dicyrtoma s.l. sp.	A	24			
Isotomidae					
Isotomidae indet.	A	65			
Onychuridae					

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

			Biologica Sample # 14-19-07		
TAXON	STAGE	No. of individuals	CC-03		
			1/12	Macro	Total
Onychuridae indet.	A	94			
Ephemeroptera					
Ephemeroptera indet.	N	132			
Ameletidae					
Ameletus sp.	N	243	1		12
Baetidae					
Baetidae indet.	N	1048	11		132
Baetis bicaudatus	N	7959	185		2220
Baetis sp.	N	1560	76		912
Ephemerellidae					
Drunella doddsii	N	3			
Drunella sp.	N	4			
Heptageniidae					
Heptageniidae indet.	N	977	20		240
Cinygma sp.	N	12			
Cinygmula sp.	N	849	15		180
Epeorus albertae	N	66			
Epeorus longimanus	N	32			
Epeorus sp.	N	132			
Lepidoptera					
Lepidoptera indet.	L	12	1		12
Plecoptera					
Plecoptera indet.	N	362	6		72
Chloroperlidae					
Chloroperlidae indet.	N	129	6		72
Paraperla sp.	N	191	5		60
Suwallia sp.	N	206	1		12
Sweltsa sp.	N	172	3		36
Leuctridae					
Leuctridae indet.	N	156	2		24
Despaxia augusta	N	44			
Perlomyia sp.	N	24	2		24
Nemouridae					
Nemouridae indet	N	180	10		120
Visoka cataractae	N	306			
Zapada cinctipes	N	4			
Zapada columbiana	N	24			
Zapada oregonensis group sp.	N	1431	36		432
Zapada sp.	N	544	6		72
Perlodidae					
Perlodidae indet	N	228	2		24
Megarcys sp.	N	57		8	8
Trichoptera					
Trichoptera indet.	L	14	1		12
Apataniidae					
Allomyia sp.	L	516			

Azimuth - Teck Creeks (Yukon) 2014 Benthic Data

TAXON	STAGE	No. of individuals	CC-03 1/12	CC-03 Macro	CC-03 Total
Biologica Sample #			14-19-07		
Glossosomatidae					
Glossosoma sp.	L	8			
Hydropsychidae					
Parapsyche sp.	L	11			
Limnephilidae					
Limnephilidae indet.	L	12			
Chyranda sp.	L	16			
Philocasca sp.	L	8			
Rhyacophilidae					
Rhyacophila sp.	L	546			
Uenoidae					
Oligophlebodes sp.	L	12	1		12
Diptera					
Diptera indet.	L	12			
Brachycera					
Brachycera indet.	P	12			
Chaoboridae					
Chaoborus sp.	L	44			
Chironomidae					
Chironomidae indet.	L	650	5		60
Chironomidae indet.	P	360	3		36
Chironominae					
Tanytarsini					
Tanytarsini indet.	L	2			
Micropsectra/Tanytarsus sp. complex	L	129	3		36
Diamesinae					
Diamesinae indet.	L	110			
Diamesa sp.	L	372	24		288
Pagastia sp.	L	60			
Orthocladiinae					
Orthocladiinae indet.	L	1414	28		336
Brillia sp.	L	86			
Corynoneura sp.	L	80			
Cricotopus/Orthocladius sp. complex	L	856	41		492
Eukiefferiella sp.	L	1887	13		156
Heleniella sp.	L	24			
Heterotrissocladius sp.	L	24	2		24
Parakiefferiella sp.	L	36			
Parametriocnemus sp.	L	30	1		12
Platysmittia sp.	L	24			
Rheocricotopus sp.	L	52	2		24
Stilocladius sp.	L	10			
Synorthocladius sp.	L	204	10		120
Synorthocladius sp. (aberrant)	L	426	27		324
Thienemanniella sp.	L	189			
Tvetenia sp.	L	760	4		48

Biologica Sample #			14-19-07		
		No. of	CC-03		
TAXON	**STAGE**	**individuals**	**1/12**	**Macro**	**Total**
Podonominae					
Boreochlus sp.	L	8			
Prodiamesinae					
Prodiamesinae indet.	L	12			
Tanypodinae					
Tanypodinae indet.	L	14			
Procladius sp.	L	6			
Psectrotanypus sp.	L	4			
Reomyia/Zavrelimyia sp. complex	L	8			
Dixidae					
Dixa sp.	L	4			
Empididae					
Empididae indet.	L	28			
Clinocera sp.	L	48			
Neoplasta sp.	L	154	11		132
Oreogeton sp.	L	951	42		504
Psychodidae					
Pericoma/Telmatoscopus sp.	L	16			
Simuliidae					
Simuliidae indet.	L	58			
Simuliidae indet.	P	19			
Prosimulium sp.	L	366			
Tipulidae					
Tipulidae indet.	L	8			
Antocha sp.	L	2			
Dicranota sp.	L	28	1		12
Total Number of Organisms		28820	610	8	7328
Total Number of Taxa		70			24
MEIOFAUNA					
Crustacea					
Cladocera indet.	A	*Present*			
Copepoda indet.	A	*Present*			
Ostracoda indet.	A	*Present*	P		P
Nematoda					
Nematoda indet.	A	*Present*			
MEMO					
Araneae indet. (spider)	A	*Present*			
Invertebrate indet.	eggs	*Present*	P		P
Terrestrial insect	A	*Present*	P		P
Terrestrial gastropoda indet.					

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TAXON	STAGE	No. of individuals	Camp Creek-C 1/6	Camp Creek-C Macro	Camp Creek-C Total
		Biologica #	14-31-01		
PLATYHELMINTHES					
Platyhelminthes indet.	A	*36*			
Planariidae					
Polycelis coronata	A	*36*	6		36
ARTHROPODA					
ARACHNIDA					
Acari					
Trombidiformes					
Hydrachnidiae					
Hydrachnidiae indet.	A	*6*	1		6
Hygrobatidae					
Hygrobates sp.	A	*6*			
Lebertiidae					
Lebertia sp.	A	*12*	1		6
Sperchontidae					
Sperchon sp.	A	*6*	1		6
INSECTA					
Coleoptera					
Staphylinidae					
Staphylinidae indet.	L	*6*			
Ephemeroptera					
Ephemeroptera indet.	N	*42*			
Ameletidae					
Ameletus sp.	N	*54*	6		36
Baetidae					
Baetidae indet.	N	*1362*			
Acerpenna sp.	N	*6*			
Baetis sp.	N	*90*			
Baetis bicaudatus	N	*24*			
Ephemerellidae					
Ephemerellidae indet.	N	*12*			
Drunella doddsii	N	*30*	2		12
Ephemerella tibialis	N	*6*	1		6
Heptageniidae					
Heptageniidae indet.	N	*804*	44		264
Cinygmula sp.	N	*282*	32		192
Epeorus deceptivus	N	*42*	7		42
Epeorus grandis/permagnus group sp.	N	*42*			
Epeorus longimanus	N	*36*	6		36
Epeorus sp.	N	*12*			
Plecoptera					
Plecoptera indet.	N	*438*	14		84
Capniidae					
Capniidae indet.	N	*6*			

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TAXON	STAGE	No. of individuals	Camp Creek-C 1/6	Macro	Total
		Biologica #	14-31-01		
Chloroperlidae					
Chloroperlidae indet.	N	*366*	22		132
Paraperla sp.	N	*48*	8		48
Suwallia sp.	N	*48*			
Sweltsa sp.	N	*342*	35		210
Leuctridae					
Leuctridae indet.	N	*30*			
Nemouridae					
Nemouridae indet.	N	*180*	11		66
Zapada cinctipes	N	*48*	2		12
Zapada columbiana	N	*696*	62		372
Zapada oregonensis group sp.	N	*180*	20		120
Zapada sp.	N	*180*	3		18
Perlodidae					
Perlodidae indet.	N	*42*			
Megarcys sp.	N	*24*	2		12
Trichoptera					
Trichoptera indet.	L	*6*			
Brachycentridae					
Brachycentridae indet.	L	*6*	1		6
Glossosomatidae					
Glossosomatidae indet.	L	*36*	2		12
Glossosoma sp.	L	*36*			
Hydropsychidae					
Parapsyche sp.	L	*11*		2	2
Limnephilidae					
Ecclisomyia sp.	L	*6*			
Polycentropodidae					
Polycentropodidae indet.	L	*24*			
Rhyacophilidae					
Rhyacophila sp.	L	*180*	21		126
Uenoidae					
Neothremma sp.	L	*24*	4		24
Diptera					
Diptera indet.	L	*30*			
Chironomidae					
Chironomidae indet.	L	*24*			
Chironomidae indet.	P	*24*	3		18
Chironominae					
Tanytarsini					
Stempellinella sp.	L	*12*	2		12
Tanytarsus sp.	L	*12*			
Diamesinae					
Pagastia sp.	L	*132*	4		24
Orthocladiinae					

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TAXON	STAGE	No. of individuals	Camp Creek-C 1/6	Camp Creek-C Macro	Camp Creek-C Total
		Biologica #	14-31-01		
Orthocladiinae indet.	L	*42*	3		18
Cricotopus/Orthocladius sp. complex	L	*30*	3		18
Eukiefferiella brehmi group	L	*60*	9		54
Eukiefferiella sp.	L	*42*	3		18
Parametriocnemus sp.	L	*6*	1		6
Rheocricotopus eminellobus	L	*24*	3		18
Synorthocladius sp.	L	*234*	36		216
Thienemanniella sp.	L	*6*			
Empididae					
Neoplasta sp.	L	*36*	1		6
Oreogeton sp.	L	*6*			
Psychodidae					
Pericoma/Telmatoscopus sp.	L	*12*			
Psychoda sp.	L	*6*			
Simuliidae					
Simuliidae indet.	P	*6*			
Tipulidae					
Dicranota sp.	L	*42*	4		24
Total Number of Organisms		*6695*	386	2	2318
Total Number of Taxa		*44*			29
MEIOFAUNA					
Crustacea					
Ostracoda indet.	A	*18*			
Nematoda					
Nematoda indet.	A	*12*	1		6
MEMO					
Acari indet. (terrestrial mite)	A	*12*			
Araneae indet. (spider)	A	*6*	1		6
Gastropoda indet. (terrestrial)	A	*6*			
Invertebrate indet.	egg mass	*192*	1		6
Insecta indet. (terrestrial)	A	*36*	1		6
Insecta indet. (terrestrial grub)	L	*6*			

Azimuth - Tech Creeks 2014
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		Biologica #		14-31-02	
		No. of	MH-11		
TAXON	STAGE	individuals	1/6	Macro	Total
PLATYHELMINTHES					
Platyhelminthes indet.	A	*36*	6		36
Planariidae					
Polycelis coronata	A	*36*			
ARTHROPODA					
ARACHNIDA					
Acari					
Trombidiformes					
Hydrachnidiae					
Hydrachnidiae indet.	A	*6*			
Hygrobatidae					
Hygrobates sp.	A	*6*			
Lebertiidae					
Lebertia sp.	A	*12*			
Sperchontidae					
Sperchon sp.	A	*6*			
INSECTA					
Coleoptera					
Staphylinidae					
Staphylinidae indet.	L	*6*	1		6
Ephemeroptera					
Ephemeroptera indet.	N	*42*	7		42
Ameletidae					
Ameletus sp.	N	*54*	2		12
Baetidae					
Baetidae indet.	N	*1362*	33		198
Acerpenna sp.	N	*6*			
Baetis sp.	N	*90*	1		6
Baetis bicaudatus	N	*24*	2		12
Ephemerellidae					
Ephemerellidae indet.	N	*12*			
Drunella doddsii	N	*30*	3		18
Ephemerella tibialis	N	*6*			
Heptageniidae					
Heptageniidae indet.	N	*804*	46		276
Cinygmula sp.	N	*282*	9		54
Epeorus deceptivus	N	*42*			
Epeorus grandis/permagnus group sp.	N	*42*	7		42
Epeorus longimanus	N	*36*			
Epeorus sp.	N	*12*	2		12
Plecoptera					
Plecoptera indet.	N	*438*	49		294
Capniidae					
Capniidae indet.	N	*6*	1		6

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TAXON	STAGE	No. of individuals	MH-11 1/6	MH-11 Macro	MH-11 Total
		Biologica #	14-31-02		
Chloroperlidae					
Chloroperlidae indet.	N	*366*			
Paraperla sp.	N	*48*			
Suwallia sp.	N	*48*	8		48
Sweltsa sp.	N	*342*	22		132
Leuctridae					
Leuctridae indet.	N	*30*	5		30
Nemouridae					
Nemouridae indet.	N	*180*	6		36
Zapada cinctipes	N	*48*	5		30
Zapada columbiana	N	*696*	40		240
Zapada oregonensis group sp.	N	*180*	6		36
Zapada sp.	N	*180*	27		162
Perlodidae					
Perlodidae indet.	N	*42*			
Megarcys sp.	N	*24*			
Trichoptera					
Trichoptera indet.	L	*6*	1		6
Brachycentridae					
Brachycentridae indet.	L	*6*			
Glossosomatidae					
Glossosomatidae indet.	L	*36*			
Glossosoma sp.	L	*36*	6		36
Hydropsychidae					
Parapsyche sp.	L	*11*	1	3	9
Limnephilidae					
Ecclisomyia sp.	L	*6*	1		6
Polycentropodidae					
Polycentropodidae indet.	L	*24*	4		24
Rhyacophilidae					
Rhyacophila sp.	L	*180*	6		36
Uenoidae					
Neothremma sp.	L	*24*			
Diptera					
Diptera indet.	L	*30*	5		30
Chironomidae					
Chironomidae indet.	L	*24*	1		6
Chironomidae indet.	P	*24*			
Chironominae					
Tanytarsini					
Stempellinella sp.	L	*12*			
Tanytarsus sp.	L	*12*			
Diamesinae					
Pagastia sp.	L	*132*	2		12
Orthocladiinae					

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		Biologica #		14-31-02	
		No. of		MH-11	
TAXON	**STAGE**	**individuals**	**1/6**	**Macro**	**Total**
Orthocladiinae indet.	L	*42*			
Cricotopus/Orthocladius sp. complex	L	*30*	1		6
Eukiefferiella brehmi group	L	*60*			
Eukiefferiella sp.	L	*42*	1		6
Parametriocnemus sp.	L	*6*			
Rheocricotopus eminellobus	L	*24*	1		6
Synorthocladius sp.	L	*234*	1		6
Thienemanniella sp.	L	*6*			
Empididae					
Neoplasta sp.	L	*36*	2		12
Oreogeton sp.	L	*6*	1		6
Psychodidae					
Pericoma/Telmatoscopus sp.	L	*12*	2		12
Psychoda sp.	L	*6*	1		6
Simuliidae					
Simuliidae indet.	P	*6*	1		6
Tipulidae					
Dicranota sp.	L	*42*	1		6
Total Number of Organisms		*6695*	327	3	1965
Total Number of Taxa		*44*			29
MEIOFAUNA					
Crustacea					
Ostracoda indet.	A	*18*	3		18
Nematoda					
Nematoda indet.	A	*12*			
MEMO					
Acari indet. (terrestrial mite)	A	*12*	2		12
Araneae indet. (spider)	A	*6*			
Gastropoda indet. (terrestrial)	A	*6*	1		6
Invertebrate indet.	egg mass	*192*			
Insecta indet. (terrestrial)	A	*36*	4		24
Insecta indet. (terrestrial grub)	L	*6*			

Azimuth - Tech Creeks 2014
Prepared by Biologica Environmental Services Ltd.

		Biologica #	14-31-03	
			MH-30	
TAXON	STAGE	No. of individuals	1/6	Total
PLATYHELMINTHES				
Platyhelminthes indet.	A	*36*		
Planariidae				
Polycelis coronata	A	*36*		
ARTHROPODA				
ARACHNIDA				
Acari				
Trombidiformes				
Hydrachnidiae				
Hydrachnidiae indet.	A	*6*		
Hygrobatidae				
Hygrobates sp.	A	*6*	1	6
Lebertiidae				
Lebertia sp.	A	*12*	1	6
Sperchontidae				
Sperchon sp.	A	*6*		
INSECTA				
Coleoptera				
Staphylinidae				
Staphylinidae indet.	L	*6*		
Ephemeroptera				
Ephemeroptera indet.	N	*42*		
Ameletidae				
Ameletus sp.	N	*54*	1	6
Baetidae				
Baetidae indet.	N	*1362*	194	1164
Acerpenna sp.	N	*6*	1	6
Baetis sp.	N	*90*	14	84
Baetis bicaudatus	N	*24*	2	12
Ephemerellidae				
Ephemerellidae indet.	N	*12*	2	12
Drunella doddsii	N	*30*		
Ephemerella tibialis	N	*6*		
Heptageniidae				
Heptageniidae indet.	N	*804*	44	264
Cinygmula sp.	N	*282*	6	36
Epeorus deceptivus	N	*42*		
Epeorus grandis/permagnus group sp.	N	*42*		
Epeorus longimanus	N	*36*		
Epeorus sp.	N	*12*		
Plecoptera				
Plecoptera indet.	N	*438*	10	60
Capniidae				
Capniidae indet.	N	*6*		

Azimuth - Tech Creeks 2014
Prepared by Biologica Environmental Services Ltd.

TAXON	STAGE	Biologica # No. of individuals	14-31-03 MH-30 1/6	Total
Chloroperlidae				
Chloroperlidae indet.	N	*366*	39	234
Paraperla sp.	N	*48*		
Suwallia sp.	N	*48*		
Sweltsa sp.	N	*342*		
Leuctridae				
Leuctridae indet.	N	*30*		
Nemouridae				
Nemouridae indet.	N	*180*	13	78
Zapada cinctipes	N	*48*	1	6
Zapada columbiana	N	*696*	14	84
Zapada oregonensis group sp.	N	*180*	4	24
Zapada sp.	N	*180*		
Perlodidae				
Perlodidae indet.	N	*42*	7	42
Megarcys sp.	N	*24*	2	12
Trichoptera				
Trichoptera indet.	L	*6*		
Brachycentridae				
Brachycentridae indet.	L	*6*		
Glossosomatidae				
Glossosomatidae indet.	L	*36*	4	24
Glossosoma sp.	L	*36*		
Hydropsychidae				
Parapsyche sp.	L	*11*		
Limnephilidae				
Ecclisomyia sp.	L	*6*		
Polycentropodidae				
Polycentropodidae indet.	L	*24*		
Rhyacophilidae				
Rhyacophila sp.	L	*180*	3	18
Uenoidae				
Neothremma sp.	L	*24*		
Diptera				
Diptera indet.	L	*30*		
Chironomidae				
Chironomidae indet.	L	*24*	3	18
Chironomidae indet.	P	*24*	1	6
Chironominae				
Tanytarsini				
Stempellinella sp.	L	*12*		
Tanytarsus sp.	L	*12*	2	12
Diamesinae				
Pagastia sp.	L	*132*	16	96
Orthocladiinae				

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		Biologica #	14-31-03	
			MH-30	
TAXON	**STAGE**	**No. of individuals**	**1/6**	**Total**
Orthocladiinae indet.	L	*42*	4	24
Cricotopus/Orthocladius sp. complex	L	*30*	1	6
Eukiefferiella brehmi group	L	*60*	1	6
Eukiefferiella sp.	L	*42*	3	18
Parametriocnemus sp.	L	*6*		
Rheocricotopus eminellobus	L	*24*		
Synorthocladius sp.	L	*234*	2	12
Thienemanniella sp.	L	*6*	1	6
Empididae				
Neoplasta sp.	L	*36*	3	18
Oreogeton sp.	L	*6*		
Psychodidae				
Pericoma/Telmatoscopus sp.	L	*12*		
Psychoda sp.	L	*6*		
Simuliidae				
Simuliidae indet.	P	*6*		
Tipulidae				
Dicranota sp.	L	*42*	2	12
Total Number of Organisms		*6695*	402	2412
Total Number of Taxa		*44*		22
MEIOFAUNA				
Crustacea				
Ostracoda indet.	A	*18*		
Nematoda				
Nematoda indet.	A	*12*	1	6
MEMO				
Acari indet. (terrestrial mite)	A	*12*		
Araneae indet. (spider)	A	*6*		
Gastropoda indet. (terrestrial)	A	*6*		
Invertebrate indet.	egg mass	*192*	31	186
Insecta indet. (terrestrial)	A	*36*	1	6
Insecta indet. (terrestrial grub)	L	*6*	1	6

APPENDIX E

False Canyon Creek Environmental Monitoring Report (Laberge 2015)

ENVIRONMENTAL MONITORING

AT

FALSE CANYON CREEK, 2014

For

Teck Resources Ltd

Sä Dena Hes Operating Corporation,

Submitted by

Laberge Environmental Services
&
Can-Nic-A-Nick Environmental Sciences

January 2015

P.O. Box 21072
Whitehorse, Y.T.
Y1A 6P7

Office Phone: 867-668-6838
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LETTER OF TRANSMITTAL

Dave Ryder
Senior Environmental Coordinator
Teck Resources Limited
Bag 2000,
Kimberley, BC
V1A 3E1

Dear Dave:

Re: **Environmental Monitoring at False Canyon Creek, 2014**

We are pleased to submit herewith, the above report covering the environmental monitoring programs completed in 2014 at the Sä Dena Hes property.

The water and stream sediment chemistry in the False Canyon Creek drainage continue to be of good quality for the support of freshwater aquatic life. Robust communities of benthic invertebrates and fish, primarily slimy sculpin, were present at each site.

Should you have any questions or comments on the report, please do not hesitate to contact the undersigned.

Sincerely,

Bonnie Burns
Laberge Environmental Services

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1.0 INTRODUCTION

The Sä Dena Hes Operating Corporation is a joint venture comprised of Teck Resources Limited (Teck) at 50 percent and 50 percent Pan-Pacific Metal Mining Corp., a wholly-owned subsidiary of Korea Zinc. The Joint Venture purchased the Sä Dena Hes lead/zinc property north of Watson Lake, Yukon, in March 1994. Teck is the operator under the joint venture agreement.

The current use of water and disposal of waste at the property is governed by Water Licence Number QZ99-045 which was re-issued by the Yukon Territory Water Board in January 2002 and will expire on December 31st, 2015. Active mining and milling occurred from July 1991 until temporary shut down on December 2, 1992. There has been no production at Sä Dena Hes since operations were suspended in 1992 and the property has since been maintained in a temporary shut down mode. Permanent closure of the mine site was initiated in 2013 with site decommissioning, closure and reclamation planned to be completed by December 2015. The water licence requires that certain fish, benthic invertebrate and sediment monitoring programs be carried out every two years (Part F, Sections 57 to 67).

Teck engaged Laberge Environmental Services (LES) and Can-Nic-A-Nick Environmental Sciences to conduct the monitoring programs required for 2014. This report presents the results of the programs with some comparisons made with previous studies conducted in 1992 (P.A. Harder and Associates, 1993), in 1994 (LES and WMEC, 1995), in 1996 (LES, 1996), in 1998 (LES and Can-Nic-A-Nick, 1998), in 2000 (LES and Can-Nic-A-Nick, 2000), in 2002 (LES and Can-Nic-A-Nick, 2002) in 2004 (LES and Can-Nic-A-Nick, 2004), in 2006 (LES and Can-Nic-A-Nick, 2006), in 2008, 2010 (LES and Can-Nic-A-Nick, 2011) and 2012 (LES and Can-Nic-A-Nick, 2012).

2.0 STUDY AREA

The study area is located in the upper part of the Liard River basin, 40 air kilometres, and 70 road kilometres north of Watson Lake.

The Sä Dena Hes property lies within the ecoregion known as Liard Basin. This ecoregion is characterized by low hills separated by broad plains and surrounded by mountains and plateaus. The low elevation, moderate precipitation and relatively long, warm summers results in vigorous forest growth, most notably in the floodplains of the major rivers of the area (Ecoregion Working Group, 2004)

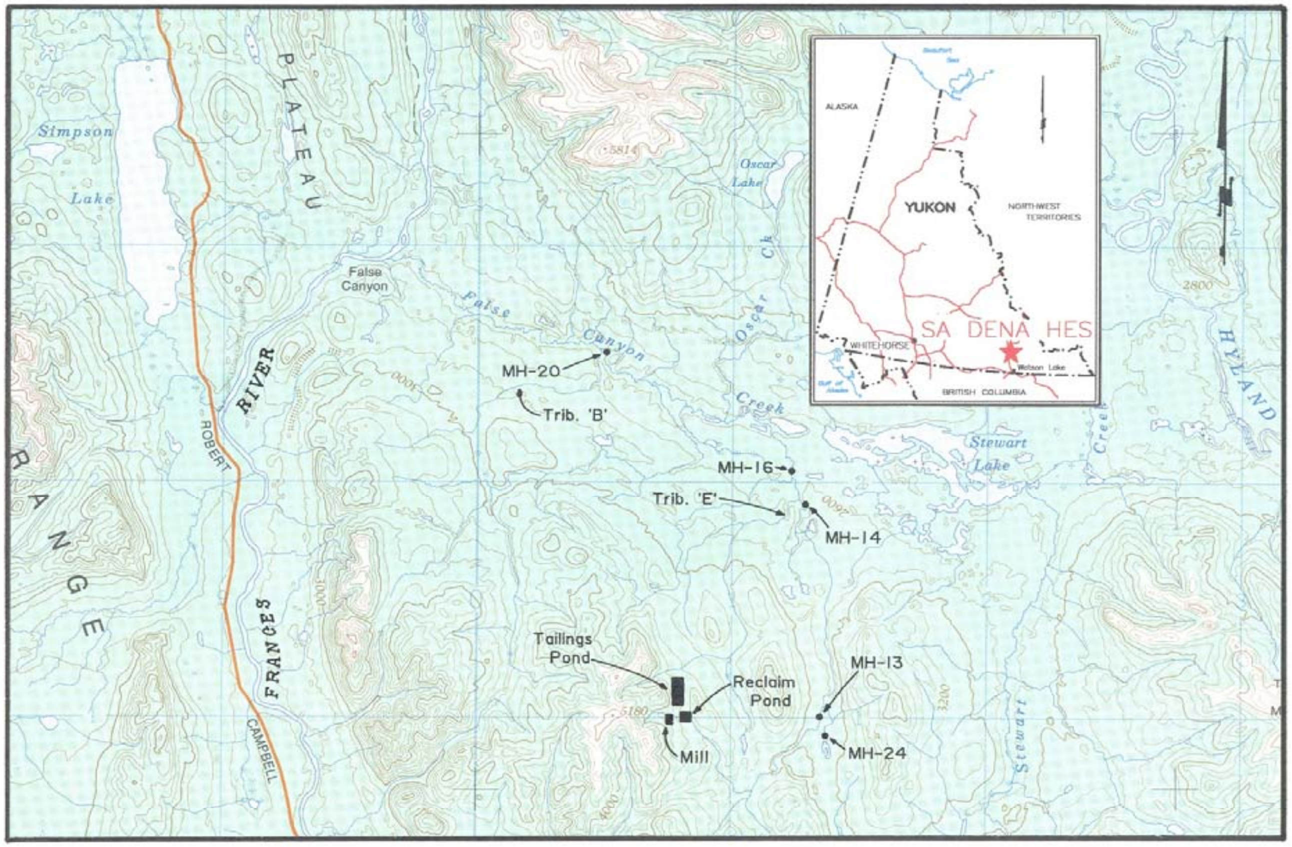
The mine is primarily an underground operation with potential for two small open pits. Waste dumps and sediment ponds are situated in tributary drainages. Tailings and wastewater are discharged to the tailings pond. (Note that the mill and mine have not operated since December 2, 1992.) The tailings pond water flows to the reclaim pond which is licensed to discharge to upper False Canyon Creek, a tributary of the Frances River, during specified time periods each year. Decommissioning of the site has been ongoing for the past few years. From May 15th to August 4th, 2014, the reclaim and south ponds were dewatered resulting in a release of 414,328 m^3 of treated water to the False Canyon Creek watershed.

The sample sites are within the drainage basin of False Canyon Creek which has a total catchment area of 492 km^2. The Frances River discharges into the Liard River 55 kilometres downstream from the confluence with False Canyon Creek. Three sites on False Canyon Creek (MH13, MH16 and MH20) were sampled for water, sediment, fish and benthos (Figure 1). The site locations, descriptions and types of monitoring are outlined in Table 1.

TABLE 1
SAMPLE SITE DESCRIPTIONS

SITE #	DESCRIPTION	COORDINATES	SAMPLE TYPE
MH13	False Canyon Cr approx 10 km d/s of reclaim pond.	60° 31' 21.1" N 128° 45' 34.6" W	WQ, SS, BI, F
MH16	False Canyon Cr. approx 22 km d/s of reclaim pond	60° 37' 37.3" N 128° 46' 53.2" W	WQ, SS, BI, F
MH20	False Canyon Cr approx 33 km d/s of reclaim pond	60° 39' 06.8" N 128° 51' 32.4" W	WQ, SS, BI, F

WQ = water quality SS = stream sediments
BI = benthic invertebrates F = fish



FALSE CANYON CREEK

FIGURE 1 - LOCATION OF SAMPLE SITES

5 0 5 10 15 20 km

SCALE 1 : 250,000

MH-20 · · · · · · · · · · · Sample Site

The licence states that sampling should also be undertaken at MH14, MH18 and MH-19 for the benthos, fish and sediment surveys. MH14 was submerged between 1996 to 2006, and the alternate site MH16, located two kilometers downstream, had been used for those studies. The present sampling location at MH14 is now no longer flooded, however in the pursuit of consistency, MH16 was again used as the sample site rather than MH14. Regular water samples are collected quarterly at MH14 and MH16, both located on the main stem of False Canyon Creek. However, MH16 is unaffected by beaver activity and is representative of a more stable environment than MH14.

As with all previous monitoring surveys, a suitable landing site could not be located for MH18 and an alternate sample location has not been established. To maintain consistency with the 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010 and 2012 studies, MH20 was sampled for benthos instead of MH19.

Site MH24, on the headwaters of False Canyon Creek, was to serve as the control site since 1998, as it is unaffected by any potential mining activity. It was discovered in 1998 that the site characteristics and sampling limitations were similar to those associated with MH14. Specifically, MH24 was underlain with water with no defined stable channel, and no safe landing site. These conditions make this site unsuitable as a background/control site for the monitoring program and no attempts were made to collect any data in 2014.

2.1 Sample Site Descriptions

MH13
MH13 is located on the main stem of False Canyon Creek approximately ten kilometres downstream of the reclaim pond in a beaver/wetland complex. The water levels were very high during the 2014 field trip. The area to the base of the hill was inundated and the regular region of benthic and sediment sampling could not be accessed and was under more water than on any previous occasion. The ponds were deeper and larger where the fisheries assessments are conducted. During the survey conducted in 2008, water levels were very low throughout the area of MH13 (LES, 2008) but were at typical levels by the 2010 survey. Benthic invertebrates have frequently been difficult to collect here due to unconfined channels, deep pools, and altered watercourses resulting from beaver activity. The conditions encountered in 2014 created challenges for the collection of stream sediment and benthos samples and only one small section of running water could be located that was suitable for the collection methodologies (see Photos #1 and 2 in Appendix A).

MH14
MH14 is located on the main stem of False Canyon Creek approximately twenty kilometres downstream of the reclaim pond in a beaver/wetland complex. This reach has undergone considerable alteration since the survey in 1994. Beaver dams in 1996 had caused flooding of the original site and this continued to be the case until 2006. No sampling, other than routine water quality (see annual report) was undertaken in 2014.

MH16
MH16 is located on the main stem of False Canyon Creek approximately twenty-two kilometres downstream of the reclaim pond. The channel is moderately well confined and appears stable with well-vegetated banks. This site has changed very little over time although the water was slightly turbid during the 2014 episode.

MH20

MH20 is located on the main stem of False Canyon Creek approximately thirty-three kilometres downstream of the reclaim pond and approximately 13 kilometres upstream of the confluence with the Frances River. The channel is well defined and stable with exposed gravel bars throughout the reach. The physical characteristics of this site have remained essentially unchanged since the monitoring program commenced in 1992, with the exception of several downed trees, which had fallen into the stream in 2008. However, due to high water in 2014, the helicopter could not land safely on the regular gravel bar. After aerially assessing the reach, the site was re-located approximately 75 m upstream. This site has the same characteristics as the original and the fisheries assessments could be conducted at the original location by wading downstream. The large woody debris that was present near this site in 2012 appears to have been dislodged downstream.

MH24

As stated earlier, a site for MH24 had not been established due to wet conditions. If appropriate conditions were met (confined channel, and stable banks and substrate), this site would have been located on upper False Canyon Creek upstream of the confluence with the reach on which MH13 is situated. MH24 would then have represented a control/background site for the downstream, potentially mine affected sites. As this was not possible, assessments of the fish communities at sites MH13, MH16 and MH20 shall continue to act as monitors of changes in water quality. All of these sites now have considerable fisheries, sediment, water quality and benthic invertebrate data, collected over many years providing an opportunity for trend and cumulative effects analyses. In addition, the less mobile slimy sculpin community associated with the beaver/wetland complex at MH13 serves virtually as an in-stream bioassay of surface waters originating from the mine.

3.0 METHODS

The environmental monitoring programs described below were completed on August 23rd and 24th, 2014. All sites were accessed by helicopter.

3.1 Water Quality

Water quality samples were collected at each site. The samples were collected in a fast flowing section of the stream, prior to any other sampling activity.

3.1.1 Field Measurements

In-situ measurements were taken at each site. Temperature, conductivity and pH measurements were obtained using a Hanna multi-probe.

3.1.2 Chemical Analyses

All sample bottles were supplied by Maxxam Analytics Inc (Maxxam) of Burnaby, B.C. At each site, samples were collected in one litre plastic bottles for sulphates, alkalinity and nonfilterable residue. Samples to be analyzed for total metals were collected in 250 ml plastic bottles. The dissolved metals samples were filtered in the field using disposable sterile syringes and in-line filters (filter pore size 0.45 microns). Dissolved and total metals samples were preserved with nitric acid. All sample bottles with the exception of the dissolved metals sample, were partially filled and rinsed three times prior to collecting sample waters. The dissolved metals sample bottle was rinsed three times with the filtrate. Samples were kept cool prior to shipment to Maxxam.

3.2 Sediment Sampling

Triplicate sediment samples were collected from MH13, MH16 and MH20. Sample sites were selected from areas of deposition along the stream bank, generally characterized by the finest grain size evident at the site. Samples were collected with a stainless steel trowel and placed in ziplock freezer bags. The samples were packed with ice packs when shipped to Maxxam in B.C.

At the lab the samples were dried, passed through a 100 mesh (0.15 mm) stainless steel sieve, and then run through an ICP analysis to determine total metals levels.

3.3 Benthic Invertebrates

Benthic invertebrates were sampled at three similar locations per site and labeled A, B and C. The samples were collected from an undisturbed, fast flowing, gravel strewn riffle habitat at each of the sites where possible. Collections were made with a Surber sampler (area = 0.0929 m^2) which had a 300 micron mesh net. The bed material within the frame was cleaned and washed by hand, with the fast flowing current carrying the disturbed bottom fauna and detritus into the collection bag. The level of effort for each sample and at each site was comparable. The captured invertebrates and detritus were placed in one-litre Nalgene bottles, preserved in 10% formalin, and shipped to Cordillera Consulting in Summerland, B.C., for sorting, identification and enumeration.

At the lab, all samples were washed through two screens with mesh sizes 1 millimetre and 180 microns. All of the organisms retained by the coarse screen were counted and identified, whereas the organisms on the 180 micron screen were subsampled as necessary. A Folsom plankton splitter was used for the subsampling. The majority of the benthos was identified to the genus level.

3.4 Fish Monitoring

Three sites on False Canyon Creek (MH13, MH16, and MH20) were sampled for the presence of fish during the week of August 23rd, 2014. The methodology and timing of the assessment was consistent with all previous monitoring projects for the watershed. The current water license requires fish biennial monitoring during periods when the mine is not active. The mine has not been active since the early 1990s. Fisheries monitoring began in 1994 (LES 1995).

As in all previous assessments, a Smith Route model LR24 battery powered electrofisher was the primary method used for establishing fish presence at each site. A conductivity meter was used to measure the conductivity of the surface flows at each site to assist in determining the most appropriate settings of the electrofisher. The shocking time (seconds) and settings used to collect fish were recorded for each sampling site. Three Gee type baited minnow traps were also set overnight at each of the sampling sites using methods described by the Yukon River Panel (2007). Angling and seining were additionally used at sites MH16 and MH20. Angling employed the use of small spinners. The time spent angling was used as an index of sampling effort. All captured fish were identified and measured. The numbers of lure strikes were also noted. A 1.5 X 7 meter seine net (6.3 mm oval mesh) was used to sample shallow water sidebars at site MH20. All captured fish were identified and measured for a length (± 1mm) and weight (± 0.1gm). Weight was determined using an Ohaus Scout II digital scale. All fish were live released at site of capture.

4.0 RESULTS AND DISCUSSION

4.1 Water Quality

Water quality samples were collected from each of the three sites on the main channel of False Canyon Creek during the 2014 study. As a measure of quality control and quality assurance, a field blank was prepared. All data are presented in Appendix B. Of the 34 metals analyzed, seven were below detection at each site in both the total and dissolved states (beryllium, bismuth, boron, sulphur, titanium, thallium, and zirconium).

The results for the field data and for the specified licensed parameters are presented in Table 2. Concentrations of the various water quality parameters were compared to the Canadian Council of Ministers of the Environment (CCME, 1999) guidelines for the protection of freshwater aquatic life. Parameters that have exceeded the guidelines are indicated in bold and highlighted. It is important to note that the limits as set out under the Water Licence issued by the Yukon Territory Water Board apply to the discharge point and there is no obligation to meet the CCME criteria in the receiving waters at this time.

The waters of the study area were cool and slightly alkaline. Conductivity is generally a measure of dissolved ions in water. Conductivity at all sites was relatively high, predominately due to the concentrations of calcium and magnesium ions.

Alkalinity is a measure of water's ability to neutralize acid. The creeks sampled in this study had high alkalinity values and the waters were hard to very hard, providing this region with a relatively good buffering capacity. Hardness is an important modifying factor in water quality as it can significantly influence the form and hence toxicity of numerous heavy metals. In general terms, the toxicity of certain metals is lowered with an increase in hardness.

Sulphate levels were low at all sites ranging from 6.15 to 7.56 mg/L. Natural sulphate concentrations in surface waters have been found to vary from 3 to 80 mg/L (CCREM, 1987). Sulphate can contribute to changes in pH in water systems. The alkaline waters of the False Canyon Creek drainage are a reflection of naturally high carbonate/bicarbonate and low sulphate concentrations.

False Creek Canyon waters were clear at MH13 and MH20. The water at MH16 was slightly turbid and had a total suspended solids value of 13 mg/L. Due to recent precipitation events, water levels at all sites were somewhat higher than experienced during past surveys. The turbid waters at MH16 may be attributable to surface runoff.

Concentrations of the examined metals were generally low. There is an anomalous reading of copper in the dissolved sample at MH16 where the concentration is almost twice that of the total metals sample. Since the water here contained suspended sediment the total value should be higher than the dissolved sample since the analysis would also include any undissolved material. Although not confirmed, the samples may have been switched or mislabeled in the laboratory. The dissolved concentrations for lead, zinc and iron however, are much lower than the total concentrations at MH16.

The CCME recommended guideline for iron was slightly exceeded at MH13. The remaining samples met all of the applicable guidelines for the parameters examined in Table 2.

TABLE 2

WATER QUALITY DATA, AUGUST 2014

Sample Site	**MH13**	**MH16**	**MH20**	Detection Limit	CCME Guideline for freshwater aquatic life
Date Sampled	August 23	August 23	August 24		
Time Sampled	13:10	14:30	12:10		
Water Temp °C	8.7	10.0	9.9		
pH: in-situ	8.05	8.26	8.28		6.5 to 9.0
pH: lab	8.29	8.40	8.33		
Conductivity (uS/cm) field	370	381	320		
Conductivity (uS/cm) Lab	360	376	316	1.0	
Alkalinity (mg/L as CaCO3)	190	202	164	0.5	
Sulphate (mg/L)	7.32	6.15	7.56	0.50	
Total Suspended Solids (ppm)	<4.0	13	<4.0	4	
Cu: total (ug/L)	0.409	0.286	0.412	0.050	4
Cu: dissolved (u/gL)	0.313	0.501	0.280	0.050	
Pb: total (ug/L)	0.434	0.087	0.075	0.005	6
Pb: dissolved (ug/L)	0.032	0.007	0.011	0.005	
Zn: total (ug/L)	2.38	1.11	2.96	1.0	30
Zn: dissolved (ug/L)	0.89	0.13	0.38	1.0	
Fe: total (ug/L)	**309**	231	181	1.0	300
Fe: dissolved (ug/L)	65.9	80.3	74.9	1.0	
Total Hardness mg/L as CaC03	184	210	163		

Concentrations of potential toxicants in water collected during the twelve surveys (1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012 and 2014) are compiled in Table 3. The majority of the analyses were below the method detection limit. The method detection limit (MDL) has decreased over time providing more precision at lower concentrations. The concentration of cadmium has slightly exceeded the MDL at each of the sites on rare occasions. The analytical procedure in 2000 allowed for a lower MDL for copper resulting in reportable copper values at each site from 2000 to the present. The level of nickel has consistently been below the MDL with the exception of a low concentration documented in the 1998 dissolved sample at MH16. The MDL for nickel, lead and zinc was lowered for the 2014 analyses allowing for reportable concentrations of some of these metals at sites where they had previously been rarely or not documented before. Zinc has been occasionally detected at each of the sites.

None of the detectable values exceeded the CCME recommended guidelines. The low concentrations of reported metals throughout the study area over the study period indicate good water quality for the support of freshwater aquatic life.

TABLE 3

COMPARISON OF POTENTIAL TOXICANTS (mg/L) AT EACH OF THE SITES OVER THE STUDY PERIOD

Site	Year	Cadmium Total	Cadmium Dissolved	Copper Total	Copper Dissolved	Nickel Total	Nickel Dissolved	Lead Total	Lead Dissolved	Zinc Total	Zinc Dissolved
MH - 13	1992	<0.0005	<0.0005	<0.001	<0.001	<0.008	<0.008	0.002	<0.001	0.004	<0.002
	1994	<0.0001	<0.0001	<0.002	<0.001	<0.01	<0.008	<0.003	<0.001	<0.01	<0.002
	1996	<0.0001	<0.0001	<0.002	<0.001	<0.01	<0.008	<0.003	<0.001	0.07	<0.002
	1998	<0.002	<0.002	<0.003	0.001	<0.01	<0.008	<0.03	<0.02	<0.01	<0.002
	2000	0.00008	<0.00002	0.0008	0.0006	<0.01	<0.008	<0.001	<0.001	<0.005	<0.005
	2002	<0.00001	0.00002	0.0006	0.0005	<0.008	<0.008	<0.0005	<0.0005	0.01	<0.005
	2004	0.00002	<0.00001	0.0003	0.0004	<0.008	<0.008	<0.0005	<0.0005	<0.005	<0.005
	2006	0.00001	0.00001	0.0003	0.0003	<0.008	<0.008	<0.0005	<0.0005	<0.005	<0.005
	2008	0.00003	0.00003	0.0004	0.0004	<0.001	<0.001	<0.0002	<0.0002	<0.005	<0.005
	2010	not reported	0.00002	0.0003	0.0006	<0.001	<0.001	<0.0002	<0.0002	<0.005	<0.005
	2012	0.000026	0.000019	0.00038	0.0005	<0.0010	<0.0010	<0.00020	<0.00020	<0.0050	<0.0050
	2014	0.000036	0.000017	0.00041	0.00031	0.00053	0.00048	0.000434	0.000032	0.00238	0.00089
MH - 16	1992	<0.0005	<0.0005	<0.001	<0.001	<0.008	<0.008	0.003	<0.001	0.002	<0.002
	1998	<0.002	<0.002	0.004	0.001	<0.01	0.010	<0.03	<0.02	<0.01	<0.002
	2000	0.00002	<0.00002	0.0006	0.0006	<0.01	<0.008	<0.001	<0.001	<0.005	<0.005
	2002	<0.00001	<0.00001	0.0005	0.0005	<0.008	<0.008	<0.0005	<0.0005	0.009	<0.005
	2004	0.00002	<0.00001	0.0003	0.0004	<0.008	<0.008	<0.0005	<0.0005	<0.005	<0.005
	2006	0.00002	<0.00001	0.0004	0.0003	<0.0008	<0.008	<0.0005	<0.0005	<0.005	<0.005
	2008	0.00001	0.00004	0.0003	0.0008	<0.001	<0.001	<0.0002	0.0002	<0.005	0.005
	2010	not reported	<0.00001	0.0002	0.0002	<0.001	<0.001	<0.0002	<0.0002	<0.005	<0.005
	2012	0.000012	<0.000010	0.00026	0.00034	<0.0010	<0.0010	<0.00020	<0.00020	<0.0050	<0.0050
	2014	0.000014	0.000008	0.00029	0.00050	0.00035	0.00029	0.000087	0.000007	0.00111	0.00013
MH - 20	1992	<0.0005	<0.0005	<0.001	<0.001	<0.008	<0.008	0.002	0.001	0.002	<0.002
	1994	<0.0001	<0.0001	<0.002	<0.001	<0.01	<0.008	<0.003	<0.001	<0.01	<0.002
	1996	<0.0001	<0.0001	<0.002	<0.001	<0.01	<0.008	<0.003	<0.001	0.01	<0.002
	1998	<0.002	<0.002	<0.003	<0.001	<0.01	<0.008	<0.03	<0.02	<0.01	<0.002
	2000	<0.00002	<0.00002	0.0008	0.0005	<0.01	<0.008	<0.001	<0.001	<0.005	<0.005
	2002	<0.00001	<0.00001	0.0006	0.0005	<0.008	<0.008	<0.0005	<0.0005	0.009	<0.005
	2004	<0.00001	<0.00001	0.0003	0.0005	<0.008	<0.008	<0.0005	0.0006	<0.005	<0.005
	2006	0.00001	<0.00001	0.0003	0.0003	<0.008	<0.008	<0.0005	<0.0005	<0.005	<0.005
	2008	0.00001	0.00001	0.0005	0.0004	<0.001	<0.001	<0.0002	<0.0002	<0.005	<0.005
	2010	not reported	<0.00001	0.0003	0.0003	<0.001	<0.001	<0.0002	<0.0002	<0.005	<0.005
	2012	<0.000010	<0.000010	0.00039	0.00179	<0.0010	<0.0010	<0.00020	<0.00020	<0.0050	<0.0050
	2014	0.00002	0.000012	0.000412	0.00028	0.000635	0.000492	0.000075	0.000011	0.00296	0.00038

4.2 Sediments

Upon review of the analytical geochemical data, some anomalies were noted. Concentrations of copper and lead were extremely high in sample MH13B, and the concentration of copper was very high in samples MH20A and MH20B. These values were so out of the ordinary when compared to the past 22 years of data that a request was made of the lab for reanalysis.

The reanalysis confirmed the data at MH13B (Appendix B) and the originally reported data is included in the following tables. However, the concentrations of copper in samples MH20A and MH20B were considerably reduced following retesting, reflecting typical levels that have historically been reported. The copper levels initially presented in the laboratory report were 322 ppm and 65.1 ppm at MH20A and MH20B respectively. Reanalysis produced concentrations of 11.5 ppm and 17.1 ppm (Appendix B). The revised data are reported below.

The final results for the metals analyses of all stream sediment samples are presented in Appendix B with the water quality data. Of the 32 metals analyzed, only sodium was not detected in any of the samples.

Seven elements (As, Cd, Cr, Cu, Hg, Pb, and Zn) were chosen for closer examination as these can be potentially toxic to aquatic systems. The data for the triplicates was averaged per site and standard deviation was performed to determine the spread of the data (Table 4). Metals in sediments are often difficult to interpret because levels can vary widely as a function of natural mineralization of local soils in a given watershed. The standard deviation analysis shows that representative samples were collected at the majority of the sites. Due to the very high concentrations of copper and lead in sample MH-13B, the standard deviation was high indicating a wide range of values. Although reanalysis confirmed these high values it is unknown why concentrations were so great in this sample only. All three samples were collected from the same stretch of running water. As mentioned earlier, the region of MH13 was flooded to a greater extent than in previous years and the site of sample collection occurred in an area that had previously been above the waterline. In is unknown how long the water had been at this stage, but it was a sufficient time period for the establishment of a small running stream with a fine muddy substrate (see Photo #1).

TABLE 4 METAL CONCENTRATIONS (ug/g) IN THE INDIVIDUAL SEDIMENT SAMPLES, AUGUST 2014								
	pH	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Zinc**
Units	pH	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
MH-13A	8.32	14.3	0.862	19.7	36.6	31.4	0.073	158
MH-13B	8.02	23.0	4.32	14.6	439	243	0.125	338
MH-13C	7.91	22.8	3.70	21.9	35.4	60.8	0.097	306
Mean:	8.08	20.03	2.96	18.7	170.3	111.7	0.10	267
S.D.:	0.21	4.97	1.84	3.7	232.7	114.6	0.03	96
MH-16A	8.16	5.74	0.743	16.1	13.0	11.0	<0.050	99
MH-16B	8.14	6.59	0.826	17.7	15.5	12.3	0.053	110
MH-16C	8.14	6.55	0.892	18.5	16.1	11.9	0.060	106
Mean:	8.15	6.29	0.82	17.4	14.9	11.7	0.06	105
S.D.:	0.01	0.48	0.07	1.2	1.6	0.7	0.005	6
MH-20A	8.50	5.75	0.463	29.2	11.5	7.27	<0.050	71
MH-20B	8.43	6.26	0.581	28.8	17.1	9.27	<0.050	93
MH-20C	8.18	13.6	1.60	44.5	37.2	27.7	0.108	200
Mean:	8.37	8.54	0.88	34.2	21.9	14.7	0.11	121
S.D.:	0.17	4.39	0.63	9.0	13.5	11.3	0.00	69

The mean concentrations of these metals were compared to the CCME (1999) interim freshwater sediment quality guidelines (ISQG), and to the probable effects levels (PEL). Concentrations greater than the PEL have a 50% incidence of creating adverse biological effects (Table 5).

Arsenic concentrations in the stream sediments exceeded the recommended ISQG guideline at all three sites, and the PEL was also exceeded at MH-13. The ISQG for cadmium was also exceeded at all of the sites. Concentrations of copper, lead and zinc exceeded the ISQG guidelines in the sediments collected from MH-13 with the level of lead also exceeding the PEL.

TABLE 5 SUMMARY OF METAL CONCENTRATIONS (ug/g) IN THE STREAM SEDIMENTS, AUGUST 2014								
Site	**pH**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Zinc**
MH-13	8.08	**20.0**	**2.96**	18.7	**170.3**	**111.7**	0.10	**267**
MH-16	8.15	**6.3**	**0.82**	17.4	14.9	11.7	0.06	105
MH-20	8.37	**8.5**	**0.88**	34.2	21.9	14.7	0.11	121
ISQG		5.9	0.6	37.3	35.7	35.0	0.170	123
PEL		17.0	3.5	90	197.0	91.3	0.486	315

The 2014 sediment results were compared to data collected in previous studies for sites MH13, MH16 and MH20 (Table 6 and Figures 2 to 6). The applicable ISQG and/or PEL were plotted on each figure.

The concentration of arsenic in the sediments has consistently surpassed the ISQG at each site and approached or exceeded the PEL at MH13. These levels do not appear to have impacted the aquatic communities (see sections 4.3 and 4.4).

TABLE 6

COMPARISON OF METALS (ug/g) IN SEDIMENTS OVER THE STUDY PERIOD

Site	Year	Arsenic	Copper	Cadmium	Lead	Zinc
MH - 13	1992	**17.0**	21.7	**1.2**	**65**	**256**
	1994	**11.5**	22.8	**1.5**	**47**	**216**
	1996	**12.0**	19.2	**1.7**	27	**160**
	1998	**14.0**	20.7	**1.2**	**37**	**174**
	2000	**17.3**	24.1	**2.1**	**71**	**266**
	2002	**8.1**	17.8	**1.2**	24	**148**
	2004	**9.6**	23.5	**1.3**	30	**185**
	2006	**18.2**	23.9	**2.4**	**38**	**224**
	2008	**12.8**	22.0	**1.9**	**48**	**226**
	2010	**16.1**	24.5	**1.9**	**38**	**233**
	2012	**16.2**	22.9	**2.0**	28	**199**
	2014	**20.0**	**170.3**	**3.0**	**112**	**267**
MH - 16	1998	**<8**	9.2	0.4	8	72
	2000	**11.3**	9.8	0.4	8	80
	2002	**6.0**	13.0	**0.8**	11	90
	2004	**7.8**	17.5	**1.0**	13	118
	2006	**8.4**	14.6	**0.8**	11	96
	2008	5.9	13.8	**0.8**	11	95
	2010	**9.3**	20.0	**1.4**	15	**138**
	2012	4.3	10.4	0.6	8	82
	2014	**6.3**	14.9	**0.8**	12	105
MH - 20	1992	**13.0**	22.1	**<0.1**	15	78
	1994	**<10**	20.6	0.5	9	70
	1996	**9.0**	16.6	**1.5**	9	69
	1998	**10.0**	18.7	0.3	11	74
	2000	**7.3**	23.0	0.3	13	88
	2002	4.6	16.9	0.3	8	57
	2004	**6.1**	22.9	0.4	10	78
	2006	**6.0**	18.0	0.3	8	66
	2008	5.8	21.2	0.4	10	75
	2010	**9.3**	16.8	0.5	8	75
	2012	**6.0**	21.2	0.6	9	69
	2014	**8.5**	21.9	**0.9**	15	121

Note: ISQG = Interim freshwater Sediment Quality Guidelines, in **bold** where exceeded.
PEL = Probable Effects Level (>50% of adverse effects occur above this level), shaded and in bold where exceeded.

Copper levels have been consistent over time and remained well below the ISQG of 37.3 ug/g until 2014 when an outlier was documented at MH-13. The average concentration of copper at MH13 prior to 2014 was 22.1 ppm. Cadmium concentrations tended to fluctuate slightly at each site, with overall levels higher at MH-13 where the ISQG guideline was exceeded on all occasions.

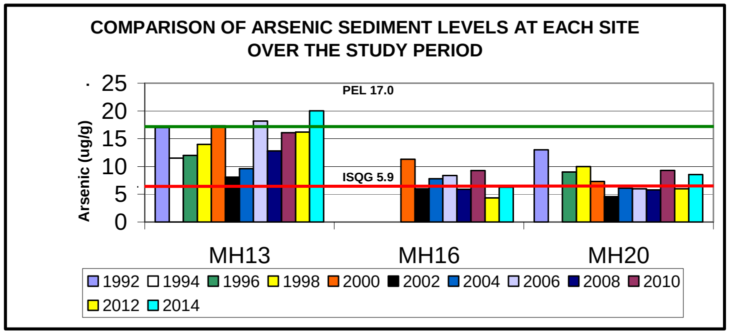


Figure 2

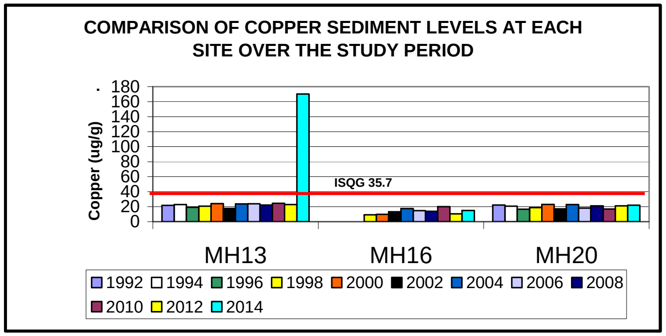


Figure 3

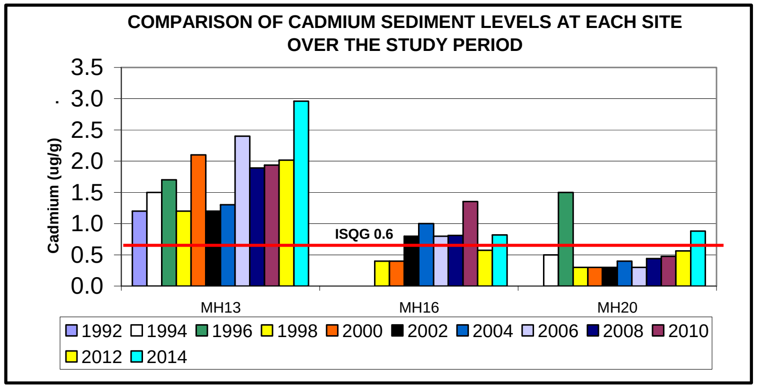


Figure 4

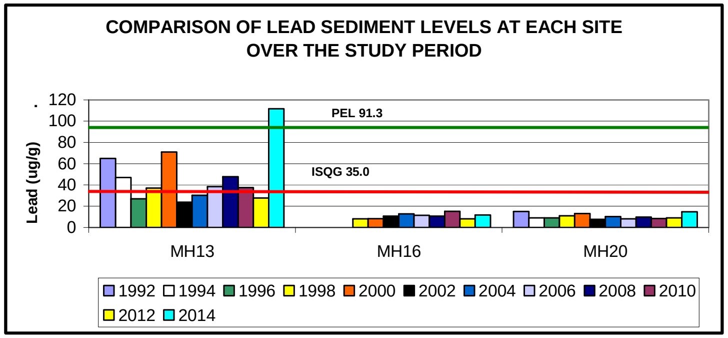


Figure 5

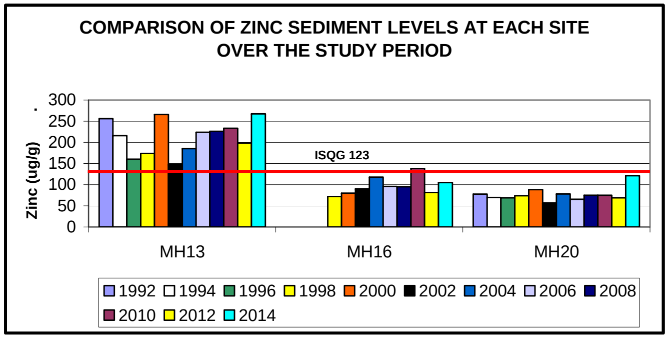


Figure 6

Lead concentrations were very low at the downstream sites MH-16 and MH-20. Levels frequently exceeded the ISQG at MH-13, with an anomalously high value recorded at MH-13 in 2014 that exceeded the PEL. Prior to 2104, the average lead concentration at MH13 was 41.0 ppm.

Zinc concentrations were significantly higher in the stream sediments at MH13 where the ISQG was exceeded throughout the study period. Generally zinc levels were higher at MH-16 that at MH-20. The ISQG was exceeded once at MH-16, in 2010.

In general, the concentrations of the various metals have remained relatively consistent in the stream sediments at MH20. Concentrations tended to fluctuate more widely in the sediments at MH13 and moderately in the sediments at MH16.

4.3 Benthic Invertebrates

Six phyla were found in the study area: Arthropoda, Mollusca, Nematoda, Annelida, Cnidaria, and Platyhelminthes. A total of 9,455 benthic invertebrates, representing 101 different taxonomic groups, were identified within these phyla. These data are presented in Appendix C.

4.3.1 Abundance and Taxonomic Richness

The total number of organisms of the triplicates for each site was summed to give a total abundance value for that site. The total populations were 4,400 individuals at MH13, 4,682 individuals at MH16, and 373 individuals at MH20. Density was calculated for each site and these values followed the same trend as the abundance values. The low population at MH20 may be reflective of the high water levels resulting from recent rainfall events, that may have created bed scour displacing organisms along with the relocation of the large in-stream woody debris that typically has been at this site.

Taxonomic richness was determined for each site by enumerating all the different taxonomic groups identified from species to phylum as a measure of community diversity. The diversity at all the communities was very similar. To further characterize the taxonomic wealth of each community, the diversity was related to the population size using the formula: (Diversity – 1) divided by the natural log of the population. The community at MH20 had the greatest taxonomic wealth and the community at MH13 the least. All of the above data are included in Table 7.

TABLE 7 GENERAL STATISTICS ON THE BENTHIC COMMUNITIES, 2014

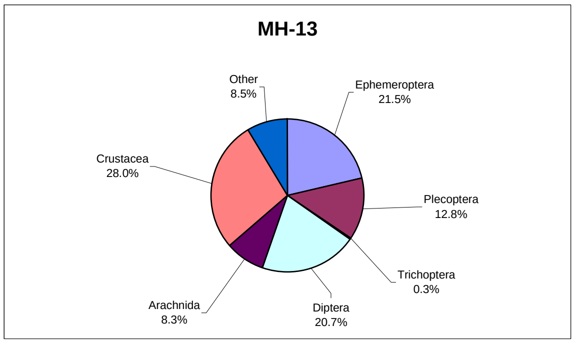
Site	Abundance	Density (#/m^2)	Diversity	Taxonomic Richness
MH-13	4,400	15,788	52	6.1
MH-16	4,682	16,799	55	6.4
MH-20	373	1,338	53	8.8

4.3.2 Distribution

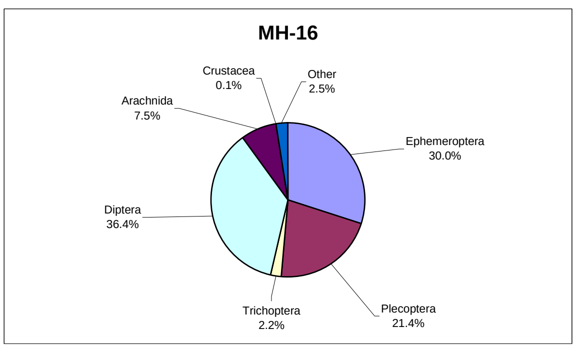
The percent composition of the major taxonomic groups was calculated for each station (Figure 7). Based on the percentages of each group, taxa were classified with respect to their dominance within the benthic community for each site (Table 8). The group "Other" includes invertebrates from Collembola, Coleoptera, Oligochaeta, Gastropoda, Hydrozoa, Turbellaria and Nematoda.

FIGURE 7 COMPOSITION OF TAXONOMIC GROUPS AT EACH SITE

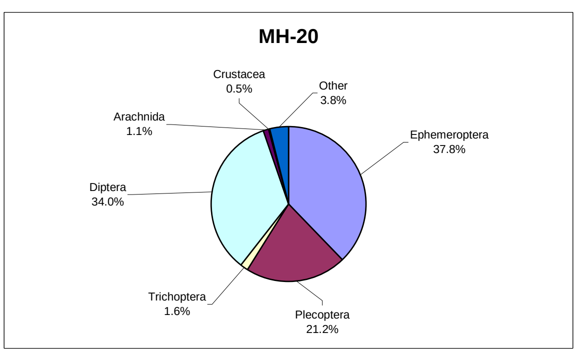
TABLE 8 TAXONOMIC DISTRIBUTION OF BENTHIC INVERTEBRATES



DOMINANT (>25%)	SUBDOMINANT (10% to 24.9%)	COMMON (1.0% to 9.9%)	RARE (0.1% to 0.9%)
Crustacea	Ephemeroptera Diptera Plecoptera	Other Arachnida	Trichoptera



DOMINANT (>25%)	SUBDOMINANT (10% to 24.9%)	COMMON (1.0% to 9.9%)	RARE (0.1% to 0.9%)
Diptera Ephemeroptera	Plecoptera	Arachnida Other Tricoptera	Crustacea



DOMINANT (>25%)	SUBDOMINANT (10% to 24.9%)	COMMON (1.0% to 9.9%)	RARE (0.1% to 0.9%)
Ephemeroptera Diptera	Plecoptera	Other Trichoptera Arachnida	Crustacea

Crustaceans, composed largely of Copepods and Ostracods (seed shrimp), dominated the community at MH13. Copepods tend to be more pelagic (dwelling in the water column) rather than benthic, and both taxa prefer slower moving water such as ponds and lakes. Their high presence here is indicative of the habitat at MH13 – large ponded areas. Crustaceans were rare at MH-16 and MH-20. The insect orders Ephemeroptera, Diptera and Plecoptera were subdominant at MH-13.

The composition of the communities at MH-16 and MH-20 was relatively similar. Diptera and Ephemeroptera shared dominance at both MH-16 and MH-20, and Plecoptera was subdominant at both sites.

4.3.3 EPT

Many aquatic insects require good water quality to thrive. Larvae of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) require clear, clean, well oxygenated water and have very low tolerance to pollution (Rosenberg and Resh, 1993). Analyzing the combined EPT (Ephemeroptera, Plecoptera, Trichoptera) at a site, gives an indication of the overall health of the stream. Table 9 summarizes the number of EPT found per site, the number of EPT taxa (richness) and the proportion of EPT in each community.

TABLE 9 EPT ABUNDANCE, RICHNESS & PROPORTION

Site	EPT Abundance	EPT Richness	EPT %
MH-13	1525	17	34.7
MH-16	2508	27	53.6
MH-20	226	27	60.6

Abundance was lowest at MH-20 but the proportion of EPT within the community was the greatest here. The community at MH-13 had the lowest EPT richness and lowest representation. Twenty-seven EPT taxa were identified at both MH-16 and MH-20. Stream Keepers have indicated that streams with an EPT richness greater than 8 are of good quality (DFO). Richness values below 5 could indicate that the habitat is compromised in some way. Based on this criteria, False Canyon Creek at MH13 is also of good quality.

Due to the sensitivity of EPT, Lehmkuhl (1979) has identified several groups within these insect orders that have very low tolerance to chemical pollution. Ten of these taxa (five taxa within Plecoptera, three taxa within Ephemeroptera and two taxa within Trichoptera) have been identified in the study area. Table 10 summarizes the presence or absence of each of these taxa per site.

Only four of the sensitive taxa were collected at MH13. The habitat here is not conducive to populations of EPT due to the lack of clean washed gravels with a relatively high velocity of flow. The flow was very sluggish in this reach with a high degree of fines comprising the substrate. Other zones within this reach consisted of beaver dams or flooded willow areas.

Nine of the ten sensitive taxa were identified at MH16 and at MH20. High representation of these sensitive organisms at these two sites indicates good water and stream sediment quality for the support of benthic invertebrates.

TABLE 10
Presence (+) and Absence (-) of Sensitive Taxa at False Canyon Creek Study Area, 2014

Sensitive Taxa	MH13	MH16	MH20
Plecoptera			
Capniidae	+	+	+
Chloroperlidae	-	+	+
Nemouridae	+	+	+
Perlodidae	+	+	+
Taeniopterygidae	-	+	-
Ephemeroptera			
Ephemerellidae	+	+	+
Rhrithrogena sp.	-	+	+
Epeorus	-	-	+
Trichoptera			
Brachycentriidae	-	+	+
Rhyacophilidae	-	+	+
Total # of sensitive taxa:	4	9	9

After Lehmkuhl (1979)

4.3.4 Comparisons with Past Data

Data collected biannually from False Canyon Creek since 1992 have been summarized and compiled in Table 11. Population densities were greatest in 1998 at MH13, and in 2010 at MH16 and MH20 (Figure 8). The population at MH13 has fluctuated considerably over the study period which probably reflects the instability of this site. Population numbers have consistently been lower downstream at MH20 than at the other two upstream sites.

Diversity has continued to fluctuate over time at MH13 and MH20, but has been relatively stable at MH16. Overall, the communities at MH16 have been the most diverse.

The number of sensitive taxa has varied significantly at MH13 but has been very low during recent surveys. This was likely due to natural degradation in habitat quality. The communities at MH16 and MH20 continue to have high numbers of sensitive taxa.

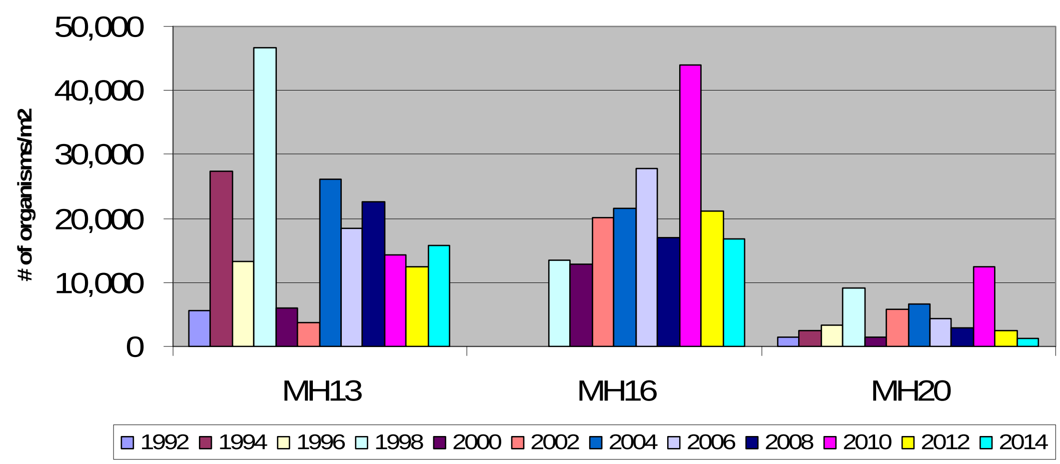
The dominance of the respective communities has remained virtually unchanged over the study period up until 2014. Diptera has been the dominant or co-dominant order at MH13 during every sampling period, with the addition of Ostracoda as the co-dominant order in 2010. In 2014 Crustacea (which included Ostracoda and Copepoda) dominated the community. Ephemeroptera and/or Diptera have been the dominant orders at MH16 and MH20 over time.

The temporal data generally indicates that the community at MH13 fluctuates depending on the changing habitat characteristics during the particular sampling period. Although abundance varies somewhat over time, the communities at MH16 and MH20 are relatively stable.

Table 10
COMPARISON OF BENTHIC DATA OVER THE STUDY PERIOD

Site	Year	Total Abundance	Diversity	Density (# of organisms/m²)	Dominant Taxa	Total # of Sensitive Taxa
MH13	1992	1,562	25	5,605	Diptera	7
	1994	7,631	37	27,380	Ephemeroptera & Diptera	9
	1996	3,682	57	13,211	Diptera	8
	1998	13,033	30	46,764	Diptera	2
	2000	1,704	50	6,114	Plecoptera & Diptera	4
	2002	1,020	43	3,660	Diptera	3
	2004	7,289	72	26,153	Diptera	9
	2006	5,168	46	18,543	Diptera	4
	2008	6,319	50	22,673	Diptera & Plecoptera	8
	2010	4,003	33	14,363	Ostracoda & Diptera	0
	2012	3,465	53	12,433	Diptera & Other	3
	2014	4,400	52	15,788	Crustacea	4
MH16	1998	3,754	60	13,470	Diptera & Ephemeroptera	10
	2000	3,578	65	12,838	Diptera & Ephemeroptera	9
	2002	5,588	67	20,050	Diptera & Ephemeroptera	8
	2004	5,995	63	21,510	Diptera & Ephemeroptera	10
	2006	7,445	76	27,713	Diptera	10
	2008	4,769	58	17,112	Diptera & Ephemeroptera	8
	2010	12,266	52	44,011	Diptera	6
	2012	5,893	61	21,145	Diptera	8
	2014	4,682	55	16,799	Diptera & Ephemeroptera	9
MH20	1992	394	22	1,414	Ephemeroptera	6
	1994	720	31	2,583	Ephemeroptera & Diptera	8
	1996	936	54	3,358	Ephemeroptera & Diptera	12
	1998	2,564	59	9,200	Ephemeroptera & Diptera	10
	2000	412	28	1,478	Diptera & Ephemeroptera	6
	2002	1,591	43	5,709	Diptera	6
	2004	1,853	56	6,648	Diptera & Ephemeroptera	11
	2006	1,196	64	4,291	Ephemeroptera & Diptera	11
	2008	826	49	2,964	Ephemeroptera & Diptera	7
	2010	3,474	54	12,465	Diptera & Ephemeroptera	8
	2012	682	52	2,447	Ephemeroptera	10
	2014	373	53	1,338	Ephemeroptera	9

FIGURE 8 COMMUNITY DENSITY PER SITE OVER THE STUDY PERIOD



4.4 Fish

4.4.1 Fish Distribution and Abundance

Slimy sculpin (*Cottus cognatus*) and Arctic grayling (*Thymallus arcticus*) continue to be the most common species captured or observed at sampling sites in False Canyon Creek. Other species captured in 2014 were juvenile burbot (*Lota lota*) and a whitefish species (*Prosopim sp*). Table 12 summarizes fish capture results using the various gear types at the three surveyed sites in the False Canyon Creek drainage in 2014. Individual fish length and weight data for each site is presented in Table 1 of Appendix D.

Table 12
SUMMARY OF SAMPLING EFFORT AND TOTAL CATCH USING VARIOUS FISH CAPTURE METHODS AT EACH SAMPLING LOCATION, AUGUST 2014.

Sample Site	Capture Method	Sample Effort	Catch				Observations
			Arctic Grayling	Burbot	Slimy Sculpin	Whitefish	
MH13	MNT	21.0 hrs	0	0	0	0	
MH13	Electro	766 sec	0	0	1	0	
MH16	MNT	21.0 hrs	0	1	0	0	
MH16	Electro	627 sec	1	1	13	0	6 sculpin + fry
MH16	Angling	15 min	1	0	0	0	4 grayling strikes (< 300 mm TL)
MH20	MNT	20.5 hrs	0	0	0	0	
MH20	Electro	723 sec	1	0	11	1	6 sculpin + fry
MH20	Seine	30 m2	0	0	0	5	
MH20	Angling	20 min	0	0	0	0	3 grayling strikes (< 200 mm FL)

Legend: MNT = Minnow trap (3 traps)
Electro = Electrofisher
Seine = Pole Seine (2 sweeps)
Angle = Angling

As with all previous sampling years, slimy sculpin were once again the only fish species represented in the catch at site MH13. Only a single sculpin was encountered indicating extremely low densities at this site. The modest catch is well below the 2002 to 2012 site average of 21.7 captures for each sampling year (Table 13). Low densities at this site were also documented in 1992, 2000 and 2002. Arctic grayling have never been captured at this location. The single slimy sculpin was 61 mm in total length representing a juvenile life history stage. No slimy sculpin fry were observed at MH13 as in the past.

Slimy sculpin of varying size were more numerous in the catches at sites MH16 and MH20. Capture numbers were near historic averages (Table 13). Sculpin fry were also observed while electrofishing at both these sites. Large adults (> 90mm TL) were not well represented in the catch in 2014.

TABLE 13

COMPARISON OF FISH CATCH AT THREE SAMPLING SITES OVER A 22 YEAR PERIOD

SPECIES	SAMPLE SITE	CATCH (#)	
		1992 to 2012* (Average)	2014 (Total)
Slimy sculpin	MH13	21.7	1
	MH16	12.1	13
	MH20	14.7	11
Arctic grayling	MH13	0	0
	MH16	3.3	2
	MH20	4.3	1
Burbot	MH13	0	0
	MH16	0.9	2
	MH20	0.8	0
Whitefish sp.	MH13	0	0
	MH16	0	0
	MH20	0.7	6
Lake chub	MH13	0	0
	MH16	0	0
	MH20	0.1	0
Char sp.	MH13	0	0
	MH16	0	0
	MH20	0.1	0

* Note that site MH16 was not sampled during the 1992, 1994 and 1996 surveys.

Only two Arctic grayling were captured at site MH16. A single fry (43 mm FL) and a reasonably good-sized adult (210 mm FL) embodied the catch. Several juvenile Arctic grayling were also observed while angling at this site. Only a single Arctic grayling fry was captured at site MH20 (55 mm FL) however several juveniles were observed while angling. Historically, captures of grayling at site MH20 have been more numerous than at site MH16. Arctic grayling of all life history stages have in the past been well represented at site MH20 (Figure 2 of Appendix D).

As in the past, whitefish (*Prosopium sp*) continue to be captured in low numbers at site MH20. Whitefish are known to inhabit the Liard River basin (Anon. 1996, McPhail 2007, LES 2004). Lake chub and Dolly Varden/bull trout were not represented in the catch in 2014 as only a single specimen of each has ever been documented over the 22-year monitoring period. Dolly Varden, most likely bull trout, are apparently abundant at the confluence with the Frances River and are utilized as part of a food fishery (Donnessey, pers. com., 2006). A total of two juvenile burbot were also captured at site MH16 in 2014. This species has been previously documented sporadically at sites MH16 and MH20.

Fish distribution and catch comparisons for all sites sampled in 2014 generally indicate little change in the dominant fish types or their relative abundance when compared to previous surveys (Table 12). While the absolute number of captured fish varies from year to year, the species composition continues to be consistent and indicative of a stable fish community.

Notable in 2014 was the capture of several whitefish at site MH20. This species has been previously documented at this location.

4.4.2 Fish Habitat

Water levels were high and did not vary much between sampling sites in False Canyon Creek during 2014. Beaver activity at site MH13 continues to be a major influence on the aquatic environs at this location. Water levels were once again high compared to the survey in 2008 when levels were dramatically lower which resulted in the capture of large numbers of fish during that monitoring year. The many barriers, debris piles and active beaver dams associated with this site are believed to be an impediment to the upstream movement of other species and may be a factor preventing their colonization.

Water levels at sites MH16 and MH20 were also higher than normal at the time of the survey. The Watson Lake region recorded an above average snow pack during the spring of 2014 (Environment Yukon 2015). The combination of a high snow pack and above average rainfall during July seemed to result in wetter conditions and higher than average base flows prevailing throughout southeastern Yukon in 2014 (Environment Canada 2015). Most of the gravel bars were under water at site MH20 making aerial access challenging. Evidence of channel modifying flows and flooding was evident in many areas along the banks of the creek. Snags and accumulations of woody debris that were apparent during previous years were notably absent or repositioned (see Photos 3 to 6 in Appendix A). Some sections of the stream had eroding banks that seemed relatively recent. None-the-less, the main channel continues to provide good fish cover values in the form of deep pools, overhanging vegetation and accumulations of woody debris. The mature forest that predominates the riparian habitat along the banks of the main channel remains healthy. Site-specific physical habitat descriptions for all three sites have been previously described (LES 1998).

5.0 SUMMARY

No anomalies were apparent in the water quality during the 2014 study. The alkaline waters of the drainage were hard to very hard and concentrations of metals were low where detected. All samples met the applicable CCME guidelines for the protection of freshwater aquatic life with the exception of iron in the total metals sample collected at MH13.

Metal concentrations in the sediments at MH13 were higher than at MH16 and MH20, indicating its location in a mineralized area. Very high concentrations of lead and copper were reported in one of the stream sediments collected from MH13, which had previously not be documented. Reanalysis confirmed the high levels. The concentrations of various metals have exceeded the CCME guidelines for the protection of freshwater aquatic life at MH13 over the 22 year study period. Concentrations of metals have fluctuated over time at MH13 but have remained relatively stable at MH16 and MH20.

Although the stream sediment data indicates that there could be negative effects on the aquatic biota, the benthic invertebrate communities were diverse and had good representation from the major groups of organisms that are usually present in lotic waters. The presence of EPT at all sites, including MH13, suggest that the metals documented in the sediments are likely not in a bioavailable form. The composition of the benthic population at MH13 is different from that of the other two sites, and is a function of the physical habitat rather than the quality of the water and stream sediments at this site.

Fish distribution and catch comparisons for all sites sampled in 2014 generally indicate little change in the dominant fish types or their relative abundance when compared to previous surveys. While the absolute number of captured fish varies from year to year, the species composition continues to be consistent and indicative of a stable fish community. Notable in 2014 was the capture of several whitefish at site MH20. This species has been previously documented at this location.

6.0 REFERENCES

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APPENDIX A

PHOTOGRAPHS, AUGUST 2014

Photo #1: The small stream that was sampled at MH-13, looking upstream from sample site MH-13A, August 23rd, 2014.

Photo #2: Looking downstream from the sample site MH-13A, August 23rd, 2014.

Photo #3: Accumulations of woody debris at MH20 on August 14th, 2012.

Photo #4: The same gravel bar at MH20 on August 23rd, 2014. The woody debris has been flushed away.

Photo #5: Looking downstream from MH20 on August 12th, 2012 at in-stream woody debris.

Photo #6: The same view as Photo #5 as it appeared on August 23rd, 2014.

APPENDIX B

MAXXAM ANALYTICAL REPORT FOR WATER AND SEDIMENT, 2014

- **Work Order #: B474948**

Maxxam

Data Re-check Form

PM
SS

Project Manager:	KP5	Data Validation Coordinator:	RR5	Client:	Teck Resources Ltd
Job Number:	B474948	Project #:	SA DENA HES	Date:	2014/09/17
Reason for Re-Check:	Client Request				

Type of Re-Check: Raw Data Recheck

Client Comments:

It appears there may be anomalous readings for sample number MH-13B for copper and lead values. We have been collecting sediment from this site since 1992 and copper values have always been in the 20 to 40 ppm range and lead has been in the 30 to 60 ppm range. Can you please have the reported values confirmed, and that its not just a misplaced decimal?

QA/QC Review

Raw Data Check:	No	Label Check - Maxxam vs. Client:	No	Status Check Calc's Redone/Checked:	No
QA/QC Check	No	Bottle Check - Preservative:	No	Comments:	

*2nd rework must be done when necessary to confirm data change.

Client Sample ID	Maxxam Sample ID	Test	Analyte	Units	Bottle submitted	Initial w/in Hold Time	Original Result	Rework Result	RPD %	2nd Rework Result*	RPD % (1st & 2nd RW)	Confirmed
MH-13B	KL2360	ICPMS2TV-S	Cu	mg/kg	Recommend	Yes	439	436	0.7%			**Yes**
			Pb	mg/kg	Recommend	Yes	243	238	2.1%			**Yes**

Lab/SS Comments:

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Your Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Your C.O.C. #: 08396251, 446148-01-01

Attention:Michelle Unger

TECK RESOURCES LTD.
SULLIVAN
BAG 2000
601 Knighton Rd.
KIMBERLEY, BC
Canada V1A 3E1

Report Date: 2014/11/19
Report #: R1686293
Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B474948
Received: 2014/08/26, 12:45

Sample Matrix: Soil
Samples Received: 12

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Elements by ICPMS (total)	11	2014/09/02	2014/09/03	BBY7SOP-00001	EPA 6020a R1 m
Elements by ICPMS (total)	1	2014/11/08	2014/11/10	BBY7SOP-00001	EPA 6020a R1 m
pH (2:1 DI Water Extract)	12	2014/09/03	2014/09/03	BBY6SOP-00028	BCMOE BCLM Mar2005 m

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	3	2014/08/27	2014/08/27	BBY6SOP-00026	SM 22 2320 B m
Alkalinity - Water	1	2014/08/27	2014/08/28	BBY6SOP-00026	SM 22 2320 B m
Conductance - water	3	N/A	2014/08/27	BBY6SOP-00026	SM 22 2510 B m
Conductance - water	1	N/A	2014/08/28	BBY6SOP-00026	SM 22 2510 B m
Hardness Total (calculated as CaCO3)	4	N/A	2014/09/03	BBY7SOP-00002	EPA 6020a R1 m
Hardness (calculated as CaCO3)	4	N/A	2014/09/04	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Dissolved-LowLevel) by CVAF	4	N/A	2014/09/02	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Mercury (Total-LowLevel) by CVAF	4	2014/09/04	2014/09/05	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	4	N/A	2014/09/04	BBY7SOP-00002	EPA 6020A R1 m
Elements by ICPMS Low Level (dissolved)	1	N/A	2014/09/03	BBY7SOP-00002	EPA 6020A R1 m
Elements by ICPMS Low Level (dissolved)	3	N/A	2014/09/04	BBY7SOP-00002	EPA 6020A R1 m
Na, K, Ca, Mg, S by CRC ICPMS (total)	4	N/A	2014/09/03	BBY7SOP-00002	EPA 6020A R1 m
Elements by ICPMS Low Level (total)	4	N/A	2014/09/03	BBY7SOP-00002	EPA 6020A R1 m
Ammonia-N (Preserved)	3	N/A	2014/08/28	BBY6SOP-00009	SM 22 4500-NH3- G m
Ammonia-N (Preserved)	1	N/A	2014/09/08	BBY6SOP-00009	SM 22 4500-NH3- G m
Filter and HNO3 Preserve for Metals	1	N/A	2014/09/03	BBY7 WI-00004	BCMOE Reqs 08/14
Filter and HNO3 Preserve for Metals	3	N/A	2014/09/04	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	3	N/A	2014/08/27	BBY6SOP-00026	SM 22 4500-H+ B m
pH Water (1)	1	N/A	2014/08/28	BBY6SOP-00026	SM 22 4500-H+ B m
Sulphate by Automated Colourimetry	4	N/A	2014/08/28	BBY6SOP-00017	SM 22 4500-SO42- E m
Total Suspended Solids	1	N/A	2014/08/27	BBY6SOP-00034	SM 22 2540 D

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Your Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Your C.O.C. #: 08396251, 446148-01-01

Attention:Michelle Unger

TECK RESOURCES LTD.
SULLIVAN
BAG 2000
601 Knighton Rd.
KIMBERLEY, BC
Canada V1A 3E1

Report Date: 2014/11/19
Report #: R1686293
Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B474948
Received: 2014/08/26, 12:45

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Total Suspended Solids	3	N/A	2014/08/29	BBY6SOP-00034	SM 22 2540 D

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B474948
Report Date: 2014/11/19

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KL2370		KL2371		KL2372		KL2373		
Sampling Date		2014/08/12 10:45		2014/08/12 12:30		2014/08/12 15:15		2014/08/12		
COC Number		446148-01-01		446148-01-01		446148-01-01		446148-01-01		
	Units	**MH-13**	**QC Batch**	**MH-16**	**QC Batch**	**MH-20**	**QC Batch**	**FIELD BLANK**	**RDL**	**QC Batch**
Calculated Parameters										
Filter and HNO3 Preservation	N/A	FIELD	ONSITE	FIELD	ONSITE	FIELD	ONSITE	FIELD	N/A	ONSITE
Misc. Inorganics										
Alkalinity (Total as CaCO3)	mg/L	190	7617250	202	7617250	164	7617250	0.52	0.50	7617255
Alkalinity (PP as CaCO3)	mg/L	<0.50	7617250	3.74	7617250	1.95	7617250	<0.50	0.50	7617255
Bicarbonate (HCO3)	mg/L	232	7617250	237	7617250	195	7617250	0.63	0.50	7617255
Carbonate (CO3)	mg/L	<0.50	7617250	4.49	7617250	2.34	7617250	<0.50	0.50	7617255
Hydroxide (OH)	mg/L	<0.50	7617250	<0.50	7617250	<0.50	7617250	<0.50	0.50	7617255
Anions										
Dissolved Sulphate (SO4)	mg/L	7.32	7619030	6.15	7619030	7.56	7619030	<0.50	0.50	7619030
Nutrients										
Total Ammonia (N)	mg/L	0.017	7619667	0.024	7619667	0.024	7619667	0.060	0.0050	7629947
Physical Properties										
Conductivity	uS/cm	360	7617254	376	7617254	316	7617254	<1.0	1.0	7617257
pH	pH	8.29	7617252	8.40	7617252	8.33	7617252	6.01	N/A	7617256
Physical Properties										
Total Suspended Solids	mg/L	<4.0 (1)	7616272	13.0 (1)	7617941	<4.0 (1)	7617953	<4.0 (1)	4.0	7617953

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Sample arrived to laboratory past recommended hold time.

Maxxam Job #: B474948
Report Date: 2014/11/19

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		KL2359	KL2360	KL2361	KL2362	KL2363	KL2364	KL2365		
Sampling Date		2014/08/12 11:15	2014/08/12 11:15	2014/08/12 11:15	2014/08/12 13:00	2014/08/12 13:00	2014/08/12 13:00	2014/08/12 15:30		
COC Number		08396251	08396251	08396251	08396251	08396251	08396251	08396251		
	Units	**MH-13A**	**MH-13B**	**MH-13C**	**MH-16A**	**MH-16B**	**MH-16C**	**MH-20A**	**RDL**	**QC Batch**
Physical Properties										
Soluble (2:1) pH	pH	8.32	8.02 (1)	7.91 (2)	8.16	8.14	8.14	8.50	N/A	7622305
Total Metals by ICPMS										
Total Aluminum (Al)	mg/kg	11700	7940	10400	8130	8680	8320	6240	100	7622283
Total Antimony (Sb)	mg/kg	1.45	3.79	1.18	0.59	0.63	0.63	0.89	0.10	7622283
Total Arsenic (As)	mg/kg	14.3	23.0	22.8	5.74	6.59	6.55	4.74	0.50	7622283
Total Barium (Ba)	mg/kg	283	484	474	268	287	306	238	0.10	7622283
Total Beryllium (Be)	mg/kg	0.49	<0.40	0.48	<0.40	<0.40	<0.40	<0.40	0.40	7622283
Total Bismuth (Bi)	mg/kg	0.19	0.61	0.21	0.10	0.10	0.11	0.11	0.10	7622283
Total Cadmium (Cd)	mg/kg	0.862	4.32	3.70	0.743	0.826	0.892	0.484	0.050	7622283
Total Calcium (Ca)	mg/kg	7280	21300	16600	7760	8530	8380	8400	100	7622283
Total Chromium (Cr)	mg/kg	19.7	14.6	21.9	16.1	17.7	18.5	31.0	1.0	7622283
Total Cobalt (Co)	mg/kg	9.61	9.41	10.9	5.66	6.31	5.95	5.77	0.30	7622283
Total Copper (Cu)	mg/kg	36.6	439	35.4	13.0	15.5	16.1	322	0.50	7622283
Total Iron (Fe)	mg/kg	25900	30100	32600	15700	16700	17100	15900	100	7622283
Total Lead (Pb)	mg/kg	31.4	243	60.8	11.0	12.3	11.9	21.3	0.10	7622283
Total Lithium (Li)	mg/kg	19.5	11.3	15.3	12.0	12.6	12.5	8.1	5.0	7622283
Total Magnesium (Mg)	mg/kg	5400	4760	5470	4810	4820	4710	6300	100	7622283
Total Manganese (Mn)	mg/kg	433	2300	2100	432	547	527	257	0.20	7622283
Total Mercury (Hg)	mg/kg	0.073	0.125	0.097	<0.050	0.053	0.060	<0.050	0.050	7622283
Total Molybdenum (Mo)	mg/kg	1.72	1.96	1.81	0.65	0.73	0.70	1.10	0.10	7622283
Total Nickel (Ni)	mg/kg	26.0	34.0	38.4	20.4	22.7	21.7	30.3	0.80	7622283
Total Phosphorus (P)	mg/kg	966	866	1090	750	768	742	723	10	7622283
Total Potassium (K)	mg/kg	767	868	1090	634	685	708	586	100	7622283
Total Selenium (Se)	mg/kg	1.34	4.25	4.11	1.14	1.53	1.52	<0.50	0.50	7622283
Total Silver (Ag)	mg/kg	0.419	0.506	0.435	0.205	0.209	0.225	0.143	0.050	7622283
Total Sodium (Na)	mg/kg	<100	<100	<100	<100	<100	<100	<100	100	7622283
Total Strontium (Sr)	mg/kg	38.1	85.8	71.8	32.7	36.4	34.7	32.5	0.10	7622283
Total Thallium (Tl)	mg/kg	0.111	0.131	0.144	0.096	0.101	0.102	0.071	0.050	7622283
Total Tin (Sn)	mg/kg	3.17	83.9	0.71	0.35	0.53	1.78	6.66	0.10	7622283
Total Titanium (Ti)	mg/kg	85.1	42.8	50.3	98.5	100	109	118	1.0	7622283
Total Uranium (U)	mg/kg	1.03	2.28	1.48	0.708	0.762	0.755	0.695	0.050	7622283

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Due to insufficient sample water:soil extraction ratio has changed from 2:1 to 10:1 in order to analyse sample.
(2) Due to insufficient sample water:soil extraction ratio has changed from 2:1 to 3:1 in order to analyse sample.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B474948
Report Date: 2014/11/19

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		KL2359	KL2360	KL2361	KL2362	KL2363	KL2364	KL2365		
Sampling Date		2014/08/12 11:15	2014/08/12 11:15	2014/08/12 11:15	2014/08/12 13:00	2014/08/12 13:00	2014/08/12 13:00	2014/08/12 15:30		
COC Number		08396251	08396251	08396251	08396251	08396251	08396251	08396251		
	Units	**MH-13A**	**MH-13B**	**MH-13C**	**MH-16A**	**MH-16B**	**MH-16C**	**MH-20A**	**RDL**	**QC Batch**
Total Vanadium (V)	mg/kg	30.3	23.5	26.6	21.7	23.8	24.8	24.9	2.0	7622283
Total Zinc (Zn)	mg/kg	158	338	306	99.0	110	106	118	1.0	7622283
Total Zirconium (Zr)	mg/kg	1.74	2.05	2.41	1.39	1.46	1.39	2.47	0.50	7622283
RDL = Reportable Detection Limit										

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B474948
Report Date: 2014/11/19

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		KL2366		KL2366		KL2367	KL2493	KL2494		
Sampling Date		2014/08/12 15:30		2014/08/12 15:30		2014/08/12 15:30	2014/08/25	2014/08/23		
COC Number		08396251		08396251		08396251				
	Units	**MH-20B**	**QC Batch**	**MH-20B REPEAT**	**QC Batch**	**MH-20C**	**MH-11**	**MH-30**	**RDL**	**QC Batch**
Physical Properties										
Soluble (2:1) pH	pH	8.43	7622305		7622305	8.18 (1)	8.25	7.47	N/A	7622305
Total Metals by ICPMS										
Total Aluminum (Al)	mg/kg	6450	7622283	6290	7712166	9530	12100	8370	100	7622283
Total Antimony (Sb)	mg/kg	1.03	7622283	1.00	7712166	2.45	1.53	0.79	0.10	7622283
Total Arsenic (As)	mg/kg	5.96	7622283	6.26	7712166	13.6	13.7	4.61	0.50	7622283
Total Barium (Ba)	mg/kg	246	7622283	251	7712166	369	133	284	0.10	7622283
Total Beryllium (Be)	mg/kg	<0.40	7622283	<0.40	7712166	0.57	<0.40	<0.40	0.40	7622283
Total Bismuth (Bi)	mg/kg	0.14	7622283	0.11	7712166	0.24	0.22	0.10	0.10	7622283
Total Cadmium (Cd)	mg/kg	0.546	7622283	0.581	7712166	1.60	3.61	1.07	0.050	7622283
Total Calcium (Ca)	mg/kg	8390	7622283	8930	7712166	13300	12000	5270	100	7622283
Total Chromium (Cr)	mg/kg	27.3	7622283	28.8	7712166	44.5	22.3	18.3	1.0	7622283
Total Cobalt (Co)	mg/kg	6.60	7622283	7.58	7712166	11.7	8.07	5.67	0.30	7622283
Total Copper (Cu)	mg/kg	65.1	7622283	17.1	7712166	37.2	26.3	19.0	0.50	7622283
Total Iron (Fe)	mg/kg	16000	7622283	17300	7712166	26600	20800	16200	100	7622283
Total Lead (Pb)	mg/kg	19.8	7622283	9.27	7712166	27.7	283	30.8	0.10	7622283
Total Lithium (Li)	mg/kg	8.5	7622283	8.6	7712166	12.7	26.0	13.6	5.0	7622283
Total Magnesium (Mg)	mg/kg	6450	7622283	6770	7712166	9160	7450	3950	100	7622283
Total Manganese (Mn)	mg/kg	283	7622283	353	7712166	663	1340	118	0.20	7622283
Total Mercury (Hg)	mg/kg	<0.050	7622283	<0.050	7712166	0.108	<0.050	0.052	0.050	7622283
Total Molybdenum (Mo)	mg/kg	1.32	7622283	1.49	7712166	4.46	1.57	1.06	0.10	7622283
Total Nickel (Ni)	mg/kg	33.8	7622283	35.9	7712166	62.1	25.1	24.3	0.80	7622283
Total Phosphorus (P)	mg/kg	722	7622283	838	7712166	888	809	872	10	7622283
Total Potassium (K)	mg/kg	653	7622283	611	7712166	900	606	574	100	7622283
Total Selenium (Se)	mg/kg	<0.50	7622283	0.51	7712166	1.50	0.88	0.98	0.50	7622283
Total Silver (Ag)	mg/kg	0.147	7622283	0.171	7712166	0.560	0.350	0.275	0.050	7622283
Total Sodium (Na)	mg/kg	<100	7622283	<100	7712166	<100	<100	<100	100	7622283
Total Strontium (Sr)	mg/kg	35.5	7622283	36.8	7712166	51.4	47.3	25.3	0.10	7622283
Total Thallium (Tl)	mg/kg	0.075	7622283	0.095	7712166	0.139	0.101	0.133	0.050	7622283
Total Tin (Sn)	mg/kg	5.91	7622283	0.25	7712166	0.36	2.03	1.01	0.10	7622283
Total Titanium (Ti)	mg/kg	102	7622283	117	7712166	96.2	362	63.5	1.0	7622283
Total Uranium (U)	mg/kg	0.740	7622283	0.779	7712166	1.18	0.823	1.16	0.050	7622283
Total Vanadium (V)	mg/kg	23.7	7622283	26.4	7712166	33.3	28.5	20.7	2.0	7622283

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Due to insufficient sample water:soil extraction ratio has changed from 2:1 to 3:1 in order to analyse sample.

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Maxxam Job #: B474948
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TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		KL2366		KL2366		KL2367	KL2493	KL2494		
Sampling Date		2014/08/12 15:30		2014/08/12 15:30		2014/08/12 15:30	2014/08/25	2014/08/23		
COC Number		08396251		08396251		08396251				
	Units	**MH-20B**	**QC Batch**	**MH-20B REPEAT**	**QC Batch**	**MH-20C**	**MH-11**	**MH-30**	**RDL**	**QC Batch**
Total Zinc (Zn)	mg/kg	84.8	7622283	93.2	7712166	200	670	139	1.0	7622283
Total Zirconium (Zr)	mg/kg	2.44	7622283	2.43	7712166	3.06	1.67	1.75	0.50	7622283
RDL = Reportable Detection Limit										

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TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		KL2495		
Sampling Date		2014/08/23		
COC Number				
	Units	**CC AT CONFLUENCE**	**RDL**	**QC Batch**
Physical Properties				
Soluble (2:1) pH	pH	8.14	N/A	7622305
Total Metals by ICPMS				
Total Aluminum (Al)	mg/kg	11200	100	7622283
Total Antimony (Sb)	mg/kg	1.91	0.10	7622283
Total Arsenic (As)	mg/kg	14.1	0.50	7622283
Total Barium (Ba)	mg/kg	169	0.10	7622283
Total Beryllium (Be)	mg/kg	<0.40	0.40	7622283
Total Bismuth (Bi)	mg/kg	0.21	0.10	7622283
Total Cadmium (Cd)	mg/kg	3.60	0.050	7622283
Total Calcium (Ca)	mg/kg	11700	100	7622283
Total Chromium (Cr)	mg/kg	21.5	1.0	7622283
Total Cobalt (Co)	mg/kg	8.19	0.30	7622283
Total Copper (Cu)	mg/kg	25.1	0.50	7622283
Total Iron (Fe)	mg/kg	22300	100	7622283
Total Lead (Pb)	mg/kg	155	0.10	7622283
Total Lithium (Li)	mg/kg	21.6	5.0	7622283
Total Magnesium (Mg)	mg/kg	7480	100	7622283
Total Manganese (Mn)	mg/kg	845	0.20	7622283
Total Mercury (Hg)	mg/kg	<0.050	0.050	7622283
Total Molybdenum (Mo)	mg/kg	2.60	0.10	7622283
Total Nickel (Ni)	mg/kg	30.3	0.80	7622283
Total Phosphorus (P)	mg/kg	1000	10	7622283
Total Potassium (K)	mg/kg	661	100	7622283
Total Selenium (Se)	mg/kg	1.36	0.50	7622283
Total Silver (Ag)	mg/kg	0.430	0.050	7622283
Total Sodium (Na)	mg/kg	<100	100	7622283
Total Strontium (Sr)	mg/kg	50.9	0.10	7622283
Total Thallium (Tl)	mg/kg	0.115	0.050	7622283
Total Tin (Sn)	mg/kg	1.59	0.10	7622283
Total Titanium (Ti)	mg/kg	169	1.0	7622283
Total Uranium (U)	mg/kg	1.21	0.050	7622283
Total Vanadium (V)	mg/kg	31.1	2.0	7622283

RDL = Reportable Detection Limit
N/A = Not Applicable

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Maxxam Job #: B474948
Report Date: 2014/11/19

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		KL2495		
Sampling Date		2014/08/23		
COC Number				
	Units	**CC AT CONFLUENCE**	**RDL**	**QC Batch**
Total Zinc (Zn)	mg/kg	424	1.0	7622283
Total Zirconium (Zr)	mg/kg	1.97	0.50	7622283
RDL = Reportable Detection Limit				

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TECK RESOURCES LTD.
Client Project #: SA DENA HES
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LOW LEVEL DISSOLVED METALS WITH CV HG (WATER)

Maxxam ID		KL2370		KL2371	KL2372	KL2373		
Sampling Date		2014/08/12 10:45		2014/08/12 12:30	2014/08/12 15:15	2014/08/12		
COC Number		446148-01-01		446148-01-01	446148-01-01	446148-01-01		
	Units	**MH-13**	**QC Batch**	**MH-16**	**MH-20**	**FIELD BLANK**	**RDL**	**QC Batch**
Misc. Inorganics								
Dissolved Hardness (CaCO3)	mg/L	190	7615999	197	162	<0.50	0.50	7615999
Elements								
Dissolved Mercury (Hg)	ug/L	0.0040	7618981	0.0042	0.0045	0.0023	0.0020	7618981
Dissolved Metals by ICPMS								
Dissolved Aluminum (Al)	ug/L	3.04	7622363	2.32	2.75	1.08	0.50	7622363
Dissolved Antimony (Sb)	ug/L	0.128	7622363	0.084	0.100	0.134 (1)	0.020	7622363
Dissolved Arsenic (As)	ug/L	0.393	7622363	0.363	0.389	<0.020	0.020	7622363
Dissolved Barium (Ba)	ug/L	135	7622363	163	126	<0.020	0.020	7622363
Dissolved Beryllium (Be)	ug/L	<0.010	7622363	<0.010	<0.010	<0.010	0.010	7622363
Dissolved Bismuth (Bi)	ug/L	<0.0050	7622363	<0.0050	<0.0050	<0.0050	0.0050	7622363
Dissolved Boron (B)	ug/L	<20	7622363	<20	<20	<20	20	7622363
Dissolved Cadmium (Cd)	ug/L	0.0170	7622363	0.0080	0.0120	<0.0050	0.0050	7622363
Dissolved Chromium (Cr)	ug/L	<0.10	7622363	<0.10	<0.10	<0.10	0.10	7622363
Dissolved Cobalt (Co)	ug/L	0.0380	7622363	0.0240	0.0340	<0.0050	0.0050	7622363
Dissolved Copper (Cu)	ug/L	0.313	7622363	0.501 (1)	0.280	<0.050	0.050	7622363
Dissolved Iron (Fe)	ug/L	65.9	7622363	80.3	74.9	1.2	1.0	7622363
Dissolved Lead (Pb)	ug/L	0.0320	7622363	0.0070	0.0110	0.0050	0.0050	7622363
Dissolved Lithium (Li)	ug/L	1.06	7622363	1.21	1.20	<0.50	0.50	7622363
Dissolved Manganese (Mn)	ug/L	11.9	7622363	8.27	17.6	<0.050	0.050	7622363
Dissolved Molybdenum (Mo)	ug/L	1.07	7627635	1.20	1.39	<0.050	0.050	7622363
Dissolved Nickel (Ni)	ug/L	0.477	7622363	0.287	0.492	0.022	0.020	7622363
Dissolved Selenium (Se)	ug/L	0.462	7622363	0.410	0.423	<0.040	0.040	7622363
Dissolved Silicon (Si)	ug/L	3110	7622363	3270	3220	<100	100	7622363
Dissolved Silver (Ag)	ug/L	0.0060	7622363	<0.0050	<0.0050	0.0160	0.0050	7622363
Dissolved Strontium (Sr)	ug/L	200	7622363	213	168	<0.050	0.050	7622363
Dissolved Thallium (Tl)	ug/L	<0.0020	7622363	<0.0020	<0.0020	<0.0020	0.0020	7622363
Dissolved Tin (Sn)	ug/L	0.51	7622363	<0.20	0.74	<0.20	0.20	7622363
Dissolved Titanium (Ti)	ug/L	<0.50	7622363	<0.50	<0.50	<0.50	0.50	7622363
Dissolved Uranium (U)	ug/L	1.23	7622363	0.829	0.873	<0.0020	0.0020	7622363
Dissolved Vanadium (V)	ug/L	<0.20	7622363	<0.20	<0.20	<0.20	0.20	7622363
Dissolved Zinc (Zn)	ug/L	0.89	7622363	0.13	0.38	0.51	0.10	7622363
Dissolved Zirconium (Zr)	ug/L	<0.10	7622363	<0.10	<0.10	<0.10	0.10	7622363
Dissolved Calcium (Ca)	mg/L	55.3	7616000	56.6	46.1	<0.050	0.050	7616000

RDL = Reportable Detection Limit
(1) Dissolved greater than total. Reanalysis yields similar results.

Maxxam Job #: B474948
Report Date: 2014/11/19

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

LOW LEVEL DISSOLVED METALS WITH CV HG (WATER)

Maxxam ID		KL2370		KL2371	KL2372	KL2373		
Sampling Date		2014/08/12 10:45		2014/08/12 12:30	2014/08/12 15:15	2014/08/12		
COC Number		446148-01-01		446148-01-01	446148-01-01	446148-01-01		
	Units	**MH-13**	**QC Batch**	**MH-16**	**MH-20**	**FIELD BLANK**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	12.5	7616000	13.6	11.4	<0.050	0.050	7616000
Dissolved Potassium (K)	mg/L	0.381	7616000	0.402	0.473	<0.050	0.050	7616000
Dissolved Sodium (Na)	mg/L	0.870	7616000	1.15	1.16	<0.050	0.050	7616000
Dissolved Sulphur (S)	mg/L	<3.0	7616000	<3.0	<3.0	<3.0	3.0	7616000
RDL = Reportable Detection Limit								

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Report Date: 2014/11/19

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

LOW LEVEL TOTAL METALS WITH CV HG (WATER)

Maxxam ID		KL2370	KL2371	KL2372		KL2373		
Sampling Date		2014/08/12 10:45	2014/08/12 12:30	2014/08/12 15:15		2014/08/12		
COC Number		446148-01-01	446148-01-01	446148-01-01		446148-01-01		
	Units	**MH-13**	**MH-16**	**MH-20**	**QC Batch**	**FIELD BLANK**	**RDL**	**QC Batch**
Calculated Parameters								
Total Hardness (CaCO3)	mg/L	184	210	163	7615935	<0.50	0.50	7615935
Elements								
Total Mercury (Hg)	ug/L	0.0023	<0.0020	0.0028	7625631	<0.0020	0.0020	7625631
Total Metals by ICPMS								
Total Aluminum (Al)	ug/L	15.1	11.9	13.9	7622378	0.64	0.50	7622378
Total Antimony (Sb)	ug/L	0.133	0.086	0.117	7622378	<0.020	0.020	7622378
Total Arsenic (As)	ug/L	0.580	0.446	0.446	7622378	<0.020	0.020	7622378
Total Barium (Ba)	ug/L	139	154	124	7622378	<0.020	0.020	7622378
Total Beryllium (Be)	ug/L	<0.010	<0.010	<0.010	7622378	<0.010	0.010	7622378
Total Bismuth (Bi)	ug/L	<0.0050	<0.0050	<0.0050	7622378	<0.0050	0.0050	7622378
Total Boron (B)	ug/L	<20	<20	<20	7622378	<20	20	7622378
Total Cadmium (Cd)	ug/L	0.0360	0.0140	0.0200	7622378	<0.0050	0.0050	7622378
Total Chromium (Cr)	ug/L	0.10	<0.10	<0.10	7622378	<0.10	0.10	7622378
Total Cobalt (Co)	ug/L	0.0740	0.0450	0.0550	7622378	<0.0050	0.0050	7622378
Total Copper (Cu)	ug/L	0.409	0.286	0.412	7622378	<0.050	0.050	7629591
Total Iron (Fe)	ug/L	309	231	181	7622378	<1.0	1.0	7622378
Total Lead (Pb)	ug/L	0.434	0.0870	0.0750	7622378	<0.0050	0.0050	7622378
Total Lithium (Li)	ug/L	1.15	1.21	1.37	7622378	<0.50	0.50	7622378
Total Manganese (Mn)	ug/L	29.8	16.1	20.9	7622378	<0.050	0.050	7622378
Total Molybdenum (Mo)	ug/L	1.08	1.06	1.24	7622378	<0.050	0.050	7622378
Total Nickel (Ni)	ug/L	0.533	0.348	0.635	7622378	<0.020	0.020	7629591
Total Selenium (Se)	ug/L	0.423	0.453	0.450	7622378	<0.040	0.040	7622378
Total Silicon (Si)	ug/L	2580	3300	3050	7622378	<100	100	7622378
Total Silver (Ag)	ug/L	<0.0050	<0.0050	<0.0050	7622378	0.0090	0.0050	7622378
Total Strontium (Sr)	ug/L	205	215	176	7622378	<0.050	0.050	7622378
Total Thallium (Tl)	ug/L	<0.0020	<0.0020	<0.0020	7622378	<0.0020	0.0020	7622378
Total Tin (Sn)	ug/L	<0.20	<0.20	<0.20	7622378	<0.20	0.20	7622378
Total Titanium (Ti)	ug/L	<0.50	<0.50	<0.50	7622378	<0.50	0.50	7622378
Total Uranium (U)	ug/L	1.29	0.863	0.899	7622378	<0.0020	0.0020	7622378
Total Vanadium (V)	ug/L	0.21	0.23	0.21	7622378	<0.20	0.20	7622378
Total Zinc (Zn)	ug/L	2.38	1.11	2.96	7622378	<0.10	0.10	7622378
Total Zirconium (Zr)	ug/L	<0.10	<0.10	<0.10	7622378	<0.10	0.10	7622378
Total Calcium (Ca)	mg/L	53.0	61.4	45.7	7616001	<0.050	0.050	7616001
Total Magnesium (Mg)	mg/L	12.6	13.8	11.8	7616001	<0.050	0.050	7616001
RDL = Reportable Detection Limit								

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Maxxam Job #: B474948
Report Date: 2014/11/19

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

LOW LEVEL TOTAL METALS WITH CV HG (WATER)

Maxxam ID		KL2370	KL2371	KL2372		KL2373		
Sampling Date		2014/08/12 10:45	2014/08/12 12:30	2014/08/12 15:15		2014/08/12		
COC Number		446148-01-01	446148-01-01	446148-01-01		446148-01-01		
	Units	**MH-13**	**MH-16**	**MH-20**	**QC Batch**	**FIELD BLANK**	**RDL**	**QC Batch**
Total Potassium (K)	mg/L	0.404	0.422	0.478	7616001	<0.050	0.050	7616001
Total Sodium (Na)	mg/L	0.907	1.29	1.30	7616001	<0.050	0.050	7616001
Total Sulphur (S)	mg/L	<3.0	<3.0	<3.0	7616001	<3.0	3.0	7616001
RDL = Reportable Detection Limit								

GENERAL COMMENTS

Sample KL2366-01 : Revised Report (Version: 3): Due to client request, sample was reanalyzed for metals. The results from the reanalysis are included in this report.

Sample KL2370, Elements by ICPMS Low Level (dissolved): Test repeated.
Sample KL2373, Elements by ICPMS Low Level (total): Test repeated.

Results relate only to the items tested.

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Maxxam Job #: B474948
Report Date: 2014/11/19

QUALITY ASSURANCE REPORT

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7616272	Total Suspended Solids	2014/08/27	109	80 - 120	108	80 - 120	<4.0	mg/L	NC	20		
7617250	Alkalinity (PP as CaCO3)	2014/08/27					<0.50	mg/L	NC	20		
7617250	Alkalinity (Total as CaCO3)	2014/08/27	NC	80 - 120	100	80 - 120	<0.50	mg/L	0.22	20		
7617250	Bicarbonate (HCO3)	2014/08/27					<0.50	mg/L	0.22	20		
7617250	Carbonate (CO3)	2014/08/27					<0.50	mg/L	NC	20		
7617250	Hydroxide (OH)	2014/08/27					<0.50	mg/L	NC	20		
7617252	pH	2014/08/27			101	97 - 103			0.53	N/A		
7617254	Conductivity	2014/08/27			98	80 - 120	<1.0	uS/cm	0.31	20		
7617255	Alkalinity (PP as CaCO3)	2014/08/28					<0.50	mg/L	NC	20		
7617255	Alkalinity (Total as CaCO3)	2014/08/28	92	80 - 120	99	80 - 120	<0.50	mg/L	NC	20		
7617255	Bicarbonate (HCO3)	2014/08/28					<0.50	mg/L	NC	20		
7617255	Carbonate (CO3)	2014/08/28					<0.50	mg/L	NC	20		
7617255	Hydroxide (OH)	2014/08/28					<0.50	mg/L	NC	20		
7617256	pH	2014/08/28			101	97 - 103			1.7	N/A		
7617257	Conductivity	2014/08/28			100	80 - 120	<1.0	uS/cm	NC	20		
7617941	Total Suspended Solids	2014/08/29	120	80 - 120	101	80 - 120	<4.0	mg/L	4.0 (1)	20		
7617953	Total Suspended Solids	2014/08/29	101	80 - 120	98	80 - 120	<4.0	mg/L	NC	20		
7618981	Dissolved Mercury (Hg)	2014/09/02	105	80 - 120	112	80 - 120	<0.0020	ug/L	NC	20		
7619030	Dissolved Sulphate (SO4)	2014/08/28			91	80 - 120	0.52, RDL=0.50	mg/L				
7619667	Total Ammonia (N)	2014/08/28	93	80 - 120	101	80 - 120	0.0050, RDL=0.0050	mg/L	1.1	20		
7622283	Total Aluminum (Al)	2014/09/03					<100	mg/kg	0.92	35	118	70 - 130
7622283	Total Antimony (Sb)	2014/09/03	97	75 - 125	100	75 - 125	<0.10	mg/kg	NC	30	103	70 - 130
7622283	Total Arsenic (As)	2014/09/03	96	75 - 125	101	75 - 125	<0.50	mg/kg	3.8	30	101	70 - 130
7622283	Total Barium (Ba)	2014/09/03	NC	75 - 125	103	75 - 125	<0.10	mg/kg	0.58	35	105	70 - 130
7622283	Total Beryllium (Be)	2014/09/03	97	75 - 125	99	75 - 125	<0.40	mg/kg	NC	30		
7622283	Total Bismuth (Bi)	2014/09/03					<0.10	mg/kg	NC	30		
7622283	Total Boron (B)	2014/09/03							NC	30		
7622283	Total Cadmium (Cd)	2014/09/03	97	75 - 125	106	75 - 125	<0.050	mg/kg	NC	30	106	70 - 130
7622283	Total Calcium (Ca)	2014/09/03					<100	mg/kg	5.5	30	100	70 - 130
7622283	Total Chromium (Cr)	2014/09/03	NC	75 - 125	98	75 - 125	<1.0	mg/kg	3.8	30	103	70 - 130

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QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7622283	Total Cobalt (Co)	2014/09/03	91	75 - 125	99	75 - 125	<0.30	mg/kg	1.6	30	91	70 - 130
7622283	Total Copper (Cu)	2014/09/03	102	75 - 125	108	75 - 125	<0.50	mg/kg	0.89	30	94	70 - 130
7622283	Total Iron (Fe)	2014/09/03					<100	mg/kg	0.90	30	101	70 - 130
7622283	Total Lead (Pb)	2014/09/03	102	75 - 125	108	75 - 125	0.13, RDL=0.10	mg/kg	7.4	35	103	70 - 130
7622283	Total Lithium (Li)	2014/09/03	93	75 - 125	98	75 - 125	<5.0	mg/kg	NC	30		
7622283	Total Magnesium (Mg)	2014/09/03					<100	mg/kg	4.2	30	97	70 - 130
7622283	Total Manganese (Mn)	2014/09/03	NC	75 - 125	99	75 - 125	<0.20	mg/kg	5.7	30	98	70 - 130
7622283	Total Mercury (Hg)	2014/09/03	99	75 - 125	102	75 - 125	<0.050	mg/kg	NC	35	96	70 - 130
7622283	Total Molybdenum (Mo)	2014/09/03	106	75 - 125	101	75 - 125	<0.10	mg/kg	5.3	35	122	70 - 130
7622283	Total Nickel (Ni)	2014/09/03	NC	75 - 125	104	75 - 125	<0.80	mg/kg	2.0	30	94	70 - 130
7622283	Total Phosphorus (P)	2014/09/03					<10	mg/kg	10	30	89	70 - 130
7622283	Total Potassium (K)	2014/09/03					<100	mg/kg	0.58	35		
7622283	Total Selenium (Se)	2014/09/03	97	75 - 125	107	75 - 125	<0.50	mg/kg	NC	30		
7622283	Total Silver (Ag)	2014/09/03	95	75 - 125	98	75 - 125	<0.050	mg/kg	NC	35		
7622283	Total Sodium (Na)	2014/09/03					<100	mg/kg	NC	35		
7622283	Total Strontium (Sr)	2014/09/03	NC	75 - 125	98	75 - 125	<0.10	mg/kg	0.86	35	107	70 - 130
7622283	Total Sulphur (S)	2014/09/03							NC	30		
7622283	Total Tellurium (Te)	2014/09/03							NC	30		
7622283	Total Thallium (Tl)	2014/09/03	99	75 - 125	103	75 - 125	<0.050	mg/kg	NC	30	93	70 - 130
7622283	Total Thorium (Th)	2014/09/03							3.3	30		
7622283	Total Tin (Sn)	2014/09/03	96	75 - 125	98	75 - 125	<0.10	mg/kg	NC	35		
7622283	Total Titanium (Ti)	2014/09/03	NC	75 - 125	92	75 - 125	<1.0	mg/kg	2.6	35	107	70 - 130
7622283	Total Tungsten (W)	2014/09/03							NC	30		
7622283	Total Uranium (U)	2014/09/03	102	75 - 125	103	75 - 125	<0.050	mg/kg	0.16	30	102	70 - 130
7622283	Total Vanadium (V)	2014/09/03	NC	75 - 125	97	75 - 125	<2.0	mg/kg	5.8	30	102	70 - 130
7622283	Total Zinc (Zn)	2014/09/03	NC	75 - 125	110	75 - 125	<1.0	mg/kg	4.4	30	91	70 - 130
7622283	Total Zirconium (Zr)	2014/09/03					<0.50	mg/kg	3.9	30		
7622305	Soluble (2:1) pH	2014/09/03			101	97 - 103			0.29	N/A		
7622363	Dissolved Aluminum (Al)	2014/09/04	104	80 - 120	100	80 - 120	<0.50	ug/L	NC	20		
7622363	Dissolved Antimony (Sb)	2014/09/04	97	80 - 120	97	80 - 120	<0.020	ug/L	NC	20		
7622363	Dissolved Arsenic (As)	2014/09/04	100	80 - 120	97	80 - 120	<0.020	ug/L	2.2	20		

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QUALITY ASSURANCE REPORT(CONT'D)

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7622363	Dissolved Barium (Ba)	2014/09/04	NC	80 - 120	99	80 - 120	<0.020	ug/L	0.60	20		
7622363	Dissolved Beryllium (Be)	2014/09/04	103	80 - 120	101	80 - 120	<0.010	ug/L	NC	20		
7622363	Dissolved Bismuth (Bi)	2014/09/04	100	80 - 120	99	80 - 120	<0.0050	ug/L	NC	20		
7622363	Dissolved Boron (B)	2014/09/04					<20	ug/L	NC	20		
7622363	Dissolved Cadmium (Cd)	2014/09/04	100	80 - 120	100	80 - 120	<0.0050	ug/L	NC	20		
7622363	Dissolved Calcium (Ca)	2014/09/04							0.49	20		
7622363	Dissolved Cesium (Cs)	2014/09/04							NC	20		
7622363	Dissolved Chromium (Cr)	2014/09/04	98	80 - 120	98	80 - 120	<0.10	ug/L	NC	20		
7622363	Dissolved Cobalt (Co)	2014/09/04	99	80 - 120	101	80 - 120	<0.0050	ug/L	NC	20		
7622363	Dissolved Copper (Cu)	2014/09/04	97	80 - 120	97	80 - 120	<0.050	ug/L	NC	20		
7622363	Dissolved Iron (Fe)	2014/09/04	95	80 - 120	105	80 - 120	<1.0	ug/L	5.8	20		
7622363	Dissolved Lanthanum (La)	2014/09/04							NC	20		
7622363	Dissolved Lead (Pb)	2014/09/04	98	80 - 120	100	80 - 120	<0.0050	ug/L	0	20		
7622363	Dissolved Lithium (Li)	2014/09/04	104	80 - 120	101	80 - 120	<0.50	ug/L	NC	20		
7622363	Dissolved Magnesium (Mg)	2014/09/04							7.0	20		
7622363	Dissolved Manganese (Mn)	2014/09/04	NC	80 - 120	100	80 - 120	<0.050	ug/L	1.1	20		
7622363	Dissolved Mercury (Hg)	2014/09/04							NC	20		
7622363	Dissolved Molybdenum (Mo)	2014/09/04	NC	80 - 120	93	80 - 120	<0.050	ug/L	2.3	20		
7622363	Dissolved Nickel (Ni)	2014/09/04	98	80 - 120	101	80 - 120	<0.020	ug/L	0	20		
7622363	Dissolved Phosphorus (P)	2014/09/04							2.7	20		
7622363	Dissolved Potassium (K)	2014/09/04							0.37	20		
7622363	Dissolved Rubidium (Rb)	2014/09/04							0.19	20		
7622363	Dissolved Selenium (Se)	2014/09/04	97	80 - 120	98	80 - 120	<0.040	ug/L	NC	20		
7622363	Dissolved Silicon (Si)	2014/09/04					<100	ug/L	0.51	20		
7622363	Dissolved Silver (Ag)	2014/09/04	106	80 - 120	96	80 - 120	<0.0050	ug/L	NC	20		
7622363	Dissolved Sodium (Na)	2014/09/04							2.6	20		
7622363	Dissolved Strontium (Sr)	2014/09/04	NC	80 - 120	99	80 - 120	<0.050	ug/L	0.94	20		
7622363	Dissolved Sulphur (S)	2014/09/04							2.8	20		
7622363	Dissolved Tellurium (Te)	2014/09/04							NC	20		
7622363	Dissolved Thallium (Tl)	2014/09/04	99	80 - 120	102	80 - 120	<0.0020	ug/L	NC	20		
7622363	Dissolved Thorium (Th)	2014/09/04							NC	20		
7622363	Dissolved Tin (Sn)	2014/09/04	90	80 - 120	103	80 - 120	<0.20	ug/L	NC	20		

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QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7622363	Dissolved Titanium (Ti)	2014/09/04	101	80 - 120	98	80 - 120	<0.50	ug/L	NC	20		
7622363	Dissolved Tungsten (W)	2014/09/04							0.28	20		
7622363	Dissolved Uranium (U)	2014/09/04	99	80 - 120	98	80 - 120	<0.0020	ug/L	0.39	20		
7622363	Dissolved Vanadium (V)	2014/09/04	105	80 - 120	101	80 - 120	<0.20	ug/L	NC	20		
7622363	Dissolved Zinc (Zn)	2014/09/04	104	80 - 120	114	80 - 120	<0.10	ug/L	1.0	20		
7622363	Dissolved Zirconium (Zr)	2014/09/04					<0.10	ug/L	NC	20		
7622378	Total Aluminum (Al)	2014/09/03	NC	80 - 120	101	80 - 120	<0.50	ug/L	1.1	20		
7622378	Total Antimony (Sb)	2014/09/03	100	80 - 120	95	80 - 120	<0.020	ug/L	NC	20		
7622378	Total Arsenic (As)	2014/09/03	99	80 - 120	98	80 - 120	<0.020	ug/L	2.4	20		
7622378	Total Barium (Ba)	2014/09/03	NC	80 - 120	94	80 - 120	<0.020	ug/L	0.67	20		
7622378	Total Beryllium (Be)	2014/09/03	94	80 - 120	94	80 - 120	<0.010	ug/L	NC	20		
7622378	Total Bismuth (Bi)	2014/09/03	101	80 - 120	93	80 - 120	<0.0050	ug/L	NC	20		
7622378	Total Boron (B)	2014/09/03					<20	ug/L	NC	20		
7622378	Total Cadmium (Cd)	2014/09/03	96	80 - 120	97	80 - 120	<0.0050	ug/L	2.5	20		
7622378	Total Calcium (Ca)	2014/09/03							1.8	20		
7622378	Total Cesium (Cs)	2014/09/03							NC	20		
7622378	Total Chromium (Cr)	2014/09/03	100	80 - 120	100	80 - 120	<0.10	ug/L	NC	20		
7622378	Total Cobalt (Co)	2014/09/03	102	80 - 120	100	80 - 120	<0.0050	ug/L	1.8	20		
7622378	Total Copper (Cu)	2014/09/03	96	80 - 120	99	80 - 120	<0.050	ug/L	1.4	20		
7622378	Total Iron (Fe)	2014/09/03	NC	80 - 120	108	80 - 120	<1.0	ug/L	1.5	20		
7622378	Total Lanthanum (La)	2014/09/03							NC	20		
7622378	Total Lead (Pb)	2014/09/03	100	80 - 120	96	80 - 120	<0.0050	ug/L	6.9	20		
7622378	Total Lithium (Li)	2014/09/03	90	80 - 120	90	80 - 120	<0.50	ug/L	NC	20		
7622378	Total Magnesium (Mg)	2014/09/03							1.0	20		
7622378	Total Manganese (Mn)	2014/09/03	NC	80 - 120	98	80 - 120	<0.050	ug/L	5.2	20		
7622378	Total Mercury (Hg)	2014/09/03							NC	20		
7622378	Total Molybdenum (Mo)	2014/09/03	NC	80 - 120	95	80 - 120	<0.050	ug/L	0.22	20		
7622378	Total Nickel (Ni)	2014/09/03	102	80 - 120	106	80 - 120	<0.020	ug/L	1.3	20		
7622378	Total Potassium (K)	2014/09/03							3.9	20		
7622378	Total Rubidium (Rb)	2014/09/03							NC	20		
7622378	Total Selenium (Se)	2014/09/03	92	80 - 120	97	80 - 120	<0.040	ug/L	NC	20		
7622378	Total Silicon (Si)	2014/09/03					<100	ug/L	7.5	20		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7622378	Total Silver (Ag)	2014/09/03	94	80 - 120	91	80 - 120	<0.0050	ug/L	NC	20		
7622378	Total Sodium (Na)	2014/09/03							1.1	20		
7622378	Total Strontium (Sr)	2014/09/03	NC	80 - 120	98	80 - 120	<0.050	ug/L	3.1	20		
7622378	Total Sulphur (S)	2014/09/03							5.8	20		
7622378	Total Tellurium (Te)	2014/09/03							NC	20		
7622378	Total Thallium (Tl)	2014/09/03	96	80 - 120	94	80 - 120	<0.0020	ug/L	NC	20		
7622378	Total Thorium (Th)	2014/09/03							NC	20		
7622378	Total Tin (Sn)	2014/09/03	101	80 - 120	95	80 - 120	<0.20	ug/L	NC	20		
7622378	Total Titanium (Ti)	2014/09/03	101	80 - 120	91	80 - 120	<0.50	ug/L	NC	20		
7622378	Total Tungsten (W)	2014/09/03							NC	20		
7622378	Total Uranium (U)	2014/09/03	100	80 - 120	94	80 - 120	<0.0020	ug/L	0	20		
7622378	Total Vanadium (V)	2014/09/03	104	80 - 120	96	80 - 120	<0.20	ug/L	NC	20		
7622378	Total Zinc (Zn)	2014/09/03	NC	80 - 120	122 (2)	80 - 120	<0.10	ug/L	1.3	20		
7622378	Total Zirconium (Zr)	2014/09/03					<0.10	ug/L	NC	20		
7625631	Total Mercury (Hg)	2014/09/05	88	80 - 120	102	80 - 120	<0.0020	ug/L	NC	20		
7627635	Dissolved Aluminum (Al)	2014/09/08							NC	20		
7627635	Dissolved Antimony (Sb)	2014/09/08							1.6	20		
7627635	Dissolved Arsenic (As)	2014/09/08							NC	20		
7627635	Dissolved Barium (Ba)	2014/09/08							NC	20		
7627635	Dissolved Beryllium (Be)	2014/09/08							NC	20		
7627635	Dissolved Bismuth (Bi)	2014/09/08							NC	20		
7627635	Dissolved Boron (B)	2014/09/08							NC	20		
7627635	Dissolved Cadmium (Cd)	2014/09/08							NC	20		
7627635	Dissolved Calcium (Ca)	2014/09/08							NC	20		
7627635	Dissolved Cesium (Cs)	2014/09/08							NC	20		
7627635	Dissolved Chromium (Cr)	2014/09/08							NC	20		
7627635	Dissolved Cobalt (Co)	2014/09/08							NC	20		
7627635	Dissolved Copper (Cu)	2014/09/08							NC	20		
7627635	Dissolved Iron (Fe)	2014/09/08							NC	20		
7627635	Dissolved Lanthanum (La)	2014/09/08							NC	20		
7627635	Dissolved Lead (Pb)	2014/09/08							NC	20		
7627635	Dissolved Lithium (Li)	2014/09/08							NC	20		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7627635	Dissolved Magnesium (Mg)	2014/09/08							NC	20		
7627635	Dissolved Manganese (Mn)	2014/09/08							NC	20		
7627635	Dissolved Mercury (Hg)	2014/09/08							NC	20		
7627635	Dissolved Molybdenum (Mo)	2014/09/08	101	80 - 120	92	80 - 120	<0.050	ug/L	NC	20		
7627635	Dissolved Phosphorus (P)	2014/09/08							NC	20		
7627635	Dissolved Potassium (K)	2014/09/08							NC	20		
7627635	Dissolved Rubidium (Rb)	2014/09/08							NC	20		
7627635	Dissolved Selenium (Se)	2014/09/08							NC	20		
7627635	Dissolved Silicon (Si)	2014/09/08							NC	20		
7627635	Dissolved Sodium (Na)	2014/09/08							NC	20		
7627635	Dissolved Strontium (Sr)	2014/09/08							NC	20		
7627635	Dissolved Sulphur (S)	2014/09/08							NC	20		
7627635	Dissolved Tellurium (Te)	2014/09/08							NC	20		
7627635	Dissolved Thallium (Tl)	2014/09/08							NC	20		
7627635	Dissolved Thorium (Th)	2014/09/08							NC	20		
7627635	Dissolved Tin (Sn)	2014/09/08							NC	20		
7627635	Dissolved Titanium (Ti)	2014/09/08							NC	20		
7627635	Dissolved Tungsten (W)	2014/09/08							NC	20		
7627635	Dissolved Uranium (U)	2014/09/08							NC	20		
7627635	Dissolved Vanadium (V)	2014/09/08							NC	20		
7627635	Dissolved Zinc (Zn)	2014/09/08							NC	20		
7627635	Dissolved Zirconium (Zr)	2014/09/08							NC	20		
7629591	Total Aluminum (Al)	2014/09/08							NC	20		
7629591	Total Antimony (Sb)	2014/09/08							NC	20		
7629591	Total Arsenic (As)	2014/09/08							NC	20		
7629591	Total Barium (Ba)	2014/09/08							NC	20		
7629591	Total Beryllium (Be)	2014/09/08							NC	20		
7629591	Total Bismuth (Bi)	2014/09/08							NC	20		
7629591	Total Boron (B)	2014/09/08							NC	20		
7629591	Total Cadmium (Cd)	2014/09/08							NC	20		
7629591	Total Calcium (Ca)	2014/09/08							NC	20		
7629591	Total Cesium (Cs)	2014/09/08							NC	20		

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QUALITY ASSURANCE REPORT(CONT'D)

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7629591	Total Chromium (Cr)	2014/09/08							NC	20		
7629591	Total Cobalt (Co)	2014/09/08							NC	20		
7629591	Total Copper (Cu)	2014/09/08	91	80 - 120	92	80 - 120	<0.050	ug/L	NC	20		
7629591	Total Iron (Fe)	2014/09/08							NC	20		
7629591	Total Lanthanum (La)	2014/09/08							NC	20		
7629591	Total Lead (Pb)	2014/09/08							NC	20		
7629591	Total Lithium (Li)	2014/09/08							NC	20		
7629591	Total Magnesium (Mg)	2014/09/08							NC	20		
7629591	Total Manganese (Mn)	2014/09/08							NC	20		
7629591	Total Mercury (Hg)	2014/09/08							NC	20		
7629591	Total Molybdenum (Mo)	2014/09/08							NC	20		
7629591	Total Nickel (Ni)	2014/09/08	93	80 - 120	96	80 - 120	<0.020	ug/L	NC	20		
7629591	Total Phosphorus (P)	2014/09/08							NC	20		
7629591	Total Potassium (K)	2014/09/08							NC	20		
7629591	Total Rubidium (Rb)	2014/09/08							NC	20		
7629591	Total Selenium (Se)	2014/09/08							NC	20		
7629591	Total Silicon (Si)	2014/09/08							NC	20		
7629591	Total Sodium (Na)	2014/09/08							NC	20		
7629591	Total Strontium (Sr)	2014/09/08							NC	20		
7629591	Total Sulphur (S)	2014/09/08							NC	20		
7629591	Total Tellurium (Te)	2014/09/08							NC	20		
7629591	Total Thallium (Tl)	2014/09/08							NC	20		
7629591	Total Thorium (Th)	2014/09/08							NC	20		
7629591	Total Tin (Sn)	2014/09/08							NC	20		
7629591	Total Titanium (Ti)	2014/09/08							NC	20		
7629591	Total Tungsten (W)	2014/09/08							NC	20		
7629591	Total Uranium (U)	2014/09/08							NC	20		
7629591	Total Vanadium (V)	2014/09/08							NC	20		
7629591	Total Zinc (Zn)	2014/09/08							NC	20		
7629591	Total Zirconium (Zr)	2014/09/08							NC	20		
7629947	Total Ammonia (N)	2014/09/08	NC	80 - 120	101	80 - 120	<0.0050	mg/L	0.41	20		
7640941	Total Boron (B)	2014/09/17							NC	30		

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QUALITY ASSURANCE REPORT(CONT'D)

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7640941	Total Sulphur (S)	2014/09/17							NC	30		
7640941	Total Tellurium (Te)	2014/09/17							NC	30		
7640941	Total Thorium (Th)	2014/09/17							9.5	30		
7640941	Total Tungsten (W)	2014/09/17							NC	30		
7712166	Total Aluminum (Al)	2014/11/10					<100	mg/kg	0.75	35	115	70 - 130
7712166	Total Antimony (Sb)	2014/11/10	101	75 - 125	93	75 - 125	<0.10	mg/kg	NC	30	97	70 - 130
7712166	Total Arsenic (As)	2014/11/10	106	75 - 125	100	75 - 125	<0.50	mg/kg	NC	30	104	70 - 130
7712166	Total Barium (Ba)	2014/11/10	NC	75 - 125	102	75 - 125	<0.10	mg/kg	22	35	103	70 - 130
7712166	Total Beryllium (Be)	2014/11/10	105	75 - 125	100	75 - 125	<0.40	mg/kg	NC	30		
7712166	Total Bismuth (Bi)	2014/11/10					<0.10	mg/kg	NC	30		
7712166	Total Boron (B)	2014/11/10							NC	30		
7712166	Total Cadmium (Cd)	2014/11/10	109	75 - 125	104	75 - 125	<0.050	mg/kg	NC	30	110	70 - 130
7712166	Total Calcium (Ca)	2014/11/10					<100	mg/kg	4.4	30	104	70 - 130
7712166	Total Chromium (Cr)	2014/11/10	102	75 - 125	102	75 - 125	<1.0	mg/kg	2.4	30	115	70 - 130
7712166	Total Cobalt (Co)	2014/11/10	108	75 - 125	105	75 - 125	<0.30	mg/kg	6.3	30	104	70 - 130
7712166	Total Copper (Cu)	2014/11/10	108	75 - 125	106	75 - 125	<0.50	mg/kg	8.6	30	100	70 - 130
7712166	Total Iron (Fe)	2014/11/10					<100	mg/kg	0.13	30	106	70 - 130
7712166	Total Lead (Pb)	2014/11/10	109	75 - 125	104	75 - 125	<0.10	mg/kg	4.1	35	109	70 - 130
7712166	Total Lithium (Li)	2014/11/10	105	75 - 125	98	75 - 125	<5.0	mg/kg	NC	30		
7712166	Total Magnesium (Mg)	2014/11/10					<100	mg/kg	1.3	30	104	70 - 130
7712166	Total Manganese (Mn)	2014/11/10	NC	75 - 125	104	75 - 125	<0.20	mg/kg	0.27	30	103	70 - 130
7712166	Total Mercury (Hg)	2014/11/10	108	75 - 125	100	75 - 125	<0.050	mg/kg	NC	35	98	70 - 130
7712166	Total Molybdenum (Mo)	2014/11/10	109	75 - 125	103	75 - 125	<0.10	mg/kg	NC	35	117	70 - 130
7712166	Total Nickel (Ni)	2014/11/10	109	75 - 125	102	75 - 125	<0.80	mg/kg	1.3	30	100	70 - 130
7712166	Total Phosphorus (P)	2014/11/10					<10	mg/kg	3.0	30	103	70 - 130
7712166	Total Potassium (K)	2014/11/10					<100	mg/kg	2.7	35		
7712166	Total Selenium (Se)	2014/11/10	109	75 - 125	106	75 - 125	<0.50	mg/kg	NC	30		
7712166	Total Silver (Ag)	2014/11/10	90	75 - 125	81	75 - 125	<0.050	mg/kg	NC	35		
7712166	Total Sodium (Na)	2014/11/10					<100	mg/kg	NC	35		
7712166	Total Strontium (Sr)	2014/11/10	NC	75 - 125	101	75 - 125	<0.10	mg/kg	4.3	35	106	70 - 130
7712166	Total Sulphur (S)	2014/11/10							NC	30		
7712166	Total Tellurium (Te)	2014/11/10							NC	30		

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TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7712166	Total Thallium (Tl)	2014/11/10	106	75 - 125	101	75 - 125	<0.050	mg/kg	NC	30	101	70 - 130
7712166	Total Thorium (Th)	2014/11/10							0.27	30		
7712166	Total Tin (Sn)	2014/11/10	101	75 - 125	93	75 - 125	<0.10	mg/kg	NC	35		
7712166	Total Titanium (Ti)	2014/11/10	NC	75 - 125	97	75 - 125	<1.0	mg/kg	2.5	35	120	70 - 130
7712166	Total Tungsten (W)	2014/11/10							NC	30		
7712166	Total Uranium (U)	2014/11/10	105	75 - 125	99	75 - 125	<0.050	mg/kg	4.1	30	106	70 - 130
7712166	Total Vanadium (V)	2014/11/10	NC	75 - 125	101	75 - 125	<2.0	mg/kg	0.59	30	116	70 - 130
7712166	Total Zinc (Zn)	2014/11/10	NC	75 - 125	109	75 - 125	<1.0	mg/kg	13	30	96	70 - 130
7712166	Total Zirconium (Zr)	2014/11/10					<0.50	mg/kg	5.0	30		
ONSITE	Cylinder Rental Fee								0	N/A		
ONSITE	Each	2014/09/30							0	N/A		
ONSITE	No Parameter								0	N/A		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) RDL raised due to high concentration of solids in the sample.

(2) Blank Spike outside acceptance criteria (10% of analytes failure allowed).

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B474948
Report Date: 2014/11/19

TECK RESOURCES LTD.
Client Project #: SA DENA HES
Site Location: SA DENA HES, YUKON
Sampler Initials: BB

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Rob Reinert, Data Validation Coordinator

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

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Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Maxxam Job #: B474948 **COC #:** 08396251

Page: 1 of 2

Invoice To: Require Report? Yes ☑ No ☐

	Invoice To		Report To		
Company Name:	Teck Resources Ltd	Company Name:	Laberge Environmental Services	PO #:	
Contact Name:	Dave Ryder	Contact Name:	Bonnie Burns	Quotation #:	
Address:	Bag 2000	Address:	P.O. Box 21072	Project #:	
	Kimberley, BC PC: V1A 3E1		Whitehorse, YT PC: Y1A 6P7	Proj. Name:	Sa Dena Hes
Phone / Fax#:	Ph: 867-668-6838 Fax: 867-667-6956	Phone / Fax#:	Ph: 867-668-6838 Fax: 867-667-6956	Location:	Sa Dena Hes, Yukon
E-mail	Dave.Ryder@teck.com	E-mail	bonnieburns@northwestel.net	Sampled by:	Bonnie Burns

REGULATORY REQUIREMENTS:
- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:
- ◉ Regular Turn Around Time (TAT) (5 days for most tests)
- **RUSH** (Please contact the lab) ○ 1 Day ○ 2 Day ○ 3 Day
- Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

#	Sample Identification	Lab Identification (Lab Use Only)	Sample Type	Date/Time(24hr) Sampled	Field Filtered? Y/N Dissolved Metals (DM)	Field Acidified? Y/N	Field Acidified? Y/N Total Metals	dry and thoroughly mix	sieve through a 100 mesh screen (size 0.15 mm)	analyze portion passing sieve for metals	Number of Containers
1	MH-13A	KL2359		12/08/14 11:15				X	X	X	1
2	MH-13B	KL2360		12/08/14 11:15				X	X	X	1
3	MH-13C	KL2361		12/08/14 11:15				X	X	X	1
4	MH-16A	KL2362		12/08/14 13:00				X	X	X	1
5	MH-16B	KL2363		12/08/14 13:00				X	X	X	1
6	MH-16C	KL2364		12/08/14 13:00				X	X	X	1
7	MH-20A	KL2365		12/08/14 15:30				X	X	X	1
8	MH-20B	KL2366		12/08/14 15:30				X	X	X	1
9	MH-20C	KL2367		12/08/14 15:30							
10	NOTE THESE ARE SOIL SAMPLES BUT THERE IS NO DESIGNATION FOR THAT.										
11											
12											

B474948

*Relinquished By: (Print name and sign)	Date (yy/mm/dd):	Time (24hr):	Received by: (Print name and sign)	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive
			[illegible signature]	2014/08/26	12:45	☐

Laboratory Use Only

Temperature on Receipt (°C): A) 9 B) 8 C) 9

Just sampled & rec'd on ice ☐

Custody Seal: Present? Yes ☐ No ☑; Intact? Yes ☐ No ☐ N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

BBY FCD-00077/R1_C

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4606 Canada Way, Burnaby, British Columbia Canada V5G 1K5 Tel:(604) 734 7276 Toll-Free:800-563-6266 Fax:(604) 731 2386 www.maxxam.ca

Chain Of Custody Record Page of

INVOICE INFORMATION:		Report Information		Project Information		Laboratory Use Only	
Company Name	#1787 TECK RESOURCES LTD.	Company Name	#26043 LABERGE ENVIRONMENTAL SERVICES	Quotation #	B30782	Maxxam Job #	Bottle Order #:
Contact Name	Purchasing Kimberley	Contact Name	BONNIE BURNS	P.O. #		B474948	446148
Address	BAG 2000 601 Knighton Rd.	Address	P.O. BOX 21072	Project #	SA DENA HES	Chain Of Custody Record	Project Manager
	KIMBERLEY BC V1A 3E1		WHITEHORSE YT Y1A6P7	Project Name		C#446148-01-01	Ken Pomeroy
Phone	(250) 427-8409 Fax (250) 427-8451	Phone	(867) 668-6838 Fax	Site #			
Email	Roxanne.Menear@teck.com	Email	BONNIEBURNS@Northwestel.net	Sampled By			

Regulatory Criteria:
- [ ] CSR
- [x] CCME
- [ ] BC Water Quality
- [ ] Other

Special Instructions: I don't have enough COC forms so the sediment samples COC is send digitally.

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects
Regular (Standard) TAT: (will be applied if Rush TAT is not specified) Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.
Job Specific Rush TAT (if applies to entire submission)
1 DAY [ ] 2 Day [ ] 3 Day [ ] Date Required: ____
Rush Confirmation Number: ____ (call lab for #)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Metals Field Filtered ? (Y / N)	Ammonia	Sulphate	Total Suspended Solids	Alkalinity	Conductance	pH	Low Level Dissolved Metals with CV Hg (incl. Hardness)	Low Level Total Metals with CV Hg			# of Bottles	Comments
1	KL2370	MH-13			H_2O	✓	L	L	L	L	L	L	L	L			8	
2	KL2371	MH-16			H_2O	✓	L	L	L	L	L	L	L	L			8	
3	KL2372	MH-20			H_2O	✓	L	✓	L	L	L	L	L	L			8	
4	KL2373	Field Blank			H_2O	✓	L	L	L	L	L	L	L	L			8	
5	There are a total of 15																	
6	sediment samples included																	
7	in this shipment.																	
8																		
9																		B474948
10																		

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Time Sensitive	Temperature (°C) on Receipt	Custody Seal Intact on Cooler?
			Laurel Berthier	2014/08/26	12:45		[ ]	9,8,9 / 10,8,9 / 9,9,9	NA [ ] Yes [ ] No

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

Maxxam

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Maxxam Job #: B474948 COC # 08396252

CHAIN OF CUSTODY RECORD

Page: 2 of 2

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Teck Resources Ltd
Contact Name: Dave Ryder
Address: Bag 2000, Kimberley, BC PC: V1A 3E1
Phone / Fax#: Ph: Fax:
E-mail: Dave.Ryder@teck.com

Report To:

Company Name: Laberge Environmental Services
Contact Name: Bonnie Burns
Address: P.O. Box 21072, Whitehorse, YT PC: Y1A 6P7
Phone / Fax#: Ph: 867-668-6838 Fax: 867-667-6956
E-mail: bonnieburns@northwestel.net

PO #:
Quotation #:
Project # :
Proj. Name: Sa Dena Hes
Location: Sa Dena Hes, Yukon
Sampled by: Bonnie Burns

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

- ◉ Regular Turn Around Time (TAT) (5 days for most tests)
- **RUSH** (Please contact the lab) ○ 1 Day ○ 2 Day ○ 3 Day
- Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

Field Filtered? Y/N ☐ · Field Acidified? Y/N ☐ · Field Acidified? Y/N ☐

	Sample Identification	Lab Identification (Lab Use Only)	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM)	Total Metals	Ammonia	SO4	TSS	Alkalinity	Hardness	Conductivity	pH	Low level dissolved metals	low level total metals	Number of Containers
1	MH-13	KL2370		12/08/14 10:45	X	X	X	X	X	X	X	X	X	X	X	5
2	MH-16	KL2371		12/08/14 12:30	X	X	X	X	X	X	X	X	X	X	X	5
3	MH-20	KL2372		12/08/14 15:15	X	X	X	X	X	X	X	X	X	X	X	5
4	BD (blind duplicate)	KL2373		12/08/14	X	X	X	X	X	X	X	X	X	X	X	
5																
6																
7																
8																
9																
10																
11																
12																

B474948

*Relinquished By: (Print name and sign)	Date (yy/mm/dd):	Time (24hr):	Received by: (Print name and sign)	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
			[signature]	2014/08/26	12:45	☐	A) 9 B) 8 C) 9	Present?	☐	☑
							Just sampled & rec'd on ice: ☐	Intact?	☐	☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

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CHAIN OF CUSTODY RECORD

Maxxam Job #: B474948 COC #: Click here to get the COC number Page: 1 of 2

Invoice To: Require Report? Yes ☑ No ☐

Company Name:	Teck Resources Ltd
Contact Name:	Dave Ryder
Address:	Bag 2000
	Kimberley, BC PC: V1A 3E1
Phone / Fax#:	Ph: 867-668-6838 Fax: 867-667-6956
E-mail	Dave.Ryder@teck.com

Report To:

Company Name:	Laberge Environmental Services
Contact Name:	Bonnie Burns
Address:	P.O. Box 21072
	Whitehorse, YT PC: Y1A 6P7
Phone / Fax#:	Ph: 867-668-6838 Fax: 867-667-6956
E-mail	bonnieburns@northwestel.net

PO #:
Quotation #: B14-152-KP
Project #:
Proj. Name: Sa Dena Hes
Location: Sa Dena Hes, Yukon
Sampled by: Bonnie Burns

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

- ◉ Regular Turn Around Time (TAT) (5 days for most tests)
- **RUSH** (Please contact the lab) ○ 1 Day ○ 2 Day ○ 3 Day
- Date Required:

SPECIAL INSTRUCTIONS:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

#	Sample Identification	Lab Identification (Lab Use Only)	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y/N	Field Acidified? Y/N	Total Metals Field Acidified? Y/N	dry and thoroughly mix	sieve through a 100 mesh screen (siz	analyze portion passing sieve for met	Number of Containers
1	MH-13A		Soil	14/08/23 13:10				X	X	X	1
2	MH-13B		Soil	14/08/23 13:10				X	X	X	1
3	MH-13C		Soil	14/08/23 13:10				X	X	X	1
4	MH-16A		Soil	14/08/23 14:30				X	X	X	1
5	MH-16B		Soil	14/08/23 14:30				X	X	X	1
6	MH-16C		Soil	14/08/23 14:30				X	X	X	1
7	MH-20A		Soil	14/08/24 12:10				X	X	X	1
8	MH-20B		Soil	14/08/24 12:10				X	X	X	
9	MH-20C		Soil	14/08/24 12:10				X	X	X	1
11	MH-11		Soil	14/08/25 11:30				X	X	X	1
11	MH-30		Soil	14/08/23 11:00				X	X	X	1
12	CC at Confluence		Soil	14/08/23 10:30				X	X	X	1

B474948

Print name and sign *Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Print name and sign Received by:	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Laboratory Use Only Temperature on Receipt (°C)	Custody Seal	Yes	No
							A) B) C)	Present?	☐	☐
Bonnie Burns	14/08/25	19:00				☐	Just sampled & rec'd on ice ☐	Intact?	☐	☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

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APPENDIX C

BENTHIC INVERTEBRATE DATA, 2014

APPENDIX C

BENTHIC INVERTEBRATE DATA, 2014

Site:	MH-13	MH-13	MH-13	MH-16	MH-16	MH-16	MH-20	MH-20	MH-20	Totals
Sample:	A	B	C	A	B	C	A	B	C	
SubSample %:	100	62.5	25	31.25	25	18.75	100	100	100	
Phylum: Arthropoda										
Subphylum: Hexapoda										
| Class: Insecta										
| Order: Ephemeroptera										
| Family: Ameletidae										
Ameletus	11	11	20	3			2			47
| Family: Baetidae										
Acentrella sp.								1		1
Baetis	73	70	712	99	196	283	27	44	37	1541
| Family: Ephemerellidae		3	8	138	308	256	3		1	717
Drunella doddsii					4					4
Drunella sp.					4					4
Drunella spinifera				22	16	11		3	2	54
Ephemerella		2		3						5
Ephemerella dorothea									3	3
Serratella						5				5
| Family: Heptageniidae	5	5	24	10	12	16	2	8	2	84
Cinygmula sp.	1				4					5
Epeorus sp.								1		1
Rhithrogena					4	11	1	2	2	20
| Family: Siphlonuridae		2								2
										0
| Order: Plecoptera									1	1
| Family: Capniidae	5	35	208	10	12	16	7	23	12	328
| Family: Chloroperlidae				6			1	4	2	13
Haploperla sp.								6	1	7
Sweltsa sp.			4	3					1	8
| Family: Nemouridae	2	8	144	109	200	192	5	3	2	665
Zapada	1		84	22	80	53			2	242
Zapada cinctipes				13	44	43			1	101
Zapada oregonensis group		2	4					1	2	9
| Family: Perlodidae	1		20	10	36	53	1		1	122
Diura sp.		3								3
Isoperla sp.	2	10	32					1		45
Megarcys sp.								1	1	2
| Family: Taeniopterygidae				19	44	37				100
| Order: Trichoptera										
| Family: Brachycentridae								1		1
Brachycentrus americanus					12	5				17
Brachycentrus sp.					16	11	1			28
Micrasema						5				5
| Family: Glossosomatidae										
Glossosoma					4					4
| Family: Hydropsychidae					8	5				13
| Family: Hydroptilidae										
Hydroptila									1	1
Oxyethira sp.							1			1
| Family: Limnephilidae	10			6	8		1			25
Hesperophylax sp.		3								3
| Family: Rhyacophilidae								1		1
Rhyacophila					12	5				17
Rhyacophila brunnea/vemna group					4					4
| Order: Coleoptera	1	2								3
| Order: Diptera	3	3	8							14
| Family: Ceratopogonidae										0
Ceratopogon sp.	3									3

APPENDIX C

BENTHIC INVERTEBRATE DATA, 2014

Site:	**MH-13**	**MH-13**	**MH-13**	**MH-16**	**MH-16**	**MH-16**	**MH-20**	**MH-20**	**MH-20**	**Totals**
Sample:	A	B	C	A	B	C	A	B	C	
SubSample %:	100	62.5	25	31.25	25	18.75	100	100	100	
Probezzia					4		1	1		6
| Family: Chironomidae										0
| Subfamily: Chironominae										0
| Tribe: Chironomini										0
Polypedilum sp.							1			1
| Tribe: Tanytarsini										0
Micropsectra		2	188		84	64		3		341
Rheotanytarsus				102	204	165	11		22	504
Stempellina sp.	61	114	20							195
Tanytarsus	17	6	52			27	1			103
| Subfamily: Diamesinae										
| Tribe: Diamesini										
Diamesa	2									2
Pagastia				22	40	11				73
| Subfamily: Orthocladiinae										
Brillia sp.	28	6	16	16						66
Diplocladius cultriger		2								2
Eukiefferiella			268	186		43		3	4	504
Heterotrissocladius sp.	1	2								3
Orthocladius complex		8								8
Orthocladius sp.				208	152	112	4	9	6	491
Parametriocnemus			16							16
Rheosmittia sp.									47	47
Synorthocladius									2	2
Tvetenia		11						1		12
| Tribe: Corynoneurini										
Corynoneura									1	1
Thienemanniella			4					1		5
| Subfamily: Tanypodinae										
Ablabesmyia								1		1
| Tribe: Pentaneuriini										
Thienemannimyia group	3				8					11
| Family: Empididae	5	3								8
Neoplasta sp.				26	12	16		1	1	56
| Family: Psychodidae										
Pericoma/Telmatoscopus sp.	1	2		42	68	53		1		167
| Family: Simuliidae			12		12	21	1			46
Metacnephia sp.			4							4
| Family: Tipulidae										
Dicranota	8	18	12			5	2		1	46
Limnophila sp.							1			1
| Class: Entognatha										
| Order: Collembola	5						1			6
Subphylum: Chelicerata										
| Class: Arachnida										
| Order: Trombidiformes				6	8	21	1	1		37
| Family: Aturidae										
Aturus				42	40	21				103
| Family: Feltriidae										
Feltria sp.		2								2
| Family: Hygrobatidae										
Atractides				3	8					11
Hygrobates	20	18	16	3	4					61
| Family: Lebertiidae										

APPENDIX C

BENTHIC INVERTEBRATE DATA, 2014

Site:	**MH-13**	**MH-13**	**MH-13**	**MH-16**	**MH-16**	**MH-16**	**MH-20**	**MH-20**	**MH-20**	**Totals**
Sample:	A	B	C	A	B	C	A	B	C	
SubSample %:	100	62.5	25	31.25	25	18.75	100	100	100	
Lebertia	1	3		6	4	16	1			31
| Family: Sperchontidae										
Sperchon			48	16	4	11		1		80
Sperchonopsis sp.				3	4	11				18
| Family: Torrenticolidae										
Testudacarus sp.				22	56	32				110
| Order: Sarcoptiformes										
| Family: Hydrozetidae	16	35	204	3		5				263
Subphylum: Crustacea										
| Class: Ostracoda	50	80	400	6						536
| Class: Branchiopoda										
| Order: Cladocera	10							2		12
| Class: Copepoda	70	320	300							690
Phylum: Mollusca										
| Class: Gastropoda								1		1
Phylum: Annelida										
Subphylum: Clitellata										
| Class: Oligochaeta										
| Order: Lumbriculida										
| Family: Lumbriculidae			8		28	27	1			64
Rhynchelmis sp.			4							4
| Order: Tubificida										
| Family: Enchytraeidae										
Fridericia	37	219	28	13						297
Phylum: Cnidaria										
| Class: Hydrozoa										
| Order: Anthoathecatae										
| Family: Hydridae										
Hydra	1		12	3						16
Phylum: Nemata	8	48		3	12	27	3		8	109
Phylum: Platyhelminthes										
| Class: Turbellaria				3						3
Totals per sample:	462	1058	2880	1207	1780	1695	81	126	166	9455
Totals per site:	4400			4682			373			
Diversity per sample:	32	33	31	36	40	36	25	28	27	101
Diversity per site:	52			55			53			

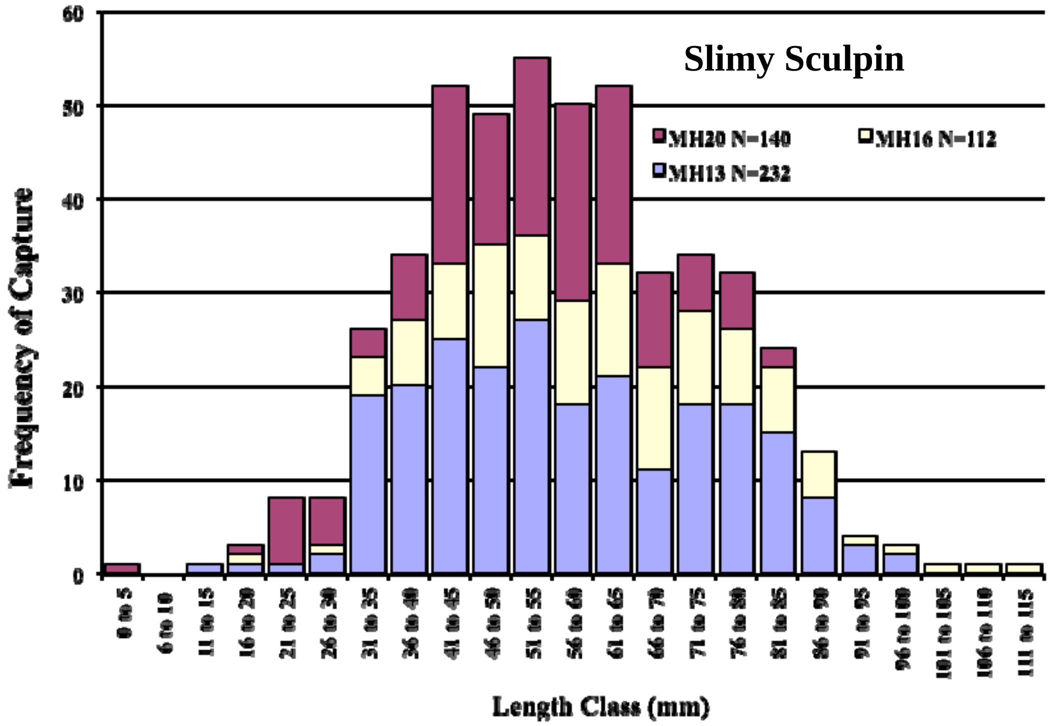
APPENDIX D

FISH DATA, 2014

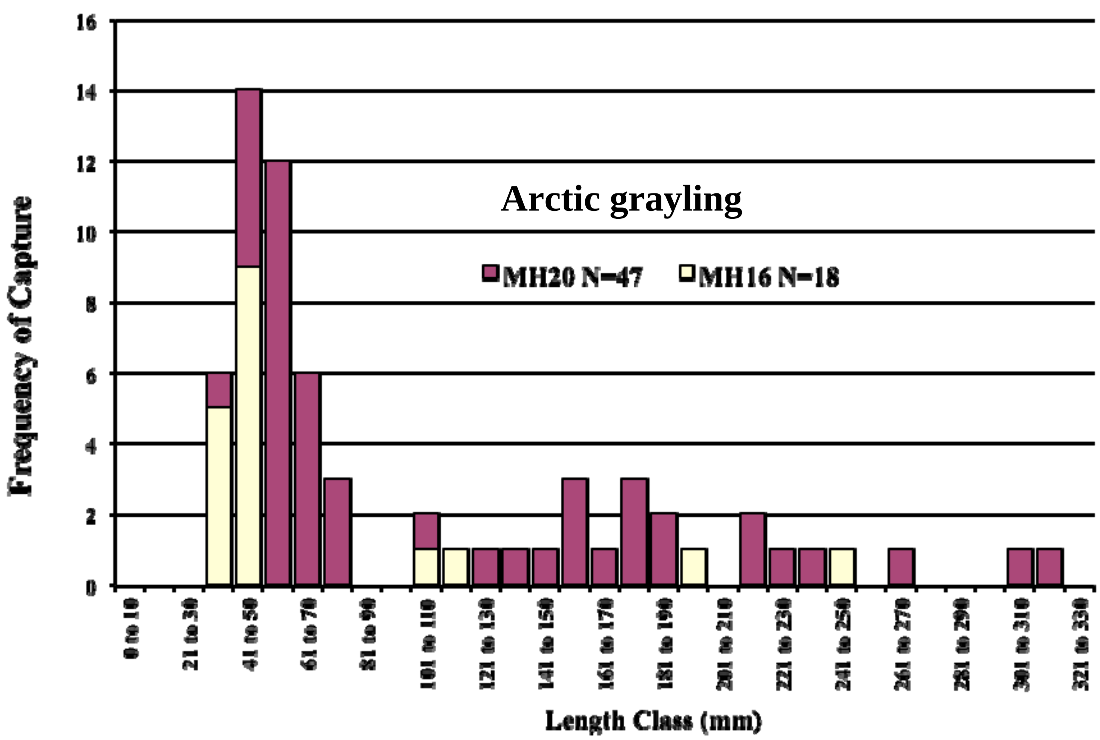
APPENDIX D TABLE 1: LENGTH DATA COLLECTED FROM FISH CAPTURED DURING SAMPLING OF FALSE CANYON CREEK, AUGUST 2014.

Species	Sample Site	Length (mm)	Weight (gms)
Arctic Grayling	MH16	52	15.0
Arctic Grayling	MH16	210	-
Arctic Grayling	MH20	55	1.4
Burbot	MH20	130	14.9
Burbot	MH20	210	52.2
Slimy Sculpin	MH13	61	2.3
Slimy Sculpin	MH16	20	0.1
Slimy Sculpin	MH16	37	0.5
Slimy Sculpin	MH16	38	0.8
Slimy Sculpin	MH16	38	0.5
Slimy Sculpin	MH16	43	0.9
Slimy Sculpin	MH16	47	1.1
Slimy Sculpin	MH16	69	3.4
Slimy Sculpin	MH16	70	4.2
Slimy Sculpin	MH16	76	4.4
Slimy Sculpin	MH16	76	4.8
Slimy Sculpin	MH16	81	6.3
Slimy Sculpin	MH16	88	7.1
Slimy Sculpin	MH16	115	15.6
Slimy Sculpin	MH20	47	1.1
Slimy Sculpin	MH20	51	1.3
Slimy Sculpin	MH20	55	1.4
Slimy Sculpin	MH20	57	2.1
Slimy Sculpin	MH20	57	2.0
Slimy Sculpin	MH20	62	2.2
Slimy Sculpin	MH20	64	2.7
Slimy Sculpin	MH20	65	2.8

Species	Sample Site	Length (mm)	Weight (gms)
Slimy Sculpin	MH20	66	2.9
Slimy Sculpin	MH20	67	3.0
Slimy Sculpin	MH20	77	5.0
Whitefish sp.	MH20	50	1.1
Whitefish sp.	MH20	52	1.2
Whitefish sp.	MH20	52	1.3
Whitefish sp.	MH20	52	1.3
Whitefish sp.	MH20	53	1.3
Whitefish sp.	MH20	54	1.4



APPENDIX D FIGURE 1: LENGTH FREQUENCIES OF SLIMY SCULPIN MEASURED AT SITES OF CAPTURE IN FALSE CANYON CREEK, YUKON, 1994 TO 2014.



APPENDIX D FIGURE 2: LENGTH FREQUENCY OF ARCTIC GRAYLING MEASURED AT SITES OF CAPTURE IN FALSE CANYON CREEK, YUKON, 1994 TO 2014.

APPENDIX F

Nautilus Toxicity Testing Laboratory Reports

Nautilus Environmental

Sä Dena Hes Mixture testing

Final Report

Report date: July 17, 2015

Submitted to:

Azimuth Consulting Group
Vancouver, BC

Burnaby Laboratory
8664 Commerce Court
Burnaby, BC
V5A 4N7

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SIGNATURE PAGE

Bonnie Lo, M.E.T.
Environmental Scientist

James Elphick, R.P.Bio.
Senior Reviewer

This report has been prepared by Nautilus Environmental Company Inc. based on data and/or samples provided by our client and the results of this study are for their sole benefit. Any reliance on the data by a third party is at the sole and exclusive risk of that party. The results presented here relate only to the samples tested.

1.0 INTRODUCTION

Nautilus Environmental conducted sub-lethal toxicity tests for Azimuth Consulting Group on a mixture of samples identified as MH-04 and MH-25. The samples were collected on June 27th, 2014 from the Sä Dena Hes Mine Site (the "Site"), Yukon Territory and delivered to the Nautilus laboratory in Burnaby, BC on June 28th, 2014. Each sample was transported in a cooler containing one 20-L carboy and seven 1-L plastic containers and was received at a temperature of 8.5°C. The sample was stored in the dark at 4 ± 2°C prior to testing. The following sub-lethal toxicity tests were conducted on the sample:

- *Ceriodaphnia dubia* survival and reproduction
- *Pseudokirchneriella subcapitata* growth inhibition

This report describes the results of these toxicity tests. Copies of laboratory data sheets and printouts of statistical analyses for each test are provided in Appendices A and B. The chain-of-custody form is provided in Appendix C.

2.0 METHODS

Methods for the toxicity tests are summarized in Tables 1 and 2. Testing was conducted according to procedures described by Environment Canada (2007a and 2007b), with modifications made to testing concentrations and dilutions. Statistical analyses were performed using CETIS (Tidepool Scientific Software, 2013).

Table 1. Summary of test conditions: *Ceriodaphnia dubia* survival and reproduction test.

Test organism	*Ceriodaphnia dubia*
Test organism source	In-house culture
Test organism age	<24-hour old neonates produced within 12 hours
Test type	Static-renewal
Test duration	7 ± 1 day
Test vessel	20-mL test tube
Test volume	15 mL
Test replicates	10 test replicates per treatment
Number of organisms	1 per replicate
Control/dilution water	Diluted Perrier water (hardness 140 mg/L $CaCO_3$)
Test solution renewal	Daily
Test temperature	25 ± 1°C
Feeding	*Pseudokirchneriella subcapitata* and YCT
Light intensity	100 to 600 lux at water surface
Photoperiod	16 hours light/8 hours dark
Aeration	None
Test protocol	Environment Canada (2007a), EPS 1/RM/21
Statistical Software	CETIS (2013)
Test endpoints	Survival and reproduction
Test acceptability criterion for controls	≥80% survival; ≥15 young per surviving control producing three broods; ≥60% of controls producing three or more broods
Reference Toxicant	Sodium Chloride

Table 2. Summary of test conditions: *Pseudokirchneriella subcapitata* growth inhibition test.

Test organism	*Pseudokirchneriella subcapitata*, strain UTCC#37
Test organism source	In-house culture, obtained from Canadian Phycological Culture Centre, and originally isolated from Nitelva River, Norway.
Test organism age	4- to 7-d old culture in logarithmic growth phase
Test type	Static
Test duration	72 h
Test vessel	Microplate
Test volume	220 µL
Test replicates	4 test replicates per treatment; 8 replicates for control
Number of organisms	10,000 cells/mL
Control water	Deionized water with supplemented nutrients
Test solution renewal	None
Test temperature	24 ± 2°C
Light intensity	3600 to 4400 lux
Photoperiod	24 hours light
Aeration	None
Test protocol	Environment Canada (2007b) EPS 1/RM/25
Statistical software	CETIS (2013)
Test endpoint	Algal cell growth inhibition
Test acceptability criteria for controls	≥ 16-fold increase in number of algal cells; CV ≤20%; no trend when analyzed using Mann-Kendall test
Reference toxicant	Zinc

A mixture of 85% MH-04 and 15% MH-25 was used as the highest concentration tested. This mixture, identified as "100% Mixture", was further diluted using MH-04 to 30, 10, 3, 1, 0.3 and 0.1%, resulting in seven concentrations of the mixture (Table 3). MH-04 was also tested as a site water control for this test.

Because there was a potential that the MH-04 sample might itself exhibit toxicity, this sample was also tested after dilution to 50 and 10%, with a laboratory-prepared control water that was prepared by diluting Perrier water to achieve a hardness consistent with that of the MH-04 sample.

Due to the different dilution waters (laboratory water and MH-04), the results were analyzed as two independent datasets; MH-04 and Mixture. Results of the MH-04 samples were compared to the laboratory control and the Mixture samples were compared to the results for MH-04.

Table 3. Dilution series of MH-04 and MH-25.

%									
10 MH04	50 MH04	100 MH-04	0.1 Mixture	0.3 Mixture	1 Mixture	3 Mixture	10 Mixture	30 Mixture	100 Mixture
------------------------Low to High COPCs---------------------→									

Note: Mixture = 85% MH-04 and 15% MH-25

3.0 RESULTS

Results of the toxicity tests on samples MH-04 and the mixture of MH-04 with MH-25 are summarized in Tables 4 and 5, and provided in Appendices A and B, for *C. dubia* and *P. subcapitata*, respectively. Included in the appendices are summaries of organism response relative to measured concentrations of lead and zinc, which were identified by Azimuth as two of the main contaminants of interest for the site.

In the MH-04 tests, *C. dubia* survival was 100% in the undiluted MH-04 water and ranged from 90 to 100% in the MH-04 sample diluted with laboratory water, resulting in an LC50 of >100%. Similarly, no adverse effects were observed on reproduction in these dilutions resulting in the IC25 and IC50 values for MH-04 of >100%.

In the test of the Mixture (85% MH-04 and 15% MH-25, diluted with MH-04), *C. dubia* exhibited no survival in the 10, 30 and 100% Mixture concentrations, while survival ranged from 80 to 100% in the 0.1, 1 and 3% Mixture treatments. The calculated LC50 with 95% confidence limits was 4.1 (2.5-6.3)% Mixture. Adverse effects on reproduction were also observed, resulting in IC25 and IC50 estimates of 0.9 (0.6-1.6) and 2.3 (1.3-3.8)% Mixture, respectively.

The 72-h *P. subcapitata* toxicity test exhibited a decrease in cell yield in the MH-04 sample relative to the hardness-adjusted control; the IC25 and IC50 values were <10 and >100% for MH-04 relative to the hardness adjusted laboratory control. Although the IC25 was <10% sample relative to the hardness-adjusted control, it should be noted that the cell growth in all MH-04 treatments exceeded the standard laboratory control for this test, and based on a comparison to that control, the IC25 and IC50 would both have been >100% sample.

For the test of the mixture, adverse effects on cell growth were observed relative to the MH-04 sample (i.e., the site water control), as well as to both laboratory water controls. The IC25 and IC50 (and 95% confidence limits) were calculated to be 0.49 (0.27-0.60) and 0.82 (0.64-0.94)% Mixture, respectively, based on a comparison to performance in the MH-04 site water control. These estimates would have been higher, and have fallen between 1 and 3%, if the standard laboratory control water had been used for comparison in this test.

The concentration of zinc that was present in the Mixture appears to be sufficient to explain the adverse response reported for *P. subcapitata*. For example, zinc was present in the 1% dilution of the Mixture at 60.2 µg/L and in MH-04 at 7.3 µg/L; consequently, at the IC50 of the sample of 0.82% Mixture, there was 50.7 µg/L of zinc present. This concentration exceeds the long term average IC50 of 23.8 µg/L zinc reported in reference toxicant tests with this species (Table 6). Similarly, for *C. dubia*, 132 µg/L zinc would have been present at the IC50 of 2.3% Mixture. Although zinc is not used as a reference toxicant by the laboratory for this species, this is consistent with concentrations that exhibit adverse effects on this species (Nautilus Environmental, unpublished data). Of the 31 analytes measured in the metals scan, only five others (i.e., in addition to zinc) were present above detection limits in the Mixture diluted to 1% (barium, calcium, magnesium, silicon, and strontium [Appendix C]). The other five constituents would not be expected to have contributed to toxicity.

Table 4. Results: *Ceriodaphnia dubia* survival and reproduction test.

Concentration (% v/v)	Survival (%)	Reproduction (mean ± SD)
Laboratory control	90	19.4 ± 5.1
10% MH-04	90	19.8 ± 7.2
50% MH-04	100	21.1 ± 4.8
100% MH-04 (site water control)	100	20.4 ± 3.9
0.1% mixture	100	20.2 ± 3.4
0.3% mixture	100	20.7 ± 2.8
1% mixture	90	14.7 ± 7.6
3% mixture	80	8.5 ± 6.3
10% mixture	0	--
30% mixture	0	--
100% mixture	0	--
Test endpoint (% v/v)		
MH-04		
LC50	>100	--
IC25	--	>100
IC50	--	>100
Mixture		
LC50	4.1 (2.5 - 6.3)[1]	--
IC25	--	0.9 (0.6 – 1.5)[1]
IC50	--	2.3 (1.0 – 3.7)[1]

SD= Standard Deviation, LC= Lethal Concentration, IC= Inhibition Concentration.
Mixture = 85% MH-04 and 15% MH-25
[1] results calculated using 100% MH-04 as control

Table 5. Results: *Pseudokirchneriella subcapitata* growth inhibition test.

Concentration (% v/v)	Cell Yield (x 10^4 cells/mL) (Mean ± SD)
Regular control water	55.4 ± 10.3
Hardness-adjusted (dilution water control)	359.3 ± 36.5
10% MH-04	224.8 ± 12.0
50% MH-04	206.8 ± 11.5
100% MH-04 (site water control)	201.5 ± 25.2
0.1% mixture	297.0 ± 31.3
0.3% mixture	185.5 ± 23.5
1% mixture	77.0 ± 14.1
3% mixture	5.5 ± 3.8
10% mixture	1.25 ± 1.9
30% mixture	1.75 ± 0.5
100% mixture	0.75 ± 1.0
Test endpoint (% v/v)	
MH-04	
IC25	<10 [2]
IC50	>100
Mixture[1]	
IC25	0.49 (0.27 – 0.6) [1]
IC50	0.82 (0.64 – 0.94) [1]

SD= Standard Deviation, IC= Inhibition Concentration.
*= Indicates cell yield that were significantly greater than the control.
Mixture = 85% MH-04 and 15% MH-25
[1] results calculated using 100% MH-04 as negative control
[2] note that although the IC25 is <10% relative to the hardness-adjusted control, there is stimulation in all concentrations of MH-04 relative to the normal laboratory control

4.0 QA/QC

The health history of the test organisms used in the exposures was acceptable and met the requirements of the Environment Canada protocols. The tests met all control acceptability criteria and water quality parameters remained within acceptable ranges specified in the protocols throughout the tests. The holding time of 72 hours was exceeded; however the samples were tested following discussion with Azimuth. Uncertainty associated with these tests is best described by the standard deviation around the mean and/or the confidence limits around the point estimates.

Results of the reference toxicant tests conducted during the testing program are summarized in Table 6. Results for these tests fell within the range for organism performance of mean and two standard deviation range, based on historical results obtained by the laboratory with these tests. Thus, the sensitivity of the organisms used in these tests was appropriate.

Table 6. Reference toxicant test results.

Test Species	Endpoint	Historical Mean (2 SD Range)	CV (%)	Test Date
C. dubia	Survival (LC50): 1.8 g/L NaCl	1.7 (1.2 – 2.6)	23	June 26, 2014
	Reproduction (IC50): 1.7 g/L NaCl	1.3 (0.9 – 1.9)	21	
P. subcapitata	Growth (IC50): 19.0 µg/L Zn	23.8 (15.0 – 37.8)	26	July 11, 2014

SD = Standard Deviation, CV = Coefficient of Variation, LC = Lethal Concentration, IC = Inhibition Concentration.

5.0 REFERENCES

Environment Canada. 2007a. Biological test method: test of reproduction and survival using the cladoceran *Ceriodaphnia dubia*. Environmental Protection Series. Report EPS 1/RM/21, Second Edition, February 2007. Environment Canada, Method Development and Application Section, Environmental Science and Technology Centre, Science and Technology Branch, Ottawa, ON. 74 pp.

Environment Canada. 2007b. Biological test method: growth inhibition test using the freshwater alga. Environmental Protection Series, Report EPS 1/RM/25. Second Edition, March 2007. Environment Canada, Method Development and Application Section, Environmental Science and Technology Centre, Science and Technology Branch, Ottawa, ON. 53 pp.

Tidepool Scientific Software. 2013. CETIS comprehensive environmental toxicity information system, version 1.8.7.16 Tidepool Scientific Software, McKinleyville, CA. 222 pp.

APPENDIX A – *Ceriodaphnia dubia* Toxicity Test Data

Ceriodaphnia dubia Summary Sheet

Client: Azimuth
Work Order No.: 14399

Start Date/Time: June 30/14 @ 1500h
Set up by: KLP/HMM

Sample Information:

Sample ID: MH-04 (diluted w/ lab H_2O)
Sample Date: June 27/14
Date Received: June ~~[illegible]~~ 28/14
Sample Volume: 1L×7, 20L×1

Test Validity Criteria:

1) Mean survival of first generation controls is ≥80 %
2) At least 60% of controls have produced three broods within 8 days
3) An average of ≥15 live young produced per surviving female in the control solutions during the first three broods.
4) Invalid if ephippia observed in any control solution at any time.

WQ Ranges:

T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 ; pH = 6.0 to 8.5

Test Organism Information:

Broodstock No.: 062014 (3rd Generation 160mg/L hardness |ever)
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d: 20
Mortality (%) in previous 7 d: 10
Individual female # used ≥8 young on test day: 1,2,4,5,6,7,8,10

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd114
Stock Solution ID: 14Na01
Date Initiated: June 26/14

7-d LC50 (95% CL): 1.8 (1.6 - 2.2) g/L NaCL
7-d IC50 (95% CL): 1.7 (1.3 - 2.0) g/L NaCL

7-d LC50 Reference Toxicant Mean and Historical Range: 1.7 (1.2-2.6) g/L NaCL CV (%): 23
7-d IC50 Reference Toxicant Mean and Historical Range: 1.3 (0.9-1.9) g/L NaCL CV (%): 21

Test Results:

	Survival	Reproduction
LC50 % (v/v) (95% CL)	>100	
IC25 % (v/v) (95% CL)		>100
IC50 % (v/v) (95% CL)		>100

Reviewed by: A. Tang

Date reviewed: September 18, 2014

Ceriodaphnia dubia Summary Sheet

Client: Azimuth
Work Order No.: 14399

Start Date/Time: June 30/14 @ 1500h
Set up by: KLP/FMM

Sample Information:

Sample ID: MH04/MH25 Mixture (diluted w/ MH04 site H2O)
Sample Date: June 27/14
Date Received: June 28/14
Sample Volume: 1L x 7, 20L x 1

Test Validity Criteria:

1) Mean survival of first generation controls is ≥80 %
2) At least 60% of controls have produced three broods within 8 days
3) An average of ≥15 live young produced per surviving female in the control solutions during the first three broods.
4) Invalid if ephippia observed in any control solution at any time.

WQ Ranges:

T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 ; pH = 6.0 to 8.5

Test Organism Information:

Broodstock No.: 062014 (3rd Generation 160mg/L Hardness Premix)
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d: 20
Mortality (%) in previous 7 d: 10
Individual female # used ≥8 young on test day: 1,2,4,5,6,7,8,10

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd 114
Stock Solution ID: 14NaO1
Date Initiated: June 26/14

7-d LC50 (95% CL): 1.8 (1.6-2.2) g/L NaCL
7-d IC50 (95% CL): 1.7 (1.3-2.0) g/L NaCL

7-d LC50 Reference Toxicant Mean and Historical Range: 1.7 (1.2-2.6) g/L NaCL CV (%): 23
7-d IC50 Reference Toxicant Mean and Historical Range: 1.3 (0.9-1.9) g/L NaCL CV (%): 21

Test Results:

	Survival	Reproduction
LC50 % (v/v) (95% CL)	4.1 (2.5 - 6.3)	
IC25 % (v/v) (95% CL)		~~Z~~ 0.9 (0.6 - 1.6) emm
IC50 % (v/v) (95% CL)		~~2.3 (1.0 - 3.7)~~ ema 2.3 (1.3 - 3.8)

Reviewed by: A. Tang

Date reviewed: September 18, 2014

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Azimuth
Sample ID: MH-04 / MH-25
Work Order #: 14399

Start Date & Time: June 30/14 @1500h
Stop Date & Time: July 7/14 @ 1500h
Test Species: *Ceriodaphnia dubia*

% (v/v)

Concentration 160 mg/L Hardness Perrier Lab Control	0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)	24.0	24.5	24.0	25.0	24.0	25.0	24.0	25.0	24.0	25.0	24.0	25.0	24.0	25.0
DO (mg/L)	7.9	7.8	8.2	7.7	8.2	7.0	8.2	7.4	8.3	7.2	8.2	7.5	8.2	7.6
pH	8.3	8.1	8.3	8.3	8.3	8.1	8.3	7.7	8.3	7.8	8.1	7.9	8.1	7.9
Cond. (µS/cm)	312	282		244		246		273		335		337		339
Initials	EMM	EMM		KLP		[illegible]		EMM		[illegible]		[illegible]		EMM

Concentration 102.5% MH-04①	0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)	24.0	24.5	24.0	25.0	24.0	25.0	24.0	25.0	24.0	25.0	24.0	25.0	24.0	25.0
DO (mg/L)	7.8	7.7	8.1	7.7	7.6	7.5	7.8	7.6	8.2	7.3	8.2	7.5	8.2	7.6
pH	8.2	8.1	8.2	8.3	8.3	8.1	8.3	7.8	8.3	7.9	8.1	8.0	8.1	8.0
Cond. (µS/cm)	294 ~~280~~	282		245		296		273		349		321		326
Initials	EMM	EMM		KLP		KJL		EMM		[illegible]		[illegible]		EMM

Concentration 50% MH-04①	0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)	24.0	24.5	24.0	25.0	25.5	25.0	~~24.0~~ 25.0	25.0	24.0	25.0	24.0	25.0	24.0	25.0
DO (mg/L)	7.9	7.8	8.1	7.6	7.8	7.2	8.1	7.7	8.2	7.3	8.2	7.0	8.2	7.5
pH	8.2	8.2	8.2	8.3	8.2	8.2	8.2	7.8	8.2	7.9	8.1	8.0	8.1	8.1
Cond. (µS/cm)	EMM 280 ~~294~~	282		261		292		276		303		309		317
Initials	EMM	EMM		KLP		KJL		EMM		[illegible]		[illegible]		EMM

Concentration 100% MH-04①	0 init.	1 old	1 new	2 old	2 new	3 old	3 new	4 old	4 new	5 old	5 new	6 old	6 new	7 final
Temperature (°C)	24.0	24.5	24.0	25.0	26.0	25.0	25.0	25.0	24.0	25.0	24.0	25.0	24.0	25.0
DO (mg/L)	7.9	7.8	8.1	7.6	8.0	7.3	8.1	7.7	8.2	7.2	8.2	7.6	8.1	7.6
pH	8.2	8.2	8.1	8.3	8.1	8.2	8.1	7.9	8.2	7.7	8.1	8.0	8.1	8.1
Cond. (µS/cm)	277	284		283		286		280		278		280		285
Initials	EMM	EMM		KLP		KJL		EMM		[illegible]		[illegible]		EMM

	Control (160 mg/L Hardness Perrier)	MH-04 100%	100% Mixture	MH-25 100%
Hardness*	140	146	148	152
Alkalinity*	78	114	124	32

* mg/L as CaCO3

WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5

Analysts: EMM, KLP, AWD
Reviewed by: AT
Date reviewed: Sept 17/14

Sample Description: MH-04 & clear   MH-25 & clear

Comments: Broodboard Used: 062014 (3rd generation 160 mg/L Hardness Perrier)
① MH-04 diluted w/ lab water

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Azimuth
Sample ID: MH-04/MH-25
Work Order #: 14399

Start Date & Time: June 30/14 @ 1500h
Stop Date & Time: July 7/14 @ 1500h
Test Species: *Ceriodaphnia dubia*

% (v/v) Concentration	Days 0	1		2		3		4		5		6		7
0.1% mixture①	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.5	24.0	25.0	26.0	25.0	25.0	25.0	24.5	25.0	24.0	25.0	24.0	25.0
DO (mg/L)	7.9	7.8	8.3	7.4	7.8	7.2	8.0	7.6	8.1	7.3	8.2	7.6	8.1	7.4
pH	8.3	8.2	8.3	8.3	8.3	8.2	8.3	7.9	8.2	7.9	8.1	8.0	8.1	8.1
Cond. (µS/cm)	274 ~~312~~ em	283		278		284		290		284		288		300
Initials	EMM	EMM		KLP		KJL		EMM		A		A		EMM

Concentration	Days 0	1		2		3		4		5		6		7
0.3% Mixture①	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.5	24.0	25.0	24.0	25.0	26.0	25.0	25.0	25.0	24.0	25.0	24.0	25.0
DO (mg/L)	7.9	7.8	8.3	7.6	7.8	7.1	8.0	7.6	8.1	7.3	8.2	7.6	8.1	7.5
pH	8.4	8.2	8.4	8.4	8.5	8.4	8.3	7.9	8.2	7.9	8.2	8.0	8.1	8.1
Cond. (µS/cm)	275 ~~280~~ em	283		273		280		284		275		280		284
Initials	EMM	EMM		KLP		KJL		EMM		A		A		EMM

Concentration	Days 0	1		2		3		4		5		6		7
1% Mixture①	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.5	24.0	25.0	24.0	25.0	26.0	25.0	25.5	25.0	24.0	25.0	24.0	25.0
DO (mg/L)	8.0	7.9	8.3	7.6	7.8	7.1	8.1	7.6	8.1	7.2	8.2	7.5	8.1	7.5
pH	8.4	8.2	8.4	8.4	8.6	8.4	8.3	7.9	8.2	7.9	8.2	8.0	8.1	8.2
Cond. (µS/cm)	278 ~~294~~ em	283		274		280		285		275		283		284
Initials	EMM	EMM		KLP		KJL		EMM		A		A		EMM

Concentration	Days 0	1		2		3		4		5		6		7
3% Mixture①	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.5	24.0	25.0	24.0	25.0	26.0	25.0	25.5	25.0	24.0	25.0	24.0	25.0
DO (mg/L)	7.9	7.8	8.3	7.6	7.8	7.2	8.0	7.6	8.1	7.3	8.2	7.6	8.1	7.5
pH	8.4	8.2	8.4	8.4	8.5	8.5	8.3	7.9	8.2	7.9	8.2	8.0	8.1	8.2
Cond. (µS/cm)	278 em	277		275		280		286		277		281		280
Initials	EMM	EMM		KLP		KJL		EMM		A		A		EMM

	Control (160 mg/L Hardness Perrier)	MH-04 100%	100% Mixture	MH-25 100%
Hardness*	140	146	148	152
Alkalinity*	78	114	124	32

* mg/L as $CaCO_3$

Analysts: EMM, KLP, AWO
Reviewed by: ARF
Date reviewed: Sept 18/14

WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5

Sample Description: MH-04: clear MH-25: clear

Comments: **Broodboard Used:** 062014 (3rd generation 160 mg/L Hardness Perrier)
① "Mixture" consists of 85% MH-04 & 15% MH-25; diluted w/ MH-04

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: Azimuth
Sample ID: MH-04 / MH-25
Work Order #: 14399

Start Date & Time: June 30/14 @ 1500h
Stop Date & Time:
Test Species: *Ceriodaphnia dubia*

Concentration	Days 0	1		final 2		3		4		5		6		7
10% Mixture①	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.5	24.0	25.0	24.0									
DO (mg/L)	7.9	7.8	8.2	7.9										
pH	8.2	8.1	8.1	8.0	8.5									
Cond. (µS/cm)	~~277~~ 282 em	279		① 277 ② 278										
Initials	EMM	EMM		KLP										

emm

Concentration	Days 0	1		final 2		3		4		5		6		7
30% Mixture①	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.5	24.0	25.0										
DO (mg/L)	7.9	7.8	8.2	7.8										
pH	8.2	8.0	8.1	8.0										
Cond. (µS/cm)	280	285		279										
Initials	EMM	EMM		EMM										

Concentration	Days 0	final 1		2		3		4		5		6		7
100% Mixture	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	24.5	24.0											
DO (mg/L)	7.9	7.8	8.3											
pH	8.0	7.8	7.8											
Cond. (µS/cm)	292	299												
Initials	EMM	EMM												

Concentration	Days 0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)														
DO (mg/L)														
pH														
Cond. (µS/cm)														
Initials														

	Control (160 mg/L Hardness Perrier)	MH-04 100%	100% Mixture	MH-25 100%
Hardness*	140	146	148	152
Alkalinity*	78	114	124	32

* mg/L as CaCO3

Analysts: EMM, KLP, AWD
Reviewed by: [signature]
Date reviewed: Sept 18/14

WQ Ranges: T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 (mg/L) ; pH = 6 to 8.5

Sample Description: MH-04: clear   MH-25: clear

Comments: **Broodboard Used:** 060814 (3rd generation 160 mg/L Hardness Perrier)
① "mixture" consists of 85% MH-04 : 15% MH-25; diluted w/ MH-04

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: Azimuth
Sample ID: MH-04 / MH-25
Work Order: 14399

Start Date & Time: June 30/14 @ 1500h
Stop Date & Time: July 7/14 @ 1500h
Set up by: KLP/EMM

% (v/v)

Concentration: 160 mg/L Hardness Perrier Lab Control

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLP
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Emm
3	/	/	/	/	/	/	/	/	/	/	m
4	✓	4	3	3	4	4	4	4	4	4	JW
5	5	/	6	✓	/	/	/	/	/	6	As
6	6	5X	✓	6	5	6	7	6	6	✓	m
7	✓	|	14	11	12	11	12	12	11	13	Emm
8											
Total	11	9*	23	20	21	21	23	22	21	23	Emm

Concentration: 10% MH-04 ②

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLP
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Emm
3	/	/	/	/	/	/	/	/	/	/	m
4	4	3	✓	4	4	4	4	5	4	5	JW
5	6	5	X	5	5	✓	/	/	6	3	As
6	/	/	|	/	/	7	5	6	/	/	m
7	15	13	|	13	10	12	11	13	12	14	Emm
8											
Total	25	21	0*	22	19	23	20	24	22	22	Emm

Concentration: 50% MH-04 ②

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLP
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Emm
3	/	/	/	/	/	/	/	/	/	/	m
4	✓	5	5	4	5	2	3	4	4	3	JW
5	/	/	/	/	/	/	5	/	/	5	As
6	8	7	7	6	7	6	✓	6	6	✓	m
7	✓	10	10	14	14	14	13	11	13	14	Emm
8											
Total	8	22	22	24	26	22	21	21	23	22	Emm

Concentration: 100% MH-04

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLP
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Emm
3	/	/	/	/	/	/	/	/	/	/	m
4	4	4	4	✓	4	4	3	4	✓	3	JW
5	/	/	/	5	4	/	/	/	4	✓	As
6	6	7	5	4	✓	6	5	5	6	6	m
7	13	12	13	10	12	11	13	14	✓	13	Emm
8											
Total	23	23	22	19	20	21	21	23	10	22	Emm

Concentration: 0.1% Mixture ①

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLP
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Emm
3	/	/	/	/	/	/	/	/	/	/	As
4	3	4	4	4	3	✓	3	4	4	4	JW
5	5	/	/	/	/	5	/	/	/	5	As
6	/	5	6	6	6 ~~8~~	✓	6	6	5	✓	m
7	13	10	14	13	7	8	12	11	13	13	Emm
8											
Total	21	19	24	23	16	13	21	21	22	22	Emm

Concentration: 0.3% Mixture ①

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLP
2	✓	✓	✓	✓	✓	✓	✓	/	/	✓	Emm
3	/	/	/	X	/	/	/	/	/	/	m
4	4	3	3	~~3~~	4	3	4	3	4	4	JW
5	/	/	/	~	5	/	/	/	/	/	As
6	5	6	5	~	5	6	5	6	5	5	m
7	14	12	12	~~14~~	15	13	13	12	12	10	Emm
8				~							
Total	23	21	20	~~24~~	[illegible]	22	22	21	21	19	Emm

Concentration: 1% Mixture ①

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLP
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Emm
3	/	/	/	/	/	/	/	/	X	/	As
4	4	4	4	4	✓	4	✓	4	|	4	JW
5	/	/	/	/	/	/	/	/	|	/	As
6	5	5	5	5	6	7	6	5	|	5	m
7	10	10	11	11	✓	10	✓	10	|	8	Emm
8									|		
Total	19	19	20	20	6	21	6	19	0*	17	Emm

Concentration: 3% Mixture ①

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	KLP
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Emm
3	/	/	/	X	/	X	/	/	/	/	As
4	✓	✓	1	|	✓	|	✓	3	✓	✓	JW
5	5	5	/	|	/	|	4	✓	3	/	m
6	3	3	5	|	5	|	4	4	4	4	m
7	9	✓	9	|	✓	|	✓	6	8	✓	Emm
8				|		|					
Total	17	8	15	0*	5	0*	8	13	15	4	Emm

Concentration: 10% Mixture ①

Days	A	B	C	D	E	F	G	H	I	J	Init
1	X	✓	X	X	X	✓	X	✓	✓	✓	KLP
2	|	X	|	|	|	X	|	X	X	X	Emm
3	|	|	|	|	|	|	|	|	|	|	
4	|	|	|	|	|	|	|	|	|	|	
5	|	|	|	|	|	|	|	|	|	|	
6	|	|	|	|	|	|	|	|	|	|	
7	|	|	|	|	|	|	|	|	|	|	
8	|	|	|	|	|	|	|	|	|	|	
Total	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	Emm

① "mixture" consists of 85% MH-04 & 15% MH-25; diluted w/ MH-04
② MH-04 diluted w/ lab water

Notes: X = mortality.

Sample Description: MH-04: Clear   MH-25: Clear

Comments: Total # Young only based on the first 3 Broods. Fourth and subsequent broods not included in total count.

Reviewed by: A. Teng

Date reviewed: Sept 17/14

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: Azimuth
Sample ID: MH-04 / MH-25
Work Order: 14399

Start Date & Time: June 30/14 @ ~~1459~~ 1500h KLP
Stop Date & Time: July 7/14 @ 1500h
Set up by: KLP/EMM

%(v/v)

Days	Concentration: 30% Mixture (1)										
	A	B	C	D	E	F	G	H	I	J	Init
1	X	X	X	X	X	✓	X	X	X	X	KLP
2						X					
3											
4											
5											
6											
7											
8											
Total	0x	0x	0x	0x	0x	0x	0x	0x	0x	0x	EMM

Days	Concentration: 100% Mixture (1)										
	A	B	C	D	E	F	G	H	I	J	Init
1	X	X	X	X	X	X	X	X	X	X	KLP
2											
3											
4											
5											
6											
7											
8											
Total	0x	0x	0x	0x	0x	0x	0x	0x	0x	0x	EMM

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Days	Concentration:										
	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Notes: X = mortality.

(1) "mixture" consists of 85% MH-04 & 15% MH-25; diluted w/ MH-04

Sample Description: MH-04: ~~clear~~ clear   MH-25: clear.
Comments: Total # Young only based on the first 3 Broods. Fourth and subsequent broods not included in total count.

Reviewed by: A. Teng

Date reviewed: Sept 17/14

CETIS Analytical Report

Report Date: 11 Sep-14 18:35 (p 1 of 2)
Test Code: 14399 | 09-5449-2254

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	00-3349-2105	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 18:34	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	19-3955-3931	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 15:00	**Protocol:**	~~EPA/821/R-02-013 (2002)~~ EC/EPS 1/RM/21 BCL	**Diluent:**	Laboratory Water
Ending Date:	07 Jul-14 15:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	7d 0h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	05-7149-1570	**Code:**	221044F2	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:05	**Material:**	Effluent	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	72h (8.5 °C)	**Station:**	MH-04		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1507363	200	Yes	Two-Point Interpolation

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	0.9	0.8 - NL	Yes	Passes Acceptability Criteria

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
EC5	>100	N/A	N/A	<1	NA	NA
EC10	>100	N/A	N/A	<1	NA	NA
EC15	>100	N/A	N/A	<1	NA	NA
EC20	>100	N/A	N/A	<1	NA	NA
EC25	>100	N/A	N/A	<1	NA	NA
EC40	>100	N/A	N/A	<1	NA	NA
EC50	>100	N/A	N/A	<1	NA	NA

7d Survival Rate Summary

			Calculated Variate(A/B)								
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	10	0.9	0	1	0.1	0.3162	35.14%	0.0%	9	10
10		10	0.9	0	1	0.1	0.3162	35.14%	0.0%	9	10
50		10	1	1	1	0	0	0.0%	-11.11%	10	10
100		10	1	1	1	0	0	0.0%	-11.11%	10	10

7d Survival Rate Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1	0	1	1	1	1	1	1	1	1
10		1	1	0	1	1	1	1	1	1	1
50		1	1	1	1	1	1	1	1	1	1
100		1	1	1	1	1	1	1	1	1	1

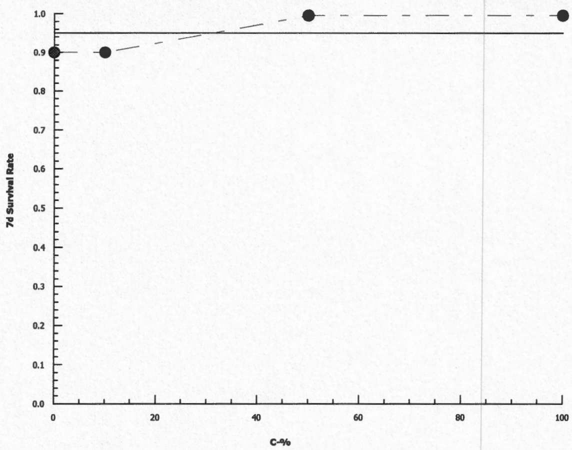
7d Survival Rate Binomials

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1/1	0/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
10		1/1	1/1	0/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
50		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
100		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	00-3349-2105	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 18:34	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Report Date: 11 Sep-14 18:35 (p 1 of 2)
Test Code: 14399 | 09-5449-2254

Ceriodaphnia 7-d Survival and Reproduction Test — Nautilus Environmental

Analysis ID:	20-6228-1997	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 18:35	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	19-3955-3931	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 15:00	**Protocol:**	~~EPA/821/R-02-013 (2002)~~ BR EC/EPS 1/RM/21	**Diluent:**	Laboratory Water
Ending Date:	07 Jul-14 15:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	7d 0h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	05-7149-1570	**Code:**	221044F2	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:05	**Material:**	Effluent	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	72h (8.5 °C)	**Station:**	MH-04		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1026362	200	Yes	Two-Point Interpolation

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	19.4	15 - NL	Yes	Passes Acceptability Criteria

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	>100	N/A	N/A	<1	NA	NA
IC10	>100	N/A	N/A	<1	NA	NA
IC15	>100	N/A	N/A	<1	NA	NA
IC20	>100	N/A	N/A	<1	NA	NA
IC25	>100	N/A	N/A	<1	NA	NA
IC40	>100	N/A	N/A	<1	NA	NA
IC50	>100	N/A	N/A	<1	NA	NA

Reproduction Summary

			Calculated Variate						
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	19.4	9	23	1.607	5.082	26.19%	0.0%
10		10	19.8	0	25	2.27	7.177	36.25%	-2.06%
50		10	21.1	8	26	1.531	4.841	22.94%	-8.76%
100		10	20.4	10	23	1.231	3.893	19.08%	-5.16%

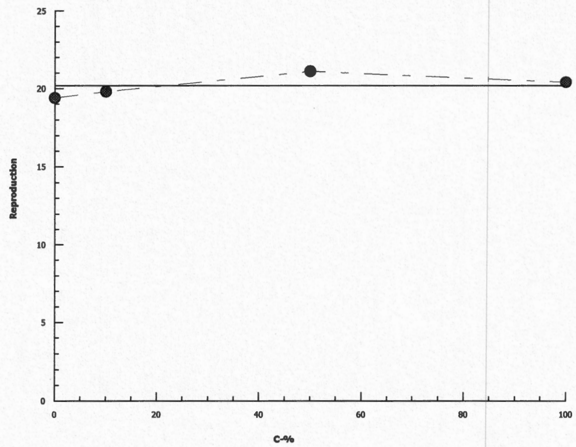
Reproduction Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	11	9	23	20	21	21	23	22	21	23
10		25	21	0	22	19	23	20	24	22	22
50		8	22	22	24	26	22	21	21	23	22
100		23	23	22	19	20	21	21	23	10	22

Ceriodaphnia 7-d Survival and Reproduction Test | **Nautilus Environmental**

Analysis ID: 20-6228-1997		**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.7
Analyzed: 11 Sep-14 18:35		**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Test Code: 14399 | 09-5449-2254

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	08-8403-1574	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 18:35	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	19-3955-3931	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 15:00	**Protocol:**	~~EPA/821/R-02-013 (2002)~~ EEL EC/EPS 1/RM/21	**Diluent:**	Laboratory Water
Ending Date:	07 Jul-14 15:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	7d 0h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	05-7149-1570	**Code:**	221044F2	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:05	**Material:**	Effluent	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	72h (8.5 °C)	**Station:**	MH-04		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	NOEL	LOEL	TOEL	TU
Untransformed	NA	C < T	NA	NA	26.5%	100	>100	NA	1

Steel Many-One Rank Sum Test

Control	vs	C-%	Test Stat	Critical	Ties	DF	P-Value	P-Type	Decision(α:5%)
Negative Control		10	98	77	4	18	0.5283	Asymp	Non-Significant Effect
		50	91.5	77	3	18	0.3140	Asymp	Non-Significant Effect
		100	102	77	4	18	0.6610	Asymp	Non-Significant Effect

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	19.4	15 - NL	Yes	Passes Acceptability Criteria
PMSD	0.2647	0.13 - 0.47	Yes	Passes Acceptability Criteria

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	16.475	5.491667	3	0.1895	0.9029	Non-Significant Effect
Error	1043.3	28.98056	36			
Total	1059.775		39			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	3.449	11.34	0.3275	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.6848	0.9236	<0.0001	Non-normal Distribution

Reproduction Summary

C-%	Control Type	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	Negative Control	10	19.4	15.76	23.04	21	9	23	1.607	26.19%	0.0%
10		10	19.8	14.67	24.93	22	0	25	2.27	36.25%	-2.06%
50		10	21.1	17.64	24.56	22	8	26	1.531	22.94%	-8.76%
100		10	20.4	17.62	23.18	21.5	10	23	1.231	19.08%	-5.16%

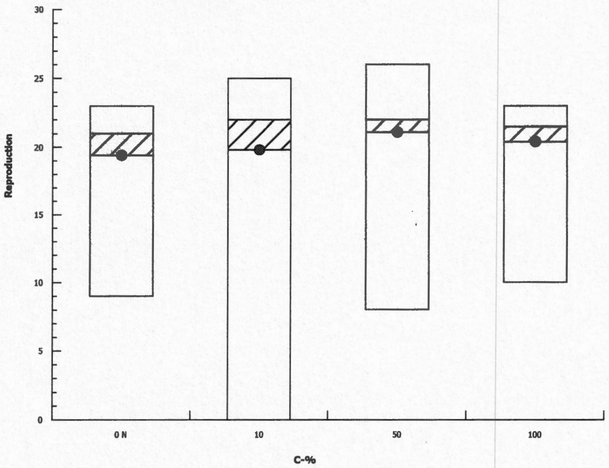
Reproduction Detail

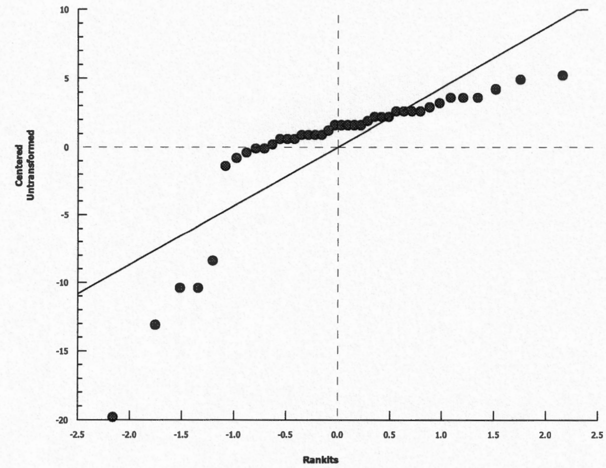
C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	11	9	23	20	21	21	23	22	21	23
10		25	21	0	22	19	23	20	24	22	22
50		8	22	22	24	26	22	21	21	23	22
100		23	23	22	19	20	21	21	23	10	22

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	08-8403-1574	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 18:35	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Graphics





CETIS Analytical Report

Report Date:	11 Sep-14 18:47 (p 1 of 3)
Test Code:	14399b | 12-6036-2619

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	07-1329-2681	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 18:46	**Analysis:**	Linear Regression (MLE)	**Official Results:**	Yes
Batch ID:	18-2891-1839	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 15:00	**Protocol:**	~~EPA/821/R-02-013 (2002)~~ RRL EC/EPS 1/RM21	**Diluent:**	Site Water
Ending Date:	07 Jul-14 15:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	7d 0h	**Source:**	In-House Culture	**Age:**	<24h
Sample ID:	13-8577-1250	**Code:**	529930F2	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:45	**Material:**	Effluent	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	71h (8.5 °C)	**Station:**	MH25		

Linear Regression Options

Model Function	Threshold Option	Threshold	Optimized	Pooled	Het Corr	Weighted
Log-Gompertz [log(-log(1-P)=A+B*log(X)]	Control Threshold	1E-07	No	Yes	No	Yes

Regression Summary

Iters	LL	AICc	BIC	Mu	Sigma	Adj R2	F Stat	Critical	P-Value	Decision(α:5%)
13	-9.083	24.57	22.32	0.6921		0.9686				Lack of Fit Not Tested

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
EC5	1.191	0.2274	2.108	83.96	47.44	439.7
EC10	1.68	0.463	2.717	59.53	36.81	216
EC15	2.066	0.7037	3.195	48.4	31.29	142.1
EC20	2.404	0.9488	3.625	41.6	27.59	105.4
EC25	2.714	1.198	4.037	36.84	24.77	83.5
EC40	3.57	1.96	5.324	28.01	18.78	51.01
EC50	4.131	2.478	6.341	24.21	15.77	40.36

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.8 - NL	Yes	Passes Acceptability Criteria

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
Slope	4.821	1.318	2.237	7.405	3.657	0.0106	Significant Parameter
Intercept	-3.336	0.9659	-5.229	-1.443	-3.454	0.0136	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	67.80976	67.80976	1	217.1	<0.0001	Significant
Residual	1.874311	0.312385	6			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Goodness-of-Fit	Pearson Chi-Sq GOF	1.874	12.59	0.9309	Non-Significant Heterogenity
	Likelihood Ratio GOF	1.656	12.59	0.9485	Non-Significant Heterogenity
Distribution	Shapiro-Wilk W Normality	0.8717	0.6805	0.1565	Normal Distribution
	Anderson-Darling A2 Normality	0.6941	2.492	0.0699	Normal Distribution

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID: 07-1329-2681 **Endpoint:** 7d Survival Rate **CETIS Version:** CETISv1.8.7
Analyzed: 11 Sep-14 18:46 **Analysis:** Linear Regression (MLE) **Official Results:** Yes

7d Survival Rate Summary

			Calculated Variate(A/B)								
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	10	1	1	1	0	0	0.0%	0.0%	10	10
0.1		10	1	1	1	0	0	0.0%	0.0%	10	10
0.3		10	1	1	1	0	0	0.0%	0.0%	10	10
1		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
3		10	0.8	0	1	0.1333	0.4216	52.7%	20.0%	8	10
10		10	0	0	0	0	0		100.0%	0	10
30		10	0	0	0	0	0		100.0%	0	10
100		10	0	0	0	0	0		100.0%	0	10

7d Survival Rate Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1	1	1	1	1	1	1	1	1	1
0.1		1	1	1	1	1	1	1	1	1	1
0.3		1	1	1	1	1	1	1	1	1	1
1		1	1	1	1	1	1	1	1	0	1
3		1	1	1	0	1	0	1	1	1	1
10		0	0	0	0	0	0	0	0	0	0
30		0	0	0	0	0	0	0	0	0	0
100		0	0	0	0	0	0	0	0	0	0

7d Survival Rate Binomials

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
0.1		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
0.3		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
1		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1	1/1
3		1/1	1/1	1/1	0/1	1/1	0/1	1/1	1/1	1/1	1/1
10		0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
30		0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1
100		0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

CETIS Analytical Report

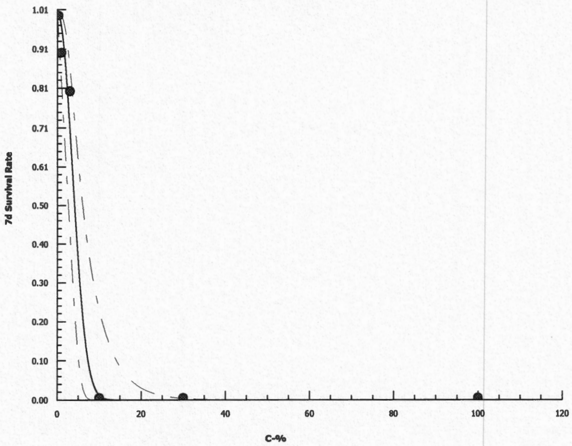
Report Date: 11 Sep-14 18:47 (p 3 of 3)
Test Code: 14399b | 12-6036-2619

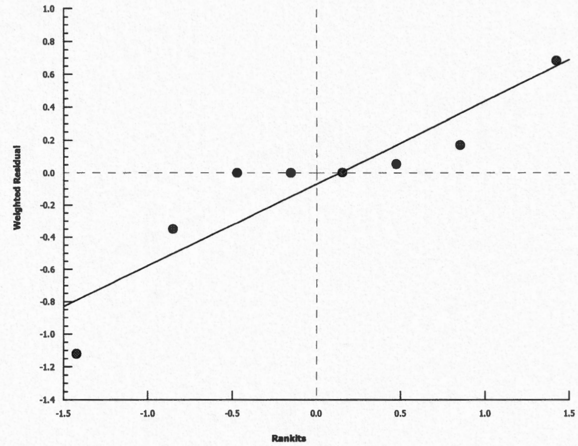
Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

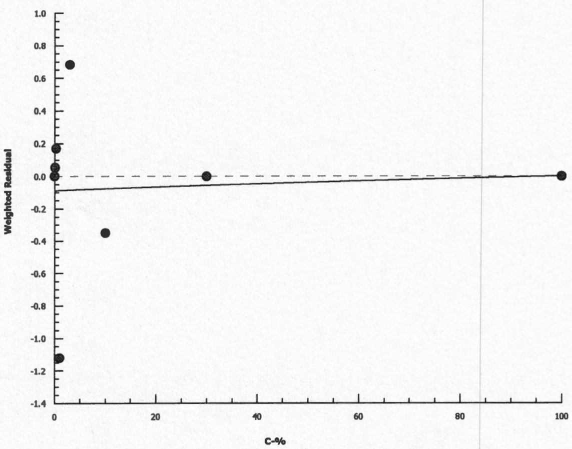
Analysis ID:	07-1329-2681	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 18:46	**Analysis:**	Linear Regression (MLE)	**Official Results:**	Yes

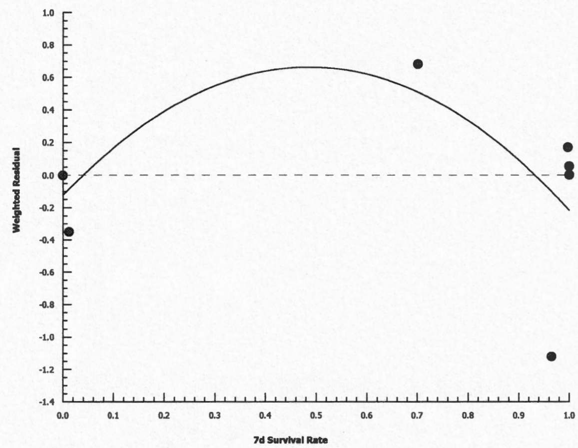
Graphics

Log-Gompertz [log(-log(1-P)=A+B*log(X)]









CETIS Analytical Report

Report Date: 18 Sep-14 14:37 (p 1 of 2)
Test Code: 14399b | 12-6036-2619

Ceriodaphnia 7-d Survival and Reproduction Test — Nautilus Environmental

Analysis ID:	17-2369-3812	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.7
Analyzed:	18 Sep-14 14:37	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	18-2891-1839	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 15:00	**Protocol:**	~~EPA/821/R-02-013 (2002)~~ BRL EC/EPS 1/RM 21	**Diluent:**	Site Water
Ending Date:	07 Jul-14 15:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	7d 0h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	13-8577-1250	**Code:**	529930F2	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:45	**Material:**	Effluent	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	71h (8.5 °C)	**Station:**	MH25		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	2045163	200	Yes	Two-Point Interpolation

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	20.4	15 - NL	Yes	Passes Acceptability Criteria

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	0.4037	0.05247	0.713	247.7	140.3	1906
IC10	0.5157	0.208	1.074	193.9	93.11	480.8
IC15	0.6367	0.3572	1.179	157.1	84.81	279.9
IC20	0.7672	0.4595	1.374	130.3	72.77	217.6
IC25	0.9083	0.5508	1.564	110.1	63.93	181.5
IC40	1.627	0.8422	3.053	61.45	32.76	118.7
IC50	2.301	1.346	3.786	43.45	26.41	74.31

Reproduction Summary

			Calculated Variate						
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	20.4	10	23	1.231	3.893	19.08%	0.0%
0.1		10	20.2	13	24	1.062	3.36	16.63%	0.98%
0.3		10	20.7	14	24	0.8699	2.751	13.29%	-1.47%
1		10	14.7	0	21	2.413	7.631	51.91%	27.94%
3		10	8.5	0	17	1.985	6.276	73.84%	58.33%
10		10	0	0	0	0	0		100.0%
30		10	0	0	0	0	0		100.0%
100		10	0	0	0	0	0		100.0%

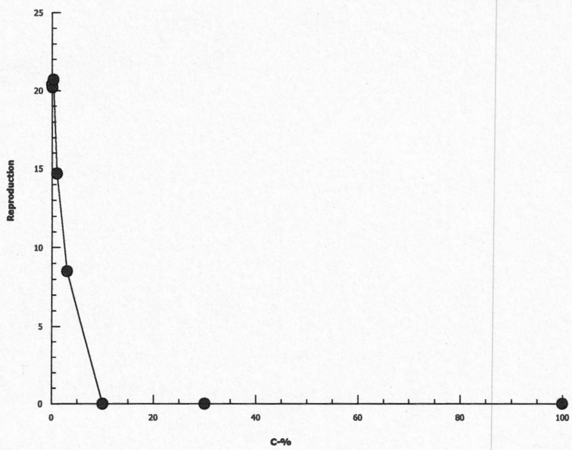
Reproduction Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	23	23	22	19	20	21	21	23	10	22
0.1		21	19	24	23	16	13	21	21	22	22
0.3		23	21	20	24	14	22	22	21	21	19
1		19	19	20	20	6	21	6	19	0	17
3		17	8	15	0	5	0	8	13	15	4
10		0	0	0	0	0	0	0	0	0	0
30		0	0	0	0	0	0	0	0	0	0
100		0	0	0	0	0	0	0	0	0	0

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	17-2369-3812	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.7
Analyzed:	18 Sep-14 14:37	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Client: Azimuth

W.O.#: 14401 / 14399

Hardness and Alkalinity Datasheet

		Alkalinity				Hardness			
Sample ID	Sample Date	Sample Volume (mL)	(mL) 0.02N HCL/H_2SO_4 used to pH 4.5	(mL) of 0.02N HCL/H_2SO_4 used to pH 4.2	Total Alkalinity (mg/L$CaCO_3$)	Sample Volume (mL)	Volume of 0.01M EDTA Used (mL)	Total Hardness (mg/L $CaCO_3$)	Technician
MH-04	June30/14	50	5.8	5.9	114	50	7.3	146	KLP
MH25	June30/14	50	1.7	1.8	32	50	7.6	152	EMM
160 mg/L Hardness Perrier.	June 30/14	50	4.0	4.1	78	50	7.0	140	KLP
100% Mixture	June30/14	50	6.0	6.2	124	50	7.4	148	EMM

Notes:

Reviewed by: A. Teng

Date Reviewed: September 17, 2014

APPENDIX B - *Pseudokirchneriella subcapitata* Toxicity Test Data

Pseudokirchneriella subcapitata Summary Sheet

Client: Azimuth

Work Order No.: 14400

Start Date: June 30/14

Set up by: EMM

Sample Information:

Sample ID: MH-04 diluted with laboratory water (160mg/L hardness)

Sample Date: June 27/14

Date Received: June 28/14

Sample Volume: 7x1L, 1x20L

Test Organism Information:

Culture Date: June 27/14

Age of culture (Day 0): 3d

Zinc Reference Toxicant Results:

Reference Toxicant ID: SC114

Stock Solution ID: 14Zn01

Date Initiated: July 11/14

72-h IC50 (95% CL): ~~19.04~~ em 19.0 (16.6-21.9) µg/L Zn

72-h IC50 Reference Toxicant Mean and Range: 23.8 (15.0 - 37.8) µg/L Zn CV (%): 26

Test Results:

	Algal Growth emm
IC25 %(v/v) (95% CL)	~~≥100%~~ emm ~~7.0(2.8-6.3)~~ <10
IC50 %(v/v) (95% CL)	~~>100%~~ emm >100

Reviewed by: A. Tong

Date reviewed: September 18, 2014

Pseudokirchneriella subcapitata Summary Sheet

Client: Azimuth
Work Order No.: 14400

Start Date: June 30/14
Set up by: EMM

Sample Information:

Sample ID: MH25/MH-04 mixture (diluted with MH-04 site water)
Sample Date: June 27/14
Date Received: June 28/14
Sample Volume: 7x1L, 1x20L

Test Organism Information:

Culture Date: June 27/14
Age of culture (Day 0): 3d

Zinc Reference Toxicant Results:

Reference Toxicant ID: SC114
Stock Solution ID: 14Zn01
Date Initiated: July 11/14

72-h IC50 (95% CL): 19.0 (16.6-21.9) µg/L Zn

72-h IC50 Reference Toxicant Mean and Range: 23.8 (15.0-37.8) µg/L Zn CV (%): 26

Test Results:

	Algal Growth
IC25 %(v/v) (95% CL)	0.49 (0.27-0.60)
IC50 %(v/v) (95% CL)	0.82 (0.64-6.94)

Reviewed by: A. Tong

Date reviewed: September 18, 2014

72-h Algal Growth Inhibition Toxicity Test
Water Quality Measurements

Client : WER/Azimuth **Setup by:** EMM

Sample ID: MH04 MH25 mixture test **Test Date/Time:** June 30/14 @ 1230

Work Order No.: 14400 **Test Species:** *Pseudokirchneriella subcapitata*

Culture Date: June 27/14 **Age of Culture:** ~~225.5~~ 3d EMM **Culture Health:** Good

Culture Count: 1 240 2 211 **Average:** 225.5 **Culture Cell Density (c1):** 225.5x10^4 cells/mL

$$v1 = \frac{220{,}000 \text{ cells/ml} \times 50 \text{ ml}}{(c1)\ 225.5\times10^4 \text{ cells/ml}} = 5\text{mL}$$

Time Zero Counts: 1 18 2 24 **Average:** 21

No. of Cells/mL: 21x10^4 **Initial Density:** # cells/mL ÷ 220 µL x 10 µL = 9545 cells/mL

Concentration %(v/v)	Water Quality Measurements					Microplates rotated 2X per day?			
	pH	Temp (°C)							
	0 h	0 h	24 h	48 h	72 h	0 h	24 h	48 h	72 h
Control	7.0	24.0	25.0	25.5	25.5	✓	✓	✓	✓
Dilution water Ctrl	8.3	24.0				✓	✓	✓	✓
② 10% MH04	8.3	24.0				✓	✓	✓	✓
② 50 MH04	8.3	24.0				✓	✓	✓	✓
100 MH04	8.2	24.0				✓	✓	✓	✓
① 0.1 mixture	8.3	24.0				✓	✓	✓	✓
① 0.3 mixture	8.3	24.0				✓	✓	✓	✓
① 1 mixture	8.2	24.0				✓	✓	✓	✓
① 3 mixture	8.2	24.0				✓	✓	✓	✓
① 10 mixture	8.1	24.0							
Initials	EMM	EMM	EMM	EMM	EMM	EMM	EMM	EMM	EMM

Initial control pH: Well 1: 7.0 Well 2: 7.0

Final control pH: Well 1: 7.0 Well 2: 7.0

Light intensity (lux): 4200 **Date measured:** June 30/14

Sample Description: MH-04: clear ; MH-25 : clear

Comments: ① "mixture" consists of 85% MH-04 & 15% MH-25 ; diluted w/ MH04
② "MH-04" diluted w/ lab water

Reviewed: A. Tang **Date reviewed:** Sept 17, 2014 page 2 of 2

72-h Algal Growth Inhibition Toxicity Test
Water Quality Measurements

Client : WER / Azimuth
Setup by: EMM
Sample ID: MH04-MH25
Test Date/Time: June 30/14 @ 1230
Work Order No.: 14400
Test Species: *Pseudokirchneriella subcapitata*

refer to page 1

Culture Date: ______ Age of Culture: ______ Culture Health: ______

Culture Count: 1 ______ 2 ______ Average: ______ Culture Cell Density (c1): ______

v1 = 220,000 cells/ml x ______ ml / (c1) ______ cells/ml = ______

Time Zero Counts: 1 ______ 2 ______ Average: ______

No. of Cells/mL: ______ Initial Density: # cells/mL ÷ 220 µL x 10 µL = ______

Concentration %(v/v)	Water Quality Measurements					Microplates rotated 2X per day?			
	pH	Temp (°C)							
	0 h	0 h	24 h	48 h	72 h	0 h	24 h	48 h	72 h
① ~~Control~~ er 30 mixture	8.1	24.0	25.0	25.5	25.5	✓	✓	✓	✓
100 mixture	7.9	24.0	25.0	25.5	25.5	✓	✓	✓	✓
Initials	EMM	EMM	EMM	EMM	EMM	EMM	EMM	EMM	EMM

refer to page 1. emm

Initial control pH: Well 1: ______ Well 2: ______

Final control pH: Well 1: ______ Well 2: ______

Light intensity (lux): ______ Date measured: ______

Sample Description: ______

Comments: ______

Reviewed: A. Tang Date reviewed: September 17, 2014

Pseudokirchneriella subcapitata Toxicity Test Data Sheet
72-h Algal Cell Counts

sample ID:
~~Client:~~ emm MH04/MH25 mixture test
Start Date/Time: June 30/14 @ 1230h
Work Order #: 14400
Termination Date: July 2/14 @ 1230h
~~Sample ID:~~ emm client: Azimuth (WER)
Test set up by: YL/EMM

Concentration %(v/v)	Rep	Count 1	Count 2	Count 3	Count 4	Comments	Initials
Control	A	58					YL
	B	47					
	C	48					
	D	64					
	E	36	44				
	F	54					
	G	53					
	H	60					
Dilution water Control	A	390					
	B	399					
	C	344					
	D	341					
Dilution ~~10% MH04~~ YL	E ~~A~~ YL	396					
	F ~~B~~ YL	368					
	G ~~C~~ YL	290					
	H ~~D~~ YL	354					
10% ~~50~~ MH04 YL	A	230					
	B	212					
	C	221					
	D	240					
50 MH04	A	206					
	B	209					
	C	194					
	D	222					
100 MH04	A	232					
	B	199					
	C	208					
	D	171					
0.1 Mixture	A	292					
	B	258					
	C	310					
	D	332					
0.3 Mixture	A	173					
	B	142	183				
	C	194					
	D	222	210				

Comments:

Reviewed by: A. Tong
Date Reviewed: September 17, 2014

page 2 of 2

Pseudokirchneriella subcapitata Toxicity Test Data Sheet
72-h Algal Cell Counts

Client: ______
Work Order #: ______
Sample ID: ______

Start Date/Time: ______
Termination Date: ______
Test set up by: ______

%(v/v) Concentration	Rep	Count 1	Count 2	Count 3	Count 4	Comments	Initials
Control	A						
	B						
	C						
	D						
	E						
	F						
	G						
	H						
1 mixture	A	95	87				YL
	B	89					
	C	63					
	D	69					
3 mixture	A	3	5				
	B	4					
	C	11	12				
	D	6					
10 mixture	A	5					
	B	1					
	C	2					
	D	1					
30 mixture	A	3					
	B	3					
	C	2					
	D	3					
100 mixture	A	2					
	B	0					
	C	1					
	D	3					
	A						
	B						
	C						
	D						
	A						
	B						
	C						
	D						

Comments: ______

Reviewed by: A. Tang

Date Reviewed: September 17, 2014

Pseudokirchneriella subcapitata Algal Counts

Client:	Azimuth	Start Date/Time:	30-Jun-14 @ 1230h	
WO#:	14400	Termination Date:	02-Jul-14 @ 1230h	
Sample ID:	MH-04/ MH-25 Mixture Test			
		Initial Cell Density:	9545 cell/mL	210000
				0.22
				0.01

Concentration (% v/v)	Rep	Count 1 (x 10^4)	Count 2 (x 10^4)	Count 3 (x 10^4)	Count 4 (x 10^4)	Mean (x 10^4)	Cell Yield (x 10^4)		9545.455
Control	A	58				58	57.0	mean	55.4
D.I water with	B	74				74	73.0	SD	10.28088
nutrients	C	48				48	47.0	CV	18.55069
	D	64				64	63.0		
	E	36	44			40	39.0		
	F	54				54	53.0		
	G	53				53	52.0		
	H	60				60	59.0		
Dilution water	A	390				390	389.0	mean	359.3
control	B	399				399	398.0	SD	36.51516
	C	344				344	343.0	CV	10.16299
	D	341				341	340.0		
	E	396				396	395.0		
	F	368				368	367.0		
	G	290				290	289.0		
	H	354				354	353.0		
10% MH04	A	230				230	229.0		
	B	212				212	211.0		
	C	221				221	220.0		
	D	240				240	239.0		
50% MH04	A	206				206	205.0		
	B	209				209	208.0		
	C	194				194	193.0		
	D	222				222	221.0		
100% MH04	A	232				232	231.0		
	B	199				199	198.0		
	C	208				208	207.0		
	D	171				171	170.0		

AET
Sept 17/14

Pseudokirchneriella subcapitata Algal Counts

Client: Azimuth
WO#: 14400
Sample ID: MH-04/ MH-25 Mixture Test

Start Date/Time: 30-Jun-14 @ 1230h
Termination Date: 02-Jul-14 @ 1230h

Initial Cell Density: 9545 cell/mL 210000
0.22
0.01

Concentration (% v/v)	Rep	Count 1 ($x 10^4$)	Count 2 ($x 10^4$)	Count 3 ($x 10^4$)	Count 4 ($x 10^4$)	Mean ($x 10^4$)	Cell Yield ($x 10^4$)		9545.455
Control	A	58				58	57.0	mean	55.4
D.I water with	B	74				74	73.0	SD	10.28088
nutrients	C	48				48	47.0	CV	18.55069
	D	64				64	63.0		
	E	36	44			40	39.0		
	F	54				54	53.0		
	G	53				53	52.0		
	H	60				60	59.0		
Dilution water	A	390				390	389.0	mean	359.3
control	B	399				399	398.0	SD	36.51516
	C	344				344	343.0	CV	10.16299
	D	341				341	340.0		
	E	396				396	395.0		
	F	368				368	367.0		
	G	290				290	289.0		
	H	354				354	353.0		
0.1% Mixture	A	292				292	291.0		
	B	258				258	257.0		
	C	310				310	309.0		
	D	332				332	331.0		
0.3% Mixture	A	173				173	172.0		
	B	142	183			162.5	161.5		
	C	194				194	193.0		
	D	222	210			216	215.0		
1.0% Mixture	A	95	87			91	90.0		
	B	89				89	88.0		
	C	63				63	62.0		
	D	69				69	68.0		
3.0% Mixture	A	3	5			4	3.0		
	B	4				4	3.0		
	C	11	12			11.5	10.5		
	D	6				6	5.0		
10% Mixture	A	5				5	4.0		
	B	1				1	0.0		
	C	2				2	1.0		
	D	1				1	0.0		
30% Mixture	A	3				3	2.0		
	B	3				3	2.0		
	C	2				2	1.0		
	D	3				3	2.0		
100% Mixture	A	2				2	1.0		
	B	0				0	-1.0		
	C	1				1	0.0		
	D	3				3	2.0		

AET
Sept 17/14

EC Alga Growth Inhibition Test — **Nautilus Environmental**

Analysis ID:	21-4322-0234	**Endpoint:**	Cell Yield	**CETIS Version:**	CETISv1.8.7
Analyzed:	18 Sep-14 14:43	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	11-7849-5797	**Test Type:**	Cell Growth	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 12:30	**Protocol:**	EC/EPS 1/RM/25	**Diluent:**	Laboratory Water
Ending Date:	02 Jul-14 12:30	**Species:**	Pseudokirchneriella subcapitata	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	3d

Sample ID:	05-7149-1570	**Code:**	221044F2	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:05	**Material:**	Effluent	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	69h (8.5 °C)	**Station:**	MH-04		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1002426	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Control Trend	Mann-Kendall Trend			0.2751	Non-significant Trend in Controls

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	0.3775	0.312	0.4944	264.9	202.3	320.5
IC10	0.8974	0.7199	1.228	111.4	81.43	138.9
IC15	1.614	1.252	2.315	61.97	43.19	79.86
IC20	2.6	1.946	3.923	38.46	25.49	51.38
IC25	3.959	2.849	6.3	25.26	15.87	35.09
IC40	23.09	0.8401	N/A	4.33	NA	119
IC50	>100	N/A	N/A	<1	NA	NA

Cell Yield Summary

			Calculated Variate						
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	* Negative Control	8	359.3	289	398	12.91	36.52	10.16%	0.0%
10		4	224.8	211	239	6.005	12.01	5.34%	37.44%
50		4	206.8	193	221	5.75	11.5	5.56%	42.45%
100		4	201.5	170	231	12.6	25.2	12.51%	43.91%

Cell Yield Detail

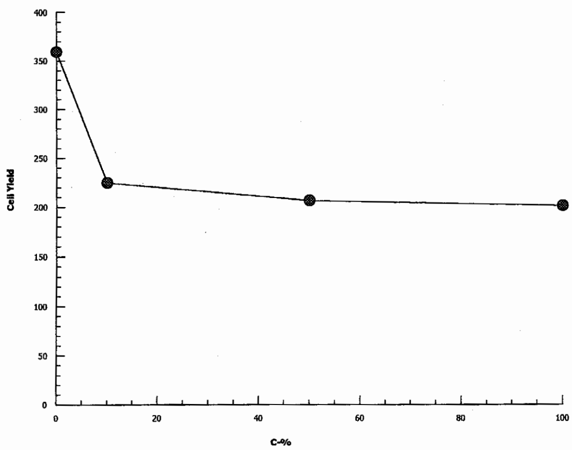
C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	* Negative Control	389	398	343	340	395	367	289	353
10		229	211	220	239				
50		205	208	193	221				
100		231	198	207	170				

* negative control = 160mg/L hardness water for dilution

EC Alga Growth Inhibition Test **Nautilus Environmental**

Analysis ID: 21-4322-0234 **Endpoint:** Cell Yield **CETIS Version:** CETISv1.8.7
Analyzed: 18 Sep-14 14:43 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

Graphics



CETIS Analytical Report

EC Alga Growth Inhibition Test — **Nautilus Environmental**

Analysis ID:	08-7341-1968	**Endpoint:**	Cell Yield	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 18:13	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes
Batch ID:	17-3028-5836	**Test Type:**	Cell Growth	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 12:30	**Protocol:**	EC/EPS 1/RM/25	**Diluent:**	Site Water
Ending Date:	02 Jul-14 12:30	**Species:**	Pseudokirchneriella subcapitata	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	3d
Sample ID:	13-8577-1250	**Code:**	529930F2	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:45	**Material:**	Effluent	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	69h (8.5 °C)	**Station:**	MH25		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1957888	200	Yes	Two-Point Interpolation

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	0.1365	0.1218	0.1624	732.5	615.7	820.9
IC10	0.1742	0.144	0.2281	573.9	438.3	694.5
IC15	0.2132	0.1665	0.2973	469	336.3	600.5
IC20	0.2535	0.1894	0.3671	394.5	272.4	527.9
IC25	0.2951	0.2127	0.4411	338.9	226.7	470.1
IC40	0.4994	0.3244	0.6443	200.2	155.2	308.3
IC50	0.6554	0.5043	0.794	152.6	125.9	198.3

Cell Yield Summary

			Calculated Variate						
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	4	201.5	170	231	12.6	25.2	12.51%	0.0%
0.1 ①		4	297	257	331	15.64	31.28	10.53%	-47.39%
0.3 ①		4	185.5	162	215	11.77	23.53	12.68%	7.94%
1 ①		4	77	62	90	7.047	14.09	18.31%	61.79%
3 ①		4	5.5	3	11	1.893	3.786	68.84%	97.27%
10 ①		4	1.25	0	4	0.9465	1.893	151.4%	99.38%
30 ①		4	1.75	1	2	0.25	0.5	28.57%	99.13%
100 ①		4	0.75	0	2	0.4787	0.9574	127.7%	99.63%

Cell Yield Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	231	198	207	170
0.1		291	257	309	331
0.3		172	162	193	215
1		90	88	62	68
3		3	3	11	5
10		4	0	1	0
30		2	2	1	2
100		1	0	0	2

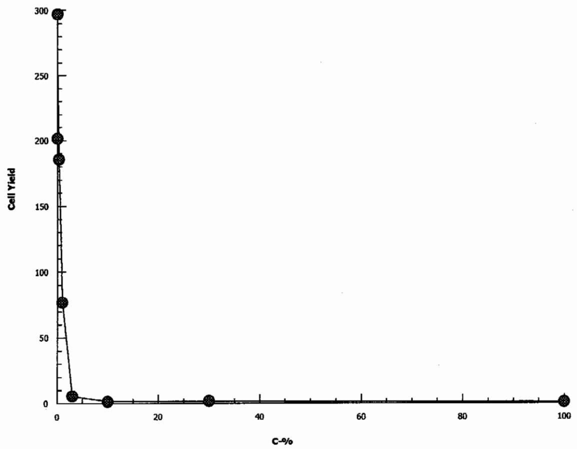
negative control : 100% MH-04 site water

① "100% mixture" consists of 85% MH-04 & 15% MH-25 ; diluted w/ MH04

EC Alga Growth Inhibition Test **Nautilus Environmental**

Analysis ID:	08-7341-1968	**Endpoint:**	Cell Yield	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 18:13	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Report Date:	11 Sep-14 18:22 (p 1 of 2)
Test Code:	14400(adj) | 05-1253-0187

EC Alga Growth Inhibition Test — **Nautilus Environmental**

Analysis ID:	09-5731-5419	**Endpoint:**	Cell Yield	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 18:22	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	11-7849-5797	**Test Type:**	Cell Growth	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 12:30	**Protocol:**	EC/EPS 1/RM/25	**Diluent:**	Laboratory Water
Ending Date:	02 Jul-14 12:30	**Species:**	Pseudokirchneriella subcapitata	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	3d

Sample ID:	00-7421-3635	**Code:**	46C6903	**Client:**	Azimuth
Sample Date:	11 Sep-14 18:21	**Material:**	Effluent	**Project:**	
Receive Date:	11 Sep-14 18:21	**Source:**	Azimuth		
Sample Age:	NA	**Station:**	MH25(adj)		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1329488	200	Yes	Two-Point Interpolation

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	0.222	N/A	0.4231	450.4	236.3	NA
IC10	0.3216	N/A	0.4425	310.9	226	NA
IC15	0.3755	0.09173	0.4922	266.3	203.2	1090
IC20	0.4317	0.1884	0.5436	231.7	184	530.8
IC25	0.4901	0.2692	0.5987	204	167	371.4
IC40	0.6801	0.4867	0.7861	147	127.2	205.5
IC50	0.82	0.6406	0.9442	121.9	105.9	156.1

Cell Yield Summary

			Calculated Variate						
C-%	**Control Type**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	Negative Control	4	201.5	170	231	12.6	25.2	12.51%	0.0%
0.1		4	201.5	170	231	12.6	25.2	12.51%	0.0%
0.3		4	185.5	162	215	11.77	23.53	12.68%	7.94%
1		4	77	62	90	7.047	14.09	18.31%	61.79%
3		4	5.5	3	11	1.893	3.786	68.84%	97.27%
10		4	1.25	0	4	0.9465	1.893	151.4%	99.38%
30		4	1.75	1	2	0.25	0.5	28.57%	99.13%
100		4	0.75	0	2	0.4787	0.9574	127.7%	99.63%

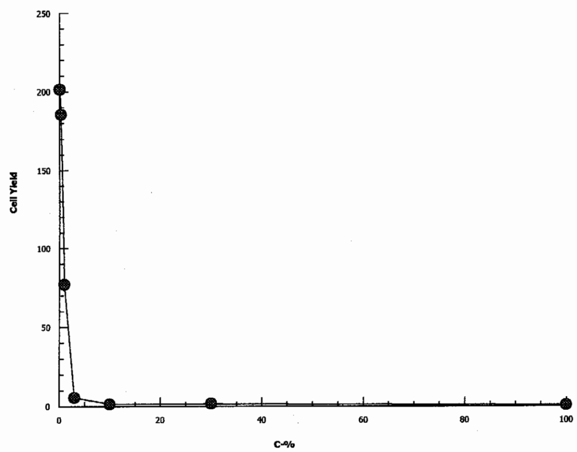
Cell Yield Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	231	198	207	170
0.1		231	198	207	170
0.3		172	162	193	215
1		90	88	62	68
3		3	3	11	5
10		4	0	1	0
30		2	2	1	2
100		1	0	0	2

EC Alga Growth Inhibition Test — **Nautilus Environmental**

Analysis ID:	09-5731-5419	**Endpoint:**	Cell Yield	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 18:22	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



APPENDIX C – Chemistry Reports

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 02-JUL-14
Report Date: 14-JUL-14 11:55 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1480947

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 0936
Legal Site Desc:

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480947-1	L1480947-2			
	Description	H2O	H2O			
	Sampled Date	02-JUL-14	02-JUL-14			
	Sampled Time	16:00	16:00			
	Client ID	MH-04	LAB WATER			
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	139	125			
	Chloride (Cl) (mg/L)	<0.50	11.7			
	Sulfate (SO4) (mg/L)	10.9	18.4			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	1.57	<0.50			
Total Metals	Calcium (Ca)-Total (mg/L)	56.8	59.0			
	Magnesium (Mg)-Total (mg/L)	2.73	2.57			
	Potassium (K)-Total (mg/L)	<2.0	<2.0			
	Sodium (Na)-Total (mg/L)	<2.0	5.8			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Total	MS-B	L1480947-1, -2
Matrix Spike	Sodium (Na)-Total	MS-B	L1480947-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

0936

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

BRITISH COLUMBIA
8664 Commerce Court
Burnaby British Columbia Canada V5A 4N7
Phone 604.420.8773
Fax 604.357.1361

①

Chain of Custody

0936

Date July 2/2014 Page 1 of 1

Sample Collection by: BPL

Report to:
Company G
Address
City Prov. PC
Contact bonnie@nautilusenvironmental.com
Phone No. kryst@nautilusenvironmental.com

Invoice to:
Company
Address
City Prov. PC
Contact
Phone No.

SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NUMBER OF CONTAINERS	COMMENTS	$Ca^{2+}, Mg^{2+}, Na^+, K^+$	Cl^-, SO_4^{2-}	Alkalinity	DOC								RECEIPT TEMPERATURE (°C)
HH-04	07/02	1600	H2O	Bottle 1L	1		✓	✓	✓	✓								
Lab water	↓	↓	↓	↓	1		✓	✓	✓	✓								

Short Holding Time

Rush Processing

L1480947-COFC

PROJECT INFORMATION	SAMPLE RECEIPT	
CLIENT	TOTAL NO. OF CONTAINERS	
P.O. NO.	REC'D GOOD CONDITION	
SHIPPED VIA:		

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (CLIENT)
(Signature) (Time)
(Printed Name) Emma Marus July 2/14 (Date) @ 1730h
(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (LABORATORY)
(Signature) Doren (Time) 1900
(Printed Name) 13°C (Date) July 2

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

DISTRIBUTION: WHITE - Nautilus Environmental, COLOR - Originator

Nautilus Environmental

BRITISH COLUMBIA
8664 Commerce Court
Burnaby British Columbia Canada V5A 4N7
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

0936

Date July 2/2014 Page 1 of 1

Sample Collection by: BPL

Report to:	Invoice to:
Company G	Company
Address	Address
City Prov. PC	City Prov. PC
Contact bonnie@nautilusenvironmental.com	Contact
Phone No. kryst@nautilusenvironmental.com	Phone No.

ANALYSIS REQUIRED

SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NUMBER OF CONTAINERS	COMMENTS	$Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}$	Cl^{-}, SO_4	Alkalinity	DOC							RECEIPT TEMPERATURE (°C)
HH-04	07/02	1600	H_2O	Bottle 1L	1		✓	✓	✓	✓							
Lab water	↓	↓	↓	↓	1		✓	✓	✓	✓							

Short Holding Time

Rush Processing

L1480947-COFC

PROJECT INFORMATION	SAMPLE RECEIPT	
CLIENT	TOTAL NO. OF CONTAINERS	
P.O. NO.	REC'D GOOD CONDITION	
SHIPPED VIA:		

RELINQUISHED BY (CLIENT)
(Signature) (Time)
(Printed Name) Emma Marus July 2/14 (Date) @ 1730h
(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (LABORATORY)
(Signature) Doren (Time) 1900
(Printed Name) 13°C (Date) July 2

SPECIAL INSTRUCTIONS/COMMENTS:

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

DISTRIBUTION: WHITE - Nautilus Environmental, COLOR - Originator

NAUTILUS ENVIRONMENTAL
ATTN: Krysta Pearcy
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 30-JUN-14
Report Date: 09-JUL-14 10:09 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1479858

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 2, OL-1357
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479858-1	L1479858-2	L1479858-3	L1479858-4	L1479858-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	13:00	13:00	13:00	13:00	13:00
	Client ID	10% MH-04 (LAB WATER DILUTION)	50% MH-04 (LAB WATER DILUTION)	100% MH-04 (LAB WATER DILUTION)	0.1% MIXTURE (MH-04 DILUTION)	0.3% MIXTURE (MH-04 DILUTION)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Total (mg/L)	0.018	0.017	0.019	0.019	0.019
	Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Bismuth (Bi)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)-Total (mg/L)	54.7	58.7	56.6	55.8	56.8
	Chromium (Cr)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Total (mg/L)	0.060	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Total (mg/L)	2.45	2.37	2.62	2.57	2.63
	Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Total (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Total (mg/L)	2.66	2.52	2.84	2.80	2.86
	Silver (Ag)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Total (mg/L)	<2.0	2.8	<2.0	<2.0	<2.0
	Strontium (Sr)-Total (mg/L)	0.190	0.246	0.188	0.185	0.188
	Thallium (Tl)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Total (mg/L)	0.0053	<0.0050	0.0073	0.0170	0.0268
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Dissolved (mg/L)	0.018	0.016	0.019	0.019	0.019
	Beryllium (Be)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479858-6	L1479858-7	L1479858-8	L1479858-9	L1479858-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	13:00	13:00	13:00	13:00	13:00
	Client ID	1% MIXTURE (MH-04 DILUTION)	3% MIXTURE (MH-04 DILUTION)	10% MIXTURE (MH-04 DILUTION)	30% MIXTURE (MH-04 DILUTION)	100% MIXTURE (85% MH-04, 15% MH-25)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Total (mg/L)	0.019	0.018	0.020	0.019	0.018
	Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Bismuth (Bi)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	<0.010	<0.010	<0.010	0.017	0.055
	Calcium (Ca)-Total (mg/L)	57.2	55.5	58.0	57.6	59.8
	Chromium (Cr)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Total (mg/L)	2.61	2.52	2.67	2.60	2.59
	Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	0.0050	0.0157
	Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Total (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Total (mg/L)	2.85	2.74	2.90	2.87	2.96
	Silver (Ag)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Total (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Strontium (Sr)-Total (mg/L)	0.186	0.180	0.191	0.183	0.174
	Thallium (Tl)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Total (mg/L)	0.0602	0.170	0.533	1.62	5.27
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Dissolved (mg/L)	0.018	0.019	0.019	0.019	0.017
	Beryllium (Be)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479858-11				
	Description	Water				
	Sampled Date	30-JUN-14				
	Sampled Time	13:00				
	Client ID	160MG/L HARDNESS PERRIER WATER (LAB WATER)				
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20				
	Antimony (Sb)-Total (mg/L)	<0.20				
	Arsenic (As)-Total (mg/L)	<0.20				
	Barium (Ba)-Total (mg/L)	0.014				
	Beryllium (Be)-Total (mg/L)	<0.0050				
	Bismuth (Bi)-Total (mg/L)	<0.20				
	Boron (B)-Total (mg/L)	<0.10				
	Cadmium (Cd)-Total (mg/L)	<0.010				
	Calcium (Ca)-Total (mg/L)	59.7				
	Chromium (Cr)-Total (mg/L)	<0.010				
	Cobalt (Co)-Total (mg/L)	<0.010				
	Copper (Cu)-Total (mg/L)	<0.010				
	Iron (Fe)-Total (mg/L)	<0.030				
	Lead (Pb)-Total (mg/L)	<0.050				
	Lithium (Li)-Total (mg/L)	<0.010				
	Magnesium (Mg)-Total (mg/L)	2.10				
	Manganese (Mn)-Total (mg/L)	<0.0050				
	Molybdenum (Mo)-Total (mg/L)	<0.030				
	Nickel (Ni)-Total (mg/L)	<0.050				
	Phosphorus (P)-Total (mg/L)	<0.30				
	Potassium (K)-Total (mg/L)	<2.0				
	Selenium (Se)-Total (mg/L)	<0.20				
	Silicon (Si)-Total (mg/L)	2.12				
	Silver (Ag)-Total (mg/L)	<0.010				
	Sodium (Na)-Total (mg/L)	4.9				
	Strontium (Sr)-Total (mg/L)	0.298				
	Thallium (Tl)-Total (mg/L)	<0.20				
	Tin (Sn)-Total (mg/L)	<0.030				
	Titanium (Ti)-Total (mg/L)	<0.010				
	Vanadium (V)-Total (mg/L)	<0.030				
	Zinc (Zn)-Total (mg/L)	<0.0050				
Dissolved Metals	Dissolved Metals Filtration Location	LAB				
	Aluminum (Al)-Dissolved (mg/L)	<0.20				
	Antimony (Sb)-Dissolved (mg/L)	<0.20				
	Arsenic (As)-Dissolved (mg/L)	<0.20				
	Barium (Ba)-Dissolved (mg/L)	0.013				
	Beryllium (Be)-Dissolved (mg/L)	<0.0050				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479858-1	L1479858-2	L1479858-3	L1479858-4	L1479858-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	13:00	13:00	13:00	13:00	13:00
	Client ID	10% MH-04 (LAB WATER DILUTION)	50% MH-04 (LAB WATER DILUTION)	100% MH-04 (LAB WATER DILUTION)	0.1% MIXTURE (MH-04 DILUTION)	0.3% MIXTURE (MH-04 DILUTION)
Grouping	**Analyte**					
WATER						
Dissolved Metals	Bismuth (Bi)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Dissolved (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)-Dissolved (mg/L)	56.2	56.4	56.2	55.4	55.4
	Chromium (Cr)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Dissolved (mg/L)	2.51	2.26	2.58	2.57	2.54
	Manganese (Mn)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Dissolved (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Dissolved (mg/L)	2.72	2.42	2.81	2.80	2.76
	Silver (Ag)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Dissolved (mg/L)	<2.0	2.7	<2.0	<2.0	<2.0
	Strontium (Sr)-Dissolved (mg/L)	0.195	0.231	0.184	0.184	0.181
	Thallium (Tl)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Dissolved (mg/L)	<0.0050	<0.0050	0.0056	0.0130	0.0234

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479858-6	L1479858-7	L1479858-8	L1479858-9	L1479858-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	13:00	13:00	13:00	13:00	13:00
	Client ID	1% MIXTURE (MH-04 DILUTION)	3% MIXTURE (MH-04 DILUTION)	10% MIXTURE (MH-04 DILUTION)	30% MIXTURE (MH-04 DILUTION)	100% MIXTURE (85% MH-04, 15% MH-25)
Grouping	**Analyte**					
WATER						
Dissolved Metals	Bismuth (Bi)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Dissolved (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Dissolved (mg/L)	<0.010	<0.010	<0.010	0.017	0.052
	Calcium (Ca)-Dissolved (mg/L)	54.7	55.4	56.5	57.0	56.7
	Chromium (Cr)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Dissolved (mg/L)	2.49	2.54	2.58	2.57	2.46
	Manganese (Mn)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	0.0149
	Molybdenum (Mo)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Dissolved (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Dissolved (mg/L)	2.73	2.75	2.79	2.84	2.82
	Silver (Ag)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Dissolved (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Strontium (Sr)-Dissolved (mg/L)	0.177	0.180	0.183	0.180	0.164
	Thallium (Tl)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Dissolved (mg/L)	0.0552	0.161	0.515	1.56	5.01

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479858-11				
	Description	Water				
	Sampled Date	30-JUN-14				
	Sampled Time	13:00				
	Client ID	160MG/L HARDNESS PERRIER WATER (LAB WATER)				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Bismuth (Bi)-Dissolved (mg/L)	<0.20				
	Boron (B)-Dissolved (mg/L)	<0.10				
	Cadmium (Cd)-Dissolved (mg/L)	<0.010				
	Calcium (Ca)-Dissolved (mg/L)	58.1				
	Chromium (Cr)-Dissolved (mg/L)	<0.010				
	Cobalt (Co)-Dissolved (mg/L)	<0.010				
	Copper (Cu)-Dissolved (mg/L)	<0.010				
	Iron (Fe)-Dissolved (mg/L)	<0.030				
	Lead (Pb)-Dissolved (mg/L)	<0.050				
	Lithium (Li)-Dissolved (mg/L)	<0.010				
	Magnesium (Mg)-Dissolved (mg/L)	2.05				
	Manganese (Mn)-Dissolved (mg/L)	<0.0050				
	Molybdenum (Mo)-Dissolved (mg/L)	<0.030				
	Nickel (Ni)-Dissolved (mg/L)	<0.050				
	Phosphorus (P)-Dissolved (mg/L)	<0.30				
	Potassium (K)-Dissolved (mg/L)	<2.0				
	Selenium (Se)-Dissolved (mg/L)	<0.20				
	Silicon (Si)-Dissolved (mg/L)	2.09				
	Silver (Ag)-Dissolved (mg/L)	<0.010				
	Sodium (Na)-Dissolved (mg/L)	4.8				
	Strontium (Sr)-Dissolved (mg/L)	0.290				
	Thallium (Tl)-Dissolved (mg/L)	<0.20				
	Tin (Sn)-Dissolved (mg/L)	<0.030				
	Titanium (Ti)-Dissolved (mg/L)	<0.010				
	Vanadium (V)-Dissolved (mg/L)	<0.030				
	Zinc (Zn)-Dissolved (mg/L)	<0.0050				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-DIS-ICP-VA	Water	Dissolved Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2	OL-1357

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

(ALS) Environmental

Chain of Custody / Analytical Request Form

Canada Toll Free : 1 800 668 9878

www.alsglobal.com

L1479858

Sample #	Sample Identification (This will appear on the report)	Coordinates: Longitude	Coordinates: Latitude	Date	Time	Sample Type	Number of Containers	Total metals	Dissolved metals	Total Metals	Dissolved Metals
	Please indicate below Filtered, Preserved or both(F, P, F/P)								F		F
	30% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	100% Mixture (85% MH-04, 15% MH-25)			Jun-30-2014	01:00 PM	Water	2			R	R
	160 mg/L Hardness Perrier Water (lab water)			Jun-30-2014	01:00 PM	Water	2	R	R		

L1479858-COFC

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free : 1 800 668 9878
www.alsglobal.com

Report To	
Company:	Nautilus Environmental
Contact:	Krysta Pearcy
Address:	8664 Commerce Court Imperial Square Lake City Burnaby, BC Canada, V5A 4N7
Phone:	604-420-8773 Fax: 604-357-1361
Invoice To	☑ Email ☐ Mail
Company:	Nautilus Environmental
Contact:	Krysta Pearcy
Address:	8664 Commerce Court Imperial Square Lake City Burnaby, BC Canada, V5A 4N7
Email:	krysta@nautilusenvironmental.com
Phone:	604-420-8773
Lab Work Order # (lab use only)	L1479858

Reporting	
Distribution:	☐ Fax ☐ Mail ☑ Email
☐ Criteria on Report (select from Guidelines below)	
Report Type:	☑ Excel ☑ Digital
Report Format:	
Report Email(s):	krysta@nautilusenvironmental.com
EDD Format:	
EDD Email(s):	
Project Info	
Job #:	
PO/AFE:	
LSD:	
Quote #:	
ALS Contact: Janie Lo	Sampler: Krysta Pearcy

Service Requested

- ◉ Regular (Standard Turnaround Times - Business Days) - R
- ○ Priority (3 Days) - surcharge will apply - P
- ○ Priority (2 Days) - surcharge will apply - P2
- ○ Emergency (1-2 day) – surcharge will apply - E
- ○ Same Day or Weekend Emergency - surcharge will apply - E2
- ○ Specify date required - X

Analysis Requests

L1479858-COFC

Please indicate below Filtered, Preserved or both(F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Total metals	Dissolved metals	Total Metals	Dissolved Metals
									F		F
	10 % MH-04 (lab water dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	50% MH-04 (lab water dilution)			Jun-30-2014	01:00 PM	Water	2			R	R
	100% MH-04 (lab water dilution)			Jun-30-2014	01:00 PM	Water	2			R	R
	0.1% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	0.3% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	1% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	3% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	10% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		

(See page 2 for further samples)

Special Instructions/Comments

Samples for dissolved metals ~~have been filtered through 0.45 um.~~ have been filtered.
Samples NOT preserved.

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐ Yes ☒ No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐ Yes ☒ No

Guidelines

SAMPLE CONDITION (lab use only)

☐ Frozen ☐ Cold ☐ Ambient ☐ Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Krysta Pearcy	Date: June 30/14	Time: 1700h	Received by: JYL	Date: June 30	Time: 17:21	Temperature: 20.6°C	Verified by:	Date:	Time:	Observations: ☐ Yes If Yes add SIF

APPENDIX D – Chain of Custody

Nautilus Environmental

BRITISH COLUMBIA
8664 Commerce Court
Burnaby British Columbia Canada V5A 4N7
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

0952

Date ______ Page 1 of 1

Sample Collection by: ______

Report to:		Invoice to:	
Company	Azimuth	Company	Azimuth
Address		Address	
City / Prov. / PC		City / Prov. / PC	
Contact		Contact	
Phone No.		Phone No.	

ANALYSIS REQUIRED

SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NUMBER OF CONTAINERS	COMMENTS	7-d C.dubia wo#14399	72-h P.subcapitata wo#14400	48-h C.dubia wo#14401									RECEIPT TEMPERATURE (°C)
MH-04	June27 /14	1505		1L 20L	x 7 x 1	For mixture Test	X	X										8.5
MH-25	June27 /14	1545		1L 20L	x 7 x 1													8.5
Water Effects Ratio						Using MH-04 as site water			X									

PROJECT INFORMATION	SAMPLE RECEIPT	
CLIENT	TOTAL NO. OF CONTAINERS	
P.O. NO.	REC'D GOOD CONDITION	
SHIPPED VIA:		

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (CLIENT)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RELINQUISHED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (LABORATORY)
(Signature) [signature] (Time) 1000
(Printed Name) Krystal Karg (Date) June28/14

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

DISTRIBUTION: WHITE - Nautilus Environmental, COLOR - Originator

Water Effect Ratio Testing for Sä Dena Hes Mine

Final Report

Report date:
August 27, 2015

Submitted to:

Azimuth Consulting Group
Vancouver, BC

8664 Commerce Court
Burnaby, BC
V5A 4N7

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LIST OF APPENDICES

SIGNATURE PAGE

Bonnie Lo, M.E.T.
Environmental Scientist

James Elphick, B.Sc., R.P.Bio.
Senior Reviewer

This report has been prepared based on data and/or samples provided by our client and the results of this study are for their sole benefit. Any reliance on the data by a third party is at the sole and exclusive risk of that party. The results presented here relate only to the samples tested.

1.0 INTRODUCTION

The British Columbia Ministry of Environment has published guidelines for deriving site-specific water quality objectives. The purpose of a site specific objective is to account for physico-chemical properties of the site water which affect the toxicity of the chemical or differences in biological communities between the site and those used to derive the guideline.

In cases where characteristics of the site water alter the toxicity of the chemical, a Water Effect Ratio (WER) study can be conducted. A WER test involves evaluating the toxicity of a parameter of interest added separately into site water and into laboratory water. The results of the testing provide an estimate for toxicological endpoints, such as LC50 values, which can then be compared between the site water and laboratory water. The ratio between these values can be used to adjust a water quality guideline to account for site specific water quality characteristics. For example, if the toxicity of copper was two-fold lower in the site water than in the laboratory water, the calculated WER value would be two, and it would be appropriate to adjust the water quality criterion by a factor of two to derive the site specific objective.

Testing was conducted to determine whether a WER approach would be warranted for water quality objectives for seven metals (aluminum (Al), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb) and zinc (Zn)) for water collected from the Sa Dena Hes Mine. Sample water from the MH-04 site was collected in June, 2014 and was tested using the *Ceriodaphnia dubia* 48-hour acute test.

2.0 METHODS

2.1 Samples

Sample was collected from site MH-04 on June 27th, 2014, and delivered by courier to the Nautilus Environmental laboratory in Burnaby, BC the following day. The sample was collected in a 20-L collapsible carboy and transported in coolers containing ice-packs to chill the sample.

2.2 Test methods

The initial tests were conducted using each metal on June 30, 2014; however, for some of the metals, the tests required repeating because there was either no adverse response, or a complete adverse response in all test concentrations, which prevented calculation of LC50 estimates. The remaining testing was performed by July 13, 2014. Acute toxicity tests with *C. dubia* were conducted according to procedures summarized in Table 1. Testing was conducted according to procedures described by the USEPA protocol (2002) for measuring acute toxicity of effluents and receiving water to freshwater and marine organisms. Statistical analyses for all tests were performed using CETIS (Tidepool Scientific Software, 2013).

Prior to exposure, the MH-04 sample was spiked separately with reagent grade Al, Cd, Cr, Cu, Fe, Pb, and Zn in order to achieve the highest test concentration. Remaining test concentrations were prepared using the unspiked sample (MH-04) for dilution. Similarly, the metals were also spiked into laboratory-prepared water (reconstituted water prepared by addition of reagent grade salts to deionized water to match the hardness of the sample), and test concentrations were prepared using laboratory water for dilution. The tests using each metal were performed concurrently in laboratory and site waters. Test solutions were not renewed during the exposures.

Subsamples were collected from all concentrations at test initiation for measurement of the spiked metal (total and dissolved). At test termination, subsamples were collected for measurement of the total metal. Toxicity test end-points were calculated on the basis of measured total metal concentration, with the exception of Al, which was calculated based on the concentration of dissolved metal.

Table 1. Summary of test conditions: 48 hr *Ceriodaphnia dubia* test.

Test type	Static
Endpoints	Survival
Organism source	In-house culture
Organism age	<24 hr old neonates
Feeding	None
Test chamber	Glass test tube
Test volume	15 mL
Test temperature	25±1°C
Control water	Moderately hard synthetic water, amended to approximately 140 mg/L hardness to match the hardness of the sample
Number of organisms/replicate	5
Number of replicates	4
Photoperiod	16 hours light/8 hours dark
Aeration	None
Test acceptability criterion for controls	≥90% survival

3.0 RESULTS

Results of toxicity tests and calculated WER values are provided in Tables 2 through 8. The hardness of the sample collected from MH-04 was 146 mg/L and the laboratory water was 140 mg/L, as $CaCO_3$.

The effect of aluminum was very similar in the site and laboratory waters, with 45 to 55% survival in the lowest test concentration, and no survival in the remaining concentrations (Table 2). Thus, the LC50 was estimated by inspection of the data to be equivalent to the lowest test concentration in each test, and the WER for Al was approximately 1.0, indicating that there was no effect of the site water on toxicity of aluminum.

Concentrations of cadmium diminished during the test; measured concentrations at the start of the tests were close to target values, but measurements at test termination were approximately one quarter of the values that were present at initiation in both site and laboratory waters. The concentrations of total metal that were present at the start of the tests were used to calculate the test endpoints for this metal. The toxicity of Cd was higher in the lab water than the site water, resulting in a WER of 2.4 (Table 3).

Test endpoints for chromium were calculated on the basis of the average of measured total concentration of chromium at test initiation and termination (Table 4). The toxicity of chromium was higher in the site water than the laboratory water, resulting in a WER of 0.3.

Concentrations of total copper that were measured at test initiation were used to calculate the test endpoints for this metal, since copper diminished by approximately two-fold during the laboratory water test. The toxicity of copper was higher in the site water than the lab water, resulting in a WER of 1.9 (Table 5).

Concentrations of total iron measured at test termination were used to calculate the test endpoints for this metal. The measured concentrations of iron at test initiation were lower than the targeted values, whereas concentrations measured at test termination were in good agreement with the targeted values. This may have resulted from a subsampling or analytical error for the subsamples collected at test initiation, such as not mixing to ensure suspension of particulate iron. The organisms were somewhat less sensitive to iron in site water, resulting in a WER of 1.2 (Table 6).

The average of total lead concentrations measured at test initiation and termination were used to calculate the point estimates for lead. This metal exhibited low solubility and the test concentrations deviated from the target values. Regardless, the test organisms performed similarly in the two water types, producing a WER of 1.1 (Table 7).

The average of total zinc concentrations measured at test initiation and termination were used to calculate point estimates for zinc. The test organisms were somewhat more sensitive to zinc in site water, producing a WER of 0.7.

Raw data from the WER tests are provided in Appendices A. Supporting water quality variables are provided in Table 9 and are provided in Appendix B, along with total and dissolved metals concentrations for the samples and control waters.

Table 2. Results of Water Effect Ratio tests for *Ceriodaphnia dubia* using aluminum.

	Laboratory Water		Site Water (MH-04)	
Nominal Aluminum	Measured aluminum, dissolved (µg/L)	Survival (%)	Measured aluminum, dissolved (µg/L)	Survival (%)
Control	<200	100	1.6	100
250	172	45	171	55
500	301	0	282	0
1000	312	0	329	0
2000	320	0	344	0
4000	344	0	399	0
LC50	~ 172		~ 171	
WER		**~1.0**		

Table 3. Results of Water Effect Ratio tests for *Ceriodaphnia dubia* using cadmium.

	Laboratory Water			Site Water (MH-04)	
Nominal cadmium	Measured cadmium, total (µg/L)	Survival (%)	Nominal cadmium	Measured cadmium, total (µg/L)	Survival (%)
Control	<0.05	100	Control	0.2	90
6.25	6.0	100	25	22.9	100
12.5	12.5	100	50	47.1	45
25	23.1	20	100	95.5	0
50	46.5	0	200	192.0	0
100	87.3	0	400	387.0	0
LC50	19.4 (17.2-21.9)			46.1 (39.3-54.0)	
WER			**2.4**		

Table 4. Results of Water Effect Ratio tests for *Ceriodaphnia dubia* using chromium.

	Laboratory Water		Site Water (MH-04)	
Nominal chromium	Measured chromium, total (µg/L)	Survival (%)	Measured chromium, total (µg/L)	Survival (%)
Control	<0.5	100	<0.5	100
43.75	43.0	100	41.9	95
87.5	91.3	100	91.25	5
175	178.5	95	181.0	0
350	357.5	0	353.0	0
700	732.5	0	734.0	0
LC50	244.1 (228.4 – 260.9)		61.8 (58.3 – 65.6)	
WER		**0.3**		

Table 5. Results of Water Effect Ratio tests for *Ceriodaphnia dubia* using copper.

	Laboratory Water		Site Water (MH-04)	
Nominal copper	Measured copper, total (µg/L)	Survival (%)	Measured copper, total (µg/L)	Survival (%)
Control	<0.5	100	<0.5	100
1.56	3.15	100	2.97	100
3.13	3.31	100	4.70	100
6.25	5.91	95	8.89	100
12.5	10.8	0	15.8	40
25	22.8	0	28.8	10
LC50	7.8 (7.3 – 8.2)		15.2 (12.8 – 18.1)	
WER		**1.9**		

Table 6. Results of Water Effect Ratio tests for *Ceriodaphnia dubia* using iron.

Nominal iron	Laboratory Water: Measured iron, total (mg/L)	Laboratory Water: Survival (%)	Site Water (MH-04): Measured iron, total (mg/L)	Site Water (MH-04): Survival (%)
Control	0.05	100	0.02	90
2.5	0.1	90	2.1	100
5.0	3.8	65	4.9	65
10.0	9.1	20	9.2	5
20.0	18.1	10	19.5	5
40.0	37.0	0	37.3	0
LC50	4.6 (3.1 – 6.6)		5.7 (4.8 – 6.9)	
WER		**1.2**		

Table 7. Results of Water Effect Ratio tests for *Ceriodaphnia dubia* using lead.

Nominal lead	Laboratory Water: Measured lead, total (µg/L)	Laboratory Water: Survival (%)	Site Water (MH-04): Measured lead, total (µg/L)	Site Water (MH-04): Survival (%)
Control	<0.05	100	0.29	100
62.5	28.6	100	40.5	100
125	61.8	100	47.1	100
250	133.0	100	188.0	100
500	301.0	85	243.5	70
1000	329.0	0	623.0	0
LC50	294.0 (273.5 – 316.1)		325.4 (287.8 – 367.9)	
WER		**1.1**		

Table 8. Results of Water Effect Ratio tests for *Ceriodaphnia dubia* using zinc.

Nominal zinc	Laboratory Water: Measured zinc, total (µg/L)	Laboratory Water: Survival (%)	Site Water (MH-04): Measured zinc, total (µg/L)	Site Water (MH-04): Survival (%)
Control	<3.0	100	7.0	100
50	41.4	90	44.4	90
100	73.9	80	81.2	65
200	158.5	40	152.0	20
400	332.5	25	330.0	0
800	638.5	0	671.5	0
LC50	146.7 (108.4 – 198.6)		97.7 (78.5 – 121.5)	
WER		**0.7**		

Table 9. Water chemistry measurements.

	TOC (mg/L)	Hardness (mg/L)
MH-04	1.57	146
Laboratory water	<0.5	140

4.0 DISCUSSION

The results of this testing program demonstrated a relatively small effect of the site water on sensitivity to metals. For aluminum, iron, and lead, there was little-to-no difference in sensitivity between the water types. Chromium and zinc appeared to exhibit a higher degree of sensitivity in the site water, and copper and cadmium exhibited a lower degree of toxicity in site water relative to laboratory water. Thus, of the seven metals, it appears that a higher water quality guideline might be acceptable for only cadmium and copper on the basis of a WER approach. However, additional testing would be required to establish the actual WER for the site, since data is generally required for multiple species and seasons. It should be noted that the total organic carbon measured in the sample was relatively low (1.57 mg/L). Seasonal variation in TOC at MH-04 would be expected to alter the WER for copper and cadmium.

5.0 REFERENCES

Tidepool Scientific Software. 2013. CETIS comprehensive environmental toxicity information system, version 1.8.7.16 Tidepool Scientific Software, McKinleyville, CA. 222 pp.

USEPA (US Environmental Protection Agency). 2002. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. EPA-821-R-02-012.

APPENDIX A - Water Effect Ratio Toxicity Data

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Aluminum WER (lab water)
Work Order No.: 14401e

Start Date & Time: June 30/14 @ 1400h
End Date & Time: July 2/14 @ 1400h
Test Organisms: C. dubia

Conc. mg/L Al	Rep	Number of Live Organisms 24	48	Temperature (°C) 0		24	48	Dissolved Oxygen (mg/L) 0		24	48	pH 0		24	48	Conductivity (uS/cm) 0	48
Control	A		5	24.0		24.5	24.5	7.7			7.3	8.2			8.3	307	302
	B		5														
	C		5														
	D		5														
250	A		4	24.0		24.5	24.5	7.7			7.3	8.3			8.3	312	307
	B		1														
	C		2														
	D		2														
500	A		0	24.0		24.5	24.5	7.7			7.3	8.2			8.2	312	308
	B		0														
	C		0														
	D		0														
1000	A		0	24.0		24.5	24.5	7.7			7.3	8.1			8.2	315	318
	B		0														
	C		0														
	D		0														
2000	A		0	24.0		24.5	24.5	7.7			7.3	7.9			8.2	318	320
	B		0														
	C		0														
	D		0														
4000	A		0	24.0		24.5	24.5	7.7			7.3	7.6			8.2	325	326
	B		0														
	C		0														
	D		0														
Technician Initials		—	KLP	KLP		KLP	KLP	KLP		—	KLP	KLP		—	KLP	KLP	KLP

Conc.	Hardness (mg/L as CaCO3)	Alkalinity (mg/L as CaCO3)
control	140	78
highest conc.	—	—

Sample Description: Aluminum spiked into 160 mg/L hardness Perrier lab water
Analyst Initials: KLP, EMM

Comments: Used stock solution: 1000 mg/L Al made June 27/14 (made from $AlCl_3$)

Reviewed by: A. Tang

Date reviewed: September 19, 2014

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Aluminum WER (site water)
Work Order No.: 14401 f

Start Date & Time: June 30/14 @ 1400h
End Date & Time: July 2/14 @ 1400h
Test Organisms: C. dubia

Conc. mg/L Al	Rep	Number of Live Organisms 24	48	Temperature (°C) 0		24	48	Dissolved Oxygen (mg/L) 0		24	48	pH 0		24	48	Conductivity (uS/cm) 0	48
Control	A		5	24.0		24.5	24.5	7.9			7.3	8.2			8.3	273	269
	B		5														
	C		5														
	D		5														
250	A		2	24.0		24.5	24.5	7.9			7.4	8.3			8.4	275	280
	B		3														
	C		2														
	D		4														
500	A		0	24.0		24.5	24.5	7.9			7.4	8.2			8.4	276	280
	B		0														
	C		0														
	D		0														
1000	A		0	24.0		24.5	24.5	7.9			7.4	8.1			8.4	277	281
	B		0														
	C		0														
	D		0														
2000	A		0	24.0		24.5	24.5	7.9			7.4	7.9			8.3	281	284
	B		0														
	C		0														
	D		0														
4000	A		0	24.0		24.5	24.5	7.9			7.4	7.6			8.3	288	289
	B		0														
	C		0														
	D		0														
Technician Initials		—	KLP	KLP	KLP	KLP		KLP	—		KLP	KLP	—		KLP	KLP	KLP

Conc.	Hardness (mg/L as CaCO3)	Alkalinity (mg/L as CaCO3)
control	146	114
highest conc.	—	—

Sample Description: Aluminum spiked into site water MH-04
Analyst Initials: KLP, EMM

Comments: Used stock solution: made June 27/14 1000 mg/L AL (made from $AlCl_3$)

Reviewed by: A. Tang

Date reviewed: September 19, 2014

Version 1.0: Issued November 1, 2007

Nautilus Environmental

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	21-2476-0346	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	26 Sep-14 19:11	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	13-2051-8392	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 14:00	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Laboratory Water
Ending Date:	02 Jul-14 14:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	12-7301-5978	**Code:**	4BE0AEAA	**Client:**	Azimuth
Sample Date:	30 Jun-14	**Material:**	Aluminum	**Project:**	
Receive Date:	30 Jun-14	**Source:**	Azimuth		
Sample Age:	14h	**Station:**	Aluminum WER (lab water)		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	2065631	200	Yes	Two-Point Interpolation

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

Point Estimates

Level	µg/L	95% LCL	95% UCL
EC5	0.5976	0.2974	1.818
EC10	1.552	0.6494	6.384
EC15	3.077	1.038	17.6
EC20	5.514	1.415	44.77
EC25	9.406	1.672	110
EC40	41.43	N/A	274.8
EC50	107.3	N/A	261.9

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
172		4	0.45	0.2	0.8	0.1258	0.2517	55.92%	55.0%	9	20
312		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	1	1	1	1
172		0.8	0.2	0.4	0.4
312		0	0	0	0

48h Survival Rate Binomials

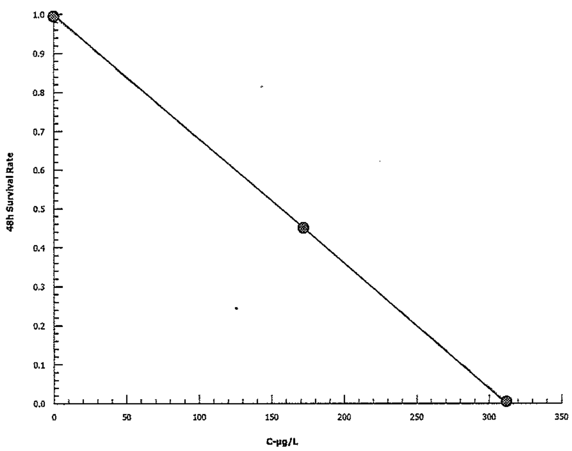
C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	5/5	5/5	5/5	5/5
172		4/5	1/5	2/5	2/5
312		0/5	0/5	0/5	0/5

July 28/15

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	21-2476-0346	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	26 Sep-14 19:11	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



July 28/15

Ceriodaphnia 48-h Acute Survival Test

Nautilus Environmental

Analysis ID:	00-7583-9002	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	24 Sep-14 15:00	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	08-9935-2457	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 14:00	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Site Water
Ending Date:	02 Jul-14 14:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	15-0489-7655	**Code:**	59B2EA77	**Client:**	Azimuth
Sample Date:	27 Jun-14 14:00	**Material:**	Aluminum	**Project:**	
Receive Date:	02 Jul-14 14:00	**Source:**	Azimuth		
Sample Age:	72h	**Station:**	Aluminum WER (MH-04 site water)		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	789309	200	Yes	Two-Point Interpolation

Point Estimates

Level	µg/L	95% LCL	95% UCL
EC5	3.142	2.414	6.135
EC10	5.6	3.406	17.29
EC15	9.515	4.555	44.15
EC20	15.75	5.772	107.9
EC25	25.69	6.844	258.2
EC40	107	2.272	247.7
EC50	181.5	26.35	231.5

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
1.6	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
171		4	0.55	0.4	0.8	0.09574	0.1915	34.82%	45.0%	11	20
329		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
1.6	Negative Control	1	1	1	1
171		0.4	0.6	0.4	0.8
329		0	0	0	0

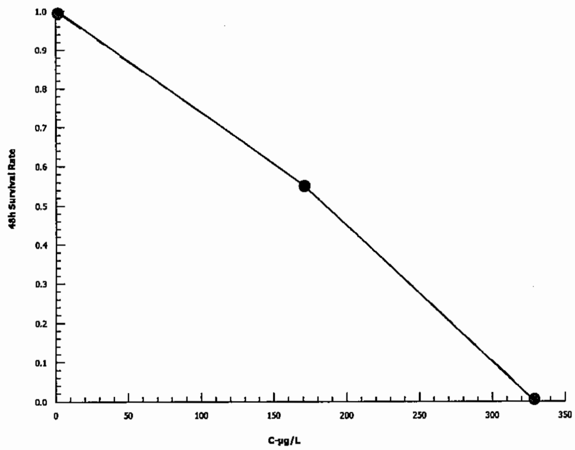
48h Survival Rate Binomials

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
1.6	Negative Control	5/5	5/5	5/5	5/5
171		2/5	3/5	2/5	4/5
329		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	00-7583-9002	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	24 Sep-14 15:00	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Cd in Labwater WER
Work Order No.: 14401e

Start Date & Time: July 11/14 @ 1430h
End Date & Time: July 13/14 @ 1430h
Test Organisms: C. dubia

Conc. (µg/L Cd)	Rep	Number of Live Organisms 24	48	Temperature (°C) 0		24	48	Dissolved Oxygen (mg/L) 0		24	48	pH 0		24	48	Conductivity (uS/cm) 0	48
Control	A	5	5	24.0		25.0	25.0	8.2			7.5	8.2			8.0	302	295
	B																
	C																
	D																
6.25	A			24.0		25.0	25.0	8.2			7.5	8.1			7.9	301	295
	B																
	C																
	D																
12.5	A			24.0		25.0	25.0	8.1			7.6	8.2			8.0	300	297
	B																
	C																
	D																
25	A		2	24.0		25.0	25.0	8.2			7.6	8.2			8.0	300	296
	B		1														
	C		1														
	D		0														
50	A		0	24.0		25.0	25.0	8.2			7.6	8.1			8.0	296	296
	B																
	C																
	D																
100	A			24.0		25.0	25.0	8.2			7.6	8.1			8.0	295	297
	B																
	C																
	D																
Technician Initials		A	m	EMM		A	m	EMM		Am	A	EMM			m	EMM	A

Conc.	Hardness	Alkalinity
	(mg/L as CaCO3)	
control	168	120
highest conc.		

Sample Description: AWD, EMM — Cadmium spiked into lab water (160mg/L Hardness)
Analyst Initials:

Comments: used stock solution: (93.6mg/L Cd) 14Cd01 Cd emm

Reviewed by: A. Tang

Date reviewed: September 19, 2014

Version 1.0: Issued November 1, 2007

Nautilus Environmental

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Cadmium WER (site water)
Work Order No.: 14401 d

Start Date & Time: June 30/14 @ 1400h
End Date & Time: July 2/14 @ 1400h
Test Organisms: C. dubia

Conc. mg/L Cd	Rep	Number of Live Organisms 24	Number of Live Organisms 48	Temperature (°C) 0	Temperature (°C) 24	Temperature (°C) 48	Dissolved Oxygen (mg/L) 0	Dissolved Oxygen (mg/L) 24	Dissolved Oxygen (mg/L) 48	pH 0	pH 24	pH 48	Conductivity (uS/cm) 0	Conductivity (uS/cm) 48
Control	A		4	24.0	24.5	25.0	7.9		7.5	8.2		8.3	273	279
	B		4											
	C		5											
	D		5											
25	A		5	24.0	24.5	25.0	7.9		7.5	8.4		8.4	274	278
	B		5											
	C		5											
	D		5											
50	A		3	24.0	24.5	25.0	7.9		7.5	8.4		8.4	273	280
	B		3											
	C		1											
	D		2											
100	A		0	24.0	24.5	25.0	7.9		7.2	8.4		8.4	273	279
	B		0											
	C		0											
	D		0											
200	A		0	24.0	24.5	25.0	7.9		7.3	8.4		8.4	273	280
	B		0											
	C		0											
	D		0											
400	A		0	24.0	24.5	25.0	7.9		7.3	8.4		8.4	273	278
	B		0											
	C		0											
	D		0											
Technician Initials		—	EMM	KLP	KLP	EMM	KLP	—	EMM	KLP	—	EMM	KLP	EMM

Conc.	Hardness (mg/L as CaCO3)	Alkalinity (mg/L as CaCO3)
control	146	114
highest conc.	—	—

Sample Description: Cadmium spiked into site water MH-04

Analyst Initials: KLP, EMM

Comments: Used stock solution: 14Cd01 (93.6 mg/L Cd)

Reviewed by: A. Tang

Date reviewed: September 19, 2014

CETIS Analytical Report

Report Date:	23 Sep-14 18:12 (p 1 of 2)
Test Code:	14401c | 07-6687-4047

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	12-7792-7916	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:36	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Batch ID:	06-3803-1020	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	11 Jul-14 14:30	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Laboratory Water
Ending Date:	13 Jul-14 14:30	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	09-1081-2136	**Code:**	3649E3E8	**Client:**	Azimuth
Sample Date:	11 Jul-14	**Material:**	Cadmium	**Project:**	
Receive Date:	11 Jul-14	**Source:**	Azimuth		
Sample Age:	14h	**Station:**	Cadmium WER (lab water)		

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	0.00%	1.287	0.02552	19.38	17.23	21.79

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-ug/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
6.04		4	1	1	1	0	0	0.0%	0.0%	20	20
12.5		4	1	1	1	0	0	0.0%	0.0%	20	20
23.1		4	0.2	0	0.4	0.08165	0.1633	81.65%	80.0%	4	20
46.5		4	0	0	0	0	0		100.0%	0	20
87.3		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	1	1	1	1
6.04		1	1	1	1
12.5		1	1	1	1
23.1		0.4	0.2	0.2	0
46.5		0	0	0	0
87.3		0	0	0	0

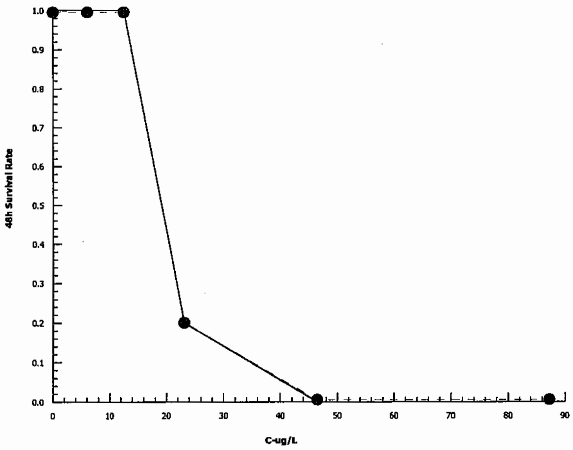
48h Survival Rate Binomials

C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	5/5	5/5	5/5	5/5
6.04		5/5	5/5	5/5	5/5
12.5		5/5	5/5	5/5	5/5
23.1		2/5	1/5	1/5	0/5
46.5		0/5	0/5	0/5	0/5
87.3		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test **Nautilus Environmental**

Analysis ID:	12-7792-7916	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:36	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Report Date:	11 Sep-14 16:39 (p 1 of 2)
Test Code:	14401d | 08-3058-4924

Ceriodaphnia 48-h Acute Survival Test | **Nautilus Environmental**

Analysis ID:	02-8514-9976	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:38	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Batch ID:	03-4073-4844	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 14:00	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Site Water
Ending Date:	02 Jul-14 14:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	11-9658-4485	**Code:**	47526E25	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:05	**Material:**	Cadmium	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	71h	**Station:**	Cadmium WER (MH-04 site water)		

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0.1	0.00%	1.663	0.03462	46.06	39.27	54.02

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-ug/L	**Control Type**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A**	**B**
0.214	Negative Control	4	0.9	0.8	1	0.05774	0.1155	12.83%	0.0%	18	20
22.9		4	1	1	1	0	0	0.0%	-11.11%	20	20
47.1		4	0.45	0.2	0.6	0.09574	0.1915	42.55%	50.0%	9	20
95.5		4	0	0	0	0	0		100.0%	0	20
192		4	0	0	0	0	0		100.0%	0	20
387		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0.214	Negative Control	0.8	0.8	1	1
22.9		1	1	1	1
47.1		0.6	0.6	0.2	0.4
95.5		0	0	0	0
192		0	0	0	0
387		0	0	0	0

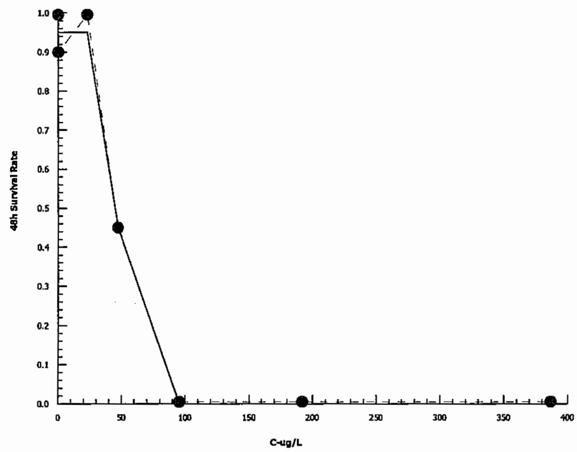
48h Survival Rate Binomials

C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0.214	Negative Control	4/5	4/5	5/5	5/5
22.9		5/5	5/5	5/5	5/5
47.1		3/5	3/5	1/5	2/5
95.5		0/5	0/5	0/5	0/5
192		0/5	0/5	0/5	0/5
387		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID: 02-8514-9976	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed: 11 Sep-14 16:38	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Chromium WER (lab water)
Work Order No.: 14401i

Start Date & Time: ~~June 30/14@~~ July 1/14@ 1400h
End Date & Time: ~~July 2/14@~~ July 3/14@ 1400h
Test Organisms: C. dubia

Conc. mg/L Cr	Rep	Number of Live Organisms 24	48	Temperature (°C) 0		24	48	Dissolved Oxygen (mg/L) 0		24	48	pH 0		24	48	Conductivity (uS/cm) 0	48
Control	A		5	24.0			25.0	8.0			7.3	8.1			8.1	280	280
	B																
	C																
	D																
43.75	A			24.0			25.0	8.0			7.3	8.2			8.1	281	280
	B																
	C																
	D																
87.5	A			24.0			25.0	8.0			7.2	8.2			8.2	280	281
	B																
	C																
	D																
175	A		4	24.0			25.0	8.0			7.3	8.2			8.2	280	280
	B		5														
	C		5														
	D		5														
350	A		0	24.0			25.0	8.0			7.2	8.2			8.2	281	279
	B																
	C																
	D																
700	A			24.0			25.0	8.0			7.2	8.2			8.2	282	280
	B																
	C																
	D																
Technician Initials		—	m	KLP			m	KLP		—	MS	KLP		—	m	KLP	KLP

Conc.	Hardness	Alkalinity
	(mg/L as CaCO3)	
control	140	78
highest conc.	—	—

Sample Description: Chromium spiked into 160 mg/L hardness Perrier lab water
Analyst Initials: KLP, EMM

Comments: Used stock solution: 100 mg/L Cr made June 12/14 (made from K_2CrO_4)

Reviewed by: A. Tang

Date reviewed: September 19, 2014

Version 1.0: Issued November 1, 2007

Nautilus Environmental

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Chromium WER (site water)
Work Order No.: ~~14SEP~~ 14401 j

Start Date & Time: ~~June 30/14@~~ July 1/14 @1400h
End Date & Time: ~~July 2/14@~~ July 3/14 @1400h
Test Organisms: C.dubia

Conc. mg/L Cr	Rep	Number of Live Organisms 24	Number of Live Organisms 48	Temperature (°C) 0		Temperature (°C) 24	Temperature (°C) 48	Dissolved Oxygen (mg/L) 0		Dissolved Oxygen (mg/L) 24	Dissolved Oxygen (mg/L) 48	pH 0		pH 24	pH 48	Conductivity (uS/cm) 0	Conductivity (uS/cm) 48
Control	A		5	24.0		24.5	25.0	8.0			7.2	8.4			8.2	278	281
	B																
	C																
	D																
43.75	A		5	24.0		24.0	25.0	8.0			7.2	8.4			8.2	277	281
	B		4														
	C		5														
	D		5														
87.5	A		1	24.0		25.0	25.0	8.0			7.2	8.4			8.2	277	282
	B		0														
	C		0														
	D		0														
175	A		0	24.0		25.0	25.0	8.0			7.2	8.4			8.2	277	282
	B																
	C																
	D																
350	A			24.0		26.0	25.0	8.0			7.2	8.4			8.2	278	281
	B																
	C																
	D																
700	A			24.0		25.0	25.0	8.0			7.2	8.4			8.2	280	281
	B																
	C																
	D																
Technician Initials				KLP				KLP				KLP				KLP	

Conc.	Hardness (mg/L as CaCO3)	Alkalinity (mg/L as CaCO3)
control	146	114
highest conc.		

Sample Description: Chromium spiked into site water MH-04

Analyst Initials: KLP, EMM

Comments: Used stock solution: 100 mg/L Cr made June 12/14 (made from K_2CrO_4)

Reviewed by: A. Tang

Date reviewed: September 19, 2014

Version 1.0: Issued November 1, 2007

Nautilus Environmental

CETIS Analytical Report

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	07-4690-7704	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:58	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Batch ID:	00-8476-6902	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	01 Jul-14 14:00	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Laboratory Seawater
Ending Date:	03 Jul-14 14:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	10-7274-3035	**Code:**	3FF0C27B	**Client:**	Azimuth
Sample Date:	30 Jun-14	**Material:**	Chromium	**Project:**	
Receive Date:	30 Jun-14	**Source:**	Azimuth		
Sample Age:	38h	**Station:**	Chromium WER (lab water)		

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	0.00%	2.388	0.01444	244.1	228.4	260.9

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
43.05		4	1	1	1	0	0	0.0%	0.0%	20	20
91.3		4	1	1	1	0	0	0.0%	0.0%	20	20
178.5		4	0.95	0.8	1	0.05	0.1	10.53%	5.0%	19	20
357.5		4	0	0	0	0	0		100.0%	0	20
732.5		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	1	1	1	1
43.05		1	1	1	1
91.3		1	1	1	1
178.5		0.8	1	1	1
357.5		0	0	0	0
732.5		0	0	0	0

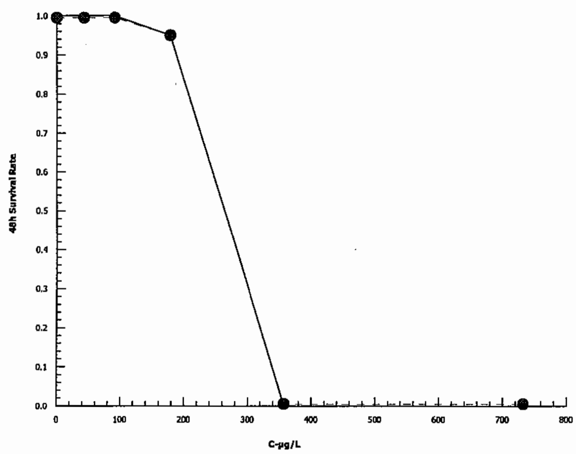
48h Survival Rate Binomials

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	5/5	5/5	5/5	5/5
43.05		5/5	5/5	5/5	5/5
91.3		5/5	5/5	5/5	5/5
178.5		4/5	5/5	5/5	5/5
357.5		0/5	0/5	0/5	0/5
732.5		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test | **Nautilus Environmental**

Analysis ID: 07-4690-7704	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed: 11 Sep-14 16:58	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	05-2793-6179	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:59	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes
Batch ID:	15-3617-3809	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	01 Jul-14 14:00	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Site Water
Ending Date:	03 Jul-14 14:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h
Sample ID:	05-0569-1222	**Code:**	1E243C56	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:05	**Material:**	Chromium	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	95h	**Station:**	Chromium WER (MH-04 site water)		

Trimmed Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	5.00%	1.791	0.01294	61.83	58.26	65.63

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
41.9		4	0.95	0.8	1	0.05	0.1	10.53%	5.0%	19	20
91.25		4	0.05	0	0.2	0.05	0.1	200.0%	95.0%	1	20
181		4	0	0	0	0	0		100.0%	0	20
353		4	0	0	0	0	0		100.0%	0	20
734		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	1	1	1	1
41.9		1	0.8	1	1
91.25		0.2	0	0	0
181		0	0	0	0
353		0	0	0	0
734		0	0	0	0

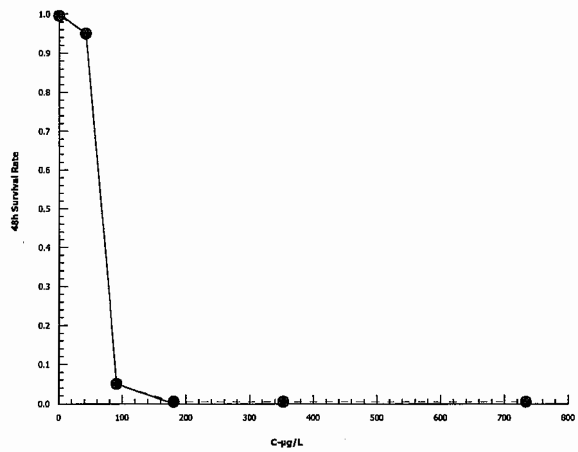
48h Survival Rate Binomials

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	5/5	5/5	5/5	5/5
41.9		5/5	4/5	5/5	5/5
91.25		1/5	0/5	0/5	0/5
181		0/5	0/5	0/5	0/5
353		0/5	0/5	0/5	0/5
734		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	05-2793-6179	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:59	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Cu in Lab water (WER)
Work Order No.: 14401 k

Start Date & Time: July 11/14 @ 1455
End Date & Time: July 13/14 @ 1455
Test Organisms: C. dubia

Conc. (mg/L Cu)	Rep	Number of Live Organisms 24	Number of Live Organisms 48	Temperature (°C) 0	Temperature (°C) 24	Temperature (°C) 48	Dissolved Oxygen (mg/L) 0	Dissolved Oxygen (mg/L) 24	Dissolved Oxygen (mg/L) 48	pH 0	pH 24	pH 48	Conductivity (uS/cm) 0	Conductivity (uS/cm) 48
Control	A	5	5	24.0	25.0	25.0	8.2		7.5	8.2		8.0	302	291
	B													
	C													
	D													
1.56	A			24.0	25.0	25.0	8.1		7.6	8.2		8.0	300	292
	B													
	C													
	D													
3.13	A			24.0	25.0	25.0	8.1		7.4	8.2		8.0	300	292
	B													
	C													
	D													
6.25	A		4	24.0	25.0	25.0	8.1		7.4	8.1		8.0	302	294
	B		5											
	C		5											
	D		5											
12.5	A		0	24.0	25.0	25.0	8.1		7.4	8.1		8.0	300	294
	B													
	C													
	D													
25	A	4		24.0	25.0	25.0	8.1		7.5	8.1		8.0	300	293
	B	3												
	C	3												
	D	3												
Technician Initials		~	~	EMM	~	~	EMM		~	EMM		~	EMM	~

Conc.	Hardness (mg/L as CaCO3)	Alkalinity (mg/L as CaCO3)
control	168	120
highest conc.		

Sample Description: AWD, EMM Cu spiked into lab water (160mg/L hardness)
Analyst Initials:

Comments: used copper stock solution 13CuO5

Reviewed by: A. Tang

Date reviewed: September 19, 2014

Version 1.0: Issued November 1, 2007

Nautilus Environmental

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Cu in site water (WER)
Work Order No.: 14401 C

Start Date & Time: July 11/14 @ 1445
End Date & Time: July 13/14 @ 1445
Test Organisms: C. dubia

Conc. (µg/L Cu)	Rep	Number of Live Organisms 24	Number of Live Organisms 48	Temperature (°C) 0	Temperature (°C) 24	Temperature (°C) 48	Dissolved Oxygen (mg/L) 0	Dissolved Oxygen (mg/L) 24	Dissolved Oxygen (mg/L) 48	pH 0	pH 24	pH 48	Conductivity (uS/cm) 0	Conductivity (uS/cm) 48
Control	A	5	5	24.0	25.0	25.0	8.2		7.6	8.2		8.1	274	281
	B													
	C													
	D													
1.56	A			24.0	25.0	25.0	8.2		7.6	8.2		8.1	275	276
	B													
	C													
	D													
3.13	A			24.0	25.0	25.0	8.1		7.6	8.1		8.1	278	281
	B													
	C													
	D													
6.25	A			24.0	25.0	25.0	8.1		7.5	8.2		8.0	278	279
	B													
	C													
	D													
12.5	A		2	24.0	25.0	25.0	8.1		7.5	8.2		8.0	272	280
	B		1											
	C		2											
	D		3											
25	A	4	0	24.0	25.0	25~~.5~~ 0	8.1		7.5	8.2		8.0	272	283
	B	3	0											
	C	2	1											
	D	3	0											
Technician Initials		A	A	EMM	A	A	EMM		A	EMM		A	EMM	A

Conc.	Hardness (mg/L as CaCO3)	Alkalinity (mg/L as CaCO3)
control	146	114
highest conc.		

Sample Description: AWD, EMM — Copper spiked into site water MH-04
Analyst Initials:

Comments: used copper stock solution 13Cu05

Reviewed by: A. Teng

Date reviewed: September 19, 2014

CETIS Analytical Report

Report Date: 23 Sep-14 18:10 (p 1 of 2)
Test Code: 14401k | 14-4548-5365

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	02-7809-8907	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 17:14	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes
Batch ID:	05-0718-0851	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	11 Jul-14 14:55	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Laboratory Water
Ending Date:	13 Jul-14 14:55	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h
Sample ID:	18-6374-2452	**Code:**	6F1673F4	**Client:**	Azimuth
Sample Date:	11 Jul-14	**Material:**	Copper	**Project:**	
Receive Date:	11 Jul-14	**Source:**	Azimuth		
Sample Age:	15h	**Station:**	Copper WER (lab water)		

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	0.00%	0.8897	0.01251	7.756	7.322	8.217

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-ug/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
3.15		4	1	1	1	0	0	0.0%	0.0%	20	20
3.31		4	1	1	1	0	0	0.0%	0.0%	20	20
5.91		4	0.95	0.8	1	0.05	0.1	10.53%	5.0%	19	20
10.8		4	0	0	0	0	0		100.0%	0	20
22.8		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	1	1	1	1
3.15		1	1	1	1
3.31		1	1	1	1
5.91		0.8	1	1	1
10.8		0	0	0	0
22.8		0	0	0	0

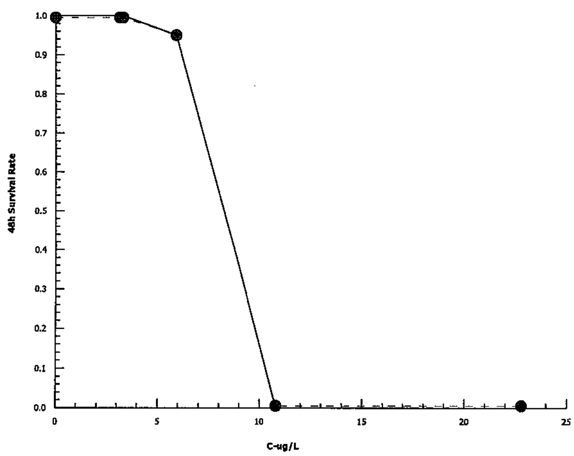
48h Survival Rate Binomials

C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	5/5	5/5	5/5	5/5
3.15		5/5	5/5	5/5	5/5
3.31		5/5	5/5	5/5	5/5
5.91		4/5	5/5	5/5	5/5
10.8		0/5	0/5	0/5	0/5
22.8		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test	**Nautilus Environmental**

Analysis ID:	02-7809-8907	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 17:14	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	18-8609-0180	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 17:15	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes
Batch ID:	12-8368-3192	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	11 Jul-14 14:45	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Site Water
Ending Date:	13 Jul-14 14:45	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h
Sample ID:	00-8039-3177	**Code:**	4CAB3D9	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:05	**Material:**	Copper	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	14d	**Station:**	Copper WER (MH-04 site water)		

Trimmed Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	10.00%	1.183	0.03707	15.22	12.83	18.06

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-ug/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
2.97		4	1	1	1	0	0	0.0%	0.0%	20	20
4.7		4	1	1	1	0	0	0.0%	0.0%	20	20
8.89		4	1	1	1	0	0	0.0%	0.0%	20	20
15.8		4	0.4	0.2	0.6	0.08165	0.1633	40.82%	60.0%	8	20
28.8		4	0.1	0	0.2	0.05774	0.1155	115.5%	90.0%	2	20

48h Survival Rate Detail

C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	1	1	1	1
2.97		1	1	1	1
4.7		1	1	1	1
8.89		1	1	1	1
15.8		0.4	0.2	0.4	0.6
28.8		0.2	0	0.2	0

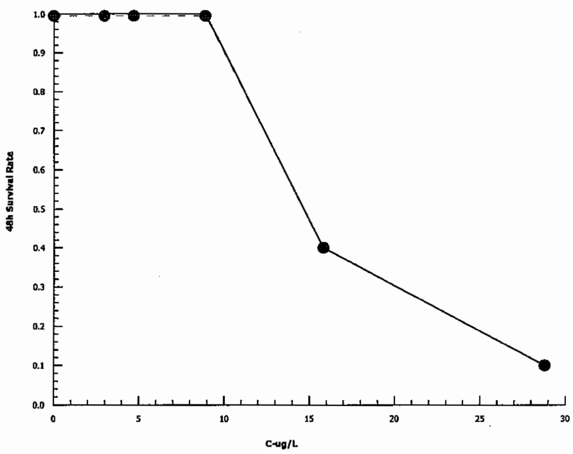
48h Survival Rate Binomials

C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	5/5	5/5	5/5	5/5
2.97		5/5	5/5	5/5	5/5
4.7		5/5	5/5	5/5	5/5
8.89		5/5	5/5	5/5	5/5
15.8		2/5	1/5	2/5	3/5
28.8		1/5	0/5	1/5	0/5

Ceriodaphnia 48-h Acute Survival Test | **Nautilus Environmental**

Analysis ID: 18-8609-0180	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed: 11 Sep-14 17:15	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Fe in lab water
Work Order No.: 14401m

Start Date & Time: July 16/14 @ 1315h
End Date & Time: July 18/14 @ 1315h
Test Organisms: C. dubia

Conc. mg/L Fe	Rep	Number of Live Organisms 24	Number of Live Organisms 48	Temperature (°C) 0	Temperature (°C) 24	Temperature (°C) 48	Dissolved Oxygen (mg/L) 0	Dissolved Oxygen (mg/L) 24	Dissolved Oxygen (mg/L) 48	pH 0	pH 24	pH 48	Conductivity (uS/cm) 0	Conductivity (uS/cm) 48
Control	A		5	24.5	25.0	24.0	8.2		7.8	8.2		7.8	205	206
	B		5											
	C		5											
	D		5											
2.5	A		3	24.5		24.0	8.1		8.1	8.2		7.7	208	212
	B		5											
	C		5											
	D		5											
5.0	A		4	24.5		24.0	8.1		8.2	8.1		7.7	210	217
	B		3											
	C		3											
	D		3											
10.0	A		1	25.0		24.0	8.0		8.2	8.0		7.6	218	226
	B		1											
	C		2											
	D		0											
20.0	A		1	25.0		24.0	8.0		8.2	8.0		7.2	232	240
	B		0											
	C		1											
	D		0											
40.0	A		0	25.0		24.0	8.1		8.2	8.0		3.4	441	450
	B		0									①		
	C		0											
	D		0											
Technician Initials			JW	EMM	EMM	JW	EMM		JW	EMM		JW	EMM	JW

Conc.	Hardness	Alkalinity
	(mg/L as CaCO3)	
control	168	120
highest conc.	—	—

Sample Description: Fe in labwater (160mg/L hardness water)
Analyst Initials: EMM, JW

Comments: used stock solution 1000mg/L Fe made day of testing. ($FeCl_3 \cdot 6H_2O$)
① Checked with another pH meter.

Reviewed by: A. Tang

Date reviewed: September 19, 2014

Version 1.0: Issued November 1, 2007

Nautilus Environmental

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Fe in site water
Work Order No.: 14401 A

Start Date & Time: July 16/14 @ 1315h
End Date & Time: July 18/14 @ 1315h
Test Organisms: C. dubia

Conc. mg/L Fe	Rep	Number of Live Organisms 24	Number of Live Organisms 48	Temperature (°C) 0	Temperature (°C) 24	Temperature (°C) 48	Dissolved Oxygen (mg/L) 0	Dissolved Oxygen (mg/L) 24	Dissolved Oxygen (mg/L) 48	pH 0	pH 24	pH 48	Conductivity (uS/cm) 0	Conductivity (uS/cm) 48
Control	A		5	25.0	25.0	24.0	8.1		7.9	8.2		7.9	279	281
	B		4											
	C		5											
	D		4											
2.5	A		5	25.5		24.0	8.2		8.0	8.1		8.0	~~277~~	278
	B		5											
	C		5											
	D		5											
5.0	A		3	25.5		24.0	8.2		8.1	8.1		7.9	285	286
	B		4											
	C		1											
	D		5											
10.0	A		0	25.5		24.0	8.1		8.1	8.2		7.9	290	289
	B		0											
	C		1											
	D		0											
20.0	A		1	25.5		24.0	8.2		8.1	8.1		7.6	308	303
	B		0											
	C		0											
	D		0											
40.0	A		0	25.5		24.0	8.2		8.1	8.0		6.8	333	329
	B		0											
	C		0											
	D		0											
Technician Initials			JW	EMM	EMM	JW	EMM		JW	EMM		JW	EMM	JW

Conc.	Hardness (mg/L as CaCO3)	Alkalinity (mg/L as CaCO3)
control	146	114
highest conc.	—	—

Sample Description: Fe in site water (MH-04)
Analyst Initials: EMM

Comments: used stock solution 1000mg/L Fe made day of testing. ($FeCl_3 \cdot 6H_2O$)

Reviewed by: A. Tang
Date reviewed: September 19, 2014

CETIS Analytical Report

Report Date:	23 Sep-14 18:08 (p 1 of 2)
Test Code:	14401m | 09-5074-0715

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	00-7943-3695	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 17:18	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes

Batch ID:	18-7278-2852	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	16 Jul-14 13:15	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Laboratory Water
Ending Date:	18 Jul-14 13:15	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	00-7457-0522	**Code:**	471DB1A	**Client:**	Azimuth
Sample Date:	16 Jul-14	**Material:**	Iron	**Project:**	
Receive Date:	16 Jul-14	**Source:**	Azimuth		
Sample Age:	13h	**Station:**	Iron WER (lab water)		

Trimmed Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	10.00%	0.6586	0.08123	4.556	3.134	6.623

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-mg/L	**Control Type**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A**	**B**
0.049	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
0.929		4	0.9	0.6	1	0.1	0.2	22.22%	10.0%	18	20
3.84		4	0.65	0.6	0.8	0.05	0.1	15.38%	35.0%	13	20
9.08		4	0.2	0	0.4	0.08165	0.1633	81.65%	80.0%	4	20
18.1		4	0.1	0	0.2	0.05774	0.1155	115.5%	90.0%	2	20
37		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0.049	Negative Control	1	1	1	1
0.929		0.6	1	1	1
3.84		0.8	0.6	0.6	0.6
9.08		0.2	0.2	0.4	0
18.1		0.2	0	0.2	0
37		0	0	0	0

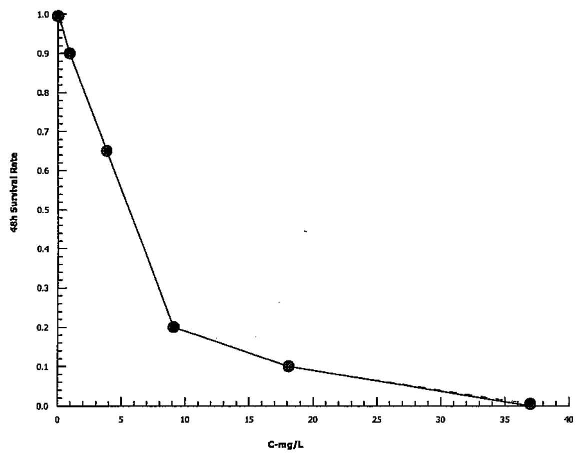
48h Survival Rate Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0.049	Negative Control	5/5	5/5	5/5	5/5
0.929		3/5	5/5	5/5	5/5
3.84		4/5	3/5	3/5	3/5
9.08		1/5	1/5	2/5	0/5
18.1		1/5	0/5	1/5	0/5
37		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test | **Nautilus Environmental**

Analysis ID: 00-7943-3695	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed: 11 Sep-14 17:18	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



Ceriodaphnia 48-h Acute Survival Test — Nautilus Environmental

Analysis ID:	10-9299-2065	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 17:20	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes
Batch ID:	15-3962-0861	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	16 Jul-14 13:15	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Site Water
Ending Date:	18 Jul-14 13:15	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h
Sample ID:	19-4546-0421	**Code:**	73F55EC5	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:05	**Material:**	Iron	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	18d 22h	**Station:**	Iron WER (MH-04 site water)		

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0.1	0.00%	0.7585	0.03936	5.734	4.784	6.874

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-mg/L	**Control Type**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A**	**B**
0.019	Negative Control	4	0.9	0.8	1	0.05774	0.1155	12.83%	0.0%	18	20
2.13		4	1	1	1	0	0	0.0%	-11.11%	20	20
4.89		4	0.65	0.2	1	0.1708	0.3416	52.55%	27.78%	13	20
9.23		4	0.05	0	0.2	0.05	0.1	200.0%	94.44%	1	20
19.5		4	0.05	0	0.2	0.05	0.1	200.0%	94.44%	1	20
37.3		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0.019	Negative Control	1	0.8	1	0.8
2.13		1	1	1	1
4.89		0.6	0.8	0.2	1
9.23		0	0	0.2	0
19.5		0.2	0	0	0
37.3		0	0	0	0

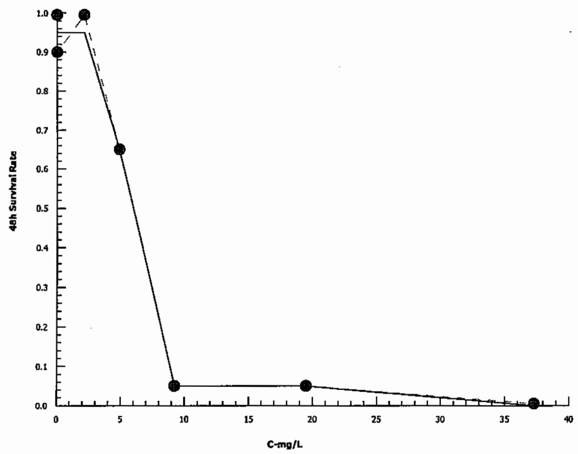
48h Survival Rate Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0.019	Negative Control	5/5	4/5	5/5	4/5
2.13		5/5	5/5	5/5	5/5
4.89		3/5	4/5	1/5	5/5
9.23		0/5	0/5	1/5	0/5
19.5		1/5	0/5	0/5	0/5
37.3		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test **Nautilus Environmental**

Analysis ID: 10-9299-2065		**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed: 11 Sep-14 17:20		**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Lead WER (lab water)
Work Order No.: 14401 g

Start Date & Time: ~~June 30/14 @~~ KLP July 1/14 @ 1400h
End Date & Time: ~~July 2/14 @~~ KLP July 3/14 @ 1400h
Test Organisms: C. dubia

Conc. mg/L Pb	Rep	Number of Live Organisms 24	Number of Live Organisms 48	Temperature (°C) 0		Temperature (°C) 24	Temperature (°C) 48	Dissolved Oxygen (mg/L) 0		Dissolved Oxygen (mg/L) 24	Dissolved Oxygen (mg/L) 48	pH 0		pH 24	pH 48	Conductivity (uS/cm) 0	Conductivity (uS/cm) 48
Control	A		5	24.0		25.0	25.0	8.0			7.2	8.1			8.2	280	281
	B																
	C																
	D																
62.5	A			24.0		25.0	25.0	8.0			7.2	8.2			8.2	280	281
	B																
	C																
	D																
125	A			24.0		25.0	25.0	8.0			7.2	8.2			8.2	280	281
	B																
	C																
	D																
250	A			24.0		25.0	25.0	8.0			7.1	8.2			8.2	280	281
	B																
	C																
	D																
500	A		4	24.0		25.0	25.0	8.0			7.2	8.2			8.2	280	284
	B		4														
	C		4														
	D		3														
1000	A		0	24.0		25.0	25.0	8.0			7.2	8.1			8.2	280	284
	B		0														
	C		0														
	D		0														
Technician Initials				KLP				KLP				KLP				KLP	

Conc.	Hardness	Alkalinity
	(mg/L as CaCO3)	
control	140	78
highest conc.	—	—

Sample Description: Lead spiked into 160 mg/L hardness Perrier lab water
Analyst Initials: KLP, EMM

Comments: Used stock solution: 100 mg/L Pb made June 30/14 (made from $PbCl_2$)

Reviewed by: A. Tang

Date reviewed: September 19, 2014

Version 1.0: Issued November 1, 2007

Nautilus Environmental

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Lead WER (site water)
Work Order No.: 14401 ge h

Start Date & Time: ~~June 30/14@~~ KLP July 1/14 @ 1400h
End Date & Time: ~~July 2/14@~~ KLP July 3/14 @ 1400h
Test Organisms: C. dubia

Conc. mg/L Pb	Rep	Live Organisms 24	Live Organisms 48	Temp (°C) 0	Temp (°C) 24	Temp (°C) 48	DO (mg/L) 0	DO (mg/L) 24	DO (mg/L) 48	pH 0	pH 24	pH 48	Conductivity (uS/cm) 0	Conductivity (uS/cm) 48
Control	A		5	24.0	25.0	25.0	8.0		7.3	8.4		8.2	278	281
	B													
	C													
	D													
62.5	A			24.0	25.0	25.0	8.0		7.3	8.3		8.2	278	281
	B													
	C													
	D													
125	A			24.0	25.0	25.0	8.0		7.2	8.3		8.2	278	280
	B													
	C													
	D													
250	A			24.0	25.0	25.0	8.0		7.2	8.3		8.2	277	~~28~~ 281
	B													
	C													
	D													
500	A		3	24.0	25.0	25.0	8.0		7.3	8.3		8.2	278	280
	B		4											
	C		3											
	D		4											
1000	A		0	24.0	25.0	25.0	8.0		7.3	8.3		8.2	278	280
	B													
	C													
	D													
Technician Initials		—		KLP	m	m	KLP	—	m	KLP	—	m	KLP	m

Conc.	Hardness (mg/L as CaCO3)	Alkalinity (mg/L as CaCO3)
control	146	114
highest conc.	—	—

Sample Description: Lead spiked into site water MH-04
Analyst Initials: KLP, EMM

Comments: Used stock solution: 100 mg/L Pb made June 30/14 (made from $PbCl_2$)

Reviewed by: A. Tong
Date reviewed: September 19, 2014

Version 1.0: Issued November 1, 2007

Nautilus Environmental

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	06-0765-8096	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:50	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Batch ID:	20-0367-8918	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	01 Jul-14 14:00	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Laboratory Water
Ending Date:	03 Jul-14 14:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	18-5358-1686	**Code:**	6E7B6976	**Client:**	Azimuth
Sample Date:	30 Jun-14	**Material:**	lead	**Project:**	
Receive Date:	30 Jun-14	**Source:**	Azimuth		
Sample Age:	38h	**Station:**	Lead WER (lab water)		

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	0.00%	2.468	0.0157	294	273.5	316.1

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
28.6		4	1	1	1	0	0	0.0%	0.0%	20	20
61.8		4	1	1	1	0	0	0.0%	0.0%	20	20
133		4	1	1	1	0	0	0.0%	0.0%	20	20
301		4	0.85	0.8	1	0.05	0.1	11.76%	15.0%	17	20
329		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	1	1	1	1
28.6		1	1	1	1
61.8		1	1	1	1
133		1	1	1	1
301		0.8	0.8	0.8	1
329		0	0	0	0

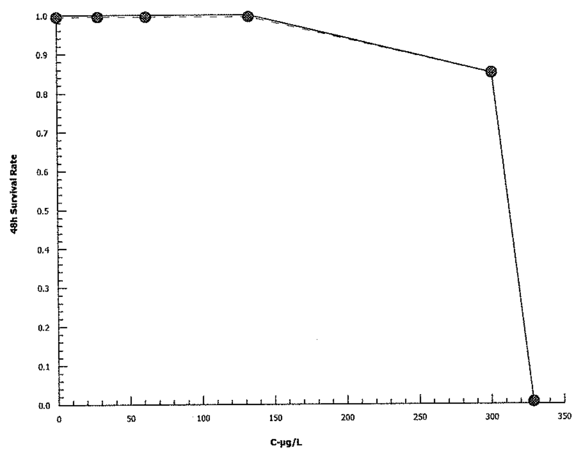
48h Survival Rate Binomials

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	5/5	5/5	5/5	5/5
28.6		5/5	5/5	5/5	5/5
61.8		5/5	5/5	5/5	5/5
133		5/5	5/5	5/5	5/5
301		4/5	4/5	4/5	5/5
329		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test | **Nautilus Environmental**

Analysis ID: 06-0765-8096	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed: 11 Sep-14 16:50	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



ABT Sept 26/14

CETIS Analytical Report

Report Date:	11 Sep-14 16:51 (p 1 of 2)
Test Code:	14401h | 15-3953-0882

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	14-4772-4974	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:51	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Batch ID:	16-0069-7706	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	01 Jul-14 14:00	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Site Water
Ending Date:	03 Jul-14 14:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	18-0801-3590	**Code:**	6BC41916	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:05	**Material:**	lead	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	95h	**Station:**	Lead WER (MH-04 site water)		

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	0.00%	2.512	0.02666	325.4	287.8	367.9

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-µg/L	**Control Type**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A**	**B**
0.292	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
40.5		4	1	1	1	0	0	0.0%	0.0%	20	20
47.1		4	1	1	1	0	0	0.0%	0.0%	20	20
188		4	1	1	1	0	0	0.0%	0.0%	20	20
243.5		4	0.7	0.6	0.8	0.05774	0.1155	16.5%	30.0%	14	20
623		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0.292	Negative Control	1	1	1	1
40.5		1	1	1	1
47.1		1	1	1	1
188		1	1	1	1
243.5		0.6	0.8	0.6	0.8
623		0	0	0	0

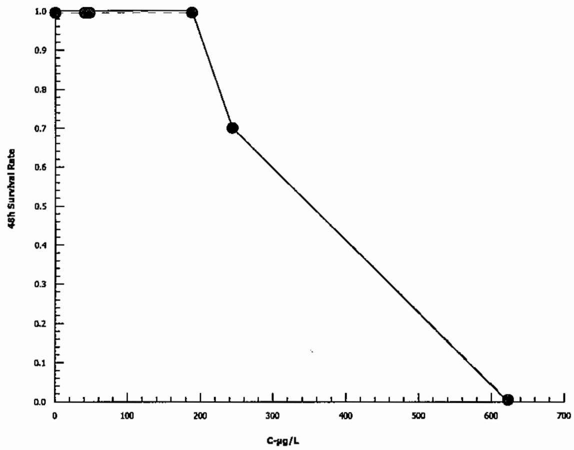
48h Survival Rate Binomials

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0.292	Negative Control	5/5	5/5	5/5	5/5
40.5		5/5	5/5	5/5	5/5
47.1		5/5	5/5	5/5	5/5
188		5/5	5/5	5/5	5/5
243.5		3/5	4/5	3/5	4/5
623		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	14-4772-4974	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:51	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Zinc WER (labwater)
Work Order No.: 14401

Start Date & Time: June 30/14 @ 1400h
End Date & Time: July 2/14 @ 1400h
Test Organisms: C. dubia

Conc. mg/L Zn	Rep	Number of Live Organisms 24	48	Temperature (°C) 0		24	48	Dissolved Oxygen (mg/L) 0		24	48	pH 0		24	48	Conductivity (uS/cm) 0	48
Control	A		5	24.0		24.5	24.5	7.7			7.4	8.2			8.2	307	307
	B		5														
	C		5														
	D		5														
50	A		5	24.0		24.5	24.5	7.7			7.3	8.3			8.3	310	311
	B		5														
	C		4														
	D		4														
100	A		5	24.0		24.5	24.5	7.7			7.3	8.3			8.3	307	310
	B		4														
	C		4														
	D		3														
200	A		1	24.0		24.5	24.5	7.7			7.2	8.3			8.3	304	311
	B		3														
	C		1														
	D		3														
400	A		1	24.0		24.5	24.5	7.7			7.3	8.2			8.3	300	303
	B		1														
	C		2														
	D		1														
800	A		0	24.0		24.5	24.5	7.7			7.3	8.2			8.2	289	292
	B		0														
	C		0														
	D		0														
Technician Initials		—	KLP	KLP		KLP	KLP	KLP		—	EMM	KLP		—	EMM	KLP	EMM

Conc.	Hardness (mg/L as CaCO3)	Alkalinity (mg/L as CaCO3)
control	140	78
highest conc.	—	—

Sample Description: Zinc spiked into 160 mg/L hardness Perrier lab water
Analyst Initials: KLP, EMM

Comments: Used stock solution: 14 Zn01 (9.78 mg/L Zn)

Reviewed by: A. Tang

Date reviewed: September 19, 2014

Version 1.0: Issued November 1, 2007

Nautilus Environmental

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Azimuth
Sample ID: Zinc WER (site water)
Work Order No.: 14401 b

Start Date & Time: June 30/14 @ 1400h
End Date & Time: July 2/14 @ 1400h
Test Organisms: C. dubia

Conc. mg/L Zn	Rep	Number of Live Organisms 24	Number of Live Organisms 48	Temperature (°C) 0		Temperature (°C) 24	Temperature (°C) 48	Dissolved Oxygen (mg/L) 0		Dissolved Oxygen (mg/L) 24	Dissolved Oxygen (mg/L) 48	pH 0		pH 24	pH 48	Conductivity (uS/cm) 0	Conductivity (uS/cm) 48
Control	A		5	24.0		24.5	24.5	7.9			7.4	8.2			8.3	273	278
	B		5														
	C		5														
	D		5														
50	A		5	24.0		24.5	24.5	7.9			7.4	8.3			8.4	273	279
	B		5														
	C		4														
	D		4														
100	A		4	24.0		24.5	24.5	7.9			7.3	8.3			8.4	271	276
	B		2														
	C		3														
	D		4														
200	A		1	24.0		24.5	24.5	7.9			7.4	8.3			8.4	269	275
	B		1														
	C		1														
	D		1														
400	A		0	24.0		24.5	24.5	7.9			7.4	8.3			8.4	263	270
	B		0														
	C		0														
	D		0														
800	A		0	24.0		24.5	24.5	7.9			7.4	8.3			8.3	259	261
	B		0														
	C		0														
	D		0														
Technician Initials		—	KLP	KLP		KLP	KLP	KLP	—	—	EMM	KLP	—	—	EMM	KLP	EMM

Conc.	Hardness (mg/L as CaCO3)	Alkalinity (mg/L as CaCO3)
control	146	114
highest conc.	—	—

Sample Description: Zinc spiked into site water MH-04
Analyst Initials: KLP, EMM

Comments: Used stock solution: 14Zn01 (9.78 mg/L Zn)

Reviewed by: A. Tang

Date reviewed: September 19, 2014

Version 1.0: Issued November 1, 2007

Nautilus Environmental

CETIS Analytical Report

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	03-1179-2665	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:26	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes
Batch ID:	20-6968-9064	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 14:00	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Laboratory Water
Ending Date:	02 Jul-14 14:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24
Sample ID:	08-4035-6405	**Code:**	3216D235	**Client:**	Azimuth
Sample Date:	30 Jun-14	**Material:**	Zinc	**Project:**	
Receive Date:	30 Jun-14	**Source:**	Azimuth		
Sample Age:	14h	**Station:**	Zinc WER (lab water)		

Trimmed Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	10.00%	2.167	0.06572	146.7	108.4	198.6

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
41.45		4	0.9	0.8	1	0.05774	0.1155	12.83%	10.0%	18	20
73.9		4	0.8	0.6	1	0.08165	0.1633	20.41%	20.0%	16	20
158.5		4	0.4	0.2	0.6	0.1155	0.2309	57.74%	60.0%	8	20
332.5		4	0.25	0.2	0.4	0.05	0.1	40.0%	75.0%	5	20
638.5		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	1	1	1	1
41.45		1	1	0.8	0.8
73.9		1	0.8	0.8	0.6
158.5		0.2	0.6	0.2	0.6
332.5		0.2	0.2	0.4	0.2
638.5		0	0	0	0

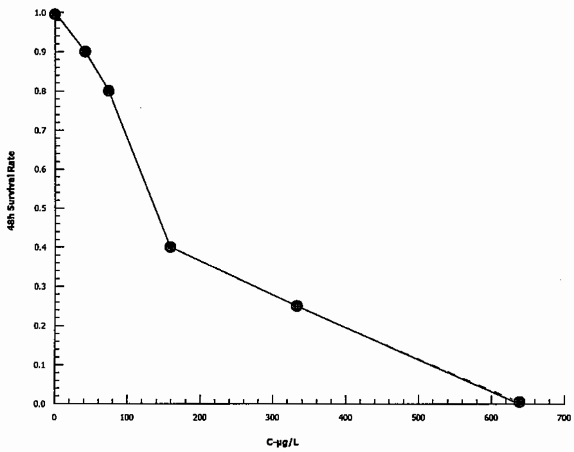
48h Survival Rate Binomials

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	5/5	5/5	5/5	5/5
41.45		5/5	5/5	4/5	4/5
73.9		5/5	4/5	4/5	3/5
158.5		1/5	3/5	1/5	3/5
332.5		1/5	1/5	2/5	1/5
638.5		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID: 03-1179-2665		**Endpoint:** 48h Survival Rate		**CETIS Version:** CETISv1.8.7	
Analyzed: 11 Sep-14 16:26		**Analysis:** Trimmed Spearman-Kärber		**Official Results:** Yes	

Graphics



CETIS Analytical Report

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	02-1951-6979	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:32	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes
Batch ID:	02-8549-0219	**Test Type:**	Survival (48h)	**Analyst:**	Emma Marus
Start Date:	30 Jun-14 14:00	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Site Water
Ending Date:	02 Jul-14 14:00	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	48h	**Source:**	In-House Culture	**Age:**	<24
Sample ID:	01-1974-3213	**Code:**	72322ED	**Client:**	Azimuth
Sample Date:	27 Jun-14 15:05	**Material:**	Zinc	**Project:**	
Receive Date:	28 Jun-14 10:00	**Source:**	Azimuth		
Sample Age:	71h	**Station:**	Zinc WER (MH-04 site water)		

Trimmed Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	10.00%	1.99	0.04741	97.71	78.54	121.5

48h Survival Rate Summary

			Calculated Variate(A/B)								
C-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
7	Negative Control	4	1	1	1	0	0	0.0%	0.0%	20	20
44.45		4	0.9	0.8	1	0.05774	0.1155	12.83%	10.0%	18	20
81.25		4	0.65	0.4	0.8	0.09574	0.1915	29.46%	35.0%	13	20
152		4	0.2	0.2	0.2	0	0	0.0%	80.0%	4	20
330		4	0	0	0	0	0		100.0%	0	20
671.5		4	0	0	0	0	0		100.0%	0	20

48h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
7	Negative Control	1	1	1	1
44.45		1	1	0.8	0.8
81.25		0.8	0.4	0.6	0.8
152		0.2	0.2	0.2	0.2
330		0	0	0	0
671.5		0	0	0	0

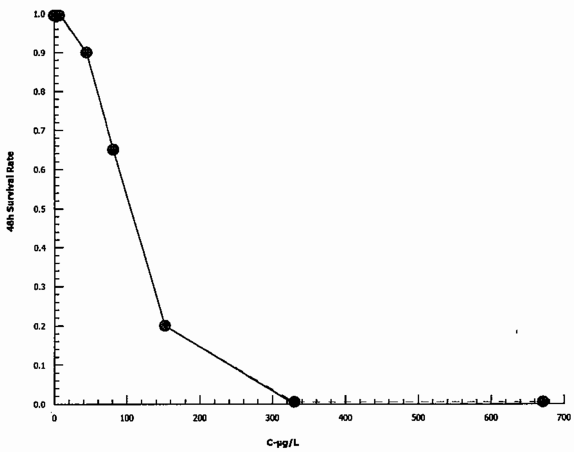
48h Survival Rate Binomials

C-µg/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
7	Negative Control	5/5	5/5	5/5	5/5
44.45		5/5	5/5	4/5	4/5
81.25		4/5	2/5	3/5	4/5
152		1/5	1/5	1/5	1/5
330		0/5	0/5	0/5	0/5
671.5		0/5	0/5	0/5	0/5

Ceriodaphnia 48-h Acute Survival Test — **Nautilus Environmental**

Analysis ID:	02-1951-6979	**Endpoint:**	48h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	11 Sep-14 16:32	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



Nautilus Environmental

BRITISH COLUMBIA
8664 Commerce Court
Burnaby British Columbia Canada V5A 4N7
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

0952

Date ______ Page ______ of ______

Sample Collection by:

Report to:		Invoice to:	
Company	Azimuth	Company	Azimuth
Address		Address	
City / Prov. / PC		City / Prov. / PC	
Contact		Contact	
Phone No.		Phone No.	

ANALYSIS REQUIRED

SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NUMBER OF CONTAINERS	COMMENTS	7-d C.dubia wo#14399	72-h P.subcapitata wo#14400	48-h C.dubia wo#14401	RECEIPT TEMPERATURE (°C)
MH-04	June27 /14	1505		1L / 20L	x 7 / x 1	For mixture Test	X	X		8.5
MH-25	June27 /14	1545		1L / 20L	x 7 / x 1					8.5
Water Effects Ratio						Using MH-04 as site water			X	

COPY

PROJECT INFORMATION	SAMPLE RECEIPT
CLIENT	TOTAL NO. OF CONTAINERS
P.O. NO.	REC'D GOOD CONDITION
SHIPPED VIA:	

SPECIAL INSTRUCTIONS/COMMENTS:

RELINQUISHED BY (CLIENT)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RELINQUISHED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (LABORATORY)
(Signature) [signature] (Time) 1000
(Printed Name) Krystel Perry (Date) June28/14

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

DISTRIBUTION: WHITE - Nautilus Environmental, COLOR - Originator

APPENDIX B – Chemistry Data

NAUTILUS ENVIRONMENTAL
ATTN: Krysta Pearcy
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 30-JUN-14
Report Date: 09-JUL-14 10:09 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1479858

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 2, OL-1357
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479858-1	L1479858-2	L1479858-3	L1479858-4	L1479858-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	13:00	13:00	13:00	13:00	13:00
	Client ID	10% MH-04 (LAB WATER DILUTION)	50% MH-04 (LAB WATER DILUTION)	100% MH-04 (LAB WATER DILUTION)	0.1% MIXTURE (MH-04 DILUTION)	0.3% MIXTURE (MH-04 DILUTION)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Total (mg/L)	0.018	0.017	0.019	0.019	0.019
	Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Bismuth (Bi)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)-Total (mg/L)	54.7	58.7	56.6	55.8	56.8
	Chromium (Cr)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Total (mg/L)	0.060	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Total (mg/L)	2.45	2.37	2.62	2.57	2.63
	Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Total (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Total (mg/L)	2.66	2.52	2.84	2.80	2.86
	Silver (Ag)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Total (mg/L)	<2.0	2.8	<2.0	<2.0	<2.0
	Strontium (Sr)-Total (mg/L)	0.190	0.246	0.188	0.185	0.188
	Thallium (Tl)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Total (mg/L)	0.0053	<0.0050	0.0073	0.0170	0.0268
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Dissolved (mg/L)	0.018	0.016	0.019	0.019	0.019
	Beryllium (Be)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479858-6	L1479858-7	L1479858-8	L1479858-9	L1479858-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	13:00	13:00	13:00	13:00	13:00
	Client ID	1% MIXTURE (MH-04 DILUTION)	3% MIXTURE (MH-04 DILUTION)	10% MIXTURE (MH-04 DILUTION)	30% MIXTURE (MH-04 DILUTION)	100% MIXTURE (85% MH-04, 15% MH-25)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Total (mg/L)	0.019	0.018	0.020	0.019	0.018
	Beryllium (Be)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Bismuth (Bi)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	<0.010	<0.010	<0.010	0.017	0.055
	Calcium (Ca)-Total (mg/L)	57.2	55.5	58.0	57.6	59.8
	Chromium (Cr)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Total (mg/L)	2.61	2.52	2.67	2.60	2.59
	Manganese (Mn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	0.0050	0.0157
	Molybdenum (Mo)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Total (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Total (mg/L)	2.85	2.74	2.90	2.87	2.96
	Silver (Ag)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Total (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Strontium (Sr)-Total (mg/L)	0.186	0.180	0.191	0.183	0.174
	Thallium (Tl)-Total (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Total (mg/L)	0.0602	0.170	0.533	1.62	5.27
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Antimony (Sb)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Arsenic (As)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Barium (Ba)-Dissolved (mg/L)	0.018	0.019	0.019	0.019	0.017
	Beryllium (Be)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479858-11				
	Description	Water				
	Sampled Date	30-JUN-14				
	Sampled Time	13:00				
	Client ID	160MG/L HARDNESS PERRIER WATER (LAB WATER)				
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	<0.20				
	Antimony (Sb)-Total (mg/L)	<0.20				
	Arsenic (As)-Total (mg/L)	<0.20				
	Barium (Ba)-Total (mg/L)	0.014				
	Beryllium (Be)-Total (mg/L)	<0.0050				
	Bismuth (Bi)-Total (mg/L)	<0.20				
	Boron (B)-Total (mg/L)	<0.10				
	Cadmium (Cd)-Total (mg/L)	<0.010				
	Calcium (Ca)-Total (mg/L)	59.7				
	Chromium (Cr)-Total (mg/L)	<0.010				
	Cobalt (Co)-Total (mg/L)	<0.010				
	Copper (Cu)-Total (mg/L)	<0.010				
	Iron (Fe)-Total (mg/L)	<0.030				
	Lead (Pb)-Total (mg/L)	<0.050				
	Lithium (Li)-Total (mg/L)	<0.010				
	Magnesium (Mg)-Total (mg/L)	2.10				
	Manganese (Mn)-Total (mg/L)	<0.0050				
	Molybdenum (Mo)-Total (mg/L)	<0.030				
	Nickel (Ni)-Total (mg/L)	<0.050				
	Phosphorus (P)-Total (mg/L)	<0.30				
	Potassium (K)-Total (mg/L)	<2.0				
	Selenium (Se)-Total (mg/L)	<0.20				
	Silicon (Si)-Total (mg/L)	2.12				
	Silver (Ag)-Total (mg/L)	<0.010				
	Sodium (Na)-Total (mg/L)	4.9				
	Strontium (Sr)-Total (mg/L)	0.298				
	Thallium (Tl)-Total (mg/L)	<0.20				
	Tin (Sn)-Total (mg/L)	<0.030				
	Titanium (Ti)-Total (mg/L)	<0.010				
	Vanadium (V)-Total (mg/L)	<0.030				
	Zinc (Zn)-Total (mg/L)	<0.0050				
Dissolved Metals	Dissolved Metals Filtration Location	LAB				
	Aluminum (Al)-Dissolved (mg/L)	<0.20				
	Antimony (Sb)-Dissolved (mg/L)	<0.20				
	Arsenic (As)-Dissolved (mg/L)	<0.20				
	Barium (Ba)-Dissolved (mg/L)	0.013				
	Beryllium (Be)-Dissolved (mg/L)	<0.0050				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID		L1479858-1	L1479858-2	L1479858-3	L1479858-4	L1479858-5
Description		Water	Water	Water	Water	Water
Sampled Date		30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
Sampled Time		13:00	13:00	13:00	13:00	13:00
Client ID		10% MH-04 (LAB WATER DILUTION)	50% MH-04 (LAB WATER DILUTION)	100% MH-04 (LAB WATER DILUTION)	0.1% MIXTURE (MH-04 DILUTION)	0.3% MIXTURE (MH-04 DILUTION)
Grouping	**Analyte**					
WATER						
Dissolved Metals	Bismuth (Bi)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Dissolved (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Calcium (Ca)-Dissolved (mg/L)	56.2	56.4	56.2	55.4	55.4
	Chromium (Cr)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Dissolved (mg/L)	2.51	2.26	2.58	2.57	2.54
	Manganese (Mn)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Dissolved (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Dissolved (mg/L)	2.72	2.42	2.81	2.80	2.76
	Silver (Ag)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Dissolved (mg/L)	<2.0	2.7	<2.0	<2.0	<2.0
	Strontium (Sr)-Dissolved (mg/L)	0.195	0.231	0.184	0.184	0.181
	Thallium (Tl)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Dissolved (mg/L)	<0.0050	<0.0050	0.0056	0.0130	0.0234

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479858-6	L1479858-7	L1479858-8	L1479858-9	L1479858-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	13:00	13:00	13:00	13:00	13:00
	Client ID	1% MIXTURE (MH-04 DILUTION)	3% MIXTURE (MH-04 DILUTION)	10% MIXTURE (MH-04 DILUTION)	30% MIXTURE (MH-04 DILUTION)	100% MIXTURE (85% MH-04, 15% MH-25)
Grouping	**Analyte**					
WATER						
Dissolved Metals	Bismuth (Bi)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)-Dissolved (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Dissolved (mg/L)	<0.010	<0.010	<0.010	0.017	0.052
	Calcium (Ca)-Dissolved (mg/L)	54.7	55.4	56.5	57.0	56.7
	Chromium (Cr)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cobalt (Co)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Copper (Cu)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Iron (Fe)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Lithium (Li)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Magnesium (Mg)-Dissolved (mg/L)	2.49	2.54	2.58	2.57	2.46
	Manganese (Mn)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	0.0149
	Molybdenum (Mo)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Nickel (Ni)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Dissolved (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Silicon (Si)-Dissolved (mg/L)	2.73	2.75	2.79	2.84	2.82
	Silver (Ag)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Sodium (Na)-Dissolved (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Strontium (Sr)-Dissolved (mg/L)	0.177	0.180	0.183	0.180	0.164
	Thallium (Tl)-Dissolved (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20
	Tin (Sn)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Zinc (Zn)-Dissolved (mg/L)	0.0552	0.161	0.515	1.56	5.01

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479858-11
	Description	Water
	Sampled Date	30-JUN-14
	Sampled Time	13:00
	Client ID	160MG/L HARDNESS PERRIER WATER (LAB WATER)
Grouping	**Analyte**	
WATER		
Dissolved Metals	Bismuth (Bi)-Dissolved (mg/L)	<0.20
	Boron (B)-Dissolved (mg/L)	<0.10
	Cadmium (Cd)-Dissolved (mg/L)	<0.010
	Calcium (Ca)-Dissolved (mg/L)	58.1
	Chromium (Cr)-Dissolved (mg/L)	<0.010
	Cobalt (Co)-Dissolved (mg/L)	<0.010
	Copper (Cu)-Dissolved (mg/L)	<0.010
	Iron (Fe)-Dissolved (mg/L)	<0.030
	Lead (Pb)-Dissolved (mg/L)	<0.050
	Lithium (Li)-Dissolved (mg/L)	<0.010
	Magnesium (Mg)-Dissolved (mg/L)	2.05
	Manganese (Mn)-Dissolved (mg/L)	<0.0050
	Molybdenum (Mo)-Dissolved (mg/L)	<0.030
	Nickel (Ni)-Dissolved (mg/L)	<0.050
	Phosphorus (P)-Dissolved (mg/L)	<0.30
	Potassium (K)-Dissolved (mg/L)	<2.0
	Selenium (Se)-Dissolved (mg/L)	<0.20
	Silicon (Si)-Dissolved (mg/L)	2.09
	Silver (Ag)-Dissolved (mg/L)	<0.010
	Sodium (Na)-Dissolved (mg/L)	4.8
	Strontium (Sr)-Dissolved (mg/L)	0.290
	Thallium (Tl)-Dissolved (mg/L)	<0.20
	Tin (Sn)-Dissolved (mg/L)	<0.030
	Titanium (Ti)-Dissolved (mg/L)	<0.010
	Vanadium (V)-Dissolved (mg/L)	<0.030
	Zinc (Zn)-Dissolved (mg/L)	<0.0050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1479858-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-DIS-ICP-VA	Water	Dissolved Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2	OL-1357

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

(ALS) Environmental

Chain of Custody / Analytical Request Form

Canada Toll Free : 1 800 668 9878

www.alsglobal.com

L1479858

Sample #	Sample Identification (This will appear on the report)	Coordinates: Longitude	Coordinates: Latitude	Date	Time	Sample Type	Number of Containers	Analysis Requests: Total metals	Dissolved metals	Total Metals	Dissolved Metals
	Please indicate below Filtered, Preserved or both(F, P, F/P)								F		F
	30% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	100% Mixture (85% MH-04, 15% MH-25)			Jun-30-2014	01:00 PM	Water	2			R	R
	160 mg/L Hardness Perrier Water (lab water)			Jun-30-2014	01:00 PM	Water	2	R	R		

L1479858-COFC

ALS Environmental

Chain of Custody / Analytical Request Form

Canada Toll Free : 1 800 668 9878

www.alsglobal.com

Report To	
Company:	Nautilus Environmental
Contact:	Krysta Pearcy
Address:	8664 Commerce Court Imperial Square Lake City Burnaby, BC Canada, V5A 4N7
Phone:	604-420-8773 Fax: 604-357-1361
Invoice To	☑ Email ☐ Mail
Company:	Nautilus Environmental
Contact:	Krysta Pearcy
Address:	8664 Commerce Court Imperial Square Lake City Burnaby, BC Canada, V5A 4N7
Email:	krysta@nautilusenvironmental.com
Phone:	604-420-8773
Lab Work Order # (lab use only)	L1479858

Reporting	
Distribution:	☐ Fax ☐ Mail ☑ Email
☐ Criteria on Report (select from Guidelines below)	
Report Type:	☑ Excel ☑ Digital
Report Format:	
Report Email(s):	krysta@nautilusenvironmental.com
EDD Format:	
EDD Email(s):	
Project Info	
Job #:	
PO/AFE:	
LSD:	
Quote #:	
ALS Contact: Janie Lo	Sampler: Krysta Pearcy

Service Requested

- ◉ Regular (Standard Turnaround Times - Business Days) - R
- ○ Priority (3 Days) - surcharge will apply - P
- ○ Priority (2 Days) - surcharge will apply - P2
- ○ Emergency (1-2 day) – surcharge will apply - E
- ○ Same Day or Weekend Emergency - surcharge will apply - E2
- ○ Specify date required - X

Analysis Requests

L1479858-COFC

Please indicate below Filtered, Preserved or both(F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Total metals	Dissolved metals	Total Metals	Dissolved Metals
									F		F
	10 % MH-04 (lab water dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	50% MH-04 (lab water dilution)			Jun-30-2014	01:00 PM	Water	2			R	R
	100% MH-04 (lab water dilution)			Jun-30-2014	01:00 PM	Water	2			R	R
	0.1% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	0.3% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	1% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	3% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		
	10% Mixture (MH-04 dilution)			Jun-30-2014	01:00 PM	Water	2	R	R		

(See page 2 for further samples)

Special Instructions/Comments

Samples for dissolved metals ~~have been filtered through 0.45 um.~~ have been filtered.
Samples NOT preserved.

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐ Yes ☒ No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐ Yes ☒ No

Guidelines

SAMPLE CONDITION (lab use only)

☐ Frozen ☐ Cold ☐ Ambient ☐ Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Krysta Pearcy	Date: June 30/14	Time: 1700h	Received by: JYL	Date: June 30	Time: 17:21	Temperature: 20.6°C	Verified by:	Date:	Time:	Observations: ☐ Yes If Yes add SIF

NAUTILUS ENVIRONMENTAL
ATTN: Krysta Pearcy
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 30-JUN-14
Report Date: 14-JUL-14 16:31 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1479859

Project P.O. #:	NOT SUBMITTED
Job Reference:	
C of C Numbers:	2, 3, 4, 5, 6, 7, 8, OL-1355
Legal Site Desc:	

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479859-1	L1479859-2	L1479859-3	L1479859-4	L1479859-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	12.5 UG/L CU (LAB WATER)	25 UG/L CU (LAB WATER)	50 UG/L CU (LAB WATER)	100 UG/L CU (LAB WATER)	200 UG/L CU (LAB WATER)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)	0.0135	0.0247	0.0491	0.0983	0.194
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)	0.0114	0.0182	0.0512	0.0921	0.181
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479859-6	L1479859-7	L1479859-8	L1479859-9	L1479859-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	25 UG/L CU (MH-04)	50 UG/L CU (MH-04)	100 UG/L CU (MH-04)	200 UG/L CU (MH-04)	400 UG/L CU (MH-04)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)	0.0244	0.0477	0.0962	0.188	0.365
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)	0.0211	0.0421	0.0853	0.169	0.335
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479859-11	L1479859-12	L1479859-13	L1479859-14	L1479859-15
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	50 UG/L ZN (LAB WATER)	100 UG/L ZN (LAB WATER)	200 UG/L ZN (LAB WATER)	400 UG/L ZN (LAB WATER)	800 UG/L ZN (LAB WATER)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)	0.0445	0.0817	0.171	0.356	0.677
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)	0.0418	0.0780	0.164	0.338	0.656

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1479859-16	L1479859-17	L1479859-18	L1479859-19	L1479859-20
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	50 UG/L ZN (MH-04)	100 UG/L ZN (MH-04)	200 UG/L ZN (MH-04)	400 UG/L ZN (MH-04)	800 UG/L ZN (MH-04)
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)	0.0473	0.0880	0.163	0.349	0.708
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)	0.0449	0.0843	0.157	0.325	0.681

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479859-21	L1479859-22	L1479859-23	L1479859-24	L1479859-25
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	25 UG/L CD (LAB WATER)	50 UG/L CD (LAB WATER)	100 UG/L CD (LAB WATER)	200 UG/L CD (LAB WATER)	400 UG/L CD (LAB WATER)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)	0.0212	0.0429	0.0870	0.175	0.347
	Chromium (Cr)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)	0.0117	0.0217	0.0337	0.0801	0.137
	Chromium (Cr)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479859-26	L1479859-27	L1479859-28	L1479859-29	L1479859-30
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	25 UG/L CD (MH-04)	50 UG/L CD (MH-04)	100 UG/L CD (MH-04)	200 UG/L CD (MH-04)	400 UG/L CD (MH-04)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)	0.0229	0.0471	0.0955	0.192	0.387
	Chromium (Cr)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)	0.0223	0.0460	0.0940	0.187	0.378
	Chromium (Cr)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479859-31	L1479859-32	L1479859-33	L1479859-34	L1479859-35
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	250 UG/L AL (LAB WATER)	500 UG/L AL (LAB WATER)	1000 UG/L AL (LAB WATER)	2000 UG/L AL (LAB WATER)	4000 UG/L AL (LAB WATER)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	0.213	0.606	1.05	1.07	6.62
	Cadmium (Cd)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)	0.172	0.312	0.344	0.320	0.301
	Cadmium (Cd)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479859-36	L1479859-37	L1479859-38	L1479859-39	L1479859-40
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14	30-JUN-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	250 UG/L AL (MH-04)	500 UG/L AL (MH-04)	1000 UG/L AL (MH-04)	2000 UG/L AL (MH-04)	4000 UG/L AL (MH-04)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	0.231	0.456	1.12	2.46	8.37
	Cadmium (Cd)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)	0.171	0.329	0.399	0.344	0.282
	Cadmium (Cd)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1479859-41	L1479859-42			
	Description	Water	Water			
	Sampled Date	30-JUN-14	30-JUN-14			
	Sampled Time	12:00	12:00			
	Client ID	160 MG/L HARDNESS PERRIER WATER	MH-04			
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	<0.0030	0.0041			
	Cadmium (Cd)-Total (mg/L)	<0.000010	0.000227			
	Chromium (Cr)-Total (mg/L)	0.00011	0.00022			
	Copper (Cu)-Total (mg/L)	<0.00050	<0.00050			
	Iron (Fe)-Total (mg/L)	<0.030	<0.030			
	Lead (Pb)-Total (mg/L)	<0.000050	0.000278			
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0064			
Dissolved Metals	Dissolved Metals Filtration Location					
	Aluminum (Al)-Dissolved (mg/L)		0.0016			
	Cadmium (Cd)-Dissolved (mg/L)		0.000204			
	Chromium (Cr)-Dissolved (mg/L)		0.00015			
	Copper (Cu)-Dissolved (mg/L)		0.00023			
	Iron (Fe)-Dissolved (mg/L)		<0.030			
	Lead (Pb)-Dissolved (mg/L)		0.000185			
	Zinc (Zn)-Dissolved (mg/L)		0.0045			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Aluminum (Al)-Total	MS-B	L1479859-31, -32, -33, -34, -35, -36, -37, -38, -39, -40

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-DIS-ICP-VA	Water	Dissolved Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2	3	4	5	6
7	8	OL-1355		

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

COC #: OL-1355

(ALS) Environmental

Chain of Custody / Analytical Request Form

Canada Toll Free : 1 800 668 9878

www.alsglobal.com

Report To	
Company:	Nautilus Environmental
Contact:	Krysta Pearcy
Address:	8664 Commerce Court Imperial Square Lake City Burnaby, BC Canada, V5A 4N7
Phone:	604-420-8773
Fax:	604-357-1361
Invoice To	☑Email ☐Mail
Company:	Nautilus Environmental
Contact:	Krysta Pearcy
Address:	8664 Commerce Court Imperial Square Lake City Burnaby, BC Canada, V5A 4N7
Email:	krysta@nautilusenvironmental.com
Phone:	604-420-8773
Lab Work Order # (lab use only)	L1479859

Reporting	
Distribution:	☐Fax ☐Mail ☑Email
☐Criteria on Report (select from Guidelines below)	
Report Type:	☑Excel ☑Digital
Report Format:	
Report Email(s):	krysta@nautilusenvironmental.com
EDD Format:	
EDD Email(s):	
Project Info	
Job #:	
PO/AFE:	
LSD:	
Quote #:	
ALS Contact:	Janie Lo
Sampler:	Krysta Pearcy

Service Requested

- ⊙Regular (Standard Turnaround Times - Business Days) - R
- ○Priority (3 Days) - surcharge will apply - P
- ○Priority (2 Days) - surcharge will apply - P2
- ○Emergency (1-2 day) – surcharge will apply - E
- ○Same Day or Weekend Emergency - surcharge will apply - E2
- ○Specify date required - X

Analysis Requests

Please indicate below Filtered, Preserved or both(F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Total Cu	Dissolved Cu	Total Cu	Total Zn	Dissolved Zn	Total Cd	Dissolved Cd	Total Al	Dissolved Al	Total Pb	Dissolved Pb	Total Fe	Dissolved Fe	(See page 2 for further requests)
									~~F~~			~~F~~		~~F~~		~~F~~		~~F~~		~~F~~	not filtered
	12.5 ug/L Cu (lab water)			Jun-30-2014	12:00 PM	Water	2	R	R												
	25 ug/L Cu (lab water)			Jun-30-2014	12:00 PM	Water	2	R	R												
	50 ug/L Cu (lab water)			Jun-30-2014	12:00 PM	Water	2	R	R												
	100 ug/L Cu (lab water)			Jun-30-2014	12:00 PM	Water	2	R	R												
	200 ug/L Cu (lab water)			Jun-30-2014	12:00 PM	Water	2	R	R												
	25 ug/L Cu (MH-04)			Jun-30-2014	12:00 PM	Water	2	R	R												
	50 ug/L Cu (MH-04)			Jun-30-2014	12:00 PM	Water	2	R	R												
	100 ug/L Cu (MH-04)			Jun-30-2014	12:00 PM	Water	2	R	R												

(See page 3 for further samples)

L1479859-COFC

Special Instructions/Comments

Samples for dissolved metals NOT filtered ~~[illegible]~~.
Samples NOT preserved.

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☒No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐Yes ☒No

Guidelines

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Krysta Pearcy	Date: June 30/14	Time: 1700h	Received by: JK	Date: June 30	Time: 17:19	Temperature: 22.1 °C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

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Sample #	Sample Identification (This will appear on the report)	Coordinates: Longitude	Coordinates: Latitude	Date	Time	Sample Type	Number of Containers	Total Cr	Dissolved Cr	Total Cu, Zn, Cd, Al, Pb, Fe, Cr	Dissolved Cu, Zn, Cd, Al, Pb, Fe, Cr										
								Please indicate below Filtered, Preserved or both(F, P, F/P)													
									~~F~~		~~P~~	not filtered									
	12.5 ug/L Cu (lab water)			Jun-30-2014	12:00 PM	Water	2														
	25 ug/L Cu (lab water)			Jun-30-2014	12:00 PM	Water	2														
	50 ug/L Cu (lab water)			Jun-30-2014	12:00 PM	Water	2														
	100 ug/L Cu (lab water)			Jun-30-2014	12:00 PM	Water	2														
	200 ug/L Cu (lab water)			Jun-30-2014	12:00 PM	Water	2														
	25 ug/L Cu (MH-04)			Jun-30-2014	12:00 PM	Water	2														
	50 ug/L Cu (MH-04)			Jun-30-2014	12:00 PM	Water	2														
	100 ug/L Cu (MH-04)			Jun-30-2014	12:00 PM	Water	2														

(See page 3 for further samples)

L1479859-COFC

ALS Environmental

Chain of Custody / Analytical
Canada Toll Free : 1 800
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L1479859-COFC

COC #: OL-1355

Sample #	Sample Identification (This will appear on the report)	Coordinates Longitude	Coordinates Latitude	Date	Time	Sample Type	Number of Containers	Total Cu	Dissolved Cu	Total Cu	Total Zn	Dissolved Zn	Total Cd	Dissolved Cd	Total Al	Dissolved Al	Total Pb	Dissolved Pb	Total Fe	Dissolved Fe	Total Cr	Dissolved Cr	Total Cu, Zn, Cd, Al, Pb, Fe, Cr	(See page 4 for further requests)
								Please indicate below Filtered, Preserved or both(F, P, F/P)																
									~~F~~			~~F~~		~~F~~		~~F~~		~~F~~		~~F~~		~~F~~		not filtered
	200 ug/L Cu (MH-04)			Jun-30-2014	12:00 PM	Water	2		R	R														
	400 ug/L Cu (MH-04)			Jun-30-2014	12:00 PM	Water	2	R	R															
	50 ug/L Zn (lab water)			Jun-30-2014	12:00 PM	Water	2				R	R												
	100 ug/L Zn (lab water)			Jun-30-2014	12:00 PM	Water	2				R	R												
	200 ug/L Zn (lab water)			Jun-30-2014	12:00 PM	Water	2				R	R												
	400 ug/L Zn (lab water)			Jun-30-2014	12:00 PM	Water	2				R	R												
	800 ug/L Zn (lab water)			Jun-30-2014	12:00 PM	Water	2				R	R												
	50 ug/L Zn (MH-04)			Jun-30-2014	12:00 PM	Water	2				R	R												
	100 ug/L Zn (MH-04)			Jun-30-2014	12:00 PM	Water	2				R	R												
	200 ug/L Zn (MH-04)			Jun-30-2014	12:00 PM	Water	2				R	R												
	400 ug/L Zn (MH-04)			Jun-30-2014	12:00 PM	Water	2				R	R												
	800 ug/L Zn (MH-04)			Jun-30-2014	12:00 PM	Water	2				R	R												
	25 ug/L Cd (lab water)			Jun-30-2014	12:00 PM	Water	2						R	R										
	50 ug/L Cd (lab water)			Jun-30-2014	12:00 PM	Water	2						R	R										
	100 ug/L Cd (lab water)			Jun-30-2014	12:00 PM	Water	2						R	R										
	200 ug/L Cd (lab water)			Jun-30-2014	12:00 PM	Water	2						R	R										
	400 ug/L Cd (lab water)			Jun-30-2014	12:00 PM	Water	2						R	R										
	25 ug/L Cd (MH-04)			Jun-30-2014	12:00 PM	Water	2						R	R										
	50 ug/L Cd (MH-04)			Jun-30-2014	12:00 PM	Water	2						R	R										
	100 ug/L Cd (MH-04)			Jun-30-2014	12:00 PM	Water	2						R	R										
	200 ug/L Cd (MH-04)			Jun-30-2014	12:00 PM	Water	2						R	R										
	400 ug/L Cd (MH-04)			Jun-30-2014	12:00 PM	Water	2						R	R										
	250 ug/L Al (lab water)			Jun-30-2014	12:00 PM	Water	2								R	R								
	500 ug/L Al (lab water)			Jun-30-2014	12:00 PM	Water	2								R	R								
	1000 ug/L Al (lab water)			Jun-30-2014	12:00 PM	Water	2								R	R								
	2000 ug/L Al (lab water)			Jun-30-2014	12:00 PM	Water	2								R	R								
	4000 ug/L Al (lab water)			Jun-30-2014	12:00 PM	Water	2								R	R								

(See page 5 for further samples)

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Sample #	Sample Identification (This will appear on the report)	Coordinates: Longitude	Coordinates: Latitude	Date	Time	Sample Type	Number of Containers	Analysis Requests: Dissolved Cu, Zn, Cd, Al, Pb, Fe, Cr
	Please indicate below Filtered, Preserved or both(F, P, F/P)							c-F not filtered
	200 ug/L Cu (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	400 ug/L Cu (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	50 ug/L Zn (lab water)			Jun-30-2014	12:00 PM	Water	2	
	100 ug/L Zn (lab water)			Jun-30-2014	12:00 PM	Water	2	
	200 ug/L Zn (lab water)			Jun-30-2014	12:00 PM	Water	2	
	400 ug/L Zn (lab water)			Jun-30-2014	12:00 PM	Water	2	
	800 ug/L Zn (lab water)			Jun-30-2014	12:00 PM	Water	2	
	50 ug/L Zn (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	100 ug/L Zn (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	200 ug/L Zn (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	400 ug/L Zn (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	800 ug/L Zn (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	25 ug/L Cd (lab water)			Jun-30-2014	12:00 PM	Water	2	
	50 ug/L Cd (lab water)			Jun-30-2014	12:00 PM	Water	2	
	100 ug/L Cd (lab water)			Jun-30-2014	12:00 PM	Water	2	
	200 ug/L Cd (lab water)			Jun-30-2014	12:00 PM	Water	2	
	400 ug/L Cd (lab water)			Jun-30-2014	12:00 PM	Water	2	
	25 ug/L Cd (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	50 ug/L Cd (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	100 ug/L Cd (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	200 ug/L Cd (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	400 ug/L Cd (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	250 ug/L Al (lab water)			Jun-30-2014	12:00 PM	Water	2	
	500 ug/L Al (lab water)			Jun-30-2014	12:00 PM	Water	2	
	1000 ug/L Al (lab water)			Jun-30-2014	12:00 PM	Water	2	
	2000 ug/L Al (lab water)			Jun-30-2014	12:00 PM	Water	2	
	4000 ug/L Al (lab water)			Jun-30-2014	12:00 PM	Water	2	

L1479859-COFC

(See page 5 for further samples)

ALS En

Chain of Custody / Analytical Request Form
Canada Toll Free : 1 800 668 9878
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Sample #	Sample Identification (This will appear on the report)	Coordinates: Longitude	Coordinates: Latitude	Date	Time	Sample Type	Number of Containers	Total Cu	Dissolved Cu	Total Cu	Total Zn	Dissolved Zn	Total Cd	Dissolved Cd	Total Al	Dissolved Al	Total Pb	Dissolved Pb	Total Fe	Dissolved Fe	Total Cr	Dissolved Cr	Total Cu, Zn, Cd, Al, Pb, Fe, Cr	
							Please indicate below Filtered, Preserved or both(F, P, F/P)		F			F		F		F		F		F		F	not filtered	
	250 ug/L Al (MH-04)			Jun-30-2014	12:00 PM	Water	2								R	R								
	500 ug/L Al (MH-04)			Jun-30-2014	12:00 PM	Water	2								R	R								
	1000 ug/L Al (MH-04)			Jun-30-2014	12:00 PM	Water	2								R	R								
	2000 ug/L Al (MH-04)			Jun-30-2014	12:00 PM	Water	2								R	R								
	4000 ug/L Al (MH-04)			Jun-30-2014	12:00 PM	Water	2								R	R								
	~~62.5 ug/L Pb (lab water)~~			~~Jun-30-2014~~	~~12:00 PM~~	~~Water~~	~~2~~										~~R~~	~~R~~						
	~~125 ug/L Pb (lab water)~~			~~Jun-30-2014~~	~~12:00 PM~~	~~Water~~	~~2~~										~~R~~	~~R~~						
	250 ug/L Pb (lab water)			Jun-30-2014	12:00 PM	Water	2										R	R						
	500 ug/L Pb (lab water)			Jun-30-2014	12:00 PM	Water	2										R	R						
	1000 ug/L Pb (lab water)			Jun-30-2014	12:00 PM	Water	2										R	R						
	62.5 ug/L Pb (MH-04)			Jun-30-2014	12:00 PM	Water	2										R	R						
	125 ug/L Pb (MH-04)			Jun-30-2014	12:00 PM	Water	2										R	R						
	250 ug/L Pb (MH-04)			Jun-30-2014	12:00 PM	Water	2										R	R						
	500 ug/L Pb (MH-04)			Jun-30-2014	12:00 PM	Water	2										R	R						
	1000 ug/L Pb (MH-04)			Jun-30-2014	12:00 PM	Water	2										R	R						
	6.25 mg/L Fe (lab water)			Jun-30-2014	12:00 PM	Water	2												R	R				
	12.5 mg/L Fe (lab water)			Jun-30-2014	12:00 PM	Water	2												R	R				
	25 mg/L Fe (lab water)			Jun-30-2014	12:00 PM	Water	2												R	R				
	50 mg/L Fe (lab water)			Jun-30-2014	12:00 PM	Water	2												R	R				
	100 mg/L Fe (lab water)			Jun-30-2014	12:00 PM	Water	2												R	R				
	6.25 mg/L Fe (MH-04)			Jun-30-2014	12:00 PM	Water	2												R	R				
	12.5 mg/L Fe (MH-04)			Jun-30-2014	12:00 PM	Water	2												R	R				
	25 mg/L Fe (MH-04)			Jun-30-2014	12:00 PM	Water	2												R	R				
	50 mg/L Fe (MH-04)			Jun-30-2014	12:00 PM	Water	2												R	R				
	100 mg/L Fe (MH-04)			Jun-30-2014	12:00 PM	Water	2												R	R				
	43.75 ug/L Cr (lab water)			Jun-30-2014	12:00 PM	Water	2														R	R		
	87.5 ug/L Cr (lab water)			Jun-30-2014	12:00 PM	Water	2														R	R		

Samples cancelled KL

(See page 6 for further requests)

(See page 7 for further samples)

(ALS) Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free : 1 800 668 9878
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COC #: OL-1355

L1479859-COFC

Sample #	Sample Identification (This will appear on the report)	Coordinates: Longitude	Coordinates: Latitude	Date	Time	Sample Type	Number of Containers	Analysis Requests: Dissolved Cu, Zn, Cd, Al, Pb, Fe, Cr	Analysis Requests
								Please indicate below Filtered, Preserved or both(F, P, F/P)	
								F	not filtered
	250 ug/L Al (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	500 ug/L Al (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	1000 ug/L Al (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	2000 ug/L Al (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	4000 ug/L Al (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	~~62.5 ug/L Pb (lab water)~~			~~Jun-30-2014~~	~~12:00 PM~~	~~Water~~	2		
	125 ug/L Pb (lab water)			Jun-30-2014	12:00 PM	Water	2		
	250 ug/L Pb (lab water)			Jun-30-2014	12:00 PM	Water	2		
	500 ug/L Pb (lab water)			Jun-30-2014	12:00 PM	Water	2		
	1000 ug/L Pb (lab water)			Jun-30-2014	12:00 PM	Water	2		
	62.5 ug/L Pb (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	125 ug/L Pb (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	250 ug/L Pb (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	500 ug/L Pb (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	1000 ug/L Pb (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	6.25 mg/L Fe (lab water)			Jun-30-2014	12:00 PM	Water	2		
	12.5 mg/L Fe (lab water)			Jun-30-2014	12:00 PM	Water	2		
	25 mg/L Fe (lab water)			Jun-30-2014	12:00 PM	Water	2		
	50 mg/L Fe (lab water)			Jun-30-2014	12:00 PM	Water	2		
	100 mg/L Fe (lab water)			Jun-30-2014	12:00 PM	Water	2		
	6.25 mg/L Fe (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	12.5 mg/L Fe (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	25 mg/L Fe (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	50 mg/L Fe (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	100 mg/L Fe (MH-04)			Jun-30-2014	12:00 PM	Water	2		
	43.75 ug/L Cr (lab water)			Jun-30-2014	12:00 PM	Water	2		
	~~87.5 ug/L Cr (lab water)~~			~~Jun-30-2014~~	12:00 PM	Water	2		

(See page 7 for further samples)

Samples cancelled Kp

ALS Environmental

Chain of Custody / Analytical Request Form
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samples cancelled

Sample #	Sample Identification (This will appear on the report)	Coordinates: Longitude	Coordinates: Latitude	Date	Time	Sample Type	Number of Containers	Total Cu	Dissolved Cu	Total Cu	Total Zn	Dissolved Zn	Total Cd	Dissolved Cd	Total Al	Dissolved Al	Total Pb	Dissolved Pb	Total Fe	Dissolved Fe	Total Cr	Dissolved Cr	Total Cu, Zn, Cd, Al, Pb, Fe, Cr	
	Please indicate below Filtered, Preserved or both(F, P, F/P)								F			F		F		F		F		F		F	not filtered,	
	~~475 ug/L Cr (lab water)~~			~~Jun-30-2014~~	~~12:00 PM~~	~~Water~~	2														R	R		
	~~350 ug/L Cr (lab water)~~			Jun-30-2014	12:00 PM	Water	2														R	R		
	700 ug/L Cr (lab water)			Jun-30-2014	12:00 PM	Water	2														R	R		
	43.75 ug/L Cr (MH-04)			Jun-30-2014	12:00 PM	Water	2														R	R		
	87.5 ug/L Cr (MH-04)			Jun-30-2014	12:00 PM	Water	2														R	R		
	175 ug/L Cr (MH-04)			Jun-30-2014	12:00 PM	Water	2														R	R		
	350 ug/L Cr (MH-04)			Jun-30-2014	12:00 PM	Water	2														R	R		
	~~700 ug/L Cr (MH-04)~~			~~Jun-30-2014~~	12:00 PM	Water	2														R	R		
	160 mg/L Hardness Perrier Water			Jun-30-2014	12:00 PM	Water	2																R	
	MH-04			Jun-30-2014	12:00 PM	Water	2																R	

(See page 8 for further requests)

L1479859-COFC

ALS Environmental

Chain of Custody / Analytical Request Form

Canada Toll Free : 1 800 668 9878

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Sample #	Sample Identification (This will appear on the report)	Coordinates Longitude	Coordinates Latitude	Date	Time	Sample Type	Number of Containers	Dissolved Cu, Zn, Cd, Al, Pb, Fe, Cr
								Please indicate below Filtered, Preserved or both(F, P, F/P)
								~~F~~ not Filtered
	~~175 ug/L Cr (lab water)~~			~~Jun-30-2014~~	~~12:00 PM~~	~~Water~~	2	
	350 ug/L Cr (lab water)			Jun-30-2014	12:00 PM	Water	2	
	700 ug/L Cr (lab water)			Jun-30-2014	12:00 PM	Water	2	
	43.75 ug/L Cr (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	87.5 ug/L Cr (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	175 ug/L Cr (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	350 ug/L Cr (MH-04)			Jun-30-2014	12:00 PM	Water	2	
	~~700 ug/L Cr (MH-04)~~			~~Jun-30-2014~~	~~12:00 PM~~	~~Water~~	~~2~~	
	160 mg/L Hardness Perrier Water			Jun-30-2014	12:00 PM	Water	2	R
	MH-04			Jun-30-2014	12:00 PM	Water	2	R

Samples cancelled Kp

L1479859-COFC

NAUTILUS ENVIRONMENTAL
ATTN: Krysta Pearcy
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 02-JUL-14
Report Date: 10-JUL-14 15:09 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: **L1480149**

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Comments: Please note ALS identified samples L1480149-10,13 and 35 were spot on ICPOES because the samples were biased low compared to the concentration on sample id.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480149-1	L1480149-2	L1480149-3	L1480149-4	L1480149-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	12.5 UG/L CU (LAB WATER)	25 UG/L CU (LAB WATER)	50 UG/L CU (LAB WATER)	100 UG/L CU (LAB WATER)	200 UG/L CU (LAB WATER)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)	0.0179	0.0224	0.0393	0.0898	0.174
	Zinc (Zn)-Total (mg/L)					

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480149-6	L1480149-7	L1480149-8	L1480149-9	L1480149-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	25 UG/L CU (MH-04)	50 UG/L CU (MH-04)	100 UG/L CU (MH-04)	200 UG/L CU (MH-04)	400 UG/L CU (MH-04)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)	0.0235	0.0460	0.0863	0.169	0.318
	Zinc (Zn)-Total (mg/L)					

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480149-11	L1480149-12	L1480149-13	L1480149-14	L1480149-15
	Description	Water	Water	Water	Water	Water
	Sampled Date	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	50 UG/L ZN (LAB WATER)	100 UG/L ZN (LAB WATER)	200 UG/L ZN (LAB WATER)	400 UG/L ZN (LAB WATER)	800 UG/L ZN (LAB WATER)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)	0.0384	0.0661	0.146	0.309	0.600

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480149-16	L1480149-17	L1480149-18	L1480149-19	L1480149-20
	Description	Water	Water	Water	Water	Water
	Sampled Date	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	50 UG/L ZN (MH-04)	100 UG/L ZN (MH-04)	200 UG/L ZN (MH-04)	400 UG/L ZN (MH-04)	800 UG/L ZN (MH-04)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)	0.0416	0.0745	0.141	0.311	0.635

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480149-21	L1480149-22	L1480149-23	L1480149-24	L1480149-25
	Description	Water	Water	Water	Water	Water
	Sampled Date	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	25 UG/L CD (LAB WATER)	50 UG/L CD (LAB WATER)	100 UG/L CD (LAB WATER)	200 UG/L CD (LAB WATER)	400 UG/L CD (LAB WATER)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)	0.00851	0.0101	0.0267	0.0430	0.107
	Copper (Cu)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480149-26	L1480149-27	L1480149-28	L1480149-29	L1480149-30
	Description	Water	Water	Water	Water	Water
	Sampled Date	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	25 UG/L CD (MH-04)	50 UG/L CD (MH-04)	100 UG/L CD (MH-04)	200 UG/L CD (MH-04)	400 UG/L CD (MH-04)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)	0.0208	0.0433	0.0899	0.211	0.357
	Copper (Cu)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480149-31	L1480149-32	L1480149-33	L1480149-34	L1480149-35
	Description	Water	Water	Water	Water	Water
	Sampled Date	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	250 UG/L AL(LAB WATER)	500 UG/L AL (LAB WATER)	1000 UG/L AL (LAB WATER)	2000 UG/L AL (LAB WATER)	4000 UG/L AL (LAB WATER)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	0.169	0.353	0.724	1.16	1.72
	Cadmium (Cd)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480149-36	L1480149-37	L1480149-38	L1480149-39	L1480149-40
	Description	Water	Water	Water	Water	Water
	Sampled Date	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	250 UG/L AL (MH-04)	500 UG/L AL (MH-04)	1000 UG/L AL (MH-04)	2000 UG/L AL (MH-04)	4000 UG/L AL (MH-04)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)	0.171	0.369	0.739	1.50	2.08
	Cadmium (Cd)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480149-41	L1480149-42	L1480149-43	L1480149-44	L1480149-45
	Description	Water	Water	Water	Water	Water
	Sampled Date	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14	02-JUL-14
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	160 MG/L HARDNESS PERRIER WATER (CU TEST)	160 MG/L HARDNESS PERRIER WATER (ZN TEST)	160 MG/L HARDNESS PERRIER WATER (CD TEST)	160 MG/L HARDNESS PERRIER WATER (AL TEST)	MH-04 (CU TEST)
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)				<0.20	
	Cadmium (Cd)-Total (mg/L)			<0.010		
	Copper (Cu)-Total (mg/L)	<0.010				<0.010
	Zinc (Zn)-Total (mg/L)		<0.0050			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480149-46	L1480149-47	L1480149-48		
	Description	Water	Water	Water		
	Sampled Date	02-JUL-14	02-JUL-14	02-JUL-14		
	Sampled Time	12:00	12:00	12:00		
	Client ID	MH-04 (ZN TEST)	MH-04 (CD TEST)	MH-04 (AL TEST)		
Grouping	**Analyte**					
WATER						
Total Metals	Aluminum (Al)-Total (mg/L)			<0.20		
	Cadmium (Cd)-Total (mg/L)		<0.010			
	Copper (Cu)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)	0.0072				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Chain of Custody / Analytical Request Form
Canada Toll Free : 1 800 668 9878
www.alsglobal.com

COC #: OL-1355

Report To

Company: Nautilus Environmental
Contact: Krysta Pearcy
Address: 8664 Commerce Court, Imperial Square Lake City, Burnaby, BC, Canada, V5A 4N7
Phone: 604-420-8773 Fax: 604-357-1361

Invoice To ☑Email ☐Mail

Company: Nautilus Environmental
Contact: Krysta Pearcy
Address: 8664 Commerce Court, Imperial Square Lake City, Burnaby, BC, Canada, V5A 4N7
Email: krysta@nautilusenvironmental.com
Phone: 604-420-8773

Lab Work Order # (lab use only)

Reporting

Distribution: ☐Fax ☐Mail ☑Email
☐Criteria on Report (select from Guidelines below)
Report Type: ☑Excel ☑Digital
Report Format:
Report Email(s): krysta@nautilusenvironmental.com
EDD Format:
EDD Email(s):

L1480149-COFC

Proj
Job #
PO/
LSD:
Quote #:
ALS Contact: Janie Lo
Sampler: Krysta Pearcy

Service Requested

- ⦿Regular (Standard Turnaround Times - Business Days) - R
- ○Priority (3 Days) - surcharge will apply - P
- ○Priority (2 Days) - surcharge will apply - P2
- ○Emergency (1-2 day) – surcharge will apply - E
- ○Same Day or Weekend Emergency - surcharge will apply - E2
- ○Specify date required - X

Analysis Requests

Please indicate below Filtered, Preserved or both(F, P, F/P)

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	Total Cu	Total Cu	Total Zn	Total Cd	Total Al	Total Pb	Total Fe	Total Cr
	12.5 ug/L Cu (lab water)			Jul-02-2014	12:00 PM	Water	1	R							
	25 ug/L Cu (lab water)			Jul-02-2014	12:00 PM	Water	1	R							
	50 ug/L Cu (lab water)			Jul-02-2014	12:00 PM	Water	1	R							
	100 ug/L Cu (lab water)			Jul-02-2014	12:00 PM	Water	1	R							
	200 ug/L Cu (lab water)			Jul-02-2014	12:00 PM	Water	1	R							
	25 ug/L Cu (MH-04)			Jul-02-2014	12:00 PM	Water	1	R							
	50 ug/L Cu (MH-04)			Jul-02-2014	12:00 PM	Water	1	R							
	100 ug/L Cu (MH-04)			Jul-02-2014	12:00 PM	Water	1	R							

(See page 2 for further samples)

Special Instructions/Comments

Samples NOT preserved.

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☐No
If yes, please use an authorized drinking water COC
Is the water sampled intended to be potable for human consumption? ☐Yes ☐No

Guidelines

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Krysta Pearcy	Date: July 2/14	Time: 1700h	Received by:	Date:	Time:	Temperature: °C	Verified by: Aren	Date: July 2	Time: 1900	Observations: ☐Yes 18°C If Yes add SIF

ALS Environmental

Chain of Custody / Analytical Request Form
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Sample #	Sample Identification (This will appear on the report)	Coordinates: Longitude	Coordinates: Latitude	Date	Time	Sample Type	Number of Containers	Total Cu	Total Cu	Total Zn	Total Cd	Total Al	Total Pb	Total Fe	Total Cr
								Please indicate below Filtered, Preserved or both(F, P, F/P)							
	200 ug/L Cu (MH-04)			Jul-02-2014	12:00 PM	Water	1		R						
	400 ug/L Cu (MH-04)			Jul-02-2014	12:00 PM	Water	1	R							
	50 ug/L Zn (lab water)			Jul-02-2014	12:00 PM	Water	1			R					
	100 ug/L Zn (lab water)			Jul-02-2014	12:00 PM	Water	1			R					
	200 ug/L Zn (lab water)			Jul-02-2014	12:00 PM	Water	1			R					
	400 ug/L Zn (lab water)			Jul-02-2014	12:00 PM	Water	1			R					
	800 ug/L Zn (lab water)			Jul-02-2014	12:00 PM	Water	1			R					
	50 ug/L Zn (MH-04)			Jul-02-2014	12:00 PM	Water	1			R					
	100 ug/L Zn (MH-04)			Jul-02-2014	12:00 PM	Water	1			R					
	200 ug/L Zn (MH-04)			Jul-02-2014	12:00 PM	Water	1			R					
	400 ug/L Zn (MH-04)			Jul-02-2014	12:00 PM	Water	1			R					
	800 ug/L Zn (MH-04)			Jul-02-2014	12:00 PM	Water	1			R					
	25 ug/L Cd (lab water)			Jul-02-2014	12:00 PM	Water	1				R				
	50 ug/L Cd (lab water)			Jul-02-2014	12:00 PM	Water	1				R				
	100 ug/L Cd (lab water)			Jul-02-2014	12:00 PM	Water	1				R				
	200 ug/L Cd (lab water)			Jul-02-2014	12:00 PM	Water	1				R				
	400 ug/L Cd (lab water)			Jul-02-2014	12:00 PM	Water	1				R				
	25 ug/L Cd (MH-04)			Jul-02-2014	12:00 PM	Water	1				R				
	50 ug/L Cd (MH-04)			Jul-02-2014	12:00 PM	Water	1				R				
	100 ug/L Cd (MH-04)			Jul-02-2014	12:00 PM	Water	1				R				
	200 ug/L Cd (MH-04)			Jul-02-2014	12:00 PM	Water	1				R				
	400 ug/L Cd (MH-04)			Jul-02-2014	12:00 PM	Water	1				R				
	250 ug/L Al (lab water)			Jul-02-2014	12:00 PM	Water	1					R			
	500 ug/L Al (lab water)			Jul-02-2014	12:00 PM	Water	1					R			
	1000 ug/L Al (lab water)			Jul-02-2014	12:00 PM	Water	1					R			
	2000 ug/L Al (lab water)			Jul-02-2014	12:00 PM	Water	1					R			
	4000 ug/L Al (lab water)			Jul-02-2014	12:00 PM	Water	1					R			

(See page 3 for further samples)

L1480149-COFC

ALS Environmental

Chain of Custody / Analytical Request
Canada Toll Free : 1 800 668 9878
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L1480149-COFC

COC #: OL-1355

Samples cancelled

Sample #	Sample Identification (This will appear on the report)	Coordinates: Longitude	Coordinates: Latitude	Date	Time	Sample Type	Number of Containers	Total Cu	Total Cu	Total Zn	Total Cd	Total Al	Total Pb	Total Fe	Total Cr
								Please indicate below Filtered, Preserved or both(F, P, F/P)							
	250 ug/L Al (MH-04)			Jul-02-2014	12:00 PM	Water	1					R			
	500 ug/L Al (MH-04)			Jul-02-2014	12:00 PM	Water	1					R			
	1000 ug/L Al (MH-04)			Jul-02-2014	12:00 PM	Water	1					R			
	2000 ug/L Al (MH-04)			Jul-02-2014	12:00 PM	Water	1					R			
	4000 ug/L Al (MH-04)			Jul-02-2014	12:00 PM	Water	1					R			
	~~62.5 ug/L Pb (lab water)~~			~~Jul-02-2014~~	~~12:00 PM~~	~~Water~~	~~1~~						~~R~~		
	125 ug/L Pb (lab water)			Jul-02-2014	12:00 PM	Water	1						R		
	250 ug/L Pb (lab water)			Jul-02-2014	12:00 PM	Water	1						R		
	500 ug/L Pb (lab water)			Jul-02-2014	12:00 PM	Water	1						R		
	1000 ug/L Pb (lab water)			Jul-02-2014	12:00 PM	Water	1						R		
	62.5 ug/L Pb (MH-04)			Jul-02-2014	12:00 PM	Water	1						R		
	125 ug/L Pb (MH-04)			Jul-02-2014	12:00 PM	Water	1						R		
	250 ug/L Pb (MH-04)			Jul-02-2014	12:00 PM	Water	1						R		
	500 ug/L Pb (MH-04)			Jul-02-2014	12:00 PM	Water	1						R		
	1000 ug/L Pb (MH-04)			Jul-02-2014	12:00 PM	Water	1						R		
	6.25 mg/L Fe (lab water)			Jul-02-2014	12:00 PM	Water	1							R	
	12.5 mg/L Fe (lab water)			Jul-02-2014	12:00 PM	Water	1							R	
	25 mg/L Fe (lab water)			Jul-02-2014	12:00 PM	Water	1							R	
	50 mg/L Fe (lab water)			Jul-02-2014	12:00 PM	Water	1							R	
	100 mg/L Fe (lab water)			Jul-02-2014	12:00 PM	Water	1							R	
	6.25 mg/L Fe (MH-04)			Jul-02-2014	12:00 PM	Water	1							R	
	12.5 mg/L Fe (MH-04)			Jul-02-2014	12:00 PM	Water	1							R	
	25 mg/L Fe (MH-04)			Jul-02-2014	12:00 PM	Water	1							R	
	50 mg/L Fe (MH-04)			Jul-02-2014	12:00 PM	Water	1							R	
	100 mg/L Fe (MH-04)			Jul-02-2014	12:00 PM	Water	1							R	
	43.75 ug/L Cr (lab water)			Jul-02-2014	12:00 PM	Water	1								R
	~~87.5 ug/L Cr (lab water)~~			~~Jul-02-2014~~	~~12:00 PM~~	~~Water~~	~~1~~								~~R~~

(See page 4 for further samples)

ALS Environmental

Chain of Custody / Analytical Request Form

Canada Toll Free : 1 800 668 9878

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COC #: OL-1355

L1480149-COFC

Samples cancelled

Sample #	Sample Identification (This will appear on the report)	Coordinates: Longitude	Coordinates: Latitude	Date	Time	Sample Type	Number of Containers	Total Cu	Total Cu	Total Zn	Total Cd	Total Al	Total Pb	Total Fe	Total Cr
	Please indicate below Filtered, Preserved or both(F, P, F/P)														
	~~175 ug/L Cr (lab water)~~			~~Jul-02-2014~~	~~12:00 PM~~	~~Water~~	~~1~~								~~R~~
	350 ug/L Cr (lab water)			Jul-02-2014	12:00 PM	Water	1								R
	700 ug/L Cr (lab water)			Jul-02-2014	12:00 PM	Water	1								R
	43.75 ug/L Cr (MH-04)			Jul-02-2014	12:00 PM	Water	1								R
	87.5 ug/L Cr (MH-04)			Jul-02-2014	12:00 PM	Water	1								R
	175 ug/L Cr (MH-04)			Jul-02-2014	12:00 PM	Water	1								R
	350 ug/L Cr (MH-04)			Jul-02-2014	12:00 PM	Water	1								R
	~~700 ug/L Cr (MH-04)~~			~~Jul-02-2014~~	~~12:00 PM~~	~~Water~~	~~1~~								~~R~~
	160 mg/L Hardness Perrier Water (Cu test)			Jul-02-2014	12:00 PM	Water	1	R							
	160 mg/L Hardness Perrier Water (Zn test)			Jul-02-2014	12:00 PM	Water	1			R					
	160 mg/L Hardness Perrier Water (Cd test)			Jul-02-2014	12:00 PM	Water	1				R				
	160 mg/L Hardness Perrier Water (Al test)			Jul-02-2014	12:00 PM	Water	1					R			
	~~160 mg/L Hardness Perrier~~ Water (Pb test)			~~Jul-02-2014~~	~~12:00 PM~~	~~Water~~	~~1~~						~~R~~		
	~~160 mg/L Hardness Perrier~~ Water (Fe test)			~~Jul-02-2014~~	~~12:00 PM~~	~~Water~~	~~1~~							~~R~~	
	~~160 mg/L Hardness Perrier~~ Water (Cr test)			Jun-30-2014	12:00 PM	~~Water~~	~~1~~								~~R~~
	MH-04 (Cu test)			Jul-02-2014	12:00 PM	Water	1	R							
	MH-04 (Zn test)			Jul-02-2014	12:00 PM	Water	1			R					
	MH-04 (Cd test)			Jul-02-2014	12:00 PM	Water	1				R				
	MH-04 (Al test)			Jul-02-2014	12:00 PM	Water	1					R			
	~~MH-04 (Pb test)~~			~~Jul-02-2014~~	~~12:00 PM~~	~~Water~~	~~1~~						~~R~~		

samples cancelled

sample cancelled

(See page 5 for further samples)

ALS Environmental

Chain of Custody / Analytical Request Form

Canada Toll Free : 1 800 668 9878

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Samples cancelled

Sample #	Sample Identification (This will appear on the report)	Coordinates Longitude	Coordinates Latitude	Date	Time	Sample Type	Number of Containers	Total Cu	Total Cu	Total Zn	Total Cd	Total Al	Total Pb	Total Fe	Total Cr
	~~MH-04 (Fe test)~~			~~Jul-02-2014~~	~~12:00 PM~~	~~Water~~	~~1~~							R	
	~~MH-04 (Cr test)~~			~~Jul-02-2014~~	~~12:00 PM~~	~~Water~~	~~1~~								R

Please indicate below Filtered, Preserved or both(F, P, F/P)

L1480149-COFC

NAUTILUS ENVIRONMENTAL
ATTN: Krysta Pearcy
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 02-JUL-14
Report Date: 15-JUL-14 17:18 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: **L1480117**

Project P.O. #: NOT SUBMITTED

Job Reference:

C of C Numbers:

Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480117-1	L1480117-2	L1480117-3	L1480117-4	L1480117-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14
	Sampled Time					
	Client ID	160MG/L HARDNESS CTRL	MH-04 SITE CTRL	6.25 MG/L FE (LAB)	12.5 MG/L FE (LAB)	25 MG/L FE (LAB)
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	129	153			
Total Metals	Aluminum (Al)-Total (mg/L)	<0.0030	0.0049			
	Antimony (Sb)-Total (mg/L)	0.00030	0.00013			
	Arsenic (As)-Total (mg/L)	<0.00010	0.00036			
	Barium (Ba)-Total (mg/L)	0.0149	0.0208			
	Beryllium (Be)-Total (mg/L)	<0.00050	<0.00050			
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.00050			
	Boron (B)-Total (mg/L)	0.017	<0.010			
	Cadmium (Cd)-Total (mg/L)	<0.000050	0.000214			
	Calcium (Ca)-Total (mg/L)	51.8	57.7			
	Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050			
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00011			
	Copper (Cu)-Total (mg/L)	<0.00050	0.00113			
	Iron (Fe)-Total (mg/L)	<0.030	<0.030	5.94	12.2	25.6
	Lead (Pb)-Total (mg/L)	<0.000050	0.000292			
	Lithium (Li)-Total (mg/L)	<0.0050	<0.0050			
	Magnesium (Mg)-Total (mg/L)	2.21	2.68			
	Manganese (Mn)-Total (mg/L)	<0.000050	0.000334			
	Molybdenum (Mo)-Total (mg/L)	0.000588	0.000626			
	Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050			
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30			
	Potassium (K)-Total (mg/L)	<2.0	<2.0			
	Selenium (Se)-Total (mg/L)	<0.0010	<0.0010			
	Silicon (Si)-Total (mg/L)	2.16	2.76			
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Total (mg/L)	5.0	<2.0			
	Strontium (Sr)-Total (mg/L)	0.283	0.179			
	Thallium (Tl)-Total (mg/L)	<0.00010	<0.00010			
	Tin (Sn)-Total (mg/L)	0.00054	0.00058			
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010			
	Uranium (U)-Total (mg/L)	0.00151	0.000676			
	Vanadium (V)-Total (mg/L)	<0.0010	<0.0010			
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0070			
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)	<0.0030	<0.0030			
	Antimony (Sb)-Dissolved (mg/L)	0.00027	0.00012			
	Arsenic (As)-Dissolved (mg/L)	0.00010	0.00032			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1480117-6 Water 01-JUL-14 50 MG/L FE (LAB)	L1480117-7 Water 01-JUL-14 100 MG/L FE (LAB)	L1480117-8 Water 01-JUL-14 6.25 MG/L FE (MH-04)	L1480117-9 Water 01-JUL-14 12.5 MG/L FE (MH-04)	L1480117-10 Water 01-JUL-14 25 MG/L FE (MH-04)
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)					
	Antimony (Sb)-Total (mg/L)					
	Arsenic (As)-Total (mg/L)					
	Barium (Ba)-Total (mg/L)					
	Beryllium (Be)-Total (mg/L)					
	Bismuth (Bi)-Total (mg/L)					
	Boron (B)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Calcium (Ca)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Cobalt (Co)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)	49.9	97.7	5.91	12.1	24.9
	Lead (Pb)-Total (mg/L)					
	Lithium (Li)-Total (mg/L)					
	Magnesium (Mg)-Total (mg/L)					
	Manganese (Mn)-Total (mg/L)					
	Molybdenum (Mo)-Total (mg/L)					
	Nickel (Ni)-Total (mg/L)					
	Phosphorus (P)-Total (mg/L)					
	Potassium (K)-Total (mg/L)					
	Selenium (Se)-Total (mg/L)					
	Silicon (Si)-Total (mg/L)					
	Silver (Ag)-Total (mg/L)					
	Sodium (Na)-Total (mg/L)					
	Strontium (Sr)-Total (mg/L)					
	Thallium (Tl)-Total (mg/L)					
	Tin (Sn)-Total (mg/L)					
	Titanium (Ti)-Total (mg/L)					
	Uranium (U)-Total (mg/L)					
	Vanadium (V)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)					
	Antimony (Sb)-Dissolved (mg/L)					
	Arsenic (As)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480117-11	L1480117-12	L1480117-13	L1480117-14	L1480117-15
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14
	Sampled Time					
	Client ID	50 MG/L FE (MH-04)	100 MG/L FE (MH-04)	43.75 UG/L CR (LAB)	87.5 UG/L CR (LAB)	175 UG/L CR (LAB)
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)					
	Antimony (Sb)-Total (mg/L)					
	Arsenic (As)-Total (mg/L)					
	Barium (Ba)-Total (mg/L)					
	Beryllium (Be)-Total (mg/L)					
	Bismuth (Bi)-Total (mg/L)					
	Boron (B)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Calcium (Ca)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)			0.0434	0.0904	0.175
	Cobalt (Co)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)	47.8	98.0			
	Lead (Pb)-Total (mg/L)					
	Lithium (Li)-Total (mg/L)					
	Magnesium (Mg)-Total (mg/L)					
	Manganese (Mn)-Total (mg/L)					
	Molybdenum (Mo)-Total (mg/L)					
	Nickel (Ni)-Total (mg/L)					
	Phosphorus (P)-Total (mg/L)					
	Potassium (K)-Total (mg/L)					
	Selenium (Se)-Total (mg/L)					
	Silicon (Si)-Total (mg/L)					
	Silver (Ag)-Total (mg/L)					
	Sodium (Na)-Total (mg/L)					
	Strontium (Sr)-Total (mg/L)					
	Thallium (Tl)-Total (mg/L)					
	Tin (Sn)-Total (mg/L)					
	Titanium (Ti)-Total (mg/L)					
	Uranium (U)-Total (mg/L)					
	Vanadium (V)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)					
	Antimony (Sb)-Dissolved (mg/L)					
	Arsenic (As)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480117-16	L1480117-17	L1480117-18	L1480117-19	L1480117-20
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14
	Sampled Time					
	Client ID	350 UG/L CR (LAB)	700 UG/L CR (LAB)	43.75 UG/L CR(MH04)	87.5 UG/L CR (MH04)	175 UG/L CR (MH04)
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)					
	Antimony (Sb)-Total (mg/L)					
	Arsenic (As)-Total (mg/L)					
	Barium (Ba)-Total (mg/L)					
	Beryllium (Be)-Total (mg/L)					
	Bismuth (Bi)-Total (mg/L)					
	Boron (B)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Calcium (Ca)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)	0.353	0.728	0.0418	0.0907	0.179
	Cobalt (Co)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Lithium (Li)-Total (mg/L)					
	Magnesium (Mg)-Total (mg/L)					
	Manganese (Mn)-Total (mg/L)					
	Molybdenum (Mo)-Total (mg/L)					
	Nickel (Ni)-Total (mg/L)					
	Phosphorus (P)-Total (mg/L)					
	Potassium (K)-Total (mg/L)					
	Selenium (Se)-Total (mg/L)					
	Silicon (Si)-Total (mg/L)					
	Silver (Ag)-Total (mg/L)					
	Sodium (Na)-Total (mg/L)					
	Strontium (Sr)-Total (mg/L)					
	Thallium (Tl)-Total (mg/L)					
	Tin (Sn)-Total (mg/L)					
	Titanium (Ti)-Total (mg/L)					
	Uranium (U)-Total (mg/L)					
	Vanadium (V)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)					
	Antimony (Sb)-Dissolved (mg/L)					
	Arsenic (As)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1480117-21	L1480117-22	L1480117-23	L1480117-24	L1480117-25
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14
	Sampled Time					
	Client ID	350 UG/L CR (MH04)	700 UG/L CR (MH04)	62.5 UG/L PB (LAB)	125 UG/L PB (LAB)	250 UG/L PB (LAB)
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)					
	Antimony (Sb)-Total (mg/L)					
	Arsenic (As)-Total (mg/L)					
	Barium (Ba)-Total (mg/L)					
	Beryllium (Be)-Total (mg/L)					
	Bismuth (Bi)-Total (mg/L)					
	Boron (B)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Calcium (Ca)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)	0.367	0.717			
	Cobalt (Co)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)			0.0409	0.0772	0.156
	Lithium (Li)-Total (mg/L)					
	Magnesium (Mg)-Total (mg/L)					
	Manganese (Mn)-Total (mg/L)					
	Molybdenum (Mo)-Total (mg/L)					
	Nickel (Ni)-Total (mg/L)					
	Phosphorus (P)-Total (mg/L)					
	Potassium (K)-Total (mg/L)					
	Selenium (Se)-Total (mg/L)					
	Silicon (Si)-Total (mg/L)					
	Silver (Ag)-Total (mg/L)					
	Sodium (Na)-Total (mg/L)					
	Strontium (Sr)-Total (mg/L)					
	Thallium (Tl)-Total (mg/L)					
	Tin (Sn)-Total (mg/L)					
	Titanium (Ti)-Total (mg/L)					
	Uranium (U)-Total (mg/L)					
	Vanadium (V)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)					
	Antimony (Sb)-Dissolved (mg/L)					
	Arsenic (As)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480117-26	L1480117-27	L1480117-28	L1480117-29	L1480117-30
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14
	Sampled Time					
	Client ID	500 UG/L PB (LAB)	1000 UG/L PB (LAB)	62.5 UG/L PB (MH04)	125 UG/L PB (MH04)	250 UG/L PB (MH04)
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)					
	Antimony (Sb)-Total (mg/L)					
	Arsenic (As)-Total (mg/L)					
	Barium (Ba)-Total (mg/L)					
	Beryllium (Be)-Total (mg/L)					
	Bismuth (Bi)-Total (mg/L)					
	Boron (B)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Calcium (Ca)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Cobalt (Co)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)	0.343	0.417	0.0446	0.0822	0.164
	Lithium (Li)-Total (mg/L)					
	Magnesium (Mg)-Total (mg/L)					
	Manganese (Mn)-Total (mg/L)					
	Molybdenum (Mo)-Total (mg/L)					
	Nickel (Ni)-Total (mg/L)					
	Phosphorus (P)-Total (mg/L)					
	Potassium (K)-Total (mg/L)					
	Selenium (Se)-Total (mg/L)					
	Silicon (Si)-Total (mg/L)					
	Silver (Ag)-Total (mg/L)					
	Sodium (Na)-Total (mg/L)					
	Strontium (Sr)-Total (mg/L)					
	Thallium (Tl)-Total (mg/L)					
	Tin (Sn)-Total (mg/L)					
	Titanium (Ti)-Total (mg/L)					
	Uranium (U)-Total (mg/L)					
	Vanadium (V)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)					
	Antimony (Sb)-Dissolved (mg/L)					
	Arsenic (As)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1480117-31 Water 01-JUL-14 500 UG/L PB (MH04)	L1480117-32 Water 01-JUL-14 1000 UG/L PB (MH04)			
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)					
	Antimony (Sb)-Total (mg/L)					
	Arsenic (As)-Total (mg/L)					
	Barium (Ba)-Total (mg/L)					
	Beryllium (Be)-Total (mg/L)					
	Bismuth (Bi)-Total (mg/L)					
	Boron (B)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Calcium (Ca)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Cobalt (Co)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)	0.303	0.693			
	Lithium (Li)-Total (mg/L)					
	Magnesium (Mg)-Total (mg/L)					
	Manganese (Mn)-Total (mg/L)					
	Molybdenum (Mo)-Total (mg/L)					
	Nickel (Ni)-Total (mg/L)					
	Phosphorus (P)-Total (mg/L)					
	Potassium (K)-Total (mg/L)					
	Selenium (Se)-Total (mg/L)					
	Silicon (Si)-Total (mg/L)					
	Silver (Ag)-Total (mg/L)					
	Sodium (Na)-Total (mg/L)					
	Strontium (Sr)-Total (mg/L)					
	Thallium (Tl)-Total (mg/L)					
	Tin (Sn)-Total (mg/L)					
	Titanium (Ti)-Total (mg/L)					
	Uranium (U)-Total (mg/L)					
	Vanadium (V)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB			
	Aluminum (Al)-Dissolved (mg/L)					
	Antimony (Sb)-Dissolved (mg/L)					
	Arsenic (As)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480117-1	L1480117-2	L1480117-3	L1480117-4	L1480117-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14
	Sampled Time					
	Client ID	160MG/L HARDNESS CTRL	MH-04 SITE CTRL	6.25 MG/L FE (LAB)	12.5 MG/L FE (LAB)	25 MG/L FE (LAB)
Grouping	**Analyte**					
WATER						
Dissolved Metals	Barium (Ba)-Dissolved (mg/L)	0.0144	0.0204			
	Beryllium (Be)-Dissolved (mg/L)	<0.00050	<0.00050			
	Bismuth (Bi)-Dissolved (mg/L)	<0.00050	<0.00050			
	Boron (B)-Dissolved (mg/L)	0.025	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	<0.000050	0.000228			
	Calcium (Ca)-Dissolved (mg/L)	48.3	56.9			
	Chromium (Cr)-Dissolved (mg/L)	<0.00050	<0.00050			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	<0.00050	<0.00050			
	Iron (Fe)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Dissolved (mg/L)	<0.000050	0.000212			
	Lithium (Li)-Dissolved (mg/L)	<0.0050	<0.0050			
	Magnesium (Mg)-Dissolved (mg/L)	2.11	2.65			
	Manganese (Mn)-Dissolved (mg/L)	0.000055	0.000384			
	Molybdenum (Mo)-Dissolved (mg/L)	0.000534	0.000625			
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050			
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30			
	Potassium (K)-Dissolved (mg/L)	<2.0	<2.0			
	Selenium (Se)-Dissolved (mg/L)	<0.0010	<0.0010			
	Silicon (Si)-Dissolved (mg/L)	2.07	2.72			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	4.8	<2.0			
	Strontium (Sr)-Dissolved (mg/L)	0.273	0.175			
	Thallium (Tl)-Dissolved (mg/L)	<0.00010	<0.00010			
	Tin (Sn)-Dissolved (mg/L)	0.00049	0.00057			
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010			
	Uranium (U)-Dissolved (mg/L)	0.00124	0.000645			
	Vanadium (V)-Dissolved (mg/L)	<0.0010	<0.0010			
	Zinc (Zn)-Dissolved (mg/L)	<0.0030	0.0057			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480117-6	L1480117-7	L1480117-8	L1480117-9	L1480117-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14
	Sampled Time					
	Client ID	50 MG/L FE (LAB)	100 MG/L FE (LAB)	6.25 MG/L FE (MH-04)	12.5 MG/L FE (MH-04)	25 MG/L FE (MH-04)
Grouping	**Analyte**					
WATER						
Dissolved Metals	Barium (Ba)-Dissolved (mg/L)					
	Beryllium (Be)-Dissolved (mg/L)					
	Bismuth (Bi)-Dissolved (mg/L)					
	Boron (B)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Calcium (Ca)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)					
	Cobalt (Co)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)	<0.030	37.8	<0.030	<0.030	<0.030
	Lead (Pb)-Dissolved (mg/L)					
	Lithium (Li)-Dissolved (mg/L)					
	Magnesium (Mg)-Dissolved (mg/L)					
	Manganese (Mn)-Dissolved (mg/L)					
	Molybdenum (Mo)-Dissolved (mg/L)					
	Nickel (Ni)-Dissolved (mg/L)					
	Phosphorus (P)-Dissolved (mg/L)					
	Potassium (K)-Dissolved (mg/L)					
	Selenium (Se)-Dissolved (mg/L)					
	Silicon (Si)-Dissolved (mg/L)					
	Silver (Ag)-Dissolved (mg/L)					
	Sodium (Na)-Dissolved (mg/L)					
	Strontium (Sr)-Dissolved (mg/L)					
	Thallium (Tl)-Dissolved (mg/L)					
	Tin (Sn)-Dissolved (mg/L)					
	Titanium (Ti)-Dissolved (mg/L)					
	Uranium (U)-Dissolved (mg/L)					
	Vanadium (V)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480117-11	L1480117-12	L1480117-13	L1480117-14	L1480117-15
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14
	Sampled Time					
	Client ID	50 MG/L FE (MH-04)	100 MG/L FE (MH-04)	43.75 UG/L CR (LAB)	87.5 UG/L CR (LAB)	175 UG/L CR (LAB)
Grouping	**Analyte**					
WATER						
Dissolved Metals	Barium (Ba)-Dissolved (mg/L)					
	Beryllium (Be)-Dissolved (mg/L)					
	Bismuth (Bi)-Dissolved (mg/L)					
	Boron (B)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Calcium (Ca)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)			0.0424	0.0877	0.172
	Cobalt (Co)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)	<0.030	23.6			
	Lead (Pb)-Dissolved (mg/L)					
	Lithium (Li)-Dissolved (mg/L)					
	Magnesium (Mg)-Dissolved (mg/L)					
	Manganese (Mn)-Dissolved (mg/L)					
	Molybdenum (Mo)-Dissolved (mg/L)					
	Nickel (Ni)-Dissolved (mg/L)					
	Phosphorus (P)-Dissolved (mg/L)					
	Potassium (K)-Dissolved (mg/L)					
	Selenium (Se)-Dissolved (mg/L)					
	Silicon (Si)-Dissolved (mg/L)					
	Silver (Ag)-Dissolved (mg/L)					
	Sodium (Na)-Dissolved (mg/L)					
	Strontium (Sr)-Dissolved (mg/L)					
	Thallium (Tl)-Dissolved (mg/L)					
	Tin (Sn)-Dissolved (mg/L)					
	Titanium (Ti)-Dissolved (mg/L)					
	Uranium (U)-Dissolved (mg/L)					
	Vanadium (V)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480117-16	L1480117-17	L1480117-18	L1480117-19	L1480117-20
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14
	Sampled Time					
	Client ID	350 UG/L CR (LAB)	700 UG/L CR (LAB)	43.75 UG/L CR(MH04)	87.5 UG/L CR (MH04)	175 UG/L CR (MH04)
Grouping	**Analyte**					
WATER						
Dissolved Metals	Barium (Ba)-Dissolved (mg/L)					
	Beryllium (Be)-Dissolved (mg/L)					
	Bismuth (Bi)-Dissolved (mg/L)					
	Boron (B)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Calcium (Ca)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)	0.0420	0.692	0.0409	0.0883	0.174
	Cobalt (Co)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)					
	Lithium (Li)-Dissolved (mg/L)					
	Magnesium (Mg)-Dissolved (mg/L)					
	Manganese (Mn)-Dissolved (mg/L)					
	Molybdenum (Mo)-Dissolved (mg/L)					
	Nickel (Ni)-Dissolved (mg/L)					
	Phosphorus (P)-Dissolved (mg/L)					
	Potassium (K)-Dissolved (mg/L)					
	Selenium (Se)-Dissolved (mg/L)					
	Silicon (Si)-Dissolved (mg/L)					
	Silver (Ag)-Dissolved (mg/L)					
	Sodium (Na)-Dissolved (mg/L)					
	Strontium (Sr)-Dissolved (mg/L)					
	Thallium (Tl)-Dissolved (mg/L)					
	Tin (Sn)-Dissolved (mg/L)					
	Titanium (Ti)-Dissolved (mg/L)					
	Uranium (U)-Dissolved (mg/L)					
	Vanadium (V)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480117-21	L1480117-22	L1480117-23	L1480117-24	L1480117-25
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14
	Sampled Time					
	Client ID	350 UG/L CR (MH04)	700 UG/L CR (MH04)	62.5 UG/L PB (LAB)	125 UG/L PB (LAB)	250 UG/L PB (LAB)
Grouping	**Analyte**					
WATER						
Dissolved Metals	Barium (Ba)-Dissolved (mg/L)					
	Beryllium (Be)-Dissolved (mg/L)					
	Bismuth (Bi)-Dissolved (mg/L)					
	Boron (B)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Calcium (Ca)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)	0.355	0.728			
	Cobalt (Co)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)			0.0301	0.0758	0.148
	Lithium (Li)-Dissolved (mg/L)					
	Magnesium (Mg)-Dissolved (mg/L)					
	Manganese (Mn)-Dissolved (mg/L)					
	Molybdenum (Mo)-Dissolved (mg/L)					
	Nickel (Ni)-Dissolved (mg/L)					
	Phosphorus (P)-Dissolved (mg/L)					
	Potassium (K)-Dissolved (mg/L)					
	Selenium (Se)-Dissolved (mg/L)					
	Silicon (Si)-Dissolved (mg/L)					
	Silver (Ag)-Dissolved (mg/L)					
	Sodium (Na)-Dissolved (mg/L)					
	Strontium (Sr)-Dissolved (mg/L)					
	Thallium (Tl)-Dissolved (mg/L)					
	Tin (Sn)-Dissolved (mg/L)					
	Titanium (Ti)-Dissolved (mg/L)					
	Uranium (U)-Dissolved (mg/L)					
	Vanadium (V)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480117-26	L1480117-27	L1480117-28	L1480117-29	L1480117-30
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14	01-JUL-14
	Sampled Time					
	Client ID	500 UG/L PB (LAB)	1000 UG/L PB (LAB)	62.5 UG/L PB (MH04)	125 UG/L PB (MH04)	250 UG/L PB (MH04)
Grouping	**Analyte**					
WATER						
Dissolved Metals	Barium (Ba)-Dissolved (mg/L)					
	Beryllium (Be)-Dissolved (mg/L)					
	Bismuth (Bi)-Dissolved (mg/L)					
	Boron (B)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Calcium (Ca)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)					
	Cobalt (Co)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)	0.246	0.279	0.0423	0.0795	0.156
	Lithium (Li)-Dissolved (mg/L)					
	Magnesium (Mg)-Dissolved (mg/L)					
	Manganese (Mn)-Dissolved (mg/L)					
	Molybdenum (Mo)-Dissolved (mg/L)					
	Nickel (Ni)-Dissolved (mg/L)					
	Phosphorus (P)-Dissolved (mg/L)					
	Potassium (K)-Dissolved (mg/L)					
	Selenium (Se)-Dissolved (mg/L)					
	Silicon (Si)-Dissolved (mg/L)					
	Silver (Ag)-Dissolved (mg/L)					
	Sodium (Na)-Dissolved (mg/L)					
	Strontium (Sr)-Dissolved (mg/L)					
	Thallium (Tl)-Dissolved (mg/L)					
	Tin (Sn)-Dissolved (mg/L)					
	Titanium (Ti)-Dissolved (mg/L)					
	Uranium (U)-Dissolved (mg/L)					
	Vanadium (V)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1480117-31	L1480117-32			
	Description	Water	Water			
	Sampled Date	01-JUL-14	01-JUL-14			
	Sampled Time					
	Client ID	500 UG/L PB (MH04)	1000 UG/L PB (MH04)			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Barium (Ba)-Dissolved (mg/L)					
	Beryllium (Be)-Dissolved (mg/L)					
	Bismuth (Bi)-Dissolved (mg/L)					
	Boron (B)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Calcium (Ca)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)					
	Cobalt (Co)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)	0.285	0.663			
	Lithium (Li)-Dissolved (mg/L)					
	Magnesium (Mg)-Dissolved (mg/L)					
	Manganese (Mn)-Dissolved (mg/L)					
	Molybdenum (Mo)-Dissolved (mg/L)					
	Nickel (Ni)-Dissolved (mg/L)					
	Phosphorus (P)-Dissolved (mg/L)					
	Potassium (K)-Dissolved (mg/L)					
	Selenium (Se)-Dissolved (mg/L)					
	Silicon (Si)-Dissolved (mg/L)					
	Silver (Ag)-Dissolved (mg/L)					
	Sodium (Na)-Dissolved (mg/L)					
	Strontium (Sr)-Dissolved (mg/L)					
	Thallium (Tl)-Dissolved (mg/L)					
	Tin (Sn)-Dissolved (mg/L)					
	Titanium (Ti)-Dissolved (mg/L)					
	Uranium (U)-Dissolved (mg/L)					
	Vanadium (V)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1480117-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-DIS-ICP-VA	Water	Dissolved Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-DIS-LOW-MS-VA	Water	Dissolved Metals in Water by ICPMS(Low)	EPA SW-846 3005A/6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures involves preliminary sample treatment by filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TOT-LOW-MS-VA	Water	Total Metals in Water by ICPMS(Low)	EPA SW-846 3005A/6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

L1480117-COFC

pg 1 of 4

Sample Collection By:	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Krysta Pearcy	Krysta Pearcy
Phone	604-420-8773	604-420-8773
Email	krysta@nautilusenvironmental.com	krysta@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Metals	Dissolved Metals	Total Fe	Dissolved Fe	Receipt Temperature (°C)
1	100 mg/L Hardness Ctrl	July 1/14	—	—	125mL	2	Dissolved sub sample filtered	X	X			
2	MH-04 Site Ctrl							X	X			
3	6.25 mg/L Fe (lab)									X	X	
4	12.5 mg/L Fe (lab)									X	X	
5	25 mg/L Fe (lab)									X	X	
6	50 mg/L Fe (lab)									X	X	
7	100 mg/L Fe (lab)									X	X	
8	6.25 mg/L Fe (MH-04)									X	X	
9	12.5 mg/L Fe (MH-04)									X	X	
10	25 mg/L Fe (MH-04)									X	X	

PROJECT INFORMATION	SAMPLE RECEIPT	
Client:	Total # Containers:	
P.O. No.:	Good Condition?	
Shipped Via:	Matches Schedule?	

RELIQUINSHED BY (CLIENT)
Signature:
Print:
Company:
Time/Date:

RELIQUINSHED BY (COURIER)
Signature:
Print:
Company:
Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:
Samples not preserved.
Samples for dissolved filtered through 0.45 um.

Signature: KPearcy
Print: Krysta Pearcy
Company: Nautilus Environmental
Time/Date: July 2/14 @ 1700h

RECEIVED BY (LABORATORY)
Signature: Doren
Print: 18°C
Company: Nautilus Environmental
Time/Date: July 2 1900

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

L1480117-COFC

Pg 2 of 4

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Krysta Pearcy	Krysta Pearcy
Phone	604-420-8773	604-420-8773
Email	krysta@nautilusenvironmental.com	krysta@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Fe	Dissolved Fe	Total Cr	Dissolved Cr										Receipt Temperature (°C)
1	50 mg/L Fe (MH-04)	July 1/14	—	—	125 mL	2	Dissolved sub sample filtered	X	X												
2	100 mg/L Fe (MH-04)							X	X												
3	43.75 µg/L Cr (lab)									X	X										
4	87.5 µg/L Cr (lab)									X	X										
5	175 µg/L Cr (lab)									X	X										
6	350 µg/L Cr (lab)									X	X										
7	700 µg/L Cr (lab)									X	X										
8	43.75 µg/L Cr (MH04)									X	X										
9	87.5 µg/L Cr (MH04)									X	X										
10	175 µg/L Cr (MH04)									X	X										

PROJECT INFORMATION	SAMPLE RECEIPT		RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:	Total # Containers:		Signature:	Signature:
P.O. No.:	Good Condition?		Print:	Print:
Shipped Via:	Matches Schedule?		Company:	Company:
			Time/Date:	Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:

Samples not preserved.
Samples for dissolved filtered through 0.45 µm

	RECEIVED BY (LABORATORY)
Signature: KPearcy	Signature: [signature]
Print: Krysta Pearcy	Print: 18°C
Company: Nautilus Environmental	Company: Nautilus Environmental
Time/Date: July 2/14 @ 17:00h	Time/Date: July 2 1900

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

Nautilus Environmental

Chain of Custody (electronic)

Pg 3 of 4

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

L1480117-COFC

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Krysta Pearcy	Krysta Pearcy
Phone	604-420-8773	604-420-8773
Email	krysta@nautilusenvironmental.com	krysta@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Cr	Dissolved Cr	Total Pb	Dissolved Pb									Receipt Temperature (°C)
1	350 mg/L Cr (mHo4)	July 1/14	—	—	125 mL	2	Dissolved sample filtered	X	X											
2	700 mg/L Cr (mHo4)							X	X											
3	62.5 mg/L Pb (lab)									X	X									
4	125 mg/L Pb (lab)									X	X									
5	250 mg/L Pb (lab)									X	X									
6	500 mg/L Pb (lab)									X	X									
7	1000 mg/L Pb (lab)									X	X									
8	62.5 mg/L Pb (mHo4)									X	X									
9	125 mg/L Pb (mHo4)									X	X									
10	250 mg/L Pb (mHo4)									X	X									

PROJECT INFORMATION	SAMPLE RECEIPT		RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:	Total # Containers:		Signature:	Signature:
P.O. No.:	Good Condition?		Print:	Print:
Shipped Via:	Matches Schedule?		Company:	Company:
			Time/Date:	Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:

Samples not preserved.

Samples for dissolved filtered through 0.45 µm

	RECEIVED BY (LABORATORY)
Signature: KPearcy	Signature: [signature]
Print: Krysta Pearcy	Print: 18°C
Company: Nautilus Environmental	Company: Nautilus Environmental
Time/Date: July 2/14 @ 1700h	Time/Date: July 2 1900

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

L1480117-COFC

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Krysta Pearcy	Krysta Pearcy
Phone	604-420-8773	604-420-8773
Email	krysta@nautilusenvironmental.com	krysta@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Pb	Dissolved Pb											Receipt Temperature (°C)
1	500 ug/L Pb (mHM)	July 1/14	—	—	125 mL	2	Dissolved subsample filtered	X	X											
2	1000 ug/L Pb (mHM)	↓	↓	↓	↓	↓	↓	X	X											
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				

PROJECT INFORMATION		SAMPLE RECEIPT		RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:		Total # Containers:		Signature:	Signature:
P.O. No.:		Good Condition?		Print:	Print:
Shipped Via:		Matches Schedule?		Company:	Company:
				Time/Date:	Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:

Samples not preserved

Samples for dissolved filtered through 0.45um

	RECEIVED BY (LABORATORY)
Signature: KPearcy	Signature: [illegible]
Print: Nautilus Environmental	Print: Jul/2 1°C
Company: Krysta Pearcy	Company: Nautilus Environmental
Time/Date: July 2/14 @ 1700h	Time/Date: 1900

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 19-AUG-14 13:21 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1500859

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500859-1	L1500859-2	L1500859-3	L1500859-4	L1500859-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	11-JUL-14	11-JUL-14	11-JUL-14	11-JUL-14	11-JUL-14
	Sampled Time					
	Client ID	LAB CONTROL 0 CD	LAB 6.25 CD	LAB 12.5 CD	LAB 25 CD	LAB 50 CD
Grouping	**Analyte**					
WATER						
Total Metals	Cadmium (Cd)-Total (mg/L)	<0.000010	0.00604	0.0125	0.0231	0.0465
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Cadmium (Cd)-Dissolved (mg/L)	<0.000010	0.00346	0.00251	0.0211	0.00411

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500859-6				
	Description	Water				
	Sampled Date	11-JUL-14				
	Sampled Time					
	Client ID	LAB 100 CD				
Grouping	**Analyte**					
WATER						
Total Metals	Cadmium (Cd)-Total (mg/L)	0.0873				
Dissolved Metals	Dissolved Metals Filtration Location	LAB				
	Cadmium (Cd)-Dissolved (mg/L)	0.0875				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Emma Marus	Emma Marus
Phone	604-420-8773	604-420-8773
Email	emma@nautilusenvironmental.com	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Cd (low level)	Dissolved Cd (low level)	Receipt Temperature (°C)
1	Lab Control 0 Cd	July 11/14	-	-	125mL	1	initation	x	x	
2	Lab 6.25		-	-	125mL	1	initation	x	x	
3	Lab 12.5		-	-	125mL	1	initation	x	x	
4	Lab 25		-	-	125mL	1	initation	x	x	
5	Lab 50		-	-	125mL	1	initation	x	x	
6	Lab 100		-	-	125mL	1	initation	x	x	
7			-	-						
8			-	-						
9			-	-						
10			-	-						

L1500859-COFC

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total # Containers:	
P.O. No.:		Good Condition?	
Shipped Via:		Matches Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS:

For total, samples have been preserved.

For dissolved, samples have been filtered and then preserved.

RELIQUINSHED BY (CLIENT)

Signature:

Emma Marus

Company: Nautilus Environmental

Time/Date: Aug 11, 2014 @ 1800h

Signature:

Print:

Company:

Time/Date:

RELIQUINSHED BY (COURIER)

Signature: YC Aug 11 19:00 20.8°C

Print:

Company:

Time/Date:

RECEIVED BY (LABORATORY)

Signature:

Print:

Company: Nautilus Environmental

Time/Date:

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 21-AUG-14 12:29 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: **L1500846**

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1500846-1 WATER 13-JUL-14 LAB CONTRL 0 CD	L1500846-2 WATER 13-JUL-14 LAB 6.25 CD	L1500846-3 WATER 13-JUL-14 LAB 12.5 CD	L1500846-4 WATER 13-JUL-14 LAB 25 CD	L1500846-5 WATER 13-JUL-14 LAB 50 CD
Grouping	**Analyte**					
WATER						
Total Metals	Cadmium (Cd)-Total (mg/L)	0.000029	0.00155	0.00304	0.00603	0.0102

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500846-6				
	Description	WATER				
	Sampled Date	13-JUL-14				
	Sampled Time					
	Client ID	LAB 100 CD				
Grouping	**Analyte**					
WATER						
Total Metals	Cadmium (Cd)-Total (mg/L)	0.0223				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Emma Marus	Emma Marus
Phone	604-420-8773	604-420-8773
Email	emma@nautilusenvironmental.com	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Cd (low level)	Receipt Temperature (°C)
1	Lab Control OCd	July 13/14	-	-	125mL	1	termination	x	
2	Lab 6.25		-	-	125mL	1	termination	x	
3	Lab 12.5		-	-	125mL	1	termination	x	
4	Lab 25		-	-	125mL	1	termination	x	
5	Lab 50		-	-	125mL	1	termination	x	
6	Lab 100		-	-	125mL	1	termination	x	
7			-	-					
8			-	-					
9			-	-					
10			-	-					

L1500846-COFC

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total # Containers:	
P.O. No.:		Good Condition?	
Shipped Via:		Matches Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS:

For total, samples have been preserved.

RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Signature:	Signature: VC Aug 11 1930 20.8°C
Emma Marus	Print:
Company: Nautilus Environmental	Company:
Time/Date: Aug 11, 2014 @ 1800h	Time/Date:
	RECEIVED BY (LABORATORY)
Signature:	Signature:
Print:	Print:
Company:	Company: Nautilus Environmental
Time/Date:	Time/Date:

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 19-AUG-14 10:09 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1500813

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID		L1500813-1	L1500813-2	L1500813-3	L1500813-4	L1500813-5
Description		Water	Water	Water	Water	Water
Sampled Date		03-JUL-14	03-JUL-14	03-JUL-14	03-JUL-14	03-JUL-14
Sampled Time						
Client ID		160MG/L LAB CONTROL CR	43.75 LAB CR	87.5 LAB CR	175 LAB CR	350 LAB CR
Grouping	**Analyte**					
WATER						
Total Metals	Chromium (Cr)-Total (mg/L)	<0.00010	0.0427	0.0922	0.182	0.362

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1500813-6 Water 03-JUL-14 700 LAB CR				
Grouping	**Analyte**					
WATER						
Total Metals	Chromium (Cr)-Total (mg/L)	0.737				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Emma Marus	Emma Marus
Phone	604-420-8773	604-420-8773
Email	emma@nautilusenvironmental.com	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Cr (low level)	Receipt Temperature (°C)
1	160mg/L Lab Control Cr	July 3/14	-	-	125mL	1	termination	x	
2	~~700~~ 43.75 Lab		-	-	125mL	1	termination	x	
3	87.5 Lab		-	-	125mL	1	termination	x	
4	175 Lab		-	-	125mL	1	termination	x	
5	350 Lab		-	-	125mL	1	termination	x	
6	700 Lab		-	-	125mL	1	termination	x	
7			-	-					
8			-	-					
9			-	-					
10			-	-					

L1500813-COFC

PROJECT INFORMATION	SAMPLE RECEIPT	RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:	Total # Containers:	Signature:	Signature: VL Aug 11 19:05 20.8°C
P.O. No.:	Good Condition?	Emma Marus	Print:
Shipped Via:	Matches Schedule?	Company: Nautilus Environmental	Company:
		Time/Date: Aug 11, 2014 @ 1800h	Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:		RECEIVED BY (LABORATORY)
	Signature:	Signature:
	Print:	Print:
For total, samples have been preserved.	Company:	Company: Nautilus Environmental
	Time/Date:	Time/Date:

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 19-AUG-14 10:51 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1500896

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500896-1	L1500896-2	L1500896-3	L1500896-4	L1500896-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	11-JUL-14	11-JUL-14	11-JUL-14	11-JUL-14	11-JUL-14
	Sampled Time					
	Client ID	LAB CONTROL 0 CU	LAB 1.56 CU	LAB 3.13 CU	LAB 6.25 CU	LAB 12.5 CU
Grouping	**Analyte**					
WATER						
Total Metals	Copper (Cu)-Total (mg/L)	0.00079	0.00315	0.00331	0.00591	0.0108
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Copper (Cu)-Dissolved (mg/L)	0.00093	0.00133	0.00256	0.00562	0.00975

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500896-6				
	Description	Water				
	Sampled Date	11-JUL-14				
	Sampled Time					
	Client ID	LAB 25 CU				
Grouping	**Analyte**					
WATER						
Total Metals	Copper (Cu)-Total (mg/L)	0.0228				
Dissolved Metals	Dissolved Metals Filtration Location	FIELD				
	Copper (Cu)-Dissolved (mg/L)	0.0211				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Emma Marus	Emma Marus
Phone	604-420-8773	604-420-8773
Email	emma@nautilusenvironmental.com	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Cu (low level)	Dissolved Cu (low level)										Receipt Temperature (°C)
1	Lab Control 0 Cu	July 11/14	-	-	125mL	1	initation	x	x										
2	Lab 1.56		-	-	125mL	1	initation	x	x										
3	Lab 3.13		-	-	125mL	1	initation	x	x										
4	Lab 6.25		-	-	125mL	1	initation	x	x										
5	Lab 12.5		-	-	125mL	1	initation	x	x										
6	Lab 25		-	-	125mL	1	initation	x	x										
7			-	-															
8			-	-															
9			-	-															
10			-	-															

L1500896-COFC

PROJECT INFORMATION	SAMPLE RECEIPT		RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:	**Total # Containers:**		**Signature:**	**Signature:**
P.O. No.:	**Good Condition?**		**Emma Marus**	**Print:**
Shipped Via:	**Matches Schedule?**		**Company: Nautilus Environmental**	**Company:**
			Time/Date: Aug 11, 2014 @ 1800h	**Time/Date:**
SPECIAL INSTRUCTIONS/COMMENTS:				**RECEIVED BY (LABORATORY)**
			Signature:	**Signature:** YC Aug 11 19:50 20.8°C
For total, samples have been preserved.			**Print:**	**Print:**
For dissolved, samples have been filtered and then preserved.			**Company:**	**Company: Nautilus Environmental**
			Time/Date:	**Time/Date:**

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 29-AUG-14 11:07 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: **L1500939**

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500939-1	L1500939-2	L1500939-3	L1500939-4	L1500939-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	13-JUL-14	13-JUL-14	13-JUL-14	13-JUL-14	13-JUL-14
	Sampled Time					
	Client ID	LAB CONTROL 0 CU	LAB 1.56 CU	LAB 3.13 CU	LAB 6.25 CU	LAB 12.5 CU
Grouping	**Analyte**					
WATER						
Total Metals	Copper (Cu)-Total (mg/L)	<0.00050	0.00104	0.00188	0.00333	0.00587

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500939-6				
	Description	Water				
	Sampled Date	13-JUL-14				
	Sampled Time					
	Client ID	LAB 25.0 CU				
Grouping	**Analyte**					
WATER						
Total Metals	Copper (Cu)-Total (mg/L)	0.0125				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Emma Marus	Emma Marus
Phone	604-420-8773	604-420-8773
Email	emma@nautilusenvironmental.com	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Cu (low level)	Receipt Temperature (°C)
1	Lab Control 0 Cu	July 13/14	-	-	125mL	1	termination	x	
2	Lab 1.56		-	-	125mL	1	termination	x	
3	Lab 3.13		-	-	125mL	1	termination	x	
4	Lab 6.25		-	-	125mL	1	termination	x	
5	Lab 12.5		-	-	125mL	1	termination	x	
6	Lab 25.0		-	-	125mL	1	termination	x	
7			-	-					
8			-	-					
9			-	-					
10			-	-					

L1500939-COFC

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		**Total # Containers:**	
P.O. No.:		**Good Condition?**	
Shipped Via:		**Matches Schedule?**	

RELIQUINSHED BY (CLIENT)
Signature:
Emma Marus
Company: Nautilus Environmental
Time/Date: Aug 11, 2014 @ 1800h

RELIQUINSHED BY (COURIER)
Signature:
Print:
Company:
Time/Date:

RECEIVED BY (LABORATORY)
Signature: Aug 11 19:50 20.8°C
Print:
Company: Nautilus Environmental
Time/Date:

Signature:
Print:
Company:
Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:

For total, samples have been preserved.

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 21-AUG-14 14:00 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1500948

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500948-1	L1500948-2	L1500948-3	L1500948-4	L1500948-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	16-JUL-14	16-JUL-14	16-JUL-14	16-JUL-14	16-JUL-14
	Sampled Time					
	Client ID	LAB CONTROL 0 FE	LAB 2.5 FE	LAB 5.0 FE	LAB 10.0 FE	LAB 20.0 FE
Grouping	**Analyte**					
WATER						
Total Metals	Iron (Fe)-Total (mg/L)	<0.010	1.85	3.46	6.09	9.08
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Iron (Fe)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500948-6
	Description	WATER
	Sampled Date	16-JUL-14
	Sampled Time	
	Client ID	LAB 40.0 FE
Grouping	**Analyte**	
WATER		
Total Metals	Iron (Fe)-Total (mg/L)	40.2
Dissolved Metals	Dissolved Metals Filtration Location	FIELD
	Iron (Fe)-Dissolved (mg/L)	6.14

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental ①

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Emma Marus	Emma Marus
Phone	604-420-8773	604-420-8773
Email	emma@nautilusenvironmental.com	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total ~~Cd~~ Fe low level → preserved	Dissolved ~~Cd~~ Fe low level → filtered + persevered	Receipt Temperature (°C)
1	Lab Control 0 Fe	July16/14	-	-	125mL	1	initiation	X	X	
2	lab ~~6.75~~ 2.5 Fe	↓	-	-	↓	1	↓	X	X	
3	lab ~~12.5~~ 5.0 Fe		-	-		1		X	X	
4	Lab ~~25~~ 10.0 Fe		-	-		1		X	X	
5	Lab ~~50~~ 20.0 Fe		-	-		1		X	X	
6	Lab ~~100~~ 40.0 Fe		-	-		1		X	X	
7			-	-				~~X~~	~~X~~	
8			-	-						
9			-	-						
10			-	-						

L1500948-COFC

PROJECT INFORMATION	SAMPLE RECEIPT		RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:	Total # Containers:		Signature: [signature]	Signature:
P.O. No.:	Good Condition?		Print: Emma Marus	Print:
Shipped Via:	Matches Schedule?		Company: ①	Company:
			Time/Date: Aug 11/14 @ 1800h	Time/Date:

	RECEIVED BY (LABORATORY)
Signature:	Signature: YC Aug 11 19:00 20.8°
Print:	Print:
Company:	Company: Nautilus Environmental
Time/Date:	Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:

For total ~~Cd~~ Fe, sample persevered.
for dissolved ~~Cd~~ Fe, sample filtered + persevered

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 21-AUG-14 12:55 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: **L1500888**

Project P.O. #: NOT SUBMITTED

Job Reference:

C of C Numbers:

Legal Site Desc:

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500888-1	L1500888-2	L1500888-3	L1500888-4	L1500888-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	18-JUL-14	18-JUL-14	18-JUL-14	18-JUL-14	18-JUL-14
	Sampled Time					
	Client ID	LAB CONTROL 0 FE	LAB 2.5 FE	LAB 5.0 FE	LAB 10.0 FE	LAB 20.0 FE
Grouping	**Analyte**					
WATER						
Total Metals	Iron (Fe)-Total (mg/L)	0.049	0.929	3.84	9.08	18.1

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500888-6				
	Description	Water				
	Sampled Date	18-JUL-14				
	Sampled Time					
	Client ID	LAB 40.0 FE				
Grouping	**Analyte**					
WATER						
Total Metals	Iron (Fe)-Total (mg/L)	37.0				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Emma Marus	Emma Marus
Phone	604-420-8773	604-420-8773
Email	emma@nautilusenvironmental.com	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Fe (low level)	Receipt Temperature (°C)
1	Lab Control 0 Fe	July18/14	-	-	125mL	1	termination	x	
2	Lab 2.5 Fe	↓	-	-	125mL	1	termination	x	
3	Lab 5.0 Fe		-	-	125mL	1	termination	x	
4	Lab 10.0 Fe		-	-	125mL	1	termination	x	
5	Lab 20.0 Fe		-	-	125mL	1	termination	x	
6	Lab 40.0 Fe		-	-	125mL	1	termination	x	
7			-	-					
8			-	-					
9			-	-					
10			-	-					

L1500888-COFC

PROJECT INFORMATION	SAMPLE RECEIPT		RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:	Total # Containers:		Signature:	Signature:
P.O. No.:	Good Condition?		Emma Marus	Print:
Shipped Via:	Matches Schedule?		Company: Nautilus Environmental	Company:
			Time/Date: Aug 11, 2014 @ 1800h	Time/Date:

	RECEIVED BY (LABORATORY)
Signature:	Signature: VL Aug 11 19:00 20.8°C
Print:	Print:
Company:	Company: Nautilus Environmental
Time/Date:	Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:

For total, samples have been preserved.

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 21-AUG-14 13:45 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1500827

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1500827-1 Water 03-JUL-14 LAB CONTROL 0 PB	L1500827-2 Water 03-JUL-14 LAB 62.5 PB	L1500827-3 Water 03-JUL-14 LAB 125 PB	L1500827-4 Water 03-JUL-14 LAB 250 PB	L1500827-5 Water 03-JUL-14 LAB 500 PB
Grouping	**Analyte**					
WATER						
Total Metals	Lead (Pb)-Total (mg/L)	0.00479	0.0163	0.0464	0.110	0.259

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500827-6				
	Description	Water				
	Sampled Date	03-JUL-14				
	Sampled Time					
	Client ID	LAB 1000 PB				
Grouping	**Analyte**					
WATER						
Total Metals	Lead (Pb)-Total (mg/L)	0.241				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

TESTING LOCATION (Please Circle)

Chain of Custody

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773

Date_______ Page___of___

Sample Collection By:

Report to:		Invoice To:	
Company	Nautilus Environmental	Company	Nautilus Environmental
Address	8664 Commerce Court	Address	8664 Commerce Court
City/State/Zip	Burnaby, BC, V5A 4N3	City/State/Zip	Burnaby, BC, V5A 4N3
Contact	Emma Marus	Contact	Emma Marus
Phone	604-420-8773	Phone	604-420-8773
Email	emma@nautilusenvironmental.com	Email	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	~~Total Metals~~ Total Pb (low level)	Receipt Temperature (°C)
1	Lab Control 0 Pb	July 3/14	–	–	125mL	1	Termination	X	
2	Lab 62.5 Pb	July 3/14	–	–	125mL	1	Termination	X	
3	Lab 125 Pb	July 3/14	–	–	125mL	1	Termination	X	
4	Lab 250 Pb	July 3/14	–	–	125mL	1	Termination	X	
5	Lab 500 Pb	July 3/14	–	–	125mL	1	Termination	X	
6	Lab 1000 Pb	July 3/14	–	–	125mL	1	Termination	X	
7									
8									
9									
10									

L1500827-COFC

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:		Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Samples ARE preserved.

RELINQUISHED BY (CLIENT)
(Signature) (Time)
(Printed Name) Emma Marus (Date)
(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (LABORATORY)
(Signature) (Time)
(Printed Name) YC Aug 11 19:50 2015 (Date)
(Company)

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 19-AUG-14 15:37 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1500798

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500798-1	L1500798-2	L1500798-3	L1500798-4	L1500798-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	03-JUL-14	03-JUL-14	03-JUL-14	03-JUL-14	03-JUL-14
	Sampled Time					
	Client ID	SITE CR CONTROL	SITE CR 43.75	SITE CR 87.5	SITE CR 175	SITE CR 350
Grouping	**Analyte**					
WATER						
Total Metals	Chromium (Cr)-Total (mg/L)	0.00026	0.0420	0.0918	0.183	0.339

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500798-6				
	Description	Water				
	Sampled Date	03-JUL-14				
	Sampled Time					
	Client ID	SITE CR 700				
Grouping	**Analyte**					
WATER						
Total Metals	Chromium (Cr)-Total (mg/L)	0.751				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Emma Marus	Emma Marus
Phone	604-420-8773	604-420-8773
Email	emma@nautilusenvironmental.com	emma@nautilusenvironmental.com

ANALYSES REQUIRED

L1500798-COFC

	SAMPLE ID (MH04 = Site)	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Cr (low level)	Receipt Temperature (°C)
1	Site Cr ~~Lab~~ Control	July 3/14	-	-	125mL	1	termination	x	
2	Site Cr ~~Lab~~ 43.75		-	-	125mL	1	termination	x	
3	~~Lab~~ 87.5		-	-	125mL	1	termination	x	
4	~~Lab~~ 175		-	-	125mL	1	termination	x	
5	~~Lab~~ 350		-	-	125mL	1	termination	x	
6	~~Lab~~ 700		-	-	125mL	1	termination	x	
7			-	-					
8			-	-					
9			-	-					
10			-	-					

PROJECT INFORMATION	SAMPLE RECEIPT	
Client:	Total # Containers:	
P.O. No.:	Good Condition?	
Shipped Via:	Matches Schedule?	

RELIQUINSHED BY (CLIENT)

Signature:

Emma Marus

Company: Nautilus Environmental

Time/Date: Aug 11, 2014 @ 1800h

Signature:

Print:

Company:

Time/Date:

RELIQUINSHED BY (COURIER)

Signature: YC Aug 11 19:00 2.8°C

Print:

Company:

Time/Date:

RECEIVED BY (LABORATORY)

Signature:

Print:

Company: Nautilus Environmental

Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:

For total, samples have been preserved.

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 19-AUG-14 14:38 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1500908

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500908-1	L1500908-2	L1500908-3	L1500908-4	L1500908-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	11-JUL-14	11-JUL-14	11-JUL-14	11-JUL-14	11-JUL-14
	Sampled Time					
	Client ID	SITE CONTROL 0 CU	SITE 1.56 CU	SITE 3.13 CU	SITE 6.25 CU	SITE 12.5 CU
Grouping	**Analyte**					
WATER						
Total Metals	Copper (Cu)-Total (mg/L)	0.00100	0.00297	0.00470	0.00889	0.0158
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Copper (Cu)-Dissolved (mg/L)	0.00043	0.00180	0.00297	0.00588	0.0112

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500908-6				
	Description	Water				
	Sampled Date	11-JUL-14				
	Sampled Time					
	Client ID	SITE 25 CU				
Grouping	**Analyte**					
WATER						
Total Metals	Copper (Cu)-Total (mg/L)	0.0288				
Dissolved Metals	Dissolved Metals Filtration Location	FIELD				
	Copper (Cu)-Dissolved (mg/L)	0.0239				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

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UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Emma Marus	Emma Marus
Phone	604-420-8773	604-420-8773
Email	emma@nautilusenvironmental.com	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Cu (low level)	Dissolved Cu (low level)	Receipt Temperature (°C)
1	Site Control 0 Cu	July 11/14	-	-	125mL	1	initation	x	x	
2	Site 1.56		-	-	125mL	1	initation	x	x	
3	Site 3.13		-	-	125mL	1	initation	x	x	
4	Site 6.25		-	-	125mL	1	initation	x	x	
5	Site 12.5		-	-	125mL	1	initation	x	x	
6	Site 25		-	-	125mL	1	initation	x	x	
7			-	-						
8			-	-						
9			-	-						
10			-	-						

L1500908-COFC

PROJECT INFORMATION	SAMPLE RECEIPT	
Client:	Total # Containers:	
P.O. No.:	Good Condition?	
Shipped Via:	Matches Schedule?	

RELIQUINSHED BY (CLIENT)
Signature:
Emma Marus
Company: Nautilus Environmental
Time/Date: Aug 11, 2014 @ 1800h

Signature:
Print:
Company:
Time/Date:

RELIQUINSHED BY (COURIER)
Signature:
Print:
Company:
Time/Date:

RECEIVED BY (LABORATORY)
Signature: YC Aug 11 19:50 20.8°
Print:
Company: Nautilus Environmental
Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:

For total, samples have been preserved.

For dissolved, samples have been filtered and then preserved.

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 18-AUG-14 15:36 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1500954

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500954-1	L1500954-2	L1500954-3	L1500954-4	L1500954-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	13-JUL-14	13-JUL-14	13-JUL-14	13-JUL-14	13-JUL-14
	Sampled Time					
	Client ID	SITE CONTROL 0 CU	SITE 1.56 CU	SITE 3.13 CU	SITE 6.25 CU	SITE 12.5 CU
Grouping	**Analyte**					
WATER						
Total Metals	Copper (Cu)-Total (mg/L)	0.00109	0.00188	0.00314	0.00600	0.0104

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500954-6				
	Description	WATER				
	Sampled Date	13-JUL-14				
	Sampled Time					
	Client ID	SITE 25 CU				
Grouping	**Analyte**					
WATER						
Total Metals	Copper (Cu)-Total (mg/L)	0.0213				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

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Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 21-AUG-14 13:01 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1500879

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1500879-1 Water 16-JUL-14 SITE CONTROL 0 FE	L1500879-2 Water 16-JUL-14 SITE 2.5 FE	L1500879-3 Water 16-JUL-14 SITE 5 FE	L1500879-4 Water 16-JUL-14 SITE 10 FE	L1500879-5 Water 16-JUL-14 SITE 20 FE
Grouping	**Analyte**					
WATER						
Total Metals	Iron (Fe)-Total (mg/L)	<0.010	2.00	3.28	5.08	6.11
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Iron (Fe)-Dissolved (mg/L)	<0.030	<0.030	<0.030	<0.030	0.033

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500879-6
	Description	Water
	Sampled Date	16-JUL-14
	Sampled Time	
	Client ID	SITE 40 FE
Grouping	**Analyte**	
WATER		
Total Metals	Iron (Fe)-Total (mg/L)	9.39
Dissolved Metals	Dissolved Metals Filtration Location	FIELD
	Iron (Fe)-Dissolved (mg/L)	0.033

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
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Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Emma Marus	Emma Marus
Phone	604-420-8773	604-420-8773
Email	emma@nautilusenvironmental.com	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	Total Fe (low level)	Dissolved Fe (low level)	Receipt Temperature (°C)
1	Site Control 0Fe	July16/14	-	-	125mL	1	initation	x	x	
2	Site 2.5		-	-	125mL	1	initation	x	x	
3	Site 5		-	-	125mL	1	initation	x	x	
4	Site 10		-	-	125mL	1	initation	x	x	
5	Site 20		-	-	125mL	1	initation	x	x	
6	Site 40		-	-	125mL	1	initation	x	x	
7			-	-						
8			-	-						
9			-	-						
10			-	-						

L1500879-COFC

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total # Containers:	
P.O. No.:		Good Condition?	
Shipped Via:		Matches Schedule?	

RELIQUINSHED BY (CLIENT)

Signature:

Emma Marus

Company: Nautilus Environmental

Time/Date: Aug 11, 2014 @ 1800h

RELIQUINSHED BY (COURIER)

Signature:

Print:

Company:

Time/Date:

RECEIVED BY (LABORATORY)

Signature: YL Aug 11 19:50 20°C

Print:

Company: Nautilus Environmental

Time/Date:

SPECIAL INSTRUCTIONS/COMMENTS:

For total, samples have been preserved.

For dissolved, samples have been filtered and then preserved.

Signature:

Print:

Company:

Time/Date:

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 18-AUG-14 15:49 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1500869

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500869-1	L1500869-2	L1500869-3	L1500869-4	L1500869-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	18-JUL-14	18-JUL-14	18-JUL-14	18-JUL-14	18-JUL-14
	Sampled Time					
	Client ID	SITE CONTROL 0 FE	SITE 2.5 FE	SITE 5.0 FE	SITE 10 FE	SITE 20 FE
Grouping	**Analyte**					
WATER						
Total Metals	Iron (Fe)-Total (mg/L)	0.019	2.13	4.89	9.23	19.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500869-6				
	Description	WATER				
	Sampled Date	18-JUL-14				
	Sampled Time					
	Client ID	SITE 40 FE				
Grouping	**Analyte**					
WATER						
Total Metals	Iron (Fe)-Total (mg/L)	37.3				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Iron (Fe)-Total	MS-B	L1500869-1, -2, -3, -4, -5, -6

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

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VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

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mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
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Nautilus Environmental

Chain of Custody (electronic)

[X] British Columbia: 8664 Commerce Court, Burnaby, BC, V5A 4N7

Sample Collection By:

	Report to:	Invoice to:
Company	Nautilus Environmental	Nautilus Environmental
Address	8664 Commerce Court	8664 Commerce Court
City/Prov/Postal Code	Burnaby, BC, V5A, 4N7	Burnaby, BC, V5A, 4N7
Contact	Emma Marus	Emma Marus
Phone	604-420-8773	604-420-8773
Email	emma@nautilusenvironmental.com	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	# OF CONTAINERS	COMMENTS	~~Total-Cd~~ Fe Total (low level)	Receipt Temperature (°C)
1	Site Control 0 Fe	July 18/14	-	-	125mL	1	Termination	x	
2	Site 2.5 Fe	July 18/14	-	-	125mL	1	Termination	x	
3	Site 5.0 Fe	July 18/14	-	-	125mL	1	Termination	x	
4	Site 10 Fe	July 18/14	-	-	125mL	1	Termination	x	
5	Site 20 Fe	July 18/14	-	-	125mL	1	Termination	x	
6	Site 40 Fe	July 18/14	-	-	125mL	1	Termination	x	
7			-	-					
8			-	-					
9			-	-					
10			-	-					

L1500869-COFC

PROJECT INFORMATION	SAMPLE RECEIPT		RELIQUINSHED BY (CLIENT)	RELIQUINSHED BY (COURIER)
Client:	Total # Containers:		Signature:	Signature:
P.O. No.:	Good Condition?		Emma Marus	Print:
Shipped Via:	Matches Schedule?		Company: Nautilus Environmental	Company:
			Time/Date: Aug 11, 2014 @ 1800h	Time/Date:
SPECIAL INSTRUCTIONS/COMMENTS:				RECEIVED BY (LABORATORY)
			Signature:	Signature: YL Aug 11 1900 20.8°C
Samples ARE preserved.			Print:	Print:
			Company:	Company: Nautilus Environmental
			Time/Date:	Time/Date:

Additional costs may be required for sample disposal or storage. Net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 11-AUG-14
Report Date: 21-AUG-14 13:41 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1500834

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500834-1	L1500834-2	L1500834-3	L1500834-4	L1500834-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	03-JUL-14	03-JUL-14	03-JUL-14	03-JUL-14	03-JUL-14
	Sampled Time					
	Client ID	SITE CONTROL 0 PB	SITE 62.5 PB	SITE 125 PB	SITE 250 PB	SITE 500 PB
Grouping	**Analyte**					
WATER						
Total Metals	Lead (Pb)-Total (mg/L)	0.00030	0.0364	0.0121	0.212	0.184

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1500834-6				
	Description	Water				
	Sampled Date	03-JUL-14				
	Sampled Time					
	Client ID	SITE 1000 PB				
Grouping	**Analyte**					
WATER						
Total Metals	Lead (Pb)-Total (mg/L)	0.553				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

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Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour 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.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

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UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Nautilus Environmental

TESTING LOCATION (Please Circle)

Chain of Custody

British Columbia
8664 Commerce Court
Burnaby, British Columbia, Canada V5A 4N3
Phone 604.420.8773

Date_______ Page___of___

Sample Collection By:

Report to:		Invoice To:	
Company	Nautilus Environmental	Company	Nautilus Environmental
Address	8664 Commerce Court	Address	8664 Commerce Court
City/State/Zip	Burnaby, BC, V5A 4N3	City/State/Zip	Burnaby, BC, V5A 4N3
Contact	Emma Marus	Contact	Emma Marus
Phone	604-420-8773	Phone	604-420-8773
Email	emma@nautilusenvironmental.com	Email	emma@nautilusenvironmental.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	Total Metals Pb (low level)	Receipt Temperature (°C)
1	Site Control 0 Pb	July 3/14	–	–	125mL	1	Termination	X	
2	Site 62.5 Pb	↓	–	–	125mL	1	Termination	X	
3	Site 125 Pb	↓	–	–	125mL	1	Termination	X	
4	Site 250 Pb	↓	–	–	125mL	1	Termination	X	
5	Site 500 Pb	↓	–	–	125mL	1	Termination	X	
6	Site 1000 Pb	↓	–	–	125mL	1	Termination	X	
7									
8									
9									
10									

L1500834-COFC

PROJECT INFORMATION		SAMPLE RECEIPT	
Client:		Total No. of Containers	
PO No.:		Received Good Condition?	
Shipped Via:		Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS: Samples ARE preserved.

RELINQUISHED BY (CLIENT)
(Signature) (Time)
(Printed Name) Emma Marus (Date)
(Company) Nautilus Environmental

RELINQUISHED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (LABORATORY)
(Signature) YC Aug 11 (Time) 1950 20.8°C
(Printed Name) (Date)
(Company)

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Fe in lab water

Species	Treatment	Total Fe (mg/L)	Dissolved Fe (mg/L)	Survival (%)
C. dubia	Control	0.049	<0.03	100
	2.5 mg/L Fe	0.929	<0.03	90
	5.0 mg/L Fe	3.84	<0.03	65
	10.0 mg/L Fe	9.08	<0.03	20
	20.0 mg/L Fe	18.1	<0.03	10
	40.0 mg/L Fe	37	6.14	0

used termination values

Cu in lab water

Species	Treatment	Total Cu (µg/L)	Dissolved Cu (µg/L)	Survival (%)
	Control	<0.50	<0.50	100
	1.56 µg/L Cu	3.15	1.33	100
	3.13 µg/L Cu	3.31	2.56	100
	6.25 µg/L Cu	5.91	5.62	95
P. subcapitata	12.5 µg/L Cu	10.8	9.75	0
	25.0 µg/L Cu	22.8	21.1	0

used initial values

Cr in lab water

Treatment	Total Cr (µg/L)	Dissolved Cr (µg/L)	Survival (%)
Control	<0.50	<0.50	100
43.75 µg/L Cr	43.05	42.4	100
87.5 µg/L Cr	91.3	87.7	100
175 µg/L Cr	178.5	172	95
350 µg/L Cr	357.5	420	0
700 µg/L Cr	732.5	692	0

used average between initiation and termination values

Pb in lab water

Treatment	Total Pb (µg/L)	Dissolved Pb (µg/L)	Survival (%)
Control	<0.050	<0.050	100
62.5 µg/L Pb	28.6	30.1	100
125 µg/L Pb	61.8	75.8	100

250 μg/L Pb	133	148	100
500 μg/L Pb	301	246	85
1000 μg/L Pb	329	279	0

used average between initiation and termination values

Zn in lab water

Treatment	Total Zn (μg/L)	Dissolved Zn (μg/L)	Survival (%)
Control	<3.0	<3.0	100
50 μg/L Zn	41.45	41.8	90
100 μg/L Zn	73.9	78	80
200 μg/L Zn	158.5	164	40
400 μg/L Zn	332.5	338	25
800 μg/L Zn	638.5	656	0

used average between initiation and termination values

Cd in lab water

Treatment	Total Cd (μg/L)	Dissolved Cd (μg/L)	Survival (%)
Control	<0.01	<0.050	100
6.25 μg/L Cd	6.04	3.46	100
12.5 μg/L Cd	12.5	2.51	100
25.0 μg/L Cd	23.1	21.1	20
50.0 μg/L Cd	46.5	41.1	0
100 μg/L Cd	87.3	87.5	0

used initiation values

Al in lab water

Treatment	Total Al (μg/L)	Dissolved Al (μg/L)	Survival (%)
Control	<3.0	<200	100
250 μg/L Al	213	172	45
500 μg/L Al	606	312	0
1000 μg/L Al	1050	344	0
2000 μg/L Al	1070	320	0
4000 μg/L Al	6620	301	0

used dissolved
values

Fe in site water

Treatment	Total Fe (mg/L)	Dissolved Fe (mg/L)	Survival (%)
Control	0.019	<0.03	90
2.5 mg/L Fe	2.13	<0.03	100
5.0 mg/L Fe	4.89	<0.03	65
10.0 mg/L Fe	9.23	<0.03	5
20.0 mg/L Fe	19.5	0.033	5
40.0 mg/L Fe	37.3	0.033	0

used termination values

Cu in site water

Treatment	Total Cu (µg/L)	Dissolved Cu (µg/L)	Survival (%)
Control	<0.50	<0.50	100
1.56 µg/L Cu	2.97	1.8	100
3.13 µg/L Cu	4.7	2.97	100
6.25 µg/L Cu	8.89	5.88	100
12.5 µg/L Cu	15.8	11.2	55
25.0 µg/L Cu	28.8	23.9	10

used initial values

Cr in site water

Treatment	Total Cr (µg/L)	Dissolved Cr (µg/L)	Survival (%)
Control	<0.50	<0.50	100
43.75 µg/L Cr	41.9	40.9	95
87.5 µg/L Cr	91.25	88.3	5
175 µg/L Cr	181	174	0
350 µg/L Cr	353	355	0
700 µg/L Cr	734	728	0

used average between initiation and termination values

Pb in site water

Treatment	Total Pb (µg/L)	Dissolved Pb (µg/L)	Survival (%)
Control	0.292	0.212	100
62.5 µg/L Pb	40.5	42.3	100
125 µg/L Pb	47.1	79.5	100

250 µg/L Pb	188	156	100
500 µg/L Pb	243.5	285	70
1000 µg/L Pb	623	663	0

used average between initiation and termination values

Zn in site water

Treatment	Total Zn (µg/L)	Dissolved Zn (µg/L)	Survival (%)
Control	7	5.7	100
50 µg/L Zn	44.45	44.9	90
100 µg/L Zn	81.25	84.3	65
200 µg/L Zn	152	157	20
400 µg/L Zn	330	325	0
800 µg/L Zn	671.5	681	0

used average between initiation and termination values

Cd in site water

Treatment	Total Cd (µg/L)	Dissolved Cd (µg/L)	Survival (%)
Control	0.214	0.228	90
25 µg/L Cd	22.9	22.3	100
50.0 µg/L Cd	47.1	46	45
100 µg/L Cd	95.5	94	0
200 µg/L Cd	192	187	0
400 µg/L Cd	387	378	0

used initiation values

Al in site water

Treatment	Total Al (µg/L)	Dissolved Al (µg/L)	Survival (%)
Control	4.9	1.6	100
250 µg/L Al	231	171	55
500 µg/L Al	456	329	0
1000 µg/L Al	1120	399	0
2000 µg/L Al	2460	344	0
4000 µg/L Al	8370	282	0

used dissolved values

APPENDIX C –Chain of Custody

Nautilus Environmental

BRITISH COLUMBIA
8664 Commerce Court
Burnaby British Columbia Canada V5A 4N7
Phone 604.420.8773
Fax 604.357.1361

Chain of Custody

0952

Date ______ Page 1 of 1

Sample Collection by: ______

Report to:
Company Azimuth
Address
City Prov. PC
Contact
Phone No.

Invoice to:
Company Azimuth
Address
City Prov. PC
Contact
Phone No.

ANALYSIS REQUIRED

SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NUMBER OF CONTAINERS	COMMENTS	7-d C.dubia wo#14399	72-h P.subcapitata wo#14400	48-h C.dubia wo#14401									RECEIPT TEMPERATURE (°C)
MH-04	June27 114	1505		1L x 20L x	7 1	For mixture Test	X	X										8.5
MH-25	June27 114	1545		1L x 20L x	7 1													8.5
Water Effects Ratio						Using MH-04 as site water			X									

PROJECT INFORMATION
CLIENT
P.O. NO.
SHIPPED VIA:

SAMPLE RECEIPT
TOTAL NO. OF CONTAINERS
REC'D GOOD CONDITION

RELINQUISHED BY (CLIENT)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RELINQUISHED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

SPECIAL INSTRUCTIONS/COMMENTS:

RECEIVED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (LABORATORY)
(Signature) [signature] (Time) 1000
(Printed Name) Krystal Perry (Date) June28/14