Alberni-Clayoquot Regional District

ALBERNI VALLEY & BAMFIELD SERVICES COMMITTEE MEETING
WEDNESDAY, MAY 5, 2021, 10:00 AM

Due to COVID-19, the meeting will be held via Zoom Video Conferencing and will be livestreamed on the ACRD website at:
https://www.acrd.bc.ca/events/5-5-2021/

Public Attendance: the public are welcome to attend the meeting via Zoom Webinar by registering at:
https://portalberni.zoom.us/webinar/register/WN_KYBexf-NQMSlkd-UfRBORQ

AGENDA

PAGE #

1. CALL TO ORDER

Recognition of Territories.

Notice to attendees and delegates that this meeting is being recorded and livestreamed to YouTube on the Regional District Website.

2. APPROVAL OF AGENDA
(motion to approve, including late items requires 2/3 majority vote)

3. MINUTES

a. **Alberni Valley & Bamfield Services Committee Meeting held February 25, 2021.** **3-7**

THAT the minutes of the Alberni Valley & Bamfield Committee meeting held on February 25, 2021 be received.

4. REQUEST FOR DECISIONS & BYLAWS

a. **REQUEST FOR DECISION** **8-13**
Bylaw R1029-4 Tipping fee for Organics at the Alberni Valley Landfill

THAT the Alberni Valley and Bamfield Committee recommend that the Alberni-Clayoquot Regional District Board of Directors approve adopting Bylaw R1029-4, Alberni Valley Landfill Tipping Fee and Regulation Amendment, 2021 that includes: a new fee for the disposal of Organics at $115/tonne and $5 per 20 litre container; an increased rate for Commercial Mixed Recyclables and Cardboard at $350/tonne; and a reduced rate for the minimum charge for Asbestos Containing Materials at $25.

5. REPORTS

a. **2020 Alberni Valley Landfill Annual Reports – J. Brunn, General Manager of Community Services** **14-136**

THAT this report be received.

6. LATE BUSINESS

7. QUESTION PERIOD

Questions/Comments from the public participating in the Zoom meeting.

Questions/Comments from the Public, respecting an agenda item, can be emailed to the ACRD at responses@acrd.bc.ca and will be read out by the Corporate Officer at the meeting.

8. ADJOURN

Alberni-Clayoquot Regional District

MINUTES OF THE ALBERNI VALLEY & BAMFIELD SERVICES COMMITTEE MEETING HELD ON THURSDAY, FEBRUARY 25, 2021, 10:00 AM

Due to COVID-19 pandemic, meeting conducted via Zoom video/phone conferencing

DIRECTORS PRESENT: John McNabb, Chairperson, Director, Electoral Area "E" (Beaver Creek)
Bob Beckett, Director, Electoral Area "A" (Bamfield)
Tanya Shannon, Director, Electoral Area "B" (Beaufort)
Penny Cote, Director, Electoral Area "D" (Sproat Lake)
Dianne Bodnar, Director, Electoral Area "F" (Cherry Creek)
Ron Paulson, Councillor, City of Port Alberni
Sharie Minions, Mayor, City of Port Alberni

REGRETS: Wilfred Cootes, Councillor, Uchucklesaht Tribe Government
John Jack, Councillor, Huu-ay-aht First Nation

STAFF PRESENT: Douglas Holmes, Chief Administrative Officer
Teri Fong, Chief Financial Officer
Mike Irg, General Manager of Planning and Development
Jenny Brunn, General Manager of Community Services
Heather Zenner, Protective Services Manager
Janice Hill, Executive Assistant

The meeting can be viewed on the Alberni-Clayoquot Regional District website at https://www.acrd.bc.ca/events/25-2-2021/

1. CALL TO ORDER-CAO

The CAO called the meeting to order at 10:00 am.

The CAO recognized the meeting is being held throughout the Nuu-chah-nulth territories.

The CAO reported this meeting is being recorded and livestreamed to YouTube on the Regional District website.

2. ELECTION OF CHAIRPERSON/VICE-CHAIRPERSON FOR 2021

ELECTION OF CHAIRPERSON

The Chief Administrative Officer (CAO) conducted the election for Chairperson of the Alberni Valley and Bamfield Services Committee for 2021. The CAO requested nominations three times.

The CAO declared Director McNabb to the position of Chairperson of the Alberni Valley and Bamfield Services Committee for 2021.

ELECTION OF VICE-CHAIRPERSON

The CAO conducted the election of Vice-Chairperson of the Alberni Valley and Bamfield Services Committee for 2021. The CAO requested nominations three times.

The CAO declared Director Beckett to the position of Vice-Chairperson of the Alberni Valley and Bamfield Services Committee for 2021.

Director McNabb assumed the Chair.

3. APPROVAL OF AGENDA

MOVED: Director Beckett
SECONDED: Director Bodnar

THAT the agenda be approved as circulated.

CARRIED

4. MINUTES

a. **Alberni Valley & Bamfield Services Committee Minutes – November 4, 2020**

MOVED: Director Paulson
SECONDED: Director Shannon

THAT the minutes of the Alberni Valley and Bamfield Services Committee meeting held on November 4, 2020 be received.

CARRIED

5. PETITIONS, DELEGATIONS & PRESENTATIONS

a. **Pat Deakin – City of Port Alberni Economic Development Manager regarding economic development activities in the region.**

Mr. Deakin provided an update on economic development activities in the region, including, working with Tseshaht FN and Hupacasath FN on projects that can be done in partnership, the Food Hub, Cascadia Seaweed, trail development, the proposed Municipal and Regional District Tax, and some local programs that were rolled out during the past year due to COVID's economic impact to the region.

Director Minions entered the meeting at 10:12 am.

b. **Bill Collette – Alberni Valley Chamber of Commerce regarding the Chamber of Commerce's Grant-in-Aid application and an update on McLean's Mill.**

Mr. Collette provided an update on Chamber of Commerce activities and their grant-in-aid application. The Chamber of Commerce have been developing a new website to promote Tourism. They hope to bring back their Mobile Visitors Center this year. They will have challenges with their volunteer program this year due to COVID, they will have to reinvest time and money to reinvigorate the ambassador program. McLean Mill's year end report is available on the Alberni Valley Chamber of Commerce's website. As tourism starts to recover, they will need to be ready for the on slot of business coming to McLean Mill. The Mill is focusing on five areas of business, the gift shop, food services in Grand Hall, camping, events, and Tour options. They plan to design internal tours at the Mill and a community wide tour.

c. **Al Winney & Ted Maczulat – Arrowsmith Radio Club regarding their Grant-in-Aid application.**

Mr. Winney provided information on their grant-in-aid application. The Arrowsmith Radio Club continue to build their mesh wireless land system throughout the Alberni Valley that will cover all the emergency services and ACRD EOC. After the coastal response event they found that there were improvements that needed to be made in terms of radio communications. Therefore, they are building a wireless mesh system, that will work throughout the valley. It doesn't require the internet or power as it is powered by battery or generator. The system will increase the speed at getting messages out. It has wireless ethernet and special software that provides for robustness and redundancy. The system can heal itself to route data around an outage. Mr. Maczulat stated it is possible that the project could be split and done over two years. The Johnston Street site could be completed this year and the high school site next year.

6. REQUEST FOR DECISIONS

a. Request for Decision regarding Review – Alberni Valley & Bamfield Services Committee Terms of Reference, 2021

MOVED: Director Beckett
SECONDED: Director Shannon

THAT the Alberni Valley & Bamfield Services Committee recommend that the Alberni-Clayoquot Regional District Board of Directors adopt the revised Terms of Reference for the Alberni Valley & Bamfield Services Committee for 2021.

CARRIED

b. Request for Decision regarding Sproat Lake Marine Patrol Program

MOVED: Director Minions
SECONDED: Director Paulson

THAT the Alberni Valley & Bamfield Services Committee recommend to the Alberni-Clayoquot Regional District Board of Directors that staff engage consultants to determine processes for operating the 2021 Sproat Lake Marine Patrol Program in a manner that keeps the workers and the public safe including in relation to COVID-19.

CARRIED

c. Request for Decision regarding Replacement of the Echo Aquatic and Fitness Centre

MOVED: Director Minions
SECONDED: Director Cote

THAT the Alberni Valley & Bamfield Services Committee recommend the inclusion of $100,000 for the feasibility study of an Alberni Valley Aquatics Center – Proposed Service in the Draft 2021-2025 Financial Plan for consideration by the Board of Directors.

CARRIED

7. REPORTS

a. Alberni Valley Regional Airport – verbal report T. Fong, CFO & J. Brunn, GM of Community Services

Director Minions left the meeting at 12:09 pm.

b. Alberni Valley Custom Transit Budget – verbal report, J. Brunn, GM of Community Services.

MOVED: Director Shannon
SECONDED: Director Cote

THAT the Alberni Valley & Bamfield Services Committee recommend staff bring back options for use of rate stabilization reserves as a separate item for consideration at the March 10, 2021 Committee of the Whole meeting.

CARRIED

c. Bamfield Sewage – verbal report, Director Beckett, D. Holmes, CAO, and M. Irg, GM of Planning and Development

MOVED: *Director Beckett*
SECONDED: *Director Shannon*

THAT the Alberni Valley & Bamfield Services Committee recommend that the matter of sewage treatment in Bamfield be discussed at the March 5, 2021 Committee of the Whole meeting with Minister Osborne.

CARRIED

MOVED: *Director Beckett*
SECONDED: *Director Shannon*

THAT the Alberni Valley & Bamfield Services Committee receive reports a – c for information.

CARRIED

8. LATE BUSINESS

9. QUESTION PERIOD

Questions/Comments from the public attending the meeting via Zoom webinar. The Executive Assistant advised there were no questions from the public.

In order to provide the public with an opportunity to ask questions or provide input to the Committee respecting a topic on the agenda, the Regional District set up an email address responses@acrd.bc.ca. The Executive Assistant reported there were no questions or comments received from the public with respect to the meeting today.

10. ADJOURN

MOVED: *Director Shannon*
SECONDED: *Director Beckett*

THAT the meeting be adjourned at 12:43 pm.

CARRIED

Certified Correct:

_____
John McNabb,
Chairperson

_____
Wendy Thomson,
General Manager of Administrative Services

ALBERNI-CLAYOQUOT
REGIONAL DISTRICT

3008 Fifth Avenue, Port Alberni, B.C. CANADA V9Y 2E3 Telephone (250) 720-2700 FAX: (250) 723-1327

REQUEST FOR DECISION

To: Alberni Valley and Bamfield Committee

From: Jodie Frank, Organics Coordinator

Meeting Date: May 5, 2021

Subject: Bylaw R1029-4 Tipping fee for Organics at the Alberni Valley Landfill

THAT the Alberni Valley and Bamfield Committee recommend that the Alberni-Clayoquot Regional District Board of Directors approve adopting Bylaw R1029-4, Alberni Valley Landfill Tipping Fee and Regulation Amendment, 2021 that includes: a new fee for the disposal of Organics at $115/tonne and $5 per 20 litre container; an increased rate for Commercial Mixed Recyclables and Cardboard at $350/tonne; and a reduced rate for the minimum charge for Asbestos Containing Materials at $25.

Desired Outcome:

To create a new fee for the disposal of organics to support the Regional Organics Diversion program and adjust the other rates to ensure compliance and support a cost recover model.

Summary

Organics

As part of the Strategic Priorities grant funding of the regional organic's diversion project, upgrades to the Alberni Valley Landfill (AVL) have been approved to expand the layout to support organics collection and other diversion streams. The ACRD has commissioned a contractor to begin upgrades to the AVL that will include construction of a dedicated tipping area for the City of Port Alberni's split body collection trucks to unload curbside material that will be easily transferred to the processing facilities. The new dedicated public recycling area will allow additional space for Recycle BC material and the newly expanded stewardship programs as well as residential drop-off for organic material. As a result, an amendment to the current bylaw is required to set a fee for the disposal of organic material at the landfill.

The current Bylaw R1029-3 Tipping Fee and Regulation includes fees for disposing of yard waste including branches, grass and leaves, however it needs to be expanded to include a definition and rate for organics: any food waste, kitchen scraps or yard waste. The per tonnage rate will apply to the City of Port Alberni loads of curbside collected organics and any large volume haulers and the $5 flat rate will also allow residents who are outside the City of Port Alberni to have access to organics disposal and diversion at the landfill.

The material disposed of at the organic drop off area will be transferred to Earth Land and Sea(ELS) who recently was awarded the contract for Organics Processing within the Alberni Valley. This contract requires that independent commercial organics loads be received at their site for the same tipping/processing fee of $80/tonne and that weights and volumes be reported to the Regional District for waste data tracking.

The proposed tipping fees are in-line and non-competitive with the market price of $5.00/20 litre container that ELS currently charges for the food waste drop-off service the company provides. The $115/tonne fee is recommended as it is comparable to other regional districts and establishes an incentive to divert this material as the rate is lower than the rate for waste of $130/tonne. This fee will also encourage businesses to haul directly to ELS to pay $80/tonne.

Commercial Mixed Recycling and Cardboard

The AVL currently accepts commercial cardboard and mixed recycling at a rate of $200/tonne with a $15 minimum charge. These materials are not accepted in the Recycle BC program which is limited to residential use. This rate was

recently established to provide an option for small businesses to recycle who did not produce enough volume to hire on-site collection services. Based on the analysis of costs associated with recycling these materials over the 2020 period, it was determined that the rate of $200 is running at a deficit and the cost per tonne for this material needs to increase to $350/tonne. This rate increase will encourage local businesses to set up their own cardboard collection system or if they wish to use the landfill recycling center, will charge fees to fully cover the cost of collecting, transporting and recycling this material.

Asbestos Containing Materials(ACM) - Minimum Charge

A resident recently brought a small amount of ACM to the landfill for proper disposal. The minimum rate of $120 was appropriately applied. Staff received a request from this resident to reconsider this charge as they felt it was too high. Unnecessarily high minimum rates may inadvertently encourage landfill users to hide asbestos containing materials in with other garbage to avoid high fees or find other improper disposal options. Staff have investigated the actual costs for managing ACM, the minimum rate and other informal feedback received by landfill staff. Staff recommend that the minimum rate be reduced from $120 to $25. This rate is still adequate to recover the costs associated with properly managing the material.

Time Requirements – Staff & Elected Officials:

The proposed changes to the Alberni Valley Landfill Tipping Fee and Regulation Bylaw No. R1029-4 has been prepared as an amendment (attached). There will be some staff time involved in adopting the amendment and communicating these changes to the public including advertisement and promotion if these changes are adopted.

Financial:

The organics tipping fee rates are anticipated to fully recover their own costs for the portion of landfill/transfer station operation costs, transportation costs and tipping fees at the processing facility. However, these will be reviewed after 6-9 months of program operation to confirm these estimates. The reduced volumes being landfilled will extend the life of the landfill, deferring capital projects and closure costs.

The commercial cardboard and recycling program ran a deficit of approximately $1,000 in 2020. This adjustment of rates will fully recover costs to operate the program. The reduction of the minimum rate for asbestos containing materials will reduce revenues for small volume loads by up to an estimated $1,000 in 2021 but will encourage residents to properly dispose of the material.

Strategic Plan Implications:

This initiative supports the Strategy 3.2 of the Regional Districts Strategic Plan which has an objective to improve recycling and diversion programs throughout the region.

Submitted by: _____
Jodie Frank, Organics Coordinator

Submitted by: _____
Jenny Brunn, General Manager of Community Services

Approved by: _____
Douglas Holmes, BBA, CPA, CA, Chief Administrative Officer

REGIONAL DISTRICT OF ALBERNI-CLAYOQUOT

BYLAW NO. R1029-4

A Bylaw to Provide for
the Regulation of Recycling, Solid Waste Disposal and Tipping Fees
at the Alberni Valley Landfill

WHEREAS by Supplementary Letters Patent, dated August 10, 1973 as amended, the Regional District of Alberni-Clayoquot was granted the function of Garbage Disposal under Division XIV of its Letters Patent;

AND WHEREAS the Regional District of Alberni-Clayoquot is empowered to establish a scale of charges payable for depositing Municipal Solid Waste at the Alberni Valley Landfill;

AND WHEREAS the Board of Directors of the Regional District of Alberni-Clayoquot deems it advisable to enact regulations pertaining to solid waste disposal and to establish a charge for depositing Municipal Solid Waste;

NOW THEREFORE, the Board of Directors of the Regional District of Alberni-Clayoquot in open meeting assembled enacts as follows:

1. Bylaw No. R1029, cited as "Alberni Valley Landfill Tipping Fee and Regulation Bylaw No. R1029, 2019" is hereby amended as follows:

a) Updating section 1. DEFINITIONS by adding:

1.43 **"Organic Waste"** means compostable organic material including raw and cooked food waste from a Commercial or residential premise and includes but is not limited to: fruits and vegetables, meat, fish, shellfish, poultry and bones thereof, dairy products, bread, pasta and baked goods, tea bags, coffee grounds and filters, soiled paper plates and cups, soiled paper towels and napkins, soiled waxed paper, food soiled cardboard and paper, egg shells, and waxed cardboard;

b) Updating SCHEDULE "A"
Replacing Schedule "A" with Schedule "A" attached to and forming part of this bylaw.

2. This bylaw will come into effect on June 1, 2021.

3. This bylaw may be cited as "Alberni Valley Landfill Tipping Fee and Regulation Amendment Bylaw No. R1029-4".

Read a first time this	day of ,	2021.
Read a second time this	day of ,	2021.
Read a third time this	day of ,	2021.
ADOPTED this	day of ,	2021.

Certified true and correct copy **of "Alberni Valley Landfill Tipping Fee and Regulation Amendment Bylaw No. R1029-4, 2021"**

The Corporate seal of the Regional District of Alberni-Clayoquot was hereto affixed in the presence of:

Wendy Thomson	John Jack
General Manager of Administrative Services	Chairperson

Schedule A
Charges

Solid Waste	**Tipping Fee**	**Other Charges**
Loads of 83 kg or greater	$130.00 per tonne	$12.00 minimum
Loads under 83 kg (each garbage bag or can)	$3.00 each	$6.00 minimum $12.00 maximum
Recreational Vehicle	$240.00 per tonne	$300.00 minimum
Surcharge for loads containing Recyclable Materials or Controlled Waste	Double the standard tipping fee	
Surcharge for Unsecured loads	$240.00 per tonne	
Weighing service		$10.00 each occurrence

Recyclable Materials	**Tipping Fee**	**Other Charges**
Residential Corrugated Cardboard	No Charge	
Commercial Corrugated Cardboard	$350.00 per tonne	$15.00 minimum
Commercial Mixed Recycling	$350.00 per tonne	$15.00 minimum
Metal, including appliances	No Charge	
Gypsum	$250.00 per tonne	$10.00 minimum
Clean wood waste	$120.00 per tonne	$10.00 minimum
Stewardship Materials, including car batteries	No Charge	
Tires	$170 per tonne	$2.00 each tire
Mattresses	$20.00 each	
Organics	$115.00 per tonne	$5.00 each 20 litre container
Residential Branches	$5.00 per load	
Commercial Branches	$120.00 per tonne	$10.00 minimum
Grass and Leaves Material	No charge	

Controlled Waste	**Tipping Fee**	**Other Charges**
Construction/Demolition Waste	$160.00 per tonne	$15.00 minimum
Land clearing debris	$120.00 per tonne	$15.00 minimum
Pumpings from domestic septic tanks	$160.00 per tonne	
Catch basin and manhole material	$160.00 per tonne	$150.00 minimum
Asbestos Containing Materials	$500.00 per tonne	$25.00 minimum
Fish, shrimp shells, and animal carcasses	$200.00 per tonne	$100.00 minimum
Medical Facility Waste	$132.00 per tonne	
Loads containing fish feed totes	$400.00 per tonne	$120.00 minimum
Contaminated Soils:		
Provided that the Ministry of Environment has approved of disposal of the contaminated soil, without treatment, at the Alberni Landfill	$50.00 per tonne	
Provided that the Ministry of Environment has approved of the treatment and disposal of the contaminated soil at the Alberni landfill	$100.00 per tonne	Plus estimated out-of-pocket treatment costs

To: AVB Committee

On March 12, 2021, I attended the Alberni Valley Landfill with a small bag of old duct tape which I had removed from the ducts in my 50+ year old cabin.

I googled the requirements and the product was double bagged (in the extra thick bags) and goose necked shut. The bags were not full and the attendant at the landfill said it could not have been more than a couple of pounds.

There was much discussion about the charge. It was not gypsum/ drywall (which may contain asbestos if it is old). If it had been gypsum/drywall the minimum charge would have been $10. Instead, it was coded as “asbestos containing material” with a minimum charge of $120.

The minimum charge, compared to the minimum charge for old drywall, does not seem reasonable. Perhaps the $120 minimum was designed for much more hazardous waste.

Please reconsider this minimum charge and a revised charge for future transactions.

Thank you

Ross

Ross B Hill
250.882.8593

ALBERNI-CLAYOQUOT
REGIONAL DISTRICT

3008 Fifth Avenue, Port Alberni, B.C. CANADA V9Y 2E3 Telephone (250) 720-2700 FAX: (250) 723-1327

REPORT FOR INFORMATION

To: Alberni Valley and Bamfield Committee

From: Jenny Brunn, General Manager of Community Services

Meeting Date: May 5th, 2021

Subject: 2020 Alberni Valley Landfill Annual Reports

Background:

As a condition of the Alberni Valley Landfill (AVL) operating certificate, the ACRD is required to submit an annual report on landfill operations and monitoring to the Ministry of Environment and Climate Change Strategy (MOECCS). In recent years, staff have used this requirement as an opportunity to provide a more holistic report on landfill operations and the overall solid waste service for the waste-shed of the Alberni Valley and Bamfield. This includes the goals and targets as established by the Solid Waste Management Plan plus an overview of improvement projects completed over the year and upcoming.

This report is created internally by staff and verified by an external Solid Waste Engineer. The Districts' environmental consultants, Piteau and Associates, continue to oversee the environmental monitoring program and produce an annual report to summarize the technical analysis and recommendations based on the field monitoring undertaken by ACRD staff. These two reports are attached for your review with the key points summarized below.

Overview of Landfill Report:

- Amount of waste landfilled in 2020 was 15,406 tonnes, a 3.5% drop from 2019.
- The waste generation rate reduced by 4% to 564 kg/capita. This drop from previous years is thought to be the result of stricter rules on mixed loads and loads from out of region but still higher than Solid Waste Management Plan target of 400 kg/capita.
- Total diversion increased from 20% to 23% which is mostly attributed to an increase in the collection of yard and garden waste, which includes volumes collected at Earth, Land and Sea drop-off locations in 2020. Improvements move us closer to the goal of a 50% diversion rate. Implementing organics diversion will dramatically improve how these targets are being met.
- The volume of airspace consumed at the landfill was approximately 27,125 m^3 resulting in an airspace consumption ratio of 568 kg/m^3. This is an improvement from previous years, but still below the target of 660 kg/m^3 mainly due to the higher-than-average use of cover material.
- With the estimated 2,461,060 m^3 of remaining airspace, there is 70 years of landfill life remaining, and it will not reach capacity until 2091. This could be extended with increased diversion and improved airspace utilization.
- Financial contributions for capital and closure and post-closure exceeded the 2012 DOCP (Design, Operations and Closure Plan) recommendations at $450,000 and $120,000 respectively. The DOCP update will review and update these financial requirements in 2021.

- Landfill operating costs have seen reductions over the past three years as efficiencies have been realized. However, the overall costs for solid waste management have increased as a result of organics implementation, the addition of new diversion streams and increased recycling contract costs. These costs have been offset with increased revenues from grants (for organics implementation), new fees and stewardship revenues, and increased tipping fees. Upcoming procurement processes and a thorough review of materials management will be aimed at reducing costs and improving service.

In 2019, during SCADA installation, it was discovered that the two interception well pumps were operating only intermittently due to biofouling in the wells, causing increased levels of total dissolved solids and chloride in the groundwater. A significant rehabilitation project was undertaken including cleaning of the wells, installing new instrumentation and new pumps that was completed in 2020. Further leachate interception work planned for 2021 includes providing supplementary and back-up pumps. This, along with the recently commissioned SCADA system will improve reliability and the effectiveness of this important system.

In 2020, Sperling Hansen and Associates (SHA) prepared an updated assessment of Landfill Gas emissions. The estimated landfill gas production in 2020 was 900 tonnes, which is below the 1,000 tonnes per year threshold beyond which MOECCS requires a gas collection and management system to be installed.

The upcoming work plan includes:

- Update of the Design, Operations and Closure Plan
- Implementation of the three-stream waste collection with the City of Port Alberni
- Installing a local landfill gas flare
- Embarking on a landfill gas monitoring partnership with Vancouver Island University in 2021

Communications:

The attached report has been submitted to MOECCS as per our regulations and will be posted on our website once received by the Board of Directors. Staff will work to coordinate presentation of this report to the Tseshaht and Hupacasath as well as site visits and other engagement initiatives.

Submitted by: _____
Jenny Brunn, General Manager of Community Services

Approved by: _____
Douglas Holmes, BBA, CPA, CA, Chief Administrative Officer

ALBERNI-CLAYOQUOT REGIONAL DISTRICT

Alberni Valley Landfill

2020 ANNUAL REPORT

Submitted to: BC Ministry of Environment & Climate Change Strategy

Prepared by: ACRD Environmental Services Department

Reviewed by: Paul Evans PEng.

April 2021

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Report Summary

	Reporting Year 2020	Unit
Waste Tonnage Disposed at AVL	15,406	t
Landfill Airspace Consumed	27,125	m^3
Landfill Airspace Remaining	2,461,060	m^3
Anticipated Closure Date at Current Fill Rate/Density	2091	
Waste in Place at Landfill	828,938	t
Leachate Generated & Treated	497,588	m^3
Landfill Gas Management	Monitoring program in place	
Closure Works Undertaken	Graded slopes	
Inspection Works	Review undertaken preparing for DOCP	
Changes from MOECCS Approved Plans	None	
Non-Compliances	None	
Progress on Non-Compliances	N/A	

Projects Undertaken in 2020	Future Projects Proposed
Bamfield Free Tipping Fee Pilot Program	McCoy Pump Station Upgrade
AVL Stewardship Program Expansion	3rd Ave Recycling Depot Contract – Social Focused RFP
Yard Waste Program Changes	Design Operation and Closure Plan Update
Asset Management Plan	VIU Landfill Gas Monitoring Partnership
Recollect Recycling App	Landfill Gas Flare Installation
3rd Avenue Recycling Depot Upgrades	CPA 3-Stream Waste Collection
Bear Aware Program	AVL Upgrades
Landfill Operations Contract Update and Renewal	Organics Diversion
Leachate Treatment Monitoring	Alberni Valley Collections Contract
Environmental Monitoring Program Improvements	Additional Leachate Interception Wells
Groundwater Diversion Wells Refurbishment	Replacement of the Leachate Monitoring Well
SCADA for North Boundary and Stevens Creek Sites	Construction and Demo Diversion Program
Prepare Design Operations Closure Plan (DOCP)	Waste Licensing Bylaw
Selected Contractor for composting of organic wastes	Update of Solid Waste Management Plan

Solid Waste Management Goals	Target	Actual
1 - Waste Generation Rate	< 400 kg/capita	564 kg/capita
2- Diversion of Waste	>50%	23%
3 - Airspace Consumption Ratio	>660 kg/m3	568 kg/m3
4 – Capital Contributions	>$115,000/year	$120,000/year
5 – Water Quality	Meet FWAL at boundary	Some metals exceedances
6 – Landfill Gas Generation	<1,000 tonnes CH4/year	Est. 900 tonnes CH4/year

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Background

The Alberni-Clayoquot Regional District (ACRD) operates the Alberni Valley Landfill (AVL) under the British Columbia Waste Management Act Operational Certificate Number MR-00524, issued June 29, 2004. The AVL is located approximately 5 km west of Port Alberni and has been in operation since the early 1970s. The "waste shed" for municipal solid waste destined for the AVL includes the City of Port Alberni, ACRD Electoral Areas within the Alberni Valley and Bamfield and First Nations communities Tseshaht, Hupacasath, Huu-ay-aht and Uchucklesaht.

This report has been prepared to satisfy the annual reporting requirements for the AVL, as required by the Operational Certificate and the 2016 *Landfill Criteria for Municipal Solid Waste* published by BC Ministry of Environment.

Mission Statement

"To protect human health and the environment and maximize value of service by effectively managing the region's solid waste in an environmentally, socially and economically responsible manner."

Waste Quantification

Landfilled

In 2020, the AVL accepted 15,406 tonnes of municipal solid waste (MSW) and other wastes including, construction and demolition (C&D), and asbestos containing materials (ACM). The breakdown of waste types disposed in 2020 is as shown in Table 1. The cumulative quantity of waste disposed of at the AVL as of the end of 2020 is now 828,938 tonnes.

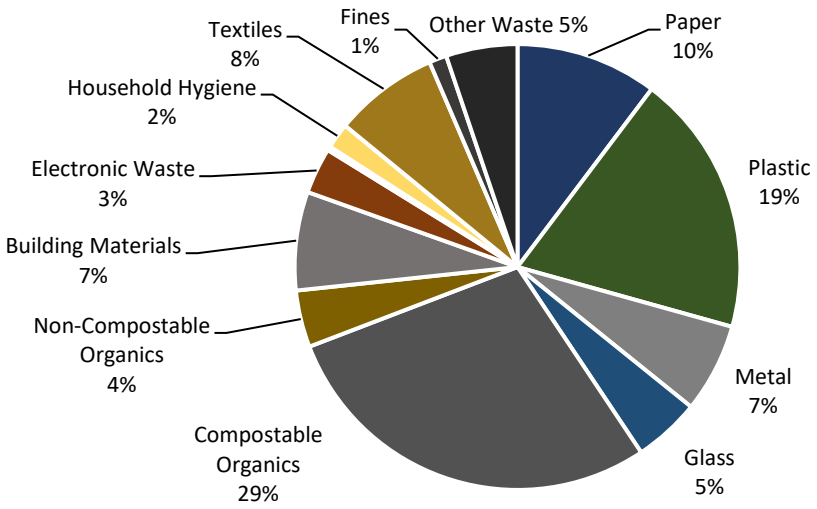
Table 1 – Landfilled Waste 2020

Residential Garbage	7,543.5
Commercial Garbage	4,520.9
Other Garbage	73.0
Construction and Demolition	3,161.1
Asbestos (ACM)	180.9
TOTAL	**15,406.3**

In 2019 the ACRD retained Dillon Consulting Limited (Dillon) to complete a Waste Composition Study. The focus of that study was to gain an understanding of the quantity of organics, recyclables and Extended Producer Responsibility (EPR) materials in the garbage streams for curbside residential, self-haul and commercial waste. The residential waste was also categorized by its origins allowing the production of composition profiles for each stream of waste by geographic location.

The graph below (Chart 1) illustrates the weighted average material composition for residential curbside municipal solid waste. The largest material category was compostable organics (28.6%) followed by plastic (19%) and paper (10%). Most of the compostable organics stream was food waste (22.5%). The largest subcategory of the plastics category was durable plastic products (non-recyclable plastics) at 7.6%, followed by film packaging (5.7%) and rigid recyclable plastic (4.7%). The Paper category was largely comprised of cardboard (6.1%) and recyclable paper (2.8%).

Chart 1 - AVL Average MSW Composition 2019

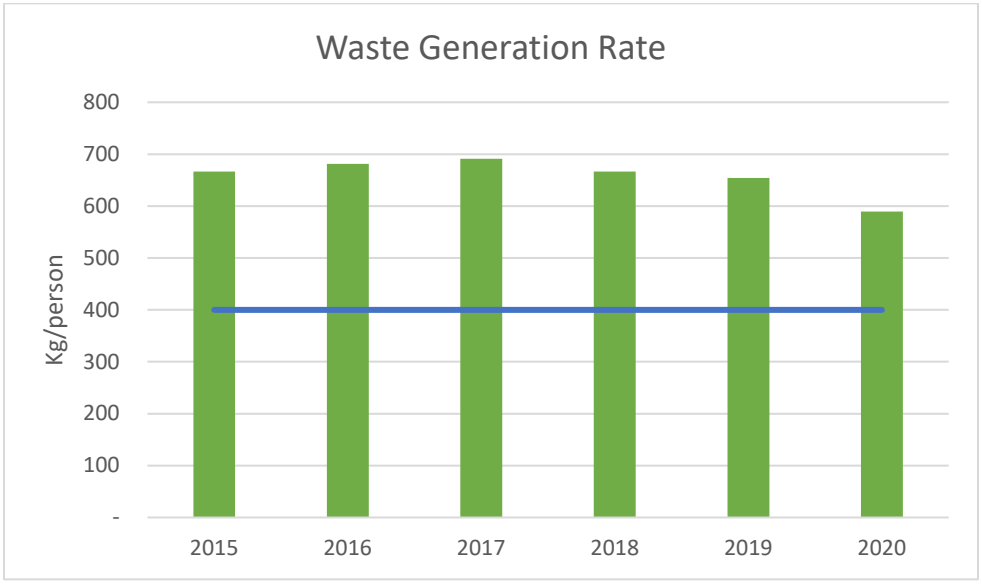


The population served by the landfill was estimated to be 27,328 in 2020 resulting in a waste production rate of 564 kg/capita per annum. This value represents a further 4% reduction year over year and continues the trend of previous years, with 2018 at 653 kg/capital and 2019 at 589 kg/capita. These reductions coincide with the implementation of enhanced education campaigns and stricter enforcement of mixed load rules at the landfill.

Target 1 - Reduce landfill disposal to less than 400 kg/capita

Although, the waste generation rate is improved over 2019 rate of 589 kg/capita it is still well above the target rate of 400 kg/capita as shown in Chart 2.

Chart 2 - Annual Waste Generation Rates



Diverted

The quantity of materials recorded as diverted from landfilling in 2020 was estimated at 4,568 tonnes. This measure is an underestimate of the actual diversion taking place. It does not include much of the diversion taking place from private sector sources. The ACRD does not have a waste licensing bylaw and so does not receive reports from many resource recovery and recycling companies and including that data would further improve the apparent diversion rate.

Chart 3 - Reported Annual Waste Diversion Rates

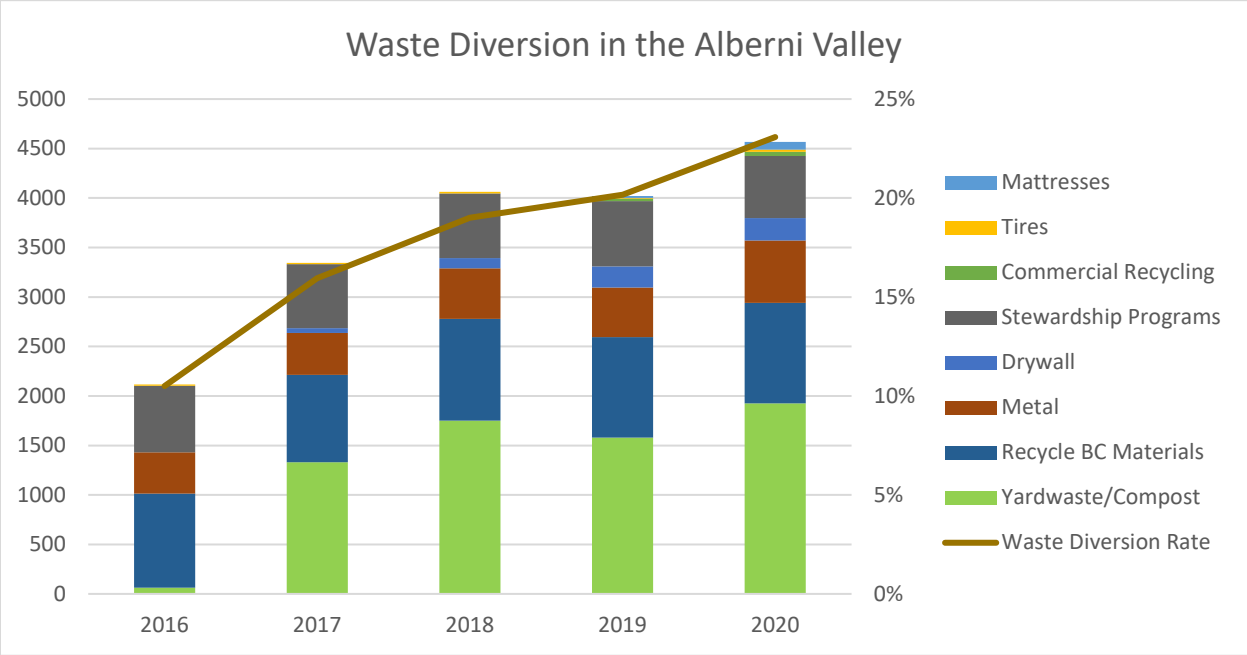


Chart 3 displays diversion rates over the last five years, collected through the following key programs:

- Curbside Recycling Collection in the City of Port Alberni and Beaver Creek
- The 4th Avenue Return-It Depot – privately operated; and
- Three ACRD operated Recycling Depots (2020 diversion tonnage):
    - 3rd Avenue Depot (122 tonnes)
    - McCoy Lake (AVLF) Depot (2,582 tonnes)
    - Bamfield Depot (43 tonnes)

The 3rd Avenue recycling depot was closed from April to September in 2020. This transferred traffic and volumes to the AVL and caused a reduction of volume received at the depot and an increase in quantities at the landfill drop-off. The AVL also expanded the range of stewardship products accepted to include batteries, paint, household hazardous waste, electronics, small and large appliances, lights, and outdoor equipment in addition to paper and packaging materials. The AVL also diverts non-stewardship products including tires, metal, clean wood waste, mattresses, gypsum, yard and garden waste.

Target 2 - Increase Diversion of Waste to 50%

These additional diversion efforts and the reduction in waste generated has resulted in an increased diversion rate of 23%, up from the 2019 rate of 20% and that of previous years. Although this is a significant improvement in recorded diversion rate, it is still well below the target set in the ACRD solid waste management plan of a 50% diversion rate.

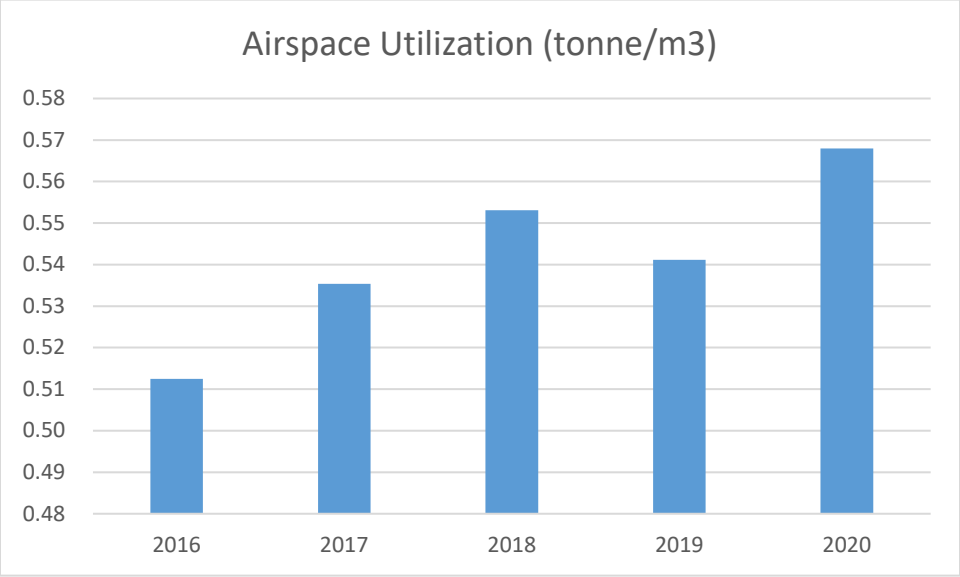
The greatest remaining single opportunity to increase waste diversion is through the diversion of organics and that will begin in 2021. Diversion will also continue to increase with continued education and promotion of the existing recycling programs and systems in place. Furthermore, the implementation of a waste licensing bylaw would provide a more accurate measurement of diversion rates in the ACRD.

Landfill Capacity

Airspace Utilization

In 2020, 18,999 m^3 of airspace was consumed by waste when taking account of the cover materials used and based on the annual topographical surveys completed at year end. The total disposed tonnage was 15,406 t, resulting in an airspace consumption ratio of 568 kg/m^3 (waste tonnage divided by airspace consumed by that waste). This is an improvement over the past five years and was a result of beneficial changes in operational methods for landfilling at the site.

Chart 4 - Airspace Consumption Ratios



563 Kg/m^3 is an improvement from previous years but still below our target of 660 Kg/m^3.

Target 3 – Minimum Airspace Consumption Ratio of 660 kg/m3

The volume of cover material used in 2020 was 8,126 m3, which is a 20% reduction from 2019. The operations contractor is investigating innovative approaches to further reduce this amount. Further

restricting cover use will not only reduce the costs of providing cover material but also preserve airspace and ultimately extend the life of the landfill.

Remaining Life

Based on the airspace consumed in 2020, there is an estimated 2,461,060 m3 remaining airspace at the AVL at the beginning of 2021. Based on the current population growth rate of 0.9%, waste generation of 564 kg/capita, and airspace consumption ratio of 568 kg/m3, the landfill will reach capacity in 2091. This estimate is five years longer than estimates from 2019. The projected life has increased because of improved waste diversion, plus generation has reduced resulting in reduced airspace consumption. However, if the targets for reducing waste generation to 400 kg/person and minimum airspace consumption ratios are met, the landfill lifespan will extend to approximately 2121.

Operations

Variations from DOCP Plan

The latest Design, Operations and Closure Plan (DOCP) was completed in 2012 by McGill and Associates Engineering. An update of this plan began in 2020 and will be completed in 2021. Variations in the last year from the 2012 plan include:

In 2019, the groundwater interceptor well system was found to no longer be operating as effectively due to fouling within the wells. The 2012 plan required the installation of wells and pumps to intercept leachate flows and direct them into the leachate collection system. This system was rehabilitated in 2020 and is now working correctly with a real time communication system (SCADA).

The 2012 DOCP included an estimate that 1,000 tonnes of methane would be produced by the landfill in 2012. That would have required the design and installation of a landfill gas collection system. In 2020 Sperling Hansen and Associates (SHA) undertook landfill gas modelling. They used two approaches and recorded good agreement between the different methodologies. The model required by the Province indicated 900 t of methane would be produced in 2020 and that quantities of methane would slightly reduce or hold level in subsequent years. This 2020 landfill gas assessment took account of the waste composition data that was acquired for the waste catchment. The projections also did not take account of the initiation of the organics diversion program that will begin in 2021. The diversion of these materials from the landfill will further reduce future methane emissions.

The emissions of methane projected by SHA using the provincial model fall below the 1,000 t threshold; this has deferred the requirement for installing a landfill gas collection system. The modelling will continue to be updated to reflect future waste compositions and tonnages.

The 2012 plan included the acquisition of ownership or long-term tenure of the AVL property. The ACRD has been working with the Province over the intervening eight years to acquire security of the property. This is ongoing but it is not yet clear if this process will be successful and what form of land use agreement may be established. The ACRD and Province have made progress in 2020 towards a decision.

Conformance to SWMP

The most recently adopted Solid Waste Management Plan (SWMP) from 2008 listed several initiatives to meet the first two targets in the report; reduce per capita waste generation to 400 kg/person; and increase diversion to 50%. Most of these initiatives have been implemented with one major outstanding

action item being the implementation of an organics diversion program. In 2020, the ACRD hired an organics coordinator who has been instrumental in making progress in many key areas. The City of Port Alberni is scheduled to have an organics curbside collection program running by late summer 2021. Supporting organics diversion for the commercial sector and surrounding electoral areas will follow in 2022.

Compliance Resolutions

The AVL has not had a compliance issue from the Ministry of Environment since 2018 when the Annual Report was submitted late and was cited as a compliance issue. The AVL has not received a site inspection from the Ministry since 2009.

Complaints

The ACRD received one complaint in 2020 related to the $5 tipping fee for yard waste. While the AVL is located away from residential communities, the ACRD and its operator still work hard at minimizing nuisances, such as odor, noise and litter. The feedback of landfill visitors is also important. A formal complaint tracking system was created in 2020 to ensure that all complaints are documented and followed up on appropriately. An enhanced customer feedback program will be launched and promoted in 2021 to encourage more feedback.

Inspections

Regular site inspections and reporting requirements have been incorporated in the updated operations contract for 2020. ACRD staff will also be performing oversight inspections to ensure compliance with the contract, operations certificate and ministry requirements.

Overview of work for upcoming year

There are several projects planned for 2021. These include the updating of the DOCP, an expansion of the landfill gas monitoring programs and other items as detailed in the Projects Upcoming section. The most visible change will be the upgrading of the drop off area to accommodate the organics diversion program.

Finances

Operating Expenses

In 2020, the operating expenses for the AVLF were:

Table 2 - Operating Expenses

	2020
LANDFILL OPERATING COSTS	$ 1,383,932
ADMIN & EDUCATION COSTS	$ 330,613
RECYCLING	$ 525,232
TOTAL COSTS	$ 2,239,777
RECOVERIES	$ 518,016
NET COST	$ 1,721,761
RESERVE FUNDS ALLOCATION	$ 614,782

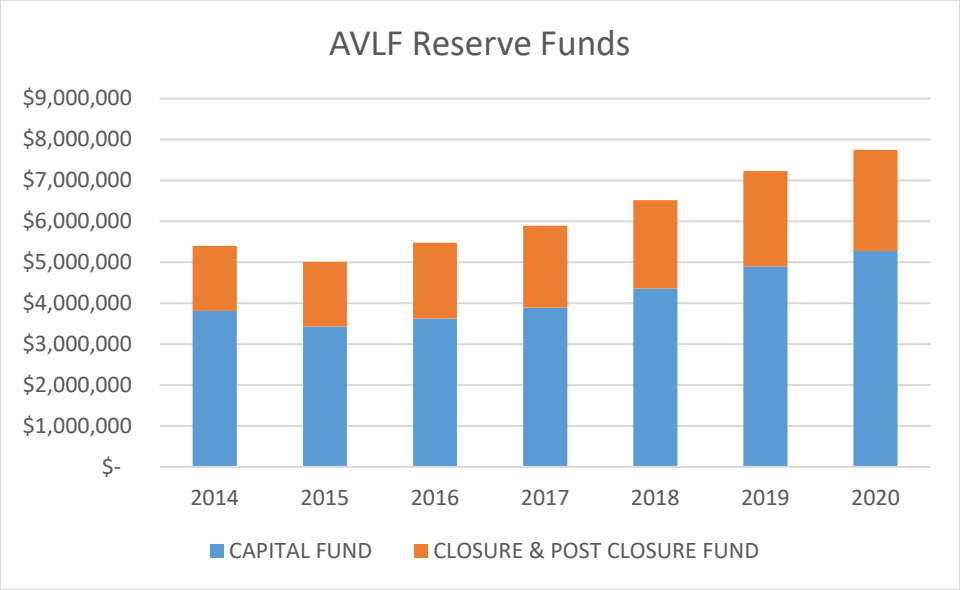
Capital and Closure Funding

The 2012 DOCP identified the need for $11,500,000 for closure and post-closure activities and recommended that the ACRD contribute approximately $115,000 annually to this fund. In the past five years, contributions have been $120,000 annually to the Closure Reserve and over $450,000 to the Capital Reserve. The growth of these funds are shown on Chart 5.

Target 4 – Annual Capital Contributions meet Funding Requirements

With an anticipated closure date of 2091, there are 70 years remaining before the end of the landfill life. At the end of 2020, the Closure and Post-Closure reserve has approximately $2,470,524. The updated DOCP which will be completed in 2021, will review and update closure and post-closure contribution requirements.

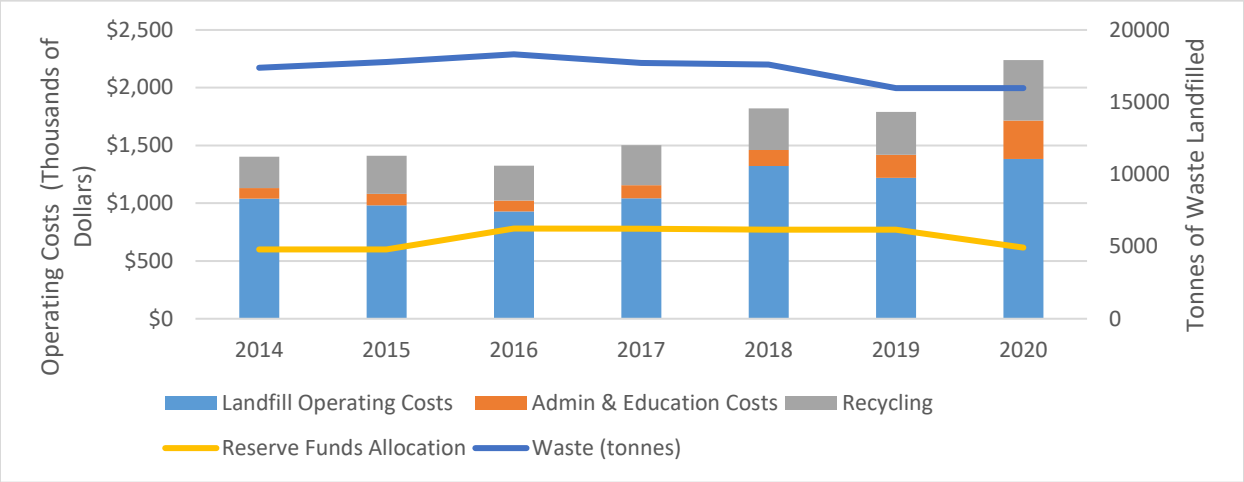
Chart 5 - Capital Reserve Funds



Operational Efficiency

Chart 6 below shows the total operating costs including contracts, administration, and support to manage solid waste in the Alberni Valley. It covers the operation of the AVL, 3rd Avenue Recycling Depot and curbside recycling collection but excludes costs related to the Bamfield Transfer Station. The costs are influenced by inflation and the volume of material landfilled.

Chart 6 - Annual Costs and Tonnages



2016 saw a five year low in costs due to staffing shortages, and that also resulted in projects not being completed. 2017 and 2018 started to see an increase in costs as landfill operations changed including a different method of managing wood waste, a diversion spotter pilot program, and the start of drywall diversion.

Along with the many benefits and additional revenues streams that new programs and initiatives provide, there are inevitably increased costs. In 2020, the cost of the residential recycling collection contract and recycling depot contract increased following renewal. This was partially offset by moving all depot operations to the AVL for a while, but the curbside collection charges rose by $140,000. It is eight years since the last Design Operations and Closure Plan (DOCP) and a new DOCP was largely undertaken. This and other unexpected consultant fees amounted to $120,000. Although accounted for in one year, these charges will have benefit to the AVL for years to come as well as satisfying a regulatory requirement. Likewise, preparation for the organics diversion program began in 2020 and cost approximately $110,000. The benefits will be felt for years ahead and include reduced greenhouse gas emissions and negating the requirement for installing and operating an active landfill gas removal system.

Greater costs were partially offset by an increase in revenues of approximately $300,000 coming from the Gas Tax Grant assistance for the organics program and user fees. The user pay approach for recycling mattresses also meant additional revenues to offset the additional costs.

Environmental Monitoring

Leachate Monitoring

The ACRD measures water quality parameters at fixed locations in and around the AVL on a fixed quarterly schedule. The locations include two leachate drains, eighteen monitoring well sites, two leachate interception wells and six surface water monitoring points. Samples are analyzed by an independent laboratory for metals, volatile organic compounds (VOCs), inorganic compounds, pH, conductivity and other water quality parameters. All monitoring data are provided directly to our environmental monitoring consultant, Piteau Associates Consulting, for their review. Piteau compiles

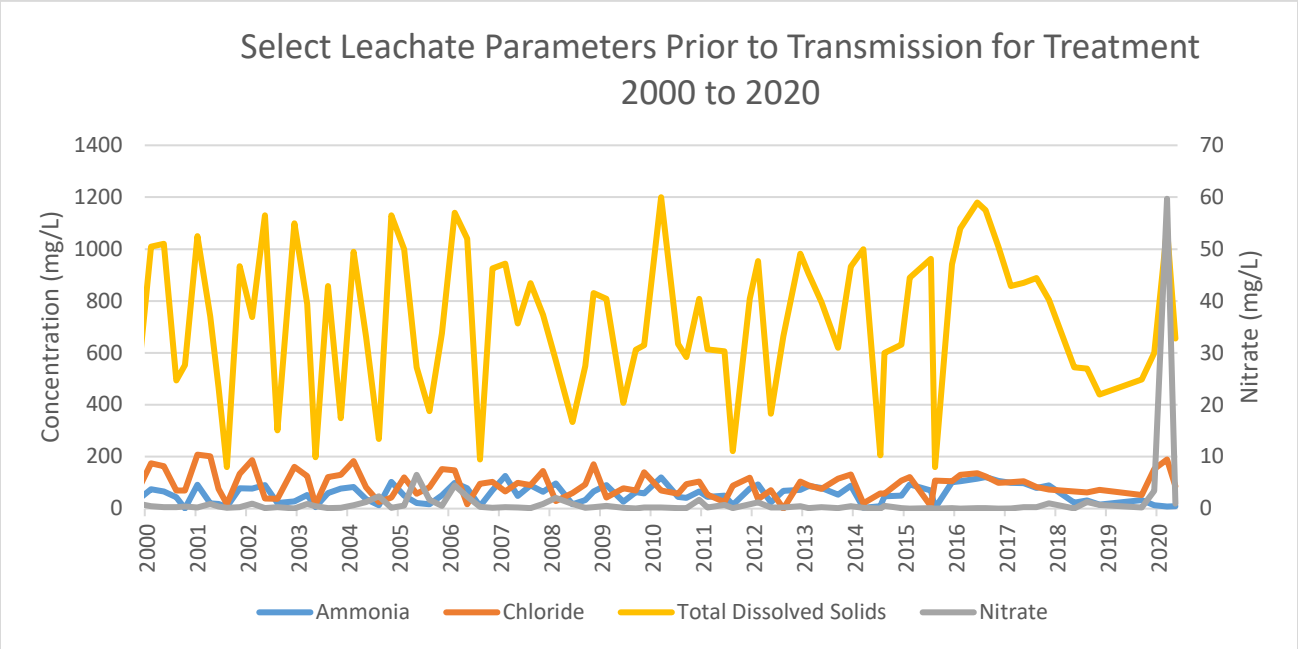
and analyzes the data and prepares an annual environmental report to accompany this report to be supplied to the BC Ministry of Environment and Climate Change Strategy (MOECCS).

Target 5 – Confirm all leachate is treated to meet the FWAL criteria

The landfill includes a leachate collection system comprised of internal drains, pumping systems, collection trenches, aeration lagoon and a flow equalization pond. Once collected, leachate is piped directly to the City of Port Alberni's (CPA) wastewater facility for treatment.

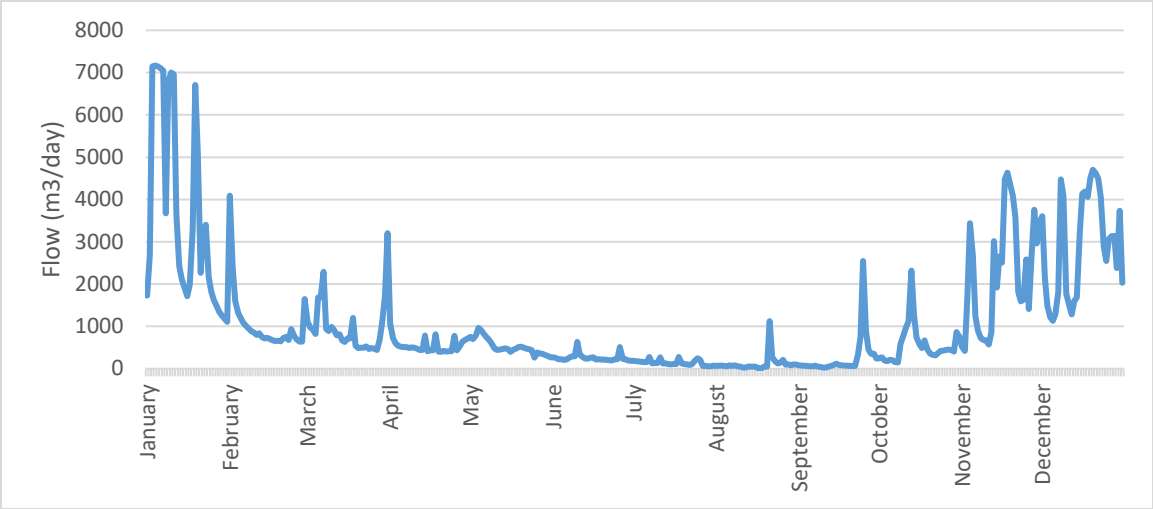
The water quality parameters of the leachate leaving the landfill have been monitored since 1990. Chart 7 below illustrates the recorded levels of ammonia, chloride, nitrate and total dissolved solids for the past 20 years. Note the seasonal variations in key parameters reflecting the lower flow conditions in the summer months. In this period of low flows in the summer of 2020, there was an unusual spike in ammonia and nitrate values. This had not occurred in previous years and Piteau recommends collecting a few more years of data to see if similar summer spikes occur or if this was a one-time event.

Chart 7 - Leachate Parameters



Leachate is transferred by a dedicated pipeline to be treated. The ACRD does not monitor the quality of treated effluent leaving the City of Port Alberni's (CPA's) lagoon but requests and receives treatment results from the CPA. Whilst the water quality of the discharges from the CPA facility meet the relevant criteria, the CPA data does not include dissolved and total metal concentrations that are important parameters for assessing the quality of landfill leachate. The graph below shows the 2020 leachate flows into the CPA sewage lagoon with a total volume of 497,588 cubic meters for 2020. Currently, there is no diversion of clean runoff water, so the graph below (Chart 8) is indicative of the amount of water generated by rainfall within the disposal area at the landfill. Future works, including final capping, will be able to divert clean runoff.

Chart 8 - 2020 Leachate Discharge Flows



Water Quality of Surrounding Environment

Piteau (2020) reported on the results of environmental monitoring conducted throughout the year. Their conclusions were as follows.

1. Groundwater flow in the limited surficial sediments beneath the landfill property is interpreted to dominate the flow regime, due to the low hydraulic conductivity of the bedrock. Flow in surficial sediments to the north are managed with a clay berm and interception trench pumping system. The French Drain in the South Expansion Area and the seepage cut-off wall/berm at the west of the property control seepage that may have migrated west to Heath Creek. Seepage east of the property is managed by the leachate interception wells.

2. Current leachate indicator concentrations are typical for a landfill of this size and age. Samples from the French Drain in the South Expansion Area indicate no significant landfill effects except for slightly elevated ammonia concentrations.

3. Leachate effects in surficial sediments were only noted at MW94-6S on the north side of the landfill, and PW-2, MW02-3S and MW05-1S near the flow equalization pond. Flow past MW94-6S is captured by the north leachate interception trench and pumping system. Minor effects by the pond can be mitigated with the operation of PW-2 and PW15-2, as described below.

4. Monitoring data for bedrock monitoring wells sampled in 2020 indicate no leachate effects have occurred to the south and only slight leachate effects have occurred to the west, north, northeast and east of the present landfill footprint.

5. When operated as recommended, the interception wells control the migration of leachate towards Christie Creek. Shallow leachate interception well PW-2 was recommissioned in 2020 and was providing adequate containment by the end of the year. PW-1, the original bedrock pumping well, appears to have been inducing a gradient from nearby observation wells MW05-1D and MW02-3S since it was recommissioned in May 2020. PW15-1 and PW15-2, the backup leachate interception wells, are being commissioned in 2021.

6. As in previous years, no leachate effects were detected in Heath Creek in 2020. Water quality results from this site in 2020 complied with all receiving surface water criteria except for phosphorus, aluminum, and copper.

7. Slight leachate effects have been detected in Stevens Creek, which flows over the north landfill property boundary onto Lot 105. With the exception of phosphorus, aluminum, and copper and manganese, water quality results from this site in 2020 complied with all receiving surface water criteria.

8. Water quality in Christie Creek has improved significantly since the discharge from the aeration lagoon was diverted to the leachate pipeline in 1998. In 2020, water quality complied with all receiving surface water quality criteria, except for phosphorus, aluminum, copper, iron, manganese, and zinc, which are unlikely to be associated with leachate.

As Piteau reported, a significant well rehabilitation project was then undertaken in 2020. The rehabilitation included cleaning the wells, installing new instrumentation and replacing the pumps. In addition to rehabilitating the existing pumps, the new wells (the "back up wells) that were previously drilled in that area of interest are to be equipped with pumps and pressure transducers. The entire well field will then be controlled automatically. The effectiveness of this enhanced groundwater diversion capability will be able to be monitored by SCADA on the AVL system.

Landfill Gas Monitoring

Target 6 - Landfill Gas Generation Less than 1,000 tonnes/year of methane

MOECCS requires that assessment of landfill gas is completed using the Provincial spreadsheet model. In 2020 Sperling Hansen and Associates (SHA) prepared an updated assessment of Landfill Gas emissions using two approaches, one of which was the Provincial Landfill Gas Assessment Tool. There was good agreement between the two methodologies. SHA projected emissions using a waste composition that was based on the waste composition study that was conducted across the ACRD in 2019.

The SHA modelling showed approximately 900 t of methane was emitted in 2020. This is less than the 1,000 t of methane threshold set by MOECCS above which a landfill gas management system would be required.

Landfill gas emissions will be monitored in 2021 as part of a research initiative in partnership with Vancouver Island University. They will also be included as part of the environmental monitoring program in 2021.

Other Greenhouse Gas Emissions

Landfilling operations require the use of motorized equipment including small machinery such as power washers, small utility vehicles (ATVs), and pickup trucks, as well as heavy duty machinery such as compactors, graders and excavators. The fuel used for this equipment is primarily diesel. In 2020, the contractor burned approximately 38,916 liters of diesel in the operation of the landfill which is estimated to have produced 102.7 tonnes of CO_2. The ACRD will continue to work with the contactor to reduce the greenhouse gas emissions from the use of equipment for the landfill operations. This can be improved with the use of newer equipment with more efficient engines. Other options to explore would be to switch the types of other power sources or fuels such as biodiesel.

Illegal Dumping

Illegal dumping of wastes is of concern to both residents and to the ACRD. These wastes include yard and household wastes dumped in quiet locations. Typically, illegal dumping has taken place on private forestlands and local forest companies are now restricting access to forestry lands to reduce illegal dumping and for fire concerns. We are also aware that waste has been illegally dumped on First Nation Lands. The frequency of illegal dumping acts is not currently measured but it is addressed in a complaint driven process. In 2020 the weight of illegally dumped waste recovered and received for proper disposal at the AVL was 5.45 tonnes.

The ACRD completes cleanup where significant quantities of waste are illegally dumped. The ACRD also waives tipping fees for approved community groups to clean up areas within the waste-shed.

Projects Completed 2020

Bamfield Free Tipping Fee Pilot Program – A Pilot Program was implemented for Electoral Area "A" (Bamfield) to provide free landfill tipping fee vouchers to all households that could be used between October 1, 2019 to September 30, 2020. The objective was to reduce the costs to the ACRD to transport garbage by encouraging residents to bring their waste directly to the landfill and hopefully limit the amount of illegal dumping, backyard burning and dumping of big items at the transfer station. This program has been extended until September 30, 2021.

AVL Stewardship Program Expansion – A part of the ACRD's solid waste management plan is to increase diversion rates, reducing the waste stream at the landfills and to help decrease illegal dumping. Therefore, it was determined to extend the stewardship programs to the Alberni Valley Landfill so residents had more than one location to drop items off for Product Care and Encore Pacific accepted materials.

Yard Waste Program Changes – To support the reduction of open burning and improvement of air quality in the Alberni Valley and to manage traffic volumes and costs at the Alberni Valley Landfill (AVLF), a $5 flat rate per residential load and a commercial rate for branches at $120.00 per tonne was adopted in the Alberni Valley Landfill Tipping Fee and Regulation Bylaw R1029-2.

Asset Management Plan - Version 1 was adopted June 24, 2020. The Alberni Valley & Bamfield Waste Management Plan (AVLF) Asset Management Plan (AMP) is part of the ACRD Asset Management program to facilitate informed decision-making and effective allocation of resources for infrastructure. The purpose of an AMP is to deliver sustainable, cost effective services to ACRD communities in a socially, economically, and environmentally responsible manner, while providing the level of service agreed upon by the Board of Directors.

Recollect Recycling App – This mobile App communicates digitally with people to provide all recycling information. This includes collection schedules, information on how to properly recycle and dispose of materials. This App allows the ability to update delays or changes due to weather conditions and build good recycling habits.

3rd Avenue Recycling Depot Upgrades – Due to COVID-19 a re-design plan was created in order to run the depot in a safe manner. The depot stopped bailing Recycle BC materials, therefore the building was

turned into the Stewardship Program drop off center with the outside of the building being the Recycle BC material drop off.

Bear Aware Program - The Bear Smart Community Program is designed and run by The Ministry of Environment and Climate Change Strategy in partnership with the British Columbia Conservation Foundation and the Union of British Columbia Municipalities. It is a voluntary, preventative conservation measure that encourages communities, businesses and individuals to work together. The goal is to address the root causes of human/bear conflicts, thereby reducing the risks to human safety and private property, as well as the number of bears that must be destroyed each year.

Landfill Operations Contract Update and Renewal – The AVL Operations Contract has been reviewed and updated to address several issues including airspace usage and safety and fire prevention requirements. The contract updated language to address a number of changes to operations over the past five years including collection of stewardship products and managing other new diversion streams and controlled waste on the site, as well as the SCADA system and additional tipping wall monitoring.

Leachate Treatment Monitoring – The AVL sends leachate directly to the CPA wastewater treatment system. The CPA now includes additional monthly testing of the treated effluent being discharged. The Ministry of Environment are now requesting the CPA to do metals analysis for iron and manganese for the leachate and other influents to their wastewater lagoon so that data will also be available going forward.

Monitoring Program Improvements – The field review recommended a number of improvements including; using dedicated bailers, increased calibration, immediate sample collection after purging and retention of field notes. The annual report also recommended using an updated procedure for dissolved copper requiring an increase in sampling.

Leachate Interception Well Rehabilitation - There are presently two pumping wells used for intercepting leachate and limiting the flow of groundwater leaving the site. These wells became fouled and their functioning was impaired. These two wells were rehabilitated in 2020 and new pumps were installed. The improvements are recognizable in the East Boundary Shallow and Deep Seepage graphs as the TDS and Chloride are now diminishing.

Solid Waste Services Resource Review – a staff time allocation review was undertaken. The objective was to determine if sufficient resources were being assigned to the solid waste service to meet regulatory requirements and to achieve the goals of the Solid Waste Management Plan. The review concluded that a gap existed as a consequence of a previous reliance on local engineering consultants. It also identified increased regulatory requirements and on-going operational deficiencies that highlighted the need to allocate additional staff resources to this service. A dedicated Solid Waste Manager position was created, with recruitment to occur in 2021 and the addition of a half time West Coast Solid Waste support staff person to begin in 2022.

SCADA for North Boundary and Stevens Creek Sites – In order to better monitor the north boundary pumping station level sensors were installed at two monitoring wells and have connected to the SCADA system. This now provides continuous monitoring of the water level in the two wells and ensures the pumps are achieving the design drawdown to limit groundwater from leaving the site in those locations.

Projects Upcoming

McCoy Pump Station Upgrade – The fresh water required for the operation of the AVL comes from the pump station located on McCoy Lake Road. This station needs a complete rehabilitation as the wood structure is rotting, pumps are at the end of their life and the piping manifold is in need of replacement. A completely new station including the building, pumps and manifold has come available from the City of Port Alberni. This will be an easy low-cost solution to upgrade the AVL's fresh water system.

3rd Ave Recycling Depot Contract – Social Focused RFP - The ACRD will be looking for businesses that create training and employment opportunities for people facing systemic barriers to entry into the mainstream labour market to take over operation of the Recycling Depot.

Design Operation and Closure Plan Update – The current DOCP was created in 2012 and requires updating as the detailed development phases set out in the plan have been completed. As well, the Province has created new landfill criteria and there are several areas identified with the landfill operation that need to be improved to meet the new criteria. The ACRD recently awarded the DOCP Updates for the Alberni Valley Landfill to Sperling Hansen and this project will be completed in 2021.

VIU Gas Monitoring Partnership – The ACRD is partnering with Vancouver Island University (VIU) on a project that will utilize sensitive scientific instruments to accurately measure the gas generation on-site. VIU has a mobile gas monitoring lab that can detect gases at much lower concentrations than handheld monitoring devices. In addition to the VIU mobile gas monitoring program, the ACRD is planning installing permanent sensors to be included in the real time monitoring of the landfill (SCADA system).

Flare Installation – In previous years, an existing monitoring water well was found producing high levels of landfill gas. In 2021 a new gas well will be drilled to facilitate the installation of a new flare to burn this off and reduce GHG emissions. A monitoring system of the flare will be incorporated into the SCADA system to determine how much gas is being destroyed and to assist in determining any future needs.

CPA 3-Stream Waste Collection – In 2021 the new Sort'nGo waste service, which includes the introduction of a three-stream (organics, recycling and garbage) automatic cart collection system, will begin for single family households in the City of Port Alberni.

AVL Upgrades: Recycling and Transfer Station upgrades at Alberni Valley Landfill, including new access roads, tipping bin walls, and associated earthworks and infrastructure. Upgrades to the landfill tipping area will be required to accommodate the new organics diversion stream.

Organics Diversion - The ACRD will begin implementing organics diversion in 2021, including public engagement and education on the new system as well as the acquisition of green bins for collection. Establishment of drop-off services as well as implementing organics bans is anticipated. As part of a phased approach the electoral areas of the Alberni Valley will be offered collection and other alternatives for organics diversion. Consultation in those areas will begin in the fall of 2021.

Alberni Valley Collections Contract – The AV Curbside recycling collection contract will be up for renewal in 2021. With the addition of organics diversion, the scope of the collection program needs to be reviewed and adjusted prior to issuing for competitive bids.

Leachate Interception Back-Up Wells Commissioning - In order to provide a more robust groundwater diversion capabilty, the leachate “backup wells” alongside the existing wells will be commissioned to operate in unision with the current wells. In 2021, these wells will be equipped with submersible pumps and the control system renewed to make these a single combined well field. The wells will then operate cooperatively and hence more effectively.

Replacement of the Leachate Monitoring Well – This well previously allowed sampling of leachate from within the landfill and requires replacement. The location of this new sampling well will be incorporated in the updated DOCP and installed in 2021. There is also some repair work needed at another location that will repaired at the same time.

Construction and Demo Diversion Program – Investigate potential Construction and Demolition waste diversion working with the CWMA Construction & Demolition working group.

Waste Licensing Bylaw – this is to enable the ACRD to receive reports from private resource recovery and recycling companies.

Update of Solid Waste Management Plan – the current Solid Waste Management Plan was completed in 2007. In British Columbia, Regional Districts are mandated by the Provincial Environmental Management Act to develop Solid Waste Management Plans that are long term visions of how each regional district would like to manage their solid wastes, including waste diversion and disposal activities.

PITEAU ASSOCIATES
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ALBERNI CLAYOQUOT REGIONAL DISTRICT

ALBERNI VALLEY LANDFILL
2020 WATER QUALITY MONITORING PROGRAM

PORT ALBERNI, BC

Prepared for

ALBERNI CLAYOQUOT REGIONAL DISTRICT

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Project 1005-20-R1

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RECORD OF AMENDMENTS

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1. INTRODUCTION

The Alberni Valley Landfill (AVL) is located on the west side of the Alberni Valley, near the crest of a wide ridge which separates the top end of Alberni Inlet from Sproat Lake (Figure 1). It is situated about 5 km west of Port Alberni at an elevation of about 80 m above sea level. Access is provided by Landfill Road off McCoy Lake Road or by the Stirling Arm logging road that passes along the south side of the property (Figure 2).

The AVL is owned by the Alberni-Clayoquot Regional District (ACRD) and operates under Operational Certificate MR-00524, issued by the Ministry of Water, Land and Air Protection on June 29, 2004. In 2020, Sperling Hansen Associates provided landfill design and operational plans to the ACRD, and Berry & Vale Contracting Ltd. operated the landfill. Piteau Associates Engineering Ltd. (Piteau) has overseen the AVL monitoring program since 1994. This groundwater and surface water quarterly monitoring program is conducted to evaluate the effect of the landfill on the surrounding surface water and groundwater regime. This report has been prepared to summarize and assess the results of the 2020 program.

For the purposes of this report, the landfill property is subdivided into four areas based on the operational certificate (Figure 2). These include the Original Landfill Area; the East Expansion Area first filled in 2004; the Northeast Expansion Area first filled in 2014; and the South Expansion area. A description of the landfill history, geology, landfill design and leachate control measures, and a history of the landfill monitoring program are included in the 2020 Water Quality Monitoring Report (Piteau, 2020).

2. DESCRIPTION OF 2020 ACTIVITIES

2.1 LEACHATE PUMPING AND SCADA SYSTEMS

In 2020, a SCADA system was installed at AVL to remotely monitor pumping systems and water levels. New pumps and control systems were installed in leachate interception wells PW-1 and PW-2, and connected to the new SCADA system to record water levels and flows that can be accessed through an online web portal.

Water level sensors were also installed on monitoring wells MW98-9 and 10 on the north side of the landfill, and MW05-1S/D and MW02-3S/D near the leachate pond to monitor the efficacy of the pumping system. The water level monitoring system was completed in December 2020, and calibration of the system is ongoing.

2.2 MONITORING FREQUENCY AND PARAMETERS

The 2020 monitoring program was conducted by ACRD personnel on a quarterly basis in accordance with Table I. Water elevation data for the monitoring wells is presented in tables and time-series plots in Appendix A. Tabulated summaries of analytical data and time-series plots of key leachate parameters for the period of record are presented in Appendix B.

2.3 MONITORING METHODS

Static water levels were measured in all pumping and monitoring wells with a graduated electric water level tape prior to each purging and sampling event. Recommended changes to purging and sampling methods following a field review in 2019 (Piteau, 2019) were fully implemented by August 2020. Sampling events in February and May 2020 were a mix between former methods (purging with a portable submersible pump and sampling with weighted polyethylene plastic bailers or Waterra inertial foot value pumps on HDPE tubing) and the current methods described below.

Most monitoring wells were purged with a Waterra Hydrolift pump with Waterra inertial foot valve pumps on HDPE tubing. When three well volumes could be purged from the well, samples were collected immediately afterwards. Some of the bedrock wells are completed in a rock mass with very low permeability and once a well volume is purged, the water level does not recover sufficiently to allow for immediate sampling (Table II). These wells were left to allow adequate time for formation water to accumulate, and sampled at the end of the sampling event.

Due to their shallow depths, the amount of standing water in MW98-9 and MW98-10 is often insufficient for use of Waterra pumps. When appropriate, these wells were purged with a low-flow peristaltic pump, and sampled once field parameters had stabilized.

Leachate interception well samples from PW-1 and PW-2 were collected from the outlet of the 50 mm diameter discharge pipe from the installed pumps. If not already operating, the pump was switched on manually and the samples collected after a few minutes of pumping.

All surface waters were grab sampled.

In all cases, field measurements for electrical conductivity, temperature and pH were obtained using hand-held digital probes calibrated against known standards or buffer solutions. Samples for ammonia and Chemical Oxygen Demand (COD) were preserved with sulphuric acid (H_2SO_4) at the time of collection, and samples for total metals were preserved with nitric acid (HNO_3). Samples for dissolved metals were filtered with single-use 0.45 micron inline filters and preserved with nitric acid at the time of collection. All samples were stored with ice in a cooler and couriered to AGAT Laboratories in Burnaby, BC for analysis.

The freshwater aquatic life (FWAL) guideline for dissolved copper was approved in August 2019 and supersedes the hardness-dependent total copper guideline (BC MOE, 2019). The new guideline is dependent on sample pH, temperature, dissolved organic carbon (DOC), humic acid (HA) content, alkalinity, and major cation and anion concentrations. To assess compliance with this new guideline at sites where only total metals are typically measured, samples for dissolved metals were also collected, but only submitted for dissolved copper analysis if total copper results exceeded the calculated guideline based on the sample-specific chemistry described above. HA is not yet an approved laboratory test in British Columbia, so the default HA content of 10% was assumed for the calculation.

2.4 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control (QA/QC) processes incorporated in the monitoring program included measures by both the analytic laboratory and by field personnel collecting surface water and groundwater samples. The laboratory component includes analysis of quality control samples to define precision and accuracy, and to demonstrate contamination control for the type of samples and parameters under investigation. These measures include analysis of laboratory replicates, method blanks, and certified reference materials.

QA/QC inherent in the field program to ensure sample integrity include prevention of cross contamination and introduction of foreign contaminants during sampling through the use of new latex or nitrile gloves and dedicated sampling equipment at each sample location and use of unused sample containers provided by the project laboratory.

The field program also included collection and analysis of one field-duplicate sample for every ten samples collected to verify analytical precision (i.e., repeatability). The relative percent difference

(RPD) between the sample and the duplicate was calculated in accordance with the following equation:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100\%$$

where:

- RPD is relative percent difference;
- C1 is the larger of the two observed values; and
- C2 is the smaller of the two observed values.

RPD values below about 35% are generally desirable, and values of up to about 65% are considered acceptable. For the eight field duplicate samples collected in 2020, all calculated RPDs were below 35%, with the following exceptions (Appendix C):

- RPDs of 56% and 67% for dissolved cadmium at MW94-6D and MW02-3D in February 2020 (Table C-1). All results were close to the laboratory reporting limit and well below the FWAL guideline;
- The May 2020 samples from MW94-5S had calculated RPDs of 161% for copper, >138% for lead, and 138% for zinc (Table C-1). Both samples were below relevant guidelines for lead and zinc, but the primary sample exceeded the dissolved copper FWAL guideline while the duplicate sample did not;
- The October 2020 samples from Stevens Creek had RPDs above 67% for all three total metals that were detected in the sample, and ammonia (Table C-3). All results were below the FWAL guidelines, and the ammonia and cadmium results were below or close to the laboratory reporting limit;
- The August 2020 samples from the Lagoon Inlet had calculated RPDs of 40% for total cadmium and chromium (Table C-4). Both parameters were measured at levels close to the laboratory reporting limit, well below FWAL guidelines; and
- The October sample from the South Expansion Leachate Drain had calculated RPDs above 35% for total cadmium (67%), lead (74%), and COD (48%). The cadmium and lead concentrations were measured very close to the laboratory reporting limit and well below their respective guidelines. COD does not have a guideline (Table C-4).

3. GROUNDWATER FLOW

3.1 GROUNDWATER FLOW IN BEDROCK

The bedrock is of very low hydraulic conductivity, based on the slow response time of the monitoring wells and incomplete recovery between quarterly sampling events (Appendix A). The flow regime in bedrock is interpreted to be very slow moving due to the low hydraulic conductivity of the rock mass and low hydraulic gradient (0.06 m/m) to the ultimate discharge area along the shore of Alberni Inlet (Piteau, 1995, 2000 and 2002).

Bedrock groundwater flow beneath the original landfill area is interpreted to be to the north, northwest, southeast and east, and flow beneath most of the expansion areas is interpreted to be to the east and southeast, except for the extreme western edge, where westward groundwater flow is interpreted (Figure 3).

A flow divide is interpreted to bisect the original landfill area. Groundwater flow in bedrock on the west side of the interpreted flow divide is interpreted to be to the west and, on the east side flow is interpreted to be southeasterly to easterly. The flow divide is interpreted to extend along the north leachate interception ditch, based on the hydraulic heads measured in MW13-1 and MW13-2, which are the highest on site when static water levels are attained (Figures 3, 4, 5 and A-9).

In 2020, the lowest representative hydraulic heads in bedrock were recorded in leachate interception wells PW-1 and PW15-1 (Table A-1 and Figure 3). Heads in adjacent monitoring wells MW05-1D, MW02-3D, and MW15-1D also appeared to show some drawdown compared to previous years. This is due to the current operation of PW-1 (Figures 4 and A-7). Although water levels in PW15-1 appear to be lower than in PW-1 (Figure A-7), they were measured on different days (Table A-1), presumably at different times in the pumping cycle.

When the pumping system is operating properly, a controlling gradient is induced in the bedrock flow regime and the wells are an effective interception measure (Figure 4). When neither PW-1 nor PW15-1 are operating, groundwater flow in bedrock beneath the east edge of the landfill is upwards towards the surficial sediments and easterly towards Christie Creek. Based on the manual water levels, PW-1 pumping rates and water elevations measured by the SCADA system, it appears the system has provided effective interception of leachate since May 2020, when it was recommissioned (Figure A-7).

3.2 GROUNDWATER FLOW IN SURFICIAL SEDIMENTS

As a result of the low bedrock permeability, a very high component of the groundwater flow beneath the area is expected to perch above the rock and seep through surficial sediments. Groundwater flow in surficial sediments is limited to the areas discussed below.

3.2.1 Landfill Expansion Areas and Bedrock Gap Along Stirling Arm Logging Road

The largest amount of groundwater seepage at AVL occurs in the sands and gravels beneath the South and East Expansion areas. These sediments are highly permeable and have a saturated thickness up to about 12 m (Figure 4).

An interpreted groundwater flow divide occurs in the sands and gravels near the seepage cut-off berm at the west side of the South Expansion Area (Figure 3). No seepage losses are interpreted to occur from the Southeast Expansion Area through this cutoff structure based on the eastward hydraulic gradient (i.e., towards landfill) on its east side. The above surface water level in MW94-4S is attributed to a localized flow regime (Figure A-2 and Piteau, 2020).

The largest component of the seepage in surficial sediments beneath the South Expansion Area is towards and into the French Drain that maintains the water table at approximately 70 m-geod. (Figures 3, 5, and A-6). Christie Creek and the PW-2 leachate interception well are the interpreted discharge points for any groundwater flow in surficial sediments beneath the South Expansion Area not intercepted by the French Drain. When PW-2 is operating, it induces a significant gradient from MW02-3S and MW05-1S (Figure A-8).

The controls at PW-2 were adjusted through 2020, and it appears the well was operating as intended by the end of the year (Figure A-8). The second well (PW15-2) will provide mechanical backup and extra pumping capacity during the winter months when water levels are high. It has not yet been put into service. If operated as intended, it is expected that these wells will sustain a hydraulic gradient towards the landfill in this area (Piteau, 2017).

3.2.2 Flow to North in Bedrock Trough

Some northward groundwater flow is interpreted to occur across the north perimeter of the landfill through sand and gravel sediments that have infilled the base of a bedrock trough near MW94-6 and MW94-9. Recharge to this localized flow regime is limited due to the confinement provided by the overlying silt and clay moraine sediments, and the northward groundwater flow is managed with an interception trench, sump and pumping system north of the landfill perimeter commissioned in 1999 (Figures 3 and 4).

As indicated on the hydrographs (Figures A-3 and A-4), piezometric levels were relatively high in the vicinity of MW94-6 and MW98-9 during the Q2 2020 monitoring event. This indicates that the interception trench was not functioning as intended at that time. The system was working normally for the remainder of the 2020 monitoring events. Water levels in MW98-9 and MW98-10 are now recorded in real-time by the SCADA system, and the system operator will be notified immediately if the level in MW98-9 rises above that in MW98-10.

3.2.3 Groundwater Flow Beneath Original Landfill

The groundwater flow regime beneath the original landfill is interpreted to follow the bedrock topography to the southwest. Recent water levels measured in BH00-1C and BH00-2C, both with screen completion zones at the base of the waste at the bedrock contact, are indicative of a perched water table at the approximate level of the trafficked surface and are not considered representative of the groundwater flow regime beneath the landfill (Figure A-3).

4. WATER QUALITY MONITORING RESULTS

Average concentrations of key leachate parameters at each monitored site during 2020 are presented in Table II, along with Guidelines for Canadian Drinking Water Quality (GCDWQ, Health Canada, 2020), working and approved guidelines for freshwater aquatic life (FWAL) in BC (BC MOE, 2019 and 2020), the phosphorus objective developed for Vancouver Island streams (BC MOE, 2014), and standards from the Contaminated Sites Regulation (CSR) for aquatic water (AW) and drinking water (DW). As the CSR AW standards are for groundwater, and assume 10 times dilution before entering surface water, analytic water quality data for natural surface watercourses have been compared to one tenth of the AW standard (Table III).

Exceedances of these standards are highlighted in the sections below, except for minor excursions of the GCDWQ and BC FWAL pH ranges.

4.1 LEACHATE

Leachate quality is monitored where the leachate drain flows into the aeration lagoon and at the discharge point from the South Expansion Area Leachate Drain (Figure 2). Due to the low permeability of the landfill foundation, most of the leachate from the landfill naturally seeps into the two drains.

4.1.1 Inorganic Chemistry

The leachate sampled from the leachate drain is characterized by neutral pH, high EC and alkalinity, and high concentrations of chloride, iron, manganese and ammonia (Tables II and B-1). Dilution at the sampling point for the main leachate drain is about 2:1 (Piteau, 2020). Concentrations are typically highest in summer due to the dry weather.

Chloride concentrations in the leachate drain discharge have ranged between about 10 and 210 mg/L (Figure B-1). Although concentrations had declined over the past four years, summer 2020 chloride concentrations (153 and 190 mg/L) were elevated, coinciding with elevated EC, TDS, field temperature, sodium, and sulfate (Table B-1).

Ammonia concentrations in 2020 remained low, continuing the trend observed since 2018 (Figure B-2). Ammonia concentrations typically follow chloride concentrations with a slight lag. All 2020 ammonia leachate samples exceeded the 1.84 mg/L-N FWAL guideline by factors of 4 to 18, with the February and May samples also exceeding the CSR AW standard (Tables III, B-1).

Nitrate concentrations in the leachate drain were elevated in 2020 (59.7 mg/L-N in August), suggesting nitrification of ammonia is occurring (Table B-1 and Figure B-2). The May and August samples exceeded the 3 mg/L-N FWAL guideline, and the August sample also exceeded the 10 mg/L-N GCDWQ and CSR DW standard (Table III).

Total phosphorus also exceeded the May to September average Vancouver Island phosphorous objective (0.005 mg/L; MOE, 2014) for both the May and August sampling events by factors of 6 and 12, respectively (Table B-1 and Table III).

Iron and manganese are the only two metals in leachate that have regularly had concentrations up to 1000 times greater than receiving water criteria (Table B-1). Leachate exceeded the iron and manganese GCDWQ, FWAL and CSR DW limits for the majority of 2020 sampling events, with results ranging as high as 35.1 mg/L-Iron in January and 11.4 mg/L-Manganese in October (Tables B-1 and III). All other monitored metal concentrations in 2020 were below limits, except for aluminum (two of four samples exceeded the 0.05 mg/L dissolved aluminum FWAL guideline), arsenic (one of four samples exceeded the 0.005 mg/L FWAL guideline), chromium (three of four samples exceeded the 0.001 mg/L working FWAL guideline), cobalt (all samples exceeded the 0.001 mg/L CSR DW standard by factors of 2 to 5), and mercury (three of four samples met or exceeded the 0.02 µg/L FWAL guideline).

The COD at the leachate drain discharge has typically ranged between 20 and 220 mg/L-O since 1998, with the higher values attributed to elevated suspended sediment (Figure B-3). In 2020 COD concentrations at this sampling location ranged between 65 and 198 mg/L-O (Table B-1).

Overall, the leachate strength appears to be relatively constant, subject to some seasonal and climatic variations. At this time, the data does not indicate any increasing trends that would raise concerns regarding future changes in the leachate character.

Samples collected from the South Expansion Area Leachate Drain are representative of very dilute leachate, due to a very small area of the catchment that has been covered with waste (Table B-2 and Figures B-1 to B-3). All 2020 monitoring results met receiving water criteria except ammonia (concentrations up to 1.8 times the FWAL guideline), total phosphorus (concentrations up to 6.6 times the Vancouver Island phosphorous objective), dissolved copper (concentrations up to 6.6 times the sample-specific calculated FWAL guidelines), total iron (only exceeding the GCDWQ AO), total manganese (at concentrations up to 2.2 times the FWAL guideline and CSR DW standard) and total cobalt (concentrations less than twice the CSR DW). The ammonia exceedances indicate that leachate is being intercepted by the drain. Discharge from the French Drain is conveyed into the flow equalization pond.

4.1.2 Organic Chemistry

Samples for organic chemistry analysis have consistently demonstrated that volatile organic compounds, acid extractable compounds and chlorinated phenols are not leaching from the landfill at a concerning rate (Piteau, 2020).

In 2020, bromomethane (10 µg/L) exceeded the 5.5 µg/L CSR DW standard for the leachate sample. The only other VOC detected in the leachate sample was chloromethane, for which no standard has been developed. All VOC parameters for the South Expansion Area Leachate Drain were non-detect (Table B-3), consistent with results since sampling began in 2016. No phenols or acid extractables were detected in the 2020 leachate sample (Table B-4).

4.2 GROUNDWATER IN SURFICIAL SEDIMENTS

Seven monitoring wells and one production well sampled as part of the 2020 monitoring program are screened in surficial sediments. These wells provide information along the potential seepage pathways in surficial sediments that have been identified at the site.

4.2.1 Southeast Side of Landfill

Chloride concentrations for MW02-3S, located on the east side of the flow equalization pond, have increased to about 90 mg/L in recent years from the background levels measured prior to 2016 (Table B-5 and Figure B-4). Other leachate indicators electrical conductivity and TDS have also been elevated in recent years, with 2020 values averaging 1206 µS/cm and 728 mg/L, respectively (Table II). Nitrate and ammonia have remained low for 2020.

In addition to the TDS exceedances of the GCDWQ, the following exceedances were noted for MW02-3S for 2020 (Tables III and A-5):

- Dissolved arsenic concentrations exceeded the 0.005 mg/L FWAL guideline for the last three sampling events of 2020;
- All four dissolved manganese concentrations exceeded the 0.02 mg/L GCDWQ AO and 0.12 mg/L MAC, but remained below the FWAL guideline and CSR DW standards;
- Dissolved copper concentrations for two sampling events slightly exceeded the sample-specific calculated FWAL guidelines, but remained below the CSR standards; and
- Dissolved cobalt exceeded the 0.004 mg/L FWAL and 0.001 mg/L CSR DW standard for three and four sampling events, but all results remained below the 0.04 mg/L CSR AW standard.

Based on rising levels of EC and chloride in recent years, there has been an increase in the leachate effect at MW02-3S. The increase coincides with a period of little to no operation of PW-2 (Figures A-8 and B-4).

Chloride, EC, and TDS are all lower at MW05-1S than MW02-3S (Table II and Figure B-4). Nitrate concentrations at MW05-1S are typically below the 3 mg/L FWAL, and ranged from 0.053 to 2.27 mg/L-N in 2020 (Table B-16 and Figure B-5). There were no exceedances at MW05-1S in 2020 for the parameters measured (Table III).

When operating, PW-2 intercepts easterly migration of groundwater and leachate in overburden. Based on the SCADA record and water levels measured prior to sampling in 2020, it was only

operating prior to the October sampling event (Figure A-8). Samples from PW-2 in 2020 continued to exhibit high chloride concentrations, with two samples exceeding the 150 mg/L FWAL guideline and the highest concentration (313 mg/L) exceeding the 250 mg/L GCDWQ and CSR DW standard (Tables III and B-18 and Figure B-4). Likewise, ammonia concentrations remained relatively elevated in 2020, with three of four results exceeding the 1.8 mg/L FWAL and 18.4 CSR AW standard by a considerable margin (Figure B-5).

TDS and dissolved iron and manganese in PW-2 all regularly exceeded all GCDWQ, FWAL and CSR DW limits by considerable margins in 2020 (Tables III and B-18). Other parameters with one or more exceedance in 2020 were sodium (222 mg/L, slightly above the 200 mg/L GCDWQ and CSR DW standard), dissolved arsenic (all three samples exceeded the 0.005 mg/L FWAL guideline but not the 0.01 mg/L GCDWQ MAC/CSR DW standard), dissolved boron (1.49 mg/L, slightly above the 1 mg/L FWAL guideline but below all other standards), dissolved chromium (two samples slightly exceeded only the 0.001 mg/L FWAL guideline), and cobalt (regular exceedance of both 0.004 mg/L FWAL guideline and 0.001 mg/L CSR DW but not 0.04 mg/L CSR AW standard).

Of the three active surficial sediment monitoring locations on the southeast side of the landfill, PW-2 displays the most significant leachate effect. When the shallow leachate pumping system (PW-2 and PW15-2) is fully operational, pumping will induce groundwater flow to these wells and reduce the effects at MW02-3S.

4.2.2 West Side of Landfill

Groundwater chemistry at the MW94-4S site has displayed consistently low chloride and nitrate concentrations since 2010 (Figures B-6 and B-7), with 2020 values averaging 7.4 mg/L and <0.13 mg/L-N, respectively (Tables II and B-7). Consistent with previous years, dissolved boron regularly exceeded the 1.2 mg/L FWAL, but remained below the GCDWQ, and CSR DW and AW standards. No other exceedances were noted at MW94-4S in 2020.

The absence of any prolonged nitrate or ammonia effect on groundwater samples collected from MW94-4S indicate a non-leachate source for the slightly elevated chloride concentration. This monitoring well is located just off the Stirling Arm Logging Road and is likely affected by road maintenance practices.

4.2.3 North Side of Landfill

Monitoring data from MW94-6S exhibit elevated concentrations of chloride (ranging from 4.0 to 7.3 mg/L in 2020) and ammonia (ranging from 8.9 to an anomalously high 251 mg/L-N) in 2020 (Table B-10 and Figures B-8 and B-9). In addition to the regular exceedances of the FWAL for ammonia (1.84 mg/L), the following dissolved metals exceedances were also noted for 2020 (Table III):

- The February sample exceeded the FWAL guideline for dissolved aluminum and GCDWQ for aluminum, but remained below the CSR AW standard;
- All four samples slightly exceeded the FWAL for arsenic, but concentrations remained below the GCDWQ, and CSR DW and AW standards;
- Three of four samples met or slightly exceeded the FWAL for chromium, but all concentrations remained below the GCDWQ, and CSR DW and AW standards;
- All four samples exceeded the CSR DW standard for cobalt, and the May sample slightly exceeded the FWAL guideline;
- Iron and manganese concentrations have generally declined since 2007 (Piteau, 2020), but all four 2020 samples exceeded FWAL, GCDWQ, and CSR DW limits by a significant margin; and
- The February sample met the FWAL for mercury, and slightly exceeded the CSR DW standard, but not the GCDWQ, FWAL guideline or CSR AW standard, for lead.

Groundwater seepage past MW94-6S is expected to be intercepted by the leachate interception trench, located immediately downgradient of this monitoring site (Figure 2).

Leachate indicator concentrations in MW98-9 and MW98-10 have generally been low since the leachate interception trench was commissioned in 1999, except following malfunctions of the interception trench pumps (Figures B-8 and B-9). Dissolved cadmium, chromium and copper concentrations exceeded the FWAL guidelines at one or both of these monitoring wells in 2020, but remained well below the GCDWQ MAC, and CSR standards (Tables III, B-12, and B-13). As the leachate concentrations were similar, or lower, the metals concentrations observed in MW98-9 and MW98-10 are considered to be background.

4.3 GROUNDWATER IN BEDROCK

4.3.1 Background Chemistry

Background bedrock groundwater quality has been measured at 13 monitoring wells since the monitoring program began, including MW02-4 and MW02-1S, which were sampled in 2020. MW02-4 is located adjacent to the landfill access road, west of the landfill, and MW02-4 is located south of the South Expansion Area. Although the MW13-series wells are not considered to be affected by the landfill, they are discussed separately in Section 4.3.5.

Chloride concentrations at MW02-4 have ranged from about 50 to 210 mg/L, with the highest concentrations exceeding those measured in the concentrated leachate sample from the leachate drain (Figures B-1 and B-8). In 2020, chloride concentrations at MW02-4 ranged from 80 to 120 mg/L, while sodium and sulphate concentrations ranged between 34.9 and 106 mg/L, and 15.1 and 65.2 mg/L, respectively (Table B-15). The elevated chloride and sodium concentrations are attributed to road maintenance practices or possibly natural background.

Results for MW02-1D display a much less mineralized chemistry than MW02-4 (Tables II, B-14 and B-15). Chloride and sulphate concentrations are generally much lower than in MW02-4, with chloride concentrations in 2020 below 8 mg/L (Figure B-6). Since late 2016, sodium and chloride concentrations have been elevated in this well, but are still well below those at MW02-4 (Table II, Figures B-6 and B-8). Groundwater at the MW02-1D location may be better "flushed" than at MW02-4.

Dissolved metal concentrations measured in background bedrock sites vary significantly between samples, with iron, manganese, boron, copper, zinc, mercury, cadmium and arsenic all exceeding receiving water criteria and sometimes leachate concentrations on more than one occasion (Piteau, 2020). The apparently elevated concentrations of metals are attributed to rock mineralogy, localized dissolution of these metals due to disturbances caused by the drilling process, and natural interactions between the rock and groundwater.

Except for a TDS exceedance above the GCDWQ at MW02-4, water quality exceedances for 2020 at the background bedrock sites were limited to the following dissolved metals (Table III):

- Aluminum in the August 2020 sample from MW02-1D exceeded the FWAL guideline (dissolved aluminum) and GCDWQ;
- Arsenic above the GCDWQ and CSR DW standard and the FWAL guideline at both sites;
- Boron exceeded the FWAL guideline at MW02-1D;
- Copper at or slightly above the sample-dependent FWAL guideline at MW02-4; and
- Iron in the August 2020 sample from MW02-1D exceeded the GCDWQ and FWAL guideline, and manganese exceeded the GCDWQ AO.

Based on the 2020 and historical sampling results, background chemistry of groundwater in the AVL area can be characterized as sodium bicarbonate-sulphate type, with varying TDS reflective of the residence time in the ground and the mineralogy of the rock mass along the groundwater flow path. Background chloride concentrations are interpreted to range from 2 to 20 mg/L and are likely higher near MW02-4. Ammonia concentrations are less than 0.5 mg/L-N.

4.3.2 East Side of Landfill

Leachate effects at MW02-3D, on the east side of the flow equalization pond, have slowly increased since 2010, when PW-1 operation became inconsistent (Figures B-4 and B-5). However, chloride concentrations at MW02-3D have increased since early 2019 to an average of 84 mg/L in 2020, above chloride concentrations measured in PW-1 and similar to those measured in MW02-3S (Table II). Based on water levels measured in MW02-3 and the timing and magnitude of chloride concentrations, it appears renewed operation of PW-1 in late 2019 created a downward gradient at MW02-3, inducing seepage from the surficial sediments (Table A-1 and Figure A-7). Nitrate and

ammonia concentrations have remained relatively low at MW02-3D, with maximums of 0.007 and 0.08 mg/L-N, respectively, in 2020 (Table B-6).

Chloride concentrations at MW05-1D have shown a delayed response to pumping of PW-1, increasing following a period of well operation and slowly declining when the well is not operating (Figures A-7 and B-4). These trends also suggest operation of the well induces shallow groundwater to seep down into bedrock in the area surrounding the well. Chloride concentrations averaged 30 mg/L in 2020 (Table II). TDS remained elevated in 2020, with two of four samples exceeding the 500 mg/L GCDWQ (Table III and B-16). Nitrate and ammonia concentrations have generally remained low, with maximums of 0.265 and 0.3 mg/L-N, respectively, noted in 2020. A very slight apparent rise in ammonia concentration may be following the rise in chloride concentrations noted in previous years.

Leachate indicators in water from PW-1 track those in MW05-1D, but at slightly higher concentrations (Table II, Figures B-4 and B-5). Similar to MW05-1D, two of four samples had GCDWQ exceedances for TDS, and all nitrate and ammonia remained below all standards and guideline values (Tables III and B-17). Elevated chloride and TDS concentrations indicate that when pumping, this well intercepts relatively deep groundwater flow that has been affected by leachate that has seeped into the bedrock.

Dissolved metals exceedances at MW02-3D and PW-1 are limited to exceedances of cobalt (above the 0.001 mg/L CSR DW standard), copper (above the sample-specific calculated FWAL guidelines), and manganese (above the 0.02 mg/L GCDWQ AO and 0.12 mg/L MAC and only exceeding the higher FWAL guideline and CSR DW standard at PW-1). Dissolved metals analysis was not conducted for MW05-1D.

4.3.3 West Side of Landfill

Monitoring data for bedrock piezometer MW94-4D displayed very similar chloride data to MW94-4S, which is screened in surficial sediments (Table B-8 and Figure B-6). Nitrate concentrations are typically higher than those measured in MW94-4S concentrations, and have fluctuated below 1 mg/L-N since 2009 (Figure B-7). Although current monitoring data indicate some very minor leachate effect in MW94-4D, leachate migration in this direction is not considered to be significant. Water level data indicate that there is no shallow leachate migration in this direction (Section 3.2.1).

4.3.4 North Side of Landfill

Recent chloride concentrations measured at MW94-5S and MW94-6D are at background levels (Figure B-8), indicating little leachate effect in bedrock on the north side of the landfill. Similarly, nitrate and ammonia concentrations in MW95-5S and MW94-6D (Tables B-9 and B-11, Figure B-9) are well below levels of concern.

Exceedances of water quality standards at these monitoring wells in 2020 were limited to (Table III):

- TDS above GCDWQ at MW94-6D;
- Dissolved aluminum above FWAL guideline and GCDWQ but below CSR AW standard at MW96-6D. Highest aluminum concentration 18 times higher than highest aluminum concentration measured in leachate sample;
- Regular dissolved arsenic above GCDWQ and CSR DW standard at MW94-6D. Arsenic concentrations are considered to be background (Piteau, 2020);
- Dissolved boron, cadmium, copper, mercury and zinc at MW94-6D and dissolved copper at MW94-5S above FWAL guidelines but below GCDWQ and CSR standards;
- Dissolved cobalt above CSR DW standard but below FWAL guideline and CSR AW standard at MW94-6D;
- Dissolved iron and manganese above GCDWQ and manganese above FWAL guidelines at both sites; and
- Dissolved lead above FWAL guideline, GCDWQ and CSR DW standard at MW94-6D.

The above exceedances are attributed to a combination of background bedrock water quality, and slight leachate effect, particularly at MW94-6D. Based on data for MW94-5S and MW94-6D, leachate effects to groundwater in bedrock at the north property line are interpreted to be very slight.

4.3.5 Northeast Side of Leachate Interception Channel

Water quality results for the monitoring wells installed on the northeast side of the leachate interception channel are indicative of a sodium-sulphate type chemistry with a very high total dissolved solids concentration and a high EC (Tables II, B-19, and B-20).

Groundwater in MW13-1D and MW13-1S is highly mineralized (Tables B-24 and B-26). TDS and EC continue to decline in samples collected from these wells, so metals and major ion chemistry is likely still affected by drilling, and is still not indicative of actual groundwater chemistry. Chloride concentrations have stabilized at about 70 mg/L in MW13-1D, and 40 mg/L in MW13-1S (Figure B-10). These concentrations are slightly higher than background concentrations observed elsewhere, and likely indicate these monitoring wells are located close to a groundwater flow divide where the flow regime is poorly flushed (Figure 3).

The chemistry in MW13-2S has shown some variability in previous years. Based on early water level trends and 2016 and 2017 ammonia concentrations (Figure B-11), it is possible MW13-2S has a discrete connection to the leachate interception/conveyance channel (Piteau, 2020).

Monitoring results for MW13-1D, MW13-1S, and MW13-2S were all within relevant guidelines in 2020, with the exception of iron and manganese at MW13-1D exceeding the GCDWQ (Table III). No leachate effect is indicated.

4.4 CREEKS

4.4.1 Heath Creek

Heath Creek is located west of the landfill, opposite to the interpreted principal direction of subsurface leachate migration (Figure 3). There have been no indications of leachate effect to Heath Creek (Table B-21).

In 2020, chloride concentrations remained below 6.5 mg/L and were within the historic range (Figure B-12). Nitrate and ammonia concentrations have not exceeded 0.3 mg/L-N since the start of the monitoring record and ammonia concentrations are typically less than 0.15 mg/L-N (Table B-21 and Figure B-13). EC values also remained within the historical range (Figure B-14).

Total phosphorus concentrations in the May and August samples slightly exceeded the Vancouver Island phosphorous objective (0.005 mg/L per MOE, 2014). The May and October total aluminum concentrations exceeded the dissolved aluminum FWAL guidelines, but were below all other standards. The aluminum concentrations are higher than those measured in the leachate and are attributed to background water quality. The October total iron concentration (0.53 mg/L) exceeded the GCDWQ AO (0.3 mg/L), and is consistent with exceedances noted in past years. The dissolved copper concentration (0.0003 mg/L) in the May 2020 sample exceeded the 0.0002 mg/L calculated dissolved copper FWAL guideline, but remained below all other standards (Table III and B-21).

4.4.2 Stevens Creek

Stevens Creek is the most likely of all the local creeks to be affected by seepage from the landfill, as it rises just below the berm located at the northwest corner of the landfill footprint (Figure 2). The water quality in this creek has displayed some slight leachate effects on occasion. Two additional sites (SCKA and SCKB) were sampled in 2015 and 2016 to assess whether this is due to seepage beneath the berm. Results indicated some leachate is seeping under the clay berm above Stevens Creek, but that at least a portion of the metal concentrations measured at the original Stevens Creek sampling site can be attributed to natural background (Piteau, 2020).

Chloride concentrations in Stevens Creek have ranged up to 55.7 mg/L with the maximum concentration to date occurring on October 7, 2002 (Figure B-12). Concentrations for the three sampling events in 2020 averaged 3.4 mg/L (Table II).

Stevens Creek 2020 nitrate concentrations fluctuated between 0.04 and 0.228 mg/L-N (Table B-22). Nitrate concentrations in Stevens Creek have not exceeded the FWAL guideline (3 mg/L-N) since the autumn of 2008 (Figure B-13).

The highest ammonia concentration reported for Stevens Creek was 1.8 mg/L-N, in the winter of 1993 (Figure B-13). Concentrations remained at or below 0.05 mg/L-N in 2020, well below the 1.8 mg/L-N FWAL guideline.

The total phosphorus concentration in the May 2020 sample exceeded the Vancouver Island phosphorus objective (MOE, 2014), but was within the envelope of previously observed data. No sample could be collected in August, as the creek was dry.

For the seven metals reported for 2020 at Stevens Creek, all concentrations were below the applicable guidelines and standards (Tables III and B-28), except:

- Total aluminum exceeded the dissolved aluminum FWAL guideline in February, and the FWAL and GCDWQ in October (consistent with previous results and approximately double the concentrations measured in the leachate);
- Total manganese exceeded the GCDWQ AO in all samples; and
- The total copper result for the May sample exceeded the CSR AW standard for surface water and the October dissolved copper result exceeded the sample-specific FWAL guideline calculated by the BC BLM.

A sample could not be collected in August, when concentrations are typically highest, as the creek was dry.

4.4.3 Christie Creek

Water quality in Christie Creek has improved significantly since the discharge from the aeration lagoon was diverted to the leachate pipeline in 1998, and shallow seepage around the south side of the flow equalization pond was addressed with a berm in 1999 (Figures B-12, B-13 and B-14).

In 2020, all leachate indicator concentrations remained low, and are similar in upstream (U/S) and downstream (D/S) samples (Table II and B-23). The sites were dry in August, when concentrations are typically highest.

Iron and manganese concentrations exceeded the GCDWQ AO in February at Christie Creek U/S, and in May and October at Christie Creek D/S (Table III and B-23). Only iron in the May sample from Christie Creek D/S (1.16 mg/L) exceeded the 1.0 mg/L FWAL guideline. On the same date, iron in the Christie Creek U/S sample was only 0.14 mg/L. The variation between upstream and downstream results is likely due to natural background variability, but could also include some leachate effects.

Total phosphorus concentrations exceeded the May to September Vancouver Island Streams phosphorus guidelines at both sites for the May sample. Phosphorus is typically higher at the Christie Creek D/S site, indicating some leachate effect.

Total copper exceeded the 0.002 mg/L CSR AW standard for surface water at both Christie Creek sites in May and October. Dissolved copper also exceeded the sample-specific calculated dissolved copper guidelines for these samples (Table III and B-23).

As in Stevens Creek, zinc concentrations have regularly exceeded the FWAL guideline and CSR AW standard for surface water of 0.0075 mg/L. These exceedances are attributed to background chemistry as the results for Christie Creek U/S typically exceed the results for Christie Creek D/S. Upstream zinc concentrations have exceeded the FWAL guideline for almost all sampling events since 2009 (Table B-29).

Similarly, aluminum concentrations above the FWAL guideline and GCDWQ are regularly measured in the upstream and downstream samples at levels double those measured in the leachate samples, and are attributed to background water quality (Table B-29).

5. SUMMARY

1. Groundwater flow in the limited surficial sediments beneath the landfill property is interpreted to dominate the flow regime, due to the low hydraulic conductivity of the bedrock. Flow in surficial sediments to the north are managed with a clay berm and interception trench pumping system. The French Drain in the South Expansion Area and the seepage cut-off wall/berm at the west of the property control seepage that may have migrated west to Heath Creek. Seepage east of the property is managed by the leachate interception wells.
2. Current leachate indicator concentrations are typical for a landfill of this size and age. Samples from the French Drain in the South Expansion Area indicate no significant landfill effects except for slightly elevated ammonia concentrations.
3. Leachate effects in surficial sediments were only noted at MW94-6S on the north side of the landfill, and PW-2, MW02-3S and MW05-1S near the flow equalization pond. Flow past MW94-6S is captured by the north leachate interception trench and pumping system. Minor effects by the pond can be mitigated with the operation of PW-2 and PW15-2, as described below.
4. Monitoring data for bedrock monitoring wells sampled in 2020 indicate no leachate effects have occurred to the south and only slight leachate effects have occurred to the west, north, northeast and east of the present landfill footprint.
5. When operated as recommended, the interception wells control the migration of leachate towards Christie Creek. Shallow leachate interception well PW-2 was recommissioned in 2020, and was providing adequate containment by the end of the year. PW-1, the original bedrock pumping well, appears to have been inducing a gradient from nearby observation wells MW05-1D and MW02-3S since it was recommissioned in May 2020. PW15-1 and PW15-2, the backup leachate interception wells, have not yet been commissioned.
6. As in previous years, no leachate effects were detected in Heath Creek in 2020. Water quality results from this site in 2020 complied with receiving surface water criteria except for phosphorus, aluminum, and copper.
7. Slight leachate effects have been detected in Stevens Creek, which flows over the north landfill property boundary onto Lot 105. With the exception of phosphorus, aluminum, and copper, water quality results from this site in 2020 complied with all receiving surface water criteria.
8. Water quality in Christie Creek has improved significantly since the discharge from the aeration lagoon was diverted to the leachate pipeline in 1998. In 2020, water quality complied with all receiving surface water quality criteria, except for phosphorus, aluminum, copper, iron, and zinc, which are unlikely to be associated with leachate.

6. RECOMMENDATIONS

6.1 MONITORING PROGRAM

The monitoring program should be continued through 2021 in accordance with Table I. Water level measurements in BH00-1C and BH00-2C can be discontinued, as they are not considered representative of true surficial sediment water levels.

Water levels in the monitoring wells around the leachate pond should be measured as close together as practical to provide contemporaneous data on which to base evaluations of groundwater flow direction. The time the water levels were measured should be recorded.

Samples collected from the Leachate Drain during the mid-summer sampling event should also be analyzed for per- and polyfluoroalkyl substances (PFAS). These are a group of chemicals used to provide water repellency that may potentially be present in landfill leachate. They were included in the Stage 10 and 11 amendments to the CSR in 2017, added to the Guidelines for Canadian Drinking Water Quality in 2018, and the British Columbia Working Water Quality Guidelines in 2020. Sampling precautions recommended in the “Guidance for the Assessment and Remediation of Per- and Polyfluoroalkyl Substances in British Columbia” (SLR, 2019) should be followed, including analysis of field and trip blanks. If any contaminants are detected at concentrations of concern, the monitoring program should be adjusted accordingly.

MW13-1S and MW13-2S should be sampled quarterly until a relatively stable chemistry is indicated. If another ammonia or nitrate result above background levels is recorded, a datalogger should be used to record water levels in the affected piezometer to assess the responsiveness of water levels to recharge events.

6.2 MONITORING WELL REPAIRS AND SURVEY

The standpipes at BH00-1C and BH00-2C are bent or broken off below ground and water levels in these wells are indicative of a perched water table close to the elevation of the trafficked surface where they were originally completed. These should be replaced with a multilevel piezometer. The replacement piezometers should have a 50 mm standpipe with a screen interval at the base of the waste to facilitate collection of water samples, and a multi-level vibrating wire piezometer to obtain water level measurements at two or three intermediate depths within the waste. Data loggers could be installed in the standpipe and on the vibrating wires to record seasonal water level fluctuations and responses to rainfall events.

MW02-1S was damaged in July 2015. It is recommended this monument stickup be repaired or replaced, and reincorporated in the monitoring program.

Recent landfill UAV surveys have been conducted in the CGVD28 (ht2_0) vertical datum. It is recommended that the ground and top of casing elevation be resurveyed with this vertical datum at each monitoring well. If possible, the surveyor should be accompanied by ACRD sampling personnel to confirm the top of casing reference point corresponds to the water level measurement point. This reference point should be clearly marked.

6.3 LEACHATE MANAGEMENT SYSTEMS

Flow data from the leachate drains and the leachate pipeline to the Alberni sewage treatment lagoons should be reviewed and reported annually.

The two recently constructed backup leachate interception wells (PW15-1 and PW15-2) should be commissioned, and the operation of PW-1 and PW-2 should be adjusted according to Piteau's previous recommendations (Piteau, 2017). Water levels and pumping rates in each well should be recorded by the SCADA system and monitored to allow for ongoing evaluation of the interception well system and periodic adjustments to the pumping controls (Piteau, 2017).

7. LIMITATIONS

Piteau Associates Engineering Ltd. has exercised reasonable skill, care and diligence in obtaining, reviewing, analyzing and interpreting the information acquired during this study, but makes no guarantees or warranties, expressed or implied, as to the completeness of the information contained in this report. Conclusions and recommendations provided in this report are based on the information available at the time of this assessment.

In preparing the recommendations contained herein, Piteau has relied on information and interpretations provided by others. Piteau is not responsible for any errors or omissions in this information. This report is comprised of text, tables, figures and appendices, and all components must be read and interpreted in the context of the whole report. The report has been prepared for the sole use of the Alberni-Clayoquot Regional District and no representation of any kind is made to any other party.

We trust this report adequately presents and discusses the leachate sampling data collected to date. If you wish to discuss the 2020 sampling results, please contact the undersigned.

Respectfully submitted,

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TABLES

TABLE I

ALBERNI VALLEY LANDFILL 2020 MONITORING PROGRAM

Suite No.	Sites	Frequency	Analyses
1	MW94-4S, MW94-5S, MW94-6S MW98-9, MW98-10 **MW02-1S when fixed**, MW02-1D MW02-3S, MW02-3D, MW02-4 PW-1 or PW15-1, PW2 or PW15-2 MW13-1D	Quarterly Quarterly Annual	Field: Conductance, temperature, pH, water level Lab: Conductance, pH, TDS, chloride, sulphate, ammonia, nitrate, hardness, COD, DOC dissolved metals, alkalinity MW02-1S damaged in July 2015. MW13-1D - water level measurements collected quarterly; chemistry annually
1a	MW94-6D	Quarterly Quarterly	Field: Conductance, temperature, pH, water level Lab: Conductance, pH, TDS, chloride, sulphate, ammonia, nitrate, hardness, COD, TOC, DOC dissolved metals, alkalinity
2	MW94-4D, MW05-1S MW05-1D, MW13-1S and MW13-2S	Quarterly Quarterly	Field: Conductance, temperature, pH, water level Lab: Conductance, pH, TDS, chloride, sulphate, nitrate, ammonia
3	Heath, Stevens and Christie Creeks	Quarterly Quarterly	Field: Conductance, temperature, pH Lab: Conductance, pH, chloride, sulphate, nitrate, ammonia, hardness, COD, tot P, alkalinity total metals, DOC, dissolved Cu (analyse only if total Cu exceeds calculated guideline)
4	Leachate Drain (Aeration lagoon inflow from landfill), South Expansion Leachate Drain **BH00-1C replacement**	Quarterly Quarterly Annual	Field: Conductance, temperature, pH Lab: Conductance, pH, TDS, chloride, nitrate, ammonia, hardness, sulphate, COD, TOC, tot P, total metals, alkalinity, DOC, dissolved Cu (analyse only if total Cu exceeds calculated guideline) Lab: VOC scan, acid extractables, **PFAS (Standard List) for Leachate Drain only**
5	BH00-1A, *BH00-1C,* *BH00-2C* , BH00-5A-S, BH00-5A-D, BH00-6A, BH00-7A, BH00-8A, MW09-1,2,3,4, and 10, MW13-2D, MW15-1S, MW15-1D, PW15-1, PW15-2	Quarterly	Field: water levels until no longer accessible

H:\Project\1005\Analysis\Chemistry\2020\[Summary Tables 2020.xlsm]Table I

Notes: 1. **Bolded** sites to be included in monitoring program when available.
2. *Italicized* sites were included in the sampling program in 2020 but should be removed for 2021.

TABLE II

SUMMARY OF LEACHATE EFFECTS BASED ON MEAN 2020 CONCENTRATIONS

MONITORING WELL	Table Reference for full chemistry results	Well Recovery[5] I = Immediate SR = Slow Recovery	Number of samples	pH-Field	EC-Lab	Total Dissolved Solids	Chloride	Ammonia Nitrogen[8]	Nitrate	Chemical Oxygen Demand	Total or Dissolved Hardness	Total or Dissolved Iron	Total or Dissolved Manganese	Total or Dissolved Copper[6,8]
				(pH Units)	(µS/cm)	(mg/L)	(mg/L)	(mg/L-N)	(mg/L-N)	(mg/L-O)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
GCDWQ [1]				7-10.5	-	500	250	-	10	-	-	0.3	0.02	1
BC FWAL GUIDELINE [2]				6.5-9	-	-	150	1.8	3	-	-	1	2.37 (leachate)	0.0002
CSR AW GUIDELINE[7]				-	-	-	1500	18.4	400	-	-	-	-	0.02
CSR DW GUIDELINE[7]				-	-	-	250	-	10	-	-	6.5	1.5	1.5
LEACHATE														
Leachate Drain (Lagoon Inlet)	B-1, 3, 4	-	4	7.6	1255	**708**	120	**16**	**16**	103	366	**11**	**5.4**	**0.008**
South Expansion Leachate Drain	B-2, 3	-	4	7.0	434	240	15	**2.7**	1.5	19	179	**0.34**	**2.7**	**0.003**
SOUTHEAST WELLS			-											
MW02-3S (Surficial Sediments)	B-5	I	4	7.1	1206	**728**	91	<0.03	<0.02	33	570	0.17	**0.55**	**0.008**
MW02-3D (Bedrock)	B-6	SR	4	7.0	1171	**692**	84	0.09	<0.01	32	487	0.13	**0.46**	**0.01**
MW05-1S (Surficial Sediments)	B-16	I	4	7.0	364	210	5.8	<0.02	1.4	-	-	-	-	-
MW05-1D (Bedrock)	B-16	I	4	6.9	829	491	30	0.22	<0.07	-	-	-	-	-
PW-1 (Bedrock Leachate Well)	B-17	I	4	7.0	946	**537**	44	1.19	<0.01	-	-	-	-	**0.003**
PW-2 (Surficial Sediment Leachate Well)	B-17	I	4	6.6	2418	**1205**	**198**	**58.33**	<0.04	-	-	-	-	<0.0004
SOUTH AND WEST WELLS														
MW94-4S (Surficial Sediments)	B-7	I	4	9.0	274	167	7.4	<0.06	<0.13	<10	6	<0.01	<0.001	<0.0003
MW94-4D (Bedrock)	B-8	I	4	8.0	301	189	7.3	<0.03	0.35	-	-	-	-	-
MW02-1D (Background Bedrock)	B-14	SR	4	9.0	246	153	5.6	<0.19	0.09	<16	5	<0.25	0.01	<0.0014
MW02-4 (Background Bedrock)	B-15	SR	4	7.1	640	405	100	<0.02	0.15	<10	133	<0.01	<0.004	**0.0004**
NORTH WELLS														
MW94-5S (Bedrock)	B-9	SR	4	7.1	270	155	1.4	<0.06	0.13	<13	131	**0.75**	**0.13**	**0.002**
MW94-6S (Surficial Sediments)	B-10	I	4	**6.4**	687	367	6.0	**70.58**	<0.01	41	263	**52**	**4.75**	<0.0017
MW94-6D (Bedrock)	B-11	SR	3	7.7	540	429	4.7	0.03	0.80	<24	8	**0.69**	**<0.055**	**0.005**
MW98-9 (Surficial Sediments)	B-12	I	4	6.5	227	134	5.8	0.04	<0.44	<28	101	<0.08	0.01	<0.0006
MW98-10 (Surficial Sediments)	B-13	I	3	6.7	74	73	0.9	<0.02	0.50	18	28	<0.02	<0.001	**0.0004**
2013 WELLS														
MW13-1S (Bedrock)	B-19	SR	4	8.2	540	353	44	0.07	<0.01	-	-	-	-	-
MW13-1D (Bedrock)	B-18	SR	2	7.8	604	371	83	0.09	<0.01	63	70	0.26	**0.84**	**0.004**
MW13-2S (Bedrock)	B-19	SR	4	7.7	251	168	2.7	<0.03	<0.06	-	-	-	-	-
CREEK SITES														
Heath Creek	B-20	-	4	7.7	69	-	4.0	<0.02	0.08	<10	28	0.22	0.01	<0
Stevens Creek	B-21	-	3	7.3	135	-	3.4	<0.03	0.10	<10	60	0.17	**0.17**	<0
Christie Creek U/S	B-22	-	3	7.3	70	-	1.3	0.01	0.05	<10	32	**0.33**	**0.05**	**0.002**
Christie Creek D/S	B-22	-	3	7.2	74	-	1.6	<0.04	0.02	<14	34	**0.63**	**0.06**	**0.002**

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NOTES:

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
3. **Bolding** denotes parameters which exceed water quality criteria.
4. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.
5. Well recovery flag indicates whether well recovers quickly and can be sampled immediately after purging (I) or well recovers slowly and cannot be sampled immediately after purging (SR).
6. Lowest calculated value of BC FWAL dissolved copper standard. The BC BLM dissolved copper guideline is dependent on sample pH, temperature, DOC, Humic Acid content, and major cation and anion chemistry.
7. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. CSR AW (aquatic life) and DW (drinking water) shown.
   AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10.
   https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/161_2020_Sch3.2
8. CSR guidelines for indicated parameter changes with pH or hardness. Value shown appropriate for pH < 7 and hardness <50 mg/L-$CaCO_3$.

TABLE III

SUMMARY OF 2020 EXCEEDANCES OF GCDWQ, BC FWAL GUIDELINES, AND CSR STANDARDS

			Physical		Nutrients			Dissolved Anions		Total Metals									Dissolved Metals												
MONITORING WELL	Table Reference for full chemistry results	Number of samples	pH	TDS	Nitrate	Ammonia	Total Phosphorous (1)	Dissolved Chloride	Dissolved Sodium	Aluminum	Arsenic	Chromium	Cobalt	Copper	Iron	Manganese	Mercury	Zinc	Aluminum	Arsenic (2)	Boron	Cadmium	Chromium	Cobalt	Copper (3)	Iron	Lead	Manganese	Mercury	Zinc	Bromomethane
LEACHATE																															
Leachate Drain (Lagoon Inlet)	B-1, 3, 4	4			DW	AW							DW		DW	DW															DW
South Expansion Leachate Drain	B-2	4											DW			DW															
SOUTHEAST WELLS																															
MW02-3S (Surficial Sediments)	B-5	4																						DW							
MW02-3D (Bedrock)	B-6	4																						DW							
MW05-1S (Surficial Sediments)	B-16	4																													
MW05-1D (Bedrock)	B-16	4																													
PW-1 (Bedrock Leachate Well)	B-17	4																						DW				DW			
PW-2 (Surficial Sediment Leachate Well)	B-17	4				AW		DW	DW															DW		DW		DW			
SOUTH AND WEST WELLS																															
MW94-4S (Surficial Sediments)	B-7	4																													
MW94-4D (Bedrock)	B-8	4																													
MW02-1S (Surficial Sediments)	B-18	0	Damaged. Will be sampled once fixed.																												
MW02-1D (Background Bedrock)	B-14	4																													
MW02-4 (Background Bedrock)	B-15	4																													
NORTH WELLS																															
MW94-5S (Bedrock)	B-9	4																													
MW94-6S (Surficial Sediments)	B-10	4				AW																		DW		DW	DW	DW			
MW94-6D (Bedrock)	B-11	3																						DW			DW				
MW98-9 (Surficial Sediments)	B-12	4																													
MW98-10 (Surficial Sediments)	B-13	3																													
2013 WELLS																															
MW13-1S (Bedrock)	B-19	4																													
MW13-1D (Bedrock)	B-18	1																													
MW13-2S (Bedrock)	B-19	4																													
CREEK SITES																															
Heath Creek	B-20	4																													
Stevens Creek	B-21	3											AW																		
Christie Creek U/S	B-22	3											AW					AW							AW						
Christie Creek D/S	B-22	3											AW					AW							AW						

H:\Project\1005\Analysis\Chemistry\2020\[Summary Tables 2020.xlsm]TableIII

NOTES:

1. Phosphorus FWAL guideline for creeks from Phosphorus Management in Vancouver Island Streams.
2. FWAL criterion for arsenic not considered relevant for groundwater.
3. Exceedences based on sample-specfic calculated dissolved copper guideline dependent on sample pH, temperature, DOC, Humic Acid, Alkalinity and major cation chemistry.

Blue shaded cells show sampling location has at least one exceedance of the BC FWAL for the parameter indicated

Red shaded cells show sampling location has at least one exceedance of the GCDWQ for the parameter indicated

Purple shaded cells show sampling location has at least one exceedance of the BC FWAL and GCDWQ for the parameter indicated

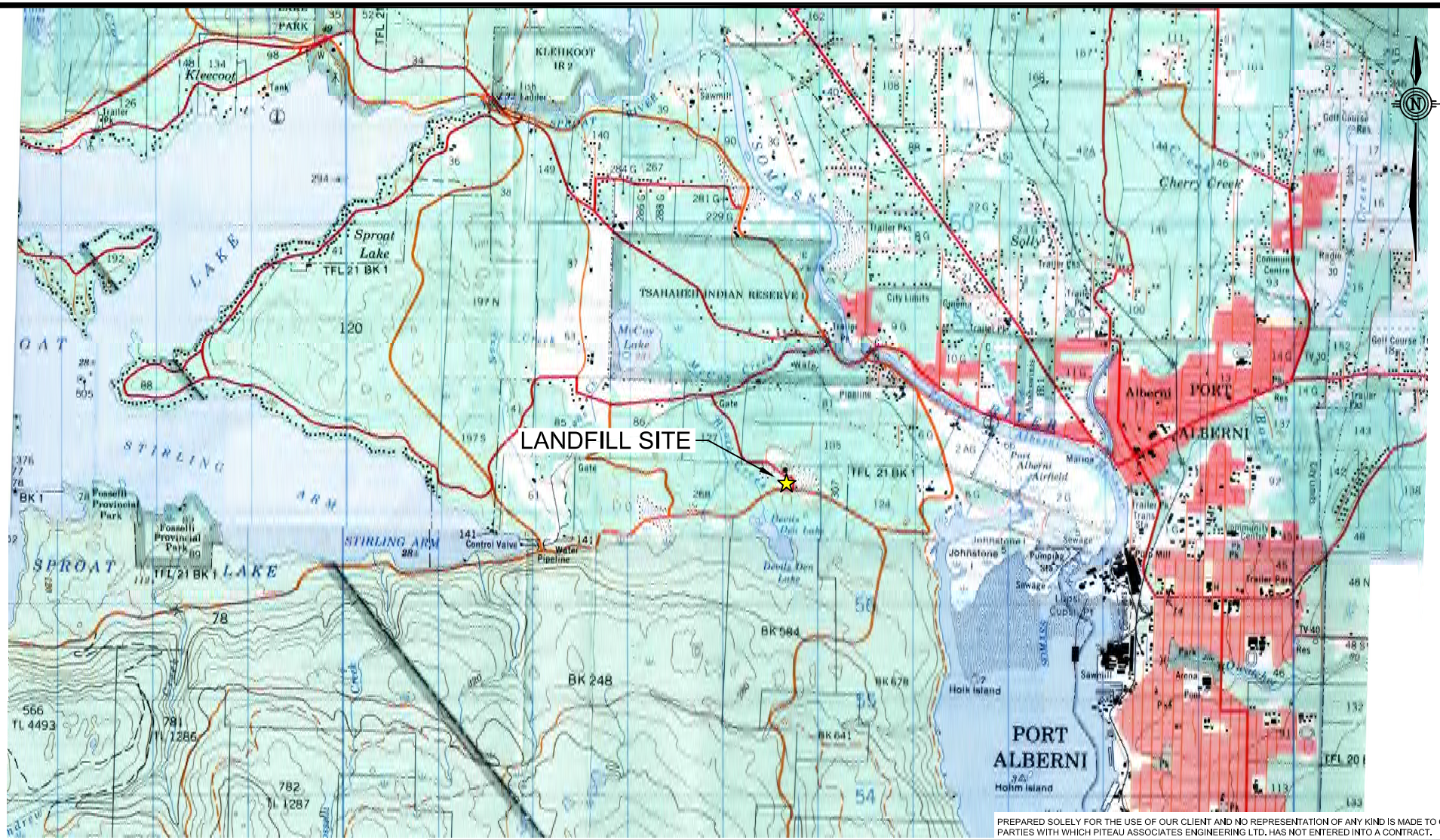
DW/AW Cells with DW or AW indicate one or more exceedance of the CSR DW or AW

No shading or text indicates all sampling results were below all guidelines

Grey shaded cells show sampling location was not analyzed for the parameter indicated

FIGURES

DWG. NUMBER: K:\1005\Cadd\1005-093.dwg (Fig 1)



ALBERNI-CLAYOQUOT REGIONAL DISTRICT
WATER QUALITY MONITORING PROGRAM
ALBERNI VALLEY LANDFILL, PORT ALBERNI, B.C.

PITEAU ASSOCIATES
GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS

LANDFILL LOCATION MAP

BY:	DATE:
RM/sl	JAN 21
APPROVED:	FIGURE:
DJT	1

DWG NUMBER: K:\1995\Cad\1995-14.dwg (Plot)

364200 E | 364400 E | 364600 E | 364800 E | 365000 E | 365200 E | 365400 E | 365600 E

5457800 N | 5457600 N | 5457400 N | 5457200 N

MW02-4
GRND EL. 67.15m
02-4 | 718 | 120 | 0.317

Stevens Cr.

MW98-9
98-9 | 271 | 14 | 0.935

FORCEMAIN PUMP STATION

MW94-6
94-6S | 810 | 7 | 11.7
94-6D | 545 | 2 | 0.852

MW98-10
GRND EL. 75.65
98-10 | 76 | 1 | 1.15

INTERCEPTION TRENCH

STEVENS CREEK | 159 | 4 | 0.228

SCKB | 254 | 6.27 | 0.31

SCKA | 457 | 12.5 | 1.55*

* SEE NOTE 7

CLAY BERM

MH

MH (INV. 70.2)

MW94-5
GRND EL. 76.14
94-5S | 332 | 2 | 0.216

* SEE NOTE 2 FOR 94-5D

94-5D | 836 | 21.8 | 0.03*

MH (INV. 70.83±)

BH00-2C

BH00-1C

MW94-1
94-1S | 311 | 4.3 | 0.21
94-1D | 650 | 8.2 | 0.67

* SEE NOTE 5

MH (INV. 70.56±)

LOT 'D'

ORIGINAL LANDFILL AREA (6.7Ha)

FORMER LEACHATE PIPE TO NORTH LEACHATE INTERCEPTION/CONVEYANCE CHANNEL DECOMMISSIONED 2015

NORTH LEACHATE INTERCEPTION/CONVEYANCE CHANNEL

NORTHEAST EXPANSION AREA

MW13-1S
MW13-1D
13-1S | 588 | 46 | 0.08
13-1D | 621 | 85 | 0.09

MW13-2D
MW13-2S
13-2D | 3070 | 99.5 | 0.12*
13-2S | 635 | 9 | 0.158

* SEE NOTE 7 FOR 13-2D

CHRISTIE CREEK D/S
83
0.06

HEATH CREEK
75
6
0.165

Heath Cr.

HEATH CREEK TRIBUTARY

94-4S | 325 | 8 | 0.433
94-4D | 354 | 8 | 0.764

MW94-4
GRND EL. 71.69

94-7S | 143 | 2.38 | 1.06

* SEE NOTE 2

MW94-7

BH00-3A

BH00-5B

MW94-3
SEE NOTE 1

94-3S | 62 | 6.4 | 0.56
94-3D | 436 | 18.0 | 0.33

BURIED LEACHATE PIPELINE

EAST EXPANSION AREA

PW-2
3240 | 313 | 98.1

PW-2
GRND EL. 71.48m

LEACHATE
1620 | 190 | 59.7

AERATION LAGOON

MW15-01

PW15-2

PW15-1

PW-1
GRND EL. 71.05m
PW-1 | 996 | 46 | 1.52

FLOW EQUALIZATION LAGOON

SW-1 | SW-2 | SW-3 | SW-4 | SW-5 | SW-6 | SW-7 | SW-8 | SW-9

MW02-3d
MW02-3s
GRND EL. 70.7m
02-3S | 1230 | 94 | 0.07
02-3D | 1290 | 89 | 0.18

Christie Cr.

SEEPAGE CUTOFF BERM

BH00-1A
GRND EL. 76.00m

FRENCH DRAIN

SOUTH EXPANSION AREA

BH00-7A
GRND EL. 70.96m

BH00-5A
75.72m

BH00-6A
GRND EL. 74.79m

BH00-8A
GRND EL. 71.66m

MW94-8

BH00-2A

BY-PASS ROAD / SHARPE ARM LOGGING ROAD

APPROXIMATE LOCATION OF TEMPORARY LEACHATE CONTAINMENT BERM

MW05-1D
MW05-1S
GRND EL. 70.95m
05-1S | 394 | 8 | 2.27
05-1D | 856 | 31 | 0.3

MW94-2
GRND EL. 68.25

SOUTH_EXP_AREA
527
22
3.36

BH00-4A

00-4A | 723 | 90.7 | 0.03

* SEE NOTE 4

BH00-9A

CHRISTIE CREEK U/S
73
2
0.114

BH00-11A

MW02-1
GRND EL. 72.79m
02-1S | 106 | 1.85 | 0.74
02-1D | 340 | 8 | 0.288

* SEE NOTE 6

MW02-2
02-2 | 242 | 1.5 | 0.03*

* SEE NOTE 4

Heath Cr.

DEVIL'S DEN LAKE

NORRIS

Norris Cr.

DW-1 | DW-2 | DW-3 | DW-4 | DW-5 | DW-6

LEGEND

- MW94-2 — GROUNDWATER MONITORING WELL (PREFIX INDICATES DATE OF INSTALLATION)
- SW-9 — SAMPLING SITES, NO LONGER MONITORED
- PW-1 — INTERCEPTION WELL (CONSTRUCTED WINTER 2005/2015)
- DUG DOMESTIC WELL
- DRILLED DOMESTIC WELL
- SURFACE WATER SAMPLING SITE
- SURFACE FLOW CHANNEL
- BURIED PIPE
- BEDROCK OUTCROPPING OR CLOSE TO SURFACE
- APPROXIMATE EXTENT OF LANDFILL EXPANSION AREAS
- Y — Y' — HYDROGEOLOGICAL SECTION (FIGS. 4 AND 5)

POSTED CONDUCTANCE, CHLORIDE AND NITRATE DATA. ALL DATA ARE MAXIMUM VALUES MEASURED IN 2020, UNLESS OTHERWISE STATED.

94-1S | 484 | 5.8 | 0.45

- CONDUCTANCE (µS/cm)
- CHLORIDE (mg/L)
- NITRATE (mg/L-N)
- * AMMONIA CONCENTRATION SHOWN WHERE IT EXCEEDS NITRATE CONCENTRATION

134 — INDICATES SURFACE WATER SAMPLE

614 — INDICATES SURFICIAL SEDIMENTS GROUNDWATER SAMPLE

895 — INDICATES BEDROCK GROUNDWATER SAMPLE

55 — TOPOGRAPHY PROVIDED BY SPERLING HANSEN

NOTES:

1. NOT SAMPLED SINCE 2005, RESULTS FROM 2005 SHOWN.
2. NOT SAMPLED SINCE 2008, RESULTS FROM 2008 SHOWN.
3. NOT SAMPLED SINCE 2010, RESULTS FROM 2010 SHOWN.
4. NOT SAMPLED SINCE 2011, RESULTS FROM 2011 SHOWN.
5. NOT SAMPLED SINCE 2013, RESULTS FROM 2013 SHOWN.
6. NOT SAMPLED SINCE 2015, RESULTS FROM 2015 SHOWN.
7. NOT SAMPLED SINCE 2016, RESULTS FROM 2016 SHOWN.
8. LANDFILL TOPOGRAPHY (AVL 20201223 for DXF.DXF) AT 1m CONTOUR INTERVAL SURVEYED ON DECEMBER 23, 2020 AND PROVIDED BY SPERLING HANSEN ON JANUARY 20 2021.

0 20 40 60 80 100m
SCALE 1:2000

ALBERNI-CLAYOQUOT REGIONAL DISTRICT
WATER QUALITY MONITORING PROGRAM
ALBERNI VALLEY LANDFILL, PORT ALBERNI, B.C.

PITEAU ASSOCIATES
GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS

SITE PLAN

BY: SC/sl | DATE: JAN 21
APPROVED: JM | FIG: 2

DWG. NUMBER: K:\1065\Cad\1065-101.dwg (Fig 3)

HEATH CREEK AT McCOY LAKE ROAD

MW02-4 64.54

Stevens Cr.

Norris Cr.

NORRIS

DW-4

DW-5

DW-3

DW-1

DW-6

DOMESTIC WELLS

DW-2

364200 E | 364400 E | 364600 E | 364800 E | 365000 E | 365200 E | 365400 E | 365600 E

5457800 N

5457600 N

5457400 N

5457200 N

FORCEMAIN PUMP STATION

INTERCEPTION TRENCH

NORTH LEACHATE INTERCEPTION/CONVEYANCE CHANNEL

MW98-9 71.16

MW98-10 73.27

MW94-6 71.35 56.89

MW94-5 74.58 N/A

CLAY BERM

MH (INV. 70.2)

MW13-2D 78.65

MW13-2S 76.76

NORTH LEACHATE INTERCEPTION/CONVEYANCE CHANNEL

NORTHEAST EXPANSION AREA

MW13-1S 71.18

MW13-1D 49.99 (NOT STATIC)

MW94-1 67.31 N/A *(APR 2013)

HEATH CREEK TRIBUTARY

MH (INV. 70.83±)

BH00-1C 81.31

BH00-2C 86.79

MH (INV. 70.56±)

LOT 'D'

ORIGINAL LANDFILL AREA (6.7Ha)

397

MW94-4 >72.56 64.07

MW09-1 73.01

MW09-2 73.53

MW09-3 72.53

MW09-4 73.96

MW09-5

BH00-3A

MW94-7

BH00-6B

MW94-3

BURIED LEACHATE PIPELINE

EAST EXPANSION AREA

AERATION LAGOON

BH00-1A 69.26

SEEPAGE CUTOFF BERM

FRENCH DRAIN

PW-2 63.77

PW15-2 67.32

PW-1 61.81

PW15-1 61.19

MW15-1S MW15-1D 69.12 68.72

Christie Cr.

FLOW EQUALIZATION POND

MW05-1S MW05-1D 67.62 66.08

MW02-3D MW02-3S 68.55 68.36

SOUTH EXPANSION AREA

BH00-7A 67.46

BH00-8A 71.23

MW09-6 73.4 *(JAN 2012)

*(JUL 2018)

MW09-9 73.63

MW09-8 72.03

MW09-10 69.93

BH00-5A 70.46 70.63

BH00-6A 68.92

MW94-2

APPROXIMATE LOCATION OF TEMPORARY LEACHATE CONTAINMENT BERM

BH00-2A

MW09-12

MW09-11 <74.2

MW09-13 68.68

BH00-4A

BYPASS ROAD / SMITH'S ARM LOGGING ROAD

BH00-11A

MW02-5 68.36 69.92 *MEASURED 2015

MW02-7 68.27 *(JULY 2011)

Heath Cr.

DEVIL'S DEN LAKE

LEGEND

- MW02-3 — GROUNDWATER MONITORING WELL (PREFIX INDICATES DATE OF INSTALLATION)
- BH00-11A — MONITORING WELL, NO LONGER MONITORED
- PW-1 — INTERCEPTION WELL (CONSTRUCTED WINTER 2005/2015)
- 69.05 / 69.05 — GROUNDWATER ELEVATIONS IN SHALLOW AND DEEP PIEZOMETER (m-geod.) - OCTOBER 2020. BASED ON MONITORING DATA, IT IS ASSUMED THAT PW-1 WAS NOT OPERATING EFFECTIVELY FOR MOST OF 2011 THROUGH 2020, BLUE DENOTES PIEZOMETRIC LEVEL IN SURFICIAL SEDIMENTS, RED DENOTES PIEZOMETRIC LEVEL IN BEDROCK.
- MEASURED NOVEMBER 2014 (NO CURRENT ACCESS)
- APPROXIMATE EXTENT OF LANDFILL EXPANSION AREAS
- ORIGINAL LANDFILL AREA
- BEDROCK OUTCROPPING OR CLOSE TO SURFACE
- INTERPRETED GROUNDWATER FLOW DIVIDE IN SURFICIAL SEDIMENTS (DASHED LINE INDICATES VERY APPROXIMATE)
- INTERPRETED GROUNDWATER FLOW DIRECTION IN SURFICIAL SEDIMENTS
- INTERPRETED GROUNDWATER FLOW DIVIDE IN BEDROCK (DASHED LINE INDICATES VERY APPROXIMATE)
- INTERPRETED GROUNDWATER FLOW DIRECTION IN BEDROCK
- 70 — INTERPRETED ALLUVIAL GROUNDWATER ELEVATION CONTOUR
- 75 — INTERPRETED BEDROCK SURFACE CONTOUR FROM DRILLING AND SEISMIC SURVEY DATA (m-geod.)
- 55 — TOPOGRAPHY PROVIDED BY SPERLING HANSEN
- HYDROGEOLOGICAL SECTIONS (FIGS. 4 AND 5)

NOTE:

1. LANDFILL TOPOGRAPHY (AVL 20201223 for DXF.DXF) AT 1m CONTOUR INTERVAL SURVEYED ON DECEMBER 23, 2020 AND PROVIDED BY SPERLING HANSEN ON JANUARY 20 2021.

0 20 40 60 80 100m

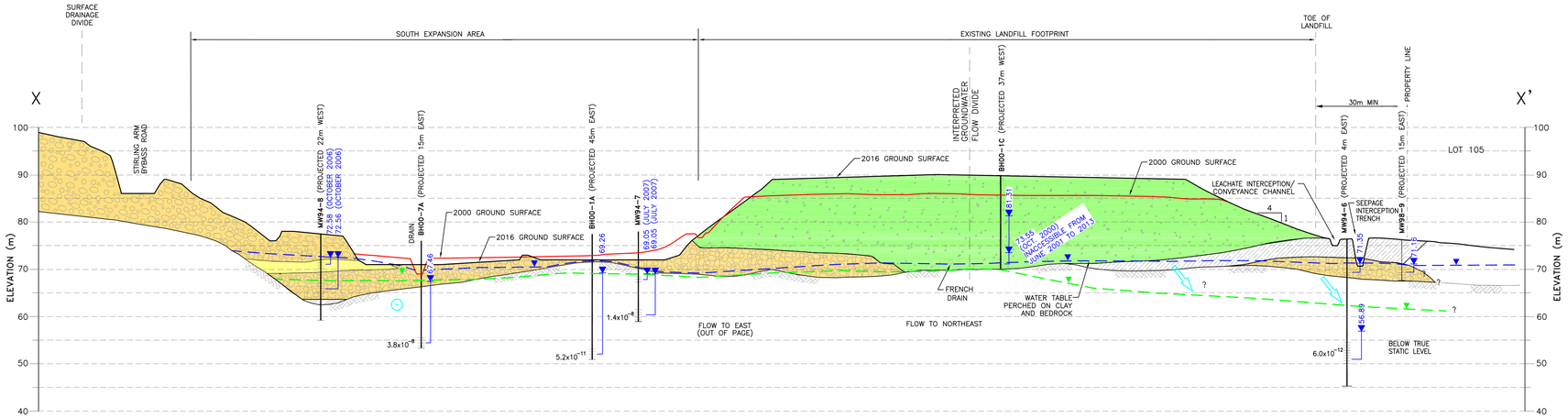
SCALE 1:2000

ALBERNI-CLAYOQUOT REGIONAL DISTRICT
WATER QUALITY MONITORING PROGRAM
ALBERNI VALLEY LANDFILL, PORT ALBERNI, B.C.

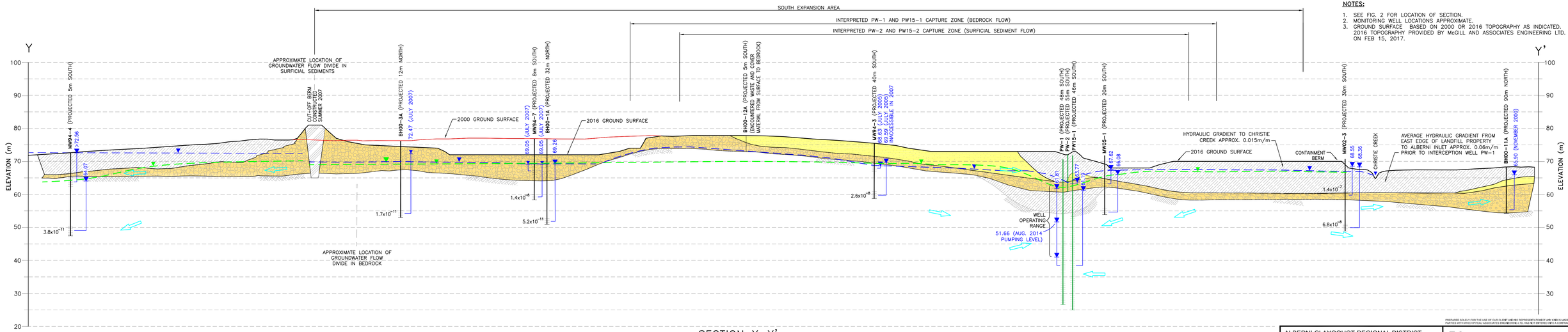
PITEAU ASSOCIATES
GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS

POSTED GROUNDWATER ELEVATIONS AND INTERPRETED GROUNDWATER FLOW DIRECTIONS

BY:	DATE:
SC/sl	JAN 21
APPROVED:	FIG:
JM	3



SECTION X–X'



SECTION Y–Y'

NOTES:

1. SEE FIG. 2 FOR LOCATION OF SECTION.
2. MONITORING WELL LOCATIONS APPROXIMATE.
3. GROUND SURFACE BASED ON 2000 OR 2016 TOPOGRAPHY AS INDICATED. 2016 TOPOGRAPHY PROVIDED BY McGILL AND ASSOCIATES ENGINEERING LTD. ON FEB 15, 2017.

LEGEND

- MUNICIPAL WASTE
- SILT AND CLAY SEDIMENTS (ML)
- SAND AND GRAVEL (GW)
- FINE SAND AND SILTY SAND (SP)
- VERY DENSE SAND AND SILT TILL – SOME GRAVEL (SM)
- BEDROCK SURFACE
- BH / MW — MONITORING WELLS SHOWING PIEZOMETER COMPLETION ZONES AND WATER LEVELS MEASURED OCTOBER 2020, UNLESS OTHERWISE NOTED. (SEE LOGS IN PITEAU, 2000, AND PITEAU 2017a) NUMBERS POSTED BESIDE SCREENS ARE HYDRAULIC CONDUCTIVITY VALUES (m/s) DETERMINED FROM RISING HEAD TEST. (1.4x10-7, 6.8x10-8)
- PW–1 — LEACHATE INTERCEPTION WELL
- INTERPRETED WATER TABLE IN SURFICIAL SEDIMENTS
- INTERPRETED 2020 PIEZOMETRIC LEVEL IN BEDROCK
- INTERPRETED GROUNDWATER FLOW DIRECTION (IF IN PLANE OF SECTION)
- INTERPRETED GROUNDWATER FLOW DIRECTION IS OUT OF PAGE

SCALE 1:1000
VERTICAL EXAGGERATION = 2X

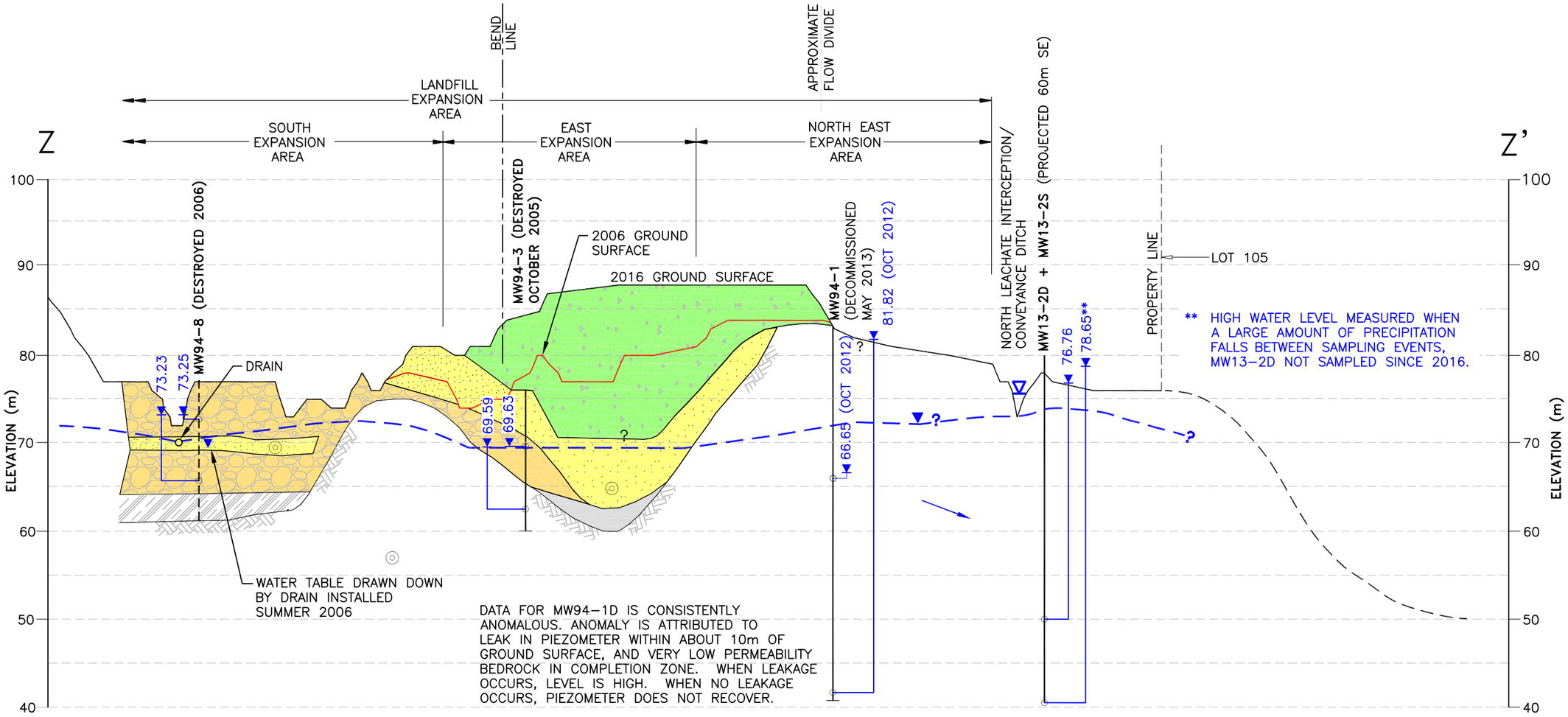
ALBERNI-CLAYOQUOT REGIONAL DISTRICT
WATER QUALITY MONITORING PROGRAM
ALBERNI VALLEY LANDFILL, PORT ALBERNI, B.C.

PITEAU ASSOCIATES
GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS

HYDROGEOLOGICAL SECTIONS X-X' AND Y-Y' THROUGH ORIGINAL LANDFILL AND SOUTH EXPANSION AREA

BY:	DATE:
RM/sl	JAN 21
APPROVED:	FIG:
JM	4

DWG. NUMBER: K:\1005\Cadd\1005-101.dwg (Fig 5)



SECTION Z–Z'

LEGEND

- MUNICIPAL WASTE AND COVER MATERIAL
- VERY DENSE SAND AND SILT WITH TRACE CLAY AND SOME GRAVEL–TILL
- SILT AND CLAY SEDIMENTS (ML)
- SAND AND GRAVEL (GW)
- FINE SAND AND SILTY SAND (SP)
- BEDROCK SURFACE
- MONITORING WELL SHOWING PIEZOMETER COMPLETION ZONES AND WATER LEVELS MEASURED AS INDICATED
- INTERPRETED WATER TABLE
- INTERPRETED GROUNDWATER FLOW DIRECTION
- FLOW OUT OF PAGE

NOTES:

1. SEE FIG. 2 FOR LOCATION OF SECTION.
2. MONITORING WELL LOCATIONS APPROXIMATE.
3. BOTH MONITORING WELL MW94–3 AND MW94–8 WERE DESTROYED. LAST AVAILABLE READINGS SHOWN ON SECTION. INTERPRETED WATER TABLE ELEVATION BASED ON DATA FROM OTHER MONITORING WELLS IN AREA.
4. MW94–1 WAS DECOMMISSIONED IN MAY 2013 AND WAS REPLACED WITH MW13–2.
5. GROUND SURFACE BASED ON 2006 OR 2016 TOPOGRAPHY AS INDICATED. 2016 TOPOGRAPHY PROVIDED BY McGILL AND ASSOCIATES ENGINEERING LTD. ON FEB 15, 2017.

0 20 40 60 80 100m

SCALE 1:2500

VERTICAL EXAGGERATION = 5X

ALBERNI-CLAYOQUOT REGIONAL DISTRICT
WATER QUALITY MONITORING PROGRAM
ALBERNI VALLEY LANDFILL, PORT ALBERNI, B.C.

PITEAU ASSOCIATES
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HYDROGEOLOGICAL SECTION Z-Z'
THROUGH ORIGINAL LANDFILL AND SOUTH EXPANSION AREA

BY:	DATE:
RM/sl	JAN 21
APPROVED:	FIG:
JM	5

APPENDIX A

WATER ELEVATION MONITORING DATA TABLES AND PLOTS

APPENDIX A - LIST OF TABLES

Table A-1 2020 Monitoring Well Elevation Data

APPENDIX A - LIST OF FIGURES

Figure A-1 Water Level Elevations for Eastern Monitoring Wells MW94-1, MW94-2, MW94-3 and MW02-3

Figure A-2 Water Level Elevations for Southern Monitoring Wells MW94-4 and MW94-7

Figure A-3 Water Level Elevations for Northern Monitoring Wells MW94-5, MW94-6 and MW02-4 and Landfill Monitoring Wells BH00-1C and BH00-2C

Figure A-4 Water Level Elevations for Northern Monitoring Wells MW98-9 and MW98-10

Figure A-5 Water Level Elevations for Expansion Area Monitoring Wells

Figure A-6 Water Level Elevations for 2009 Overburden Monitoring Wells in South Expansion Area

Figure A-7 Water Level Elevations for Bedrock Leachate Interception Well Monitoring PW-1, PW15-1, MW02-3D, MW05-1D, MW15-1D

Figure A-8 Water Level Elevations for Surficial Sediment Interception Well Monitoring PW-2, PW15-2, MW02-3S, MW05-1S, MW15-1S

Figure A-9 Water Level Elevations for Northeastern Bedrock Monitoring Wells MW13-1 and MW13-2

TABLE A-1

2020 MONITORING WELL ELEVATION DATA

Sample	Ground Elevation (m-geod)[1]	Top of Casing (m-geod)	Piezo Bottom (m-geod)	Completion Zone	Q1 Sampling Event		Q2 Sampling Event		Q3 Sampling Event		Q4 Sampling Event	
					Measured Water Elevation (m-geod)	Date	Measured Water Elevation (m-geod)	Date	Measured Water Elevation (m-geod)	Date	Measured Water Elevation (m-geod)	Date
MW94-4S	-	72.56	62.0	bdrk/surf	>72.56	11-Feb-20	>72.56	20-May-20	>72.56	18-Aug-20	>72.56	19-Oct-20
MW94-4D	-	72.67	47.2	bedrock	***70.87***	11-Feb-20	***72.67***	20-May-20	***70.73***	18-Aug-20	***64.07***	19-Oct-20
MW94-5S	-	77.29	66.5	bedrock	74.74	11-Feb-20	74.59	19-May-20	71.53	19-Aug-20	74.58	20-Oct-20
MW94-6S	-	76.18	67.6	surficial	72.22	11-Feb-20	74.54	19-May-20	70.83	18-Aug-20	71.35	20-Oct-20
MW94-6D	-	76.18	49.3	bedrock	***60.51***	11-Feb-20	***60.91***	19-May-20	***56.72***	18-Aug-20	***56.89***	15-Oct-20
MW98-9	-	76.19	68.6	surficial	72.51	11-Feb-20	74.35	19-May-20	70.84	18-Aug-20	71.16	21-Oct-20
MW98-10	-	76.14	72.0	surficial	73.83	11-Feb-20	74.04	19-May-20	72.03	17-Aug-20	73.27	15-Oct-20
BH00-1A	71.65	72.38	51.0	bedrock	69.63	24-Jan-20	70.58	06-May-20	69.40	13-Aug-20	69.26	13-Oct-20
BH00-1C	89.24	89.90	72.3	surficial	83.56	24-Jan-20	84.85	06-May-20	dry	13-Aug-20	81.31	13-Oct-20
BH00-2C	89.90	89.29	75.0	surficial	87.01	24-Jan-20	broken[3]	06-May-20	dry	13-Aug-20	86.75	13-Oct-20
BH00-5A-S	75.72	76.72	69.0	bdrk-frac	71.64	24-Jan-20	69.86	06-May-20	69.35	13-Aug-20	70.46	13-Oct-20
BH00-5A-D	75.72	76.72	62.9	bedrock	70.78	24-Jan-20	70.78	06-May-20	70.72	13-Aug-20	70.63	13-Oct-20
BH00-6A	74.79	75.64	60.5	bedrock	70.07	24-Jan-20	69.93	06-May-20	69.29	13-Aug-20	68.92	13-Oct-20
BH00-7A	70.96	71.58	53.5	bedrock	70.28	24-Jan-20	67.60	06-May-20	67.19	13-Aug-20	67.46	13-Oct-20
BH00-8A	71.66	72.40	59.3	bedrock	71.39	24-Jan-20	71.33	06-May-20	71.26	13-Aug-20	71.23	13-Oct-20
MW02-1D	77.29	78.34	19.1	bedrock	71.24	3-Feb-20	69.77	19-May-20	69.24	17-Aug-20	69.92	14-Oct-20
MW02-3S	70.65	70.65	58.5	surficial	69.26	11-Feb-20	68.43	20-May-20	67.72	19-Aug-20	68.55	20-Oct-20
MW02-3D	70.72	70.72	48.9	bedrock	69.41	11-Feb-20	68.26	20-May-20	67.70	19-Aug-20	68.36	19-Oct-20
MW02-4	67.15	68.24	29.0	bedrock	61.61	3-Feb-20	64.46	19-May-20	62.64	17-Aug-20	64.54	14-Oct-20
MW05-1S	70.82	71.51	59.8	surficial	69.25	11-Feb-20	67.65	20-May-20	67.55	19-Aug-20	67.62	19-Oct-20
MW05-1D	70.82	71.51	39.4	bdrk-frac	70.56	3-Feb-20	64.95	19-May-20	65.38	19-Aug-20	66.08	19-Oct-20
PW-1	71.52	72.01	44.8	bdrk-frac	-	-	66.36	20-May-20	-	-	61.81	14-Oct-20
PW-2	71.48	72.06	60.2	surficial	-	-	67.47	20-May-20	-	-	63.77	14-Oct-20
PW15-1	70.69	71.87	25.0	bedrock	70.36	24-Jan-20	66.32	6-May-20	58.67	13-Aug-20	61.19	13-Oct-20
PW15-2	71.28	72.00	59.7	surficial	69.94	24-Jan-20	67.85	6-May-20	67.84	13-Aug-20	67.32	13-Oct-20
MW13-1S	73.00	73.96	47.9	bedrock	71.17	3-Feb-20	70.71	20-May-20	70.00	20-Aug-20	71.18	19-Oct-20
MW13-1D	73.11	74.10	37.9	bedrock	-	-	***56.31***	20-May-20	***48.73***	20-Aug-20	***49.99***	19-Oct-20
MW13-2S	78.50	79.04	48.3	bedrock	77.82	3-Feb-20	78.16	20-May-20	***55.27***	19-Aug-20	76.76	19-Oct-20
MW13-2D	78.97	79.87	38.8	bedrock	78.52	24-Jan-20	78.43	20-May-20	77.87	13-Aug-20	78.65	19-Oct-20
MW15-1S	70.87	71.87	64.2	surficial	70.26	24-Jan-20	69.13	6-May-20	68.30	13-Aug-20	69.12	13-Oct-20
MW15-1D	70.87	71.87	46.4	bedrock	70.69	24-Jan-20	68.87	6-May-20	68.07	13-Aug-20	68.72	13-Oct-20
MW09-01	73.38	74.29	72.3	sediment	73.12	24-Jan-20	72.74	6-May-20	71.71	13-Aug-20	73.01	13-Oct-20
MW09-02	73.99	74.91	71.2	sediment	73.66	24-Jan-20	73.24	6-May-20	72.26	13-Aug-20	73.53	13-Oct-20
MW09-03	74.61	75.48	61.8	sediment	73.73	24-Jan-20	72.72	6-May-20	71.63	13-Aug-20	72.53	13-Oct-20
MW09-04	75.52	76.24	71.1	sediment	74.35	24-Jan-20	73.70	6-May-20	72.50	13-Aug-20	73.96	13-Oct-20
MW09-10	71.75	72.81	70.4	sediment	70.00	24-Jan-20	dry	6-May-20	dry	13-Aug-20	69.93	13-Oct-20

H:\Project\1005\Analysis\Water_Elevations\2020\[Tables-2020-revise.xlsx]Table A-1 2020

NOTES:

1. The locations and elevations of monitoring wells were surveyed by McGill & Associates Engineering Ltd. of Port Alberni.
2. Italicized values indicate non-static water elevations in slow responding monitoring wells.
3. Could not get water level probe past 0.24 m.

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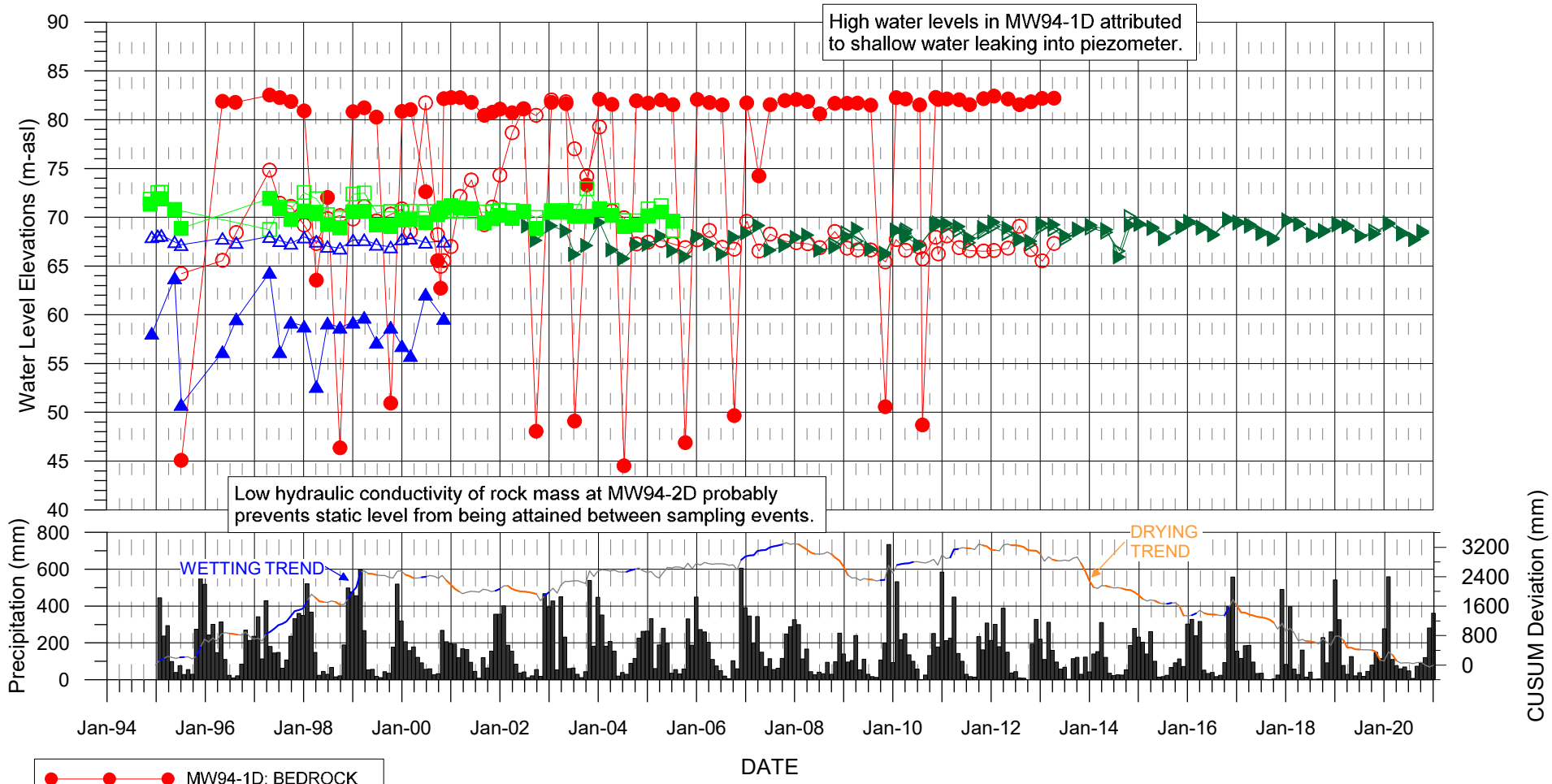

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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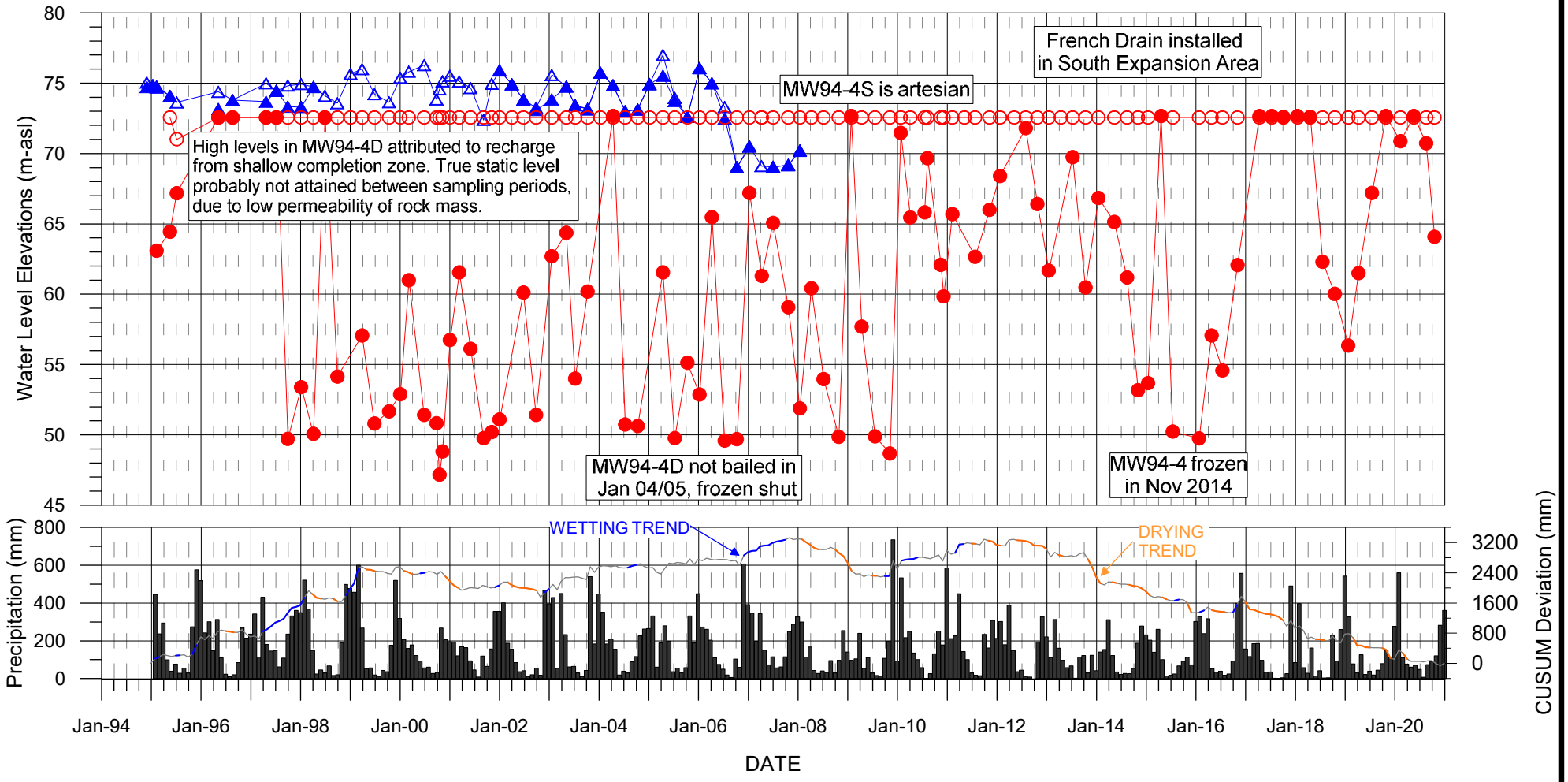
WATER LEVEL ELEVATIONS FOR EASTERN MONITORING WELLS MW94-1, MW94-2, MW94-3 AND MW02-3

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	A-1



- MW94-4D: BEDROCK
- MW94-4S: BEDROCK/SURFICIALS
- MW94-7D: BEDROCK
- MW94-7S: SURFICIALS

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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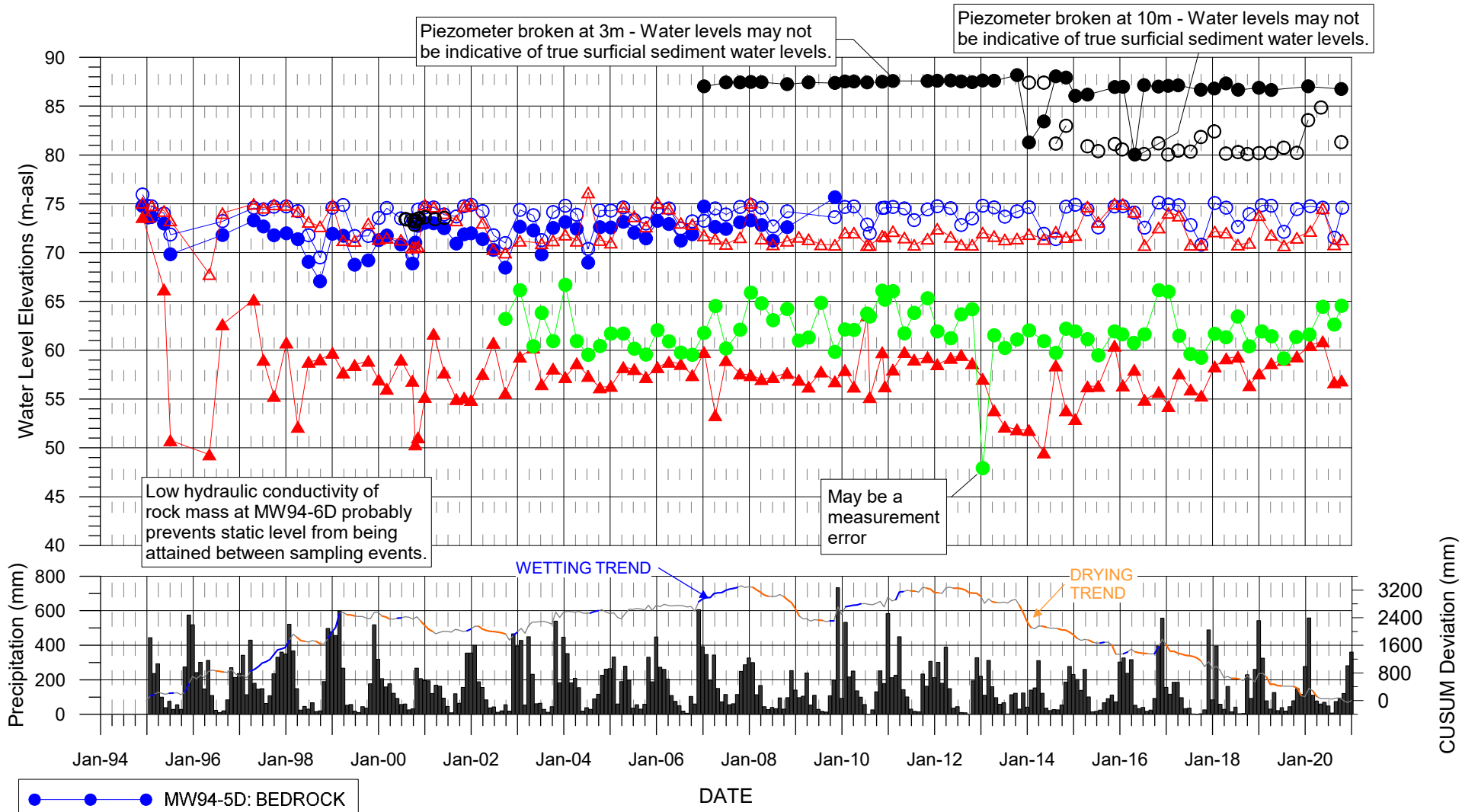
WATER LEVEL ELEVATIONS FOR SOUTHERN MONITORING WELLS MW94-4 AND MW94-7

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	A-2



Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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WATER LEVEL ELEVATIONS FOR NORTHERN MONITORING WELLS MW94-5, MW94-6 AND MW02-4 AND LANDFILL MONITORING WELLS BH00-1C AND BH00-2C

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	A-3

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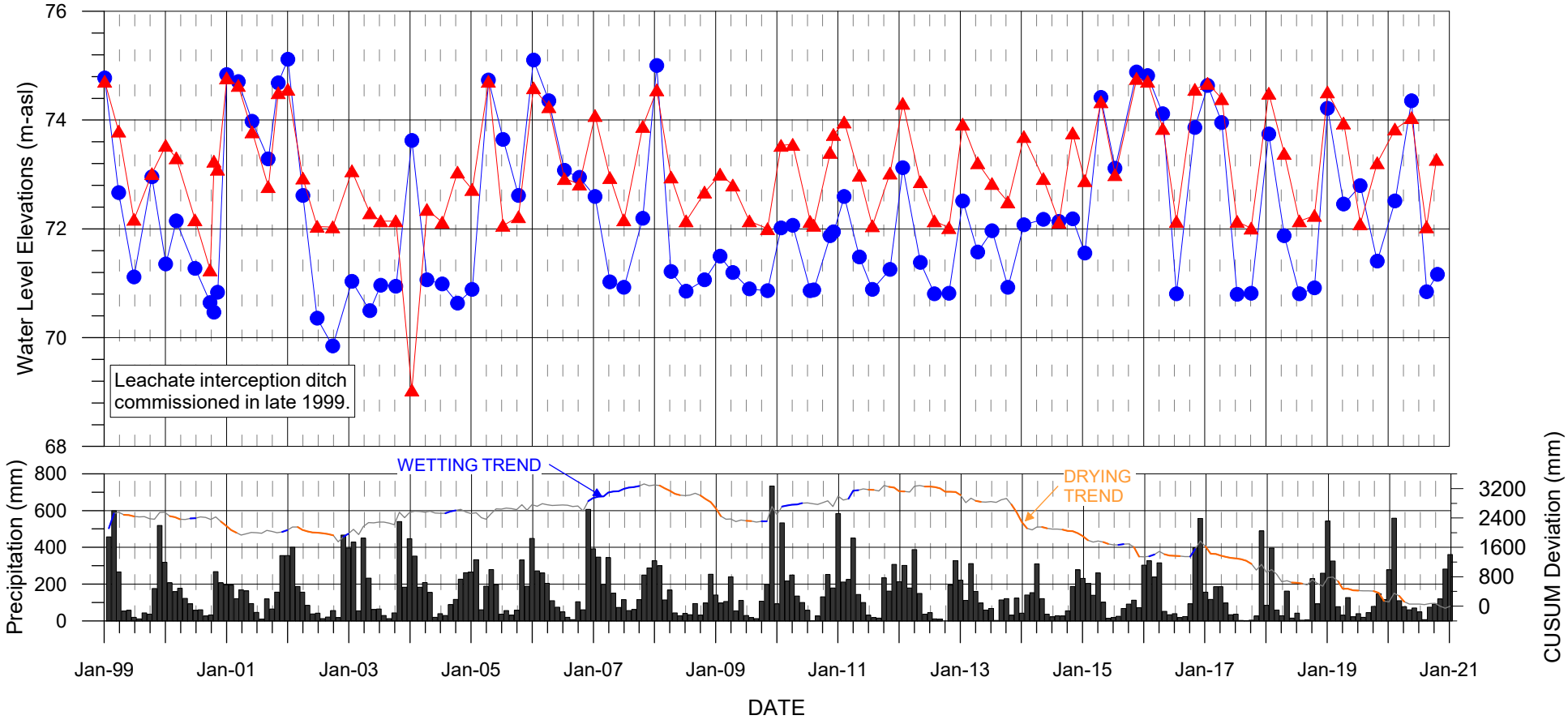
NOTE: Higher water levels in 2001 relative to 2000 identified a problem with the operation of the pump in the leachate interception trench. Levels in 2002 dropped after the pump malfunction was rectified. Similar problems indicated for brief periods in 2005, 2006, 2008, 2015-2016, 2017, 2019, and 2020.



MW98-9 : SURFICIALS
MW98-10 : SURFICIALS

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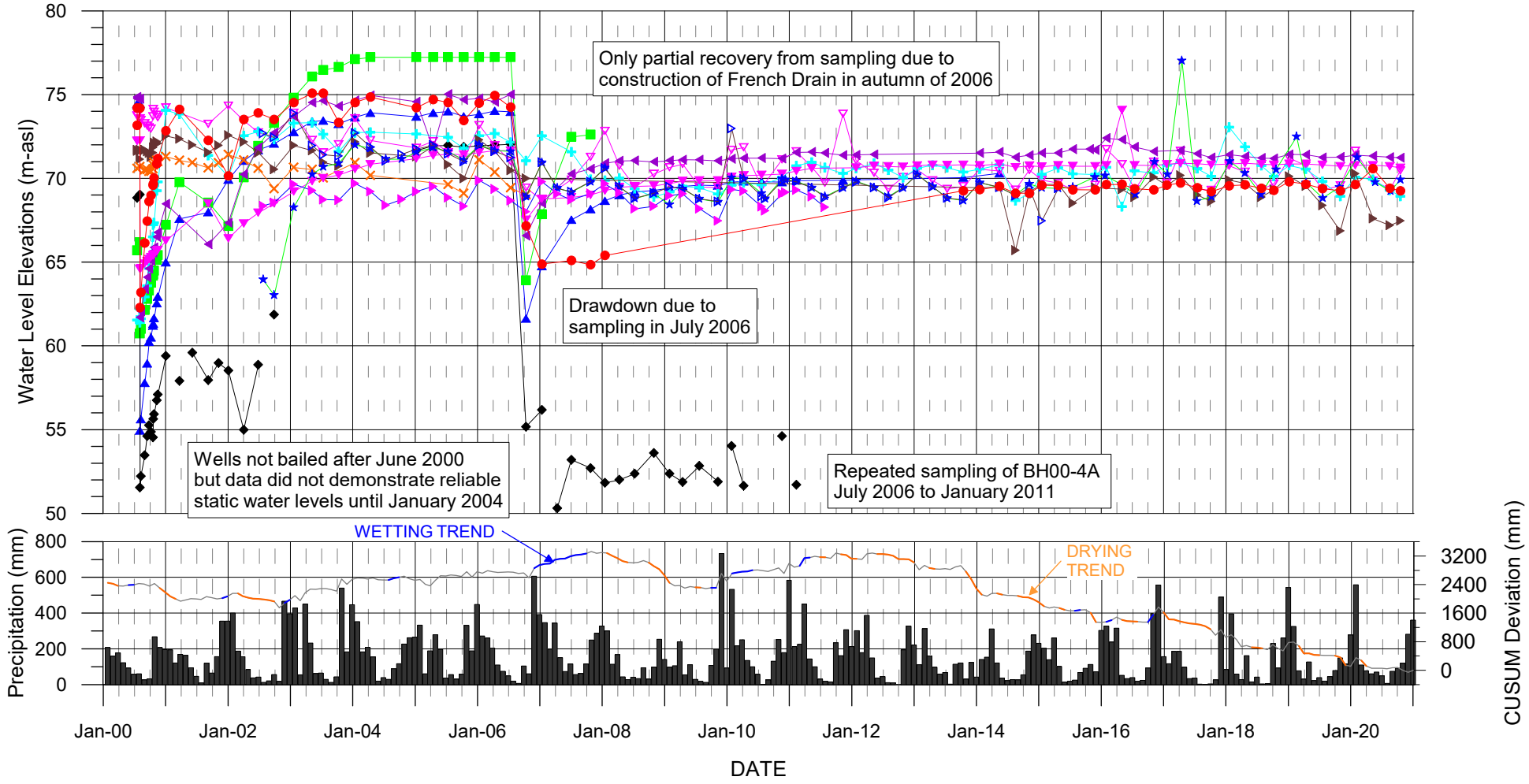
WATER LEVEL ELEVATIONS FOR NORTHERN MONITORING WELLS MW98-9 AND MW98-10

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	A-4

Notes:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

\\Nv-fps1.piteau.local\project\Project\1005\Analysis\Water_Elevations\2020\5-WL00.grf



BH00-1A
BH00-2A
BH00-3A
BH00-4A
BH00-5As
BH00-5Ad
BH00-6A
BH00-7A
BH00-8A
BH00-5B
MW02-1D
MW02-1S
MW02-2

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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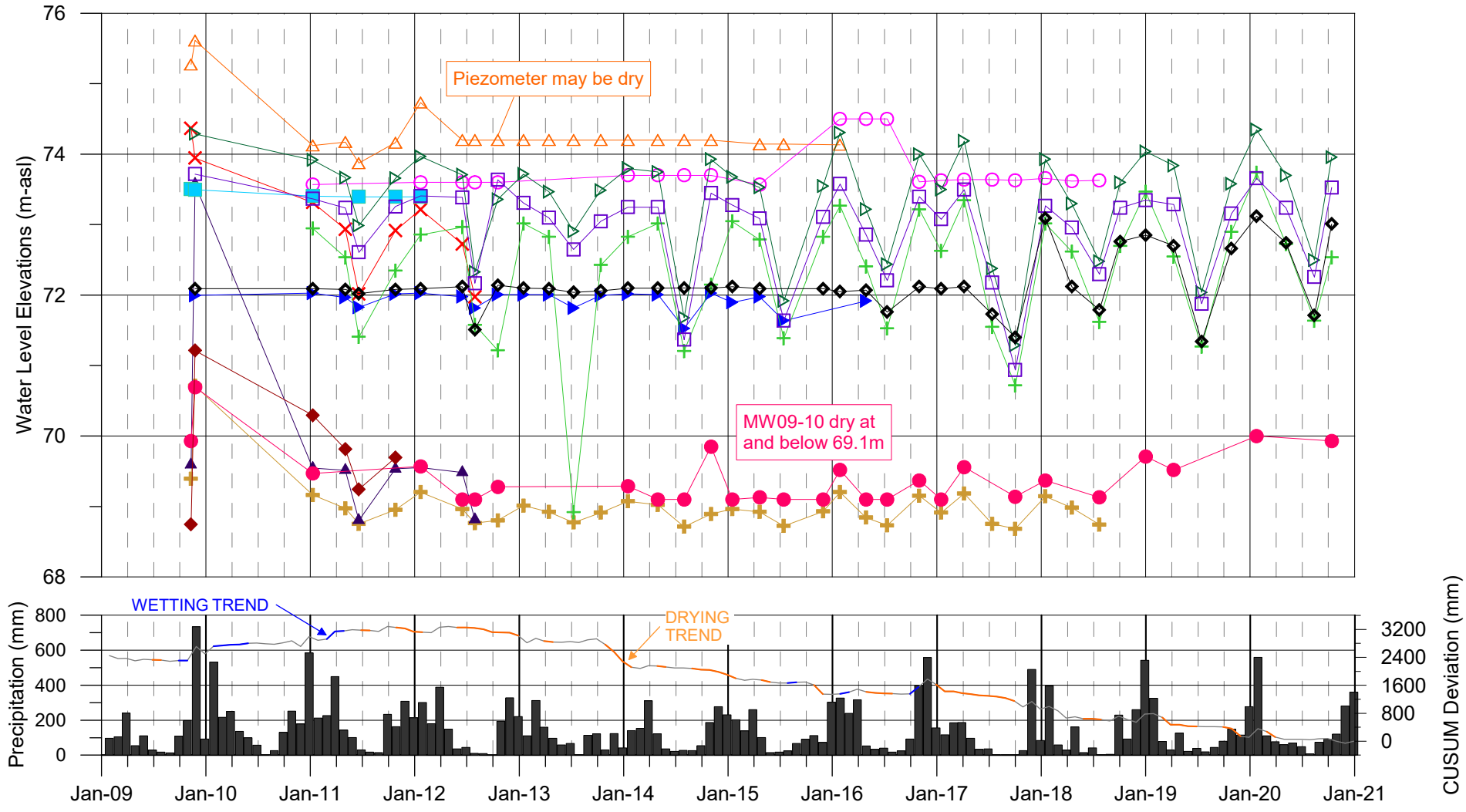
WATER LEVEL ELEVATIONS FOR EXPANSION AREA MONITORING WELLS

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	A-5

\\Nv-fps1.piteau.local\project\Project\1005\Analysis\Water_Elevations\2020\6-WL_MW_South.grf



MW09-01 MW09-02 MW09-03 MW09-04 MW09-05 MW09-06 MW09-07 MW09-08 MW09-09 MW09-10 MW09-11 MW09-12 MW09-13

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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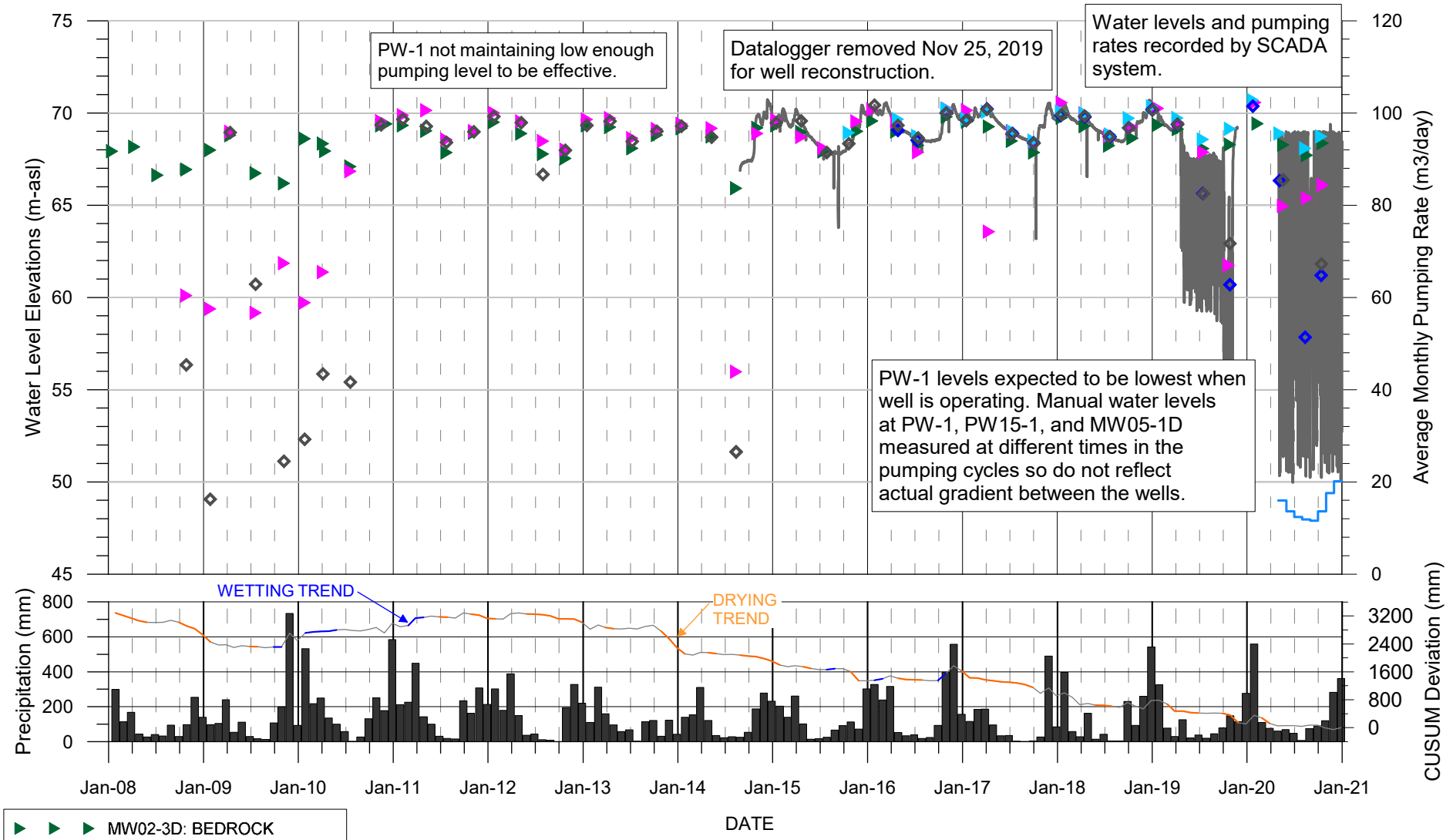
WATER LEVEL ELEVATIONS FOR 2009 OVERBURDEN MONITORING WELLS IN SOUTH EXPANSION AREA

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	A-6

H:\Project\1005\Analysis\Water_Elevations\20207-WL_PW_BEDROCK.grf



Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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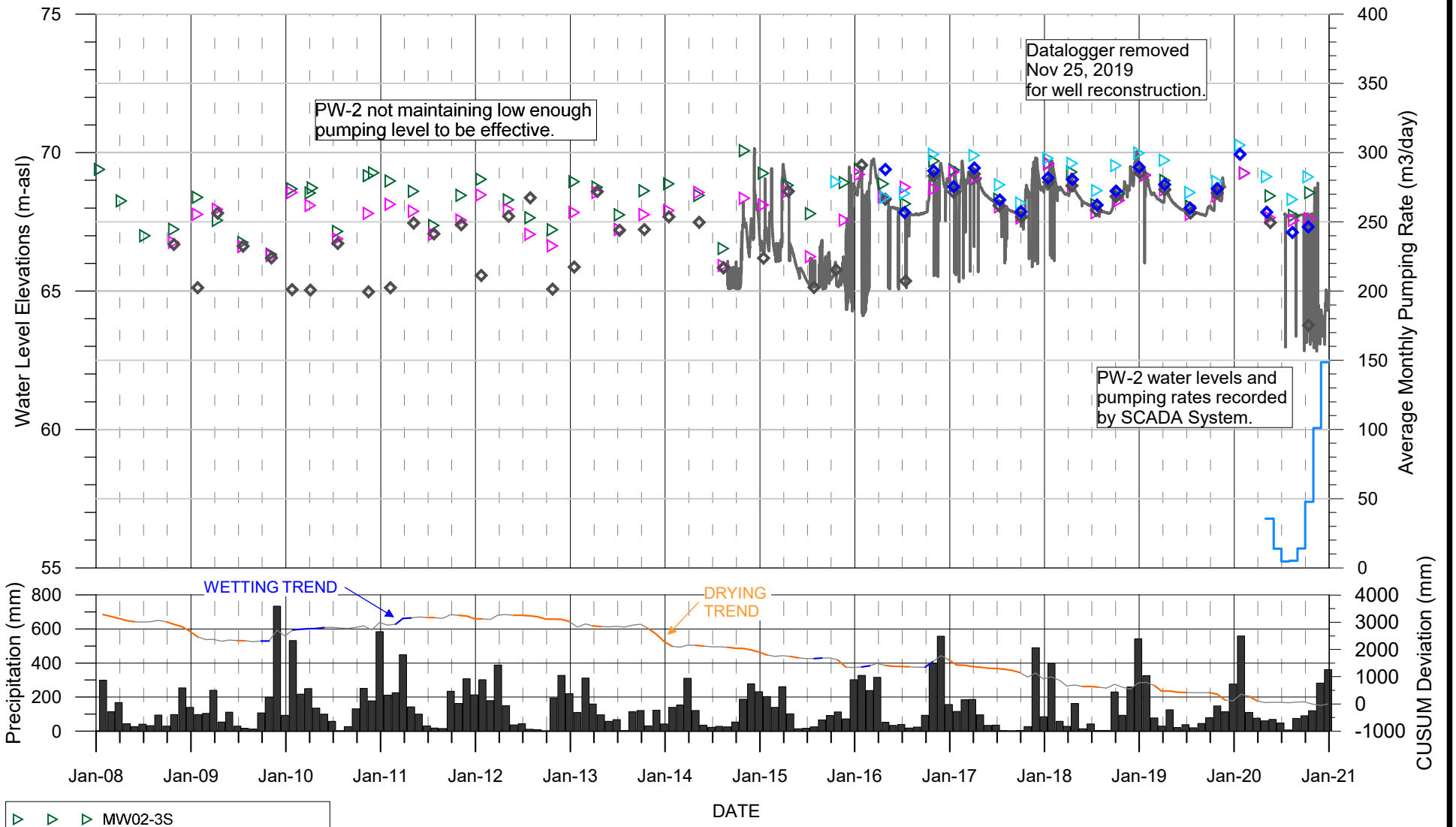
WATER LEVEL ELEVATIONS FOR BEDROCK LEACHATE INTERCEPTION WELL MONITORING PW-1, PW15-1, MW02-3D, MW05-1D, MW15-1D

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	A-7



Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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WATER LEVEL ELEVATIONS FOR SURFICIAL SEDIMENT INTERCEPTION WELL MONITORING PW-2, PW15-2, MW02-3S, MW05-1S, MW15-1S

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	A-8

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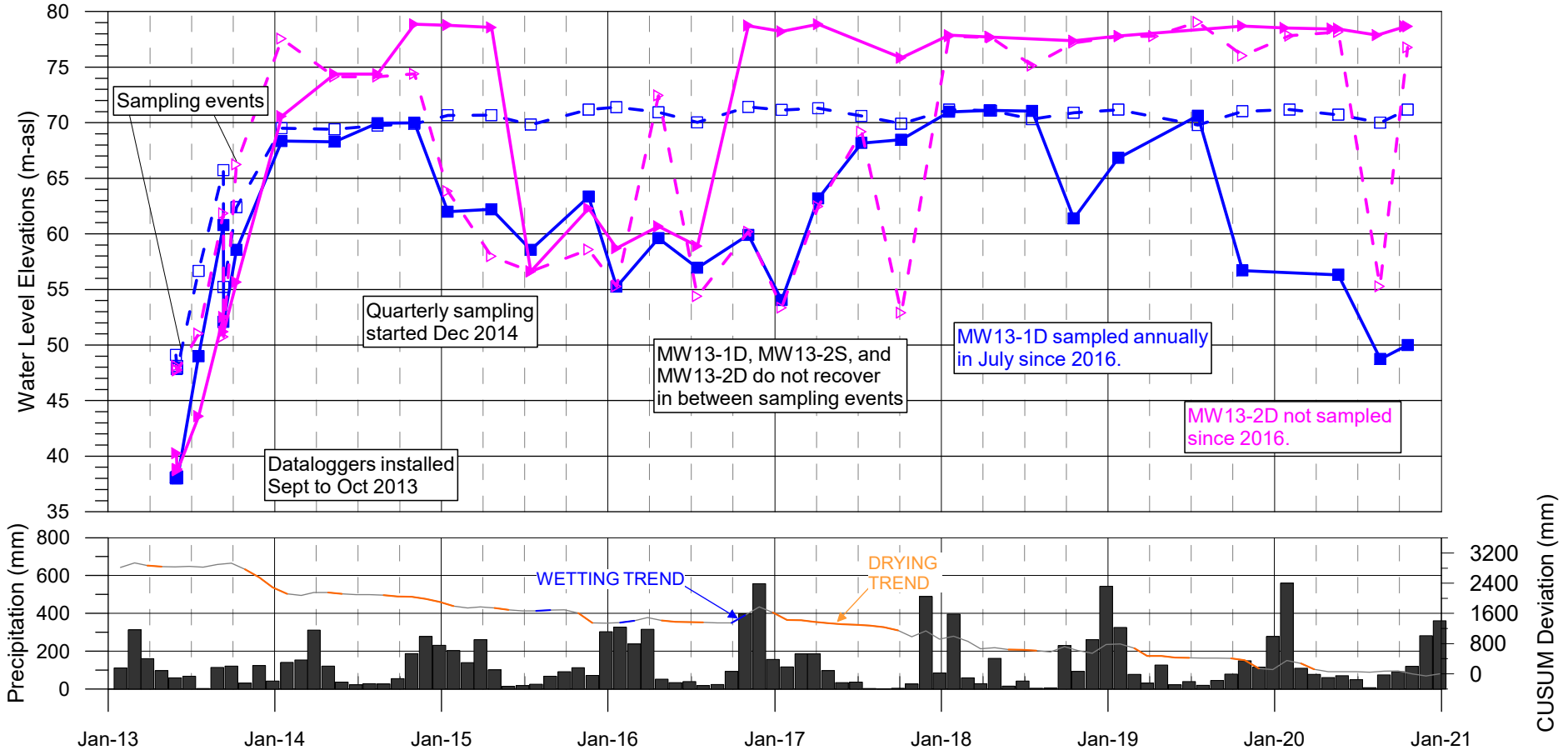

MW13-1D
MW13-1S
MW13-2D
MW13-2S

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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WATER LEVEL ELEVATIONS FOR NORTHEASTERN BEDROCK MONITORING WELLS MW13-1 AND MW13-2

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	A-9

APPENDIX B

CHEMISTRY MONITORING DATA TABLES AND PLOTS

APPENDIX B - LIST OF TABLES

Table B-1 Inorganic Chemistry Data for Leachate Drain

Table B-2 Inorganic Chemistry Data for South Expansion Area Leachate Drain

Table B-3 Leachate Volatile Organic Analyses

Table B-4 Leachate Phenol and Acid Extractable Analyses

Table B-5 Inorganic Chemistry Data for MW02-3S

Table B-6 Inorganic Chemistry Data for MW02-3D

Table B-7 Inorganic Chemistry Data for MW94-4S

Table B-8 Inorganic Chemistry Data for MW94-4D

Table B-9 Inorganic Chemistry Data for MW94-5S

Table B-10 Inorganic Chemistry Data for MW94-6S

Table B-11 Inorganic Chemistry Data for MW94-6D

Table B-12 Inorganic Chemistry Data for MW98-9

Table B-13 Inorganic Chemistry Data for MW98-10

Table B-14 Inorganic Chemistry Data for MW02-1D

Table B-15 Inorganic Chemistry Data for MW02-4

Table B-16 Inorganic Chemistry Data for MW05-1

Table B-17 Inorganic Chemistry Data for PW-1

Table B-18 Inorganic Chemistry Data for PW-2

Table B-19 Inorganic Chemistry Data for MW13-1D

Table B-20 Inorganic Chemistry Data for MW13-1S and MW13-2S

Table B-21 Inorganic Chemistry Data for Heath Creek

Table B-22 Inorganic Chemistry Data for Stevens Creek

Table B-23 Inorganic Chemistry Data for Christie Creek

APPENDIX B - LIST OF FIGURES

Figure B-1 Chloride Concentration Time-Series Plot for Leachate

Figure B-2 Ammonia Concentration Time-Series Plot for Leachate

Figure B-3 COD Concentration Time-Series Plot for Leachate

Figure B-4 Chloride Concentration Time-Series Plot for Southeast Wells MW94-1, MW94-2, MW94-3, MW02-3, MW05-1, PW-1, and PW-2

Figure B-5 Nitrogen or Ammonia Concentration Time-Series Plot for Southeast Wells MW94-1, MW94-2, MW94-3, MW02-3, MW05-1, PW-1, and PW-2

Figure B-6 Chloride Concentration Time-Series Plot for South and West Wells MW94-4, MW94-7, MW02-1 and MW02-2

Figure B-7 Nitrogen Concentration Time-Series Plot for South and West Wells MW94-4, MW94-7, MW02-1 and MW02-2

Figure B-8 Chloride Concentration Time-Series Plot for North Wells MW94-5, MW94-6, MW98-9 and MW98-10 and Background Wells BH00-4A and MW02-4

Figure B-9 Nitrogen Concentration Time-Series Plot for North Wells MW94-5, MW94-6, MW98-9 and MW98-10 and Background Wells BH00-4A and MW02-4

Figure B-10 Chloride Concentration Time-Series Plot for MW13-1S, MW13-1D, MW13-2S, and MW13-2D

Figure B-11 Nitrogen Concentration Time-Series Plot for MW13-1S, MW13-1D, MW13-2S, and MW13-2D

Figure B-12 Chloride Concentration Time-Series Plot for Creek Sampling Sites

Figure B-13 Nitrogen Concentration Time-Series Plot for Creek Sampling Sites

Figure B-14 Electrical Conductance Time-Series Plot for Creek Sampling Sites

TABLE B-1

INORGANIC CHEMISTRY DATA FOR LEACHATE DRAIN

SAMPLE DATE / LAB NAME	units	RECEIVING WATER CRITERIA				20-Feb-20	20-May-20	24-Aug-20	21-Oct-20
		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH - Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.37	7.23	8.18	7.78
pH - Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.5	7.74	8.03	7.66
EC - Field	µS/cm	-	-	-	-	826	916	24200	1180
EC - Lab	µS/cm	-	-	-	-	1080	1180	1620	1140
Total Hardness ($CaCO_3$)	mg/L	-	-	-	-	329	266	441	429
Total Dissolved Solids	mg/L	500	-	-	-	498	**600**	**1080**	**655**
Temperature - Field	°C	-	-	-	-	10.85	15.95	24.1	13.8
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-	-	-	-	310	244	456
Chloride	mg/L	250	150	250	1500	52.4	153	190	85.4
Sulphate	mg/L	500	429	500	4290	1.3	10.4	57.8	4.1
CATIONS									
Calcium	mg/L	-	-	-	-	102	79.8	130	133
Magnesium	mg/L	-	-	-	-	18	16.3	28.3	23.6
Potassium	mg/L	-	-	-	-	22.1	17.2	24.7	16.8
Sodium	mg/L	200	-	200	-	50.8	105	117	69.2
TOTAL METALS									
Aluminum	mg/L	0.10	0.050	-	9.5	0.082	0.038	0.015	0.016
Arsenic	mg/L	0.01	0.005	0.01	0.05	0.0012	0.001	0.0009	0.0056
Barium	mg/L	2	1	1	10	0.139	0.118	0.119	0.125
Boron	mg/L	5	1.2	5	12	0.67	0.386	0.689	0.31
Cadmium	mg/L	0.007	0.00059	0.005	0.004	<0.00001	0.00002	0.00002	0.00002
Chromium	mg/L	0.05	0.001	0.05	0.01	0.0019	0.0011	0.0009	0.0017
Cobalt	mg/L	-	0.004	0.001	0.04	*0.00301*	*0.00337*	*0.00202*	*0.00543*
Copper	mg/L	1	-	1.5	0.09	0.0009	0.0059	0.014	0.0119
Iron	mg/L	0.3	1	6.5	-	***35.1***	**2.5**	0.18	***6.96***
Lead	mg/L	0.005	0.022	0.01	0.16	0.00009	0.00018	0.00049	0.00034
Manganese	mg/L	0.02	2.37	1.5	-	***4.45***	***4.64***	**0.927**	***11.4***
Mercury	µg/L	1	0.02	1	0.25	<0.01	0.02	0.09	0.05
Zinc	mg/L	5	0.24	3	2.4	0.106	0.016	0.011	0.009
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.194	3.41	***59.7***	0.97
Ammonia Nitrogen	mg/L as N	-	1.84	-	11.3	32.6	13.4	8.7	9.8
Total Phosphorus	mg/L as P	-	0.005	-	-	-	0.028	0.062	0.037
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	76	65	72	198
Total Organic Carbon	mg/L as O	-	-	-	-	26	15.3	18.8	58.5
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	15.5	19.8	38.2
Dissolved Copper	mg/L	-	-	-	-	-	0.0019	-	-
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.09	-	0.0058	0.0364	0.018

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-1 to B-6.xlsx]Table B-1 LeachateDrain

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 400 mg/L, 10˚ C and a pH of 7.0.
   Phosphorus FWAL guideline for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May to September results compared against stringent guideline of 0.005 mg/L.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 400 mg/L-CaCO3 and pH of 7.5 to 8.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-2

INORGANIC CHEMISTRY DATA FOR SOUTH EXPANSION AREA LEACHATE DRAIN

SAMPLE DATE	units	RECEIVING WATER CRITERIA				20-Feb-20	20-May-20	20-Aug-20	22-Oct-20
LAB NAME		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH - Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.22	7.68	**6.48**	**6.69**
pH - Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.02	**6.8**	7	**6.87**
EC - Field	µS/cm	-	-	-	-	275	277	570	390
EC - Lab	µS/cm	-	-	-	-	426	396	527	386
Total Hardness ($CaCO_3$)	mg/L	-	-	-	-	175	163	221	157
Total Dissolved Solids	mg/L	500	-	-	-	238	195	328	198
Temperature - Field	°C	-	-	-	-	8.16	11.68	16.4	13.1
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-	-	-	173	169	214	142
Chloride	mg/L	250	150	250	1500	8.73	10.2	20.8	21.8
Sulphate	mg/L	500	429	500	4290	31.9	12.1	14	7.9
CATIONS									
Calcium	mg/L	-	-	-	-	57.2	53	71.7	51
Magnesium	mg/L	-	-	-	-	7.87	7.38	10.2	7.16
Potassium	mg/L	-	-	-	-	4.1	3.5	4.6	3.9
Sodium	mg/L	200	-	200	-	9.9	9.6	14.6	12.1
TOTAL METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	0.005	<0.005	0.011	<0.005
Arsenic	mg/L	0.01	0.005	0.01	0.05	<0.0001	0.0003	0.0003	0.0034
Barium	mg/L	2	1	1	10	0.0295	0.0279	0.0352	0.022
Boron	mg/L	5	1.2	5	12	0.192	0.176	0.238	0.169
Cadmium	mg/L	0.007	0.00035	0.005	0.0035	0.00005	0.00006	0.00007	0.00002
Chromium	mg/L	0.05	0.001	0.05	0.01	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.004	0.001	0.04	*0.00183*	*0.00178*	*0.00169*	0.00093
Copper	mg/L	1	-	1.5	0.08	0.0031	0.0028	0.0028	0.0025
Iron	mg/L	0.3	1	6.5	-	**0.75**	0.23	**0.32**	0.04
Lead	mg/L	0.005	0.011	0.01	0.06	<0.00005	<0.00005	<0.00005	0.00037
Manganese	mg/L	0.02	1.49	1.5	-	***2.94***	***2.46***	***3.36***	***2.14***
Mercury	µg/L	1	0.02	1	0.25	<0.01	0.01	<0.01	<0.01
Zinc	mg/L	5	0.09	3	0.9	<0.005	<0.005	<0.005	<0.005
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.685	1.04	2.06	2.27
Ammonia Nitrogen	mg/L as N	-	1.84	-	18.4	3.36	2.5	2.64	2.1
Total Phosphorus	mg/L	-	0.005	-	-	-	0.033	0.008	<0.005
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	22	22	14	18
Total Organic Carbon	mg/L as O	-	-	-	-	6.9	3.2	4	2.4
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	3.3	4.7	2.4
Dissolved Copper	mg/L	-	-	-	-	-	**0.0018**	**0.003**	**0.002**
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.08	-	0.0017	0.0005	0.0003

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-1 to B-6.xlsx]Table B-2 SouthExpArea

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 200 mg/L, 10˚ C and a pH of 7.0.
   Phosphorus FWAL guideline for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May to September results compared against stringent guideline of 0.005 mg/L.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 200 mg/L-CaCO3 and pH < 7.0.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-3
LEACHATE VOLATILE ORGANIC ANALYSES

						Leachate Inlet	Exp. Drain
SAMPLE DATE	RECEIVING WATER CRITERIA					24-Aug-20	20-Aug-20
LAB NAME	GCDWQ MAC[1]	GCDWQ AO[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT
units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Acetone	-	-	-	3500	-	<10	<10
Benzene	5	-	40	5	400	<0.5	<0.5
Bromodichloromethane	-	-	-	100	-	<1	<1
Bromoform	-	-	-	100	-	<1	<1
Bromomethane	-	-	-	5.5	-	*10*	<2
2-Butanone	-	-	-	-	-	<10	<10
Carbon Tetrachloride	5	-	-	2	130	<0.5	<0.5
Chlorobenzene	-	-	-	80	13	<1	<1
Chloroethane	-	-	-	-	-	<1	<1
Chloroform	-	-	-	100	20	<1	<1
Chloromethane	-	-	-	-	-	3	<1
Dibromochloromethane	-	-	-	100	-	<1	<1
1,2-Dibromoethane	-	-	-	0.5	-	<0.3	<0.3
Dichloromethane	50	-	-	50	980	<1	<1
1,2-Dichlorobenzene	200	3	-	200	7	<0.5	<0.5
1,3-Dichlorobenzene	-	-	-	-	1500	<0.5	<0.5
1,4-Dichlorobenzene	5	1	-	5	260	<0.5	<0.5
1,1-Dichloroethane	-	-	-	30	-	<1	<1
1,2-Dichloroethane	5	-	-	5	1000	<1	<1
1,1-Dichloroethene	14	-	-	-	-	<1	<1
cis-1,2-Dichloroethene	-	-	-	8	-	<1	<1
trans-1,2-Dichloroethene	-	-	-	80	-	<1	<1
1,2-Dichloropropane	-	-	-	4.5	-	<1	<1
cis-1,3-Dichloropropene	-	-	-	1.5	-	<1	<1
trans-1,3-Dichloropropene	-	-	-	1.5	-	<1	<1
Ethylbenzene	140	1.6	200	140	2000	<0.5	<0.5
Hexachlorobutadiene	-	-	-	2	15	<0.4	-
Methyl t-Butyl Ether	-	15	3400	95	34000	<1	<1
Naphthalene	-	-	1	80	10	<0.30	-
4-Methyl-2-pentanone	-	-	-	-	-	<10	<10
Styrene	-	-	-	800	720	<0.5	<0.5
1,1,2,2-Tetrachloroethane	-	-	-	0.8	-	<0.8	<0.8
1,1,1,2-Tetrachloroethane	-	-	-	6	-	<1	<1
Tetrachloroethene	5	-	111	3	1100	<1	<1
Toluene	60	24	0.5	60	5	<0.5	<0.5
1,2,4-Trichlorobenzene	-	-	-	5.5	240	<1	<1
1,1,1-Trichloroethane	-	-	-	8000	-	<1	<1
1,1,2-Trichloroethane	-	-	21	3	-	<1	<1
Trichloroethene	5	-	-	5	200	<1	<1
Trichlorofluoromethane	-	-	-	1000	-	<1	<1
Vinyl Chloride	2	-	-	2	-	<1	<1
m&p-Xylene	-	-	-	90	300	<0.5	<0.5
Xylenes	90	20	30	90	300	<0.7	<0.7

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-1 to B-6.xlsx]Table B-3 LeachateOrganic

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). MAC is maximum acceptable concentration, AO is aesthetic objective.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 200 mg/L-CaCO3 and pH of 7.5 to 8.

TABLE B-4

LEACHATE PHENOL AND ACID EXTRACTABLE ANALYSES

						Leachate Inlet
SAMPLE DATE	RECEIVING WATER CRITERIA					24-Aug-20
LAB NAME	GCDWQ[1] MAC	GCDWQ[1] AO	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT
units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ACID EXTRACTABLES						
o-Cresol (2-methylphenol)	-	-	-	-	-	<0.5
m&p Cresol	-	-	-	-	-	<0.5
2,4-Dimethylphenol	-	-	-	80	-	<0.5
2,4-Dinitrophenol	-	-	-	8	2000	<10
Phenol	-	-	50	1000	2000	<1.0
BASE/NEUTRAL EXTRACTABLES						
Acenaphthene	-	-	6	250	60	<0.30
Acenaphthylene	-	-	-	-	-	<0.31
Anthracene	-	-	4	1000	1	<0.30
Benzo(a)anthracene	-	-	0.1	-	-	<0.20
Benzo(b)fluoranthene	-	-	-	0.07	-	<0.20
Benzo(k)fluoranthene	-	-	-	-	-	<0.20
Benzo(g,h,i)perylene	-	-	-	-	-	<0.20
Benzo(a)pyrene	0.04	-	0.01	0.01	0.1	<0.01
Bis(2-chloroethyl)ether	-	-	-	150	-	<0.5
Bis(2-chloroisopropyl)ether	50	-	-	-	-	<0.5
Bis(2-Ethylhexyl)phthalate	-	-	-	10	160	<0.5
1,1-Biphenyl	200	-	3	2000	-	<0.5
p-Chloroaniline	-	-	-	0.8	-	<1.0
Chrysene	5	-	1	7	1	<0.27
3,3'-dichlorobenzidine	5	-	-	0.35	-	<0.5
Diethyl phthalate	14	-	-	3000	-	<0.5
Dimethyl phthalate	-	-	-	-	-	<0.5
2,4-Dinitrotoluene	-	-	-	0.5	-	<0.5
2,6-Dinitrotoluene	-	-	-	0.1	-	<0.5
Fluoranthene	-	-	4	150	2	<0.27
Fluorene	-	-	12	150	120	<0.31
Hexachlorobenzene	-	-	-	0.1	-	<0.5
Hexachlorobutadiene	-	-	-	2	15	<0.4
Hexachloroethane	-	-	-	3	-	<0.5
Indeno(1,2,3-cd)pyrene	140	-	1.6	100	0.2	<0.27
Naphthalene	-	-	1	80	10	<0.30
Phenanthrene	-	-	0.3	-	3	<0.32
Pyrene	20	-	-	100	0.2	<0.20
1,2,4-Trichlorobenzene	-	-	1	5.5	240	<1
CHLORINATED PHENOLS						
2-Chlorophenol	-	-	11	45	19.5	<0.5
2,4-Dichlorophenol	900	0.3	1.6	900	3	<0.3
2,4,5-Trichlorophenol	-	-	1.2	400	2.5	<0.2
2,4,6-Trichlorophenol	5	2	3.2	5	6	<0.2
2,3,4,6-Tetrachlorophenol	100	1	2.9	100	5.5	<0.5
Pentachlorophenol	60	30	0.5	60	1	<0.5

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-1 to B-6.xlsx]Table B-4 LeachatePhenol

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020).
   MAC is maximum acceptable concentration, AO is aesthetic objective.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

   Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 200 mg/L-CaCO3 and pH of 7.5 to 8.

TABLE B-5

INORGANIC CHEMISTRY DATA FOR MW02-3S

SAMPLE DATE / LAB NAME	units	RECEIVING WATER CRITERIA				20-Feb-20	20-May-20	19-Aug-20	20-Oct-20
		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.61**	7.49	7.11	7.29
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.79	7.52	7.61	7.25
EC-Field	µS/cm	-	-	-	-	828	915	1260	1180
EC-Lab	µS/cm	-	-	-	-	1230	1230	1212	1150
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	584	608	549	539
Total Dissolved Solids	mg/L	500	-	-	-	**748**	**745**	**742**	**678**
Temperature-Field	°C	-	-	-	-	9.45	13.19	16.5	10.8
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-	-	-	524	456	497	463
Chloride	mg/L	250	150	250	1500	94.3	87.5	91.6	90.6
Sulphate	mg/L	500	429	500	4290	19.4	20.5	21.5	22.4
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	162	168	152	150
Magnesium	mg/L	-	-	-	-	43.6	45.7	41.1	39.9
Potassium	mg/L	-	-	-	-	1.26	1.31	1.26	1.2
Sodium	mg/L	200	-	200	-	37.7	38.7	36.3	36.8
ION BALANCE									
Ion Balance	%		-	-	-	99	115	97	101
DISSOLVED METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	0.004	<0.002	<0.002	<0.002
Arsenic	mg/L	0.01	0.005	0.01	0.05	0.0037	0.0076	0.0078	0.0066
Barium	mg/L	2	1	1	10	0.0789	0.07	0.0582	0.0557
Boron	mg/L	5	1.2	5	12	0.557	0.418	0.47	0.417
Cadmium	mg/L	0.007	0.00047	0.005	0.004	0.00015	0.00008	0.00004	0.00003
Chromium	mg/L	0.05	0.001	0.05	0.01	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.004	0.001	0.04	*0.00319*	*0.00944*	*0.00873*	*0.00625*
Copper	mg/L	-	See Below	1.5	0.09	0.0215	0.0043	0.0034	0.0046
Iron	mg/L	0.3	0.35	6.5	-	0.03	0.21	0.22	0.23
Lead	mg/L	0.005	0.016	0.01	0.16	<0.00005	<0.00005	<0.00005	<0.00005
Manganese	mg/L	0.02	1.93	1.5	-	**0.419**	**0.622**	**0.598**	**0.546**
Mercury	µg/L	1	0.02	1	0.25	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.02	-	0.0006	<0.0005	0.0006	<0.0005
Zinc	mg/L	5	0.1650	3	2.4	0.012	<0.002	<0.002	<0.002
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.006	0.046	<0.005	<0.005
Ammonia Nitrogen	mg/L as N	-	1.84	-	18.5	<0.01	0.07	0.02	0.02
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	24	50	26	33
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	9.3	9.2	8.3
Dissolved Copper	mg/L	-	-	-	-	0.0215	0.0043	0.0034	0.0046
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.06	-	0.005	0.0027	0.0034

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-1 to B-6.xlsx]Table B-5 MW02-3S

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 300 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 300 mg/L-CaCO3 and pH of 7.0 to 7.5.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-6

SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW02-3D

SAMPLE DATE	units	RECEIVING WATER CRITERIA				20-Feb-20	20-May-20	19-Aug-20	19-Oct-20
LAB NAME		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.63**	7.16	7.08	7.12
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.78	7.29	7.57	7.17
EC-Field	µS/cm	-	-	-	-	713	1063	1270	1230
EC-Lab	µS/cm	-	-	-	-	986	1290	1209	1200
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	357	602	496	493
Total Dissolved Solids	mg/L	500	-	-	-	**570**	**755**	**735**	**708**
Temperature-Field	°C	-	-	-	-	9.84	14.2	16.9	12
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-	-	-	404	517	499	496
Chloride	mg/L	250	150	250	1500	78.5	88.6	85.8	82.5
Sulphate	mg/L	500	429	500	4290	21.3	23.7	27.3	25.4
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	103	169	143	144
Magnesium	mg/L	-	-	-	-	24.2	43.7	33.7	32.3
Potassium	mg/L	-	-	-	-	1.19	1.29	1.3	1.35
Sodium	mg/L	200	-	200	-	73.3	48.2	67.9	71.6
ION BALANCE									
Ion Balance	%		-	-	-	96	106	99	102
DISSOLVED METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	0.002	<0.002	<0.002	<0.002
Arsenic	mg/L	0.01	0.005	0.01	0.05	0.0008	0.0035	0.0007	0.0008
Barium	mg/L	2	1	1	10	0.0822	0.083	0.102	0.115
Boron	mg/L	5	1.2	5	12	0.849	0.503	0.685	0.621
Cadmium	mg/L	0.007	0.00047	0.005	0.004	0.00001	0.00006	0.00002	0.00002
Chromium	mg/L	0.05	0.001	0.05	0.01	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.004	0.001	0.04	*0.00206*	*0.00205*	*0.00191*	*0.0022*
Copper	mg/L	-	See Below	1.5	0.09	0.0049	0.0049	0.0156	0.0147
Iron	mg/L	0.3	0.35	6.5	-	0.04	0.15	0.11	0.22
Lead	mg/L	0.005	0.016	0.01	0.16	<0.00005	<0.00005	<0.00005	<0.00005
Manganese	mg/L	0.02	1.93	1.5	-	**0.319**	**0.481**	**0.484**	**0.561**
Mercury	µg/L	1	0.02	1	0.25	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.02	-	<0.0005	0.0006	0.0008	<0.0005
Zinc	mg/L	5	0.1650	3	2.4	0.006	<0.002	<0.002	<0.002
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	<0.005	0.007	<0.005	<0.005
Ammonia Nitrogen	mg/L as N	-	1.84	-	18.5	0.07	0.06	0.08	0.16
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	24	46	28	31
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	10.2	9.6	9.9
Dissolved Copper	mg/L	-	-	-	-	0.0049	0.0049	0.0156	0.0147
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.09	-	0.0034	0.0026	0.0032

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-1 to B-6.xlsx]Table B-6 MW02-3D

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "**-**" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values shown are based on average hardness of 300 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 300 mg/L-CaCO3 and pH of 7.0 to 7.5.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-7

INORGANIC CHEMISTRY DATA FOR MW94-4S

SAMPLE DATE		RECEIVING WATER CRITERIA				20-Feb-20	20-May-20	18-Aug-20	19-Oct-20
LAB NAME	units	GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	8.21	8.24	9.67	9.75
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	9.39	7.09	8.09	8.67
EC-Field	µS/cm	-	-	-	-	154	175	260	260
EC-Lab	µS/cm	-	-	-	-	257	261	325	252
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	10.1	6.8	3.4	4.3
Total Dissolved Solids	mg/L	500	-	-	-	148	148	208	162
Temperature-Field	°C	-	-	-	-	5.09	11	12.8	10.7
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$			-	-	116	138	112	107
Chloride	mg/L	250	150	250	1500	7.27	7.22	7.4	7.84
Sulphate	mg/L	500	128	500	1280	6.2	5.9	33.6	5.9
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	3.42	2.35	1.26	1.56
Magnesium	mg/L	-	-	-	-	0.37	0.22	0.05	0.1
Potassium	mg/L	-	-	-	-	0.32	0.34	0.46	0.35
Sodium	mg/L	200	-	200	-	52	54.5	56.6	58
ION BALANCE									
Ion Balance	%	-	-	-	-	93	81	80	105
DISSOLVED METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	0.007	0.008	0.008	0.008
Arsenic	mg/L	0.01	0.005	0.01	0.05	0.0047	0.0044	0.0047	0.0034
Barium	mg/L	2	1	1	10	0.0042	0.0046	0.0032	0.0031
Boron	mg/L	5	1.2	5	12	1.27	1.56	1.39	1.49
Cadmium	mg/L	0.007	0.00009	0.005	0.0005	<0.00001	0.00002	<0.00001	<0.00001
Chromium	mg/L	0.05	0.001	0.05	0.01	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.004	0.001	0.04	<0.00005	<0.00005	<0.00005	<0.00005
Copper	mg/L	-	see below	1.5	0.09	<0.0002	<0.0002	0.0006	0.0002
Iron	mg/L	0.3	0.35	6.5	-	<0.01	<0.01	<0.01	0.01
Lead	mg/L	0.01	0.004	0.01	0.04	<0.00005	<0.00005	<0.00005	<0.00005
Manganese	mg/L	0.02	0.74	1.5	-	<0.001	<0.001	<0.001	<0.001
Mercury	µg/L	1	0.02	1	0.25	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.02	-	0.0009	0.0005	<0.0005	0.0009
Zinc	mg/L	5	0.0075	3	0.075	<0.002	<0.002	<0.002	<0.002
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.032	<0.005	0.433	0.052
Ammonia Nitrogen	mg/L as N	-	0.131	-	1.31	0.07	0.11	0.03	<0.01
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	<10	<10	<10	<10
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	0.8	2.6	5.9
Dissolved Copper	mg/L	-	-	-	-	<0.0002	<0.0002	0.0006	0.0002
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.09	-	0.0009	0.0086	0.0194

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-7 to B-13.xlsx]Table B-7 MW94-4S

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 30 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 30 mg/L-CaCO3 and pH > 8.5.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-8

INORGANIC CHEMISTRY DATA FOR MW94-4D

SAMPLE DATE / LAB NAME	units	RECEIVING WATER CRITERIA				20-Feb-20 AGAT	20-May-20 AGAT	18-Aug-20 AGAT	19-Oct-20 AGAT
		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]				
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.18	7.75	8.44	8.48
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	8.34	7.87	9.27	7.64
EC-Field	µS/cm	-	-	-	-	228	172	340	360
EC-Lab	µS/cm	-	-	-	-	337	258	256	354
Total Dissolved Solids	mg/L	500	-	-	-	222	138	172	222
Temperature-Field	°C	-	-	-	-	8.48	10.77	14.2	9.3
DISSOLVED ANIONS									
Chloride	mg/L	250	150	250	1500	7.79	6.86	7.72	6.77
Sulphate	mg/L	500	128	500	1280	38.8	5.7	6.1	40.2
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.519	0.082	0.048	0.764
Ammonia Nitrogen	mg/L as N	-	0.893	-	3.7	<0.01	0.04	0.05	<0.01

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-7 to B-13.xlsx]Table B-8 MW94-4D

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 30 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 30 mg/L-$CaCO_3$ and pH of 8.0 to 8.5.

TABLE B-9

INORGANIC CHEMISTRY DATA FOR MW94-5S

SAMPLE DATE / LAB NAME	units	RECEIVING WATER CRITERIA				20-Feb-20	19-May-20	24-Aug-20	21-Oct-20
		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.47**	7.97	**6.91**	7.1
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.52	**6.59**	7.92	7.15
EC-Field	µS/cm	-	-	-	-	134	184	310	310
EC-Lab	µS/cm	-	-	-	-	201	253	295	332
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	98.8	121	137	169
Total Dissolved Solids	mg/L	500	-	-	-	128	145	175	170
Temperature-Field	°C	-	-	-	-	9	13.48	15.6	12.2
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-	-	-	101	153	139	154
Chloride	mg/L	250	150	250	1500	0.7	0.69	1.97	2.23
Sulphate	mg/L	500	309	500	3090	6	7.5	9.2	10.9
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	31.9	39.4	45	54.9
Magnesium	mg/L	-	-	-	-	4.66	5.61	6.01	7.75
Potassium	mg/L	-	-	-	-	0.51	0.3	0.36	0.38
Sodium	mg/L	200	-	200	-	3.36	3.79	3.79	4.62
ION BALANCE									
Ion Balance	%	-	-	-	-	98	80	96	-
DISSOLVED METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	0.032	<0.002	0.003	<0.002
Arsenic	mg/L	0.01	0.005	0.01	0.05	0.0002	0.0002	0.0002	0.0005
Barium	mg/L	2	1	1	10	0.0174	0.0175	0.021	0.0205
Boron	mg/L	5	1.2	5	12	0.388	0.273	0.266	0.287
Cadmium	mg/L	0.007	0.00029	0.005	0.0025	0.00003	0.00003	0.00003	0.00002
Chromium	mg/L	0.05	0.001	0.05	0.01	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.004	0.001	0.04	0.00034	<0.00005	<0.00005	0.00009
Copper	mg/L	-	see below	1.5	0.09	0.0005	0.0075	0.0009	0.0008
Iron	mg/L	0.3	0.35	6.5	-	**2.86**	0.01	0.12	0.02
Lead	mg/L	0.005	0.009	0.01	0.06	0.00021	0.00027	<0.00005	<0.00005
Manganese	mg/L	0.02	1.265	1.5	-	**0.454**	0.011	0.012	**0.025**
Mercury	µg/L	1	0.02	1	0.25	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.02	-	<0.0005	<0.0005	<0.0005	<0.0005
Zinc	mg/L	5	0.053	3	0.9	0.006	0.027	0.008	0.004
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.043	0.052	0.204	0.216
Ammonia Nitrogen	mg/L as N	-	1.8	-	18.5	0.11	0.09	0.03	<0.01
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	<10	18	<10	13
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	0.9	1.7	0.8
Dissolved Copper	mg/L	-	-	-	-	0.0005	0.0075	0.0009	0.0008
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.09	-	0.0005	0.0003	0.0002

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-7 to B-13.xlsx]Table B-9 MW94-5S

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 150 mg/L, 10° C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 150 mg/L-CaCO3 and pH of 7.0 to 7.5.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-10

INORGANIC CHEMISTRY DATA FOR MW94-6S

SAMPLE DATE		RECEIVING WATER CRITERIA				20-Feb-20	19-May-20	18-Aug-20	20-Oct-20
LAB NAME	units	GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.26**	**6.24**	**6.46**	**6.67**
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.86**	**6.54**	**6.6**	**6.48**
EC-Field	µS/cm	-	-	-	-	411	615	980	820
EC-Lab	µS/cm	-	-	-	-	510	726	810	703
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	171	299	315	265
Total Dissolved Solids	mg/L	500	-	-	-	272	352	442	400
Temperature-Field	°C	-	-	-	-	9.9	12.32	12.8	11.9
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-	-	-	270	352	424	351
Chloride	mg/L	250	150	250	1500	4.07	7.15	7.26	5.38
Sulphate	mg/L	500	429	500	4290	0.8	<0.5	<0.5	0.9
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	56.3	98	106	88.7
Magnesium	mg/L	-	-	-	-	7.39	13.1	12.1	10.5
Potassium	mg/L	-	-	-	-	5.67	7.56	7.97	8.22
Sodium	mg/L	200	-	200	-	26.4	10	10.5	10
ION BALANCE									
Ion Balance	%	-	-	-	-	85	91	80	83
DISSOLVED METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	**0.687**	0.004	0.003	<0.002
Arsenic	mg/L	0.01	0.005	0.01	0.05	0.0051	0.0062	0.0055	0.0077
Barium	mg/L	2	1	1	10	0.048	0.036	0.0402	0.0349
Boron	mg/L	5	1.2	5	12	0.533	0.274	0.264	0.332
Cadmium	mg/L	0.007	0.00047	0.005	0.004	0.00004	0.00002	<0.00001	<0.00001
Chromium	mg/L	0.05	0.001	0.05	0.01	0.0013	0.001	0.001	0.0008
Cobalt	mg/L	-	0.004	0.001	0.04	*0.0037*	*0.00473*	*0.00266*	*0.00267*
Copper	mg/L	-	see below	1.5	0.09	0.0058	0.0003	0.0003	<0.0002
Iron	mg/L	0.3	0.35	6.5	-	***28.3***	***61***	***58.9***	***58.6***
Lead	mg/L	0.005	0.016	0.01	0.11	*0.0104*	<0.00005	<0.00005	<0.00005
Manganese	mg/L	0.02	1.925	1.5	-	***2.98***	***5.41***	***5.65***	***4.94***
Mercury	µg/L	1	0.02	1	0.25	0.02	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.02	-	0.0039	0.0027	0.0018	0.0023
Zinc	mg/L	5	0.165	3	1.65	0.017	0.004	0.002	<0.002
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.032	0.007	<0.005	<0.005
Ammonia Nitrogen	mg/L as N	-	1.81	-	18.4	8.9	10.7	11.7	251
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	31	54	35	43
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	6.5	8.4	7.6
Dissolved Copper	mg/L	-	-	-	-	0.0058	0.0003	0.0003	<0.0002
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.09	-	0.0004	0.0008	0.0011

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-7 to B-13.xlsx]Table B-10 MW94-6S

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 300 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 300 mg/L-CaCO3 and pH < 7.0.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-11

INORGANIC CHEMISTRY DATA FOR MW94-6D

SAMPLE DATE / LAB NAME	units	RECEIVING WATER CRITERIA				20-Feb-20	19-May-20	19-Aug-20	15-Oct-20
		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.76**	**6.59**	9.79	dry
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	9.52	8.92	9.51	
EC-Field	µS/cm	-	-	-	-	145	457	570	
EC-Lab	µS/cm	-	-	-	-	536	539	545	
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	18.4	1.4	2.7	
Total Dissolved Solids	mg/L	500	-	-	-	378	350	**558**	
Temperature-Field	°C	-	-	-	-	10.28	13.47	16.2	
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-	-	-	240	248	228	
Chloride	mg/L	250	150	250	1500	5.1	4.69	4.21	
Sulphate	mg/L	500	128	500	1280	28.2	30.5	34.8	
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	4.84	0.58	0.87	
Magnesium	mg/L	-	-	-	-	1.53	<0.05	0.12	
Potassium	mg/L	-	-	-	-	0.67	0.46	0.51	
Sodium	mg/L	200	-	200	-	124	114	116	
ION BALANCE									
Ion Balance	%	-	-	-	-	-	86	93	
DISSOLVED METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	**1.48**	0.012	**0.137**	
Arsenic	mg/L	0.01	0.005	0.01	0.05	***0.015***	***0.0211***	***0.0191***	
Barium	mg/L	2	1	1	10	0.0323	0.0015	0.0045	
Boron	mg/L	5	1.2	5	12	2.04	2.49	2.93	
Cadmium	mg/L	0.007	0.00009	0.005	0.0005	0.00016	0.00002	0.00002	
Chromium	mg/L	0.05	0.001	0.05	0.01	<0.0005	<0.0005	<0.0005	
Cobalt	mg/L	-	0.004	0.001	0.04	*0.00183*	<0.00005	0.00023	
Copper	mg/L	-	see below	1.5	0.09	0.0048	0.0034	0.0072	
Iron	mg/L	0.3	0.35	6.5	-	**1.84**	0.03	0.19	
Lead	mg/L	0.005	0.004	0.01	0.04	***0.0149***	0.00047	0.00136	
Manganese	mg/L	0.02	0.74	1.5	-	**0.156**	<0.001	0.009	
Mercury	µg/L	1	0.02	1	0.25	0.05	0.03	0.01	
Vanadium	mg/L	-	-	0.02	-	0.0056	0.0131	0.0152	
Zinc	mg/L	5	0.0075	3	0.075	0.039	<0.002	0.006	
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.616	0.834	0.952	
Ammonia Nitrogen	mg/L as N	-	1.8	-	1.31	0.01	0.06	0.03	
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	18	45	<10	
Total Organic Carbon	mg/L as O	-	-	-	-	5.7	5.1	2.3	
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L			-	-	-	1.8	4.3	
Dissolved Copper	mg/L	-		-	-	0.0048	0.0034	0.0072	
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.09	-	0.0002	0.0182	

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-7 to B-13.xlsx]Table B-11 MW94-6D

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 30 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 30 mg/L-CaCO3 and pH of 7.5 to 8.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-12

INORGANIC CHEMISTRY DATA FOR MW98-9

SAMPLE DATE		RECEIVING WATER CRITERIA				20-Feb-20	19-May-20	18-Aug-20	21-Oct-20
LAB NAME	units	GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.73**	**6.68**	**6.5**	**6.25**
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.62	**6.69**	**6.89**	**6.39**
EC-Field	µS/cm	-	-	-	-	138	184	230	220
EC-Lab	µS/cm	-	-	-	-	204	271	211	220
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	91.1	135	72.5	104
Total Dissolved Solids	mg/L	500	-	-	-	130	155	132	118
Temperature-Field	°C	-	-	-	-	9.71	10.66	13.4	13.3
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-	-	-	100	135	99	80
Chloride	mg/L	250	150	250	1500	1.04	4.75	3.86	13.7
Sulphate	mg/L	500	309	500	1280	2	2	1.7	3
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	23	33.6	19.9	26.6
Magnesium	mg/L	-	-	-	-	8.17	12.3	5.54	9.07
Potassium	mg/L	-	-	-	-	0.19	0.78	0.27	0.21
Sodium	mg/L	200	-	200	-	3.75	4.61	4.26	5.17
ION BALANCE									
Ion Balance	%	-	-	-	-	93	100	77	-
DISSOLVED METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	<0.002	0.027	<0.002	<0.002
Arsenic	mg/L	0.01	0.005	0.01	0.05	0.0021	0.0012	<0.0001	0.0008
Barium	mg/L	2	1	1	10	0.0039	0.0101	0.0033	0.0048
Boron	mg/L	5	1.2	5	12	0.036	0.037	0.042	0.041
Cadmium	mg/L	0.007	0.00021	0.005	0.0005	<0.00001	0.00002	0.00002	<0.00001
Chromium	mg/L	0.05	0.001	0.05	0.01	0.001	0.0008	<0.0005	0.0012
Cobalt	mg/L	-	0.004	0.001	0.04	<0.00005	<0.00005	<0.00005	<0.00005
Copper	mg/L	-	see below	1.5	0.09	<0.0002	0.0012	0.0005	0.0005
Iron	mg/L	0.3	0.35	6.5	-	0.06	0.03	0.22	<0.01
Lead	mg/L	0.005	0.006	0.01	0.04	<0.00005	0.00011	0.00009	0.00009
Manganese	mg/L	0.02	1.05	1.5	-	0.001	0.006	0.012	0.015
Mercury	µg/L	1	0.02	1	0.25	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.02	-	0.0024	0.0033	<0.0005	0.0011
Zinc	mg/L	5	0.015	3	0.075	<0.002	0.003	0.002	<0.002
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.935	0.63	0.052	0.162
Ammonia Nitrogen	mg/L as N	-	1.81	-	18.4	0.04	0.09	<0.01	<0.01
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	51	39	<10	<10
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	1.2	3.5	0.8
Dissolved Copper	mg/L	-	-	-	-	<0.0002	0.0012	0.0005	0.0005
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.09	-	0.0002	0.0002	0.0002

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-7 to B-13.xlsx]Table B-12 MW98-9

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 100 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 100 mg/L-CaCO3 and pH < 7.0.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-13

INORGANIC CHEMISTRY DATA FOR MW98-10

SAMPLE DATE		RECEIVING WATER CRITERIA				20-Feb-20	19-May-20	17-Aug-20	15-Oct-20
LAB NAME	units	GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.25	**6.67**		**6.1**
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.89**	**6.39**		**6.69**
EC-Field	µS/cm	-	-	-	-	53	54	dry	70
EC-Lab	µS/cm	-	-	-	-	72	75		76
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	26.9	31.9		25
Total Dissolved Solids	mg/L	500	-	-	-	75	68		75
Temperature-Field	°C	-	-	-	-	8.09	10.48		13.3
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-	-	-	31	47		30
Chloride	mg/L	250	150	250	1500	1.18	0.81		0.7
Sulphate	mg/L	500	128	500	1280	2.1	2.2		2.2
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	7.3	8.13		6.79
Magnesium	mg/L	-	-	-	-	2.1	2.82		1.96
Potassium	mg/L	-	-	-	-	0.11	0.34		<0.05
Sodium	mg/L	200	-	200	-	6.27	4.46		4.86
ION BALANCE									
Ion Balance	%	-	-	-	-	115	82		-
DISSOLVED METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	<0.002	<0.002		<0.002
Arsenic	mg/L	0.01	0.005	0.01	0.05	0.0003	0.0002		0.0004
Barium	mg/L	2	1	1	10	0.0008	0.0026		<0.0002
Boron	mg/L	5	1.2	5	12	0.08	0.024		0.034
Cadmium	mg/L	0.007	0.00009	0.005	0.0005	<0.00001	0.00002		<0.00001
Chromium	mg/L	0.05	0.001	0.05	0.01	0.0016	0.0016		0.0019
Cobalt	mg/L	-	0.004	0.001	0.04	<0.00005	<0.00005		<0.00005
Copper	mg/L	-	see below	1.5	0.09	0.0003	0.0005		0.0003
Iron	mg/L	0.3	0.35	6.5	-	0.03	<0.01		<0.01
Lead	mg/L	0.005	0.004	0.01	0.04	<0.00005	<0.00005		0.00017
Manganese	mg/L	0.02	0.74	1.5	-	0.001	0.002		<0.001
Mercury	µg/L	1	0.02	1	0.25	<0.01	<0.01		<0.01
Vanadium	mg/L	-	-	0.02	-	0.0022	0.0033		0.0025
Zinc	mg/L	5	0.0075	3	0.075	<0.002	0.003		<0.002
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.139	0.206		1.15
Ammonia Nitrogen	mg/L as N	-	1.8	-	18.4	<0.01	0.04		<0.01
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	17	26		<10
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	0.7		3.4
Dissolved Copper	mg/L	-	-	-	-	0.0003	0.0005		0.0003
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.09	-	0.0002		0.0002

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-7 to B-13.xlsx]Table B-13 MW98-10

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
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   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 30 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 30 mg/L-CaCO3 and pH < 7.0.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-14

INORGANIC CHEMISTRY DATA FOR MW02-1D

SAMPLE DATE		RECEIVING WATER CRITERIA				20-Feb-20	19-May-20	17-Aug-20	15-Oct-20
LAB NAME	units	GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.29	8.87	9.74	9.92
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.61**	8.5	9.52	9.63
EC-Field	µS/cm	-	-	-	-	89	981	420	400
EC-Lab	µS/cm	-	-	-	-	32	270	340	340
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	9.8	5.1	3.7	1.1
Total Dissolved Solids	mg/L	500	-	-	-	18	170	212	210
Temperature-Field	°C	-	-	-	-	6.75	11.96	18	9.6
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-	-	-	12	134	151	155
Chloride	mg/L	250	150	250	1500	1.66	5.51	7.74	7.57
Sulphate	mg/L	500	128	500	1280	0.9	5.8	6.5	5.9
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	2.59	1.57	0.76	0.44
Magnesium	mg/L	-	-	-	-	0.8	0.29	0.44	<0.05
Potassium	mg/L	-	-	-	-	0.23	0.4	0.51	0.31
Sodium	mg/L	200	-	200	-	1.77	56	76.4	73.4
ION BALANCE									
Ion Balance	%	-	-	-	-	90	86	101	102
DISSOLVED METALS									
Aluminum	mg/L	0.10	0.050	-	9.5	<0.002	0.033	**0.559**	<0.002
Arsenic	mg/L	0.01	0.005	0.01	0.05	<0.0001	***0.0116***	***0.0159***	***0.0142***
Barium	mg/L	2	1	1	10	0.0017	0.0023	0.0072	0.0014
Boron	mg/L	5	1	5	12	0.045	1.87	2.44	2.54
Cadmium	mg/L	0.007	0.00009	0.005	0.0015	<0.00001	0.00008	0.00002	<0.00001
Chromium	mg/L	0.05	0.001	0.05	0.01	<0.0005	<0.0005	0.0008	<0.0005
Cobalt	mg/L	-	0.004	0.001	0.04	<0.00005	0.00011	0.00041	<0.00005
Copper	mg/L	1	see below	1.5	0.09	0.0017	0.0009	0.0028	<0.0002
Iron	mg/L	0.3	0.35	6.5	-	0.02	0.02	**0.95**	<0.01
Lead	mg/L	0.005	0.004	0.01	0.04	<0.00005	0.00008	0.00046	0.0002
Manganese	mg/L	0.02	0.74	1.5	-	0.006	0.003	**0.026**	0.002
Mercury	µg/L	1	0.02	1	0.25	<0.01	0.02	<0.01	<0.01
Vanadium	mg/L	-	-	0.02	-	<0.0005	0.0007	0.001	<0.0005
Zinc	mg/L	5	0.0075	3	0.075	<0.002	<0.002	0.004	<0.002
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.029	0.288	0.023	0.006
Ammonia Nitrogen	mg/L as N	-	1.8	-	1.31	<0.01	0.21	0.28	0.26
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	<10	34	<10	<10
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	0.8	1.3	<0.5
Dissolved Copper	mg/L	-	-	-	-	0.0017	0.0009	0.0028	<0.0002
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.09	-	0.0024	0.0056	0.0018

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-14 to B-23.xlsx]Table B-14 MW02-1D

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 30 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 30 mg/L-CaCO3 and pH > 8.5.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-15

INORGANIC CHEMISTRY DATA FOR MW02-4

SAMPLE DATE / LAB NAME	units	RECEIVING WATER CRITERIA				20-Feb-20 AGAT	19-May-20 AGAT	17-Aug-20 AGAT	15-Oct-20 AGAT
		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]				
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.4**	**6.59**	7.59	7.83
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.65	7.23	7.65	7.99
EC-Field	µS/cm	-	-	-	-	375	457	660	740
EC-Lab	µS/cm	-	-	-	-	560	651	631	718
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	131	204	111	87.8
Total Dissolved Solids	mg/L	500	-	-	-	318	**502**	370	428
Temperature-Field	°C	-	-	-	-	7.7	11.71	15.3	10.6
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-	-	-	130	119	125	125
Chloride	mg/L	250	150	250	1500	83.3	120	97	100
Sulphate	mg/L	500	309	500	3090	17.8	15.1	29.4	65.2
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	43.3	67.4	36.2	27.7
Magnesium	mg/L	-	-	-	-	5.45	8.57	5.04	4.52
Potassium	mg/L	-	-	-	-	0.74	0.36	1.15	1
Sodium	mg/L	200	-	200	-	54.1	34.9	74.7	106
ION BALANCE									
Ion Balance	%	-	-	-	-	94	92	94	-
DISSOLVED METALS									
Aluminum	mg/L	0.10	0.050	-	9.5	<0.002	0.005	<0.002	0.01
Arsenic	mg/L	0.01	0.005	0.01	0.05	0.0009	0.0005	0.0068	***0.013***
Barium	mg/L	2	1	1	10	0.0224	0.0207	0.025	0.0173
Boron	mg/L	5	1	5	12	0.645	0.334	0.524	0.649
Cadmium	mg/L	0.007	0.0003	0.005	0.0035	<0.00001	0.00002	<0.00001	<0.00001
Chromium	mg/L	0.05	0.001	0.05	0.01	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.004	0.001	0.04	<0.00005	<0.00005	<0.00005	<0.00005
Copper	mg/L	1	see below	1.5	0.09	0.0005	0.0004	0.0004	0.0002
Iron	mg/L	0.3	0.35	6.5	-	<0.01	<0.01	<0.01	<0.01
Lead	mg/L	0.01	0.009	0.01	0.06	<0.00005	<0.00005	<0.00005	0.00094
Manganese	mg/L	0.02	1.3	1.5	-	0.002	0.01	<0.001	<0.001
Mercury	µg/L	1	0.02	1	0.25	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.02	-	<0.0005	0.0007	0.0033	0.0039
Zinc	mg/L	5	0.06	3	0.9	0.005	<0.002	<0.002	<0.002
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.037	0.157	0.101	0.317
Ammonia Nitrogen	mg/L as N	-	1.8	-	18.5	<0.01	0.03	<0.01	0.03
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	<10	<10	<10	<10
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	<0.5	0.8	<0.5
Dissolved Copper	mg/L	-	-	-	-	0.0005	0.0004	0.0004	0.0002
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.09	-	0.0002	0.0004	0.0004

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-14 to B-23.xlsx]Table B-15 MW02-4

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 160 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 160 mg/L-CaCO3 and pH of 7.0 to 7.5.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-16

INORGANIC CHEMISTRY DATA FOR MW05-1

LOCATION	units	RECEIVING WATER CRITERIA				MW05-1S	MW05-1S	MW05-1S	MW05-1S
SAMPLE DATE						20-Feb-20	20-May-20	19-Aug-20	19-Oct-20
LAB NAME		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	DRINKING WATER (CSR)[3]	AQUATIC LIFE (CSR)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7	7.63	**6.71**	**6.64**
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.22	**6.65**	7.2	**6.85**
EC-Field	µS/cm	-	-	-	-	292	267	370	350
EC-Lab	µS/cm	-	-	-	-	394	360	360	341
Total Dissolved Solids	mg/L	500	-	-	-	222	190	220	208
Temperature-Field	°C	-	-	-	-	10.27	12.28	13.8	11
DISSOLVED ANIONS									
Alkalinity	mg/L $CaCO_3$	-	-			-	-	154	-
Bicarbonate	mg/L $CaCO_3$					-	-	-	-
Chloride	mg/L	250	150	250	1500	8.13	4.94	5.29	4.72
Sulphate	mg/L	500	128	500	1280	18.3	16.7	17.3	16.9
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.053	2.27	1.5	1.61
Ammonia Nitrogen	mg/L as N	-	1.8	-	18.5	<0.01	0.03	<0.01	<0.01

LOCATION	units	RECEIVING WATER CRITERIA				MW05-1D	MW05-1D	MW05-1D	MW05-1D
SAMPLE DATE						20-Feb-20	19-May-20	19-Aug-20	19-Oct-20
LAB NAME		GCDWQ[1]	AQUATIC LIFE[2]	DRINKING WATER (CSR)[3]	AQUATIC LIFE (CSR)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.84**	**6.93**	**6.91**	**6.94**
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.95	7.43	7.44	7.13
EC-Field	µS/cm	-	-	-	-	521	634	910	880
EC-Lab	µS/cm	-	-	-	-	782	823	856	856
Total Dissolved Solids	mg/L	500	-	-	-	450	488	**522**	**505**
Temperature-Field	°C	-	-	-	-	9.25	13.71	12.3	10.3
DISSOLVED ANIONS									
Chloride	mg/L	250	150	250	1500	31.1	27.9	30.5	31.1
Sulphate	mg/L	500	128	500	1280	10.4	10.9	10.8	9.6
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.265	<0.005	<0.005	<0.005
Ammonia Nitrogen	mg/L as N	-	1.8	-	18.5	0.1	0.2	0.27	0.3

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-14 to B-23.xlsx]Table B-16 MW05-1

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 30 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 30 mg/L-CaCO3 and pH of 7.0 to 7.5.

TABLE B-17

SUMMARY OF INORGANIC CHEMISTRY DATA FOR PW-1

LOCATION		RECEIVING WATER CRITERIA				PW-1	PW-1	PW-1	PW-1
SAMPLE DATE	units	GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	20-Feb-20	20-May-20	20-Aug-20	21-Oct-20
LAB NAME						AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.26	7.01	**6.9**	**6.88**
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.43	7.11	7.42	7.17
EC-Field	µS/cm	-	-	-	-	724	655	960	990
EC-Lab	µS/cm	-	-	-	-	996	880	943	965
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	-	362	375	433
Total Dissolved Solids	mg/L	500	-	-	-	**568**	480	**562**	**538**
Temperature-Field	°C	-	-	-	-	11.37	11.59	13.4	12
DISSOLVED ANIONS									
Alkalinity		-	-	-	-	-	400	446	444
Chloride	mg/L	250	150	250	1500	45.2	42.2	44	46
Sulphate	mg/L	500	309	500	3090	9.2	11.3	10.3	10
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	-	106	108	124
Magnesium	mg/L	-	-	-	-	-	23.7	25.6	29.9
Potassium	mg/L	-	-	-	-	-	1.68	1.69	2.05
Sodium	mg/L	200	-	200	-	-	44.9	46.9	53.5
ION BALANCE									
Ion Balance	%	-	-	-	-	-	98	92	-
DISSOLVED METALS									
Aluminum	mg/L	0.10	0.050	-	9.5	-	<0.002	<0.002	<0.002
Arsenic	mg/L	0.01	0.005	0.01	0.05	-	0.0017	0.0022	0.0027
Barium	mg/L	2	1	1	10	-	0.188	0.196	0.198
Boron	mg/L	5	1	5	12	-	0.618	0.779	0.577
Cadmium	mg/L	0.01	0.001	0.005	0.004	-	0.00005	<0.00001	0.00002
Chromium	mg/L	0.05	0.001	0.05	0.01	-	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.004	0.001	0.04	-	*0.00188*	*0.00245*	*0.00251*
Copper	mg/L	1	see below	1.5	0.09	-	0.0026	0.0028	0.0022
Iron	mg/L	0.30	0.35	6.5	-	-	0.17	0.19	0.27
Lead	mg/L	0.01	0.02	0.01	0.16	-	<0.00005	<0.00005	<0.00005
Manganese	mg/L	0.02	2.32	1.5	-	-	***2.05***	***2.34***	***2.54***
Mercury	mg/L	1	0.02	1	0.25	-	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.02	-	-	0.0012	<0.0005	0.0005
Zinc	mg/L	5	0.23	3	2.4	-	<0.002	<0.002	0.003
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.017	0.007	<0.005	<0.005
Ammonia Nitrogen	mg/L as N	-	1.8	-	18.50	1	1.52	1.04	1.2
POLLUTANT TESTS									
Chemical Oxygen Demand		-	-			-	23	18	16
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	4.7	5.7	6.3
Dissolved Copper	mg/L	-	-	-	-	-	0.0026	0.0028	0.0022
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.1	-	0.0013	0.0013	0.0014

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-14 to B-23.xlsx]Table B-17 PW-1

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 390 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 390 mg/L-CaCO3 and pH of 7.0 to 7.5.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-18

INORGANIC CHEMISTRY DATA FOR PW-2

LOCATION SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA				PW-2 20-Feb-20 AGAT	PW-2 20-May-20 AGAT	PW-2 20-Aug-20 AGAT	PW-2 21-Oct-20 AGAT
		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]				
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.48**	**6.7**	**6.69**	**6.7**
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	**6.92**	**6.99**	**6.75**	**6.81**
EC-Field	µS/cm	-	-	-	-	2241	1130	13600	1900
EC-Lab	µS/cm	-	-	-	-	3040	1590	3240	1800
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	-	401	828	509
Total Dissolved Solids	mg/L	500	-	-	-	**1520**	**750**	**1670**	**878**
Temperature-Field	°C	-	-	-	-	11.71	11.5	13.5	13.2
DISSOLVED ANIONS									
Alkalinity			-	-	-	-	606	1271	717
Chloride	mg/L	250	150	250	1500	245	96.3	***313***	136
Sulphate	mg/L	500	309	500	3090	0.9	9.3	<5	11.2
DISSOLVED CATIONS									
Calcium	mg/L	-	-	-	-	-	123	248	151
Magnesium	mg/L	-	-	-	-	-	22.9	50.6	32
Potassium	mg/L	-	-	-	-	-	21.4	44.1	23.1
Sodium	mg/L	200	-	200	-	-	98.4	***222***	128
ION BALANCE									
Ion Balance	%	-	-	-	-	-	85	80	-
DISSOLVED METALS									
Aluminum	mg/L	0.10	0.050	-	9.5	-	0.002	0.003	<0.002
Arsenic	mg/L	0.01	0.005	0.01	0.05	-	0.0068	0.0074	0.0067
Barium	mg/L	2	1	1	10	-	0.0968	0.221	0.101
Boron	mg/L	5	1	5	12	-	0.824	1.49	0.869
Cadmium	mg/L	0.01	0.0006	0.005	0.004	-	0.00001	0.00002	<0.00001
Chromium	mg/L	0.05	0.001	0.05	0.01	-	0.001	0.0018	0.0009
Cobalt	mg/L	-	0.004	0.001	0.04	-	*0.0047*	*0.00571*	*0.0052*
Copper	mg/L	1	see below	1.5	0.09	-	0.0007	<0.0002	0.0003
Iron	mg/L	0.30	0.35	6.5	-	-	***18.6***	***49.5***	***16.9***
Lead	mg/L	0.01	0.02	0.01	0.16	-	<0.00005	<0.00005	<0.00005
Manganese	mg/L	0.02	2.37	1.5	-	-	***4.89***	***6.55***	***5.27***
Mercury	mg/L	1	0.02	1	0.25	-	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.02	-	-	0.0037	0.0038	0.0018
Zinc	mg/L	5	0.24	3	2.4	-	<0.002	0.004	0.003
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	<0.005	0.006	<0.05	0.113
Ammonia Nitrogen	mg/L as N	-	1.8	-	18.4	88	0.2	96.1	49
POLLUTANT TESTS									
Chemical Oxygen Demand		-	-	-	-	-	80	193	94
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	21.7	51.4	24.1
Dissolved Copper	mg/L	-	-	-	-	-	0.0007	<0.0002	0.0003
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.1	-	0.0042	0.0039	0.004

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-14 to B-23.xlsx]Table B-18 PW-2

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 400 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 400 mg/L-CaCO3 and pH < 7.0.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-19

INORGANIC CHEMISTRY DATA FOR MW13-1D

SAMPLE DATE		RECEIVING WATER CRITERIA				24-Aug-20
LAB NAME	units	GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT
PHYSICAL TESTS						
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.77
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	8.03
EC-Field	µS/cm	-	-	-	-	620
EC-Lab	µS/cm	-	-	-	-	586
Dissolved Hardness ($CaCO_3$)	mg/L	-	-	-	-	61.3
Total Dissolved Solids	mg/L	500	-	-	-	370
Temperature-Field	°C	-	-	-	-	14.9
DISSOLVED ANIONS						
Alkalinity	mg/L $CaCO_3$	-	-	-	-	155
Chloride	mg/L	250	150	250	1500	81.4
Sulphate	mg/L	500	309	500	3090	5.4
DISSOLVED CATIONS						
Calcium	mg/L	-	-	-	-	20.7
Magnesium	mg/L	-	-	-	-	2.33
Potassium	mg/L	-	-	-	-	0.81
Sodium	mg/L	200	-	200	-	100
ION BALANCE						
Ion Balance	%	-	-	-	-	102
DISSOLVED METALS						
Aluminum	mg/L	0.10	0.050	-	9.5	0.01
Arsenic	mg/L	0.01	0.005	0.01	0.05	0.0035
Barium	mg/L	2	1	1	10	0.074
Boron	mg/L	5	1	5	12	0.194
Cadmium	mg/L	0.007	0.00021	0.005	0.0025	0.00001
Chromium	mg/L	0.05	0.001	0.05	0.01	<0.0005
Cobalt	mg/L	-	0.004	0.001	0.04	0.0003
Copper	mg/L	1	see below	1.5	0.04	<0.0002
Iron	mg/L	0.3	0.35	6.5	-	**<u>0.49</u>**
Lead	mg/L	0.005	0.006	0.01	0.05	<0.00005
Manganese	mg/L	0.02	1.045	1.5	-	**0.731**
Mercury	µg/L	1	0.02	1	0.25	<0.01
Vanadium	mg/L	-	-	0.02	-	<0.0005
Zinc	mg/L	5	0.015	3	0.15	<0.002
NUTRIENTS						
Nitrate	mg/L as N	10	3	10	400	<0.005
Ammonia Nitrogen	mg/L as N	-	1.84	-	11.3	0.09
POLLUTANT TESTS						
Chemical Oxygen Demand	mg/L as O	-	-	-	-	63
DISSOLVED COPPER ASSESSMENT						
Dissolved Organic Carbon	mg/L	-	-	-	-	13.8
Dissolved Copper	mg/L	-	-	-	-	<0.0002
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.04	0.0085

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-14 to B-23.xlsx]Table B-19 MW13-1D

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. <u>Underline</u> denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 100 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 100 mg/L-CaCO3 and pH of 7.5 to 8.0.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-20

INORGANIC CHEMISTRY DATA FOR MW13-1S AND MW13-2S

LOCATION		RECEIVING WATER CRITERIA				MW13-1S	MW13-1S	MW13-1S	MW13-1S
SAMPLE DATE						20-Feb-20	20-May-20	24-Aug-20	20-Oct-20
LAB NAME	units	GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	8.27	7.21	8.52	8.72
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	8.23	7.11	8.26	7.96
EC-Field	µS/cm	-	-	-	-	416	424	520	510
EC-Lab	µS/cm	-	-	-	-	580	588	497	495
Total Dissolved Solids	mg/L	500	-	-	-	408	368	320	315
Temperature-Field	°C	-	-	-	-	8.81	13.02	13.8	12.5
DISSOLVED ANIONS									
Chloride	mg/L	250	150	250	1500	42.6	42.2	44.6	46.4
Sulphate	mg/L	500	218	500	2180	21.4	21.3	16.1	16.1
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	<0.005	<0.005	<0.005	<0.005
Ammonia Nitrogen	mg/L as N	-	1.84	-	11.3	0.07	0.05	0.08	0.07

LOCATION		RECEIVING WATER CRITERIA				MW13-2S	MW13-2S	MW13-2S	MW13-2S
SAMPLE DATE						20-Feb-20	20-May-20	24-Aug-20	20-Oct-20
LAB NAME	units	GCDWQ[1]	AQUATIC LIFE[2]	CSR DRINKING WATER (AW)[3]	CSR AQUATIC LIFE (AW)[3]	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	8.05	7.33	7.69	7.77
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.69	**6.74**	8.15	7.24
EC-Field	µS/cm	-	-	-	-	81	495	660	130
EC-Lab	µS/cm	-	-	-	-	92	136	635	140
Total Dissolved Solids	mg/L	500	-	-	-	60	50	470	92
Temperature-Field	°C	-	-	-	-	9.27	13.42	13.7	13.7
DISSOLVED ANIONS									
Chloride	mg/L	250	150	250	1500	0.61	0.78	8.68	0.83
Sulphate	mg/L	500	218	500	2180	1.3	3.2	14.7	0.6
NUTRIENTS									
Nitrate	mg/L as N	10	3.0	10	400	0.07	0.158	<0.005	<0.005
Ammonia Nitrogen	mg/L as N	-	1.84	-	11.3	0.03	0.03	0.06	<0.01

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-14 to B-23.xlsx]Table B-20 MW13-1S-2S

NOTES:

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1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
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   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 60 mg/L, 10˚ C and a pH of 7.0.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 60 mg/L-CaCO3 and pH of 7.5 to 8.0.

TABLE B-21
INORGANIC CHEMISTRY DATA FOR HEATH CREEK

SAMPLE DATE / LAB NAME	units	RECEIVING WATER CRITERIA				20-Feb-20 AGAT	19-May-20 AGAT	17-Aug-20 AGAT	15-Oct-20 AGAT
		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]				
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	8.27	7.13	8.17	7.37
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.3	**6.66**	7.31	7.6
EC-Field	µS/cm	-	-	-	-	106	53	70	70
EC-Lab	µS/cm	-	-	-	-	62	67	75	72
Total Hardness (CaCO3)	mg/L	-	-	-	-	21	26	31	35
Temperature-Field	°C	-	-	-	-	4.11	14.05	21.4	11.5
DISSOLVED ANIONS									
Alkalinity	mg CaCO3/L	-	-	-	-	-	43	33	29
Chloride	mg/L	250	150	250	1500	6.27	3.95	2.4	3.33
Sulphate	mg/L	500	128	500	1280	0.8	0.8	0.7	0.6
TOTAL METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	0.043	0.087	0.027	0.064
Cadmium	mg/L	0.005	0.00009	0.005	0.0005	<0.00001	0.00002	0.00001	<0.00001
Copper	mg/L	1	-	1.5	0.02	<0.0005	0.0012	0.0011	0.001
Chromium	mg/L	0.05	0.01	50	0.01	<0.0005	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.3	1	6.5	-	0.11	0.18	0.06	**0.53**
Manganese	mg/L	0.02	0.74	1.5	-	0.007	0.006	0.007	0.007
Zinc	mg/L	5	0.0075	3	75	<0.005	<0.005	<0.005	<0.005
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.071	0.036	0.165	0.035
Ammonia Nitrogen	mg/L as N	-	1.8	-	11.3	<0.01	0.03	<0.01	0.01
Total Phosphorus	mg/L as P	-	0.005	-	-	-	0.01	0.006	<0.005
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	<10	<10	<10	<10
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	1.5	4	2.6
Dissolved Copper	mg/L	-	-	-	-	-	0.0003	-	0.0005
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.1	-	0.0002	0.0022	0.0006

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-14 to B-23.xlsx]Table B-21 HeathCrk

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 30 mg/L, 10˚ C and a pH of 7.0.

   Phosphorus FWAL guideline for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May to September results compared against stringent guideline of 0.005 mg/L.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 30 mg/L-CaCO3 and pH of 7.0 to 7.5. AW guidelines assume minimum 1:10 dilution is available. As such, samples from creeks are compared against CSR AW standards/10.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-22

INORGANIC CHEMISTRY DATA FOR STEVENS CREEK

SAMPLE DATE / LAB NAME	units	RECEIVING WATER CRITERIA				20-Feb-20 AGAT	19-May-20 AGAT	18-Aug-20 AGAT	22-Oct-20 AGAT
		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]				
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.93	**6.36**		7.49
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.48	**6.97**		7.15
EC-Field	µS/cm	-	-	-	-	82	125	dry	140
EC-Lab	µS/cm	-	-	-	-	114	159		132
Total Hardness (CaCO3)	mg/L	-	-	-	-	51	68		62
Temperature-Field	°C	-	-	-	-	5.24	11.94		7.8
DISSOLVED ANIONS									
Alkalinity	mg CaCO3/L	-	-	-	-	-	80		57
Chloride	mg/L	250	150	250	1500	3.11	3.03		4.13
Sulphate	mg/L	500	218	500	2180	1	0.8		1.1
TOTAL METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	0.052	0.023		**0.126**
Cadmium	mg/L	0.005	0.00015	0.005	0.0015	<0.00001	0.00004		<0.00001
Chromium	mg/L	0.05	0.001	0.05	0.01	<0.0005	<0.0005		<0.0005
Copper	mg/L	1	-	1.5	0.03	<0.0005	0.0033		0.0024
Iron	mg/L	0.3	1	6.5	-	0.19	0.04		0.27
Manganese	mg/L	0.02	0.87	1.5	-	**0.065**	**0.033**		**0.413**
Zinc	mg/L	5	0.0075	3	0.075	<0.005	<0.005		<0.005
NUTRIENTS									
Nitrate	mg/L as N	10	3	10	400	0.228	0.043		0.04
Ammonia Nitrogen	mg/L as N	-	1.84	-	18.5	<0.01	0.03		0.05
Total Phosphorus	mg/L as P	-	0.005	-	-	-	0.06		0.008
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	<10	<10		<10
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	1.2		1.4
Dissolved Copper	mg/L	-	-	-	-	-	<0.0002		0.001
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.02	-	0.0002		0.0005

H:\Project\1005\Analysis\Chemistry\2020\[Tables_B-14 to B-23.xlsx]Table B-22 StevensCrk

NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

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2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. Available: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
   Aquatic life guidelines for cadmium (dissolved), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Ammonia guidelines vary with hardness, temperature, and pH. Values are based on average hardness of 60 mg/L, 10˚ C and a pH of 7.0.
   Phosphorus FWAL guideline for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May to September results compared against stringent guideline of 0.005 mg/L.
3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 60 mg/L-CaCO3 and pH of 7.0 to 7.5. AW guidelines assume minimum 1:10 dilution is available. As such, samples from creeks are compared against CSR AW standards/10.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

TABLE B-23
INORGANIC CHEMISTRY DATA FOR CHRISTIE CREEK

DOWNSTREAM SAMPLING SITE

SAMPLE DATE / LAB NAME	units	RECEIVING WATER CRITERIA				20-Feb-20 AGAT	20-May-20 AGAT	20-Aug-20 AGAT	21-Oct-20 AGAT
		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]				
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.5	7.21		7.02
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.22	**6.52**		**6.77**
EC-Field	µS/cm	-	-	-	-	45	82	dry	90
EC-Lab	µS/cm	-	-	-	-	57	83		82
Total Hardness ($CaCO_3$)	mg/L	-	-	-	-	26	37		40
Temperature-Field	°C	-	-	-	-	5.66	13.28		11.3
DISSOLVED ANIONS									
Alkalinity	mg CaCO3/L	-	-	-	-	-	42		36
Chloride	mg/L	250	150	250	1500	0.97	1.21		2.59
Sulphate	mg/L	500	128	500	1280	1.2	0.5		1.9
TOTAL METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	0.081	**0.189**		**0.252**
Cadmium	mg/L	0.005	0.00009	0.005	0.005	<0.00001	0.00002		0.00003
Chromium	mg/L	0.05	0.01	0.05	0.01	<0.0005	0.0008		<0.0005
Copper	mg/L	1	-	1.5	0.02	0.001	0.0021		0.0038
Iron	mg/L	0.3	1	6.5	-	0.09	**1.16**		**0.63**
Manganese	mg/L	0.02	0.74	1.5	-	0.016	**0.136**		**0.021**
Zinc	mg/L	5	0.0075	3	0.075	0.029	0.011		0.015
NUTRIENTS									
Nitrate	mg/L as N	10	3.0	10	400	0.044	0.005		<0.005
Ammonia Nitrogen	mg/L as N	-	1.84	-	18.5	<0.01	0.05		0.06
Total Phosphorus	mg/L as P	-	0.005	-	-	-	0.04		0.017
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	<10	10		23
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	3.2		3.5
Dissolved Copper	mg/L	-	-	-	-	-	0.0014		0.0023
Dissolved Copper Guidelines	mg/L	1	-	1.5	0.02	-	0.0006		0.0005

UPSTREAM SAMPLING SITE

SAMPLE DATE / LAB NAME	units	RECEIVING WATER CRITERIA				20-Feb-20 AGAT	19-May-20 AGAT	17-Aug-20 AGAT	15-Oct-20 AGAT
		GCDWQ[1]	AQUATIC LIFE (FWAL)[2]	CSR DRINKING WATER (DW)[3]	CSR AQUATIC LIFE (AW)[3]				
PHYSICAL TESTS									
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.05	8.32		**6.65**
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.27	**6.35**		7.24
EC-Field	µS/cm	-	-	-	-	44	81	dry	70
EC-Lab	µS/cm	-	-	-	-	65	71		73
Total Hardness ($CaCO_3$)	mg/L	-	-	-	-	29	32		34
Temperature-Field	°C	-	-	-	-	4.8	14.29		11.1
DISSOLVED ANIONS									
Alkalinity	mg CaCO3/L	-	-	-	-	-	40		30
Chloride	mg/L	250	150	250	1500	1.5	1		1.39
Sulphate	mg/L	500	128	500	1280	1	0.7		2.3
TOTAL METALS									
Aluminum	mg/L	0.1	0.05	-	9.5	**0.225**	0.057		0.086
Cadmium	mg/L	0.005	0.00009	0.005	0.005	<0.00001	0.00001		<0.00001
Chromium	mg/L	0.05	0.010	0.05	0.01	0.0006	<0.0005		0.0005
Copper	mg/L	1	-	1.5	0.02	0.0011	0.0025		0.0025
Iron	mg/L	0.3	1	6.5	-	**0.69**	0.14		0.15
Manganese	mg/L	0.02	0.74	1.5	-	**0.113**	0.017		0.005
Zinc	mg/L	5	0.0075	3	0.075	0.023	0.022		0.032
NUTRIENTS									
Nitrate	mg/L as N	10	3.0	10	400	0.023	0.016		0.114
Ammonia Nitrogen	mg/L as N	-	1.84	-	18.5	0.01	0.02		0.01
Total Phosphorus	mg/L as P	-	0.005	-	-	-	0.01		0.006
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	-	<10	<10		<10
DISSOLVED COPPER ASSESSMENT									
Dissolved Organic Carbon	mg/L	-	-	-	-	-	2.3		4.1
Dissolved Copper	mg/L	-	-	-	-	-	0.0026		0.0024
Dissolved Copper Guideline[4]	mg/L	-	varies	1.5	0.02	-	0.0011		0.0003

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NOTES:

Bold denotes parameters which exceed GCDWQ water quality criteria. Underline denotes parameters which exceed BC FWAL criteria. FWAL criterion for arsenic not considered relevant for groundwater. *Italics* denotes parameters which exceed BC CSR DW criteria. Yellow highlight denotes parameters which exceed BC CSR AW criteria. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

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3. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), effective February 1, 2021. Available: https://www.bclaws.gov.bc.ca/civix/document/id/lc/bcgaz2/131-2020_Schedule3.2. CSR AW guidelines for cadmium, copper, lead, and zinc are based on total hardness, which varies between samples. Likewise, CSR AW ammonia guidelines vary with pH. Value shown appropriate for hardness of 30 mg/L-CaCO3 and pH of 7.0 to 7.5. AW guidelines assume minimum 1:10 dilution is available. As such, samples from creeks are compared against CSR AW standards/10.
4. Dissolved copper FWAL guideline is calculated for each sampling event using BC BLM software.

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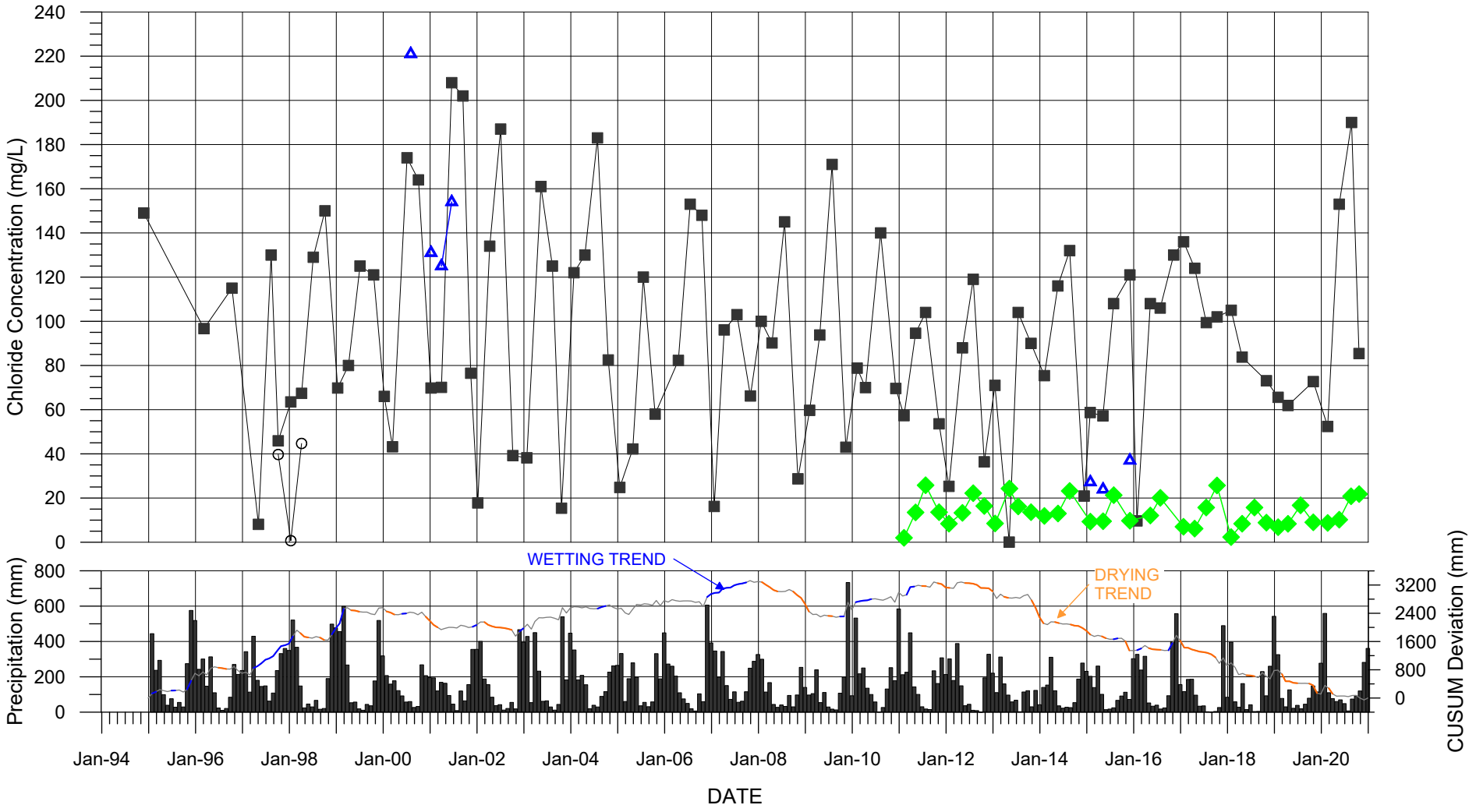

- Leachate Drain
- Surge Lagoon Outlet
- BH00-1C (Landfill Well)
- South Expansion Leachate Drain

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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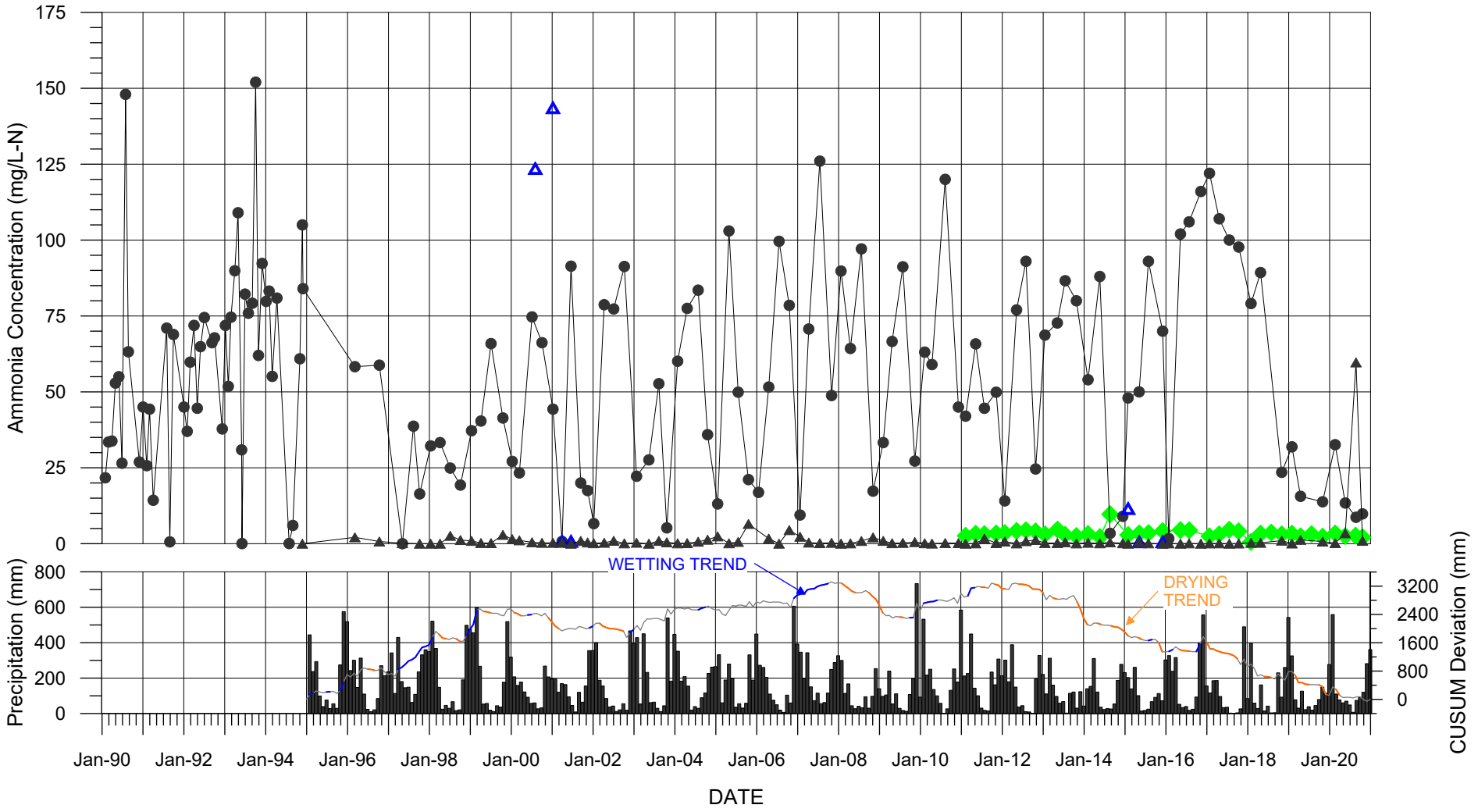
CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR LEACHATE

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-1

H:\Project\1005\Analysis\Chemistry\2020\2-LAGIN_N.GRF



- Leachate Drain
- Leachate Drain (Nitrate)
- BH00-1C
- South Expansion Leachate Drain

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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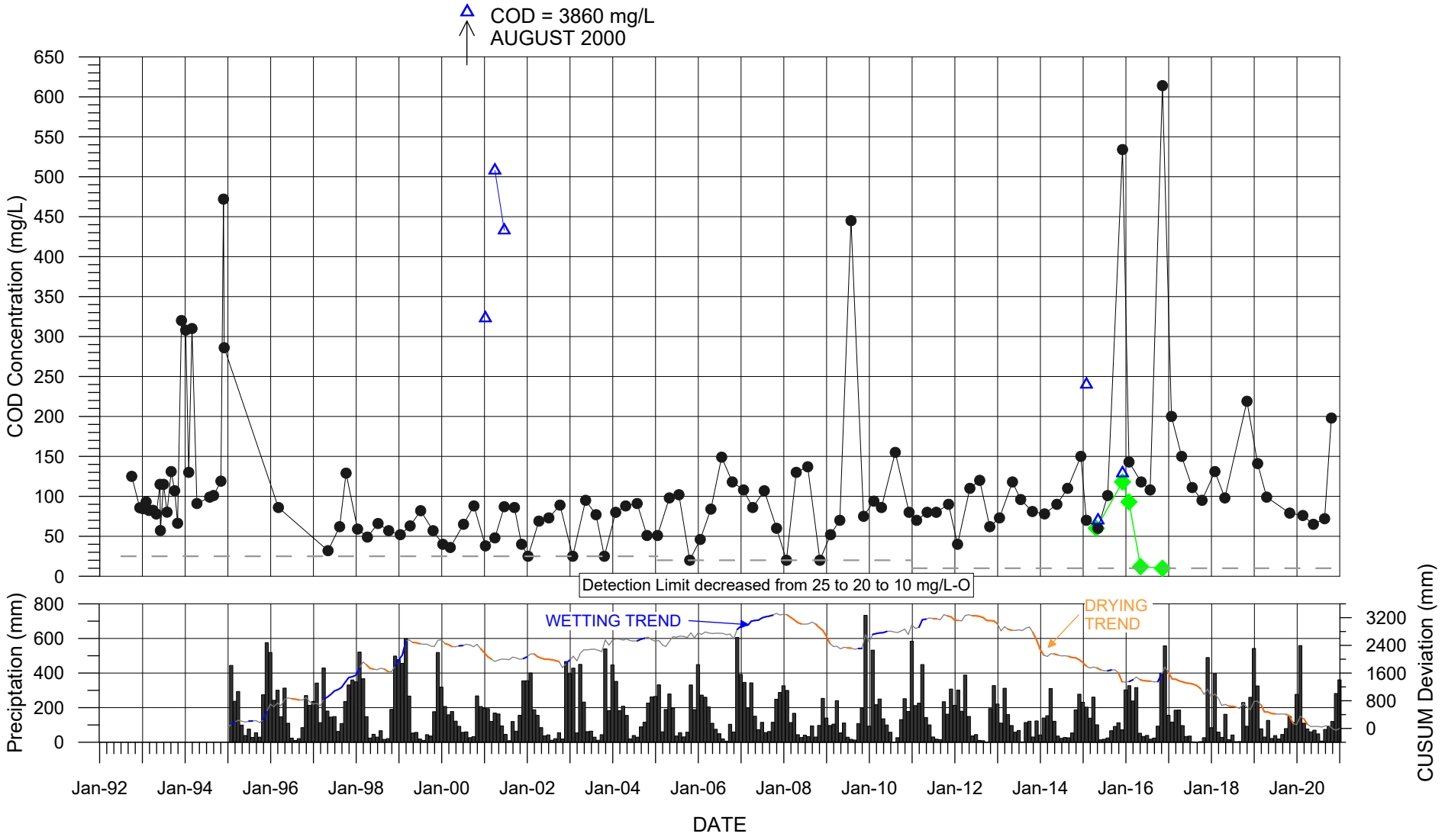
AMMONIA CONCENTRATION TIME-SERIES PLOT FOR LEACHATE

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-2

H:\Project\1005\Analysis\Chemistry\2020\3-Lagin_cod.grf



Leachate Drain
BH00-1C (Landfill Well)
South Expansion Leachate Drain

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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COD CONCENTRATION TIME-SERIES PLOT FOR LEACHATE

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-3

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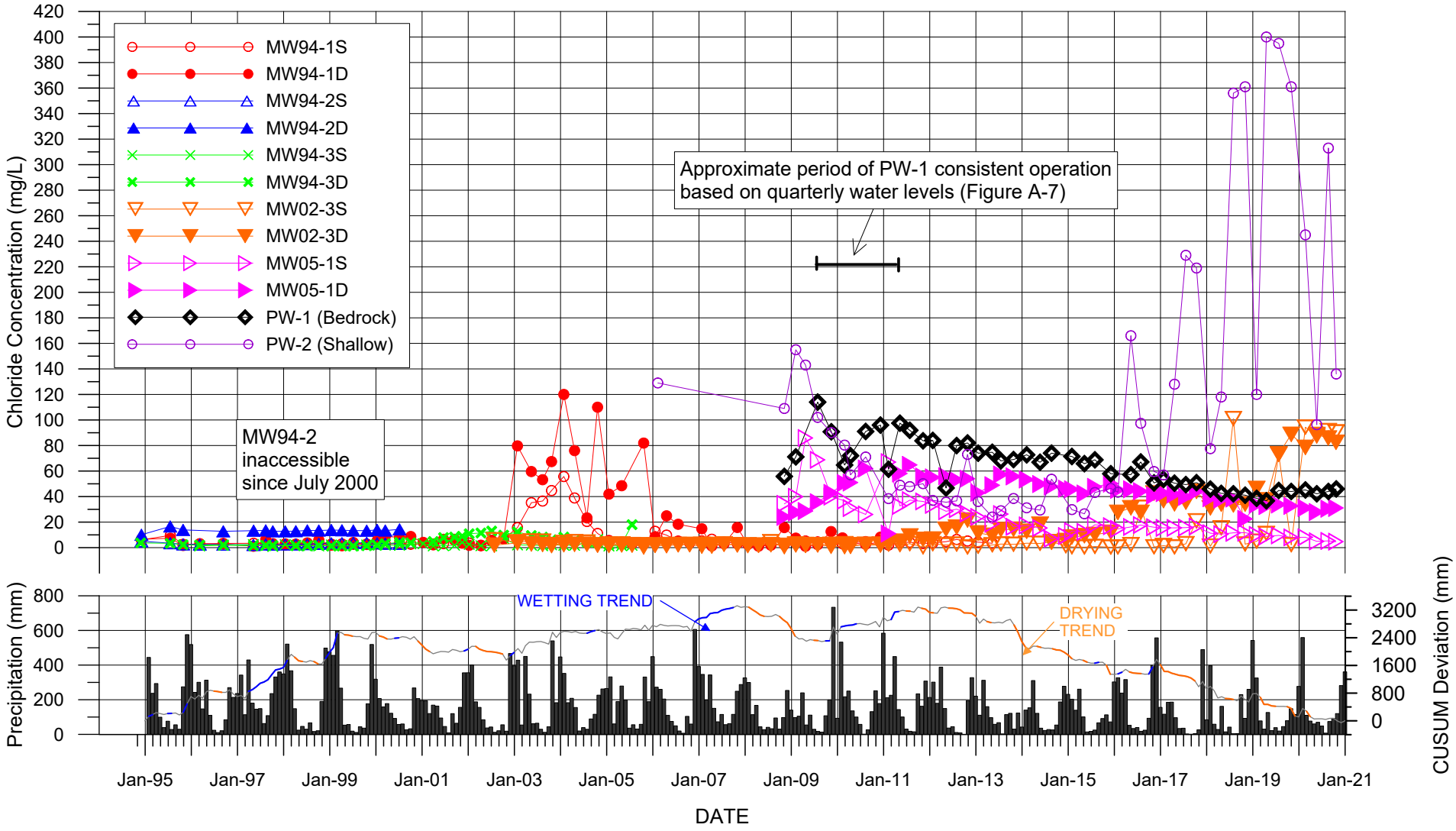

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CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR SOUTHEAST WELLS MW94-1, MW94-2, MW94-3, MW02-3, MW05-1, PW-1, AND PW-2

BY:	DATE:
SC	FEB 20
APPROVED:	FIG:
JM	B-4

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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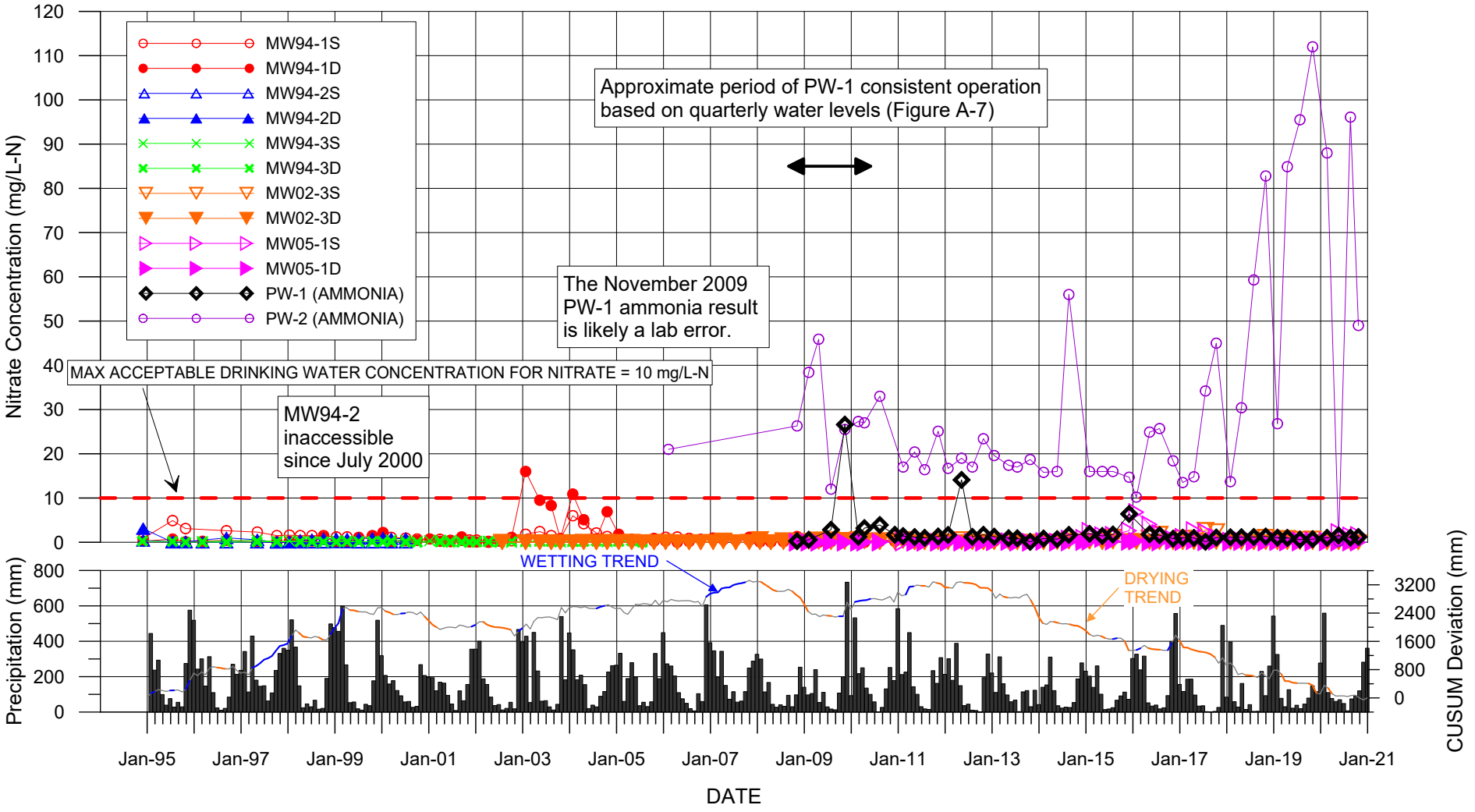

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NITROGEN CONCENTRATION TIME-SERIES PLOT FOR SOUTHEAST WELLS MW94-1, MW94-2, MW94-3, MW02-3, MW05-1, PW-1, AND PW-2

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-5

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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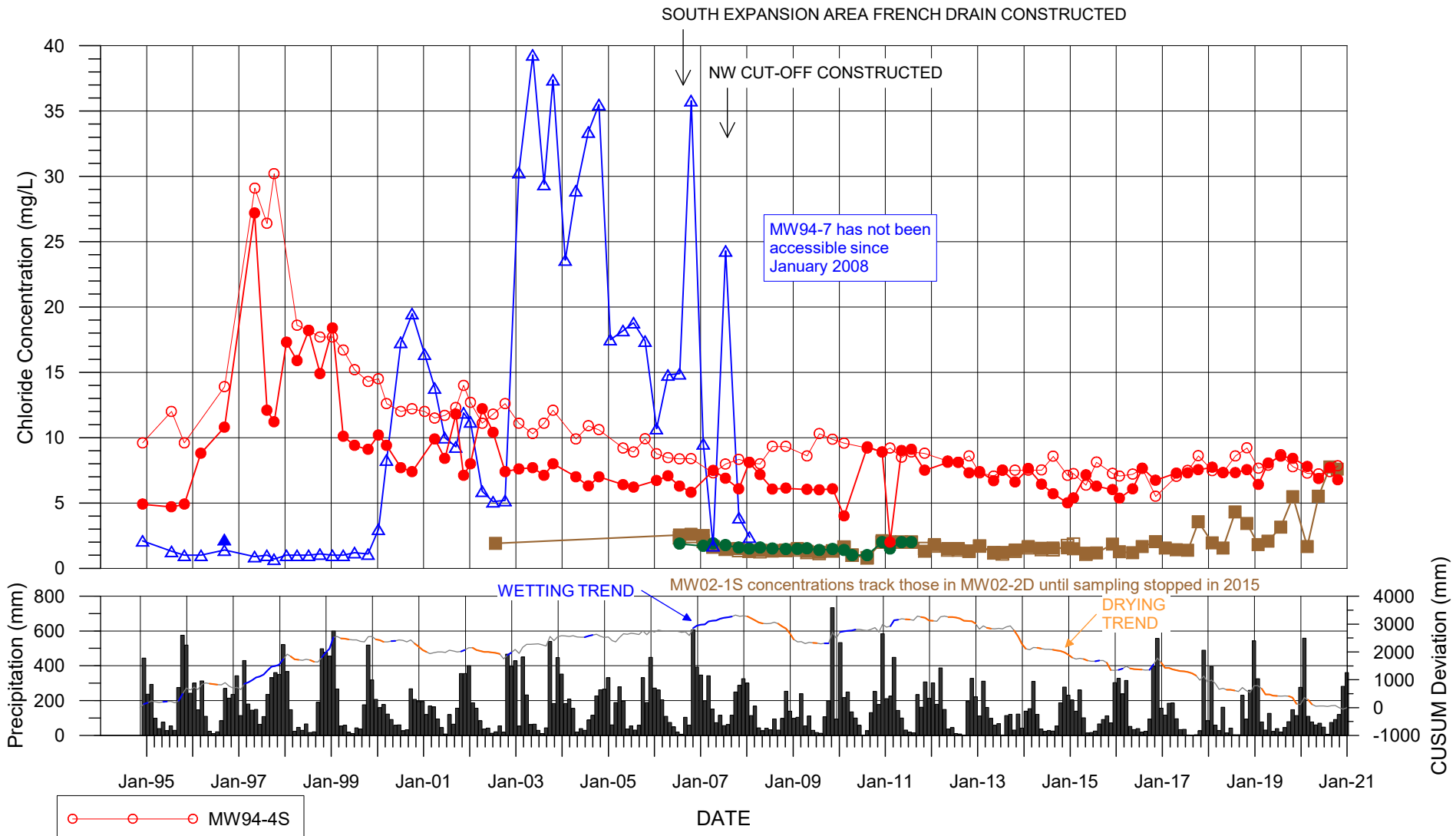

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR SOUTH AND WEST WELLS MW94-4, MW94-7, MW02-1 AND MW02-2

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-6

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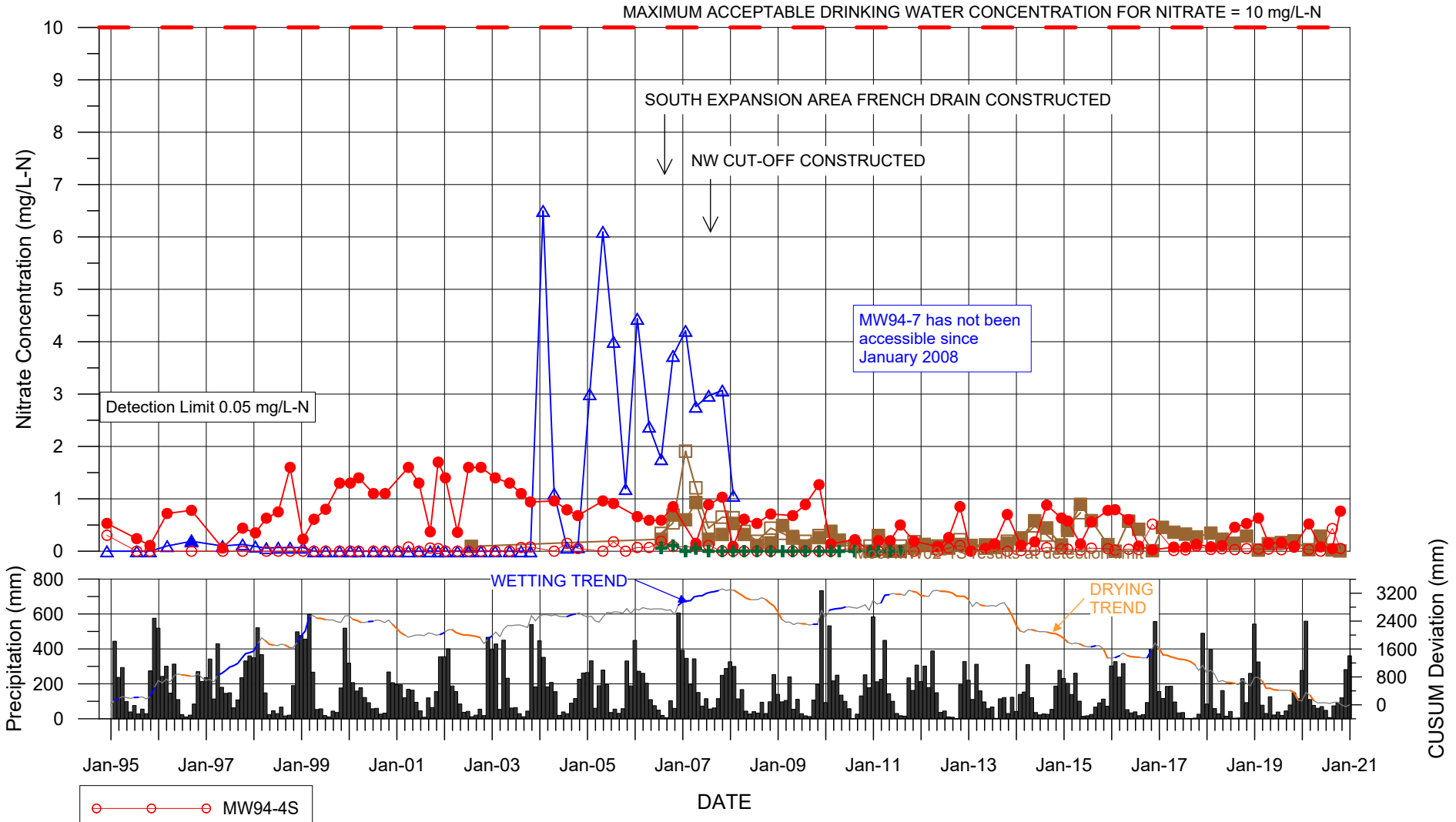

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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NITROGEN CONCENTRATION TIME-SERIES PLOT FOR SOUTH AND WEST WELLS MW94-4, MW94-7, MW02-1 AND MW02-2

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-7

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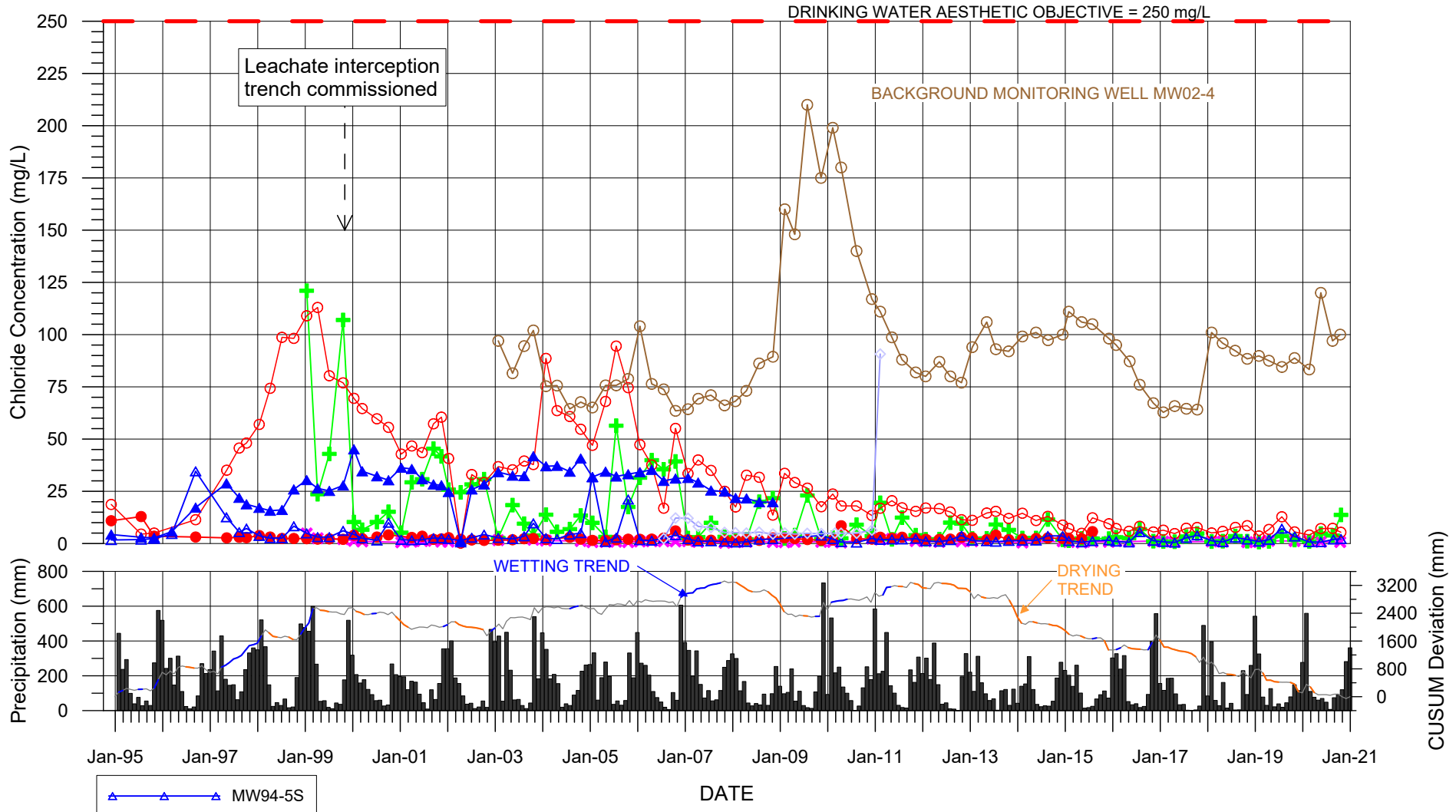

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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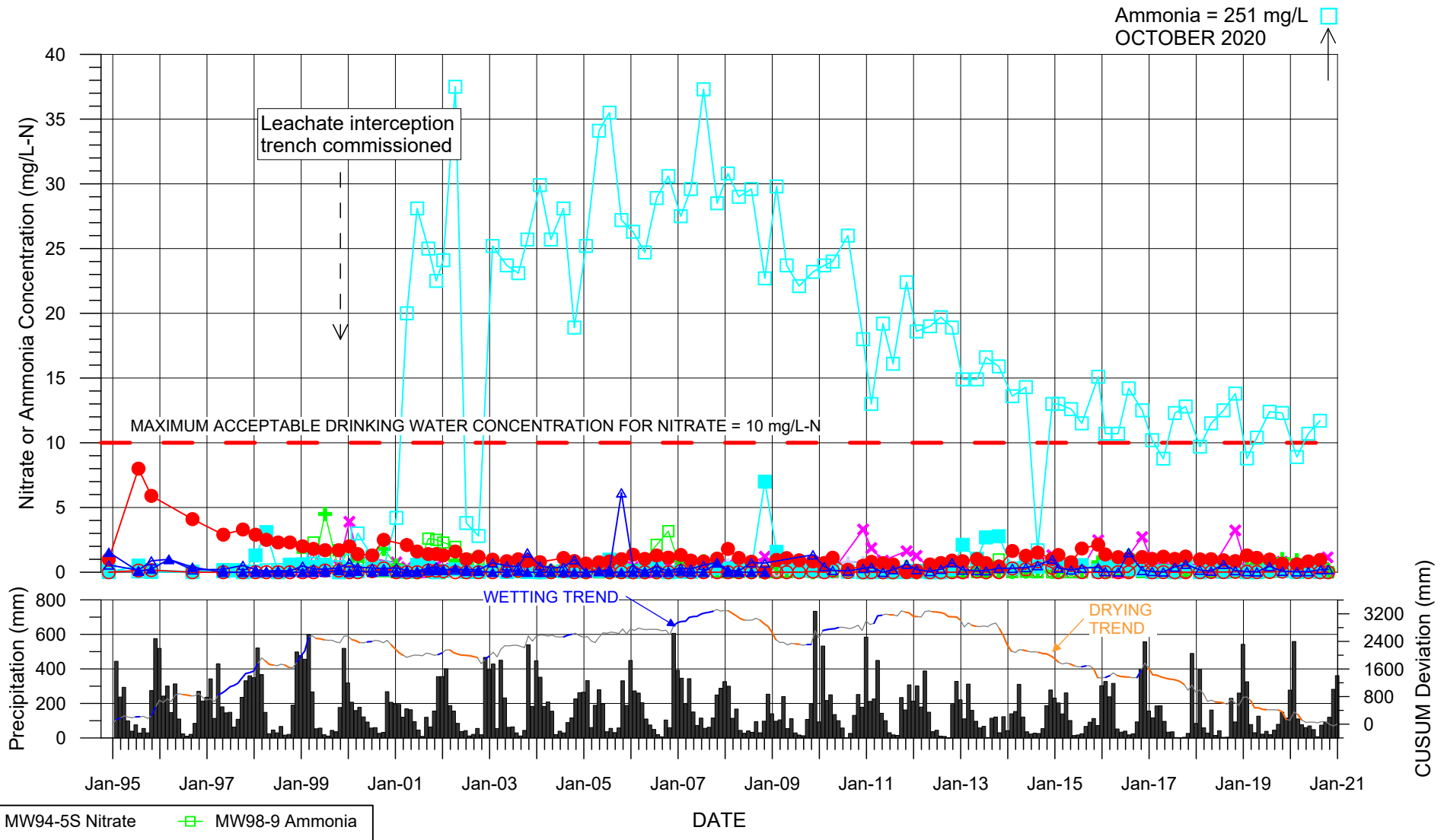
CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR NORTH WELLS MW94-5, MW94-6, MW98-9 AND MW98-10 AND BACKGROUND WELLS BH00-4A AND MW02-4

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-8

H:\Project\1005\Analysis\Chemistry\2020\9-Pz5-6+9-10_n.grf



Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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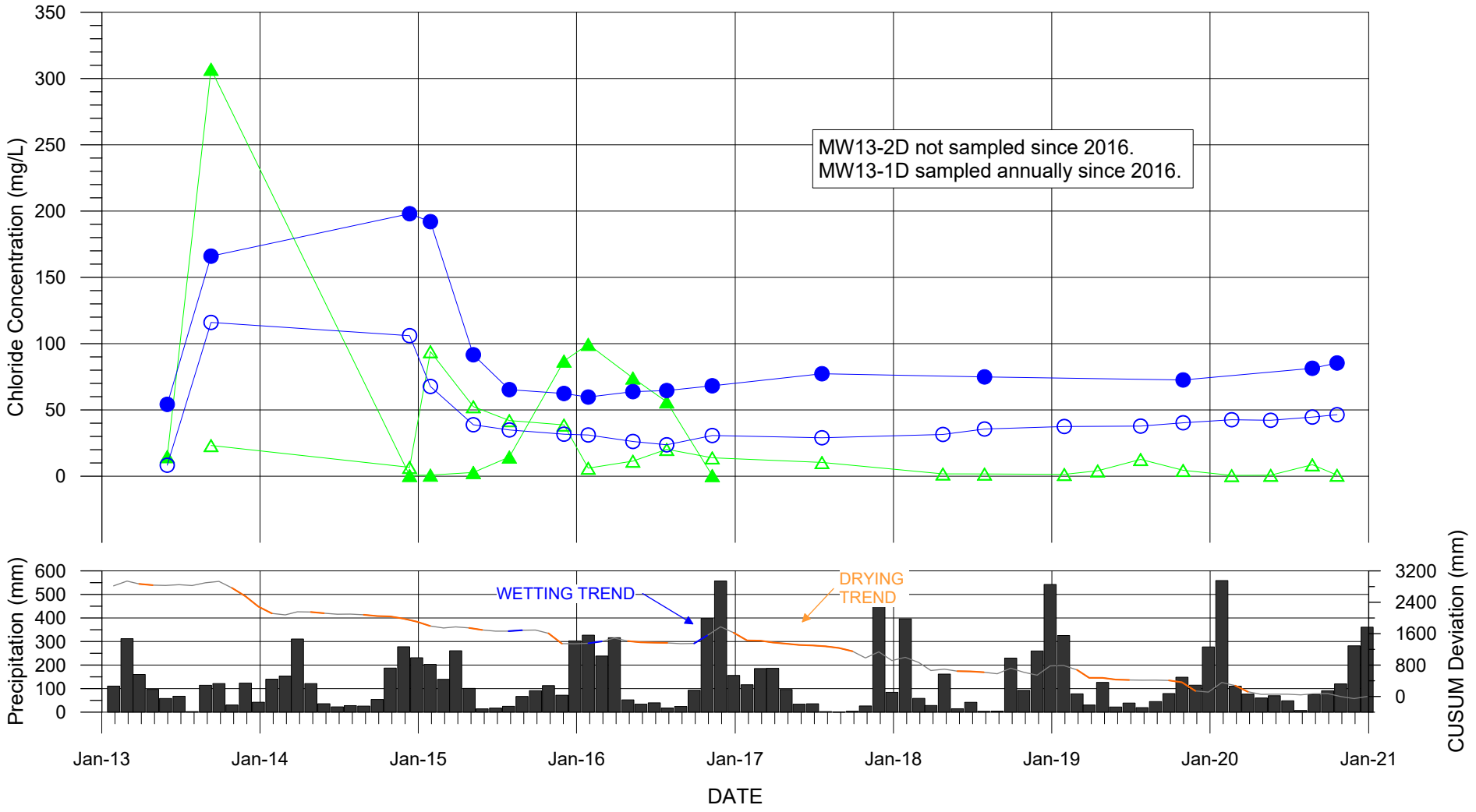
NITROGEN CONCENTRATION TIME-SERIES PLOT FOR NORTH WELLS MW94-5, MW94-6, MW98-9 AND MW98-10 AND BACKGROUND WELLS BH00-4A AND MW02-4

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-9

H:\Project\1005\Analysis\Chemistry\2020\10-MW13_CL.GRF



MW13-1S
MW13-1D
MW13-2S
MW13-2D

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CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR MW13-1S, MW13-1D, MW13-2S AND MW13-2D

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-10

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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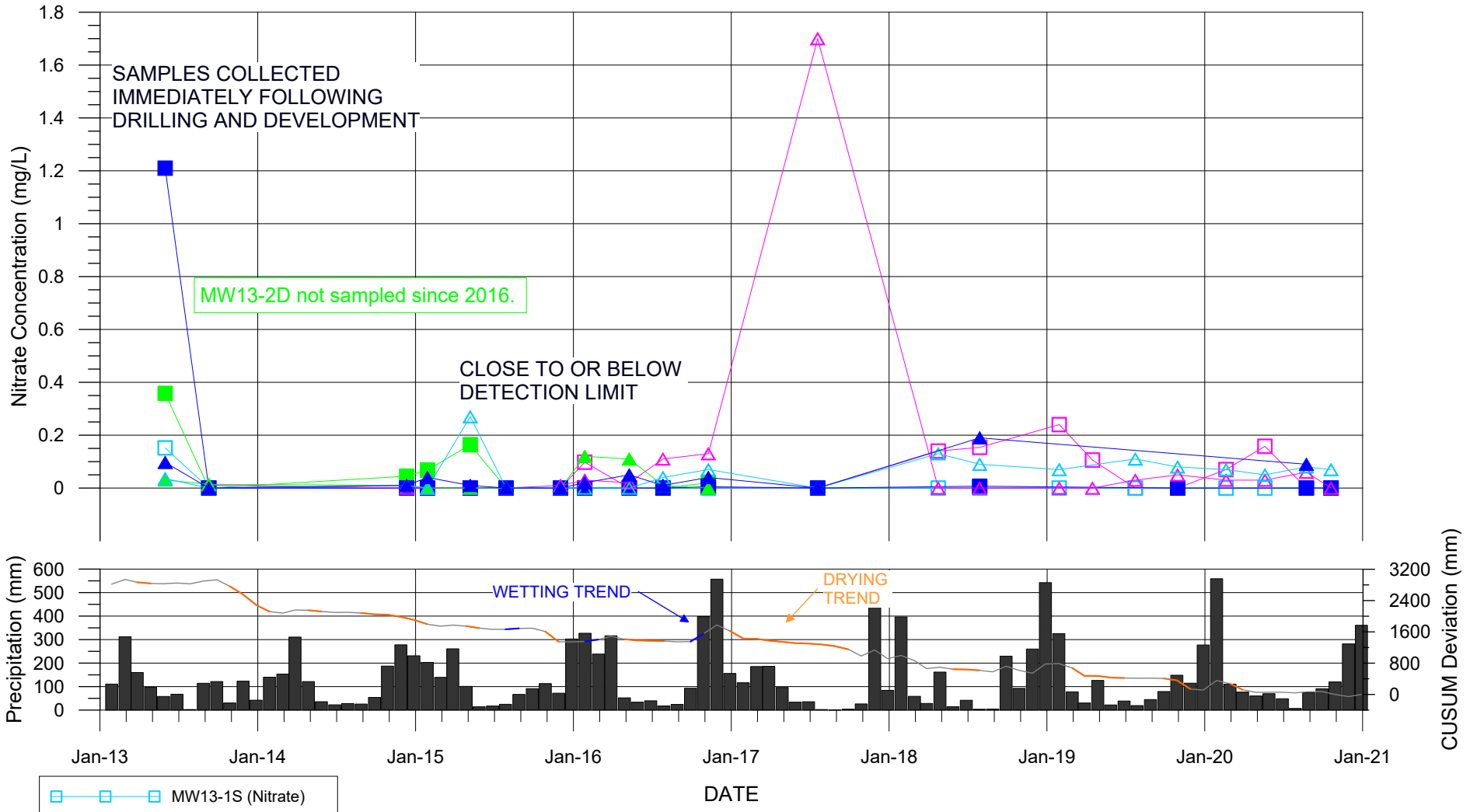

Note:
1. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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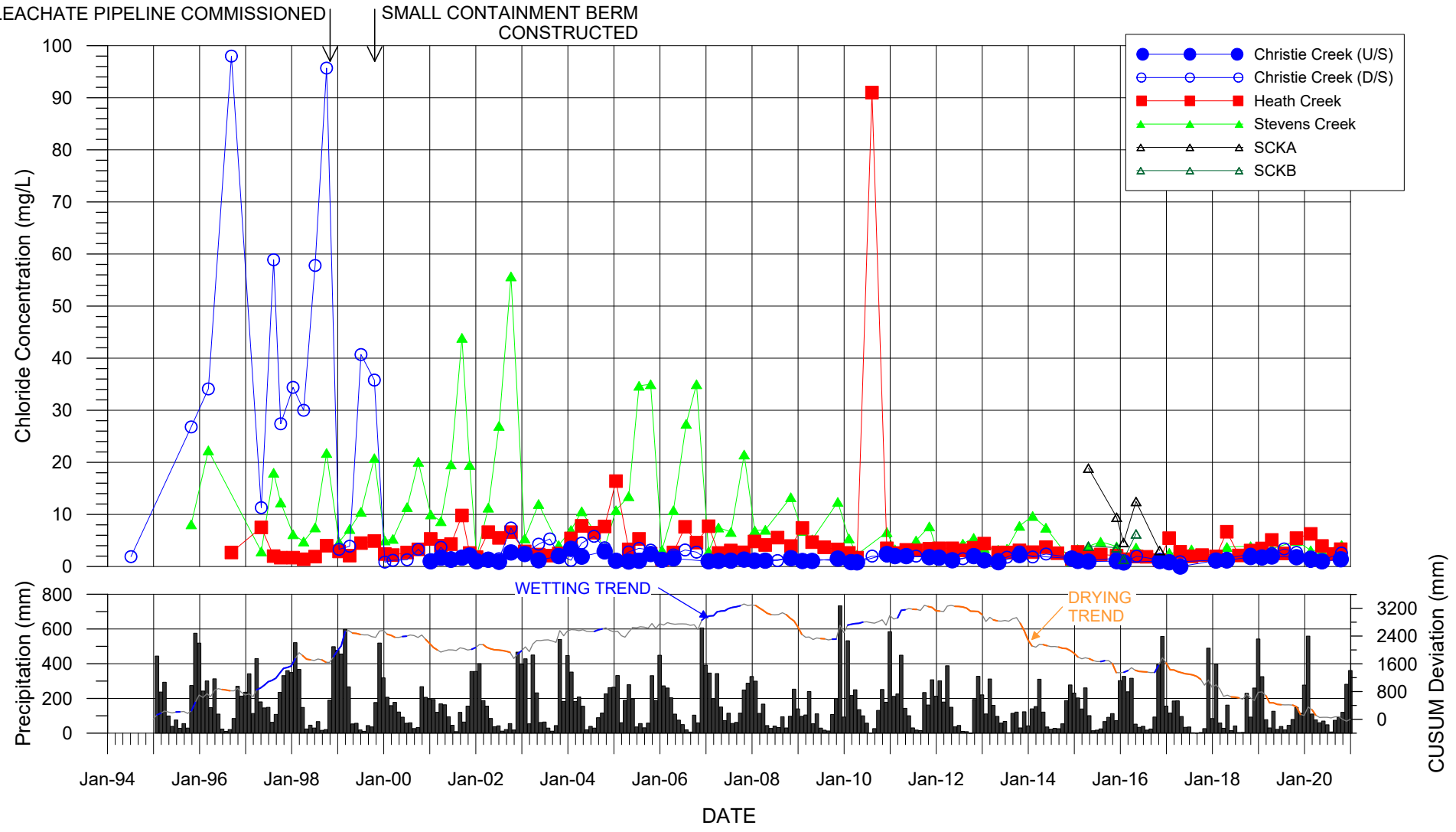
NITROGEN CONCENTRATION TIME-SERIES PLOT FOR MW13-1S, MW13-1D, MW13-2S AND MW13-2D

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-11

H:\Project\1005\Analysis\Chemistry\2020\12-CREEK_CL.GRF



Notes:
1. Christie Creek chloride concentrations dropped from a level indicative of severe leachate impact (approaching 100 mg/L), to less than 5 mg/L, and are now below background concentrations observed in Heath Creek. Values typically increase in summer, during a period of lower dilution, but are expected to stay well below previous levels.
2. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR CREEK SAMPLING SITES

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-12

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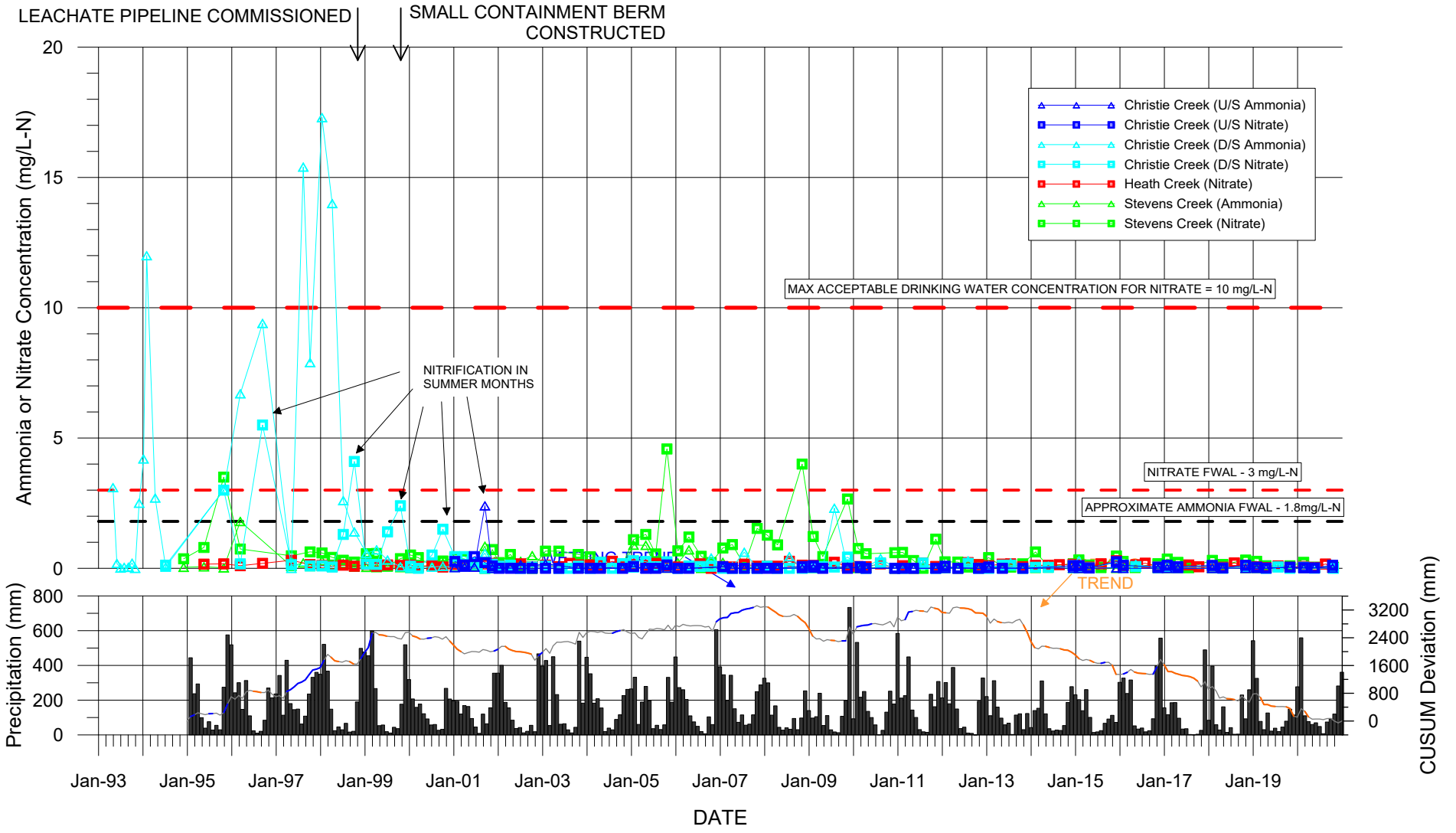

Notes:
1. Winter ammonia concentrations in Christie Creek in years previous to 1999 ranged from about 6 to 17 mg/L-N, generally exceeding the aquatic life criteria of about 1.8 mg/L-N (temperature dependent). Since 2002 concentrations have stayed below 0.07 mg/L-N, well below the aquatic life criteria, with the exception of one summer occasion in 2009.
2. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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NITROGEN CONCENTRATION TIME-SERIES PLOT FOR CREEK SAMPLING SITES

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-13

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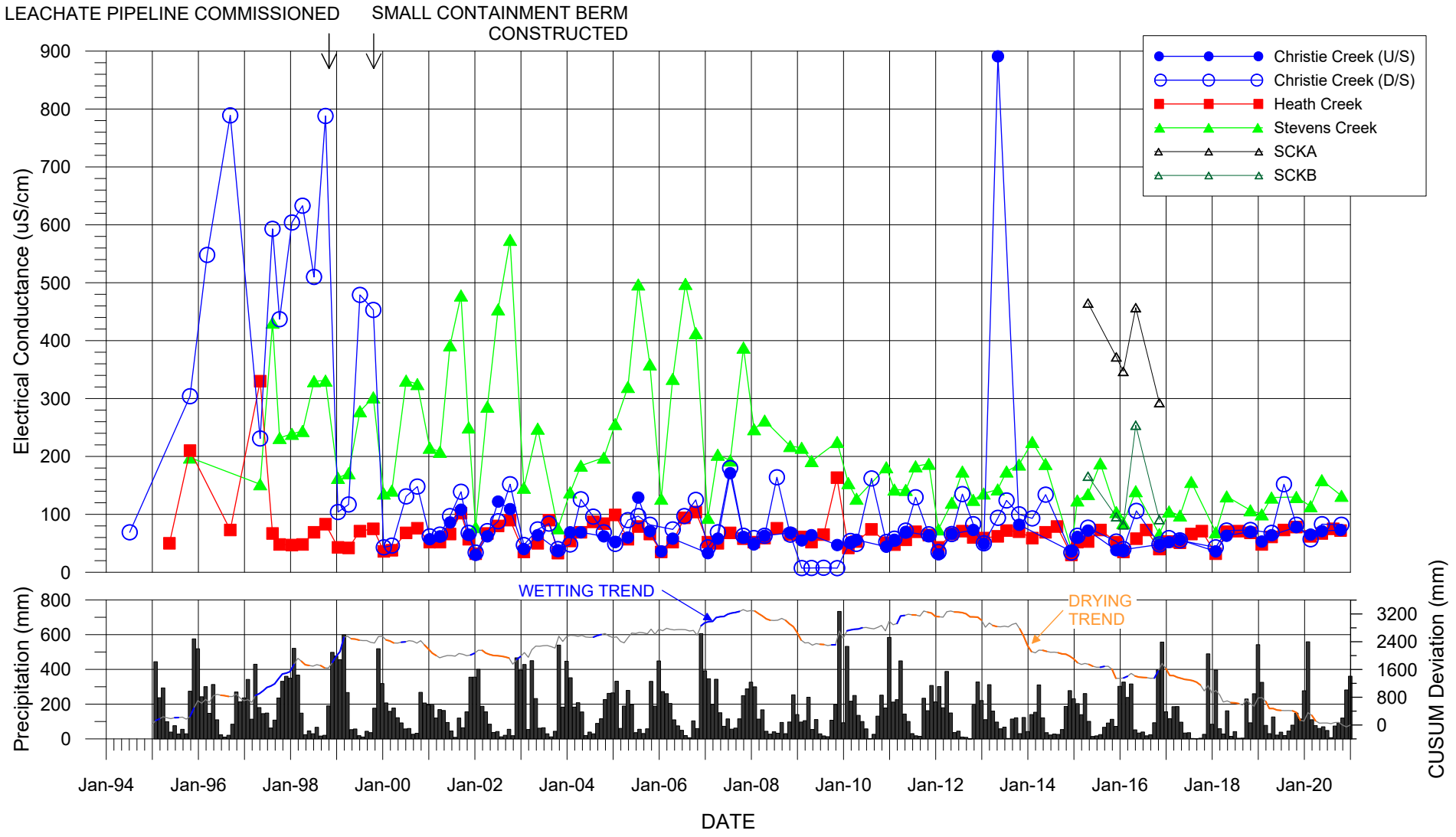

Notes:
1. Winter conductance measurements in Christie Creek approach background measured in Heath Creek, after the pipeline was commissioned.
2. Precipitation measured at Environment Canada's Robertson Creek (1995-2018) and Port Alberni (AUT) (2018-present) stations.

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ELECTRICAL CONDUCTANCE TIME-SERIES PLOT FOR CREEK SAMPLING SITES

BY:	DATE:
SC	JAN 21
APPROVED:	FIG:
JM	B-14

APPENDIX C

MONITORING DATA TABLES FOR 2020 DUPLICATE SAMPLES

APPENDIX C - LIST OF TABLES

Table C-1 Summary of Duplicate Sample Results for Suite 1 Analyses – 2020

Table C-2 Summary of Duplicate Sample Results for Suite 2 Analyses – 2020

Table C-3 Summary of Duplicate Sample Results for Suite 3 Analyses – 2020

Table C-4 Summary of Duplicate Sample Results for Suite 4 Analyses – 2020

TABLE C-1
SUMMARY OF DUPLICATE SAMPLE RESULTS
FOR SUITE 1 ANALYSES - 2020

		MW94-6D			MW02-3D			MW94-5S		
SAMPLE DATE		20-Feb-20	20-Feb-20		20-Feb-20	20-Feb-20		19-May-20	19-May-20	
SAMPLE TYPE	UNITS	PR	DUP	RPD	PR	DUP	RPD	PR	DUP	RPD
LAB NAME		AGAT	AGAT		AGAT	AGAT		AGAT	AGAT	
PHYSICAL TESTS										
pH-Lab	pH	9.52	9.59	1	7.78	7.8	0	6.59	7.17	8
EC-Lab	µS/cm	536	536	0	986	985	0	253	253	0
Dissolved Hardness ($CaCO_3$)	mg/L	18.4	16.4	11	357	321	11	121	123	2
Total Dissolved Solids	mg/L	378	365	3	570	578	1	145	135	7
DISSOLVED ANIONS										
Alkalinity	mg/L $CaCO_3$	240	236	2	404	391	3	153	126	19
Chloride	mg/L	5.1	5.06	1	78.5	77.8	1	0.69	0.69	0
Sulphate	mg/L	28.2	28.5	1	21.3	21.3	0	7.5	7.5	0
DISSOLVED METALS										
Arsenic	mg/L	0.015	0.0149	1	0.0008	0.0008	0	0.0002	0.0002	0
Barium	mg/L	0.0323	0.0285	13	0.0822	0.0837	2	0.0175	0.0167	5
Boron	mg/L	2.04	2.11	3	0.849	0.839	1	0.273	0.259	5
Cadmium	mg/L	0.00016	0.00009	56	0.00001	0.00002	**67**	0.00003	0.00003	0
Chromium	mg/L	<0.0005	<0.0005	-	<0.0005	<0.0005	-	<0.0005	<0.0005	-
Cobalt	mg/L	0.00183	0.00149	20	0.00206	0.00234	13	<0.00005	<0.00005	-
Copper	mg/L	0.0048	0.0044	9	0.0049	0.006	20	0.0075	0.0008	**161**
Iron	mg/L	1.84	1.66	10	0.04	0.05	22	0.01	<0.01	>0
Lead	mg/L	0.0149	0.0124	18	<0.00005	0.00007	>33	0.00027	<0.00005	**>138**
Manganese	mg/L	0.156	0.138	12	0.319	0.269	17	0.011	0.01	10
Mercury	µg/L	0.05	0.04	22	<0.01	<0.01	-	<0.01	<0.01	-
Vanadium	mg/L	0.0056	0.0054	4	<0.0005	<0.0005	-	<0.0005	<0.0005	-
Zinc	mg/L	0.039	0.037	5	0.006	0.007	15	0.027	0.005	**138**
NUTRIENTS										
Nitrate	mg/L as N	0.616	0.614	0	<0.005	<0.005	-	0.052	0.066	24
Ammonia Nitrogen	mg/L as N	0.01	<0.01	>0	0.07	0.08	13	0.09	0.06	40
POLLUTANT TESTS										
Chemical Oxygen Demand	mg/L as O	18	18	0	24	30	22	18	21	15

RPD Average				>9			>13			>30
RPD Min				0			0			0
RPD Max				56			**67**			**161**

H:\Project\1005\Analysis\Chemistry\2020\[QAQC.xlsm]Table C-1

NOTES:
"-" denotes the parameter was not analyzed or that both the PR and DUP have values below the detection limit, and no RPD has been calculated.
bold values indicate RPD > 65
PR = primary sample
DUP = duplicate sample
RPD = relative percent difference
">" denotes that one of the samples had a value below the detection limit. The RPD shown is a conversative value based on the detection limit.

TABLE C-2

SUMMARY OF DUPLICATE SAMPLE RESULTS
FOR SUITE 2 ANALYSES - 2020

		MW05-1S			PW-1		
SAMPLE DATE SAMPLE TYPE LAB NAME	UNITS	20-Feb-20 PR AGAT	20-Feb-20 DUP AGAT	RPD	20-May-20 PR AGAT	20-May-20 DUP AGAT	RPD
PHYSICAL TESTS							
pH-Lab	pH	7.22	7.32	1	7.11	7.18	1
EC-Lab	µS/cm	394	394	0	880	945	7
Total Dissolved Solids	mg/L	222	230	4	480	515	7
DISSOLVED ANIONS							
Chloride	mg/L	8.13	7.74	5	42.2	44.1	4
Sulphate	mg/L	18.3	18.2	1	11.3	10	12
NUTRIENTS							
Nitrate	mg/L as N	0.053	0.06	12	0.007	<0.005	>33
Ammonia Nitrogen	mg/L as N	<0.01	<0.01	-	1.52	1.42	7

16.00				4			>10
RPD Min				0			1
RPD Max				12			>33

H:\Project\1005\Analysis\Chemistry\2020\[QAQC.xlsm]Table C-2

NOTES:
"-" denotes the parameter was not analyzed or that both the PR and DUP have values below the detection limit, and no RPD has been calculated.

bold values indicate RPD > 65

PR = primary sample

DUP = duplicate sample

RPD = relative percent difference

">" denotes that one of the samples had a value below the detection limit. The RPD shown is a conversative value based on the detection limit.

TABLE C-3

SUMMARY OF DUPLICATE SAMPLE RESULTS
FOR SUITE 3 ANALYSES - 2020

		Stevens Creek		
SAMPLE DATE SAMPLE TYPE LAB NAME	UNITS	22-Oct-20 PR AGAT	22-Oct-20 DUP AGAT	RPD
PHYSICAL TESTS				
pH-Lab	pH	7.15	7.38	3
EC-Lab	µS/cm	132	134	2
Total Hardness ($CaCO_3$)	mg/L	62	60	3
DISSOLVED ANIONS				
Chloride	mg/L	4.13	4.11	0
Sulphate	mg/L	1.1	1.3	17
TOTAL METALS				
Cadmium	mg/L	<0.00001	0.00002	**>67**
Chromium	mg/L	<0.0005	<0.0005	**-**
Iron	mg/L	0.27	0.06	**127**
Manganese	mg/L	0.413	0.129	**105**
Zinc	mg/L	<0.005	<0.005	**-**
NUTRIENTS				
Nitrate	mg/L as N	0.04	0.04	0
Ammonia Nitrogen	mg/L as N	0.05	0.02	**86**
Total Phosphorus	mg/L	0.008	0.007	13
POLLUTANT TESTS				
Chemical Oxygen Demand	mg/L as O	<10	<10	**-**

RPD Average	>38
RPD Min	0
RPD Max	**127**

H:\Project\1005\Analysis\Chemistry\2020\[QAQC.xlsm]Table C-3

NOTES:

"-" denotes the parameter was not analyzed or that both the PR and DUP have values below the detection limit, and no RPD has been calculated.

bold values indicate RPD > 65

PR = primary sample

DUP = duplicate sample

RPD = relative percent difference

">" denotes that one of the samples had a value below the detection limit. The RPD shown is a conversative value based on the detection limit.

TABLE C-4

SUMMARY OF DUPLICATE SAMPLE RESULTS
FOR SUITE 4 ANALYSES - 2020

		Lagoon Inlet			South Expansion Leachate Drain		
SAMPLE DATE SAMPLE TYPE LAB NAME	UNITS	24-Aug-20 PR AGAT	24-Aug-20 DUP AGAT	RPD	22-Oct-20 PR AGAT	22-Oct-20 DUP AGAT	RPD
PHYSICAL TESTS							
pH-Lab	pH	8.03	8.01	0	6.87	6.89	0
EC-Lab	µS/cm	1620	1610	1	386	385	0
Total Hardness ($CaCO_3$)	mg/L	441	468	6	157	163	4
Total Dissolved Solids	mg/L	1080	1140	5	198	190	4
DISSOLVED ANIONS							
Alkalinity	mg/L $CaCO_3$	244	261	7	142	152	7
Chloride	mg/L	190	188	1	21.8	21.8	0
Sulphate	mg/L	57.8	56.7	2	7.9	8	1
TOTAL METALS							
Arsenic	mg/L	0.0009	0.0012	29	0.0034	0.0035	3
Boron	mg/L	0.689	0.624	10	0.169	0.16	5
Cadmium	mg/L	0.00002	0.00003	40	0.00002	0.00004	**67**
Chromium	mg/L	0.0009	0.0006	40	<0.0005	<0.0005	-
Copper	mg/L	0.014	0.015	7	0.0025	0.003	18
Iron	mg/L	0.18	0.2	11	0.04	0.05	22
Lead	mg/L	0.00049	0.0005	2	0.00037	0.00017	**74**
Manganese	mg/L	0.927	1.17	23	2.14	2.22	4
Mercury	ug/L	0.09	0.08	12	<0.01	<0.01	-
Zinc	mg/L	0.011	0.01	10	<0.005	<0.005	-
NUTRIENTS							
Nitrate	mg/L as N	59.7	57.9	3	2.27	2.27	0
Ammonia Nitrogen	mg/L as N	8.7	9.5	9	2.1	2.1	0
Total Phosphorus	mg/L	0.062	0.063	2	<0.005	<0.005	-
POLLUTANT TESTS							
Chemical Oxygen Demand	mg/L as O	72	72	0	18	11	48
Total Organic Carbon	mg/L as O	18.8	18.7	1	2.4	2.5	4

RPD Average				10			15
RPD Min				0			0
RPD Max				40			**74**

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NOTES:
"-" denotes the parameter was not analyzed or that both the PR and DUP have values below the detection limit, and no RPD has been calculated.
bold values indicate RPD > 65
PR = primary sample
DUP = duplicate sample
RPD = relative percent difference
">" denotes that one of the samples had a value below the detection limit. The RPD shown is a conversative value based on the detection limit.