

FINFISH AQUACULTURE SITE AQUACULTURE STEWARDSHIP COUNCIL REPORT Noo-LA, CLIO CHANNEL, BC

*SITE LICENSE: AQ1825
SURVEY TYPE: ASC
SURVEY DATE: JUNE 2, 2021
REPORT DATE: JUNE 19, 2021*

PREPARED FOR:

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Summary

This document presents the qualitative and quantitative assessment of sediment obtained during the survey completed at the Noo-La finfish aquaculture site operated by Grieg Seafood BC, Ltd in Clio Channel, BC, on June 2, 2021. 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, B and C was greater than the ASC Salmon Standard acceptable lower limit of 0 mV.

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 two reference stations. Emamectin 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/>

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1.0 Introduction

This document presents the marine sediment data collected as part of a benthic study completed at the Noo-La finfish aquaculture site operated by Grieg Seafood BC, Ltd (Campbell River, BC). The Noo-La site is located in Clio Channel, 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).

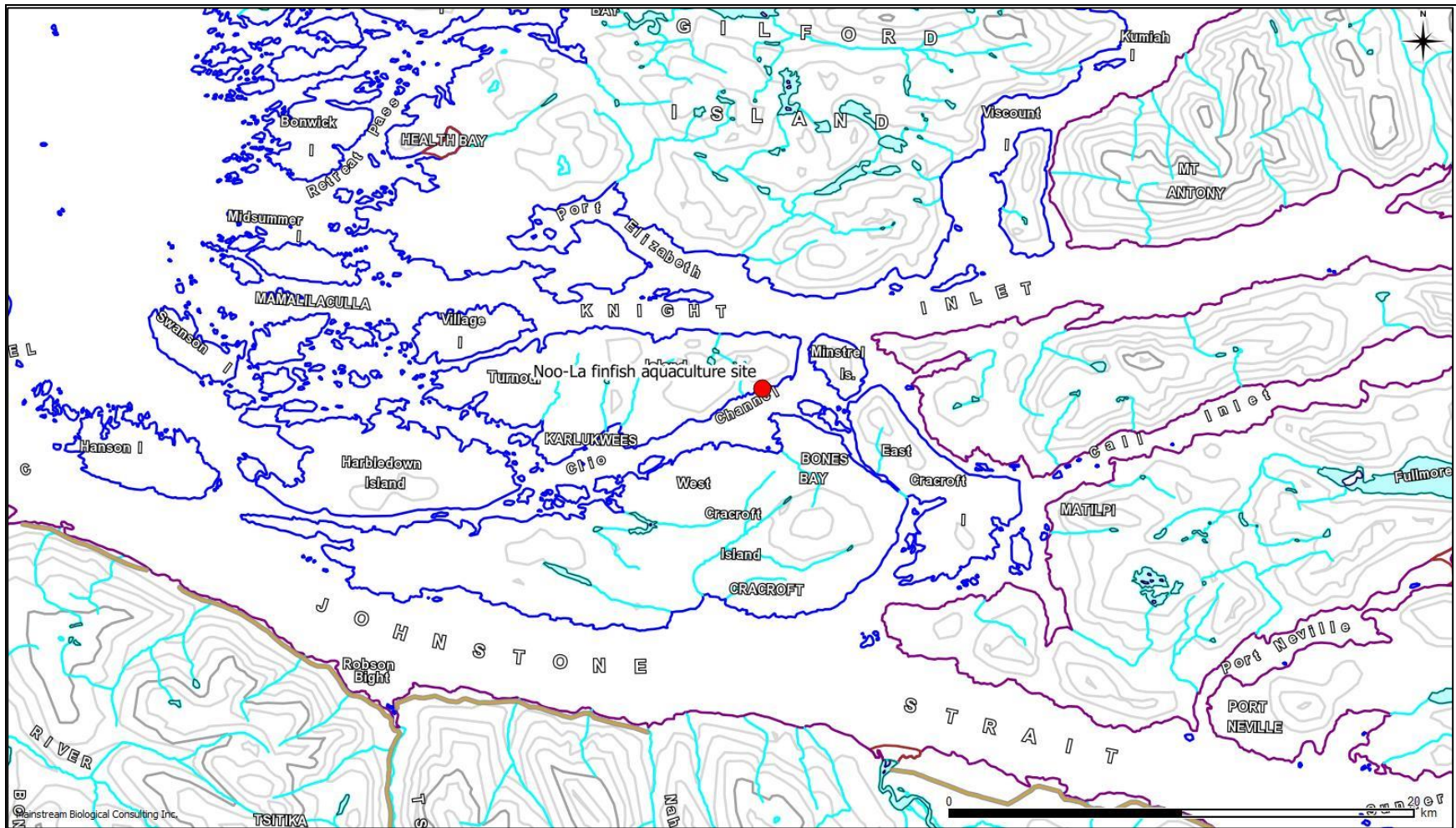


Figure 1: An overview map showing the approximate location of the Noo-La finfish aquaculture farm site (red dot) in Clio Channel, BC.

2.0 Methods

The substrate at the designated sampling locations at the Noo-La finfish aquaculture site had been previously identified to consist of “soft” sediment. Therefore, the field activities involved the 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. 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 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 Beaver Cove station (BCOV).

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.

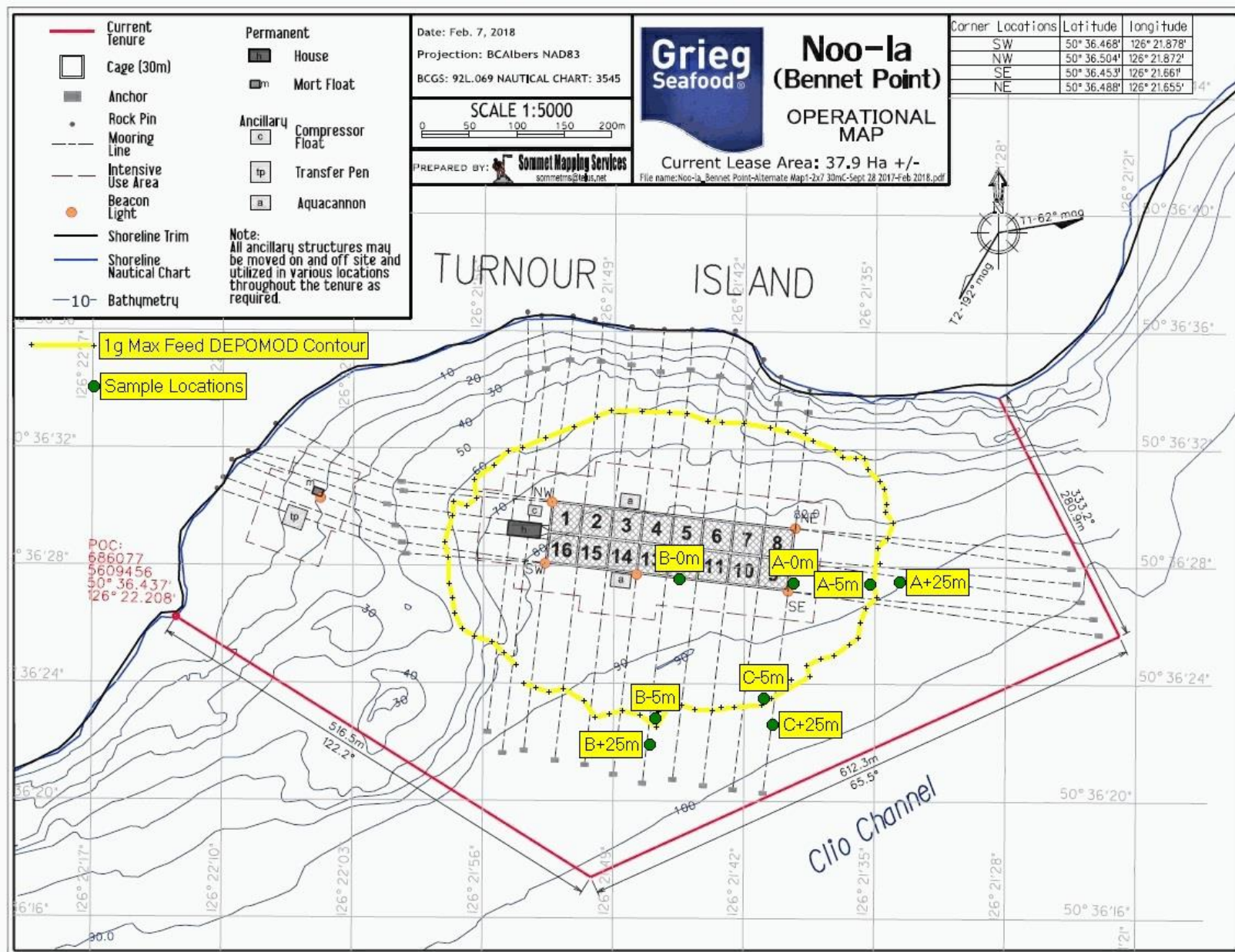


Figure 2: The locations of the sampling stations for the ASC survey at the Noo-La finfish aquaculture site in relation to the pen system and surrounding area on June 2, 2021.

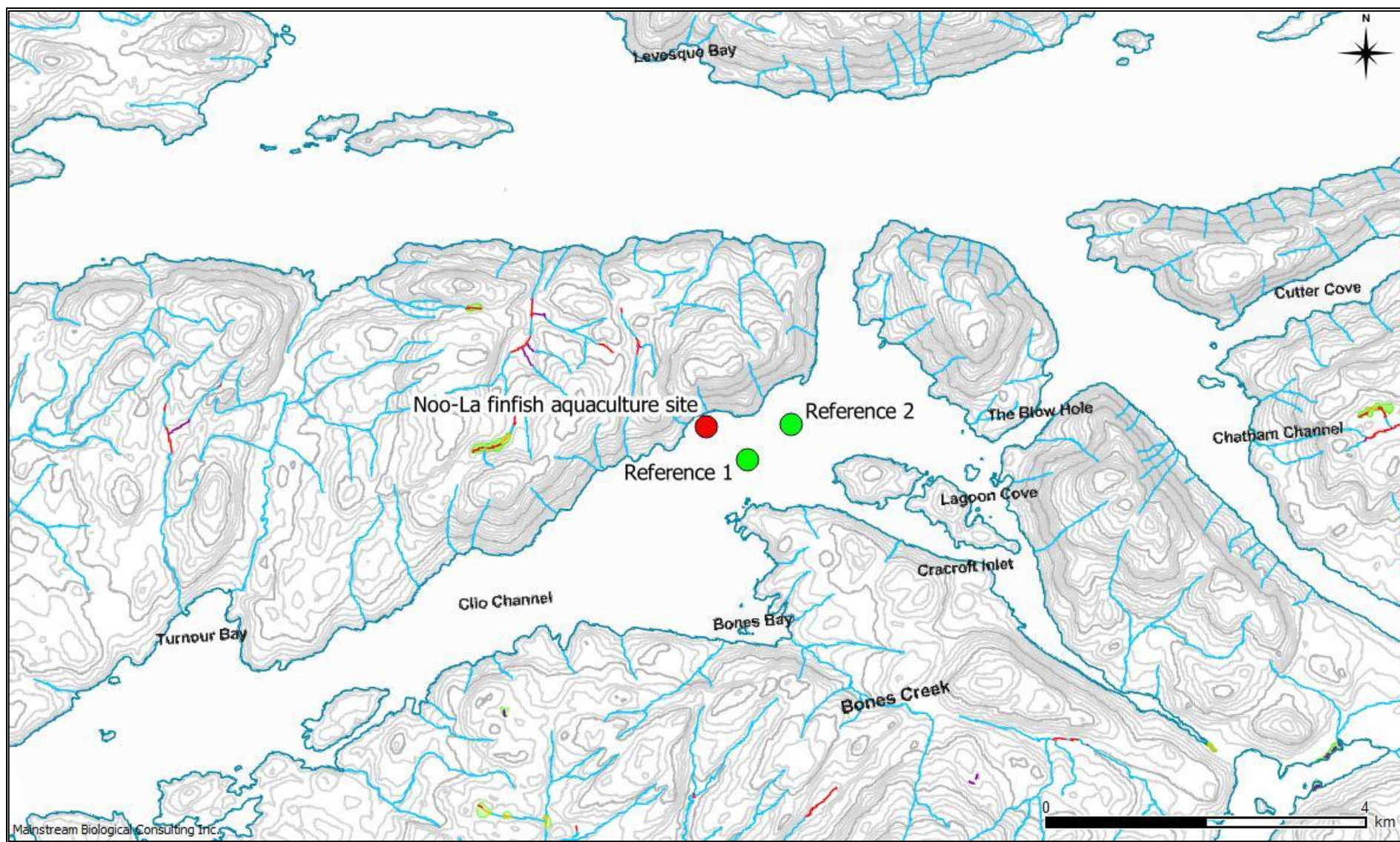


Figure 3: The locations of the reference stations for the ASC survey at the Noo-La finfish aquaculture site in relation to the site and surrounding area on June 2, 2021.

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

To evaluate if the benthic conditions at and near the Noo-La 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 Noo-La 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 Noo-La sampling stations typically consisted of green mud. Shell hash, tube worms and terrigenous material were common.

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 Noo-La 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 (260 µM, 106 µM and 93.2 µM respectively) on June 2, 2021 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, B and C (119.0 mV, 38.2 mV and 44.3 mV respectively) were greater 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 Noo-La finfish aquaculture site on June 2, 2021.

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 Noo-La site on June 2, 2021.

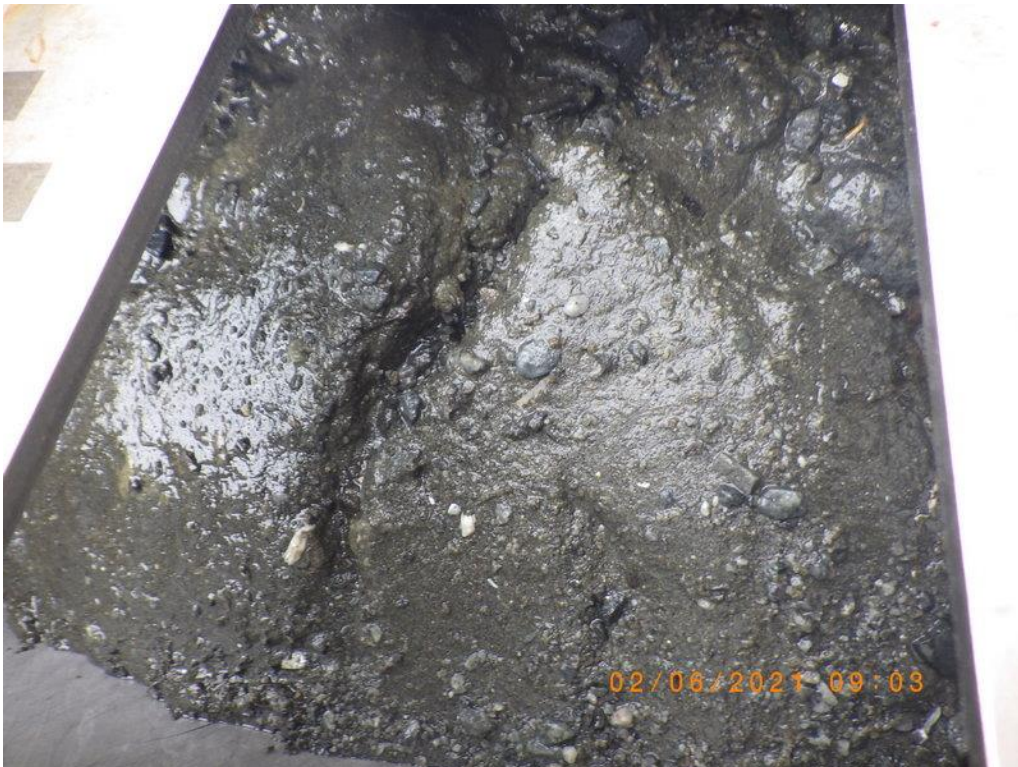


Photo 2

Sediment sample collected at the station inside the AZE on Transect A at the Noo-La site on June 2, 2021.



Photo 3

Sediment sample collected at the station outside the AZE on Transect A at the Noo-La site on June 2, 2021.



Photo 4

Sediment sample collected at the 0B station at the Noo-La site on June 2, 2021.



Photo 5

Sediment sample collected at the station inside the AZE on Transect B at the Noo-La site on June 2, 2021.



Photo 6

Sediment sample collected at the station outside the AZE on Transect B at the Noo-La site on June 2, 2021.



Photo 7

Sediment sample collected at the station inside the AZE on Transect C at the Noo-La site on June 2, 2021.



Photo 8

Sediment sample collected at the station outside the AZE on Transect C at the Noo-La site on June 2, 2021.



Photo 9

Sediment sample collected at the Reference 1 at the Noo-La site on June 2, 2021.



Photo 10

Sediment sample collected at the Reference 2 at the Noo-La site on June 2, 2021.

Appendix 2 – Noo-La Field Data

Reference Information:			
Farm site:	Noo-La	Field Crew:	E. Weiss, P. Jones
Aquaculture Company:	Grieg Seafood BC, Ltd	Field Investigator:	Mainstream Biological Consulting Inc.
Site Reference #:	AQ1825	Laboratory:	SGS Canada Inc
Geographic Region:	Clio Channel, BC		

Transect A, B, C Name	Sampling Station Name	Replicate Number	Transect A, B, C Bearing (Magnetic)	Reference Station (Y/N)	Distance from Pens (m)	Sampling Device Type	Sampling Device Capacity (m2)	Quality Control Replicate (Y/N)	Replicate Analysis Type	Sample Date (YYYY-MM-DD)	Sample Time (24HH:MM)	Sample Latitude (Degrees)	Sample Latitude (Minutes)	Sample Longitude (Degrees)	Sample Longitude (Minutes)	GPS Correction Status	Ocean Depth (m)	Sample Depth (cm)
A	A-0m	1	72	N	0	Petite Ponar	0.02	N		2021-06-02	07:33	50	36.4568	126	21.6573	Post-process corrected	89.4	5
A	A-0m	1	72	N	0	Petite Ponar	0.02	Y	Duplicate	2021-06-02	07:33	50	36.4568	126	21.6573	Post-process corrected	89.4	5
A	A-0m	1	72	N	0	Petite Ponar	0.02	Y	Triplicate	2021-06-02	07:33	50	36.4568	126	21.6573	Post-process corrected	89.4	5
A	A-0m	2	72	N	0	Petite Ponar	0.02	N		2021-06-02	07:43	50	36.4569	126	21.6573	Post-process corrected	89.4	5
A	A-5m	1	72	N	81	Van Veen	0.10	N		2021-06-02	08:53	50	36.4562	126	21.5887	Post-process corrected	92.3	10
A	A-5m	2	72	N	81	Van Veen	0.10	N		2021-06-02	08:59	50	36.4579	126	21.5911	Post-process corrected	92.3	15
A	A+25m	1	72	N	112	Van Veen	0.10	N		2021-06-02	09:38	50	36.4577	126	21.5622	Post-process corrected	96.6	16
A	A+25m	2	72	N	112	Van Veen	0.10	N		2021-06-02	09:44	50	36.4580	126	21.5632	Post-process corrected	96.5	16
B	B-0m	1	172	N	0	Van Veen	0.10	N		2021-06-02	11:08	50	36.4586	126	21.7592	Post-process corrected	87.0	10
B	B-0m	2	172	N	0	Van Veen	0.10	N		2021-06-02	11:13	50	36.4587	126	21.7592	Post-process corrected	87.0	10
B	B-5m	1	172	N	156	Van Veen	0.10	N		2021-06-02	11:25	50	36.3756	126	21.7805	Post-process corrected	102	10
B	B-5m	2	172	N	156	Van Veen	0.10	N		2021-06-02	11:30	50	36.3764	126	21.7817	Post-process corrected	102	16
B	B+25m	1	172	N	186	Van Veen	0.10	N		2021-06-02	11:39	50	36.3599	126	21.7855	Post-process corrected	96.6	10
B	B+25m	2	172	N	186	Van Veen	0.10	N		2021-06-02	11:45	50	36.3605	126	21.7849	Post-process corrected	96.6	10
C	C-5m	1	145	N	121	Petite Ponar	0.02	N		2021-06-02	10:13	50	36.3878	126	21.6837	Post-process corrected	95.3	5
C	C-5m	2	145	N	121	Petite Ponar	0.02	N		2021-06-02	10:19	50	36.3883	126	21.6842	Post-process corrected	95.2	5
C	C+25m	1	145	N	149	Van Veen	0.10	N		2021-06-02	10:40	50	36.3721	126	21.6760	Post-process corrected	110	15
C	C+25m	2	145	N	149	Van Veen	0.10	N		2021-06-02	10:53	50	36.3718	126	21.6771	Post-process corrected	110	19
Reference	Ref 1	1		Y	610	Petite Ponar	0.02	N		2021-06-02	13:23	50	36.1634	126	21.4577	Post-process corrected	103	10
Reference	Ref 1	2		Y	610	Petite Ponar	0.02	N		2021-06-02	13:29	50	36.1648	126	21.4549	Post-process corrected	103	10
Reference	Ref 2	1		Y	890	Petite Ponar	0.02	N		2021-06-02	12:58	50	36.3910	126	20.9600	Post-process corrected	107	5
Reference	Ref 2	2		Y	890	Petite Ponar	0.02	N		2021-06-02	13:06	50	36.3904	126	20.9604	Post-process corrected	107	5

<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	A-0m	1	475	8.2	-343.1	-127.1								N	N	N	N	3	N	N
A	A-0m	1	703	8.2	-351.9	-135.9								N	N	N	N	3	N	N
A	A-0m	1		8.2	-353.2	-137.2								N	N	N	N	3	N	N
A	A-0m	2	822	9.5	-349.3	-135.3								N	N	N	N	4	N	N
A	A-5m	1	408	8.9	-253.9	-38.9								N	N	N	N	2	N	N
A	A-5m	2	682	8.8	-300.8	-85.8								N	N	N	N	3	N	N
A	A+25m	1	147	9.1	-100.6	114.4								N	N	N	N	0	N	N
A	A+25m	2	373	8.8	-91.4	123.6								N	N	N	N	0	N	N
B	B-0m	1	695	10.4	-363.5	-149.5								N	N	N	N	4	N	N
B	B-0m	2	1460	9.4	-368.3	-153.3								N	N	N	N	4	N	N
B	B-5m	1	93.5	9.0	-288.4	-73.4								N	N	N	N	0	N	N
B	B-5m	2	138	9.3	-275.1	-60.1								N	N	N	N	0	N	N
B	B+25m	1	184	9.7	-107.3	106.7								N	N	N	N	0	N	N
B	B+25m	2	27.6	8.9	-245.4	-30.4								N	N	N	N	0	N	N
C	C-5m	1	21.2	10.7	2.8	215.8								N	N	N	N	0	N	N
C	C-5m	2	343	11.1	57.0	270.0								N	N	N	N	0	N	N
C	C+25m	1	19.3	9.8	-316.3	-102.3								N	N	N	N	0	N	N
C	C+25m	2	167	9.2	-24.2	190.8								N	N	N	N	0	N	N
Reference	Ref 1	1	15.4	10.0	-192.6	21.4								N	N	N	N	0	N	N
Reference	Ref 1	2	62.1	10.3	-220.6	-6.6								N	N	N	N	0	N	N
Reference	Ref 2	1	69.7	10.1	-120.0	94.0								N	N	N	N	0	N	N
Reference	Ref 2	2	52.5	10.9	-118.5	94.5								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	A-0m	1	N	Y	Y	N	N	N	Dark grey	Mud	Cedar needles
A	A-0m	1	N	Y	Y	N	N	N	Dark grey	Mud	Cedar needles
A	A-0m	1	N	Y	Y	N	N	N	Dark grey	Mud	Cedar needles
A	A-0m	2	N	N	N	N	N	N	Dark grey	Mud	
A	A-5m	1	N	Y	N	N	N	Y	Green	Mud	Tubeworms, cobble
A	A-5m	2	N	Y	N	N	N	N	Green	Gravel / mud	Cobble / pebbles
A	A+25m	1	N	Y	Y	N	N	N	Green	Mud	Twigs
A	A+25m	2	N	Y	Y	N	N	Y	Green	Mud	Twigs, tubeworms
B	B-0m	1	N	Y	Y	N	N	N	Dark grey	Mud	Wood debris
B	B-0m	2	N	Y	Y	N	N	N	Dark grey	Mud	Twigs
B	B-5m	1	N	Y	Y	N	N	Y	Green	Mud	Twigs, tubeworms
B	B-5m	2	N	Y	Y	N	N	Y	Green	Mud	Twigs, tubeworms
B	B+25m	1	N	Y	N	N	N	Y	Green	Gravel / mud	Tubeworms, pebbles
B	B+25m	2	N	Y	N	N	N	Y	Green	Mud	Tubeworms, cobble
C	C-5m	1	N	Y	N	N	N	Y	Green	Mud	Tubeworms
C	C-5m	2	N	N	N	N	N	N	Green	Gravel / mud	
C	C+25m	1	N	N	N	N	N	Y	Green	Mud	Tubeworms
C	C+25m	2	N	Y	Y	N	N	Y	Green	Mud	Twigs, worm
Reference	Ref 1	1	N	N	N	N	N	N	Green	Mud	
Reference	Ref 1	2	N	N	N	N	N	N	Green	Mud	
Reference	Ref 2	1	N	Y	N	N	N	N	Green	Mud	
Reference	Ref 2	2	N	Y	N	N	N	Y	Green	Mud	Worms

Appendix 3 – Noo-La ASC Survey Summary

Company:	Grieg Seafood BC, Ltd	Sample date:	June 2, 2021
Farm Site:	Noo-La	Field crew:	E. Weiss, P. Jones
Site License #:	AQ1825	Analytical:	SGS Canada Inc
Site Location	Clio Channel, BC		

SULPHIDES Indicator 2.1.1 Requirement ≤ 1500 (μm)					
Station	Rep 1	Rep 2	n	Mean	ASC Criteria Met
0m A	475	822	2	649	
Inside AZE A	408	682	2	545	
Outside AZE A	147	373	2	260	Yes
0m B	695	1460	2	1080	
Inside AZE B	93.5	138	2	116	
Outside AZE B	184	27.6	2	106	Yes
Inside AZE C	21.2	343	2	182	
Outside AZE C	19.3	167	2	93.2	Yes
Reference 1	15.4	62.1	2	38.8	
Reference 2	69.7	52.5	2	61.1	

REDOX POTENTIAL Indicator 2.1.1 Requirement > 0 mV					
Station	Rep 1	Rep 2	N	Mean	ASC Criteria Met
0m A	-127.1	-135.3	2	-131.2	
Inside AZE A	-38.9	-85.8	2	-62.4	
Outside AZE A	114.4	123.6	2	119.0	Yes
0m B	-149.5	-153.3	2	-151.4	
Inside AZE B	-73.4	-60.1	2	-66.8	
Outside AZE B	106.7	-30.4	2	38.2	Yes
Inside AZE C	215.8	270.0	2	242.9	
Outside AZE C	-102.3	190.8	2	44.3	Yes
Reference 1	21.4	-6.6	2	7.4	
Reference 2	94.0	94.5	2	94.3	