

FINFISH AQUACULTURE SITE AQUACULTURE STEWARDSHIP COUNCIL REPORT WA-KWA, CLIO CHANNEL, BC

SITE LICENSE: AQ1839

SURVEY TYPE: ASC

SURVEY DATE: SEPTEMBER 7 AND OCTOBER 3, 2023

REPORT DATE: OCTOBER 6, 2023

PREPARED FOR:

*GRIEG SEAFOOD BC LTD
1180 IRONWOOD ST,
CAMPBELL RIVER, BC
V9W 5Q2*



Summary

This document presents the qualitative and quantitative assessment of sediment obtained during the survey completed at the Wa-Kwa finfish aquaculture site operated by Grieg Seafood Ltd BC in Clio Channel, BC, on September 7 and October 3, 2023. Sediment was collected and the data analyzed according to the *Aquaculture Activities Regulations* (AAR) and adapted to address Criterion 2.1 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 Transect B had a mean sulphide level less than the ASC Salmon Standard acceptable limit of 1500 µm. Transect C had a mean sulphide level greater than the ASC Salmon Standard acceptable limit of 1500 µm. Sediment could not be successfully collected at the station outside the Allowable Zone of Effect (AZE) on Transect A. Redox potential measured in sediment obtained outside the AZE on Transect B was greater than the ASC Salmon Standard acceptable lower limit of 0 mV. Redox potential measured in sediment obtained outside the AZE on Transect C was less than the ASC Salmon Standard acceptable lower limit of 0 mV.

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
4.0 References	8
Appendix 1 – Sample Photographs	I
Appendix 2 – Wa-Kwa Field Data	VI
Appendix 3 – Wa-Kwa ASC Survey Summary	IX

1.0 Introduction

This document presents the marine sediment data collected as part of a benthic study completed at the Wa-Kwa finfish aquaculture site operated by Grieg Seafood BC Ltd (Campbell River, BC). The Wa-Kwa 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.

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 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.

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).

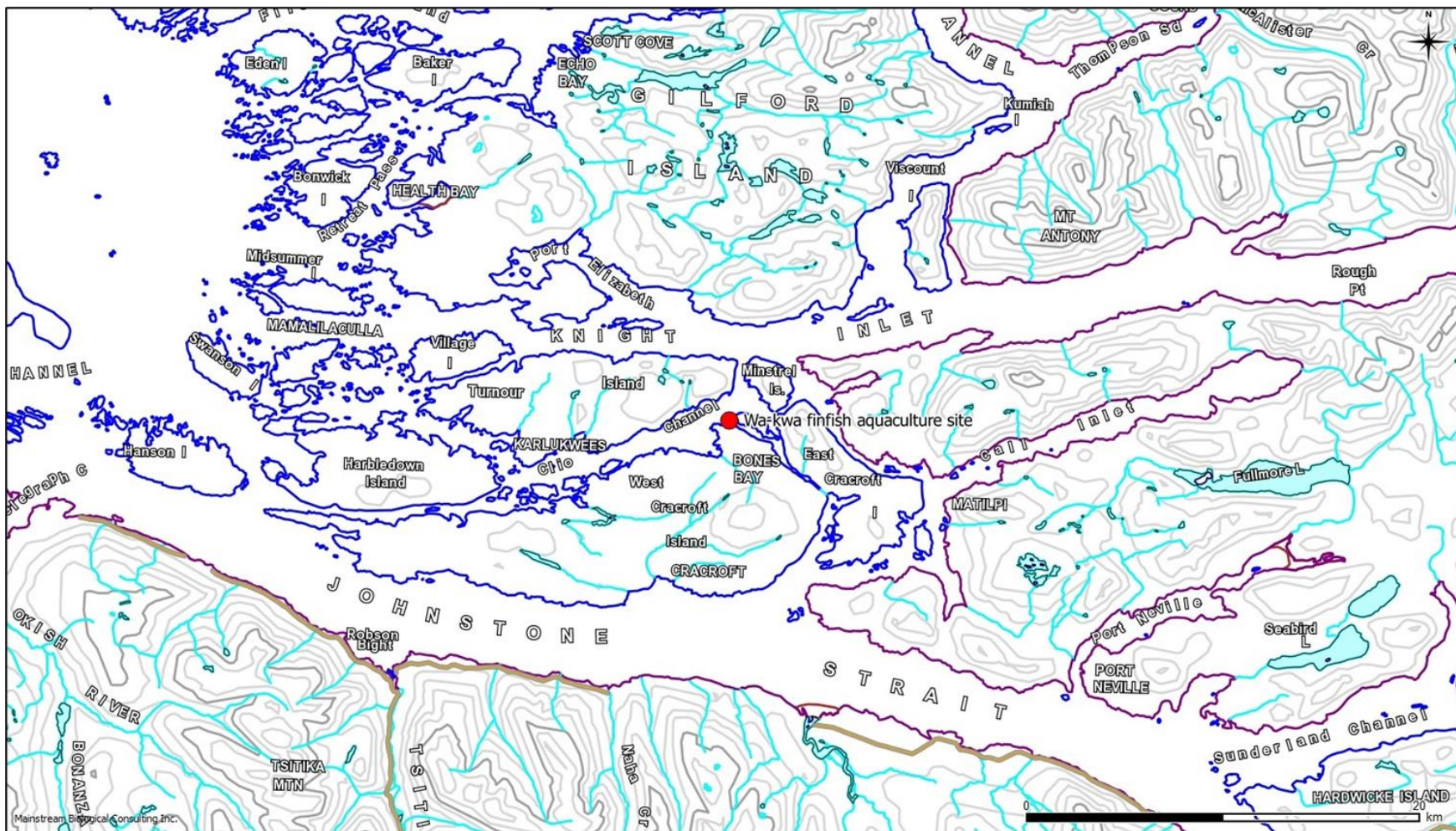


Figure 1: An overview map showing the approximate location of the Wa-Kwa finfish aquaculture farm site (red dot) in Clio Channel, BC.

2.0 Methods

The substrate at the designated sampling locations at the Wa-Kwa finfish aquaculture site had not been previously determined as a new containment system had been installed resulting in a new location of the 1 g DEPOMOD contour location and therefore new sampling locations. 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. 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 sampler. Two sediment samples were collected at each successful 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 SEAT (Seattle, WA) base station.

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.

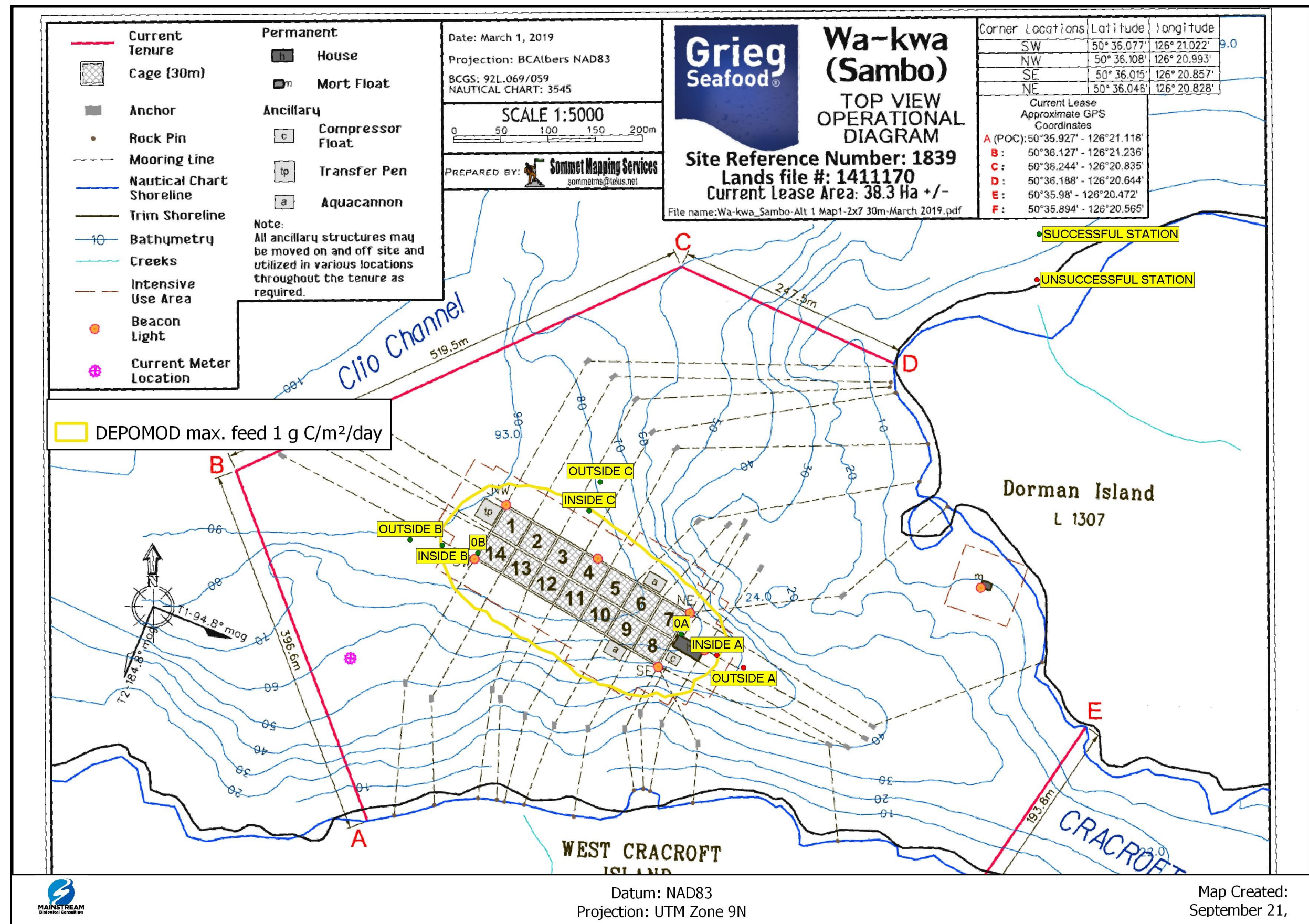


Figure 2: The locations of the sampling stations for the ASC survey at the Wa-Kwa finfish aquaculture site in relation to the pen system and surrounding area on September 7 and October 3, 2023.

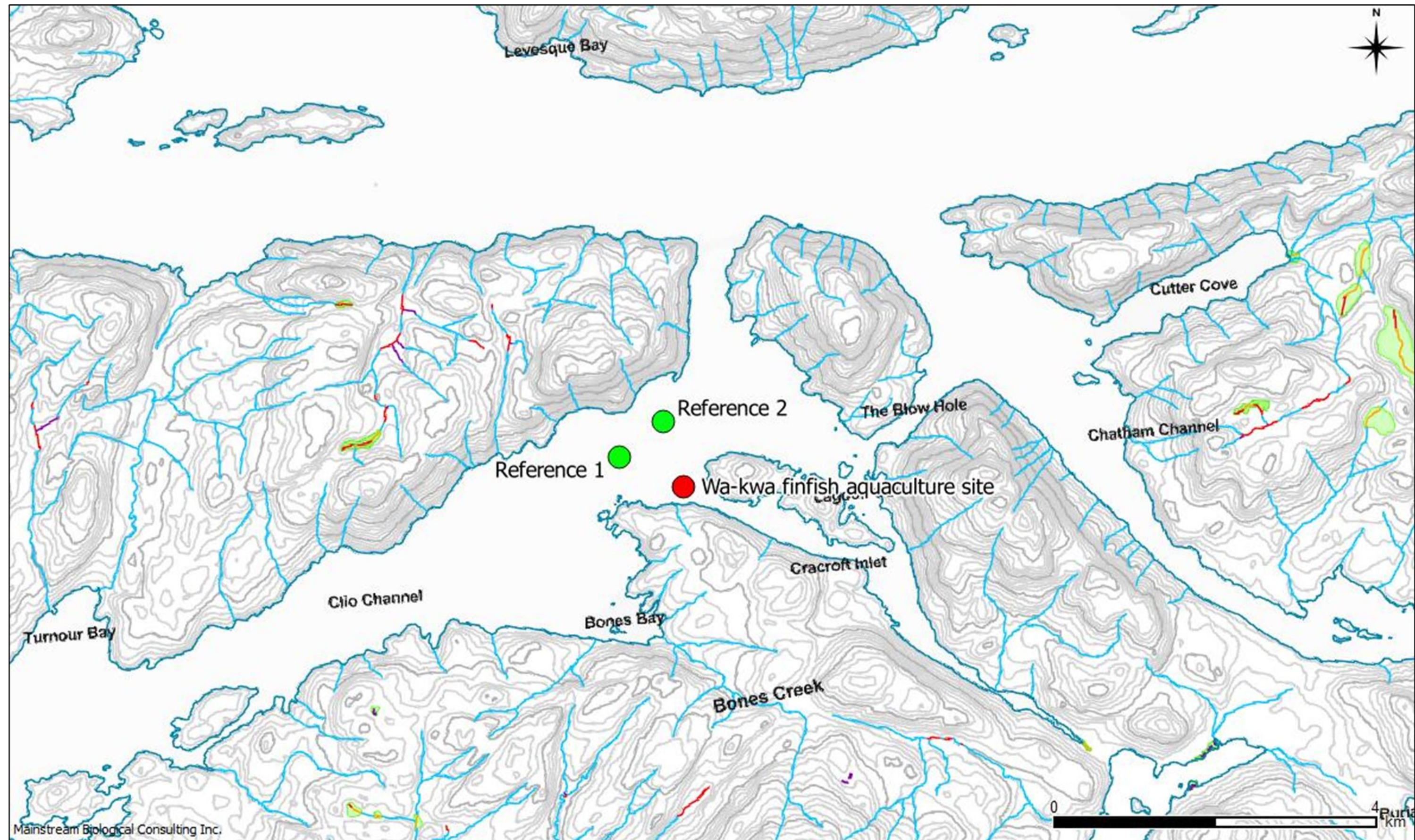


Figure 3: The locations of the reference stations for the ASC survey at the Wa-Kwa finfish aquaculture site in relation to the site and surrounding area on September 7, 2023

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.

2.2 Data Analysis

To evaluate if the benthic conditions at and near the Wa-Kwa 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.

Table 1: Summary of indicators of benthic health, biodiversity and ecosystem function that were considered during the evaluation of the Wa-Kwa 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 Wa-Kwa sampling stations typically consisted of brown mud with flecks of shell hash with a mild to strong sulphide odour.

Sediment could not be successfully collected inside the AZE on Transect A as a compressor float was located directly above the sampling location (Photo 2). Sediment could also not be successfully obtained outside the AZE on Transect A and the results of each unsuccessful grab attempt are presented in Table 2.

Table 2: The location and results of each unsuccessful grab attempt at the Wa-Kwa finfish aquaculture site on October 3, 2023.

Station	Latitude	Longitude	Distance from Pens (m)	Sampling Device	Comments
Outside AZE A	50 36.01572	126 20.77873	74	Petite Ponar	Bark, sand, shell hash
Outside AZE A	50 36.01540	126 20.77985	74	Petite Ponar	Skiff of sediment
Outside AZE A	50 36.01514	126 20.77768	74	Petite Ponar	Skiff of sediment
Outside AZE A	50 36.01497	126 20.77829	74	Petite Ponar	Few rocks

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 Wa-Kwa facility was meeting the certification requirements (Appendix 3).

The mean sulphide level in sediment collected at the stations outside AZE on Transects B and C were 276 μM , and 3065 μM respectively on October 3, 2023. The station outside the AZE on Transect B was less than the ASC Salmon Standard sulphide upper limit of 1500 μM while the station outside the AZE on Transect C was greater than the ASC upper limit.

Mean redox potential in sediment collected at the stations outside the AZE on Transect B and C were 18.0 mV and -98.6 mV respectively. The station outside the AZE on Transect B was greater than the 0 mV minimum requirement cited in Criterion 2.1.1 of the ASC Salmon Standard while the station outside the AZE on Transect C was below the lower limit.

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 Wa-Kwa site on September 7, 2023.



Photo 2

A view of the barge located directly over the station inside the AZE on Transect A at the Wa-Kwa site on October 3, 2023.



Photo 3

A typical missed grab at the station outside the AZE on Transect A at the Wa-Kwa site on October 3, 2023



Photo 4

Sediment sample collected at the 0B station at the Wa-Kwa site on September 7, 2023.



Photo 5

Sediment sample collected at the station inside the AZE on Transect B at the Wa-Kwa site on October 3, 2023.



Photo 6

Sediment sample collected at the station outside the AZE on Transect B at the Wa-Kwa site on October 3, 2023.



Photo 7

Sediment sample collected at the station inside the AZE on Transect C at the Wa-Kwa site on October 3, 2023.



Photo 8

Sediment sample collected at the station outside the AZE on Transect C at the Wa-Kwa site on October 3, 2023.



Photo 9

Sediment sample collected at the Reference 1 at the Wa-Kwa site on September 7, 2023.



Photo 10

Sediment sample collected at the Reference 2 at the Wa-Kwa site on September 7, 2023.

Appendix 2 – Wa-Kwa Field Data

Reference Information:	
Farm site:	Wa-Kwa
Aquaculture Company:	Grieg Seafood BC Ltd
Site Reference #:	AQ1839
Geographic Region:	Clio Channel, BC
Field Crew:	T. Karjala, E. Jarry
Field Investigator:	Mainstream Biological Consulting Inc.
Laboratory:	SGS Canada Inc

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			0	Ponar	0.02	N		2023-09-07	07:21	50	36.0348	126	20.8213	Post-process corrected	56.0	5
A	A-0m	2			0	Ponar	0.02	N		2023-09-07	07:27	50	36.0348	126	20.8211	Post-process corrected	54.9	6
B	B-0m	1	264		0	Ponar	0.02	N		2023-09-07	10:35	50	36.0789	126	21.0077	Post-process corrected	87.3	6
B	B-0m	1	264		0	Ponar	0.02	Y	Duplicate	2023-09-07	10:35	50	36.0789	126	21.0077	Post-process corrected	87.3	6
B	B-0m	1	264		0	Ponar	0.02	Y	Triplicate	2023-09-07	10:35	50	36.0789	126	21.0077	Post-process corrected	87.3	6
B	B-0m	2	264		0	Ponar	0.02	N		2023-09-07	10:42	50	36.0787	126	21.0074	Post-process corrected	87.3	6
B	B-5m	1	264		43	Ponar	0.02	N		2023-10-03	11:36	50	36.0864	126	21.0548	Post-process corrected	88.7	8
B	B-5m	2	264		43	Ponar	0.02	N		2023-10-03	11:47	50	36.0862	126	21.0550	Post-process corrected	88.5	5
B	B+25m	1	264		73	Ponar	0.02	N		2023-10-03	11:57	50	36.0883	126	21.0793	Post-process corrected	88.4	6
B	B+25m	2	264		73	Ponar	0.02	N		2023-10-03	12:02	50	36.0895	126	21.0796	Post-process corrected	88.6	6
C	C-5m	1	2		49	Ponar	0.02	N		2023-10-03	10:55	50	36.1108	126	20.9144	Post-process corrected	79.1	8
C	C-5m	2	2		49	Ponar	0.02	N		2023-10-03	11:01	50	36.1104	126	20.9145	Post-process corrected	79.6	6
C	C-5m	2	2		49	Ponar	0.02	Y	Duplicate	2023-10-03	11:01	50	36.1104	126	20.9145	Post-process corrected	79.6	6
C	C-5m	2	2		49	Ponar	0.02	Y	Triplicate	2023-10-03	11:01	50	36.1104	126	20.9145	Post-process corrected	79.6	6
C	C+25m	1	2		79	Ponar	0.02	N		2023-10-03	11:17	50	36.1261	126	20.9063	Post-process corrected	72.8	9
C	C+25m	2	2		79	Ponar	0.02	N		2023-10-03	11:22	50	36.1264	126	20.9062	Post-process corrected	73.3	6
Ref 1	Ref 1	1			534	Ponar	0.02	N		2023-09-07	13:19	50	36.1675	126	21.4550	Post-process corrected	105	10
Ref 1	Ref 1	2			534	Ponar	0.02	N		2023-09-07	13:22	50	36.1676	126	21.4563	Post-process corrected	104	10
Ref 2	Ref 2	1			576	Ponar	0.02	N		2023-09-07	13:32	50	36.3882	126	20.9616	Post-process corrected	107	5
Ref 2	Ref 2	2			576	Ponar	0.02	N		2023-09-07	13:38	50	36.3873	126	20.9623	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	9430	8.8	-349.2	-134.2								N	N	N	N	4	N	N
A	A-0m	2	6470	9.0	-350.9	-135.9								N	N	N	N	4	N	N
B	B-0m	1	9250	9.5	-361.4	-147.4								N	N	Y	Y	4	N	Y
B	B-0m	1	9180	9.5	-362.4	-148.4								N	N	Y	Y	4	N	Y
B	B-0m	1		9.5	-365.8	-151.8								N	N	Y	Y	4	N	Y
B	B-0m	2	8540	9.3	-360.7	-145.7								N	N	Y	Y	4	N	N
B	B-5m	1	249	9.5	-192.8	21.2								N	N	N	N	1	N	N
B	B-5m	2	158	9.7	-151.2	62.8								N	N	N	N	1	N	N
B	B+25m	1	243	9.5	-179.1	34.9								N	N	N	N	1	N	N
B	B+25m	2	308	9.8	-211.3	2.7								N	N	N	N	2	N	N
C	C-5m	1	5870	9.7	-327.8	-113.8								Y	N	N	N	4	N	N
C	C-5m	2	5930	9.6	-335.4	-121.4								Y	N	N	N	4	N	N
C	C-5m	2	6010	9.6	-336.1	-122.1								Y	N	N	N	4	N	N
C	C-5m	2		9.6	-337.6	-123.6								Y	N	N	N	4	N	N
C	C+25m	1	3510	9.7	-311.9	-97.9								Y	N	N	N	4	N	N
C	C+25m	2	2620	9.6	-313.3	-99.3								Y	N	N	N	4	N	N
Ref 1	Ref 1	1	51.9	10.6	-106.2	106.8								N	N	N	N	0	N	N
Ref 1	Ref 1	2	51.4	10.3	-85.6	128.4								N	N	N	N	0	N	N
Ref 2	Ref 2	1	34.4	9.8	-61.7	152.3								N	N	N	N	0	N	N
Ref 2	Ref 2	2	22.1	10.1	-30.6	183.4								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	A-0m	1	N	Y	Y	N	N	Y	Dark brown	Mud	Flecks shell hash, pine needle
A	A-0m	2	N	Y	Y	N	N	Y	Dark brown	Mud	Flecks shell hash, pine needle, trace beggiatoa
B	B-0m	1	Y	Y	N	N	N	N	Brown	Mud	Flecks shell hash, fish feed, fish feces
B	B-0m	1	Y	Y	N	N	N	N	Brown	Mud	Flecks shell hash, fish feed, fish feces
B	B-0m	1	Y	Y	N	N	N	N	Brown	Mud	Flecks shell hash, fish feed, fish feces
B	B-0m	2	N	Y	N	N	N	N	Brown	Mud	Flecks shell hash, fish feed, fish feces
B	B-5m	1	N	Y	N	N	N	Y	Dark Brown	Mud	Flecks shell hash, tubeworm
B	B-5m	2	N	Y	N	N	N	N	Dark Brown	Mud	Flecks shell hash
B	B+25m	1	N	Y	N	N	N	Y	Dark Brown	Mud	Flecks shell hash, tubeworm
B	B+25m	2	N	Y	N	N	N	Y	Dark Brown	Mud	Flecks shell hash, tubeworm
C	C-5m	1	N	N	N	N	N	N	Dark Brown	Mud	Trace beggiatoa
C	C-5m	2	N	N	N	N	N	N	Dark Brown	Mud	
C	C-5m	2	N	N	N	N	N	N	Dark Brown	Mud	
C	C-5m	2	N	N	N	N	N	N	Dark Brown	Mud	
C	C+25m	1	N	N	N	N	N	N	Dark Brown	Mud	Moderate beggiatoa
C	C+25m	2	N	N	N	N	N	N	Dark Brown	Mud	Trace beggiatoa
Ref 1	Ref 1	1	N	N	N	N	N	N	Light brown	Mud	
Ref 1	Ref 1	2	N	N	N	N	N	N	Light brown	Mud	
Ref 2	Ref 2	1	N	Y	N	N	N	Y	Light brown	Mud	Flecks shell hash, tubeworm
Ref 2	Ref 2	2	N	Y	N	N	N	Y	Light brown	Mud	Flecks shell hash, tubeworm

Appendix 3 – Wa-Kwa ASC Survey Summary

Company:	Grieg Seafood BC Ltd	Sample date:	September 7 and October 3, 2023
Farm Site:	Wa-Kwa	Field crew:	T. Karjala, E. Jarry
Site License #:	AQ1839	Analytical:	
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	9430	6470	2	7950	
0m B	9250	8540	2	8895	
Inside AZE B	249	158	2	204	
Outside AZE B	243	308	2	276	Yes
Inside AZE C	5870	5930	2	5900	
Outside AZE C	3510	2620	2	3065	No
Reference 1	51.9	51.4	2	51.7	
Reference 2	34.4	22.1	2	28.3	

REDOX POTENTIAL Indicator 2.1.1 Requirement > 0 mV					
Station	Rep 1	Rep 2	N	Mean	ASC Criteria Met
0m A	-134.2	-135.9	2	-135.1	
0m B	-147.4	-145.7	2	-146.6	
Inside AZE B	21.2	62.8	2	42.0	
Outside AZE B	34.9	2.7	2	18.8	Yes
Inside AZE C	-113.8	-121.2	2	-117.6	
Outside AZE C	-97.9	-99.3	2	-98.6	No
Reference 1	106.8	128.4	2	117.6	
Reference 2	152.3	183.4	2	167.9	