Mackenzie Valley Highway – Assessment of Prospective Borrow Sources

Preliminary Acid Rock Drainage / Metal Leaching Assessment

Draft

February 2021

Prepared for:
Government of Northwest Territories
Department of Infrastructure
Box 1320
Yellowknife, NT, X1A 2L9

Prepared by:
K'alo-Stantec Limited

Project Number: 144903077

K'alo-Stantec

Executive Summary

K'alo-Stantec Limited (K'alo-Stantec) has carried out a preliminary (screening) assessment of Acid Rock Drainage and Metal Leaching (ARD/ML) potential of surface material at 11 borrow sources of 35 prospects (quarry and borrow sources) being studied by the Government of Northwest Territories Department of Infrastructure (GNWT-INF) for construction and operation of the Mackenzie Valley Highway Extension Project (the Project).

To screen granular material for ARD/ML potential, a single sample of soil was collected from eleven prospect borrow sources and tested for Acid-Base Accounting (ABA), Shake Flask Extraction (SFE) and total concentration of trace elements (TEC). Potential for ARD is based on the Neutralization Potential Ratio (NPR), which is calculated as Neutralization Potential (NP) divided by Acid Potential (AP). Carbonate NP and Siderite Corrected NP are used for calculations of Carbonate NPR and Siderite Corrected NPR, respectively. A material is considered potentially acid generating (PAG) if NPR values are less than one, uncertain for NPR values between one and two, and non-PAG for NPR values greater than 2 (Price 2009). Screening for ML is done by comparing SFE results to the Guideline for Industrial Waste Discharges in the Northwest Territories (GNWT) and the Canadian Water Quality Guidelines (CWQG) for the Protection of Freshwater Aquatic Life (Short-Term and Long-Term). The screening for ML potential is based on exceedances of the following guidelines:

- GNWT - high ML potential
- CWQG, Short term – moderate ML potential
- CWQG, Long term – low ML potential

All samples are classified as non-PAG based on Carbonate NPR values being above 2, except for 7.101-TP1-1 sample. However, this sample is also not expected to generate acid and is classified as non-PAG because of undetectable sulphur, low sulphate in SFE, and neutral paste pH. Such a result is not uncommon in rocks with low values of NP (i.e., predominance of silicate minerals) and low abundance of sulphur.

Metal leaching potential of materials is low because concentrations of trace elements in SFE do not exceed either GNWT guidelines for discharges or Short-Term CWQG. Exceedances of Long-Term CWQG are noted for Al (in 7 samples), Cu (in 7 samples), Zn (in 4 samples) and Cd (in 1 sample). For these metals, concentrations in SFE are generally within a factor of two the Long-Term CWQG. The calculated CWQG values for Cu, Zn and Cd are conservatively low due to use of low hardness values (typical for deionized water used in SFE) and assumed low dissolved organic carbon (DOC) concentrations. In the natural environment, hardness and DOC concentrations could be higher resulting in a higher applicable CWQG and fewer actual exceedances for metals.

The overall results of the preliminary assessment indicate that ARD/ML potential of the tested prospect material sources is low. To confirm the preliminary conclusion, more samples of both rock and borrow sources should be assessed for ARD/ML potential during ongoing selection and characterization of potential material sources.

Table of Contents

List of Tables

List of Figures

Appendices

Abbreviations

ABA ..... acid-base accounting
AP ..... acid potential
ARD ..... acid rock drainage
CCME ..... Canadian Council of Ministers of Environment
ASTM ..... American Society for Testing and Materials
CWQG ..... Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life
GNWT ..... Government of Northwest Territories
ICP-MS ..... inductively coupled plasma mass spectrometry
INF ..... Department of Infrastructure
kg ..... kilogram
mg/l ..... milligram per litre
ML ..... metal leaching
NP ..... neutralization potential
NPR ..... neutralization potential ratio
NWT ..... Northwest Territories
PAG ..... potentially acid generating
ppm ..... parts per million
QA/QC ..... Quality Assurance and Quality Control
RPD ..... Relative Percent Difference
SFE ..... Shake Flask Extraction
wt.% ..... weight percent
µS/cm ..... microsiemens per centimetre

1 INTRODUCTION

K'alo-Stantec Limited (K'alo-Stantec) was retained in 2020 to compile information about prospect material (quarry/borrow) sources being studied by the Government of Northwest Territories Department of Infrastructure (GNWT-INF) as potential material sources for construction and operation of the Mackenzie Valley Highway Extension Project (the "Project"). As part of the field reconnaissance of 35 material sources, K'alo-Stantec proposed to conduct a preliminary assessment of Acid Rock Drainage and Metal Leaching (ARD/ML) potential. The Project study area is shown in Figure 1.1. K'alo-Stantec understands that the GNWT-INF will continue with further evaluations of material prospects, including geotechnical drilling, to confirm the quantity and quality of material, before deciding on which sources to develop. As part of the ongoing evaluation of sources, this preliminary ARD/ML assessment was conducted to identify, based on visual observation and limited sampling, if any of the prospect material sources indicate ARD/ML potential (an "ARD/ML screening"). The preliminary assessment was completed with the understanding that further testing of material sources, consistent with the Mine Environmental Neutral Drainage (MEND) Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials MEND Report 1.20.1 (Price 2009) will need to be completed at sources identified for development.

- Mackenzie Valley Highway Extension Project
- Regional Study Area
- Community
- All-Season Road
- Winter Road
- District Boundary
- Region Boundary
- Settlement Area Boundary
- Territorial Boundary

0 40 80 Kilometres

(At original document size of 8.5x11)
1:4,500,000

N

Kálo-Stantec

Project Location
Wrigley to Norman Wells, NWT

Prepared by ZN on 2020-11-23
TR by CS on 2020-11-23

Client/Project
144903025-0031 REVA

Government of Northwest Territories Mackenzie Valley Highway

Figure No.
1.1

DRAFT

Title
Project ARD/ML Study Area

Notes
1. Coordinate System: NAD 1983 Northwest Territories Lambert
2. Data Sources: Centre for Geomatics Government of NWT, Government of Canada, Stantec
3. Background: World Imagery: Earthstar Geographics World Topographic Map: Esri, FAO, NOAA, NRCan World Hillshade: Esri, USGS

2 SCOPE OF WORK

Thirty-five prospect material sources (12 rock quarries and 23 borrow sources) were selected for a field reconnaissance program that was conducted in October 2020. The purpose of the reconnaissance was to complete aerial and ground observations of specific “primary” and “secondary” material sources to supplement previous documented field-based material observations, to support further selection of borrow/quarry sources for geotechnical investigation. Specific observations and data collected during field reconnaissance would be used for preliminary ARD/ML evaluation. The results were intended to be added to the report of data compiled for borrow/material sources for the Project.

3 METHODS

3.1 Approach

The method used for screening of rock and granular material for ARD/ML potential assumes that further testing of material sources, consistent with the Mine Environmental Neutral Drainage (MEND) Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials MEND Report 1.20.1 (Price 2009) will be completed prior to use of material sources. To screen rock and granular material for ARD/ML potential, a single sample of rock or soil considered representative of visible material, was collected from prospect borrow sources where field observations indicated possibility of presence of sulphidic materials.

Surface water, if present and in contact with the material source, can be used to indicate whether the material is generating ARD/ML. No contact water was identified during the field campaign.

3.2 Fieldwork

Prospect borrow and quarry sources were accessed by helicopter and by foot between October 5 and 11, 2020. At granular sources accessible on foot, multiple test pits were hand excavated to depths of up to 1 m until refusal. Observations of granular material were based on American Society for Testing and Materials (ASTM) 2488. Where clast lithology indicated possibility of ARD/ML potential, approximately 1 kilogram (kg) of representative material, was collected and placed in polyethylene bags. A single sample was collected from 11 prospect sources where observed lithology of granular materials included both locally and distally derived rock lithologies such as granitoids, limestone, dolostone, coal and shale. Other sources were not sampled due to lack of access, and where observed lithologies at surface suggested dominant presence of carbonates and where samples fizzed when subjected to dilute Hydrochloric acid. Such observations were understood to not preclude further testing at these sources.

Sample locations are shown in Figure A.1 and Figure A.2 of Appendix A. Photographs and field data summary sheets of all observations recorded at all sources are included in Appendix E-3 of the *Assessment of Prospective Borrow Sources Geotechnical Data Report*.

3.3 Laboratory Testing

Samples of granular material were tested for:

- Acid-base accounting (ABA) package, including Modified Sobek Neutralization Potential (NP) with siderite correction, carbonate content, fizz rating, paste pH, total sulphur by LECO and sulphate sulphur by HCl extraction

- MEND Shake Flask Extraction (SFE) testing, involving continuous mixing of a crushed sample with deionized water (1:3) for 24 hours, filtered through a 0.45-µm membrane, and analysis for dissolved metals by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) for trace elements and CVAAS for mercury. In addition, SFE leachates were analyzed for pH, electrical conductivity, acidity, and alkalinity by titration, and sulphate by turbidimetry.
- Total concentrations of trace elements were analyzed by ICP-MS following aqua regia digestion .

The laboratory reports, including laboratory quality assurance and quality control (QA/QC) are presented in Appendix B.

All ABA and SFE parameters and element concentrations in laboratory duplicates samples are within the industry standard of 20% relative present difference (RPD).

Certified reference materials and method blank analysis as part of laboratory QA/QC procedure showed that all values are certified.

3.4 Data Analysis

Evaluation of ARD risks is based on the ARD classification presented in the MEND Prediction Manual. This classification is based on Neutralization Potential Ratio (NPR) calculated as Neutralization Potential (NP) divided by Acid Potential (AP) as reported in Appendix C. Carbonate NP and Siderite Corrected NP are used for calculations of Carbonate NPR and Siderite Corrected NPR, respectively. For laboratory reported values that were below detection limit, half the detection limit was used for calculations. Material is considered potentially acid generating (PAG) when NPR values are less than one, uncertain for NPR values between one and two, and non-PAG for NPR values greater than 2 (Price 2009).

Screening for ML was done by comparing SFE results to the Guideline for Industrial Waste Discharges in the Northwest Territories (NWT) (GNWT 2004) and the Canadian Water Quality Guidelines (CWQG) for the Protection of Freshwater Aquatic Life (CCME 2021) as shown in Appendix D. The screening for ML potential was based on exceedances of the following guidelines:

- GNWT - high ML potential
- CWQG, Short term – moderate ML potential
- CWQG, Long term – low ML potential

Hardness and pH dependent CWQG (e.g., Cd and Cu) were calculated using minimum hardness and maximum pH of the dataset to generate the most stringent guidelines. The CWQG guideline for Zn depends on Dissolved Organic Carbon (DOC) content, which was not measured in SFE leachates. Therefore, conservatively the lowest value of DOC (0.3 mg/l,) applicable for the equation was used to generate the most stringent guideline.

Values from total metals analysis were compared to a benchmark of 10x Average Concentration in the Earth's Upper Crust (ACUC) to verify whether ML is related to element content in rock (Appendix E).

4 RESULTS

The results of ARD/ML testing are presented for each source in the following sections.

4.1 10.043-TP1

The 10.043-TP1 sample has Carbonate and Siderite Corrected NPR values above 2 and is classified as non-PAG (Appendix C).

No exceedances of the Northwest Territories Guidelines for discharges or Short-Term Canadian Water Quality Guidelines (CWQG) are found in SFE. The long term CWQG guidelines in SFE are exceeded for Al (1.1x) and Cu (1.6x) resulting in low leaching potential for these elements (Appendix D). No exceedances of the ACUC criteria are found in 10.043-TP1 sample (Appendix E).

4.2 10.030-TP1

The 10.030-TP1 sample has Carbonate and Siderite Corrected NPR values above 2 and is classified as non-PAG (Appendix C).

No exceedances of the Northwest Territories Guidelines for discharges or Short-Term Canadian Water Quality Guidelines (CWQG) are found in SFE. The long term CWQG guidelines in SFE are exceeded for Al (1.4x) and Cu (1.3x) resulting in low leaching potential for these elements (Appendix D) . No exceedances of the ACUC criteria are found in 10.030-TP1 sample (Appendix E).

4.3 10.020-TP3

The 10.020-TP3 material has Carbonate and Siderite Corrected NPR values above 2 and is classified as non-PAG (Appendix C).

No exceedances of the Northwest Territories Guidelines for discharges or Short-Term Canadian Water Quality Guidelines (CWQG) are found in SFE. The long term CWQG guideline in SFE is exceeded for Cu (1.4x) resulting in low leaching potential for these elements (Appendix D). No exceedances of the ACUC criteria are found in 10.020-TP3 sample (Appendix E).

4.4 10.014A-TP5

The 10.014A-TP5 sample has Carbonate and Siderite Corrected NPR values above 2 and is classified as non-PAG (Appendix C).

No exceedances of the Northwest Territories Guidelines for discharges or Short-Term Canadian Water Quality Guidelines (CWQG) are found in SFE. The long term CWQG guideline in SFE is exceeded for Al (1.8x) resulting in low leaching potential for this element (Appendix D). No exceedances of the ACUC criteria are found in 10.014A-TP5 sample (Appendix E).

4.5 9.044B-TP1

The 9.044B-TP1 sample has Carbonate and Siderite Corrected NPR values above 2 and is classified as non-PAG (Appendix C).

No exceedances of the Northwest Territories Guidelines for discharges or Short-Term Canadian Water Quality Guidelines (CWQG) are found in SFE. The long term CWQG guideline in SFE is exceeded for Cu (2.1x) and Zn (1.4x) resulting in low potential for these elements (Appendix D). No exceedances of the ACUC criteria are found in 9.044B-TP1 sample (Appendix E).

4.6 9.043-TP1

The 9.043-TP1 sample has Carbonate and Siderite Corrected NPR values above 2 and is classified as non-PAG (Appendix C).

No exceedances of the Northwest Territories Guidelines for discharges or Short-Term Canadian Water Quality Guidelines (CWQG) are found in SFE. The long term CWQG guideline in SFE is exceeded for Al (1.7x) resulting in low potential for this element (Appendix D). No exceedances of the ACUC criteria are found in 9.043-TP1 sample (Appendix E).

4.7 9.024B-TP2

The 9.024B-TP2 sample has Carbonate and Siderite Corrected NPR values above 2 and is classified as non-PAG (Appendix C).

No exceedances of the Northwest Territories Guidelines for discharges or Short-Term Canadian Water Quality Guidelines (CWQG) are found in SFE. The long term CWQG guidelines in SFE are exceeded for Cd (2.1x), Cu (2.3x), and Zn (4.4) resulting in low leaching potential for these elements (Appendix D). No exceedances of the ACUC criteria are found in 9.024B-TP2 sample (Appendix E).

4.8 9.002A-TP1-1

The 9.002A-TP1-1 sample has Carbonate and Siderite Corrected NPR values above 2 and is classified as non-PAG (Appendix C).

No exceedances of the Northwest Territories Guidelines for discharges or Short-Term Canadian Water Quality Guidelines (CWQG) are found in SFE. The long term CWQG guidelines in SFE are exceeded for Al (1.5x), Cu (2.5x), and Zn (3.7) resulting in low leaching potential for these elements (Appendix D). No exceedances of the ACUC criteria are found in 9.002A-TP1-1 sample (Appendix E).

4.9 9.002-ARD1-1

The 9.002-ARD1-1 sample has Carbonate and Siderite Corrected NPR values above 2 and is classified as non-PAG (Appendix C).

No exceedances of the Northwest Territories Guidelines for discharges or Short-Term Canadian Water Quality Guidelines (CWQG) are found in SFE. The long term CWQG guideline in SFE is exceeded for Al (1.7x) resulting in low leaching potential for this element (Appendix D). No exceedances of the ACUC criteria are found in 9.002-ARD1-1 sample (Appendix E).

4.10 7.155A-ARD1-1

The 7.155A-ARD1-1 sample has Carbonate and Siderite Corrected NPR values above 2 and is classified as non-PAG (Appendix C).

No exceedances of the Northwest Territories Guidelines for discharges or Short-Term and Long-Term Canadian Water Quality Guidelines (CWQG) are found in SFE (Appendix D) considering no evidence for ML. No exceedances of the ACUC criteria are found in 7.155A-ARD1-1sample (Appendix E).

4.11 7.101-TP1-1

The 7.101-TP1-1 sample has Siderite Corrected NPR value above 2 and Carbonate NPR below 1 (Appendix C). The Carbonate NPR value is derived from Carbonate NP and AP, which are both below the detection limit (0.5 and 0.6 kg $CaCO_3$/tonne, respectively), and the Carbonate NPR value is a ratio of the detection limits. Sulfur content is below the detection limit (0.01 wt%), indicating that the content of sulfide minerals is negligeable. Additionally, the sulphate concentration in SFE from this sample is an order of magnitude lower than in SFE from other samples showing little evidence for sulphide oxidation. The pH value of SFE (5.59 pH units) is below the lower limit of CWQG pH range (6.5 – 9.0 pH Units). In SFE leachates, pH values are often below the lower pH value for CWQG because the laboratory uses DI water with a pH ~5.6 that apparently did not significantly change during the extraction. In this sample, the value of paste pH is 7.70, indicating that the sample is capable of generating alkalinity if pulverized. Based on undetectable sulphur, low sulphate in SFE and neutral paste pH the sample is not expected to generate ARD.

No exceedances of the Northwest Territories Guidelines for discharges or Short-Term Canadian Water Quality Guidelines (CWQG) are found in SFE. The long term CWQG guidelines in SFE are exceeded for Al (49x), Cu (2.4x), and Zn (3.3x) (Appendix D). No exceedances of the ACUC criteria are found in 7.101-TP1-1 sample (Appendix E).

5 DISCUSSION

5.1 Acid Rock Drainage Potential

All samples are non-PAG because their Carbonate NPR values are above 2, except for sample 7.101-TP1-1. This sample is also not expected to generate acid and classified as non-PAG because of undetectable sulphur, low sulphate in SFE and neutral paste pH.

5.2 Metal Leaching Potential

Metal leaching potential of the samples is low because SFE values do not exceed Northwest Territories Guidelines for discharges or Short-Term Canadian Water Quality Guidelines (CWQG). Exceedances of Long-Term Canadian Water Quality Guidelines (CWQG) are noted for Al (in 7 samples), Cu (in 7 samples), Zn (in 4 samples) and Cd (in 1 sample). For these metals, concentrations in SFE are generally within 2x the Long-Term CWQG (Table 5.1). Additionally, the calculated CWQG water quality standards for Cu, Zn and Cd were conservatively low because of minimum values used for hardness (typical for deionized water used in SFE) and assumed low DOC concentrations. In the natural environment, hardness and DOC concentrations could be higher resulting in higher and more realistic CWQG for metals.

Table 5.1 Summary of Preliminary ARD/ML Assessment of the Prospects

Sample ID	Samples Taken	ARD Potential	CWQG Exceedances in SFE	Total Metals Exceeding ACUC x 10	ML Potential/ Potential Parameters of Concern
10.043-TP1	1	Non-PAG	CWQG Long-Term for Al (1.1x) and Cu (1.6x)	None	Low / Al and Cu
10.030-TP1	1	Non-PAG	CWQG Long-Term for Al (1.4x) and Cu (1.3x)	None	Low / Al and Cu
10.020-TP3	1	Non-PAG	CWQG Long-Term for Cu (1.4x)	None	Low / Cu
10.014A-TP5	1	Non-PAG	CWQG Long-Term for Al (1.8x)	None	Low / Al
9.044B-TP1	1	Non-PAG	CWQG Long-Term for Cu (2.1x) and Zn (1.4x)	None	Low / Cu and Zn
9.043-TP1	1	Non-PAG	CWQG Long-Term for Al (1.7x)	None	Low / Al
9.024B-TP2	1	Non-PAG	CWQG Long-Term for Cd (2.1x), Cu (2.3x), and Zn (4.4)	None	Low / Cd, Cu, and Zn
9.002A-TP1-1	1	Non-PAG	CWQG Long-Term for Al (1.5x), Cu (2.5x), and Zn (3.7)	None	Low / Al, Cu, and Zn
9.002-ARD1-1	1	Non-PAG	CWQG Long-Term for Al (1.7x)	None	Low / Al
7.155A-ARD1-1	1	Non-PAG	None	None	None
7.101-TP1-1	1	Non-PAG	CWQG for pH (5.59 for Short-Term and Long-Term), Al (49x for Long-Term), Cu (2.4x for Long-Term), and Zn (3.3x for Long-Term)	None	Low / Al, Cu, and Zn

6 CONCLUSIONS AND RECOMMENDATIONS

Results of the preliminary assessment indicate that ARD/ML potential of the tested prospect material sources is low. To confirm the preliminary conclusion, more samples should be assessed for ARD/ML potential during ongoing selection and characterization of the potential material sources.

No samples were collected from rock sources. Additional sampling should be completed at all prospect rock (quarry) sources for ARD/ML testing.

7 CLOSURE

This document entitled Preliminary Acid Rock Drainage/Metal Leaching Assessment was prepared by K'alo-Stantec Limited ("Stantec") for the account of The GNWT Department of Infrastructure (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects K'alo-Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between K'alo-Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, K'alo-Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by _____

(signature)

Elena Khozhina, Ph.D., P.Ag. (MB, BC), R.P.Bio. (BC), Environmental Scientist

Prepared by _____

(signature)

Erica Bonhomme, P.Geo. (NWT), Project Manager

Reviewed by _____

(signature)

Nikolay Sidenko, Ph.D., P.Geo. (NWT, MB, BC), Senior Geochemist

Approved by _____

(signature)

Jim B. Finley, Ph.D., P.G. (Wyoming, USA) Principal Geochemist

8 REFERENCES

ASTM D2488-17e1. 2017. Standard Practice for Description and Identification of Soils (Visual-Manual Procedures), ASTM International.

CCME (Canadian Council of Ministers of Environment). 2021. Canadian Environmental Quality Guidelines for protection of aquatic and terrestrial ecosystems. Chapter: Water Quality Guidelines for the Protection of Aquatic Life (CWQG), Freshwater and Marine. Available at: http://www.ccme.ca/en/resources/canadian_environmental_quality_guidelines/.

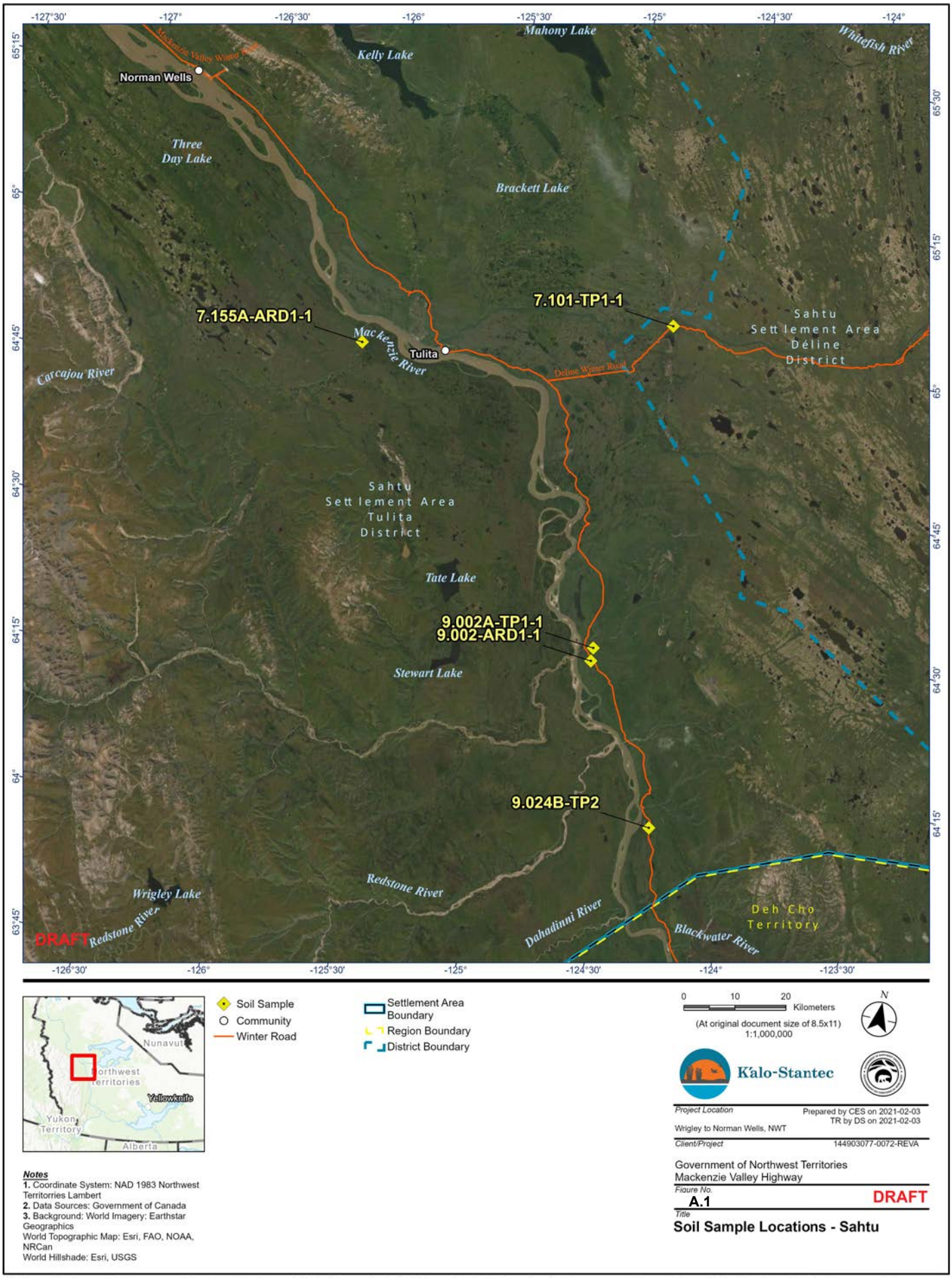
Government of Northwest Territories (GNWT). 2004. Guideline for Industrial Waste Discharges in the NWT. Available at http://www.enr.gov.nt.ca/sites/enr/files/guidelines/industrial_waste_guidelines.pdf.

Okulitch, A.V. and Irwin, D., 2016. Geological Compilation of the Western Mainland and Arctic Islands of the Northwest Territories; Northwest Territories Geological Survey, NWT Open File 2016-09.

Price, W.A. 1997. Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia. Appendix 3. Available at http://mend-nedem.org/wp-content/uploads/2013/01/1.20.1-Ref.pdf.

Price, W.A. 2009. Mine Environment Neutral Drainage (MEND) Report 1.20.1. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. Available at http://mend-nedem.org/wp-content/uploads/1.20.1_PredictionManual.pdf.

APPENDIX A Sample Locations



- Soil Sample
- Community
- Winter Road
- Settlement Area Boundary
- Region Boundary
- District Boundary

0 10 20 Kilometers

(At original document size of 8.5x11)
1:1,000,000

N

Kálo-Stantec

Project Location
Wrigley to Norman Wells, NWT

Prepared by CES on 2021-02-03
TR by DS on 2021-02-03

Client/Project
144903077-0072-REVA

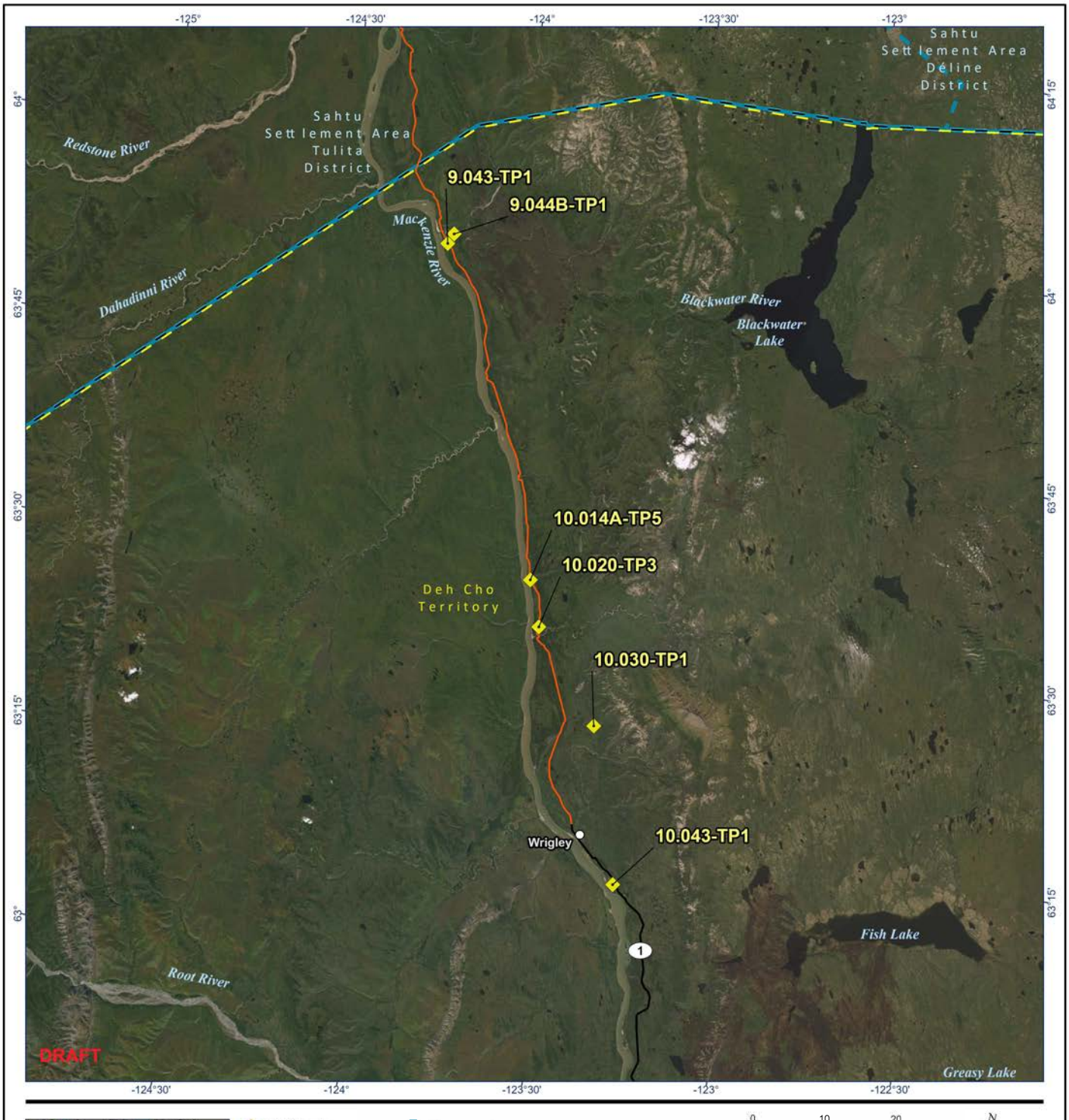
Government of Northwest Territories
Mackenzie Valley Highway

Figure No.
A.1

DRAFT

Title
Soil Sample Locations - Sahtu

Notes
1. Coordinate System: NAD 1983 Northwest Territorries Lambert
2. Data Sources: Government of Canada
3. Background: World Imagery: Earthstar Geographics
World Topographic Map: Esri, FAO, NOAA, NRCan
World Hillshade: Esri, USGS



Soil Sample
Community
All-Season Road
Winter Road
District Boundary
Region Boundary
Settlement Area Boundary

0 10 20 Kilometers
(At original document size of 8.5x11)
1:800,000

N

Kálo-Stantec

Project Location
Wrigley to Norman Wells, NWT

Prepared by CES on 2021-02-03
TR by DS on 2021-02-03

Client/Project
144903077-0071-REVA

Government of Northwest Territories
Mackenzie Valley Highway

Figure No.
A.2

DRAFT

Title
Soil Sample Locations - Deh Cho

Notes
1. Coordinate System: NAD 1983 Northwest Territorries Lambert
2. Data Sources: Centre for Geomatics Government of NWT, Government of Canada, Stantec
3. Background: World Imagery: Earthstar Geographics
World Topographic Map: Esri, FAO, NOAA, NRCan
World Hillshade: Esri, USGS

APPENDIX B Laboratory Reports

Your Project #: 144903077
Site Location: MVH BORROW ASSESSMENT

Attention: Roxanne Pyke

STANTEC CONSULTING LTD
PO BOX 1777
2nd FLOOR 4910 53 STREET
Yellowknife, NT
CANADA X1A 2P4

Report Date: 2021/01/22
Report #: R2979154
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C091932
Received: 2020/12/14, 08:53

Sample Matrix: Solid
Samples Received: 12

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Trace AquaRegia Metals by ICPMS-% (1, 2)	11	2021/01/15	2021/01/15	1DX	.
Trace AquaRegia Metals by ICPMS-ppb (1, 2)	11	2021/01/15	2021/01/15	1DX	.
Trace AquaRegia Metals by ICPMS-ppm (1, 2)	11	2021/01/15	2021/01/15	1DX	.
Acid Gen. Potential S-S by Diff. - ARD	11	N/A	2021/01/14	BBY WI-00033	Auto Calc
CaCO3 Equivalency (based on CO2) - ARD	11	N/A	2021/01/15	BBY WI-00033	Auto Calc
Carbonate C (CO2;Direct HCl Method) (1)	11	N/A	2021/01/15		SUBLET
Fizz Rating - ARD	11	2021/01/09	2021/01/09	BBY0SOP-00020 / BBY0SOP-00023	MEND 2008 1.16.1 b
Acidity pH 4.5 & pH 8.3 MEND SFE Extract	6	N/A	2021/01/11	BBY6SOP-00037	SM 23 2310 B m
Acidity pH 4.5 & pH 8.3 MEND SFE Extract	6	N/A	2021/01/19	BBY6SOP-00037	SM 23 2310 B m
EC - MEND SFE Extract	12	N/A	2021/01/11	BBY0SOP-00006	SM 23 2510B m
Hardness MEND SFE Extract	12	N/A	2021/01/13	BBY WI-00033	Auto Calc
MEND Extract Anion, Cation, Balance %	9	N/A	2021/01/19	BBY WI-00033	Auto Calc
MEND Extract Anion, Cation, Balance %	3	N/A	2021/01/21	BBY WI-00033	Auto Calc
ICP-MS DissMET MEND SFE Extract	11	N/A	2021/01/12	BBY7SOP-00002	EPA 6020B R2 m
ICP-MS DissMET MEND SFE Extract	1	N/A	2021/01/13	BBY7SOP-00002	EPA 6020B R2 m
pH MEND SFE Extract	12	N/A	2021/01/11	BBY0SOP-00003	SM 23 4500-H+ B m
Extract Sample Volume MEND SFE	12	N/A	2021/01/10	BBY0SOP-00008	MEND 2009 1.20.1 m
Extract Sample Wt MEND SFE	12	N/A	2021/01/10	BBY0SOP-00008	MEND 2009 1.20.1 m
Net Neut. Potential (SCOR-MPA S-S diff)	11	N/A	2021/01/14	BBY WI-00033	Auto Calc
Neut. Potential Ratio - ARD	11	N/A	2021/01/15	BBY WI-00033	Auto Calc
Siderite Correct. Neut. Potential - ARD	11	2021/01/09	2021/01/07	BBY0SOP-00023	JEnvQual 26(3) 673
Siderite Correct. Neut. Potential - PREP	11	2021/01/09	2021/01/07	BBY0SOP-00020	MEND 2008 1.16.1b
Paste pH - ARD	11	2021/01/02	2021/01/02	BBY0SOP-00016	MEND 2009 1.20.1 m
Prep Performed at Maxxam Location	11	N/A	2021/01/02		
Sulphate on HCL Extracts from ARD	11	N/A	2021/01/05	BBY6SOP-00017	SM 23 4500-SO42- E m
HCl Extractable Sulphate Sulphur - ARD	11	N/A	2021/01/11	BBY ARD-00009	ASTM D2492-02 m
Sulphide Sulphur (Calc) - ARD	11	N/A	2021/01/14	BBY WI-00033	Auto Calc
Total Carbon & Total Sulphur by LECO (1)	11	N/A	2021/01/14		SUBLET
Weight of Sample Received (charge/kg)	1	N/A	2021/01/12		
Weight of Sample Received	11	N/A	2021/01/12		

Your Project #: 144903077
Site Location: MVH BORROW ASSESSMENT

Attention: Roxanne Pyke

STANTEC CONSULTING LTD
PO BOX 1777
2nd FLOOR 4910 53 STREET
Yellowknife, NT
CANADA X1A 2P4

Report Date: 2021/01/22
Report #: R2979154
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C091932
Received: 2020/12/14, 08:53

Sample Matrix: Water
Samples Received: 12

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Low Level (3)	1	N/A	2021/01/14	AB SOP-00005	SM 23 2320 B m
Alkalinity - Low Level (3)	8	N/A	2021/01/15	AB SOP-00005	SM 23 2320 B m
Alkalinity - Low Level (3)	3	N/A	2021/01/21	AB SOP-00005	SM 23 2320 B m
Low level chloride/sulphate by AC (3)	2	N/A	2021/01/15	AB SOP-00020 / AB SOP-00018	SM23-4500-Cl/SO4-E m
Low level chloride/sulphate by AC (3)	10	N/A	2021/01/18	AB SOP-00020 / AB SOP-00018	SM23-4500-Cl/SO4-E m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Sub Vancouver to Acme
(2) Trace metals by aqua regia digestion followed by ICP-MS scan (group 1DX) done at Acme Labs.

(3) This test was performed by BV Labs Calgary Environmental

Your Project #: 144903077
Site Location: MVH BORROW ASSESSMENT

Attention: Roxanne Pyke

STANTEC CONSULTING LTD
PO BOX 1777
2nd FLOOR 4910 53 STREET
Yellowknife, NT
CANADA X1A 2P4

Report Date: 2021/01/22
Report #: R2979154
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C091932
Received: 2020/12/14, 08:53

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Acid Rock Drainage,
Email:
Phone# (604) 734 7276
==========
This report has been generated and distributed using a secure automated process.
BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

BV Labs Job #: C091932
Report Date: 2021/01/22

STANTEC CONSULTING LTD
Client Project #: 144903077
Site Location: MVH BORROW ASSESSMENT

CARBONATE CARBON (CO2 HCL METHOD)

BV Labs ID		ZA7038	ZA7039	ZA7040	ZA7041	ZA7042	ZA7043		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	7.101-TP1-1	7.155A-ARD1-1	9.002-ARD1-1	9.002A-TP1-1	9.024B-TP2	9.043-TP1	RDL	QC Batch
Calculated Parameters									
CaCO3 Equiv.	Kg CaCO3/T	<0.50	65.00	275.0	5.45	222.1	484.1	0.50	A118139
Physical Properties									
CO2	wt%	<0.08	2.86	12.10	0.24	9.77	21.30	0.08	A133840

RDL = Reportable Detection Limit

BV Labs ID		ZA7043	ZA7044	ZA7045	ZA7046	ZA7047	ZA7048		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	9.043-TP1 Lab-Dup	9.044B-TP1	10.014A-TP5	10.020-TP3	10.030-TP1	10.043-TP1	RDL	QC Batch
Calculated Parameters									
CaCO3 Equiv.	Kg CaCO3/T	N/A	180.9	570.2	545.9	780.0	85.91	0.50	A118139
Physical Properties									
CO2	wt%	21.57	7.96	25.09	24.02	34.32	3.78	0.08	A133840

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

MEND SHAKE FLASK EXTRACTION (SOLID)

BV Labs ID		ZA7037	ZA7038	ZA7039	ZA7040	ZA7041	ZA7042	ZA7043	
Sampling Date		2020/12/14 09:10	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	
	UNITS	SFE BLANK	7.101-TP1-1	7.155A-ARD1-1	9.002-ARD1-1	9.002A-TP1-1	9.024B-TP2	9.043-TP1	QC Batch
Industrial									
MEND Extract Sample Weight	g	0.00	250	250	251	251	251	251	A131375
Parameter									
MEND Extract Sample Volume	mL	750	750	750	750	750	750	750	A131376

BV Labs ID		ZA7044	ZA7045	ZA7046	ZA7047	ZA7048	
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	
	UNITS	9.044B-TP1	10.014A-TP5	10.020-TP3	10.030-TP1	10.043-TP1	QC Batch
Industrial							
MEND Extract Sample Weight	g	251	251	251	251	250	A131375
Parameter							
MEND Extract Sample Volume	mL	750	750	750	750	750	A131376

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

TRACE METALS BY AQUA REGIA DIGEST (SOLID)

BV Labs ID		ZA7038	ZA7039	ZA7040	ZA7040	ZA7041	ZA7042		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	7.101-TP1-1	7.155A-ARD1-1	9.002-ARD1-1	9.002-ARD1-1 Lab-Dup	9.002A-TP1-1	9.024B-TP2	RDL	QC Batch
Total Metals by ICPMS									
1DX Gold (Au)	ppb	6.4	<0.5	1.1	<0.5	<0.5	<0.5	0.5	A133861
1DX Iron (Fe)	%	1.98	0.69	1.66	1.71	2.26	1.12	0.01	A133845
1DX Molybdenum (Mo)	ppm	0.6	1.0	1.1	1.1	0.7	1.0	0.1	A133874
1DX Calcium (Ca)	%	0.32	1.87	7.30	7.39	0.41	5.61	0.01	A133845
1DX Copper (Cu)	ppm	8.4	14.2	15.3	15.0	33.2	7.7	0.1	A133874
1DX Lead (Pb)	ppm	8.3	5.4	5.5	5.6	8.9	5.9	0.1	A133874
1DX Phosphorus (P)	%	0.036	0.021	0.031	0.030	0.032	0.025	0.001	A133845
1DX Magnesium (Mg)	%	0.54	0.77	2.94	2.98	1.20	2.48	0.01	A133845
1DX Titanium (Ti)	%	0.074	0.010	0.032	0.033	0.039	0.015	0.001	A133845
1DX Zinc (Zn)	ppm	58	23	32	33	44	41	1	A133874
1DX Aluminum (Al)	%	0.91	0.21	0.60	0.60	1.39	0.50	0.01	A133845
1DX Silver (Ag)	ppm	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.1	A133874
1DX Nickel (Ni)	ppm	11.9	9.5	11.2	11.8	20.4	9.7	0.1	A133874
1DX Sodium (Na)	%	0.031	0.006	0.016	0.018	0.012	0.009	0.001	A133845
1DX Cobalt (Co)	ppm	6.7	2.3	4.8	5.3	9.5	3.9	0.1	A133874
1DX Potassium (K)	%	0.12	0.05	0.08	0.08	0.11	0.07	0.01	A133845
1DX Manganese (Mn)	ppm	445	126	372	370	407	343	1	A133874
1DX Sulphur (S)	%	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	A133845
1DX Arsenic (As)	ppm	2.4	6.9	4.1	4.5	3.4	3.5	0.5	A133874
1DX Uranium (U)	ppm	1.7	0.7	1.1	1.5	1.2	0.6	0.1	A133874
1DX Thorium (Th)	ppm	10.1	2.5	6.1	6.2	10.2	3.7	0.1	A133874
1DX Strontium (Sr)	ppm	15	26	56	54	14	41	1	A133874
1DX Cadmium (Cd)	ppm	<0.1	0.2	<0.1	<0.1	<0.1	0.2	0.1	A133874
1DX Antimony (Sb)	ppm	0.2	0.4	0.2	0.2	0.2	0.2	0.1	A133874
1DX Bismuth (Bi)	ppm	0.3	<0.1	<0.1	<0.1	1.1	<0.1	0.1	A133874
1DX Vanadium (V)	ppm	32	28	23	25	48	14	2	A133874
1DX Lanthanum (La)	ppm	21	6	12	13	16	10	1	A133874
1DX Chromium (Cr)	ppm	139	100	42	43	64	47	1	A133874
1DX Barium (Ba)	ppm	64	216	178	183	155	79	1	A133874
1DX Boron (B)	ppm	<20	<20	<20	<20	<20	<20	20	A133874
1DX Tungsten (W)	ppm	0.2	<0.1	0.1	0.1	0.2	0.1	0.1	A133874
1DX Mercury (Hg)	ppm	<0.01	0.03	0.01	0.02	<0.01	0.01	0.01	A133874

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

BV Labs Job #: C091932
Report Date: 2021/01/22

STANTEC CONSULTING LTD
Client Project #: 144903077
Site Location: MVH BORROW ASSESSMENT

TRACE METALS BY AQUA REGIA DIGEST (SOLID)

BV Labs ID		ZA7038	ZA7039	ZA7040	ZA7040	ZA7041	ZA7042		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	7.101-TP1-1	7.155A-ARD1-1	9.002-ARD1-1	9.002-ARD1-1 Lab-Dup	9.002A-TP1-1	9.024B-TP2	RDL	QC Batch
1DX Scandium (Sc)	ppm	3.2	1.3	2.5	2.4	5.6	2.2	0.1	A133874
1DX Thallium (Tl)	ppm	0.1	0.2	0.1	<0.1	<0.1	<0.1	0.1	A133874
1DX Selenium (Se)	ppm	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	A133874
1DX Gallium (Ga)	ppm	5	<1	2	2	5	2	1	A133874
1DX Tellurium (Te)	ppm	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	A133874

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

TRACE METALS BY AQUA REGIA DIGEST (SOLID)

BV Labs ID		ZA7043	ZA7044	ZA7045	ZA7046	ZA7047	ZA7048		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	9.043-TP1	9.044B-TP1	10.014A-TP5	10.020-TP3	10.030-TP1	10.043-TP1	RDL	QC Batch
Total Metals by ICPMS									
1DX Gold (Au)	ppb	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	A133861
1DX Iron (Fe)	%	1.01	1.02	0.89	1.18	0.44	3.14	0.01	A133845
1DX Molybdenum (Mo)	ppm	0.6	0.6	0.6	0.8	0.7	1.3	0.1	A133874
1DX Calcium (Ca)	%	11.3	4.89	16.9	15.0	20.7	2.33	0.01	A133845
1DX Copper (Cu)	ppm	7.4	6.8	5.8	10.2	3.1	12.1	0.1	A133874
1DX Lead (Pb)	ppm	4.8	4.0	3.4	7.1	3.5	7.1	0.1	A133874
1DX Phosphorus (P)	%	0.030	0.030	0.029	0.030	0.010	0.052	0.001	A133845
1DX Magnesium (Mg)	%	4.92	1.86	3.78	4.17	4.65	1.46	0.01	A133845
1DX Titanium (Ti)	%	0.018	0.014	0.015	0.020	0.004	0.027	0.001	A133845
1DX Zinc (Zn)	ppm	23	21	16	30	13	40	1	A133874
1DX Aluminum (Al)	%	0.43	0.39	0.29	0.37	0.17	0.95	0.01	A133845
1DX Silver (Ag)	ppm	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	A133874
1DX Nickel (Ni)	ppm	7.5	8.6	6.7	10.6	4.4	22.4	0.1	A133874
1DX Sodium (Na)	%	0.017	0.008	0.009	0.012	0.008	0.011	0.001	A133845
1DX Cobalt (Co)	ppm	3.2	3.5	2.5	3.9	1.3	7.4	0.1	A133874
1DX Potassium (K)	%	0.06	0.06	0.06	0.06	0.04	0.11	0.01	A133845
1DX Manganese (Mn)	ppm	343	269	230	296	132	1120	1	A133874
1DX Sulphur (S)	%	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	A133845
1DX Arsenic (As)	ppm	2.4	2.6	3.1	3.6	1.7	6.6	0.5	A133874
1DX Uranium (U)	ppm	0.8	0.5	0.8	0.7	1.1	0.9	0.1	A133874
1DX Thorium (Th)	ppm	6.1	4.0	3.2	2.2	1.7	6.2	0.1	A133874
1DX Strontium (Sr)	ppm	65	31	122	117	134	24	1	A133874
1DX Cadmium (Cd)	ppm	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	0.1	A133874
1DX Antimony (Sb)	ppm	<0.1	0.1	0.1	0.1	<0.1	0.2	0.1	A133874
1DX Bismuth (Bi)	ppm	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	A133874
1DX Vanadium (V)	ppm	20	12	12	17	7	32	2	A133874
1DX Lanthanum (La)	ppm	12	10	7	6	4	18	1	A133874
1DX Chromium (Cr)	ppm	35	51	27	28	17	46	1	A133874
1DX Barium (Ba)	ppm	79	146	53	110	32	189	1	A133874
1DX Boron (B)	ppm	<20	<20	<20	<20	<20	<20	20	A133874
1DX Tungsten (W)	ppm	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.1	A133874
1DX Mercury (Hg)	ppm	<0.01	0.01	0.01	0.01	0.02	0.02	0.01	A133874
1DX Scandium (Sc)	ppm	2.0	1.8	1.8	2.1	1.2	3.5	0.1	A133874

RDL = Reportable Detection Limit

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

TRACE METALS BY AQUA REGIA DIGEST (SOLID)

BV Labs ID		ZA7043	ZA7044	ZA7045	ZA7046	ZA7047	ZA7048		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	9.043-TP1	9.044B-TP1	10.014A-TP5	10.020-TP3	10.030-TP1	10.043-TP1	RDL	QC Batch
1DX Thallium (Tl)	ppm	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	A133874
1DX Selenium (Se)	ppm	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	A133874
1DX Gallium (Ga)	ppm	2	1	1	1	<1	3	1	A133874
1DX Tellurium (Te)	ppm	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	A133874
RDL = Reportable Detection Limit									

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

SIDERITE CORRECTED ABA -SULPHATE SULPHUR (SOLID)

BV Labs ID		ZA7038		ZA7038	ZA7039	ZA7040	ZA7041		
Sampling Date		2020/12/14 09:11		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	7.101-TP1-1	RDL	7.101-TP1-1 Lab-Dup	7.155A-ARD1-1	9.002-ARD1-1	9.002A-TP1-1	RDL	QC Batch
Calculated Parameters									
S2 Sulphur (S)	wt%	<0.02	0.02	N/A	0.03	<0.02	<0.02	0.02	A118474
S-S Acid Generation Potential	Kg CaCO3/T	<0.6	0.6	N/A	0.9	<0.6	<0.6	0.6	A118459
S-S Net Neut. Potential Siderite	Kg CaCO3/T	7.70	N/A	N/A	90.4	306	12.7	N/A	A118468
Neutralization Potential Ratio	N/A	#N/A	0.1	N/A	101.4	#N/A	#N/A	0.1	A118470
Physical Properties									
Paste pH	pH Units	6.67	N/A	6.74	7.84	8.12	7.00	N/A	A126317
Total Sulphur (S)	wt%	<0.02	0.02	N/A	0.04	0.02	<0.02	0.02	A133691
Scaba HCl (N)	N/A	0.100	N/A	0.100	0.500	0.500	0.100	N/A	A130542
Scaba HCl (mL)	N/A	20.0	N/A	20.0	40.0	40.0	20.0	N/A	A130542
Scaba NaOH (N)	N/A	0.100	N/A	0.100	0.500	0.500	0.100	N/A	A130542
Scaba NaOH (mL)	N/A	16.9	N/A	17.0	32.7	15.4	14.9	N/A	A130542
Scaba Neutralization Potential	Kg CaCO3/T	7.70	N/A	N/A	91.3	306	12.7	N/A	A130540
Fizz Rating	N/A	SLIGHT	N/A	SLIGHT	MODERATE	MODERATE	SLIGHT	N/A	A130544

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

BV Labs ID		ZA7042	ZA7043	ZA7044	ZA7045	ZA7046		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	9.024B-TP2	9.043-TP1	9.044B-TP1	10.014A-TP5	10.020-TP3	RDL	QC Batch
Calculated Parameters								
S2 Sulphur (S)	wt%	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	A118474
S-S Acid Generation Potential	Kg CaCO3/T	<0.6	<0.6	<0.6	<0.6	<0.6	0.6	A118459
S-S Net Neut. Potential Siderite	Kg CaCO3/T	255	522	219	616	450	N/A	A118468
Neutralization Potential Ratio	N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.1	A118470
Physical Properties								
Paste pH	pH Units	7.95	8.34	8.35	8.23	8.33	N/A	A126317
Total Sulphur (S)	wt%	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	A133691
Scaba HCl (N)	N/A	0.500	0.500	0.500	0.500	0.500	N/A	A130542
Scaba HCl (mL)	N/A	40.0	80.0	40.0	80.0	40.0	N/A	A130542
Scaba NaOH (N)	N/A	0.500	0.500	0.500	0.500	0.500	N/A	A130542
Scaba NaOH (mL)	N/A	19.5	38.0	22.5	30.5	3.80	N/A	A130542
Scaba Neutralization Potential	Kg CaCO3/T	255	522	219	616	450	N/A	A130540
Fizz Rating	N/A	MODERATE	STRONG	MODERATE	STRONG	MODERATE	N/A	A130544

RDL = Reportable Detection Limit
N/A = Not Applicable

SIDERITE CORRECTED ABA -SULPHATE SULPHUR (SOLID)

BV Labs ID		ZA7047	ZA7048		ZA7048	
Sampling Date		2020/12/14 09:11	2020/12/14 09:11		2020/12/14 09:11	
	UNITS	10.030-TP1	10.043-TP1	RDL	10.043-TP1 Lab-Dup	QC Batch
Calculated Parameters						
S2 Sulphur (S)	wt%	<0.02	<0.02	0.02	N/A	A118474
S-S Acid Generation Potential	Kg CaCO3/T	<0.6	<0.6	0.6	N/A	A118459
S-S Net Neut. Potential Siderite	Kg CaCO3/T	809	124	N/A	N/A	A118468
Neutralization Potential Ratio	N/A	#N/A	#N/A	0.1	N/A	A118470
Physical Properties						
Paste pH	pH Units	8.35	7.70	N/A	7.71	A126317
Total Sulphur (S)	wt%	<0.02	<0.02	0.02	N/A	A133691
Scaba HCl (N)	N/A	0.500	0.500	N/A	0.500	A130542
Scaba HCl (mL)	N/A	80.0	40.0	N/A	40.0	A130542
Scaba NaOH (N)	N/A	0.500	0.500	N/A	0.500	A130542
Scaba NaOH (mL)	N/A	15.3	30.1	N/A	29.7	A130542
Scaba Neutralization Potential	Kg CaCO3/T	809	124	N/A	N/A	A130540
Fizz Rating	N/A	STRONG	MODERATE	N/A	MODERATE	A130544

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

SULPHATE SULPHUR (BY DIFFERENCE)

BV Labs ID		ZA7038	ZA7038	ZA7039	ZA7040	ZA7041	ZA7042		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	7.101-TP1-1	7.101-TP1-1 Lab-Dup	7.155A-ARD1-1	9.002-ARD1-1	9.002A-TP1-1	9.024B-TP2	RDL	QC Batch
Calculated Parameters									
HCSO4 Sulphur (S)	wt%	<0.01	<0.01	0.01	0.01	<0.01	0.01	0.01	A118142
Anions									
HCl Extracted Sulphate (SO4)	mg/L	1.03	0.76	3.98	1.68	0.66	2.60	0.50	A127602

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

BV Labs ID		ZA7043	ZA7044	ZA7045	ZA7046	ZA7047	ZA7048	ZA7048		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	9.043-TP1	9.044B-TP1	10.014A-TP5	10.020-TP3	10.030-TP1	10.043-TP1	10.043-TP1 Lab-Dup	RDL	QC Batch
Calculated Parameters										
HCSO4 Sulphur (S)	wt%	<0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01	0.01	A118142
Anions										
HCl Extracted Sulphate (SO4)	mg/L	1.28	0.95	1.70	1.20	1.95	0.61	0.77	0.50	A127602

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

RESULTS OF CHEMICAL ANALYSES OF SOLID

BV Labs ID		ZA7037	ZA7038	ZA7038		ZA7039		
Sampling Date		2020/12/14 09:10	2020/12/14 09:11	2020/12/14 09:11		2020/12/14 09:11		
	UNITS	SFE BLANK	7.101-TP1-1	7.101-TP1-1 Lab-Dup	QC Batch	7.155A-ARD1-1	RDL	QC Batch
Industrial								
Dry Weight	kg	N/A	11.50	N/A	A131599	2.087	N/A	A131572
Misc. Inorganics								
MEND Extract Acidity (pH 4.5)	mg/L	<0.5	<0.5	N/A	A136443	<0.5	0.5	A136443
MEND Extract Acidity (pH 8.3)	mg/L	<0.5	1.7	N/A	A136443	<0.5	0.5	A136443
ARD								
MEND Extract Conductivity	uS/cm	<1	77	77	A131380	267	1	A131380
MEND Extract pH	pH Units	5.76	5.59	5.58	A131379	8.20	N/A	A131379
Calculated Parameters								
MEND Extract Anion Sum	N/A	0.0170	0.787	N/A	A118462	2.98	N/A	A118462
MEND Extract Cation Sum	N/A	0.00200	0.727	N/A	A118462	2.59	N/A	A118462
MEND Extract Hardness (CaCO3)	mg/L	<0.50	29.8	N/A	A118461	125	0.50	A118461
MEND Extract Ion Balance	N/A	78.9	4.00	N/A	A118462	6.90	N/A	A118462
Preparation								
Prep of Samples at Maxxam	N/A	N/A	Yes	N/A	A113303	Yes	N/A	A113303

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

RESULTS OF CHEMICAL ANALYSES OF SOLID

BV Labs ID		ZA7040		ZA7041	ZA7042		ZA7043		
Sampling Date		2020/12/14 09:11		2020/12/14 09:11	2020/12/14 09:11		2020/12/14 09:11		
	UNITS	9.002-ARD1-1	QC Batch	9.002A-TP1-1	9.024B-TP2	QC Batch	9.043-TP1	RDL	QC Batch
Industrial									
Dry Weight	kg	1.337	A131572	1.038	0.7640	A131572	0.9170	N/A	A131572
Misc. Inorganics									
MEND Extract Acidity (pH 4.5)	mg/L	<0.5	A131385	<0.5	<0.5	A136443	<0.5	0.5	A131385
MEND Extract Acidity (pH 8.3)	mg/L	<0.5	A131385	1.7	<0.5	A136443	<0.5	0.5	A131385
ARD									
MEND Extract Conductivity	uS/cm	80	A131380	97	181	A131380	85	1	A131380
MEND Extract pH	pH Units	8.90	A131379	6.57	8.16	A131379	8.96	N/A	A131379
Calculated Parameters									
MEND Extract Anion Sum	N/A	1.07	A118462	1.19	2.03	A118462	0.998	N/A	A137716
MEND Extract Cation Sum	N/A	0.823	A118462	1.03	1.70	A118462	0.842	N/A	A137716
MEND Extract Hardness (CaCO3)	mg/L	38.0	A118461	46.5	81.9	A118461	38.3	0.50	A118461
MEND Extract Ion Balance	N/A	12.9	A118462	7.10	8.80	A118462	8.50	N/A	A137716
Preparation									
Prep of Samples at Maxxam	N/A	Yes	A113303	Yes	Yes	A113303	Yes	N/A	A113303

RDL = Reportable Detection Limit
N/A = Not Applicable

RESULTS OF CHEMICAL ANALYSES OF SOLID

BV Labs ID		ZA7044		ZA7045		ZA7046	ZA7047		
Sampling Date		2020/12/14 09:11		2020/12/14 09:11		2020/12/14 09:11	2020/12/14 09:11		
	UNITS	9.044B-TP1	QC Batch	10.014A-TP5	QC Batch	10.020-TP3	10.030-TP1	RDL	QC Batch
Industrial									
Dry Weight	kg	0.5890	A131572	1.085	A131572	0.8800	0.8500	N/A	A131572
Misc. Inorganics									
MEND Extract Acidity (pH 4.5)	mg/L	<0.5	A131385	<0.5	A131385	<0.5	<0.5	0.5	A131385
MEND Extract Acidity (pH 8.3)	mg/L	<0.5	A131385	<0.5	A131385	<0.5	<0.5	0.5	A131385
ARD									
MEND Extract Conductivity	uS/cm	93	A131380	82	A131380	105	71	1	A131380
MEND Extract pH	pH Units	8.97	A131379	9.21	A131379	8.29	8.89	N/A	A131379
Calculated Parameters									
MEND Extract Anion Sum	N/A	1.45	A118462	1.08	A137716	1.46	0.874	N/A	A118462
MEND Extract Cation Sum	N/A	1.03	A118462	0.842	A137716	0.972	0.755	N/A	A118462
MEND Extract Hardness (CaCO3)	mg/L	49.3	A118461	39.0	A118461	45.8	35.3	0.50	A118461
MEND Extract Ion Balance	N/A	17.1	A118462	12.5	A137716	20.1	7.30	N/A	A118462
Preparation									
Prep of Samples at Maxxam	N/A	Yes	A113303	Yes	A113303	Yes	Yes	N/A	A113303

RDL = Reportable Detection Limit
N/A = Not Applicable

RESULTS OF CHEMICAL ANALYSES OF SOLID

BV Labs ID		ZA7048	ZA7048		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11		
	UNITS	10.043-TP1	10.043-TP1 Lab-Dup	RDL	QC Batch
Industrial					
Dry Weight	kg	0.9020	N/A	N/A	A131572
Misc. Inorganics					
MEND Extract Acidity (pH 4.5)	mg/L	<0.5	N/A	0.5	A136443
MEND Extract Acidity (pH 8.3)	mg/L	<0.5	N/A	0.5	A136443
ARD					
MEND Extract Conductivity	uS/cm	98	97	1	A131380
MEND Extract pH	pH Units	7.82	7.83	N/A	A131379
Calculated Parameters					
MEND Extract Anion Sum	N/A	1.44	N/A	N/A	A137716
MEND Extract Cation Sum	N/A	1.14	N/A	N/A	A137716
MEND Extract Hardness (CaCO3)	mg/L	54.2	N/A	0.50	A118461
MEND Extract Ion Balance	N/A	11.8	N/A	N/A	A137716
Preparation					
Prep of Samples at Maxxam	N/A	Yes	N/A	N/A	A113303

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

ELEMENTS BY ATOMIC SPECTROSCOPY (SOLID)

BV Labs ID		ZA7037	ZA7038	ZA7039	ZA7040		
Sampling Date		2020/12/14 09:10	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	SFE BLANK	7.101-TP1-1	7.155A-ARD1-1	9.002-ARD1-1	RDL	QC Batch
Dissolved Metals by ICPMS							
MEND Extract Aluminum (Al)	mg/L	<0.00050	0.245	0.0712	0.172	0.00050	A131694
MEND Extract Antimony (Sb)	mg/L	<0.000020	0.000120	0.000361	0.000087	0.000020	A131694
MEND Extract Arsenic (As)	mg/L	<0.000020	0.000472	0.000642	0.000532	0.000020	A131694
MEND Extract Barium (Ba)	mg/L	<0.000020	0.0369	0.121	0.0623	0.000020	A131694
MEND Extract Beryllium (Be)	mg/L	<0.000010	0.000028	<0.000010	<0.000010	0.000010	A131694
MEND Extract Bismuth (Bi)	mg/L	<0.0000050	0.0000063	<0.0000050	<0.0000050	0.0000050	A131694
MEND Extract Boron (B)	mg/L	<0.050	<0.050	<0.050	<0.050	0.050	A131694
MEND Extract Cadmium (Cd)	mg/L	<0.0000050	0.0000518	0.0000112	<0.0000050	0.0000050	A131694
MEND Extract Cesium (Cs)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	0.000050	A131694
MEND Extract Chromium (Cr)	mg/L	<0.00010	0.00059	<0.00010	<0.00010	0.00010	A131694
MEND Extract Cobalt (Co)	mg/L	<0.0000050	0.000371	0.0000306	0.0000241	0.0000050	A131694
MEND Extract Copper (Cu)	mg/L	<0.000050	0.00480	0.000793	0.00136	0.000050	A131694
MEND Extract Iron (Fe)	mg/L	<0.0010	0.141	0.0096	0.0412	0.0010	A131694
MEND Extract Lanthanum (La)	mg/L	<0.000050	0.000273	<0.000050	<0.000050	0.000050	A131694
MEND Extract Lead (Pb)	mg/L	<0.0000050	0.000238	0.0000303	0.0000343	0.0000050	A131694
MEND Extract Lithium (Li)	mg/L	<0.00050	0.00071	0.00227	0.00083	0.00050	A131694
MEND Extract Manganese (Mn)	mg/L	<0.000050	0.0770	0.00471	0.000956	0.000050	A131694
MEND Extract Molybdenum (Mo)	mg/L	<0.000050	0.000175	0.00114	0.000624	0.000050	A131694
MEND Extract Nickel (Ni)	mg/L	<0.000020	0.000843	0.000632	0.000200	0.000020	A131694
MEND Extract Phosphorus (P)	mg/L	0.0026	0.0158	0.0160	0.0141	0.0020	A131694
MEND Extract Rubidium (Rb)	mg/L	<0.000050	0.00364	0.00177	0.000318	0.000050	A131694
MEND Extract Selenium (Se)	mg/L	<0.000040	0.000065	0.000214	0.000180	0.000040	A131694
MEND Extract Silicon (Si)	mg/L	<0.10	1.57	1.34	0.86	0.10	A131694
MEND Extract Silver (Ag)	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000050	A131694
MEND Extract Strontium (Sr)	mg/L	<0.000050	0.0198	0.105	0.0225	0.000050	A131694
MEND Extract Tellurium (Te)	mg/L	<0.000020	<0.000020	<0.000020	<0.000020	0.000020	A131694
MEND Extract Thallium (Tl)	mg/L	<0.0000020	0.0000207	0.0000275	0.0000049	0.0000020	A131694
MEND Extract Thorium (Th)	mg/L	0.0000097	0.000444	0.0000324	0.0000272	0.0000050	A131694
MEND Extract Tin (Sn)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	0.00020	A131694
MEND Extract Titanium (Ti)	mg/L	<0.00050	0.00335	<0.00050	0.00118	0.00050	A131694
MEND Extract Tungsten (W)	mg/L	<0.000010	0.000021	0.000063	0.000046	0.000010	A131694
MEND Extract Uranium (U)	mg/L	0.0000024	0.000265	0.000133	0.000120	0.0000020	A131694
MEND Extract Vanadium (V)	mg/L	<0.00020	0.00139	0.00072	0.00054	0.00020	A131694
RDL = Reportable Detection Limit							

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

ELEMENTS BY ATOMIC SPECTROSCOPY (SOLID)

BV Labs ID		ZA7037	ZA7038	ZA7039	ZA7040		
Sampling Date		2020/12/14 09:10	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	SFE BLANK	7.101-TP1-1	7.155A-ARD1-1	9.002-ARD1-1	RDL	QC Batch
MEND Extract Zinc (Zn)	mg/L	<0.00010	0.00289	0.00036	0.00023	0.00010	A131694
MEND Extract Zirconium (Zr)	mg/L	<0.00010	0.00054	<0.00010	<0.00010	0.00010	A131694
MEND Extract Calcium (Ca)	mg/L	<0.050	7.74	44.7	12.4	0.050	A131694
MEND Extract Magnesium (Mg)	mg/L	<0.050	2.54	3.36	1.70	0.050	A131694
MEND Extract Potassium (K)	mg/L	<0.050	1.55	1.93	0.785	0.050	A131694
MEND Extract Sodium (Na)	mg/L	<0.050	1.25	0.717	0.525	0.050	A131694
MEND Extract Mercury (Hg)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	0.000050	A131694
MEND Extract Sulphur (S)	mg/L	<10	<10	35	<10	10	A131694
RDL = Reportable Detection Limit							

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

ELEMENTS BY ATOMIC SPECTROSCOPY (SOLID)

BV Labs ID		ZA7041	ZA7042	ZA7043	ZA7044		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	9.002A-TP1-1	9.024B-TP2	9.043-TP1	9.044B-TP1	RDL	QC Batch
Dissolved Metals by ICPMS							
MEND Extract Aluminum (Al)	mg/L	0.152	0.0956	0.165	0.0885	0.00050	A131694
MEND Extract Antimony (Sb)	mg/L	0.000058	0.000068	0.000045	0.000070	0.000020	A131694
MEND Extract Arsenic (As)	mg/L	0.000432	0.000183	0.000304	0.000666	0.000020	A131694
MEND Extract Barium (Ba)	mg/L	0.0785	0.0312	0.0401	0.0527	0.000020	A131694
MEND Extract Beryllium (Be)	mg/L	0.000034	<0.000010	<0.000010	<0.000010	0.000010	A131694
MEND Extract Bismuth (Bi)	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000050	A131694
MEND Extract Boron (B)	mg/L	<0.050	<0.050	<0.050	<0.050	0.050	A131694
MEND Extract Cadmium (Cd)	mg/L	0.0000359	0.000121	<0.0000050	<0.0000050	0.0000050	A131694
MEND Extract Cesium (Cs)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	0.000050	A131694
MEND Extract Chromium (Cr)	mg/L	0.00037	<0.00010	<0.00010	<0.00010	0.00010	A131694
MEND Extract Cobalt (Co)	mg/L	0.000590	0.0000876	0.0000203	0.0000842	0.0000050	A131694
MEND Extract Copper (Cu)	mg/L	0.00493	0.00453	0.00113	0.00411	0.000050	A131694
MEND Extract Iron (Fe)	mg/L	0.152	0.0389	0.0249	0.0452	0.0010	A131694
MEND Extract Lanthanum (La)	mg/L	0.000805	0.000058	<0.000050	0.000075	0.000050	A131694
MEND Extract Lead (Pb)	mg/L	0.000194	0.0000675	0.0000290	0.0000349	0.0000050	A131694
MEND Extract Lithium (Li)	mg/L	<0.00050	0.00113	0.00097	0.00069	0.00050	A131694
MEND Extract Manganese (Mn)	mg/L	0.225	0.0286	0.000950	0.00189	0.000050	A131694
MEND Extract Molybdenum (Mo)	mg/L	0.000194	0.000589	0.000700	0.000649	0.000050	A131694
MEND Extract Nickel (Ni)	mg/L	0.00109	0.000425	0.000241	0.000794	0.000020	A131694
MEND Extract Phosphorus (P)	mg/L	0.0195	0.0168	0.0209	0.0241	0.0020	A131694
MEND Extract Rubidium (Rb)	mg/L	0.00101	0.000353	0.000329	0.000191	0.000050	A131694
MEND Extract Selenium (Se)	mg/L	0.000120	0.000120	0.000108	0.000227	0.000040	A131694
MEND Extract Silicon (Si)	mg/L	1.20	0.55	0.67	0.88	0.10	A131694
MEND Extract Silver (Ag)	mg/L	0.0000091	0.0000052	<0.0000050	0.0000122	0.0000050	A131694
MEND Extract Strontium (Sr)	mg/L	0.0204	0.0451	0.0214	0.0148	0.000050	A131694
MEND Extract Tellurium (Te)	mg/L	<0.000020	<0.000020	<0.000020	<0.000020	0.000020	A131694
MEND Extract Thallium (Tl)	mg/L	0.0000052	0.0000090	0.0000041	0.0000033	0.0000020	A131694
MEND Extract Thorium (Th)	mg/L	0.000495	0.0000435	0.0000271	0.0000736	0.0000050	A131694
MEND Extract Tin (Sn)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	0.00020	A131694
MEND Extract Titanium (Ti)	mg/L	0.00178	0.00093	0.00170	0.00367	0.00050	A131694
MEND Extract Tungsten (W)	mg/L	<0.000010	0.000018	0.000030	0.000031	0.000010	A131694
MEND Extract Uranium (U)	mg/L	0.000108	0.0000776	0.0000804	0.000122	0.0000020	A131694
MEND Extract Vanadium (V)	mg/L	0.00035	0.00022	0.00038	0.00046	0.00020	A131694
RDL = Reportable Detection Limit							

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

ELEMENTS BY ATOMIC SPECTROSCOPY (SOLID)

BV Labs ID		ZA7041	ZA7042	ZA7043	ZA7044		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		
	UNITS	**9.002A-TP1-1**	**9.024B-TP2**	**9.043-TP1**	**9.044B-TP1**	**RDL**	**QC Batch**
MEND Extract Zinc (Zn)	mg/L	0.00318	0.00380	0.00019	0.00124	0.00010	A131694
MEND Extract Zirconium (Zr)	mg/L	0.00069	0.00010	<0.00010	0.00051	0.00010	A131694
MEND Extract Calcium (Ca)	mg/L	11.8	26.7	12.8	13.2	0.050	A131694
MEND Extract Magnesium (Mg)	mg/L	4.17	3.72	1.55	3.98	0.050	A131694
MEND Extract Potassium (K)	mg/L	1.73	0.675	0.998	0.392	0.050	A131694
MEND Extract Sodium (Na)	mg/L	0.611	0.823	0.716	0.479	0.050	A131694
MEND Extract Mercury (Hg)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	0.000050	A131694
MEND Extract Sulphur (S)	mg/L	<10	20	<10	<10	10	A131694
RDL = Reportable Detection Limit							

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

ELEMENTS BY ATOMIC SPECTROSCOPY (SOLID)

BV Labs ID		ZA7045	ZA7046	ZA7047		ZA7048		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		2020/12/14 09:11		
	UNITS	10.014A-TP5	10.020-TP3	10.030-TP1	QC Batch	10.043-TP1	RDL	QC Batch
Dissolved Metals by ICPMS								
MEND Extract Aluminum (Al)	mg/L	0.175	0.0844	0.142	A131694	0.110	0.00050	A131702
MEND Extract Antimony (Sb)	mg/L	0.000044	0.000072	0.000051	A131694	0.000077	0.000020	A131702
MEND Extract Arsenic (As)	mg/L	0.000327	0.000631	0.000278	A131694	0.000540	0.000020	A131702
MEND Extract Barium (Ba)	mg/L	0.0272	0.101	0.0290	A131694	0.0437	0.000020	A131702
MEND Extract Beryllium (Be)	mg/L	<0.000010	<0.000010	<0.000010	A131694	0.000013	0.000010	A131702
MEND Extract Bismuth (Bi)	mg/L	<0.0000050	<0.0000050	<0.0000050	A131694	<0.0000050	0.0000050	A131702
MEND Extract Boron (B)	mg/L	<0.050	<0.050	<0.050	A131694	<0.050	0.050	A131702
MEND Extract Cadmium (Cd)	mg/L	<0.0000050	<0.0000050	0.0000057	A131694	<0.0000050	0.0000050	A131702
MEND Extract Cesium (Cs)	mg/L	<0.000050	<0.000050	<0.000050	A131694	<0.000050	0.000050	A131702
MEND Extract Chromium (Cr)	mg/L	<0.00010	0.00011	<0.00010	A131694	0.00027	0.00010	A131702
MEND Extract Cobalt (Co)	mg/L	0.0000159	0.0000847	0.0000379	A131694	0.000119	0.0000050	A131702
MEND Extract Copper (Cu)	mg/L	0.00175	0.00279	0.00258	A131694	0.00324	0.000050	A131702
MEND Extract Iron (Fe)	mg/L	0.0279	0.0372	0.0340	A131694	0.118	0.0010	A131702
MEND Extract Lanthanum (La)	mg/L	<0.000050	<0.000050	<0.000050	A131694	0.000485	0.000050	A131702
MEND Extract Lead (Pb)	mg/L	0.0000272	0.0000322	0.0000364	A131694	0.0000498	0.0000050	A131702
MEND Extract Lithium (Li)	mg/L	0.00126	0.00113	0.00093	A131694	<0.00050	0.00050	A131702
MEND Extract Manganese (Mn)	mg/L	0.000878	0.00335	0.000876	A131694	0.00823	0.000050	A131702
MEND Extract Molybdenum (Mo)	mg/L	0.000529	0.00111	0.000983	A131694	0.000960	0.000050	A131702
MEND Extract Nickel (Ni)	mg/L	0.000209	0.000729	0.000409	A131694	0.00123	0.000020	A131702
MEND Extract Phosphorus (P)	mg/L	0.0166	0.0209	0.0200	A131694	0.0317	0.0020	A131702
MEND Extract Rubidium (Rb)	mg/L	0.000482	0.000437	0.000549	A131694	0.000607	0.000050	A131702
MEND Extract Selenium (Se)	mg/L	0.000147	0.000106	0.000161	A131694	0.000243	0.000040	A131702
MEND Extract Silicon (Si)	mg/L	0.71	0.79	0.54	A131694	0.91	0.10	A131702
MEND Extract Silver (Ag)	mg/L	0.0000061	0.0000158	0.0000182	A131694	0.0000144	0.0000050	A131702
MEND Extract Strontium (Sr)	mg/L	0.0245	0.0257	0.0161	A131694	0.0191	0.000050	A131702
MEND Extract Tellurium (Te)	mg/L	<0.000020	<0.000020	<0.000020	A131694	<0.000020	0.000020	A131702
MEND Extract Thallium (Tl)	mg/L	0.0000088	0.0000092	0.0000121	A131694	0.0000039	0.0000020	A131702
MEND Extract Thorium (Th)	mg/L	0.0000234	0.0000191	0.0000229	A131694	0.0000714	0.0000050	A131702
MEND Extract Tin (Sn)	mg/L	<0.00020	<0.00020	<0.00020	A131694	<0.00020	0.00020	A131702
MEND Extract Titanium (Ti)	mg/L	0.00116	0.00131	0.00147	A131694	0.00331	0.00050	A131702
MEND Extract Tungsten (W)	mg/L	0.000023	0.000045	0.000017	A131694	0.000052	0.000010	A131702
MEND Extract Uranium (U)	mg/L	0.000117	0.0000757	0.000123	A131694	0.0000941	0.0000020	A131702
MEND Extract Vanadium (V)	mg/L	0.00044	0.00036	0.00032	A131694	0.00050	0.00020	A131702

RDL = Reportable Detection Limit

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

ELEMENTS BY ATOMIC SPECTROSCOPY (SOLID)

BV Labs ID		ZA7045	ZA7046	ZA7047		ZA7048		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11	2020/12/14 09:11		2020/12/14 09:11		
	UNITS	**10.014A-TP5**	**10.020-TP3**	**10.030-TP1**	**QC Batch**	**10.043-TP1**	**RDL**	**QC Batch**
MEND Extract Zinc (Zn)	mg/L	0.00043	0.00037	0.00040	A131694	0.00046	0.00010	A131702
MEND Extract Zirconium (Zr)	mg/L	<0.00010	<0.00010	0.00016	A131694	0.00056	0.00010	A131702
MEND Extract Calcium (Ca)	mg/L	13.1	15.8	11.9	A131694	15.4	0.050	A131702
MEND Extract Magnesium (Mg)	mg/L	1.50	1.54	1.39	A131694	3.79	0.050	A131702
MEND Extract Potassium (K)	mg/L	0.919	1.33	0.794	A131694	0.772	0.050	A131702
MEND Extract Sodium (Na)	mg/L	0.454	0.262	0.259	A131694	0.414	0.050	A131702
MEND Extract Mercury (Hg)	mg/L	<0.000050	<0.000050	<0.000050	A131694	<0.000050	0.000050	A131702
MEND Extract Sulphur (S)	mg/L	<10	<10	<10	A131694	<10	10	A131702
RDL = Reportable Detection Limit								

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

BV Labs Job #: C091932
Report Date: 2021/01/22

STANTEC CONSULTING LTD
Client Project #: 144903077
Site Location: MVH BORROW ASSESSMENT

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		ZA7037	ZA7038		ZA7039		ZA7040	ZA7041		
Sampling Date		2020/12/14 09:10	2020/12/14 09:11		2020/12/14 09:11		2020/12/14 09:11	2020/12/14 09:11		
	UNITS	SFE BLANK	7.101-TP1-1	QC Batch	7.155A-ARD1-1	QC Batch	9.002-ARD1-1	9.002A-TP1-1	RDL	QC Batch
Misc. Inorganics										
Alkalinity (Total as CaCO3)	mg/L	<0.50	3.65	A133622	25.6	A133622	34.2	36.3	0.50	A133622
Alkalinity (PP as CaCO3)	mg/L	<0.50	<0.50	A133622	<0.50	A133622	<0.50	<0.50	0.50	A133622
Bicarbonate (HCO3)	mg/L	<0.50	4.45	A133622	31.2	A133622	41.7	44.3	0.50	A133622
Carbonate (CO3)	mg/L	<0.50	<0.50	A133622	<0.50	A133622	<0.50	<0.50	0.50	A133622
Hydroxide (OH)	mg/L	<0.50	<0.50	A133622	<0.50	A133622	<0.50	<0.50	0.50	A133622
Anions										
Dissolved Chloride (Cl)	mg/L	0.59	2.3	A135670	2.2	A134177	2.3	1.9	0.50	A135670
Dissolved Sulphate (SO4)	mg/L	<0.50	31	A135670	120	A134177	15	20	0.50	A135670

RDL = Reportable Detection Limit

BV Labs ID		ZA7042	ZA7042		ZA7043	ZA7043		ZA7044		
Sampling Date		2020/12/14 09:11	2020/12/14 09:11		2020/12/14 09:11	2020/12/14 09:11		2020/12/14 09:11		
	UNITS	9.024B-TP2	9.024B-TP2 Lab-Dup	QC Batch	9.043-TP1	9.043-TP1 Lab-Dup	QC Batch	9.044B-TP1	RDL	QC Batch
Misc. Inorganics										
Alkalinity (Total as CaCO3)	mg/L	35.6	38.1	A133624	26.1	28.4	A137971	57.8	0.50	A133624
Alkalinity (PP as CaCO3)	mg/L	<0.50	<0.50	A133624	<0.50	<0.50	A137971	<0.50	0.50	A133624
Bicarbonate (HCO3)	mg/L	43.4	46.5	A133624	31.9	34.7	A137971	70.5	0.50	A133624
Carbonate (CO3)	mg/L	<0.50	<0.50	A133624	<0.50	<0.50	A137971	<0.50	0.50	A133624
Hydroxide (OH)	mg/L	<0.50	<0.50	A133624	<0.50	<0.50	A137971	<0.50	0.50	A133624
Anions										
Dissolved Chloride (Cl)	mg/L	1.4	N/A	A135670	2.3	N/A	A135670	1.3	0.50	A135670
Dissolved Sulphate (SO4)	mg/L	62	N/A	A135670	20	N/A	A135670	12	0.50	A135670

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		ZA7045		ZA7046	ZA7047		ZA7048		
Sampling Date		2020/12/14 09:11		2020/12/14 09:11	2020/12/14 09:11		2020/12/14 09:11		
	UNITS	10.014A-TP5	QC Batch	10.020-TP3	10.030-TP1	QC Batch	10.043-TP1	RDL	QC Batch
Misc. Inorganics									
Alkalinity (Total as CaCO3)	mg/L	34.0	A137971	59.3	33.2	A133624	61.6	0.50	A137971
Alkalinity (PP as CaCO3)	mg/L	<0.50	A137971	<0.50	<0.50	A133624	<0.50	0.50	A137971
Bicarbonate (HCO3)	mg/L	41.4	A137971	72.4	40.5	A133624	75.1	0.50	A137971
Carbonate (CO3)	mg/L	<0.50	A137971	<0.50	<0.50	A133624	<0.50	0.50	A137971
Hydroxide (OH)	mg/L	<0.50	A137971	<0.50	<0.50	A133624	<0.50	0.50	A137971
Anions									
Dissolved Chloride (Cl)	mg/L	1.8	A135670	3.8	1.4	A135670	1.0	0.50	A134177
Dissolved Sulphate (SO4)	mg/L	17	A135670	8.0	8.2	A135670	8.7	0.50	A134177
RDL = Reportable Detection Limit									

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

GENERAL COMMENTS

Sample ZA7037 [SFE BLANK] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Sample ZA7038 [7.101-TP1-1] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Sample ZA7039 [7.155A-ARD1-1] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Sample ZA7040 [9.002-ARD1-1] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Sample ZA7041 [9.002A-TP1-1] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Sample ZA7042 [9.024B-TP2] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Sample ZA7043 [9.043-TP1] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Sample ZA7044 [9.044B-TP1] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Sample ZA7045 [10.014A-TP5] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Sample ZA7046 [10.020-TP3] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Sample ZA7047 [10.030-TP1] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Sample ZA7048 [10.043-TP1] : Sample was analyzed past method specified hold time for Alkalinity - Low Level. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Low level chloride/sulphate by AC.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
A118142	ASC	QC Standard	HCSO4 Sulphur (S)	2021/01/11		0.28	%	N/A
A118142	ASC	Spiked Blank	HCSO4 Sulphur (S)	2021/01/11		0.28	%	N/A
A118142	ASC	Method Blank	HCSO4 Sulphur (S)	2021/01/11	<0.01		wt%	
A118142	ASC	RPD [ZA7038-02]	HCSO4 Sulphur (S)	2021/01/12	NC		%	20
A118142	ASC	RPD [ZA7048-02]	HCSO4 Sulphur (S)	2021/01/12	NC		%	20
A118142	ASC	RPD	HCSO4 Sulphur (S)	2021/01/11	0		%	20
			HCSO4 Sulphur (S)	2021/01/11	NC		%	20
			HCSO4 Sulphur (S)	2021/01/11	0		%	20
			HCSO4 Sulphur (S)	2021/01/12	7.4		%	20
			HCSO4 Sulphur (S)	2021/01/20	0		%	20
			HCSO4 Sulphur (S)	2021/01/20	0		%	20
A126317	RHO	QC Standard	Paste pH	2021/01/02		9.1	%	N/A
A126317	RHO	RPD [ZA7038-01]	Paste pH	2021/01/02	1.0		%	N/A
A126317	RHO	RPD [ZA7048-01]	Paste pH	2021/01/02	0.13		%	N/A
A126317	RHO	RPD	Paste pH	2021/01/02	0		%	N/A
			Paste pH	2021/01/02	0.61		%	N/A
A127602	BO3	Matrix Spike	HCl Extracted Sulphate (SO4)	2021/01/05		111	%	80 - 120
A127602	BO3	QC Standard	HCl Extracted Sulphate (SO4)	2021/01/05		99	%	80 - 120
A127602	BO3	Spiked Blank	HCl Extracted Sulphate (SO4)	2021/01/05		98	%	80 - 120
A127602	BO3	Method Blank	HCl Extracted Sulphate (SO4)	2021/01/05	<0.50		mg/L	
A127602	BO3	RPD	HCl Extracted Sulphate (SO4)	2021/01/05	15		%	20
			HCl Extracted Sulphate (SO4)	2021/01/05	5.6		%	20
A127602	BO3	RPD [ZA7038-02]	HCl Extracted Sulphate (SO4)	2021/01/05	NC		%	20
A127602	BO3	RPD [ZA7048-02]	HCl Extracted Sulphate (SO4)	2021/01/05	NC		%	20
A130540	RHO	QC Standard	Scaba Neutralization Potential	2021/01/07		83	%	N/A
A130540	RHO	Method Blank	Scaba Neutralization Potential	2021/01/07	2.50		Kg CaCO3/T	
A130544	RHO	RPD [ZA7038-01]	Fizz Rating	2021/01/09	NC		%	N/A
A130544	RHO	RPD [ZA7048-01]	Fizz Rating	2021/01/09	NC		%	N/A
A131380	RHO	RPD [ZA7038-03]	MEND Extract Conductivity	2021/01/11	0		%	20
A131380	RHO	RPD [ZA7048-03]	MEND Extract Conductivity	2021/01/11	1.0		%	20
A131694	AA1	Matrix Spike	MEND Extract Aluminum (Al)	2021/01/12		100	%	80 - 120
			MEND Extract Antimony (Sb)	2021/01/12		102	%	80 - 120
			MEND Extract Arsenic (As)	2021/01/12		98	%	80 - 120
			MEND Extract Barium (Ba)	2021/01/12		101	%	80 - 120
			MEND Extract Beryllium (Be)	2021/01/12		104	%	80 - 120
			MEND Extract Bismuth (Bi)	2021/01/12		94	%	80 - 120
			MEND Extract Boron (B)	2021/01/12		104	%	80 - 120
			MEND Extract Cadmium (Cd)	2021/01/12		101	%	80 - 120
			MEND Extract Cesium (Cs)	2021/01/12		98	%	80 - 120
			MEND Extract Chromium (Cr)	2021/01/12		98	%	80 - 120
			MEND Extract Cobalt (Co)	2021/01/12		97	%	80 - 120
			MEND Extract Copper (Cu)	2021/01/12		97	%	80 - 120
			MEND Extract Iron (Fe)	2021/01/12		100	%	80 - 120
			MEND Extract Lanthanum (La)	2021/01/12		98	%	80 - 120
			MEND Extract Lead (Pb)	2021/01/12		98	%	80 - 120
			MEND Extract Lithium (Li)	2021/01/12		107	%	80 - 120
			MEND Extract Manganese (Mn)	2021/01/12		97	%	80 - 120
			MEND Extract Molybdenum (Mo)	2021/01/12		97	%	80 - 120
			MEND Extract Nickel (Ni)	2021/01/12		98	%	80 - 120
			MEND Extract Phosphorus (P)	2021/01/12		104	%	80 - 120
			MEND Extract Rubidium (Rb)	2021/01/12		97	%	80 - 120
			MEND Extract Selenium (Se)	2021/01/12		103	%	80 - 120
			MEND Extract Silicon (Si)	2021/01/12		102	%	80 - 120
			MEND Extract Silver (Ag)	2021/01/12		96	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			MEND Extract Strontium (Sr)	2021/01/12		97	%	80 - 120
			MEND Extract Tellurium (Te)	2021/01/12		107	%	80 - 120
			MEND Extract Thallium (Tl)	2021/01/12		93	%	80 - 120
			MEND Extract Thorium (Th)	2021/01/12		99	%	80 - 120
			MEND Extract Tin (Sn)	2021/01/12		102	%	80 - 120
			MEND Extract Titanium (Ti)	2021/01/12		99	%	80 - 120
			MEND Extract Tungsten (W)	2021/01/12		102	%	80 - 120
			MEND Extract Uranium (U)	2021/01/12		101	%	80 - 120
			MEND Extract Vanadium (V)	2021/01/12		98	%	80 - 120
			MEND Extract Zinc (Zn)	2021/01/12		106	%	80 - 120
			MEND Extract Zirconium (Zr)	2021/01/12		96	%	80 - 120
			MEND Extract Calcium (Ca)	2021/01/12		98	%	80 - 120
			MEND Extract Magnesium (Mg)	2021/01/12		100	%	80 - 120
			MEND Extract Potassium (K)	2021/01/12		103	%	80 - 120
			MEND Extract Sodium (Na)	2021/01/12		101	%	80 - 120
			MEND Extract Mercury (Hg)	2021/01/12		101	%	80 - 120
			MEND Extract Sulphur (S)	2021/01/12		102	%	80 - 120
A131694	AA1	Spiked Blank	MEND Extract Aluminum (Al)	2021/01/12		99	%	80 - 120
			MEND Extract Antimony (Sb)	2021/01/12		102	%	80 - 120
			MEND Extract Arsenic (As)	2021/01/12		97	%	80 - 120
			MEND Extract Barium (Ba)	2021/01/12		101	%	80 - 120
			MEND Extract Beryllium (Be)	2021/01/12		104	%	80 - 120
			MEND Extract Bismuth (Bi)	2021/01/12		97	%	80 - 120
			MEND Extract Boron (B)	2021/01/12		106	%	80 - 120
			MEND Extract Cadmium (Cd)	2021/01/12		100	%	80 - 120
			MEND Extract Cesium (Cs)	2021/01/12		99	%	80 - 120
			MEND Extract Chromium (Cr)	2021/01/12		97	%	80 - 120
			MEND Extract Cobalt (Co)	2021/01/12		95	%	80 - 120
			MEND Extract Copper (Cu)	2021/01/12		96	%	80 - 120
			MEND Extract Iron (Fe)	2021/01/12		102	%	80 - 120
			MEND Extract Lanthanum (La)	2021/01/12		100	%	80 - 120
			MEND Extract Lead (Pb)	2021/01/12		98	%	80 - 120
			MEND Extract Lithium (Li)	2021/01/12		109	%	80 - 120
			MEND Extract Manganese (Mn)	2021/01/12		97	%	80 - 120
			MEND Extract Molybdenum (Mo)	2021/01/12		101	%	80 - 120
			MEND Extract Nickel (Ni)	2021/01/12		96	%	80 - 120
			MEND Extract Phosphorus (P)	2021/01/12		101	%	80 - 120
			MEND Extract Rubidium (Rb)	2021/01/12		99	%	80 - 120
			MEND Extract Selenium (Se)	2021/01/12		100	%	80 - 120
			MEND Extract Silicon (Si)	2021/01/12		104	%	80 - 120
			MEND Extract Silver (Ag)	2021/01/12		97	%	80 - 120
			MEND Extract Strontium (Sr)	2021/01/12		99	%	80 - 120
			MEND Extract Tellurium (Te)	2021/01/12		101	%	80 - 120
			MEND Extract Thallium (Tl)	2021/01/12		93	%	80 - 120
			MEND Extract Thorium (Th)	2021/01/12		98	%	80 - 120
			MEND Extract Tin (Sn)	2021/01/12		102	%	80 - 120
			MEND Extract Titanium (Ti)	2021/01/12		98	%	80 - 120
			MEND Extract Tungsten (W)	2021/01/12		104	%	80 - 120
			MEND Extract Uranium (U)	2021/01/12		102	%	80 - 120
			MEND Extract Vanadium (V)	2021/01/12		98	%	80 - 120
			MEND Extract Zinc (Zn)	2021/01/12		99	%	80 - 120
			MEND Extract Zirconium (Zr)	2021/01/12		99	%	80 - 120
			MEND Extract Calcium (Ca)	2021/01/12		101	%	80 - 120
			MEND Extract Magnesium (Mg)	2021/01/12		101	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			MEND Extract Potassium (K)	2021/01/12		102	%	80 - 120
			MEND Extract Sodium (Na)	2021/01/12		101	%	80 - 120
			MEND Extract Mercury (Hg)	2021/01/12		100	%	80 - 120
			MEND Extract Sulphur (S)	2021/01/12		101	%	80 - 120
A131694	AA1	Method Blank	MEND Extract Aluminum (Al)	2021/01/13	<0.00050		mg/L	
			MEND Extract Antimony (Sb)	2021/01/13	<0.000020		mg/L	
			MEND Extract Arsenic (As)	2021/01/13	<0.000020		mg/L	
			MEND Extract Barium (Ba)	2021/01/13	<0.000020		mg/L	
			MEND Extract Beryllium (Be)	2021/01/13	<0.000010		mg/L	
			MEND Extract Bismuth (Bi)	2021/01/13	<0.0000050		mg/L	
			MEND Extract Boron (B)	2021/01/13	<0.050		mg/L	
			MEND Extract Cadmium (Cd)	2021/01/13	<0.0000050		mg/L	
			MEND Extract Cesium (Cs)	2021/01/13	<0.000050		mg/L	
			MEND Extract Chromium (Cr)	2021/01/13	<0.00010		mg/L	
			MEND Extract Cobalt (Co)	2021/01/13	<0.0000050		mg/L	
			MEND Extract Copper (Cu)	2021/01/13	<0.000050		mg/L	
			MEND Extract Iron (Fe)	2021/01/13	<0.0010		mg/L	
			MEND Extract Lanthanum (La)	2021/01/13	<0.000050		mg/L	
			MEND Extract Lead (Pb)	2021/01/13	<0.0000050		mg/L	
			MEND Extract Lithium (Li)	2021/01/13	<0.00050		mg/L	
			MEND Extract Manganese (Mn)	2021/01/13	<0.000050		mg/L	
			MEND Extract Molybdenum (Mo)	2021/01/13	<0.000050		mg/L	
			MEND Extract Nickel (Ni)	2021/01/13	<0.000020		mg/L	
			MEND Extract Phosphorus (P)	2021/01/13	<0.0020		mg/L	
			MEND Extract Rubidium (Rb)	2021/01/13	<0.000050		mg/L	
			MEND Extract Selenium (Se)	2021/01/13	<0.000040		mg/L	
			MEND Extract Silicon (Si)	2021/01/13	<0.10		mg/L	
			MEND Extract Silver (Ag)	2021/01/13	<0.0000050		mg/L	
			MEND Extract Strontium (Sr)	2021/01/13	<0.000050		mg/L	
			MEND Extract Tellurium (Te)	2021/01/13	<0.000020		mg/L	
			MEND Extract Thallium (Tl)	2021/01/13	<0.0000020		mg/L	
			MEND Extract Thorium (Th)	2021/01/13	<0.0000050		mg/L	
			MEND Extract Tin (Sn)	2021/01/13	<0.00020		mg/L	
			MEND Extract Titanium (Ti)	2021/01/13	<0.00050		mg/L	
			MEND Extract Tungsten (W)	2021/01/13	<0.000010		mg/L	
			MEND Extract Uranium (U)	2021/01/13	<0.0000020		mg/L	
			MEND Extract Vanadium (V)	2021/01/13	<0.00020		mg/L	
			MEND Extract Zinc (Zn)	2021/01/13	<0.00010		mg/L	
			MEND Extract Zirconium (Zr)	2021/01/13	<0.00010		mg/L	
			MEND Extract Calcium (Ca)	2021/01/13	<0.050		mg/L	
			MEND Extract Magnesium (Mg)	2021/01/13	<0.050		mg/L	
			MEND Extract Potassium (K)	2021/01/13	<0.050		mg/L	
			MEND Extract Sodium (Na)	2021/01/13	<0.050		mg/L	
			MEND Extract Mercury (Hg)	2021/01/13	<0.000050		mg/L	
			MEND Extract Sulphur (S)	2021/01/13	<10		mg/L	
A131694	AA1	RPD	MEND Extract Aluminum (Al)	2021/01/13	NC		%	20
			MEND Extract Antimony (Sb)	2021/01/13	NC		%	20
			MEND Extract Arsenic (As)	2021/01/13	NC		%	20
			MEND Extract Barium (Ba)	2021/01/13	NC		%	20
			MEND Extract Beryllium (Be)	2021/01/13	NC		%	20
			MEND Extract Bismuth (Bi)	2021/01/13	NC		%	20
			MEND Extract Boron (B)	2021/01/13	NC		%	20
			MEND Extract Cadmium (Cd)	2021/01/13	NC		%	20
			MEND Extract Cesium (Cs)	2021/01/13	NC		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			MEND Extract Chromium (Cr)	2021/01/13	NC		%	20
			MEND Extract Cobalt (Co)	2021/01/13	NC		%	20
			MEND Extract Copper (Cu)	2021/01/13	NC		%	20
			MEND Extract Iron (Fe)	2021/01/13	NC		%	20
			MEND Extract Lanthanum (La)	2021/01/13	NC		%	20
			MEND Extract Lead (Pb)	2021/01/13	NC		%	20
			MEND Extract Lithium (Li)	2021/01/13	NC		%	20
			MEND Extract Manganese (Mn)	2021/01/13	NC		%	20
			MEND Extract Molybdenum (Mo)	2021/01/13	NC		%	20
			MEND Extract Nickel (Ni)	2021/01/13	NC		%	20
			MEND Extract Phosphorus (P)	2021/01/13	NC		%	20
			MEND Extract Rubidium (Rb)	2021/01/13	NC		%	20
			MEND Extract Selenium (Se)	2021/01/13	NC		%	20
			MEND Extract Silicon (Si)	2021/01/13	NC		%	20
			MEND Extract Silver (Ag)	2021/01/13	NC		%	20
			MEND Extract Strontium (Sr)	2021/01/13	NC		%	20
			MEND Extract Tellurium (Te)	2021/01/13	NC		%	20
			MEND Extract Thallium (Tl)	2021/01/13	NC		%	20
			MEND Extract Thorium (Th)	2021/01/13	NC		%	20
			MEND Extract Tin (Sn)	2021/01/13	NC		%	20
			MEND Extract Titanium (Ti)	2021/01/13	NC		%	20
			MEND Extract Tungsten (W)	2021/01/13	NC		%	20
			MEND Extract Uranium (U)	2021/01/13	NC		%	20
			MEND Extract Vanadium (V)	2021/01/13	NC		%	20
			MEND Extract Zinc (Zn)	2021/01/13	NC		%	20
			MEND Extract Zirconium (Zr)	2021/01/13	NC		%	20
			MEND Extract Calcium (Ca)	2021/01/13	NC		%	20
			MEND Extract Magnesium (Mg)	2021/01/13	NC		%	20
			MEND Extract Potassium (K)	2021/01/13	NC		%	20
			MEND Extract Sodium (Na)	2021/01/13	NC		%	20
			MEND Extract Mercury (Hg)	2021/01/13	NC		%	N/A
			MEND Extract Sulphur (S)	2021/01/13	NC		%	20
A133622	IK0	Spiked Blank	Alkalinity (Total as CaCO3)	2021/01/14		105	%	80 - 120
A133622	IK0	Method Blank	Alkalinity (Total as CaCO3)	2021/01/14	<0.50		mg/L	
			Alkalinity (PP as CaCO3)	2021/01/14	<0.50		mg/L	
			Bicarbonate (HCO3)	2021/01/14	<0.50		mg/L	
			Carbonate (CO3)	2021/01/14	<0.50		mg/L	
			Hydroxide (OH)	2021/01/14	<0.50		mg/L	
A133622	IK0	RPD	Alkalinity (Total as CaCO3)	2021/01/14	9.3		%	20
			Alkalinity (PP as CaCO3)	2021/01/14	NC		%	20
			Bicarbonate (HCO3)	2021/01/14	9.3		%	20
			Carbonate (CO3)	2021/01/14	NC		%	20
			Hydroxide (OH)	2021/01/14	NC		%	20
A133624	IK0	Spiked Blank	Alkalinity (Total as CaCO3)	2021/01/15		100	%	80 - 120
A133624	IK0	Method Blank	Alkalinity (Total as CaCO3)	2021/01/15	<0.50		mg/L	
			Alkalinity (PP as CaCO3)	2021/01/15	<0.50		mg/L	
			Bicarbonate (HCO3)	2021/01/15	<0.50		mg/L	
			Carbonate (CO3)	2021/01/15	<0.50		mg/L	
			Hydroxide (OH)	2021/01/15	<0.50		mg/L	
A133624	IK0	RPD [ZA7042-06]	Alkalinity (Total as CaCO3)	2021/01/15	6.9		%	20
			Alkalinity (PP as CaCO3)	2021/01/15	NC		%	20
			Bicarbonate (HCO3)	2021/01/15	6.9		%	20
			Carbonate (CO3)	2021/01/15	NC		%	20
			Hydroxide (OH)	2021/01/15	NC		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
A133691	BT2	QC Standard	Total Sulphur (S)	2021/01/14		2.2	%	N/A
A133691	BT2	Spiked Blank	Total Sulphur (S)	2021/01/14		0.16	%	N/A
A133691	BT2	Method Blank	Total Sulphur (S)	2021/01/14	<0.02		wt%	
A133840	BT2	QC Standard	CO2	2021/01/15		3.5	%	N/A
A133840	BT2	Spiked Blank	CO2	2021/01/15		3.4	%	N/A
A133840	BT2	Method Blank	CO2	2021/01/15	<0.08		wt%	
A133840	BT2	RPD [ZA7043-01]	CO2	2021/01/15	1.3		%	20
A133845	BT2	QC Standard	1DX Iron (Fe)	2021/01/15		3.3	%	N/A
			1DX Calcium (Ca)	2021/01/15		3.0	%	N/A
			1DX Phosphorus (P)	2021/01/15		0.039	%	N/A
			1DX Magnesium (Mg)	2021/01/15		1.2	%	N/A
			1DX Titanium (Ti)	2021/01/15		0.0030	%	N/A
			1DX Aluminum (Al)	2021/01/15		1.3	%	N/A
			1DX Sodium (Na)	2021/01/15		0.068	%	N/A
			1DX Potassium (K)	2021/01/15		0.31	%	N/A
			1DX Sulphur (S)	2021/01/15		0.27	%	N/A
A133845	BT2	Spiked Blank	1DX Iron (Fe)	2021/01/15		3.1	%	N/A
			1DX Calcium (Ca)	2021/01/15		1.1	%	N/A
			1DX Phosphorus (P)	2021/01/15		0.075	%	N/A
			1DX Magnesium (Mg)	2021/01/15		0.87	%	N/A
			1DX Titanium (Ti)	2021/01/15		0.096	%	N/A
			1DX Aluminum (Al)	2021/01/15		1.2	%	N/A
			1DX Sodium (Na)	2021/01/15		0.075	%	N/A
			1DX Potassium (K)	2021/01/15		0.41	%	N/A
			1DX Sulphur (S)	2021/01/15		0.29	%	N/A
A133845	BT2	Method Blank	1DX Iron (Fe)	2021/01/15	<0.01		%	
			1DX Calcium (Ca)	2021/01/15	<0.01		%	
			1DX Phosphorus (P)	2021/01/15	<0.001		%	
			1DX Magnesium (Mg)	2021/01/15	<0.01		%	
			1DX Titanium (Ti)	2021/01/15	<0.001		%	
			1DX Aluminum (Al)	2021/01/15	<0.01		%	
			1DX Sodium (Na)	2021/01/15	<0.001		%	
			1DX Potassium (K)	2021/01/15	<0.01		%	
			1DX Sulphur (S)	2021/01/15	<0.05		%	
A133845	BT2	RPD [ZA7040-01]	1DX Iron (Fe)	2021/01/15	3.0		%	N/A
			1DX Calcium (Ca)	2021/01/15	1.2		%	N/A
			1DX Phosphorus (P)	2021/01/15	NC		%	N/A
			1DX Magnesium (Mg)	2021/01/15	1.4		%	N/A
			1DX Titanium (Ti)	2021/01/15	NC		%	N/A
			1DX Aluminum (Al)	2021/01/15	0		%	N/A
			1DX Sodium (Na)	2021/01/15	NC		%	N/A
			1DX Potassium (K)	2021/01/15	0		%	N/A
			1DX Sulphur (S)	2021/01/15	NC		%	N/A
A133861	BT2	QC Standard	1DX Gold (Au)	2021/01/15		58	%	N/A
A133861	BT2	Spiked Blank	1DX Gold (Au)	2021/01/15		57	%	N/A
A133861	BT2	Method Blank	1DX Gold (Au)	2021/01/15	<0.5		ppb	
A133861	BT2	RPD [ZA7040-01]	1DX Gold (Au)	2021/01/15	NC		%	N/A
A133874	BT2	QC Standard	1DX Molybdenum (Mo)	2021/01/15		0.60	%	N/A
			1DX Copper (Cu)	2021/01/15		114	%	N/A
			1DX Lead (Pb)	2021/01/15		55	%	N/A
			1DX Zinc (Zn)	2021/01/15		157	%	N/A
			1DX Silver (Ag)	2021/01/15		0.50	%	N/A
			1DX Nickel (Ni)	2021/01/15		64	%	N/A
			1DX Cobalt (Co)	2021/01/15		27	%	N/A

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			1DX Manganese (Mn)	2021/01/15		570	%	N/A
			1DX Arsenic (As)	2021/01/15		37	%	N/A
			1DX Uranium (U)	2021/01/15		1.2	%	N/A
			1DX Thorium (Th)	2021/01/15		9.5	%	N/A
			1DX Strontium (Sr)	2021/01/15		36	%	N/A
			1DX Cadmium (Cd)	2021/01/15		0.70	%	N/A
			1DX Antimony (Sb)	2021/01/15		2.5	%	N/A
			1DX Bismuth (Bi)	2021/01/15		1.0	%	N/A
			1DX Vanadium (V)	2021/01/15		22	%	N/A
			1DX Lanthanum (La)	2021/01/15		15	%	N/A
			1DX Chromium (Cr)	2021/01/15		41	%	N/A
			1DX Barium (Ba)	2021/01/15		261	%	N/A
			1DX Tungsten (W)	2021/01/15		0.10	%	N/A
			1DX Scandium (Sc)	2021/01/15		3.8	%	N/A
			1DX Thallium (Tl)	2021/01/15		0.40	%	N/A
			1DX Selenium (Se)	2021/01/15		<0.50	%	N/A
			1DX Gallium (Ga)	2021/01/15		4.0	%	N/A
			1DX Tellurium (Te)	2021/01/15		0.20	%	N/A
A133874	BT2	Spiked Blank	1DX Molybdenum (Mo)	2021/01/15		15	%	N/A
			1DX Copper (Cu)	2021/01/15		155	%	N/A
			1DX Lead (Pb)	2021/01/15		143	%	N/A
			1DX Zinc (Zn)	2021/01/15		363	%	N/A
			1DX Silver (Ag)	2021/01/15		1.8	%	N/A
			1DX Nickel (Ni)	2021/01/15		84	%	N/A
			1DX Cobalt (Co)	2021/01/15		14	%	N/A
			1DX Manganese (Mn)	2021/01/15		1060	%	N/A
			1DX Arsenic (As)	2021/01/15		45	%	N/A
			1DX Uranium (U)	2021/01/15		2.6	%	N/A
			1DX Thorium (Th)	2021/01/15		8.6	%	N/A
			1DX Strontium (Sr)	2021/01/15		67	%	N/A
			1DX Cadmium (Cd)	2021/01/15		2.5	%	N/A
			1DX Antimony (Sb)	2021/01/15		7.3	%	N/A
			1DX Bismuth (Bi)	2021/01/15		13	%	N/A
			1DX Vanadium (V)	2021/01/15		50	%	N/A
			1DX Lanthanum (La)	2021/01/15		19	%	N/A
			1DX Chromium (Cr)	2021/01/15		60	%	N/A
			1DX Barium (Ba)	2021/01/15		455	%	N/A
			1DX Tungsten (W)	2021/01/15		3.0	%	N/A
			1DX Scandium (Sc)	2021/01/15		3.2	%	N/A
			1DX Thallium (Tl)	2021/01/15		4.9	%	N/A
			1DX Selenium (Se)	2021/01/15		2.5	%	N/A
			1DX Gallium (Ga)	2021/01/15		5.0	%	N/A
			1DX Tellurium (Te)	2021/01/15		4.8	%	N/A
A133874	BT2	Method Blank	1DX Molybdenum (Mo)	2021/01/15	<0.1		ppm	
			1DX Copper (Cu)	2021/01/15	<0.1		ppm	
			1DX Lead (Pb)	2021/01/15	<0.1		ppm	
			1DX Zinc (Zn)	2021/01/15	<1		ppm	
			1DX Silver (Ag)	2021/01/15	<0.1		ppm	
			1DX Nickel (Ni)	2021/01/15	<0.1		ppm	
			1DX Cobalt (Co)	2021/01/15	<0.1		ppm	
			1DX Manganese (Mn)	2021/01/15	<1		ppm	
			1DX Arsenic (As)	2021/01/15	<0.5		ppm	
			1DX Uranium (U)	2021/01/15	<0.1		ppm	
			1DX Thorium (Th)	2021/01/15	<0.1		ppm	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			1DX Strontium (Sr)	2021/01/15	<1		ppm	
			1DX Cadmium (Cd)	2021/01/15	<0.1		ppm	
			1DX Antimony (Sb)	2021/01/15	<0.1		ppm	
			1DX Bismuth (Bi)	2021/01/15	<0.1		ppm	
			1DX Vanadium (V)	2021/01/15	<2		ppm	
			1DX Lanthanum (La)	2021/01/15	<1		ppm	
			1DX Chromium (Cr)	2021/01/15	<1		ppm	
			1DX Barium (Ba)	2021/01/15	<1		ppm	
			1DX Boron (B)	2021/01/15	<20		ppm	
			1DX Tungsten (W)	2021/01/15	<0.1		ppm	
			1DX Mercury (Hg)	2021/01/15	<0.01		ppm	
			1DX Scandium (Sc)	2021/01/15	<0.1		ppm	
			1DX Thallium (Tl)	2021/01/15	<0.1		ppm	
			1DX Selenium (Se)	2021/01/15	<0.5		ppm	
			1DX Gallium (Ga)	2021/01/15	<1		ppm	
			1DX Tellurium (Te)	2021/01/15	<0.2		ppm	
A133874	BT2	RPD [ZA7040-01]	1DX Molybdenum (Mo)	2021/01/15	0		%	35
			1DX Copper (Cu)	2021/01/15	2.0		%	35
			1DX Lead (Pb)	2021/01/15	1.8		%	35
			1DX Zinc (Zn)	2021/01/15	3.1		%	35
			1DX Silver (Ag)	2021/01/15	NC		%	N/A
			1DX Nickel (Ni)	2021/01/15	5.2		%	30
			1DX Cobalt (Co)	2021/01/15	9.9		%	30
			1DX Manganese (Mn)	2021/01/15	0.54		%	30
			1DX Arsenic (As)	2021/01/15	9.3		%	30
			1DX Uranium (U)	2021/01/15	31		%	N/A
			1DX Thorium (Th)	2021/01/15	1.6		%	20
			1DX Strontium (Sr)	2021/01/15	3.6		%	35
			1DX Cadmium (Cd)	2021/01/15	NC		%	30
			1DX Antimony (Sb)	2021/01/15	0		%	30
			1DX Bismuth (Bi)	2021/01/15	NC		%	30
			1DX Vanadium (V)	2021/01/15	8.3		%	30
			1DX Lanthanum (La)	2021/01/15	NC		%	N/A
			1DX Chromium (Cr)	2021/01/15	2.4		%	30
			1DX Barium (Ba)	2021/01/15	2.8		%	35
			1DX Boron (B)	2021/01/15	NC		%	N/A
			1DX Tungsten (W)	2021/01/15	0		%	30
			1DX Mercury (Hg)	2021/01/15	NC		%	N/A
			1DX Scandium (Sc)	2021/01/15	NC		%	N/A
			1DX Thallium (Tl)	2021/01/15	0		%	N/A
			1DX Selenium (Se)	2021/01/15	NC		%	N/A
			1DX Gallium (Ga)	2021/01/15	0		%	N/A
			1DX Tellurium (Te)	2021/01/15	NC		%	N/A
A134177	CCQ	Matrix Spike	Dissolved Chloride (Cl)	2021/01/15		110	%	80 - 120
			Dissolved Sulphate (SO4)	2021/01/15		NC	%	80 - 120
A134177	CCQ	Spiked Blank	Dissolved Chloride (Cl)	2021/01/15		114	%	80 - 120
			Dissolved Sulphate (SO4)	2021/01/15		105	%	80 - 120
A134177	CCQ	Method Blank	Dissolved Chloride (Cl)	2021/01/15	0.75, RDL=0.50 (1)		mg/L	
			Dissolved Sulphate (SO4)	2021/01/15	<0.50		mg/L	
A134177	CCQ	RPD	Dissolved Sulphate (SO4)	2021/01/15	0.25		%	20
A135670	BML	Matrix Spike	Dissolved Chloride (Cl)	2021/01/18		101	%	80 - 120
			Dissolved Sulphate (SO4)	2021/01/18		NC	%	80 - 120
A135670	BML	Spiked Blank	Dissolved Chloride (Cl)	2021/01/18		105	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Sulphate (SO4)	2021/01/18		100	%	80 - 120
A135670	BML	Method Blank	Dissolved Chloride (Cl)	2021/01/18	0.52, RDL=0.50 (2)		mg/L	
			Dissolved Sulphate (SO4)	2021/01/18	<0.50		mg/L	
A135670	BML	RPD	Dissolved Chloride (Cl)	2021/01/18	10		%	20
			Dissolved Sulphate (SO4)	2021/01/18	0.86 (3)		%	20
A136443	KRA	Spiked Blank	MEND Extract Acidity (pH 8.3)	2021/01/19		101	%	80 - 120
A136443	KRA	Method Blank	MEND Extract Acidity (pH 4.5)	2021/01/19	<0.5		mg/L	
			MEND Extract Acidity (pH 8.3)	2021/01/19	<0.5		mg/L	
A136443	KRA	RPD	MEND Extract Acidity (pH 4.5)	2021/01/19	NC		%	20
			MEND Extract Acidity (pH 8.3)	2021/01/19	NC		%	20
A137971	IK0	Spiked Blank	Alkalinity (Total as CaCO3)	2021/01/21		100	%	80 - 120
A137971	IK0	Method Blank	Alkalinity (Total as CaCO3)	2021/01/21	<0.50		mg/L	
			Alkalinity (PP as CaCO3)	2021/01/21	<0.50		mg/L	
			Bicarbonate (HCO3)	2021/01/21	<0.50		mg/L	
			Carbonate (CO3)	2021/01/21	<0.50		mg/L	
			Hydroxide (OH)	2021/01/21	<0.50		mg/L	
A137971	IK0	RPD [ZA7043-06]	Alkalinity (Total as CaCO3)	2021/01/21	8.4		%	20
			Alkalinity (PP as CaCO3)	2021/01/21	NC		%	20
			Bicarbonate (HCO3)	2021/01/21	8.4		%	20
			Carbonate (CO3)	2021/01/21	NC		%	20
			Hydroxide (OH)	2021/01/21	NC		%	20

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 spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 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 (absolute difference <= 2x RDL).

(1) Blank within 2X RDL.

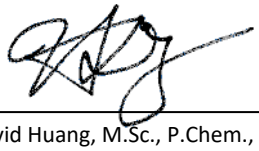
(2) Method blank above criteria but <2xRDL. Data inspected.

(3) Detection limits raised due to dilution to bring analyte within the calibrated range.

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

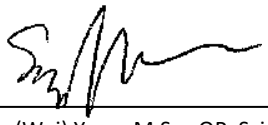
VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



David Huang, M.Sc., P.Chem., QP, Scientific Services Manager

Harry (Peng) Liang, Senior Analyst



Sandy (Wei) Yuan, M.Sc., QP, Scientific Specialist

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports.
For Service Group specific validation please refer to the Validation Signature Page.

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

C: 4202 (Scenario 16935)

Q: C01332

C091932

C091932_COC

ARD SAMPLE REQUISITION AND CHAIN OF CUSTODY FORM

Bureau Veritas Laboratories, 3456 Gardner Court, Burnaby, BC V5G 3K4

Attn: Tim O'Hearn

Page: 1 of 1

PO #: 144903057

BV Project No:

BVLabs Job Number:

Company: Stantec Consulting Ltd.	Project Name: MVH Borrow Assessment
Address: 2nd Floor, 4910 53 Street, PO Box 1777, Yellowknife NT X1A 2P4	Project No: 144903077
Telephone: (867) 920-2882	Fax:
Email: roxanne.pyke@stantec.com; erica.bonhomme@stantec.com; nikolay.sidenko@stantec.com	
Contact Person: Roxanne Pyke, Erica Bonhomme, Nikolay Sidenko	

Analysis Requested (1) (2) (3) (4)

	Sample ID		Sample Wt. (kg)	Sample Type & Condition	Rinse pH on <2mm fraction (MEND method)	Sobek ABA Package [Paste pH, Total S (by Leco) & NP]	Modified ABA Package [Paste pH, Total S (by Leco) & NP]	Sobrnik Corrected NP Package	Mod. ASTM 2492-02 Sulphur Speciation	Sulphate Sulphur (sulphide sulphur by difference)	Na2CO3 Extractable Sulphur	Total Carbon	Carbonate Carbon; (CO2:HCl method)	Single Addition NAG	NAG Extract Analysis	Trace Metals on solids by Aqua Regia Digestion	Metals on solids: 4 acid	Ultra Trace Metals on solids by Aqua Regia Digestion	Whole Rock - Majors by ICP (Group 4A)	Whole Rock - Majors by XRF	Water Extraction; MEND-SFE	Water Extraction; SPLP	Water Extraction; MWMP	Total Organic Carbon	Mineralogy; Optical Microscopy on polished thin sections	Mineralogy; Rietveld XRD	Humidity Cell - MEND method	Humidity Cell - ASTM Method	Column Testing	Particle Size Analysis (As received)		
	BV ID	Client ID																														
1	ZA7038	7.101-TP1-1	1.047					X		X			X			X					X									SFE test parameters => pH/EC/Acidity/Alkalinity/SO4/ Dissolved Metals (includes Hg)		
2		7.156A-ARD1-1	2.087					X		X			X			X					X											
3		9.002-ARD1-1	1.537					X		X			X			X					X											
4		9.002A-TP1-1	1.039					X		X			X			X					X											
5		9.024B-TP2	0.764					X		X			X			X					X											
6		9.043-TP1	0.917					X		X			X			X					X											
7		9.044B-TP1	0.589					X		X			X			X					X											
8		10.014A-TP5	1.085					X		X			X			X					X											
9		10.020-TP3	0.860					X		X			X			X					X											
10		10.030-TP1	0.800					X		X			X			X					X											
11	ZA7048	10.043-TP1	0.902					X		X			X			X					X											
12																Revised BTE Dec 14, 2020																
13		Total Wt Rec'd	11.466																													
14																																
15	ZA7037	SFE Blank - no charge																														
16																										Approved BTE Nov 30, 20						
17																																
18																																
19																																
20																																
21																																
22																																
23																																
24																																
25																																
26																																
27																																
28																																
29																																
30																																

Relinquished by:		Date:		Time:		Contact info to whom the invoice for the requested work should go to:	ARD Storage Policy:
Received by:		Date:		Time:		Contact person:	Samples will be store for 3 months after CofA reported. Beyond 3 months a storage fee will apply. Samples will be disposed of unless instructed otherwise.
Relinquished by:		Date:		Time:		Email:	
Received by:		Date:		Time:		Mailing Address: PO BOX 1777, 2ND FLOOR 4910 53 STREET, YELLOWKNIFE, NT, CANADA X1A 2P4	

605

ARD SAMPLE REQUISITION AND CHAIN OF CUSTODY FORM

Bureau Veritas Laboratories, 3450 Gardner Court, Burnaby, BC V5G 3K4
Attn: Tim O'Hearn

Phone: (604) 734-7276 Fax: (604) 731-2386
E-mail: timothy.ohearn@bvlabs.com and ard@bvlabs.com

Page: 1 of 1
PO #: 144903077
BV Project No:
BVLabs Job Number:

Company: Stantec Consulting Ltd.
Project Name: MVH Borrow Assessment
Project No: 144903077

Address:
Stantec
2nd Floor 4910 53 Street, PO Box 1777
Yellowknife NT X1A 2P4
Telephone: (867) 920-2882
Fax: —

Email: Roxanne.Pyke@stantec.com; Erica.Bonhomme@stantec.com; Nikolay.Sidenko@stantec.com
Contact Person: Roxanne Pyke; Erica Bonhomme; Nikolay Sidenko

Analysis Requested

#	Sample ID: BV ID	Sample ID: Client ID	Sample Wt. (kg)	Sample Type & Condition	Rinse pH on <2mm fraction (MEND method)	Sobek ABA Package (Paste pH, Total S (by Leco) & NP)	Modified ABA Package (Paste pH, Total S (by Leco) & NP)	Siderite Corrected NP Package	Mod. ASTM 2492-02 Sulphur Speciation	Sulphate Sulphur (sulphide sulphur by difference)	Na2CO3 Extractable Sulphur	Total Carbon	Carbonate Carbon (CO3 HCl method)	Single Addition NAG	NAG Extract Analysis	Trace Metals on solids by Aqua Regia Digestion	Metals on solids: 4 acid	Ultra Trace Metals on solids by Aqua Regia Digestion	Whole Rock - Majors by ICP (Group 4A)	Whole Rock - Majors by XRF	Water Extraction: MEND-SFE	Water Extraction: SPLP	Water Extraction: MWMP	Total Organic Carbon	Mineralogy: Optical Microscopy on polished thin sections	Mineralogy: Rietveld XRD	Humidity Cell - MEND method	Humidity Cell - ASTM Method	Column Testing	Particle Size Analysis (As received)		
1		7.101-TP1-1	1	soil				X		X			X								X											
2		7.155A-ARD1-1	1	soil				X		X			X								X											
3		9.002-ARD1-1	1	soil				X		X			X								X											
4		9.002A-TP1-1	1	soil				X		X			X								X											
5		9.024B-TP2	1	soil				X		X			X								X											
6		9.043-TP1	1	soil				X		X			X								X											
7		9.044B-TP1	1	soil				X		X			X								X											
8		10.014A-TP5	1	soil				X		X			X								X											
9		10.020-TP3	1	soil				X		X			X								X											
10		10.030-TP1	1	soil				X		X			X								X											
11		10.043-TP1	1	soil				X		X			X								X											
12																																
13																																
14																																
15																																
16																																
17																																
18																																
19																																
20																																
21																																
22																																
23																																
24																																
25																																
26																																
27																																
28																																
29																																
30																																

SFE test parameters => pH/EC/Acidity/Alkalinity/SO4/ Dissolved Metals (includes Hg)

Received in Yellowknife
By: J. Mcrorro [illegible]
10:30
NOV 26 2020

Temp: 12 12 13
ICE - N/A
CS - yes

10 : 11 11
~~ICE~~ DW2 2020/11/27
ICE: NO
Seal: yes

Relinquished by:	Roxanne Pyke	Date:	2020/11/26	Time:	10:00
Received by:	Deji Wu	Date:	2020/11/27	Time:	07:49
Relinquished by:		Date:		Time:	
Received by:		Date:		Time:	

Contact Info to whom the invoice for the requested work should go to:

Contact person:	Roxanne Pyke; Erica Bonhomme; Nikolay Sidenko
Email:	Roxanne.Pyke@stantec.com; Erica.Bonhomme@stantec.com; Nikolay.Sidenko@stantec.com
Mailing Address:	PO BOX 1777, 2ND FLOOR 4910 53 STREET, YELLOWKNIFE, NT, CANADA X1A 2P4

ARD Storage Policy:

Samples will be store for 3 months after CofA reported. Beyond 3 months a storage fee will apply. Samples will be disposed of unless instructed otherwise.

ACID ROCK DRAINAGE
Sample Inventory Form
Revision Date: 2013/08/26

MaxXam

BBY0FCD-00057/2

Date Received: 2020/11/30 **Balance ID:** BBY0-0084 **Date:** 2020/11/30
No. of Samples: 11 **Oven ID:** 10-1386 **Analyst:** JF
Customer: Stantec **Project Name:** MVH Borrow Assessment

Sample Number	Customer Sample ID	Wet Sample Weight (kg)	Dry Sample Weight (kg)	Sample Type & Condition	Notes
1	7.101-TP1-1	1.047		Wet Overburden/Coarse Rock	
2	7.155A-ARD1-1	2.087		Wet Overburden/Coarse Rock	
3	9.002-ARD1-1	1.337		Wet Overburden/Coarse Rock	
4	9.002A-TP1-1	1.038		Wet Overburden/Coarse Rock	
5	9.024B-TP2	0.764		Wet Overburden/Coarse Rock	
6	9.043-TP1	0.917		Wet Overburden/Coarse Rock	
7	9.044B-TP1	0.589		Wet Overburden/Coarse Rock	
8	10.014A-TP5	1.085		Wet Overburden/Coarse Rock	
9	10.020-TP3	0.880		Wet Overburden/Coarse Rock	
10	10.030-TP1	0.850		Wet Overburden/Coarse Rock	
11	10.043-TP1	0.902		Wet Overburden/Coarse Rock	

APPENDIX C ABA Results

Appendix C: ABA Results
Mackenzie Valley Highway – Assessment of Prospective Borrow Sources
Preliminary Acid Rock Drainage / Metal Leaching Assessment
Mackenzie Valley Highway, NT

Sample ID	Sample Description	pH	Total Sulphur	Sulphate	Sulphide	Carbonate NP ($CaCO_3$ Equiv.)	Siderite Corr. NP	AP	Fizz Rating	Carbonate NNP	Modified ABA NNP	Carbonate NPR	Siderite Corr. NPR	Classification (Carbonate NP)	Classification (Siderite Corr.)
Units		pH Units	wt%			kg $CaCO_3$/tonne			N/A	kg $CaCO_3$/tonne		ratio			
Detection Limit		1 to 14 range	0.02	0.01	0.02	0.1	0.60	0.6	N/A	0.1	0.1	N/A			
10.043-TP1	Primary Granular Borrow Source: sand, gravel from existing pit	7.70	<0.02	<0.01	<0.02	86	124	<0.6	MODERATE	86	124	286	413	Non-PAG	Non-PAG
10.030-TP1	Secondary Granular Source: sand, gravel from surface exposure in clearing	8.35	<0.02	0.01	<0.02	780	809	<0.6	STRONG	780	809	2600	2697	Non-PAG	Non-PAG
10.020-TP3	Primary Granular Source: sand, gravel in area where material had higher fines	8.33	<0.02	<0.01	<0.02	546	450	<0.6	MODERATE	546	450	1820	1500	Non-PAG	Non-PAG
10.014A-TP5	Primary Granular Source: sand, gravel, and cobble	8.23	<0.02	0.01	<0.02	570	616	<0.6	STRONG	570	616	1901	2053	Non-PAG	Non-PAG
9.044B-TP1	Secondary Granular Source: clean sand	8.35	<0.02	<0.01	<0.02	181	219	<0.6	MODERATE	181	219	603	730	Non-PAG	Non-PAG
9.043-TP1	Primary Granular Source: sand, gravel - obtained outside of existing pit	8.34	<0.02	<0.01	<0.02	484	522	<0.6	STRONG	484	522	1614	1740	Non-PAG	Non-PAG
9.024B-TP2	Secondary Granular Source: mainly sand	7.95	<0.02	0.01	<0.02	222	255	<0.6	MODERATE	222	255	740	850	Non-PAG	Non-PAG
9.002A-TP1-1	Secondary Granular Source: sand with pebbles	7.00	<0.02	<0.01	<0.02	5.5	13	<0.6	SLIGHT	5	12	18	42	Non-PAG	Non-PAG
9.002-ARD1-1	Primary Granular Source: sandy silt with cobbles, mixed lithology	8.12	0.02	0.01	<0.02	275	306	<0.6	MODERATE	275	306	917	1020	Non-PAG	Non-PAG
7.155A-ARD1-1	Primary Granular Source: sand with pebbles and cobbles	7.84	0.04	0.01	0.03	65	91	0.9	MODERATE	64	90	72	101	Non-PAG	Non-PAG
7.101-TP1-1	Secondary Granular Source: sand with pebbles and cobbles	6.67	<0.02	<0.01	<0.02	<0.5	7.7	<0.6	SLIGHT	-0.1	7.4	0.8	26	**PAG**	Non-PAG

Notes:
NP - Neutralization Potential
Corr. - Corrected
AP - Acid Generation Potential = Sulphide Sulphur (by diff.)*31.25
Fizz Rating - Reference method used is based on NP method.
NNP - Net Neutralization Potential = NP-AP (S-S by diff)
NPR = NP/AP
Siderite Corr. NP - MEND Acid Rock Drainage Prediction Manual, MEND Project 1.16.1b (pages 6.2-11 to 17), March 1991.
Sulphide = (Total Sulphur)-(Sulphate)

APPENDIX D

Summary of Shake Flask Extraction Results

Appendix D: Shake Flask Extraction Results and Exceedances
Mackenzie Valley Highway – Assessment of Prospective Borrow Sources
Preliminary Acid Rock Drainage / Metal Leaching Assessment
Mackenzie Valley Highway, NT

Parameter	Sample Description	Sulphate, Dissolved	pH (lab)	Hardness, Total (as $CaCO_3$)	Mercury, Dissolved	Aluminum, Dissolved	Arsenic, Dissolved	Barium, Dissolved	Boron, Dissolved	Cadmium, Dissolved	Chromium, Dissolved	Copper, Dissolved	Iron, Dissolved	Lead, Dissolved	Molybdenum, Dissolved	Nickel, Dissolved	Phosphorus, Dissolved	Selenium, Dissolved	Silver, Dissolved	Thallium, Dissolved	Uranium, dissolved	Zinc, dissolved
Units		mg/L	pH units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Min RDL		0.5	0.01	0.1	0.00002	0.001	0.00005	0.0001	0.002	0.000002	0.0001	0.0001	0.002	0.00005	0.00001	0.00004	0.01	0.0001	0.00001	0.000004	0.000001	0.001
CWQG Short-Term		nv	6.5-9.0	nv	nv	nv	nv	nv	29	0.0006	0.001	nv	nv	nv	nv	nv	nv	nv	nv	nv	0.033	0.021
CWQG Long-Term		nv	6.5-9.0	nv	0.000026	0.1/0.005	0.005	nv	1.5	0.00006	0.0089	0.002	0.3	0.001	0.073	0.025	guidance framework	0.001	0.00025	0.0008	0.015	0.0009
NWT Guidelines		nv	6-10.5	nv	100	nv	2.5	100	nv	1	5	nv	nv	nv	nv	nv	nv	1	5	nv	nv	500
10.043-TP1	Primary Granular Borrow Source: sand, gravel from existing pit	61.6	7.82	54.2	<0.000050	0.110	0.0005	0.04370	<0.050	<0.0000050	0.00027	0.0032	0.118	0.0000498	0.000960	0.00123	0.0317	0.000243	0.0000144	0.0000039	0.000094	0.00046
10.030-TP1	Secondary Granular Source: sand, gravel from surface exposure in clearing	33.2	8.89	35.3	<0.000050	0.142	0.0003	0.02900	<0.050	0.0000057	<0.00010	0.0026	0.0340	0.0000364	0.000983	0.000409	0.0200	0.000161	0.0000182	0.0000121	0.000123	0.00040
10.020-TP3	Primary Granular Source: sand, gravel in area where material had higher fine	59.3	8.29	45.8	<0.000050	0.084	0.0006	0.10100	<0.050	<0.0000050	0.00011	0.0028	0.0372	0.0000322	0.00111	0.000729	0.0209	0.000106	0.0000158	0.0000092	0.000076	0.00037
10.014A-TP5	Primary Granular Source: sand, gravel, and cobble	34.0	9.21	39.0	<0.000050	0.175	0.0003	0.02720	<0.050	<0.0000050	<0.00010	0.0018	0.0279	0.0000272	0.000529	0.000209	0.0166	0.000147	0.0000061	0.0000088	0.000117	0.00043
9.044B-TP1	Secondary Granular Source: clean sand	57.8	8.97	49.3	<0.000050	0.089	0.0007	0.05270	<0.050	<0.0000050	<0.00010	0.0041	0.0452	0.0000349	0.000649	0.000794	0.0241	0.000227	0.0000122	0.0000033	0.000122	0.00124
9.043-TP1	Primary Granular Source: sand, gravel - obtained outside of existing pit	26.1	8.96	38.3	<0.000050	0.165	0.0003	0.0401	<0.050	<0.0000050	<0.00010	0.0011	0.0249	0.0000290	0.000700	0.000241	0.0209	0.000108	<0.0000050	0.0000041	0.000080	0.00019
9.024B-TP2	Secondary Granular Source: mainly sand	35.6	8.16	81.9	<0.000050	0.096	0.0002	0.03120	<0.050	0.000121	<0.00010	0.0045	0.0389	0.0000675	0.000589	0.000425	0.0168	0.000120	0.0000052	0.0000090	0.000078	0.00380
9.002A-TP1-1	Secondary Granular Source: sand with pebbles	36.3	6.57	46.5	<0.000050	0.152	0.0004	0.07850	<0.050	0.0000359	0.00037	0.0049	0.152	0.000194	0.000194	0.00109	0.0195	0.000120	0.0000091	0.0000052	0.000108	0.00318
9.002-ARD1-1	Primary Granular Source: sandy silt with cobbles, mixed lithology	34.2	8.90	38.0	<0.000050	0.172	0.0005	0.06230	<0.050	<0.0000050	<0.00010	0.0014	0.0412	0.0000343	0.000624	0.000200	0.0141	0.000180	<0.0000050	0.0000049	0.000120	0.00023
7.155A-ARD1-1	Primary Granular Sourc: sand with pebbles and cobbles	25.6	8.20	125	<0.000050	0.071	0.0006	0.12100	<0.050	0.0000112	<0.00010	0.0008	0.0096	0.0000303	0.00114	0.000632	0.0160	0.000214	<0.0000050	0.0000275	0.000133	0.00036
7.101-TP1-1	Secondary Granular Source: sand with pebbles and cobbles	3.7	5.59	29.8	<0.000050	0.245	0.0005	0.03690	<0.050	0.000052	0.00059	0.0048	0.141	0.000238	0.000175	0.000843	0.0158	0.000065	<0.0000050	0.0000207	0.000265	0.00289

Notes:
Min RDL = Minimum Reportable Detection Limit.
nv = no value.
NWT Guidelines = Schedule IV: Standards for Solid Waste/Process Residuals Suitable for Landfill, Industrial Waste Guidelines, NWT (2004).
CWQG = Canadian Water Quality Guidelines for the protection of freshwater aquatic life (CCME 2021).
Values exceeding CWQG, Short-Term, are highlighted yellow, values exceeding CWQG, Long-Term, are underlined, and values exceeding NWT are outllined in thick box.
Long-Term CWQG for aluminum is pH dependent. Guideline is 5 µg/L if pH <6.5 and is 100 µg/L if pH ≥ 6.5.
CWQG, Short-Term, for cadmium is hardness dependent. For hardness 0 to 5.3 mg/L, guidelines is 0.11 µg/L. For hardness ≥5.3 to ≤ 360 mg/L, guideline is calculated = 10^(1.016(log(hardness))-1.71); for hardness > 360 mg/L, guideline is 7.7 µg/L.
CWQG, Long-Term, for cadmium is hardness dependent. For hardness 0 to 17mg/L, guideline is 0.04 µg/L; for hardness ≥17 to ≤ 280 mg/L, the guideline is = 10^(0.83(log(hardness))-2.46).
CWQG, Long Term, for copper is hardness dependent. Guideline is 2 µg/L for 0 to<82 mg/L hardness; for harness ≥82 to ≤180 mg/L guideline = 0.2*e^(0.8545(ln(hardness))-1.465); for hardness >180 mg/L guideline = 4 µg/L .
CWQG, Long-Term, for lead is hardness dependent. When the water hardness is 0 to ≤ 60 mg/L, the CWQG is 1µg/L. At hardness > 60 to ≤ 180 mg/L the CWQG is calculated using this equation: CWQG (µg/L) = e{1.273[ln(hardness)]-4.705}. At hardness >180 mg/L, the CWQG is 7 µg/L. If the hardness is unknown, the CWQG is 1 µg/L.
CWQG, Long-Term, for nickel is hardness dependent. When the water hardness is 0 to ≤ 60 mg/L, the CWQG is 25 µg/L. At hardness > 60 to ≤ 180 mg/L the CWQG is calculated using this equation: CWQG (µg/L) = e{0.76[ln(hardness)]+1.06}. At hardness >180 mg/L, the CWQG is 150 µg/L. If the hardness is unknown, the CWQG is 25 µg/L.
Only parameters with established guidelines are shown in this table, plus sulphate (characteristic parameter in ML/ARD analysis) and hardness (used for calculations of some of the guidelines).
CWQG, Short-Term, for zinc is calculated using the following equation: Benchmark = exp(0.833[ln(hardness mg·L-1)] + 0.240[ln(DOC mg·L-1)] + 0.526). The value in the table is for surface water of 50 mg CaCO3·L−1 hardness and 0.5 mg·L−1 dissolved organic carbon (DOC). The benchmark equation is valid between hardness 13.8 and 250.5 mg CaCO3·L−1 and DOC 0.3 and 17.3 mg·L−1.
CWQG, Long-Term, for zinc and is calculated using the following equation: CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625). The value in the table is for surface water of 50 mg CaCO3·L−1 hardness, pH of 7.5 and 0.5 mg·L−1 DOC. The CWQG equation is valid between hardness 23.4 and 399 mg CaCO3·L−1, pH 6.5 and 8.13 and DOC 0.3 to 22.9 mg·L−1.
The most stringent CWQG guidelnes are calculated for cadmium, copper, lead, and nickel using the minimum hardness.
The most stringent CWQG guidelnes (short-term and long-term) are calculated for zinc using the minimum hardness, maximum pH and the lowest dissoved organic carbon, for which this equation is valid.

APPENDIX E

Summary of Trace Element Data

Appendix E: Trace Element Summary Data and Exceedances
Mackenzie Valley Highway – Assessment of Prospective Borrow Sources
Preliminary Acid Rock Drainage / Metal Leaching Assessment
Mackenzie Valley Highway, NT

Parameter	Sample Description	Silver (Ag)	Aluminum (Al)	Arsenic (As)	Barium (Ba)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Iron (Fe)	Molybdenum (Mo)	Nickel (Ni)	Phosphorous (P)	Lead (Pb)	Selenium (Se)	Thallium (Tl)	Uranium (U)
Unit		ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm
MDL		0.01	0.01	0.2	10	0.02	1	0.2	0.01	0.05	0.2	0.001	0.5	1	0.02	0.1
ACUC x 10		530	41	48	6280	0.9	920	280	32.04	11	470	–	170	0.9	9	27
10.043-TP1	Primary Granular Borrow Source: sand, gravel from existing pit	<0.1	0.95	6.6	189	<0.1	46	12.1	3.14	1.3	22.4	0.052	7.1	<0.5	0.1	0.9
10.030-TP1	Secondary Granular Source: sand, gravel from surface exposure in clearing	<0.1	0.17	1.7	32	<0.1	17	3.1	0.44	0.7	4.4	0.010	3.5	<0.5	<0.1	1.1
10.020-TP3	Primary Granular Source: sand, gravel in area where material had higher fines	<0.1	0.37	3.6	110	0.2	28	10.2	1.18	0.8	10.6	0.030	7.1	<0.5	<0.1	0.7
10.014A-TP5	Primary Granular Source: sand, gravel, and cobble	<0.1	0.29	3.1	53	<0.1	27	5.8	0.89	0.6	6.7	0.029	3.4	<0.5	<0.1	0.8
9.044B-TP1	Secondary Granular Source: clean sand	<0.1	0.39	2.6	146	<0.1	51	6.8	1.02	0.6	8.6	0.030	4.0	<0.5	<0.1	0.5
9.043-TP1	Primary Granular Source: sand, gravel - obtained outside of existing pit	<0.1	0.43	2.4	79	<0.1	35	7.4	1.01	0.6	7.5	0.030	4.8	<0.5	<0.1	0.8
9.024B-TP2	Secondary Granular Source: mainly sand	<0.1	0.50	3.5	79	0.2	47	7.7	1.12	1.0	9.7	0.025	5.9	<0.5	<0.1	0.6
9.002A-TP1-1	Secondary Granular Source: sand with pebbles	<0.1	1.39	3.4	155	<0.1	64	33.2	2.26	0.7	20.4	0.032	8.9	<0.5	<0.1	1.2
9.002-ARD1-1	Primary Granular Source: sandy silt with cobbles, mixed lithology	<0.1	0.60	4.1	178	<0.1	42	15.3	1.66	1.1	11.2	0.031	5.5	<0.5	0.1	1.1
7.155A-ARD1-1	Primary Granular Sourc: sand with pebbles and cobbles	0.20	0.21	6.9	216	0.2	100	14.2	0.69	1.0	9.5	0.021	5.4	<0.5	0.2	0.7
7.101-TP1-1	Secondary Granular Source: sand with pebbles and cobbles	<0.1	0.91	2.4	64	<0.1	139	8.4	1.98	0.6	11.9	0.036	8.3	<0.5	0.1	1.7

Notes:
MDL - Method detection limit.
ACUC - Average Concentration in the Earth's Upper Crust based on Rudnick and Gao (2004) and sulphur from Price (1997).
Values exceeding 10x the Average Concentration in the Upper Earth's Crust are shaded grey.

APPENDIX F Statements of General Conditions

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client and may not be used by any third party without the express written consent of Stantec, which may be withheld at Stantec's discretion. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec's present understanding of the specific site and project scope as described by the Client. The contents of this report are applicable only to the site conditions encountered at the time of the investigation or study. If the proposed project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec is engaged by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the reasonable skill and diligence required by customarily accepted professional practices and procedures normally provided in the performance of such services at the time when and the location in which the services were performed. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, and/or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec at the time of the work at specific field observation locations and/or through interpretation of both digital imagery and/or LiDAR data. Classifications and statements of condition have been made based on anticipated behavior of the materials or geomorphic processes and are interpretive in nature; no specific description should be considered exact, but rather should be considered reflective of the anticipated behaviour of materials or geomorphic processes. Extrapolation of in situ conditions can only be made to some limited extent beyond the observed locations. The extent depends on variability of the soil, superficial materials, bedrock, soil moisture and groundwater conditions as influenced by geological processes, construction activity, and land use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report, Stantec must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec will not be responsible to any party for damages incurred as a result of failing to notify Stantec that differing site or sub-surface conditions are present.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec, sufficiently in advance initiating the next project stage (property acquisition, tender, construction, etc.), to confirm that this report adequately addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site

work relating to the recommendations included in this report should only be carried out in the presence of a qualified engineer or geoscientist; Stantec cannot be responsible for site work carried out without its representative being present.