

FINFISH AQUACULTURE SITE AQUACULTURE STEWARDSHIP COUNCIL REPORT GORE ISLAND, NOOTKA SOUND, BC

SITE LICENSE: AQ1762

SURVEY TYPE: ASC

SURVEY DATE: APRIL 27-28, 2020

REPORT DATE: MAY 6, 2020

PREPARED FOR:

*GRIEG SEAFOOD BC, LTD
#106 3001 IRONWOOD STREET
CAMPBELL RIVER, BC
V9W 5P7*



1310 Marwalk Cres
Campbell River, BC.
V9W 5X1
phone: (250) 287-2462
fax: (250) 287-2452
email: info@mainstreambio.ca
www.mainstreambio.ca



Summary

This document presents the qualitative and quantitative assessment of sediment obtained during the survey completed at the Gore Island finfish aquaculture site operated by Grieg Seafood BC Ltd. in Nootka Sound, BC, on April 27 and 28, 2020. Sediment was collected and the data analyzed according to the *Aquaculture Activities Regulations* (AAR) and adapted to address Criterion 2.1 and 5.2 of the Aquaculture Stewardship Council (ASC) Salmon Standard.

The measured and observed characteristics of the sediment collected during the sampling confirmed that the stations outside the Allowable Zone of Effect (AZE) on Transects A, B and C had mean sulphide levels less than the ASC Salmon Standard acceptable limit of 1500 µm. Redox potential measured in sediment obtained outside the AZE on Transect A and B was greater than the ASC Salmon Standard acceptable lower limit of 0 mV. However, redox potential in sediment collected at the station outside the AZE on Transect C was less than the 0 mV minimum requirement cited in Criterion 2.1.1 of the ASC Salmon Standard.

As required by Criterion 5.2 of the ASC monitoring for parasiticide residue was completed at the station outside the AZE on Transects A, B and C and at three reference stations. Enamectin benzoate and florfenicol was below detectable limits in all collected samples.

An assessment and identification of the benthic organisms present in the sediment was not completed to evaluate for potential impacts to habitat, as BC salmon farms have been granted a variance to Indicators 2.1.2 and 2.1.3 and instead rely on the scientifically proven and federally regulated sulfide surrogates (ASC VR224)¹.

¹ <http://variance-requests.asc-aqua.org/questions/vr-224-benthic-biodiversity-and-benthic-effects-salmon-v1-0-2-1-2-2-1-3/>

Table of Contents

Summary.....	ii
Table of Contents.....	iii
1.0 Introduction.....	1
2.0 Methods.....	3
2.1 Field Sampling	3
2.2 Data Analysis.....	6
3.0 Results and Discussion	7
3.1 Redox Potential and Sulphide Levels.....	7
3.2 Parasiticide Residue	7
4.0 References	9
Appendix 1 – Sample Photographs	I
Appendix 2 – Gore Island Field Data.....	VI
Appendix 3 – Gore Island ASC Survey Summary	VIII

1.0 Introduction

This document presents the marine sediment data collected as part of a benthic study completed at the Gore Island finfish aquaculture site operated by Grieg Seafood BC Ltd. (Campbell River, BC). The Gore Island site is located in King Passage, BC (Figure 1).

The study was completed by adapting the methodology required for operational monitoring of waste dispersion required under *Aquaculture Activities Regulations* (AAR) and comparing the results with the indicators listed in Criterion 2.1 of the Aquaculture Stewardship Council (ASC) Salmon Standard. Additional analysis of the collected sediment was also completed to address Criterion 5.2 of the ASC.

The purpose of the ASC Salmon Standard is to evaluate concerns of potential environmental impact related to salmon farming. The Standard is based on a combination of requirements and performance levels that must be reached in order to determine if potential impacts are being addressed. Principle 2 of the Standard addresses the “*potential impacts from salmon farms on natural habitat, local biodiversity and ecosystem function*” (ASC, 2012).

This survey was specifically designed to address Criterion 2.1 within Principle 2 of the ASC Salmon Standard which involved the collection of sediment within and outside of the Allowable Zone of Effect (AZE). Sediment was analyzed for redox potential and sulphide levels to evaluate benthic habitat conditions. In addition, testing for parasiticide residue in sediment collected at the two reference stations and at the stations outside the AZE was completed to address Criterion 5.2.1 of the ASC.

An assessment and identification of the benthic organisms present in the sediment was not completed to evaluate for potential impacts to habitat, biodiversity and ecosystem function, as BC salmon farms have been granted a variance to Indicators 2.1.2 and 2.1.3 and instead rely on the scientifically proven and federally regulated sulfide surrogates (ASC VR224).

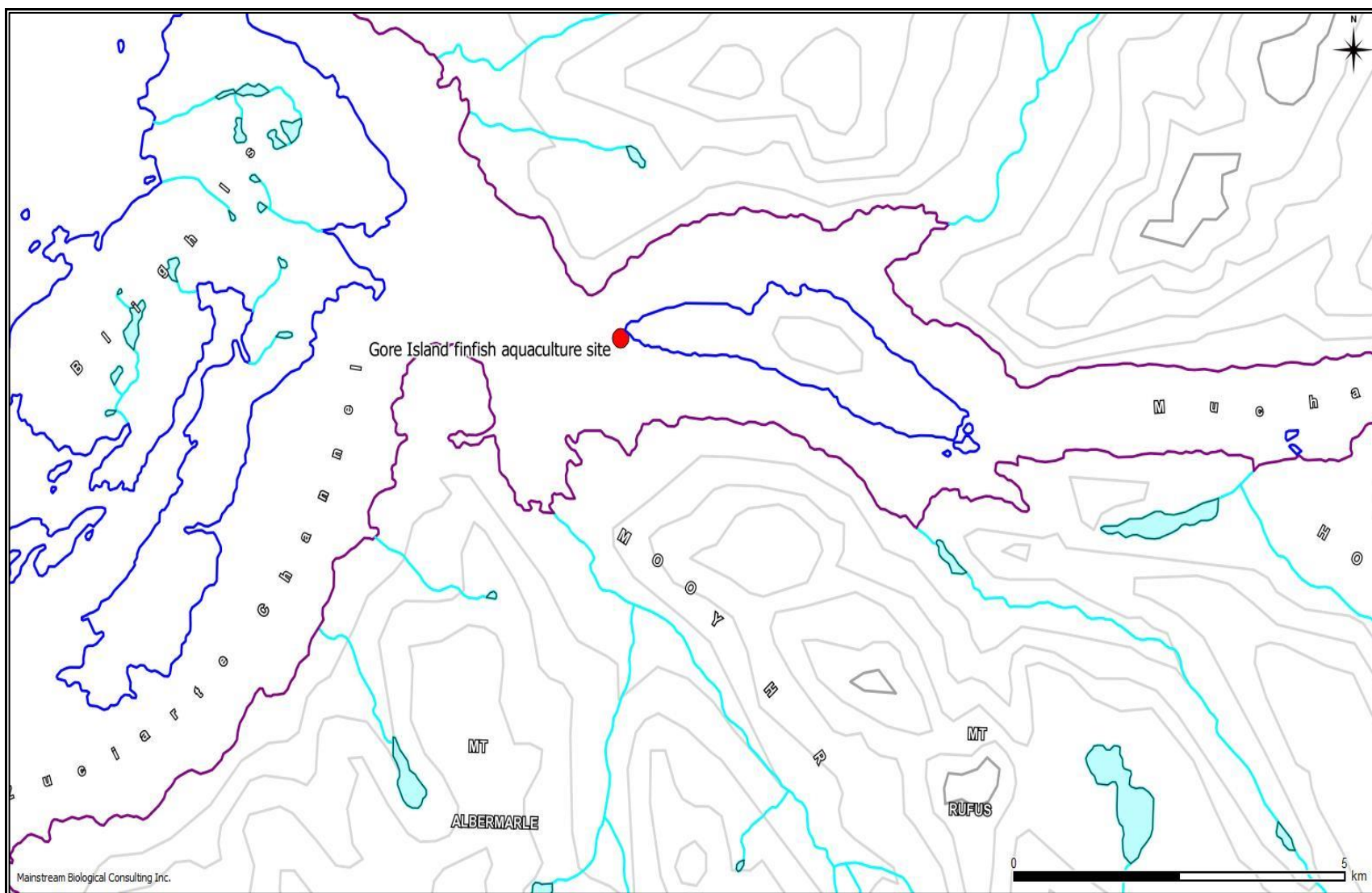


Figure 1: An overview map showing the approximate location of the Gore Island finfish aquaculture farm site (red dot) in Nootka Sound, BC.

2.0 Methods

Sampling had never been attempted at the ASC locations at the Gore Island finfish aquaculture site. Therefore, the field activities involved the attempted collection of sediment samples for physical and chemical analysis.

2.1 Field Sampling

The locations of sediment sampling stations were provided by Grieg Seafood BC Ltd..

Individual sediment sampling stations were located along three Transects A, B, and C. Stations within the AZE were located 5 m inside the 1 g DEPOMOD contour (Figure 2) for all three transects and also at the perimeter of the containment system for Transects A and B. On the A transect, the station at the perimeter of containment system was the same as the station 5 m inside the 1 g DEPOMOD contour. Stations outside the AZE were located 25 m outside of the 1 g DEPOMOD contour. Additional stations were established at two reference sites within the range of 500 m to 1000 m from the aquaculture containment system as outlined in the ASC Salmon Standard (Figure 3).

Sediment was collected using a Petite Ponar and a Van Veen sampler. Two sediment samples were collected at each station.

The coordinates of the sample locations were recorded using a Trimble GeoExplorer GeoXT (Firmware v1.05) using TerraSync 3.30 software and equipped with an external Hurricane antenna.

Data filters were set to standards recommended by the Resource Inventory Standards Committee (RISC)², with at least 15 fixes taken per location, using satellites greater than 15 % above the horizon with signal to noise ratios (SNR) greater than 40 and a horizontal dilution of precision (HDOP) of five. The GPS data was corrected post-mission with Pathfinder Office v5.40 software using data from the Nootka base station (NTKA).

The Trimble antenna was attached to the grab davit and positional fixes were obtained while the grab was completing the estimated bottom third of its descent. Positional fixes were completed when the grab was on the bottom and the drop line was as close vertical as possible.

² Integrated Land Management Bureau. 2008. Province of British Columbia Standards, Specifications and Guidelines for Resource Surveys Using Global Positioning System (GPS) Technology. Release 4.0d.

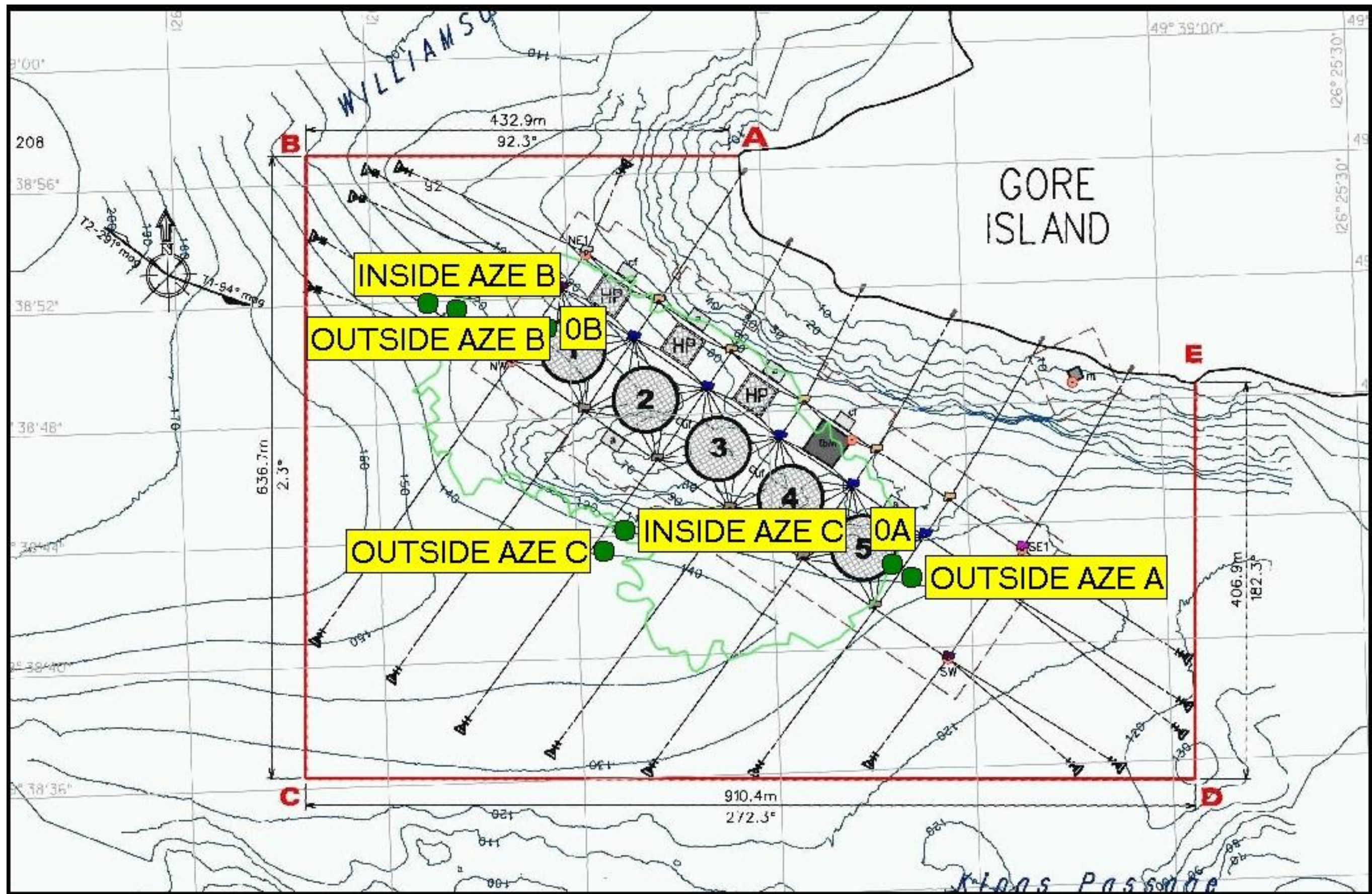


Figure 2: The locations of the sampling stations for the ASC survey at the Gore Island finfish aquaculture site in relation to the pen system and surrounding area on April 27 and 28, 2020.

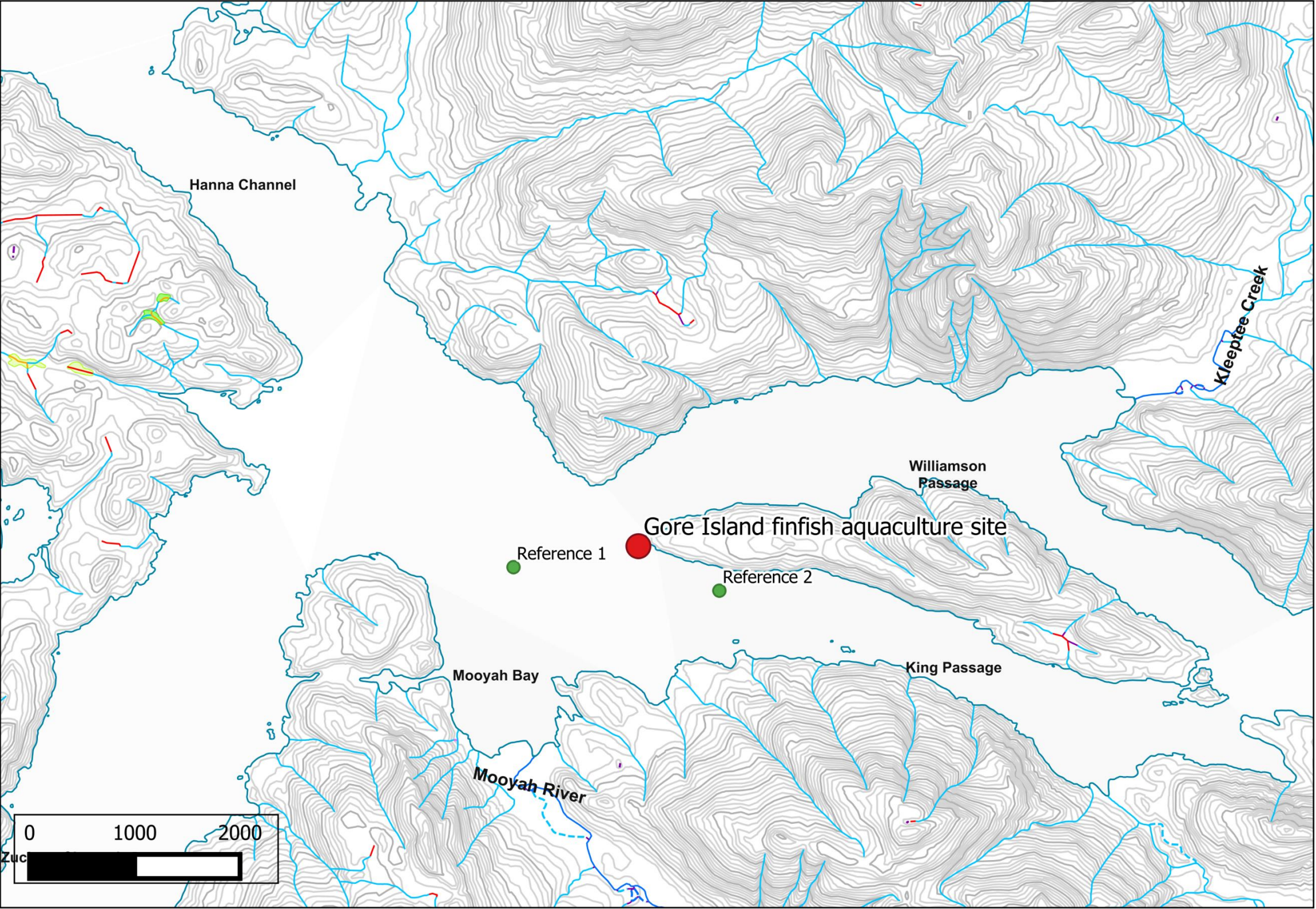


Figure 3: The locations of the reference stations for the ASC survey at the Gore Island finfish aquaculture site in relation to the site and surrounding area on April 27 and 28, 2020

The time at which each sample was successfully obtained and physical characteristics of the collected sediment were recorded. A digital photograph of each sample was also taken. As per Indicator 2.1.1, levels of free sulphides and redox potential of each sediment sample were measured in the field using an Orion A324 meter and the appropriate ISE probes. A digital thermometer was used to measure the temperature of the sediment.

As per Indicator 5.2.1, portions of the grab samples collected at the stations outside the AZE on Transects A, B and C as well as the reference stations were retained for analysis. Retained samples were stored at 4° Celsius and transported to SGS Canada Inc for analysis for emamectin benzoate and florfenicol.

2.2 Data Analysis

In order to evaluate if the benthic conditions at and near the Gore Island site met the requirements of Criterion 2.1 of the ASC Salmon Standard, the data collected was compared to required levels for indicators of potential finfish farm impacts. These indicators represent a combination of chemical and biodiversity measurements to evaluate the status of benthic health, biodiversity and ecosystem function and to detect potential impacts related to the salmon farm operation. The indicators considered for this assessment are summarized below in Table 1.

Additional analysis of parasiticide residue was completed to fulfill the requirement for monitoring of these chemicals but there is no required level presented in the ASC to compare these results to.

Table 1: Summary of indicators of benthic health, biodiversity and ecosystem function that were considered during the evaluation of the Gore Island finfish aquaculture site. The indicators have been adopted from Criterion 2.1 of the ASC Salmon Standard.

Criterion Number	Indicator	ASC Salmon Standard Requirement
2.1.1	Redox potential in sediment outside the AZE ¹ .	>0 millivolts (mV)
2.1.1	Sulphide levels in sediment outside the AZE.	≤1500 microMoles / L (µM)

1: AZE = Allowable Zone of Effect

3.0 Results and Discussion

Representative photographs of sediment obtained at each sampling station are presented in Appendix 1. Raw data obtained from sediment sampled in the field is presented in Appendix 2 and the summarized data is presented in Appendix 3.

The sediment successfully collected at the Gore Island sampling stations typically consisted of grey or green mud with shell hash and terrigenous material.

The 0A station and the station inside the AZE on Transect A were located at the same position. Therefore two grabs were completed at this station and presented in the report as Station 0A.

3.1 Redox Potential and Sulphide Levels

Following Criterion 2.1.1 of the ASC Salmon Standard, the results of redox potential and sulphide testing at the station outside the AZE were analyzed to help evaluate if the Gore Island facility was meeting the certification requirements (Appendix 3).

The mean sulphide level in sediment collected at the stations outside AZE on Transects A, B and C (40.0 μM , 35.4 μM and 84.9 μM respectively) on April 27, 2020 were less than the ASC Salmon Standard sulphide upper limit of 1500 μM .

Mean redox potential in sediment collected at the stations outside the AZE on Transect A and B (129 mV and 226 mV respectively) were greater than the 0 mV minimum requirement cited in Criterion 2.1.1 of the ASC Salmon Standard. However, redox potential in sediment collected at the station outside the AZE on Transect C (-35.7) was less than the 0 mV minimum requirement cited in Criterion 2.1.1 of the ASC Salmon Standard

3.2 Parasiticide Residue

Analysis of the sediment collected from the stations outside the AZE on Transects A, B, C and the two reference stations for emamectin benzoate and florfenicol are shown in Table 3. The analysis was completed to fulfill the requirement of the ASC Salmon Standard Criterion number 5.2.1. All of the collected sediment samples analyzed had parasiticide residue concentrations less than the laboratory detectable limit.

Table 3: The parasiticide residue concentration of collected sediment at the stations outside the AZE on Transects A, B, C and the two reference stations at the Gore Island finfish aquaculture site on April 27 and 28, 2020.

Station Name	Sample Number	Emamectin Benzoate (ppm)	Florfenicol (ng/g)	Florfenicol Amine (ng/g)
Detection Limit		1.0	2.00	5.00
Outside AZE A	1	<1.0	<2.00	<5.00
Outside AZE A	2	<1.0	<2.00	<5.00
Outside AZE B	1	<1.0	<2.00	<5.00
Outside AZE B	2	<1.0	<2.00	<5.00
Outside AZE C	1	<1.0	<2.00	<5.00
Outside AZE C	2	<1.0	<2.00	<5.00
Reference 1	1	<1.0	<2.00	<5.00
Reference 1	2	<1.0	<2.00	<5.00
Reference 2	1	<1.0	<2.00	<5.00
Reference 2	2	<1.0	<2.00	<5.00

4.0 References

- Aquaculture Stewardship Council. 2012. ASC Salmon Standard Version 1.3. Available online: www.asc-aqua.org.
- Salas, F., Patrício, J. and Marques, J.C. 2006. Ecological Indicators in Coastal and Estuarine Environmental Quality Assessment - A user friendly guide for practitioners. Imprensa da Universidade de Coimbra.

Appendix 1 – Sample Photographs



Photo 1

Sediment sample collected at the 0m station on Transect A at the Gore Island site on April 27, 2020.

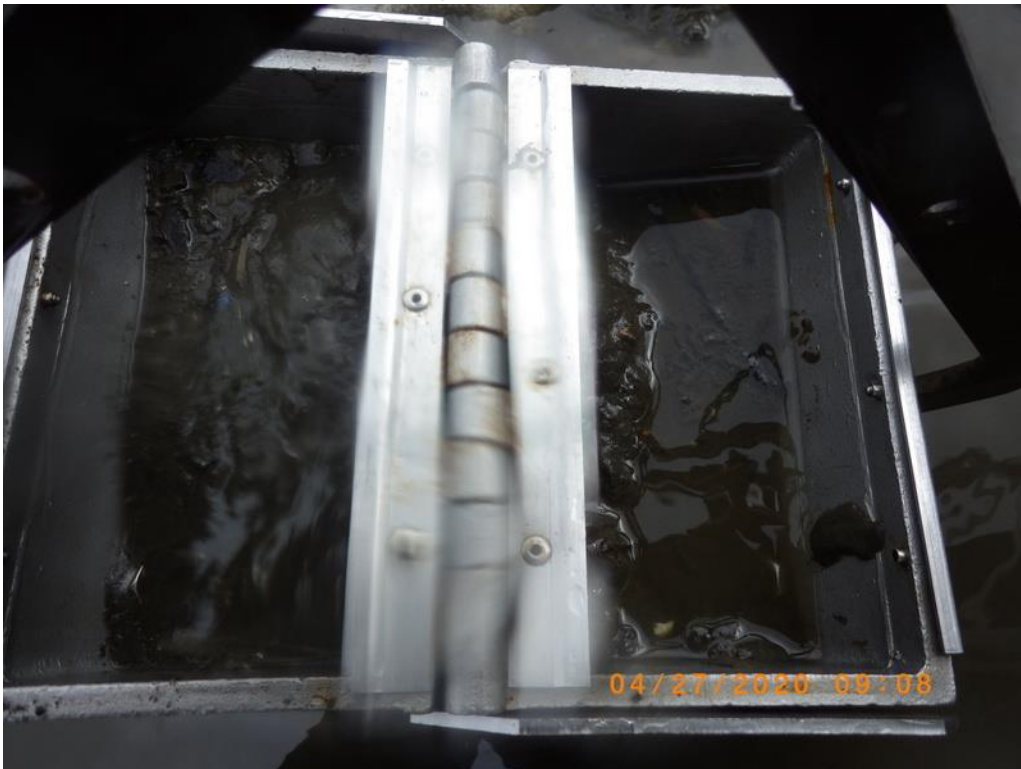


Photo 2

Sediment sample collected at the station outside the AZE on Transect A at the Gore Island site on April 27, 2020.



Photo 3

Sediment sample collected at the 0B station at the Gore Island site on April 27, 2020.



Photo 4

Sediment sample collected at the station inside the AZE on Transect B at the Gore Island site on April 27, 2020.



Photo 5

Sediment sample collected at the station outside the AZE on Transect B at the Gore Island site on April 27, 2020.



Photo 6

Sediment sample collected at the station inside the AZE on Transect C at the Gore Island site on April 27, 2020.

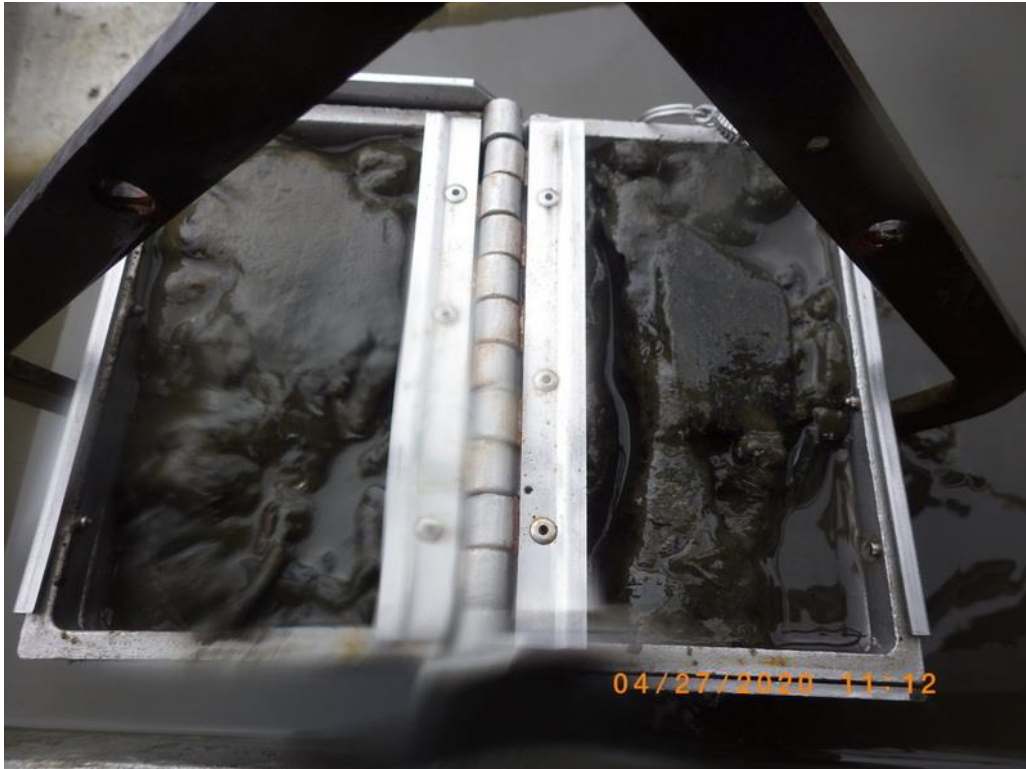


Photo 7

Sediment sample collected at the station outside the AZE on Transect C at the Gore Island site on April 27, 2020.



Photo 8

Sediment sample collected at the Reference 1 at the Gore Island site on April 28, 2020.



Photo 9

Sediment sample collected at the Reference 2 at the Gore Island site on April 28, 2020.

Appendix 2 – Gore Island Field Data

Reference Information:

Farm site:	Gore Island	Field Crew:	N. Delange, M. Wanless
Aquaculture Company:	Grieg Seafood BC Ltd.	Field Investigator:	Mainstream Biological Consulting Inc.
Site Reference #:	AQ1762	Laboratory:	SGS Canada Inc
Geographic Region:	Nootka Sound, BC		

<i>Transect A, B, C Name</i>	<i>Sampling Station Name</i>	<i>Replicate Number</i>	<i>Transect A, B, C Bearing (Magnetic)</i>	<i>Reference Station (Y/N)</i>	<i>Distance from Pens (m)</i>	<i>Sampling Device Type</i>	<i>Sampling Device Capacity (m2)</i>	<i>Quality Control Replicate (Y/N)</i>	<i>Replicate Analysis Type</i>	<i>Sample Date (YYYY-MM-DD)</i>	<i>Sample Time (24HH:MM)</i>	<i>Sample Latitude (Degrees)</i>	<i>Sample Latitude (Minutes)</i>	<i>Sample Longitude (Degrees)</i>	<i>Sample Longitude (Minutes)</i>	<i>GPS Correction Status</i>	<i>Ocean Depth (m)</i>	<i>Sample Depth (cm)</i>
A	0m	1	109	126	0	Petite Ponar	0.02			2020-04-27	09:19	49	38.7116	126	25.8934	Post-process corrected	103	5
A	0m	1	109	126	0	Petite Ponar	0.02	Y	Duplicate	2020-04-27	09:19	49	38.7116	126	25.8934	Post-process corrected	103	5
A	0m	1	109	126	0	Petite Ponar	0.02	Y	Triplicate	2020-04-27	09:19	49	38.7116	126	25.8934	Post-process corrected	103	5
A	0m	2	109	126	0	Petite Ponar	0.02			2020-04-27	09:25	49	38.7112	126	25.8927	Post-process corrected	103	6
A	25m	1	109	126	17.4	Petite Ponar	0.02			2020-04-27	09:51	49	38.7052	126	25.8851	Post-process corrected	116	5
A	25m	2	109	126	17.4	Petite Ponar	0.02			2020-04-27	09:58	49	38.7056	126	25.8835	Post-process corrected	117	6
B	0m	1	266	283	0	Petite Ponar	0.02			2020-04-27	12:35	49	38.8503	126	26.1951	Post-process corrected	103	5
B	0m	2	266	283	0	Petite Ponar	0.02			2020-04-27	12:44	49	38.8507	126	26.1954	Post-process corrected	103	7
B	5m	1	266	283	81	Petite Ponar	0.02			2020-04-27	13:26	49	38.8615	126	26.2599	Post-process corrected	106	5
B	5m	2	266	283	81	Van Veen	0.10			2020-04-27	13:58	49	38.8604	126	26.2601	Post-process corrected	106	10
B	25m	1	266	283	110	Van Veen	0.10			2020-04-27	14:22	49	38.8665	126	26.2840	Post-process corrected	113	12
B	25m	2	266	283	110	Van Veen	0.10			2020-04-27	14:47	49	38.8648	126	26.2849	Post-process corrected	113	10
C	5m	1	208	226	86.4	Petite Ponar	0.02			2020-04-27	11:28	49	38.7358	126	26.1242	Post-process corrected	112	10
C	5m	2	208	226	86.4	Petite Ponar	0.02			2020-04-27	11:36	49	38.7363	126	26.1236	Post-process corrected	112	9
C	25m	1	208	226	120	Petite Ponar	0.02			2020-04-27	12:02	49	38.7231	126	26.1436	Post-process corrected	140	10
C	25m	2	208	226	120	Petite Ponar	0.02			2020-04-27	12:09	49	38.7248	126	26.1454	Post-process corrected	140	8
Ref 1	1	1		Y	1030	Petite Ponar	0.02			2020-04-28	13:56	49	38.5977	126	26.9505	Uncorrected	140	10
Ref 1	2	2		Y	1030	Petite Ponar	0.02			2020-04-28	14:01	49	38.5983	126	26.9590	Uncorrected	140	10
Ref 2	1	1		Y	630	Petite Ponar	0.02			2020-04-28	14:19	49	38.6201	126	25.4041	Uncorrected	120	10
Ref 2	2	2		Y	630	Petite Ponar	0.02			2020-04-28	14:23	49	38.6198	126	25.3998	Uncorrected	120	9

<i>Transect A, B, C Name</i>	<i>Sampling Station Name</i>	<i>Replicate Number</i>	<i>Free Sulphide (micromolar)</i>	<i>Sediment Temperature (deg C)</i>	<i>Eh Uncorrected (mV)</i>	<i>Eh Corrected (mV)</i>	<i>Cu (micro-g/g)</i>	<i>Zn (micro-g/g)</i>	<i>Li (micro-g/g)</i>	<i>Gravel Percent</i>	<i>Sand Percent</i>	<i>Mud Percent</i>	<i>TVS Percent</i>	<i>Beggiatoa Observed (Y/N)</i>	<i>OPC Observed (Y/N)</i>	<i>Fish Feed Observed (Y/N)</i>	<i>Fish Feces Observed (Y/N)</i>	<i>Odour Rating</i>	<i>Black Sediment Observed (Y/N)</i>	<i>Gas Bubbles Observed (Y/N)</i>
A	0m	1	29.7	8.1	-175.4	40.6								N	N	N	N	1	N	N
A	0m	1	19.2	8.1	-173.7	42.3								N	N	N	N	1	N	N
A	0m	1		8.1	-198.1	17.9								N	N	N	N	1	N	N
A	0m	2	47.9	8	-177.2	38.8								N	N	N	N	1	N	N
A	25m	1	25.3	8.2	-125.2	90.8								N	N	N	N	1	N	N
A	25m	2	57.5	8.3	-48.2	167.8								N	N	N	N	1	N	N
B	0m	1	1440	8.3	-316.4	-100.4								N	N	N	N	2	N	N
B	0m	2	1360	8.5	-333.5	-118.5								N	N	N	N	3	N	N
B	5m	1	61.4	9	-55	160								N	N	N	N	0	N	N
B	5m	2	34.6	8.9	-13.7	201.3								N	N	N	N	0	N	N
B	25m	1	45.6	10.1	-4.2	209.8								N	N	N	N	0	N	N
B	25m	2	25.1	9.9	28.2	242.2								N	N	N	N	0	N	N
C	5m	1	135	8.4	-241	-25								N	N	N	N	1	N	N
C	5m	2	164	8.2	-247.4	-31.4								N	N	N	N	1	N	N
C	25m	1	84.6	9.2	-259.3	-44.3								N	N	N	N	1	N	N
C	25m	2	85.1	8.5	-242.1	-27.1								N	N	N	N	1	N	N
Ref 1	1	1	8.11	8.2	-78.2	137.8								N	N	N	N	0	N	N
Ref 1	2	2	13.1	8.1	-81.2	134.8								N	N	N	N	0	N	N
Ref 2	1	1	17.2	8.2	-66.5	149.5								N	N	N	N	0	N	N
Ref 2	2	2	17.4	8.3	-78.6	137.4								N	N	N	N	0	N	N

Table note:

- Odour rating: ranked on a scale of 0 (no odour) to 4 (very strong sulphide odour)

<i>Transect A, B, C Name</i>	<i>Sampling Station Name</i>	<i>Replicate Number</i>	<i>Flocculent Organic Material Observed (Y/N)</i>	<i>Shell Hash Observed (Y/N)</i>	<i>Terrigenous Material Observed (Y/N)</i>	<i>Farm Litter Observed (Y/N)</i>	<i>Macrophytes Observed (Y/N)</i>	<i>Megafauna Observed (Y/N)</i>	<i>Sediment Colour Observations</i>	<i>Sediment Texture Observations</i>	<i>Other Sample Observations (Comments)</i>
A	0m	1	N	Y	Y	N	N	N	Green	Mud	Twig, Pine needle
A	0m	1	N	Y	Y	N	N	N	Green	Mud	Twig, Pine needle
A	0m	1	N	Y	Y	N	N	N	Green	Mud	Twig, Pine needle
A	0m	2	N	Y	Y	N	N	N	Green	Mud	Twig
A	25m	1	N	Y	Y	N	N	N	Green	Mud	Twig
A	25m	2	N	Y	Y	N	N	N	Grey	Mud	Twig
B	0m	1	N	Y	Y	N	N	N	Grey	Gravely-mud	Alder leaf, Pine needles
B	0m	2	N	Y	Y	N	N	N	Grey	Gravely-mud	Pine needles, twigs
B	5m	1	N	Y	Y	N	N	N	Grey	Gravely-mud	Cedar needle
B	5m	2	N	Y	Y	N	N	N	Grey	Gravely-mud	Twig
B	25m	1	N	Y	Y	N	N	N	Grey	Gravely-sand	Twig, Cedar needles
B	25m	2	N	Y	Y	N	N	N	Green	Gravely-sand	Cedar needle, worm tube
C	5m	1	N	Y	Y	N	N	N	Green	Mud	Stick
C	5m	2	N	Y	N	N	N	N	Green	Mud	
C	25m	1	N	Y	Y	N	N	N	Green	Mud	Sticks, worm tubes
C	25m	2	N	Y	Y	N	N	N	Green	Mud	Twig
Ref 1	1	1	N	Y	Y	N	N	N	Green	Mud	Pine needles, twigs
Ref 1	2	2	N	Y	Y	N	N	N	Green	Mud	Twig
Ref 2	1	1	N	Y	Y	N	N	N	Green	Mud	Alder leaf
Ref 2	2	2	N	Y	N	N	N	N	Green	Mud	

Appendix 3 – Gore Island ASC Survey Summary

Company:	Grieg Seafood BC Ltd.	Sample date:	April 27 and 28, 2020
Farm Site:	Gore Island	Field crew:	N. Delange, M. Wanless
Site License #:	AQ1762	Analytical:	SGS Canada Inc
Site Location	Nootka Sound, BC		

SULPHIDES Indicator 2.1.1 Requirement ≤ 1500 (μm)					
Station	Rep 1	Rep 2	n	Mean	ASC Criteria Met
0m A	29.7	47.9	2	38.8	
Outside AZE A	25.3	54.7	2	40.0	Yes
0m B	1440	1360	2	1400	
Inside AZE B	61.4	34.6	2	48.0	
Outside AZE B	45.6	25.1	2	35.4	Yes
Inside AZE C	135	164	2	150	
Outside AZE C	84.6	85.1	2	84.9	Yes
Reference 1	8.11	13.1	2	10.6	
Reference 2	17.2	17.4	2	17.3	

REDOX POTENTIAL Indicator 2.1.1 Requirement > 0 mV					
Station	Rep 1	Rep 2	N	Mean	ASC Criteria Met
0m A	40.6	38.8	2	39.7	
Outside AZE A	90.8	167.8	2	129.3	Yes
0m B	-100.4	-118.5	2	-109.5	
Inside AZE B	160.0	201.3	2	180.7	
Outside AZE B	209.8	242.2	2	226.0	Yes
Inside AZE C	-25.0	-31.4	2	-28.2	
Outside AZE C	-44.3	-27.1	2	-35.7	No
Reference 1	137.8	134.8	2	136.3	
Reference 2	149.5	137.4	2	143.5	