REGISTRATION OF AN UNDERTAKING

UNDER THE ENVIRONMENTAL ASSESSMENT REGULATIONS, 2003, SECTION 29

"PLACENTIA BAY ATLANTIC SALMON AQUACULTURE PROJECT"

(PART 1 & PART 2)

Prepared for:
Government of Newfoundland and Labrador
Department of Environment and Conservation
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January 31st, 2016

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Bibliography

Benfey, T.J. (1999). Use of triploid Atlantic salmon (*Salmo salar*) for aquaculture. DFO Canadian Stock Assessment Secretariat. Res. Doc. 1998/166. v + 11p.

Benfey, T.J. (1999). The Physiology and Behavior of Triploid Fishes, *Review in Fisheries Science*, *7:1*, 39-97, doi: 10.1080/10641269991319162.

Benfey, T.J. (2015). Biocontainment measures to reduce/mitigate potential post-escape interactions between cultured European-origin and wild native Atlantic salmon in Newfoundland. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/003. v + 28 p.

Cotter, D., O'Donovan, V., O'Maoiléidigh, N., Rogan, G., Roche, N., Wilkins, N.P. (2000). An evaluation of the use of triploid Atlantic salmon (Salmo salar L.) in minimizing the impact of escaped farmed salmon on wild populations, *Aquaculture, 186,* 61-75.

DFO. 2013. Recovery Potential Assessment for the South Newfoundland Atlantic Salmon (*Salmo salar*) Designatable Unit. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/007.

Fjelldal, P.G., Wennevik, V., Fleming, I.A., Hansen, T., Glover, K.A. (2014). Triploid (sterile) farmed Atlantic salmon males attempt to spawn with wild females, *Aquaculture Environment Interactions, Volume 5,* 155-162. doi: 10.3354/aei00102

Pepper, V.A., Nicholls, T., and Collier, C. 2004. Reproductive technologies applied to Newfoundland salmonid aquaculture to enhance commercial production. Can. Tech. Rep. Fish. Aquat. Sci. 254: v + 50p.

Storset, A. (n.d.). Production of sterile salmon ready for sea cages? [PowerPoint slides]. Retrieved from http://aquagen.no/wp-content/uploads/2013/08/Production-of-sterile-salmon-ready-for-sea-cages.pdf

Robertson, M.J., Weir, L.K., and Dempson J.B. (2013). Population viability analysis for the South Newfoundland Atlantic Salmon (*Salmo salar*) designatable unit. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/090. vii + 26 p.

Sutterlin, A.M and C. Collier. (1991). Some observations on the commercial use of triploid rainbow trout and Atlantic salmon in Newfoundland, Canada. Can. Tech. Rep. Fish. Aquat. Sci. 1789 :89-96.

Taylor, J. F., Waagbø, R., Diez-Padrisa, M., Campbell, P., Walton, J., Hunter, D., Matthew, C., Migaud, J. (2015). Adult triploid Atlantic salmon (Salmo salar) have higher dietary histidine requirements to prevent cataract development in seawater, *Aquaculture Nutrition*, *21*, 18-32. doi:1111/anu.12130

This project is divided into two parts to better define operations that are land based and freshwater in nature (part 1) and those operations that take place at sea and are marine based (part 2).

1 NAME OF UNDERTAKING PART 1

"Placentia Bay Atlantic Salmon Aquaculture Project"

"Part 1"

2 PROPONENT PART 1

2.1 Name of Corporate Body:

Grieg NL Nurseries Ltd.

2.2 Address:

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3 THE UNDERTAKING PART 1

3.1 Nature of the Part 1 Undertaking:

This undertaking is a construction and operation of a Recirculation Aquaculture System (RAS) Hatchery for Atlantic salmon (*Salmo salar*) in the Marystown Marine Industrial Park on Lots 7, 9, 11, 13, and 15. The facility, once constructed, will produce 1,800,000 smolt of Atlantic salmon (*Salmo salar*) 300 grams in May, 2,400,000 smolt of 450 grams in July, 1,800,000 at 600 grams in October for full cycle production and 1,000,000 smolt at 1,500 grams in April for a seasonal production. This will be a biosecure facility and all access and supplies will be of a controlled nature. The smolt from the RAS Hatchery will be sold to Grieg NL Seafarms Ltd. for a sea cage operation, a sister company.

3.2 Purpose/Rationale/Need for the Part 1 Undertaking:

The purpose of the project is to produce the disease free seed stock for the sister company Grieg NL Seafarms Ltd. The Marystown site is ideal in that it provides suitable groundwater and land adjacent to the Mortier Bay for ease of loading unto a wellboat with minimal handling and without having to truck the fish. Production of the salmon smolt locally in the Province provides for ease of permitting Introduction and Transfer Licenses. The facility will provide for a critical asset in the farming production of Atlantic salmon in Newfoundland and Labrador and adding greatly to the prosperity of the Province. The use of water and land for the project are a part of the renewable and sustainable resources of the Province making this a pastoral project. The project is a very important piece of a network of assets that will provide much needed sustainable employment to rural Newfoundland and Labrador. The project will provide profit to its shareholders, business opportunity to suppliers, wholesome food to customers, and finally tax revenue to the Municipality, the Province and the Country.

3.3 Alternatives to the Part 1 Undertaking:

There are no alternatives to the undertaking as it is proposed in Marystown for Newfoundland and Labrador without compromising:

1. Management Efficiency -- by creating distance between various operations of hatchery, marine farms, and processing;

2. Economics -- by creating greater distances for transportation; and,

3. Fish Health -- by inducing more handling and for longer periods. The proposed location of the facility in Marystown is adjacent to marine farms on the south coast.

At the start of the assessment of the project, including hatching and smoltification, consideration was given to the southwest and west coasts of Newfoundland. The Hydrogeology of the west coast including the Codroy Valley and Bay St. Georges was studied for possible hatching and smoltification facilities. There appeared to be adequate supplies of suitable groundwater resources on the west coast. The consideration of building hatching and smoltification facilities on the west coast was rejected because it was more distant from the intended customers than the Marystown aquifer. Hatchery and smoltification development was given full consideration to the most economical and animal welfare sensitive solution in Marystown rather than 700 kilometers away on the west coast.

4 DESCRIPTION OF THE UNDERTAKING PART 1

4.1 Geographic Location Part 1:

Part 1 of the project will be undertaken at serviced Lots 7, 9, 11, 13, and 15 adjacent to the Marine Industrial Park Access Road from the Buin Peninsula Highway Route 210 in Marystown. For the purpose of the Aquaculture License Application the estimated central location was stated as N47º 10.741' W55º 08.271'. The area combined for all lots is 10.2455 hectares. The exact location is provided in the figures below:

Figure 1 – Location of Hatchery Provincial Perspective

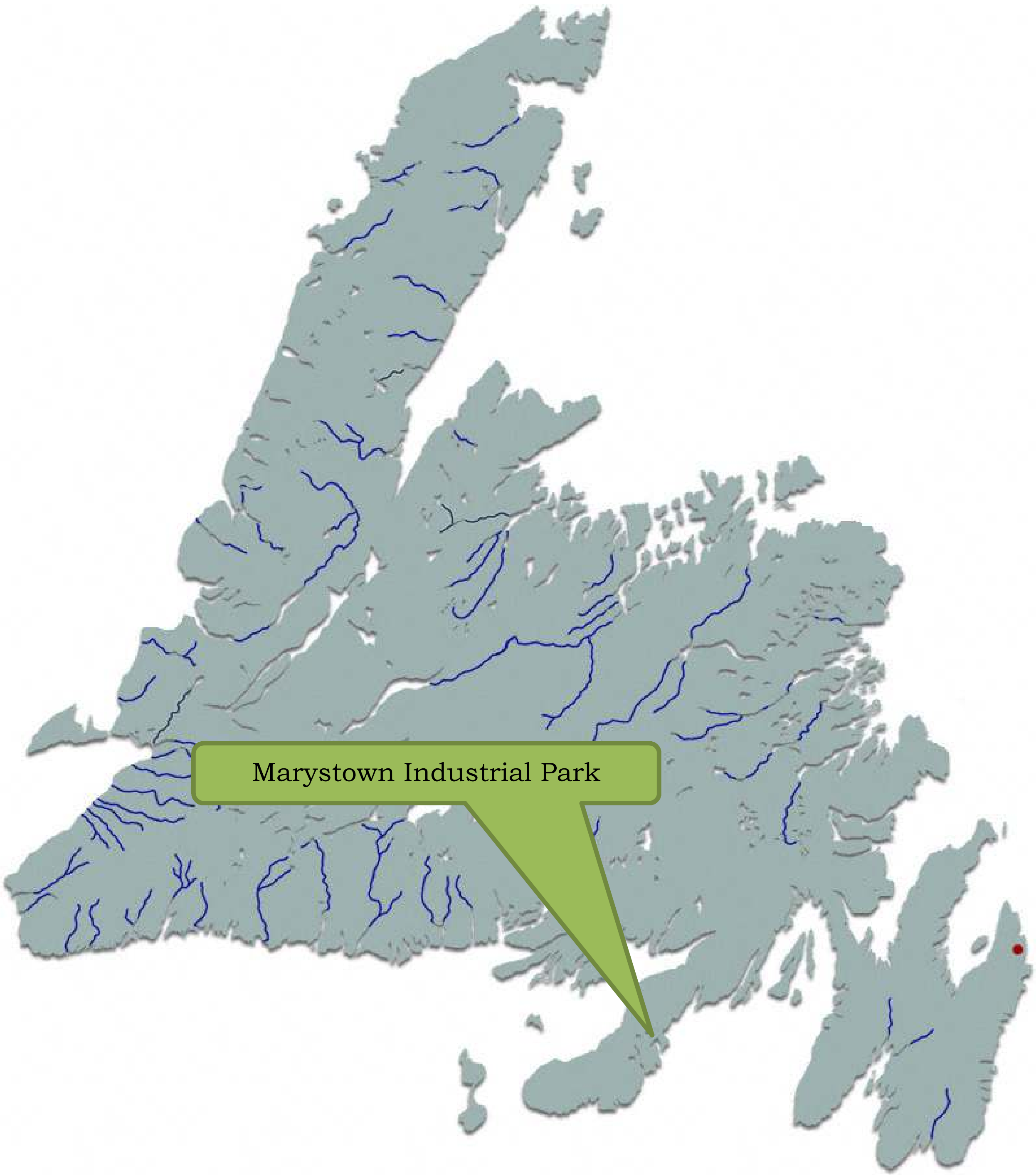


Figure 2 – Location of Hatchery Regional Perspective

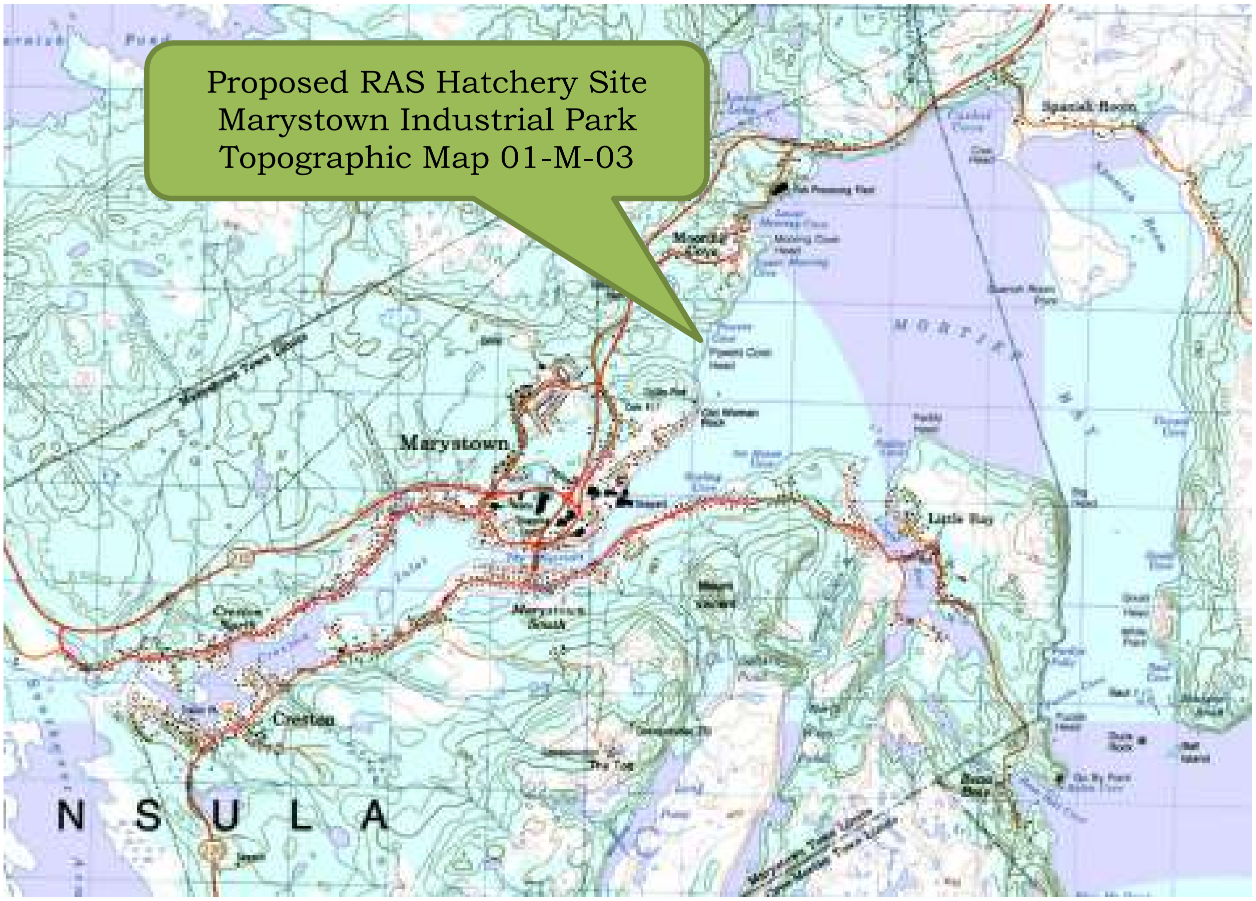


Figure 3 – Location of Hatchery Aerial Perspective

4.2 Physical Features of the Area Part 1:

4.2.1 Major Features of Part 1 of the Undertaking:

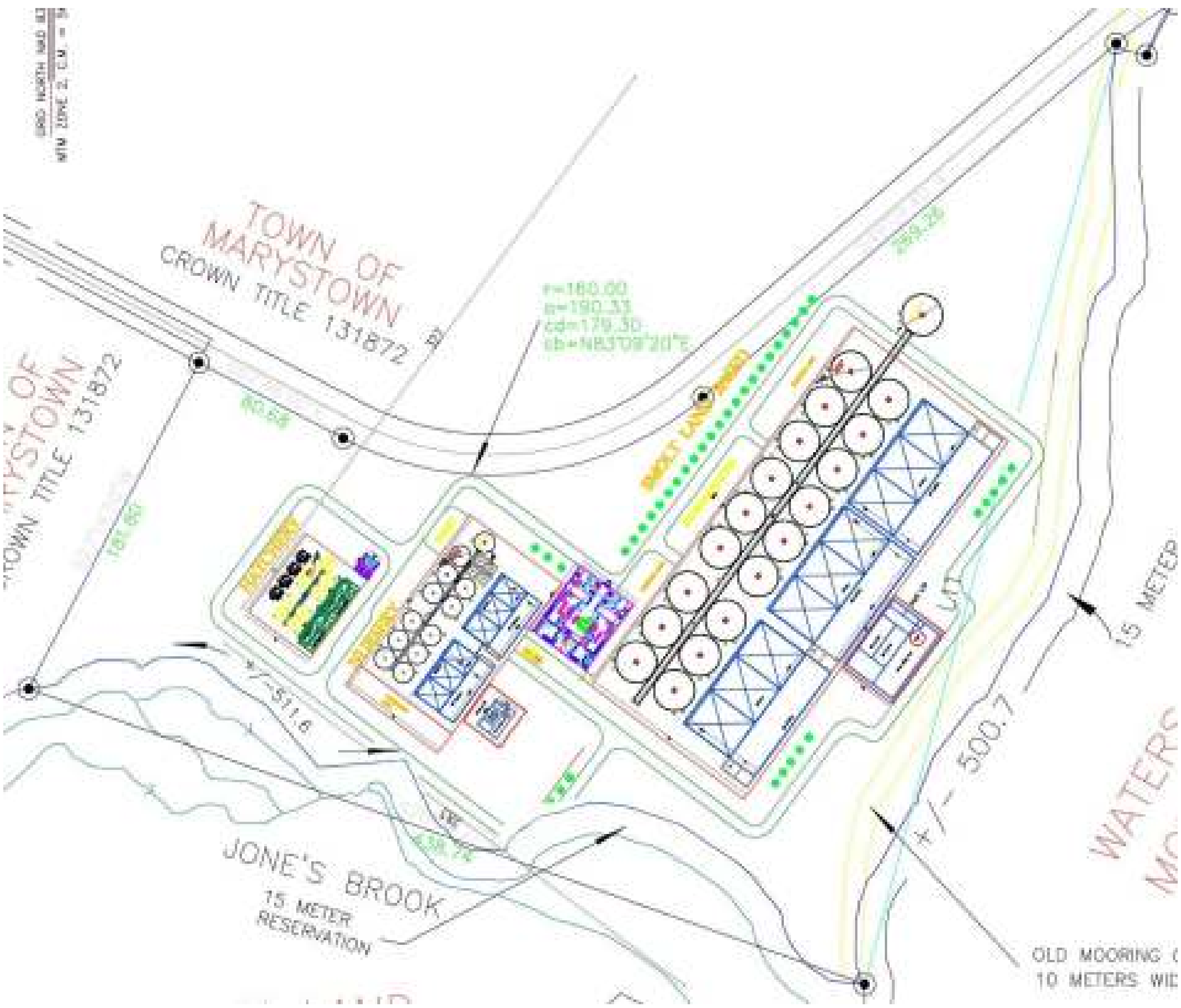
The main features of Part 1 of the undertaking will be a parking lot and the buildings -- Hatchery, Smolt Nursery, and Smolt Landbase. The lots are already serviced with 3 phase power, municipal water and sewer, and a paved access road.

Figure 4 – Picture of Service to the Hatchery Lots

4.2.2 Area to be Affected by Part 1 of the Undertaking:

The area affected by part 1 of the undertaking is 10.2455 hectares. A digital rendition of the site is presented in the figure below.

Figure 5 – Area Affected by the Part 1 Undertaking



4.2.3 Existing Biophysical Environment of Part 1:

4.2.3.1 Topography for Part 1

The project site is located within the Maritime Barrens Eco-region (6) and Sub-Region Southeastern Barrens. This is identified as 6B in the Figure below. It encompasses much of the Burin and Avalon peninsulas. The Department of Natural Resources describes the Eco-region as follows:

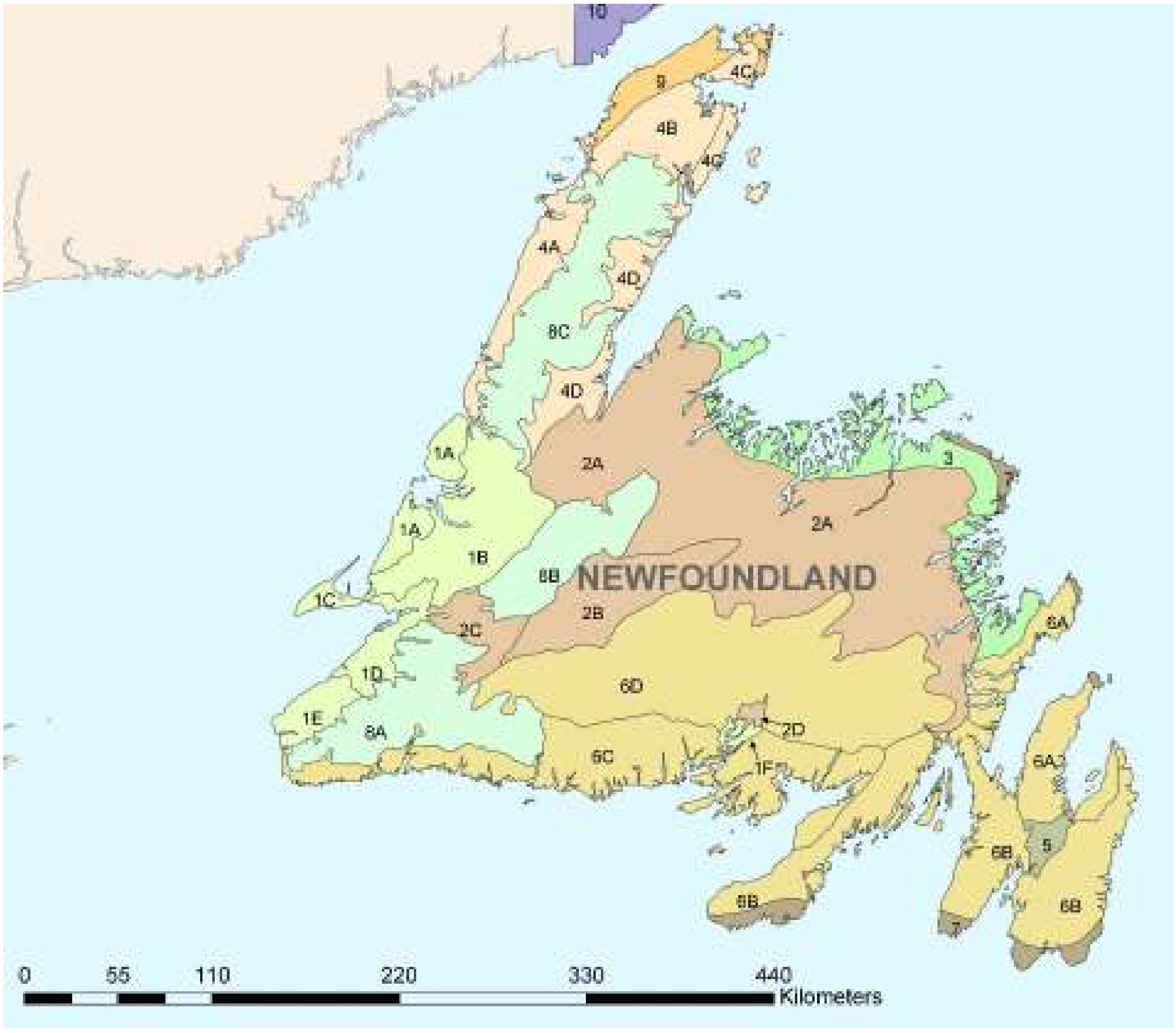
> "*The Maritime Barrens Ecoregion extends from the east coast of Newfoundland to the west coast through the south central portion of the island. This ecoregion has the coldest summers with frequent fog and strong winds. Winters are relatively mild with intermittent snow cover particularly near the coastline. Annual precipitation exceeds 1250 mm.*
>
> *The landscape pattern consists of usually stunted, almost pure stands of Balsam Fir, broken by extensive open heathland. Good forest growth is localized on long slopes of a few protected valleys. The development of the extensive heath landscape was precipitated by indiscriminate burning by European settlers. Railways in the nineteenth century also had a significant impact on fire frequency in the eastern part of the region. The heaths are dominated by* ***Kalmia angustifolia*** *on protected slopes where snow accumulates and by cushions of* ***Empetrum nigrum*** *or* ***Empetrum easmesii*** *on windswept ridges and headlands.*
>
> *Attempts to afforest these heaths with* ***Picea sitchensis*** *have been unsuccessful, but Eastern larch and Scots Pine may have potential for fuelwood stands (Hall 1986). However, site selection is critical because the historical removal of forest has deflected the natural tree line to low elevations. Wind, lack of protective snow cover and soil frost disturbance are important factors limiting plantation establishment in this ecoregion."*

The Department of Natural Resources describes the Southeastern Barrens Sub-region as follows:

> "*In this sub-region the landscape is dominated by heathlands and the forest only occurs in small acreages which escaped fire. The dominant heath shrub on uplands is* ***Empetrum nigrum*** *with* ***Kalmia angustifolia*** *forming a dense cover only in protected valleys.*
>
> *The topography is generally undulating with shallow heavily compacted till and numerous large erratics. The Clintonia-Balsam Fir type is most*

common where the forest is still present. Good forest growth only occurs in a few large protected valleys where the Dryopteris-Balsam Fir type dominates the slopes. Good specimens of Yellow Birch are also found in these stands."

Figure 6 – Newfoundland Eco-regions



The elevation of the project site ranges from 58 M above sea level near the west side of the Marine Industrial Park, to sea level at Powers Cove, with some moderate-to-steep-sloping hillsides towards the east and north.

The industrial park area is dominated by a moderate to dense vegetation cover with the exception of the road consisting primarily of balsam fir, with some spruce and juniper.

AMEC Foster Wheeler (AMEC) in their Aquifer Testing Report in support of this application (see Appendix A) described the superficial geology of the Site "consists of vegetation concealed thin veneer (<1.5M) of glacial till and angular frost heaved bedrock (Batterson and Taylor, 2007)." AMEC described the bedrock geology "Marystown lies within the Avalon tectonostratigraphic zone and is underlain by mafic to acidic volcanic rocks and minor sedimentary rocks of the Mortier Group. Rocks in the area have undergone region-scale folding related to Devonian Acadian orogenesis and form the core of a broad regional northeast – southwest trending anticline, referred to as the Burin Anticline. A series of joint sets and fracture zones occur within rocks underlying Marystown and are related to deformation (JWEL, 2008)." AMEC further describes the bedrock geology as "The Creston Formation of the Mortier Group underlies the Site and is dominated by 500 M of basaltic flows with subordinate acidic pyroclastic and sedimentary rocks with an estimated thickness of 550M. The basalts are highly amygdaloidal and green to purple. The pyroclastic and sedimentary rocks of the Mortier Group are acidic; although locally they have high concentrations of mafic debris giving the rocks a greenish colour and intermediate composition (Strong et al., 1977)."

The area east of the proposed development is characterized by the very deep water of Powers Cove in Mortier Bay. The shoreline is a mix rock and gravel.

Jone's Brook is separated from the property by a 15-meter buffer. This is a very small brook in Zone 10 and is not a Scheduled Salmon River. There are no impacts to this brook from this development.

The property has an old overgrown road that is not being used even for recreational purposes called "Old Mooring Cove Road". The Town of Marystown have applied to the Department of Transportation and Works for decommissioning.

Prior to the commencement of part 1 of this undertaking under this application the Town of Marystown will complete the clearing and grubbing of the lots as per their undertaking that was released in August 2008 with Registration number 1387.

4.2.3.2 Climate of the Part 1 Area

The following table provides the most recent month by month data for the nearby Environment Canada weather station in Winterland 15 kilometers from the project site. This is from the most recent year that complete data was available, 2007:

Table 1 – Monthly Climate Data Winterland Station 2007

Month	Mean Max Temp	Mean Min Temp	Average Temp	Extreme Max Temp	Extreme Min Temp	Total Precip
January	0.6	-5.6	-2.5	10.3	-14.9	166.0
February	-2.8	-8.6	-5.7	4.9	-15.2	128.5
March	1.8	-6.1	-2.2	7.8	-14.1	78.5
April	5.7	-2.3	1.7	11.6	-9.2	54.5
May	11.2	1.2	6.2	18.9	-2.4	74.0
June	16.1	7.0	11.6	25.5	-1.8	64.0
July	20.9	12.2	16.6	30.2	6.5	227.0
August	20.5	11.9	16.3	24.9	6.8	59.0
September	17.0	7.7	12.4	20.9	2.6	72.5
October	11.9	4.5	8.2	19.0	-1.9	93.5
November	8.1	0.5	4.3	14.2	-6.8	225.5
December	-0.3	-6.2	-3.3	7.5	-15.1	159.0
Total						**1402.0**
Average	**9.2**	**1.4**	**5.3**			
Extreme				**30.2**	**-15.2**	

4.2.3.3 Historical Resources of Part 1 Area

The Town of Marystown did a Historic Resources Assessment in 2005 for the project site; this assessment did not reveal any significant cultural or historic resources within the area. Appendix C is attached for full detail.

4.2.3.4 Groundwater Resources for Part 1

AMEC Foster Wheeler Environment & Infrastructure prepared an "Aquifer Testing Report" to describe the groundwater resources available for use with this undertaking. The report is available in Appendix A. The drilled well is 200 mm in diameter and 128 meters deep and is capable of a sustainable flow of 1,208 liters per minute of withdrawal. The undertaking has a calculated water use of 25 liters per minute in the Nursery and 175 liters per minute in the Smolt Landbase for a total of 200 liters per minute. The proposal for the facilities by AquaMaof (Appendix D) have a conservative 50% buffer on the estimated water use taking it to 300 liters per minute or about 25% of the water available from the well. The water in the system is managed with a 99.5% recirculation rate and 0.5% is removed with the sludge and is then further processed to dewater the sludge and return the water after ozone treatment back into the facility systems. Thus, there is no water effluent from the facility.

4.2.3.5 Species at Risk for the Part 1 of the Project

All activities in Newfoundland and Labrador must comply with Canada's Species at Risk Act (SARA) and then further provincially with Newfoundland and Labrador's Endangered Species Act. The "Species at Risk" are collectively a part of SARA's Public Registry, the list of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and the list of Newfoundland and Labradors Species Status Advisory Committee (SSAC). There is a general overlap of prohibitions under both jurisdictions for Species at Risk; however, there are some differences in terminology or definitions. Federally species are referred to as Extirpated or Extinct, Endangered, Threatened or Special Concern. The Provincial definitions are the same with the exception of Special Concern and are referred to as Vulnerable.

The proponent has consulted with the Atlantic Canada Conservation Data Centre (ACCDC) for an expert opinion. The ACCDC offer the following opinion:

> "Within your study area, there were 2 rare animal records found. These records were 2 Harlequin Duck observations, a species which is *Vulnerable* under our provincial Endangered Species Act (ESA) and *Special Concern* under COSEWIC. A new addition to our standard data requests is the use of Expert Opinion Maps. These maps are the result of our work with species-specific experts to gather suggestions about locations where species at risk - either provincially or COSEWIC listed - may be found. While we don't have observations in our database for these species within your study area, our Expert Opinion Maps suggest that Banded Killifish, Short-eared Owls and Boreal Felt Lichen are possible. Your area is also said to be within the Barrow's Goldeneye's range."

Table 2 – Atlantic Canada Conservation Data Centre – Rare Fauna in the 5 Kilometer Range of Part 1 of the Undertaking

OBSERVATION	GNAME	GCOMNAME	FAMILY	Observer	Total Number
1	Histrionicus histrionicus	Harlequin Duck	Anatidae	0	1
2	Histrionicus histrionicus	Harlequin Duck	Anatidae	0	1
	Month	Day	Year	SRANK	NRANK
1	11	27	1984	S3B,S2N	N3N4
2	2	10	1995	S3B,S2N	N3N4
	GRANK	General Status	COSEWIC_ST	PROVINCIAL	SARA
1	G4T4	Secure	Special Concern	Vulnerable	Special Concern
2	G4T4	Secure	Special Concern	Vulnerable	Special Concern
	SITE NAME	Accuracy	SYNAME	CITATION	IDNUM
1	Mooring Cove	0		Montevecchi list	mstr1006348
2	Mooring Cove	0		Montevecchi list	mstr1006349

Figure 7 – Atlantic Canada Conservation Data Centre – GIS Scan Rare Fauna within 5 Kilometers of Part 1 of the Undertaking

According to the advice of ACCDC and from Table 2 above there is one bird on COSEWIC's Schedule 1 list for the Atlantic Ocean that have the ability to frequent the nearshore of the project area. This is the Harlequin Duck (Special Concern) *Histrionicus histrionicus*. In the list of plants and animals prepared by the Department of Fisheries and Oceans (DFO) for its "Integrated Management Planning Placentia Bay" the Harlequin Duck is listed as an exceptional visitor. This project is adjacent to but not directly on or in Placentia Bay. No effluent from this project will enter Placentia Bay. Under the both SARA and ESA the prohibitions do not apply to species of Special Concern or Vulnerable. Further impacts to this species from this project are unlikely.

According to expert opinion provided by ACCDC the Banded Killfish *Fundulus diaphanous* may occur near the project site. The species occurs on the Burin

Peninsula at Garnish Pond at 5.25 kilometers distance and Freshwater Pond at 10 kilometers distance from the project site. This species is considered Vulnerable or of Special Concern. These waterways are not connected to the project area. Under the both SARA and ESA the prohibitions do not apply to species of Special Concern or Vulnerable. Further impacts to this species from this project are unlikely.

According to expert opinion provided by ACCDC the Boreal Felt Lichen *Eroderma pedicellatum* may occur in vicinity of the project site. This species is considered Vulnerable or of Special Concern. It has been found mainly in two population hotspots on the Avalon Peninsula and in Bay d'Espoir; 96% of all occurrences. Research at Memorial University of Newfoundland (MUN) on predictive modelling of the species indicate that coastal regimes as near the project site are the least likely occurrence habitats. Under the both SARA and ESA the prohibitions do not apply to species of Special Concern or Vulnerable. Further impacts to this species from this project are unlikely.

According to expert opinion provided by ACCDC the Short-eared Owl *Asio flammeus* may occur in vicinity of the project site. This species is considered Vulnerable or of Special Concern. Any and all of Newfoundland and Labrador has suitable habitat for this owl. The species decline has been noted in other provinces but the population is stable in Newfoundland and Labrador. According to publications by the province's Department of Environment and Conservation's Wildlife Division the population is in Newfoundland limited by prey availability. Under the both SARA and ESA the prohibitions do not apply to species of Special Concern or Vulnerable. Further impacts to this species from this project are unlikely.

According to expert opinion provided by ACCDC the Barrows Goldeneye *Bucephala islandica* may occur in vicinity of the project site. This species is considered Vulnerable or of Special Concern. The species' population in Eastern North America mostly overwinter in the St. Lawrence estuary. They summer along boreal forest lakes near the St. Lawrence waterway. Under the both SARA and ESA the prohibitions do not apply to species of Special Concern or Vulnerable. Further impacts to this species from this project are unlikely.

There is one other rare species of flora known on the Burin Peninsula that is listed as Species at Risk and that is the Water Pygmyweed *Tillaea aquatica*. The Water Pygmyweed is located on the Burin peninsula at Point May, Pieduck Point, Taylor's Bay and Garnish. This species is considered to be of Special

Concern or Vulnerable. This species does not occur in or near the project area: Garnish is the closest approach at 17.75 kilometers distance away. Under the both SARA and ESA the prohibitions do not apply to species of Special Concern or Vulnerable. Further impacts to this species from this project are unlikely.

There is a species of bird that is considered a general habitant of insular Newfoundland and Labrador and thus could potentially enter the project area and that is the Red Crossbill of the percna subspecies *Loxia curvirostra percna*. They are considered a nomadic species and their preferred habitats are mature forests of black spruce and balsam fir. This particular Species at Risk is considered Endangered. The COSEWIC status report of 2004 indicated an estimate of 500 to 1,500 individuals remain. The Department of Environment and Conservation indicate that the sighting of the last nest was in 1977 but that some juveniles were spotted in 2005. The cause for the decline of this species has been attributed to the loss of habitat through forestry operations and the introduction of the Red Squirrel *Sciurus vulgarus* to the island of Newfoundland. The presumption is that the Red Squirrel is out-competing the Red Crossbill for the food resource; namely, seeds of balsam fir and black spruce. The Red Crossbill has not been seen in vicinity of the project area and the preferred habitat does not present itself at the project area. Further impacts to this species from this project are unlikely.

There are three species of marine fish, and they are all wolfish, on COSEWIC's Schedule 1 list for the Atlantic Ocean that have the ability to frequent the nearshore of the project area. They are the Atlantic Wolfish (Special Concern) *Anarhichas lupus*, Northern Wolfish (Threatened) *Anarhichas denticulatus*, and Spotted Wolfish (threatened) *Anarhichas minor*. In the list of plants and animals prepared by the Department of Fisheries and Oceans (DFO) for its "Integrated Management Planning Placentia Bay" these marine fish are not listed. This project is adjacent to but not directly on or in Placentia Bay. No effluent from this project will enter Placentia Bay. Further impacts to these species from this project are unlikely.

There is one reptile on COSEWIC's Schedule 1 list for the Atlantic Ocean that have the ability to frequent the nearshore of the project area. This is the Leatherback Sea Turtle (Endangered) *Dermochelys coriacea*. In the list of plants and animals prepared by the Department of Fisheries and Oceans (DFO) for its "Integrated Management Planning Placentia Bay" the Leatherback Sea Turtle is listed as an exceptional visitor. This project is adjacent to but not directly on or in Placentia Bay. No effluent from this project will enter Placentia Bay. Further impacts to this species from this project are unlikely.

There are two marine mammals from COSEWIC's Schedule 1 list for the Atlantic Ocean that have the ability to frequent the nearshore of the project area. They are the Fin Whale (Special Concern) *Balaenoptera physalus* and the Blue Whale (Endangered) *Balaenoptera musculus.* In the list of plants and animals prepared by the Department of Fisheries and Oceans (DFO) for its "Integrated Management Planning Placentia Bay" these whales are listed. This project is adjacent to but not directly on or in Placentia Bay. No effluent from this project will enter Placentia Bay. Further impacts to this species from this project are unlikely.

In summary, the project site will be a developed industrial lot prior to initiation of this project. The project, a RAS hatchery with 100% efficiency in water management and thus there are no water effluents released during operation. The project is entirely enclosed with only the building exposed to the elements. Windows are minimal in the building for control of day length for the fish; thus opportunities for fauna to fly into windows is absolutely minimal. The water used in the facility will be drawn from a deep well in the Marystown aquifer and thus streams and lakes are not impacted. Escape or accidental release of stock from this land based facility is not possible, therefore the undertaking poses no risk to local stocks. Considering all these factors it is very unlikely that the project will pose further impacts to Species at Risk or other flora and fauna from the area not at risk. The project is designed to be maximally sustainable to the environment in which it finds itself.

4.2.3.6 Potential Sources of Resource Conflict for Part 1 of the Project:

It is fully anticipated that there will be no resource conflicts as a result of this project. The facilities of the project are fully enclosed with 100 % recirculation and water reuse without effluent and thus not impacting Placentia Bay. Other typical resource users are aquaculture and fishing activities. There are no aquaculture sites or commercial fishing activities within the Mortier Bay area.

4.2.4 Artist's Conceptual Drawings of Part 1 of the Project:

The conceptual drawings are as follows:

Figure 8 – Hatchery

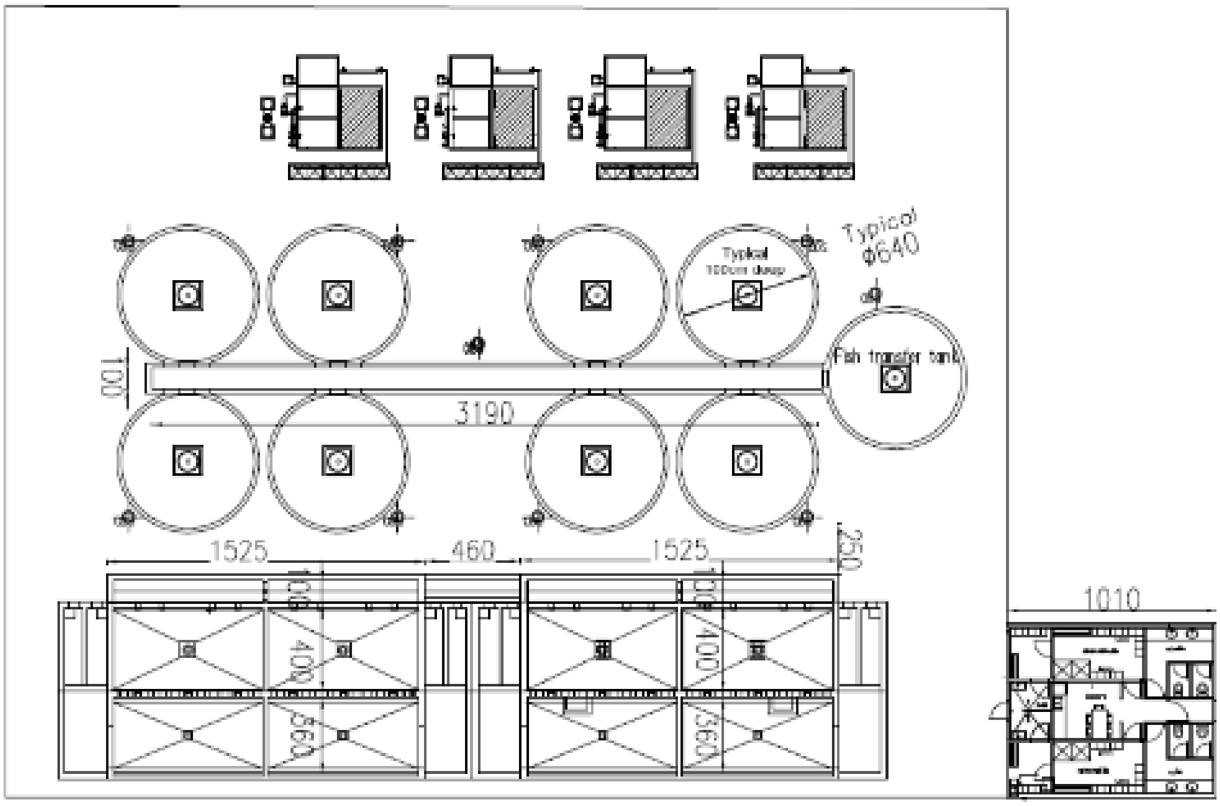


Figure *9* --Smolt Nursery

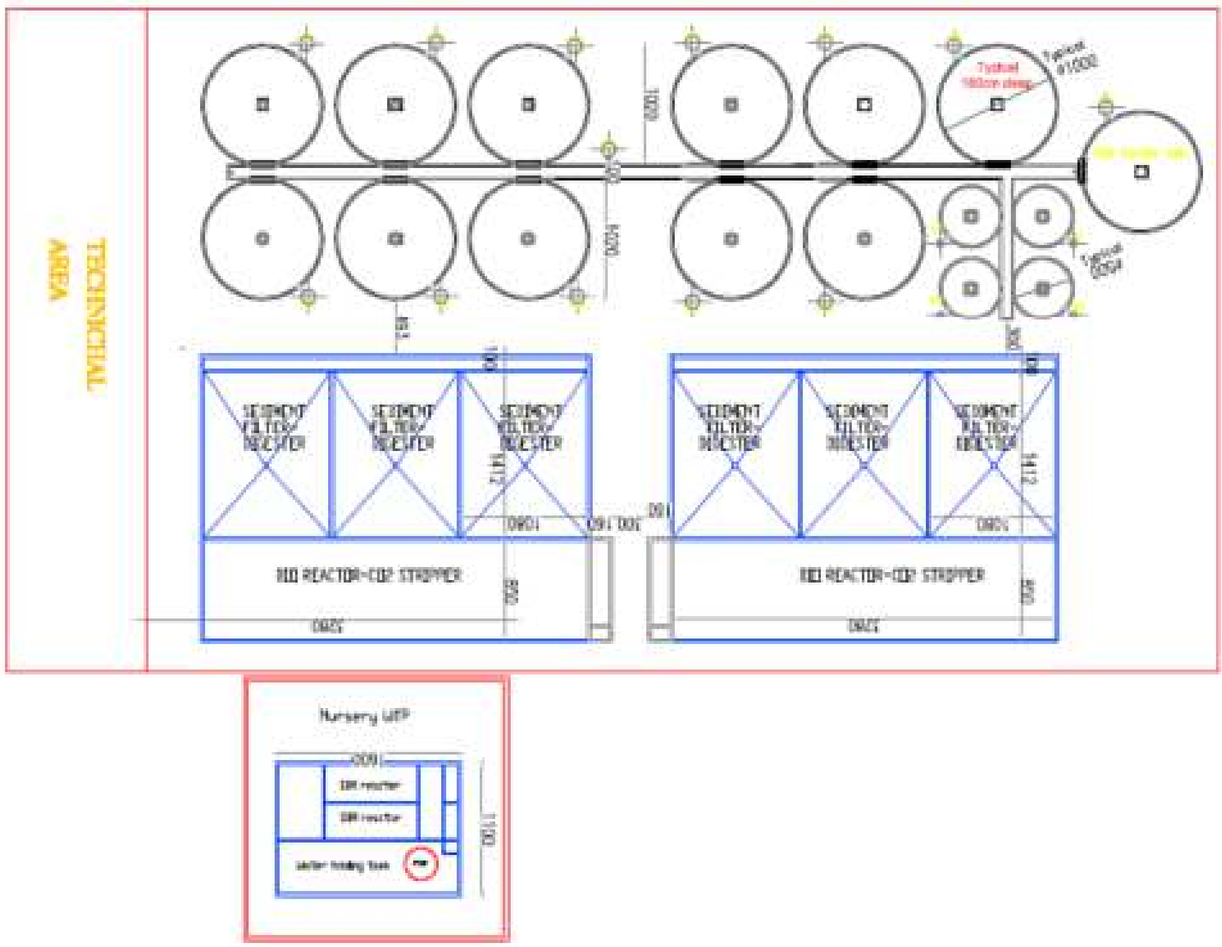


Figure 10 - Smolt Landbase

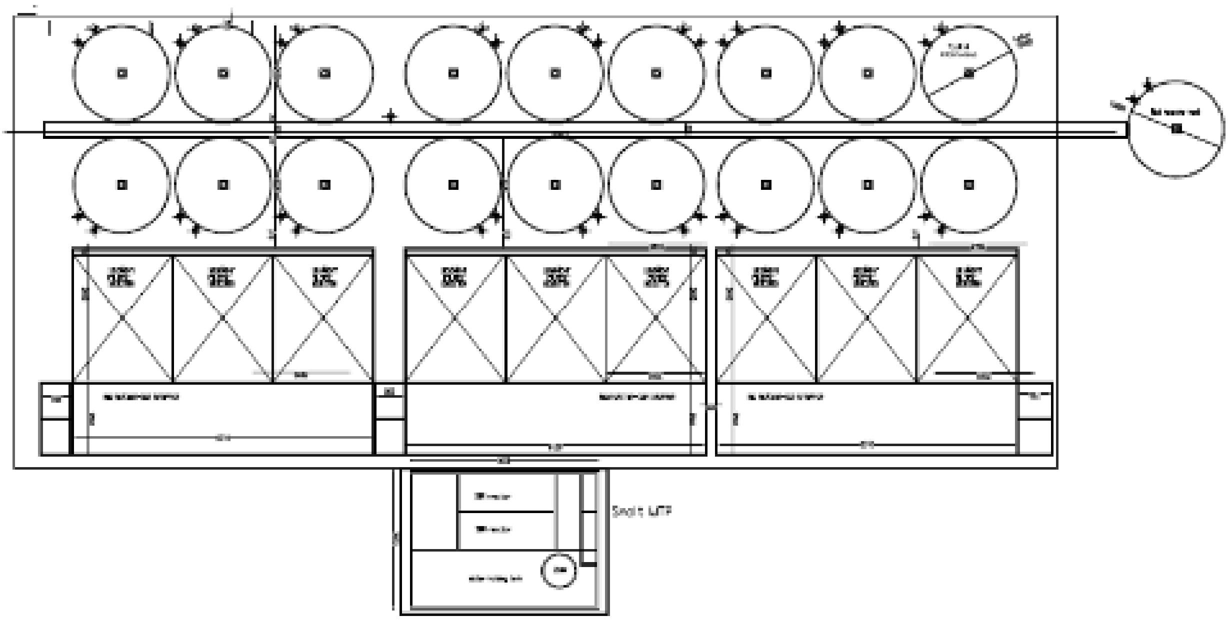
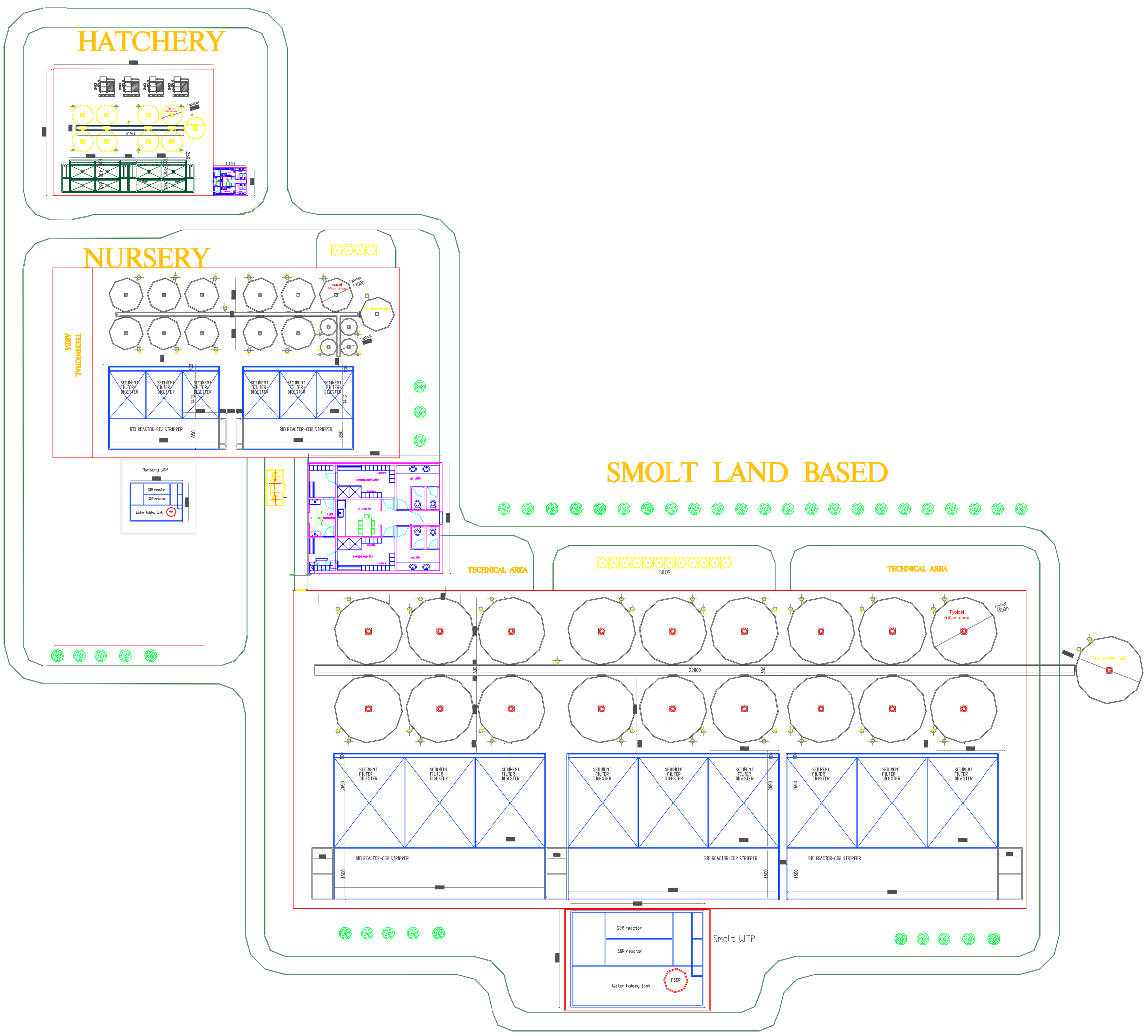


Figure 11 – Complete RAS Facility

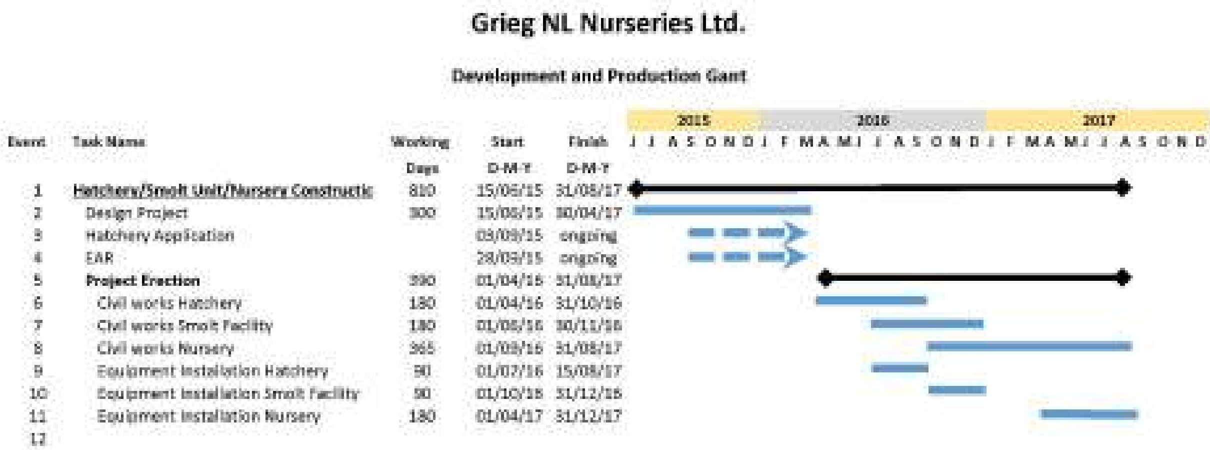


4.3 Construction Part 1:

4.3.1 The Approximate Construction Period of Part 1:

The Project construction period is approximately 18 months starting in March of 2016 and finishing at the end of August, 2017.

Figure 12 – The Approximate Construction Period of Part 1



4.3.2 The Proposed Date of First Physical Construction of Part 1:

The proposed date of first physical construction is immediately after this process. This is provided that all other licenses, permits, authorizations and titles are in place. Other licenses would include the Aquaculture License, the Water Use Authorization, the Municipal Building Permit, and the transfer of Land Title from the Town of Marystown with ancillary Municipal Tax Agreements. The proposed date is expected to be April 1st, 2016, with construction completing December 31st, 2017. Farming operations will commence part way through the construction project and in August, 2017 with first smolt available for sale in May, 2018.

4.3.3 Potential Sources of Pollutants Part 1 Construction Period:

There is some potential that the construction equipment could encounter fuel and or gear oil spillage. Federal guidelines for fuel storage and handling will be followed. Equipment used during construction will be visually inspected daily before starting work to monitor for minor leaks. All minor leaks will be attended to immediately and the offended area cleaned. A spill kit will be on hand to absorb minor spillages. The overburden will have been already removed by the Town of Marystown under their previously released undertaking 1387 and thus erosion due to rain runoff is not a factor. There will be human waste that will be managed with a portable outhouse and a chemical toilet. These human wastes will be disposed of at the Burin Peninsula Waste Management facility near Jean de Baie. The construction wastes will be disposed of with the Regional Waste Management facility as well. It is anticipated that the sources of pollutants during the construction period will be finite and short lived.

Consideration is given to the following sources of pollution during the construction period:

Noise: Load noises will be generated by the construction equipment. Workers adjacent to load generated noises will wear suitable ear protection. The construction activity is not taking place adjacent any residential or active commercial properties and it is not anticipated that noise will be a concern. It is not anticipated that noise generated by the project will impact the surrounding environment or human, animal, avian or aquatic life.

Dust: Dust and particulate matter will be generated by the project construction. The project area is of basalt rock and with very little soil to create dust and particulate matter. For those areas where soil capable of producing dust is exposed the area will be covered with gravel. Aggregate on site will be covered to minimize dust. Materials carried unto the site for construction will be covered to minimize dust. It is not anticipated that dust generated by the project will impact the surrounding environment or human, animal, avian or aquatic life.

Vehicle and Construction Equipment Emissions: The Company anticipates that land construction will require an excavator, a tractor, and a dump truck (heavy construction equipment). The heavy construction equipment and transport vehicles will use diesel and gasoline and will release carbon dioxide into the atmosphere. The vehicles and heavy equipment used on the project will be cleaned in in good repair at all times. Vehicles will not be fueled or serviced on the project site. Heavy equipment will have a designated refueling area. All vehicles and heavy equipment will follow regular maintenance requirements for optimization of fuel efficiency to minimize emissions. Idling of vehicles and heavy equipment will be kept to a minimum. It is not anticipated that increased vehicular traffic or heavy equipment use by the project will impact the surrounding environment or human, animal, avian or aquatic life.

4.3.4 Potential Causes of Resource Conflicts Part 1 Construction:

There are no resource conflicts related to the construction of the project. The project is well of the main highway and will not conflict with vehicular traffic. The project does not take place in or on Mortier Bay and thus there are no impacts to recreational fishers or boaters.

4.4 Operations Part 1:

4.4.1 Description of the Operations Part 1:

The operation will be a Recirculation Aquaculture System (RAS) with 100% recirculation with make-up water to overcome losses to evaporation. The facility will be operated to manage vapour pressure to minimize evaporation losses. The facility will not have any effluent. Water chemistry will be managed with the use of heterotrophic and autotrophic biofilters. The facility will have the capacity to produce 1,800,000 smolt of Atlantic salmon (S*almo salar*) 300 grams in May, 2,400,000 smolt at 450 grams in July, 1,800,000 at 600 grams in October for full cycle production and 1,000,000 smolt at 1,500 grams in April for a seasonal production. All stocks entering the facility will meet the approval of the Canadian Food Inspection Agency (CFIA) and the provincially and federally guided committee for Introductions and Transfers. Fish leaving the facility will only do so with permission from the Introductions and Transfers committee. The facility will be able to manage salinity at different life stages to suit the fish to eliminate the confines of smoltification windows. This means that fish can be transferred to the marine environment at any time with appropriate temperatures rather than confined to narrow natural smoltification windows in May and June of the year. Escape from the facility is not possible in as all drains go to the heterotrophic biofilter and all water flows are under anaerobic conditions for 45 minutes.

The management of this RAS facility intend to monitor and control the operation's employee safety protocols, environmental sustainability, and production traceability under a recognized international certification referred to as Best Aquaculture Practices (BAP) http://bap.gaalliance.org/ .

4.4.1.1 Design Processes Part 1:

The proposed system design and floor plans as attached in Appendix E are AquaMaof's standard design and adapted for salmon smolt production which includes the recirculation pump, ODS, fish production tank, solids settler, controlled intermittent flow trickling (CIFT) biofilter (which includes CO_2 gas stripping), and harvest channel. The system operations are described in detail in the AquaMaof Facility Proposal as attached in Appendix D. Smolt growth will require 4 months from 2.5 grams to 50 grams. After 2 months of growth the fish will be redistributed in the tanks to maintain less than 81 kg/M^3 fish biomass for this first 2 months of smolt growth.

The water circulation system is designed for a single pumping step to complete the recirculation. These pumps are submerged vertical turbine type pumps. These pumps provide high efficiency pumping (80% or greater) at 9.4 meters of head. The recirculated water flows from the pump into the ODS (oxygen dissolving system).

The ODS is designed to provide high dissolved oxygen concentration with a small amount of pumped head pressure (about 0.3 M head pressure). Improved dissolving of oxygen can be attained with the following methods: 1) increase of water pressure where oxygen bubbles are dispersed; 2) increase of residence time of oxygen bubbles in the water; 3) oxygen gas bubble size, smaller bubbles result in more gas to water surface area; and 4) water temperature, colder water results in higher oxygen concentrations at 100% saturation and warmer water results in faster dissolving rate. The ODS obtains the increased pressure with the column of water and injection of the oxygen gas near the bottom of the column, thereby attaining higher water pressure without costly pumping. The residence time for allowing the oxygen bubbles to dissolve is attained in the ODS by creating a flow of water counter to the flow of oxygen bubbles. The AquaMaof ODS allows for low head requirement for dissolving oxygen and attaining oxygen concentrations sufficient to eliminate oxygen concentration as a limiting factor in design of water flow volume. This ODS design has capability to attain oxygen concentrations up to 40 mg/liter, which is an over design safety factor to assure oxygen will never be a limiting factor for the fish and capability to maintain above 90% saturation at all times.

Oxygenated water flows from the ODS directly into the fish production tank with the water added tangentially at the outer edge of the tank at a slight downward angle which creates circular water flow in the tank and distributes water from near the surface to the tank floor. Circulated water flow leaves the tank from the drain stand-pipe at the center of the tank. The stand-pipe is perforated starting 30 cm from the tank bottom to the normal operating water level. This reduces the potential for any full blockage or plugging of the exit screen.

The fish tank is the first step in solids removal. The tank acts as a clarifier and has a drain trap around and below the central drain pipe. This sediment trap collects settled solids that are moved towards the center of the tank bottom by the circular water flow in the tank. This sediment trap is not a continuous flow but is drained 1-2 times per day significantly reducing the amount of water sent out with the settled solids. The settled solids and water in the trap are sent directly to the water re-use treatment and is not part of the recirculation water flow. The main recirculation water flows into the tank main drain pipe and directly into the solid waste settler distribution channel via gravity with minimal turbulence or bends in the pipe.

The second step in the solids removal process is the solids settler with a design concept adapted from the potable water industry used for removal of fine particulates. The settling basin is rectangular with the floor sloped to a center drain. Water is evenly distributed across the basin approximately 0.5 M above the floor from the distribution channel with pipes. A large portion of the solids settle on the floor of the basin and water flows upward through the tube settler media (Brentwood ACCU-PAC IFR 6036) and into water collection launderers and by gravity is distributed through the spray nozzles of the CIFT biofilter. Solid waste accumulated in the settler basin and on the settler media is periodically drained and washed from the media and basin into the discharge waste treatment. The exact schedule depends upon solid waste loading and can range from once every 4 days to once every 10 days.

There are several advantages of this solids removal process compared to other methods. First, there are no continuously moving parts that need maintenance or replacement. Second, this method has capability to remove very fine particles compared to mechanical screen methods which tend to increase the amount of fine particles. Third, this process will result in denitrification when managed on a proper draining schedule. The schedule for cleaning is adjusted after several months of operation to allow for stabilizing the denitrification process. The schedule will have longer intervals between cleaning in the early phase of operation then a regular schedule will be established which is in the range of 1 time per week.

The CIFT biofilter is the next step in the water recycle process. This is a trickling filter adapted for stripping carbon dioxide from the water and using a controlled and intermittent water flow over the media. The depth of media (Brentwood ACCU-PAC CF 1200) is 6 meters to provide maximum nitrification (removal of ammonia) with a single pass of water flow. This depth also allows for movement of carbon dioxide bound in the alkalinity buffer to free CO_2 as the carbon dioxide concentration is reduced in the water with counter flowing air. With this method the system can strip more mg/liter CO_2 from the water than exists as free CO_2 in the fish tanks. The hydraulic loading across the entire biofilter for CO_2 stripping is 7.8 M^3/hour/M^2, an order of magnitude less than hydraulic loadings typically used in CO_2 stripping by other companies.

The hydraulic loading on the trickling filter is designed for the optimum wetting of all surfaces of the biofilter media (14.6 M^3/hour/M^2). This loading is intermittent to obtain additional treatment advantages. The use of air circulation through the biofilter from bottom to top of the media provides all required oxygen for the bacterial processes and leaves the biofilter at near 100% oxygen saturation. This EBM-PAPST axial flow fan provides air flow of 10 times more air volume than water flow volume. The air flow is counter current to the water with air entering the base of the CIFT biofilter and water entering through the spray nozzles at the top. The CIFT biofilter can also be used for water temperature control when outside air temperature and humidity are appropriate during many months of the year. If the culture water needs to be increased and outside air temperature is higher than the water temperature, then outside air is used to supply the air fan. Also when outside humidity is low the trickling filter acts as a cooling tower. Because the facility has low water exchange rate the normal requirement for temperature control in the system water is cooling. This use for the CIFT biofilter reduces the electrical energy required for cooling fish water. Advantages for the CIFT biofilter are:

1. Water temperature increase or decrease depending upon a controlled source of air flow, inside building air or outside air. The CIFT biofilter can effectively be used as a cooling tower;
2. Can be scaled to match any nitrification quantity required by changing depth, width, and length dimensions with no change in the type of equipment used;
3. Use of solid cone spray pattern provides uniform optimal wetting of the media surfaces, much better than drip pans or the use of perforated pipes;
4. Intermittent flow provides for more effective nitrification by allowing water to more fully drain from the media surface before another water surge. This biological growth phenomenon can be observed in natural

water settings of wave action (intermittent wetting or high energy areas) promoting increased biological growth;

5. Intermittent flow allows for more residence time on the media and time with thinner water film improving CO_2 stripping. Average daily hydraulic loading rate is an order of magnitude less than normal CO_2 strippers used in aquaculture applications; and,
6. Controlled intermittent water flow (control both the amount of time a nozzle is flowing and the interval between flow cycles) enables development of a biofilter of any required nitrification rate, maintain a specified media depth, and most importantly maintain optimum hydraulic loading. Many traditional trickling filter designs cannot attain optimum hydraulic loading with continuous flow regimes; the recirculation system water flow rate is not sufficient to enable proper hydraulic loading because the square meter footprint area is too large resulting in much less than optimum hydraulic loading. The water flow volume rate is not sufficient to properly wet the bacterial surface area of the media.

Requirements of the CIFT biofilter include:

1. Requires a larger footprint for construction, however this biofilter also provides for CO_2 stripping, temperature control capabilities, and water storage pumping basin; and,
2. Requires water pumping energy to allow water to gravity flow through the media with the counter current flow of air. Submerged biofilter design concepts require less energy for pumping but increased energy for oxygenation, gas stripping, and mixing. The total energy required for the complete recirculation cycle must be considered, and this is where the combination of AquaMaof system components results in lower total energy required for operation.

The water basin below the CIFT biofilter is used as a surge tank for holding a supply of water for the total system, one third of the fish production tank volume. This allows for capacity to drain a fish tank for harvest and retain all water in the operating system.

Waste water is drained from each tank secondary drain (from the sediment trap in the tank center) and from the solid waste settlers directly to the waste treatment / denitrification system. This water treatment system returns the water back to original quality standards. The process includes sequencing batch reactors, decanting and solids settler, trickling biofilter for aeration and gas stripping, followed by fluidized bed reactor, ozone, and UV. The one-day supply of new water is held in storage for use as continuous addition or in larger quantities in a short time for refilling the system. This one-day supply of water will also ensure the facility will remain within the 300 liter per minute water use for the facility in case of any increase in water need.

The sequencing batch reactors are chosen because of the capability to process varying flow rates and allow for control flexibility. The fluidized bed reactor and ozone are selected for final polishing and breakdown of complex organic compounds that can build in aquaculture systems with very low to no water exchange. UV treatment is the final step in the waste treatment and this assures no residual ozone will reach fish production water. Waste water treatment is the only area where ozone is required or used in the salmon production facility.

It is anticipated that for every kilogram of feed entered into the system that 3% of sludge matter will produced. The production of the facility is anticipated at 4400 MT and with a Feed Conversion Rate of 0.80:1.0 some 3520 MT of feed will be consumed. At 3% 109 MT of sludge will be produced annually. This material will be collected and used for either for remediation or soil amendment or disposed at a licensed disposal facility. The remaining matter will be consumed by the biofilters. The biofilters will not need to be replaced or disposed of.

It is not considered that there will be a necessity for facility waste water to be disposed of even during maintenance periods. The facility has regular cleaning of biofilters by module with individual modules with the capacity to manage the system needs while others are offline. If facility waters were ever to be released it would first be thoroughly processed by the biofilters to remove environmental pollutants such as nitrites, nitrates, phosphates or material with Biochemical Oxygen Demand. In the unlikely event that facility water should be released it will be fully capable of sustaining flora and fauna as it does within the facility itself.

The maintenance of denitrification systems does not require addition of any chemicals. All autotrophic and heterotrophic bacteria in the system will accumulate naturally.

The maintenance of salinity will require the storage of dry marine salts. These will be stored in dry plastic sacks. The only clean up required for the marine salts is a shop vacuum for spilled granules. Alkalinity will be managed naturally with input water carrying sufficient cations. System processes will return alkalinity to baseline after CO_2 stripping at the trickle filters. The CO_2 stripping also returns the pH to the incoming baseline.

4.4.2 Estimated Period of Operations Part 1:

The facility will remain in continuous operation once operations have commenced.

4.4.3 Potential Sources of Pollutants Part 1 Operational Period:

There is some potential that the transfer trucks and the employee work vehicles could encounter a fuel and or gear oil spillage. A spill kit will be on hand to absorb minor spillages. The trucks will use gasoline and diesel and will release carbon dioxide into the atmosphere. There will be human waste with this operation that will enter Marystown's sewage treatment system. AquaMaof estimates that the facility will produce 109 MT dry weight of digested sludge per annum when at peak production. The characteristics of this digested sludge are different from many RAS in that the planned design includes a denitrification process in sequential batch reactors that further breaks down the sludge reducing the total quantity of sludge and allowing for reduction of water content in the sludge to 20% dry weight solids and 80% water. Solids removal efficiency is 100% instead of the typical 87%. Digestion reduces the sludge volume by about 33% of typical systems with raw sludge. The dry weight N content is 14% and the P content 16%. The digestion step in the waste removal makes the waste immediately suitable for agricultural purposes. The Company has a letter of understanding with the Long Harbour Development Corporation to use the digested sludge as a component of the remediation of the slag pile from the previous Phosphorous Plant tailings in the harbour (Appendix M). Should the option of using the digested sludge to remediate the Long Harbour slag pile not avail itself then other avenues will be explored including using the product as a soil amendment for local farms. Newfoundland soils become depleted over time using chemical fertilizers; this product is suitable for soil amendment. Failing that purpose, the digested sludge removal will be contracted to one of the Province's septic services. The Burin Peninsula Waste Management facility also has some capacity to accept the waste (Appendix M). There will be administrative paper waste and some industrial packaging wastes to be handled by the Burin Peninsula Waste Management facility in Jeanne de Baie.

4.4.4 Potential Causes of Resource Conflicts with Part 1 Operations:

There are no potential resource conflicts identified with this particular operation. The facility operations may temporarily interfere with recreational boaters and fishermen when the well boat is at the facility to receive smolt for transport to the sea cages. These periods are expected to be minimal.

There is an overgrown old road in the process of being decommissioned by the Town of Marystown and the Department of Works and Services. The project will not interfere with walking, snowmobile or ATV trails.

Control of lighting systems and photoperiods within the facility will be entirely indoors and contained. Facility photoperiods will not have any impact on the natural environment.

4.5 Occupations Part 1:

4.5.1 Estimated Number of Employees Part 1:

4.5.1.1 Construction Phase Part 1

During construction the proponent estimates workers during this phase will include supervisors and laborers for concrete footings and erectors of the pre-engineered steel buildings. There will be further concrete work in operational structures inside the buildings. There will also be electricians, plumbers, carpenters and finish trades for installing equipment, tanks, and various building systems and finishes. There is a potential need for up to 200 full-time and part-time workers during the construction period.

4.5.1.2 Operational Phase Part 1

The operational phase is projected to generate 23 full time positions from facility management to technicians.

4.5.2 Enumeration and Breakdown of Occupations Part 1:

4.5.2.1 Construction Phase Part 1

This particular undertaking will require workers from various trades and management. These workers will be the management responsibility of the General Contractor that submits the most competitive bid for the construction of the RAS facility. The occupations and their numbers below are an estimation by the proponent. The proponent of the undertaking will bear the responsibility of ensuring that all building and construction rules, policies, and laws of the jurisdiction are followed. The occupations are described according to the National Occupational Classification 2011:

Engineering Manager (0211) 3
Civil Engineers (2131) 2
Civil Engineering Technologists (2231) 2
Drafting Technologists and Technicians (2253) 1
Land Survey Technologists and Technicians (2254) 1
Construction Inspector (2264) 4
Electrical Power Line and Cable Workers (7244) 5
Telecommunication Line and Cable Workers (7245) 5
Steamfitters, Pipefitters and Sprinkler System Installers (7252) 20
Welder Operators (7237) 10
Carpenters (7271) 20
Concrete Finisher (7282) 20
Heavy Equipment Mechanics (7312) 4
Crane Operators (7371) 2
Truck Drivers (7511) 5
Heavy Equipment Operators (7521) 4
Construction Labourers (7611) 92

4.5.2.2 Operational Phase Part 1:

The operational phase of the undertaking is projected to have 23 full time positions. The occupations are described below according to the National Occupational Classification 2011:

Senior Manager (0016) 1
Maintenance Manager (0714) 1
Production Manager (0911) 1
Aquaculture Managers (0823) 4

Aquaculture Technicians (2221) 12
Welder (7237) 1
Heavy Equipment Operator (7521) 1
Air Conditioning Mechanic (7313) 1
Power Systems Electrician (7202) 1

4.5.3 Delineation of Work Carried Out in Part 1:

The construction of the RAS facility will be carried out by a General Contractor and hired by AquaMaof as a part of the “turnkey” purchase agreement. The proponent intends to maintain responsibility to ensure that all building and construction rules and codes, policies, and laws of the jurisdiction are followed.

The operational work will be completed directly by the proponent.

4.5.4 Employment Equity Part 1 of the Project:

The Company has an equal opportunity hiring policy and does not hire relative to age, gender, race or sexual orientation. These employment conditions will be maintained internally and with suppliers and contractors to the project.

4.6 Part 1 Project Related Documents:

The Company has a Business Plan in support of the undertaking. There a proposal by AquaMaof for the facility design Appendix D and floor plans Appendix E. There is an Aquifer Testing Report as prepared by AMEC Foster Wheeler Environmental and included as Appendix A. A Consultation Report is available in Appendix G.

5 APPROVAL OF THE UNDERTAKING PART 1

The Aquaculture License and Water Use Authorization are all pending for the undertaking that this application is related to. A permit from the Town of Marystown will be required for the development of the undertaking. A Transfer and Transport Permit will be required to stock the facility with fish.

The approval list is as follows:

Aquaculture License

Water Use Authorization

Transfer and Transport License

Land Title (transferred from the Town of Marystown)

Tax Agreement (Town of Marystown)

Construction Permit (Town of Marystown)

6 SCHEDULE PART 1

This project will commence only after it is "Released" from the Environmental Registration of an Undertaking. These commencements are scheduled for March 17th, 2016. Operations are scheduled to begin in November, 2016. The construction will be staged in such a manner that operations startup can proceed before the end of all construction process which are anticipated at August 31st, 2017. These operations will only proceed with relevant approvals, licenses and authorizations for Water Use, Aquaculture, and Transportation and Transfer of eggs.

7 FUNDING PART 1

The capital costs of Part 1 of the project are $75,000,000. The Province of Newfoundland and Labrador are anticipated partners in the project with preferred shareholdings. The government of Canada is anticipated assisting this project through the Atlantic Canada Opportunities Agency.

Date: January 31st, 2016

Signature of Director: ____________________

8 NAME OF UNDERTAKING PART 2

"Placentia Bay Atlantic Salmon Aquaculture Project"

"Part 2"

9 PROPONENT PART 2

9.1 Name of Corporate Body:

Grieg NL Seafarms Ltd.

9.2 Address:

205 McGettigan Blvd.
P. O. Box 457
Marystown NL
A0E 2M0

9.3 Chief Executive Officer:

Name: Knut Skeidsvoll
Official Title: General Manager
Address: P. O. Box 457, 205 McGettigan Blvd., Marystown, NL, A0E 2M0
Cell Number: (709) 538 7313
Telephone Number: (709) 279 3440

9.4 Principal Contact Person:

Name: Clyde Collier
Official Title: Project Manager & Director
Address: P. O. Box 457, 205 McGettigan Blvd., Marystown, NL, A0E 2M0
Cell Number: (709) 538 7413
Telephone Number: (709) 279 3440

10 THE UNDERTAKING PART 2

10.1 Nature of the Undertaking Part 2:

This undertaking is an installation and operation of a Regional Marine Farming Area in Placentia Bay divided as 4 Bay Management Areas (BMAs) with a total of 11 Sea Cage Marine Farms for Atlantic salmon (*Salmo salar*). Each marine farm will be a daughter company subsidiary of Grieg NL Seafarms Ltd. The BMAs and the relevant marine farms are as follows:

Rushoon BMA:

Oderin Island Farms Ltd.
Gallows Harbour Farms Ltd.
Long Island Farms Ltd.

Merasheen BMA:

Valen Island Farms Ltd.
Chambers Island Farms Ltd.
Ship Island Farms Ltd.

Red Island BMA:

Red Island Farms Ltd.
Darby Harbour Farms Ltd.
Butler Island Farms Ltd.

Long Harbour BMA:

Brine Island Farms Ltd.
Iona Island Farms Ltd.

The marine operations will purchase smolt from the sister company Grieg NL Nurseries Ltd. Marine farming operation at peak production will utilize 7,000,000 smolt on a yearly basis. The intention is to stock as follows: 1,000,000 in late April at around 1,500 grams for a one season production to cover marketing in December and January; 1,800,000 in May at around 300 grams for a full cycle production to cover marketing from September to November; 2,400,000 in July at around 450 grams for a full cycle production to cover marketing from February to May; 1,800,000 in October at around 600 grams for a full cycle production to cover marketing from June to August. These animals will originate from European broodstock breeding programs and will be rendered sterile by a triploid process. This will be a biosecure operation and all access and supplies will be of a controlled nature. The marine farms at peak production will produce approximately 33,000 metric tonnes of live weight Atlantic salmon. It is anticipated that the production processing will be by purchased service by joint venture or close cooperation agreement with an existing processing company on the southern part of the Burin Peninsula.

10.2 Purpose/Rationale/Need for the Undertaking Part 2:

The purpose of the project is to produce the very finest quality suite of fresh Atlantic salmon products for the North American market in a manner that is environmentally and financially sustainable. The operations will provide for critical assets in the farming production of Atlantic salmon in Newfoundland and Labrador and adding greatly to the prosperity of the Province. The use of oceanic leases for the project are a part of the renewable and sustainable resources of the Province and thus making this a pastoral project. The project is a very important piece of a network of assets that will provide much needed sustainable employment to rural Newfoundland and Labrador. The project will provide profit to its shareholders, business opportunity to suppliers, wholesome food to customers, and finally tax revenue to Municipalities of the region, the Province and the Country.

10.3 Alternatives to the Part 2 Undertaking:

There was one alternative region of the Province with adequate space to create 4 BMAs including 3 full cycle and 1 seasonal. The Company initially began its assessments on the south west coast in the region of Burgeo. The Placentia Bay Region was chosen over the Burgeo Region for the following reasons:

1. Freshwater resources for a hatchery – both regions had relatively nearby freshwater resources to supply a hatchery operation provided that it was a very efficient Recirculation Aquaculture System (RAS). The freshwater resources in the Burgeo Region was nearly twice the distance from source

to marine sites. Thus the management and other cost efficiencies favoured Placentia Bay;

2. Marine resources for fish farms – the marine resources available to be developed was only apparent but not attainable in the Burgeo Region. The area appeared empty of development but most of the potential tenures were blocked by prior claims. There were no such prior claims in the Placentia Region;

3. Processing resources – both the Burgeo Region and the Placentia Bay Region had existing and underutilized adequate resources for processing. The distances involved in the breath of potential marine farms in the Burgeo Region was nearly twice that of the Placentia Bay Region. The logistics were such that in order to maintain sufficient capacity with well boats and with processing the well boats would need to be twice the size to cover off time and distance in the Burgeo Region, thus, logistics and cost favoured the Placentia Bay Region;

4. Market access – the Burgeo Region is nearly 9 hours closer to the Port Aux Basques terminal for Marine Atlantic relative to the Placentia Bay region. The Burgeo Region provides for longer shelf life for a fresh product. The Burgeo Region is more favourable than Placentia Bay considering the market access and shelf life;

5. Community infrastructure – the community infrastructure with relevant service and supply support is much more developed in Placentia Bay relative to the Burgeo region due to a greater population and established large industries related to oil and mining;

6. Human resources – the Placentia Bay region has a population base of approximately 20,000 while the Burgeo region has approximately 2,000 and thus Placentia Bay human resources are suggestive of an adequate supply of workers available for the farming operations;

7. BMA effectiveness – the inner portion of Placentia Bay and close to the Merasheen archipelago is home to many small communities such as Rushoon, Baine Harbour, Parkers Cove, Petit Forte, Swift Current, North Harbour, Come by Chance, Arnolds Cove, Southern Harbour, Little Harbour, Fair Haven, Long Harbour, Fox Harbour, Placentia, and Argentia. Most of these communities have Harbour Authorities and existing wharf facilities. These communities are also home to many fishers with sea going skills suitable for the management of Atlantic salmon marine farms. The

traditional fishery in the area is at very low resource level and currently does not support livelihoods to the extent they would desire. Similar issues exist in the Burgeo area but the number of communities and available fishers to work on the marine farms is much less;

8. Training capacity – the Placentia Bay region and the Avalon Peninsula in general have a full complement of professional training schools for worker safety such OHS, WHMIS, Standard First Aid, MED, SVOP, FM4, and Aquaculture Technician. Training for these supports is less readily available in the Burgeo region.

The Company assessed resource capacities and capabilities between the two available regions as above; Burgeo vis à vis Placentia Bay, and Placentia presented much more favourably.

11 DESCRIPTION OF THE UNDERTAKING PART 2

11.1 Geographic Location Part 2:

The locations to be used for the marine farms will be assessed and prepared for application for an Aquaculture License (Appendix L). The Aquaculture License application is very comprehensive and captures the requirements of the provincial Aquaculture Act http://www.assembly.nl.ca/legislation/sr/statutes/a13.htm . The management of federal and provincial jurisdictions is encompassed by DFA in a Memorandum of Understanding (MOU) with DFO. The Aquaculture Application provides details for the Aquaculture License, Crown Land Lease or Permit to Occupy, Water Use Authorization, Aquaculture Activities Regulations baseline assessment http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/aar-raa-gd-eng.htm , Navigation Protection Act http://laws-lois.justice.gc.ca/eng/acts/N-22/ application for exemption under condition of marking.

The marine farms will be installed in Placentia Bay and can be described by various perspectives. Below is a Provincial perspective:

Figure 13 – Location Marine Operations Provincial Perspective

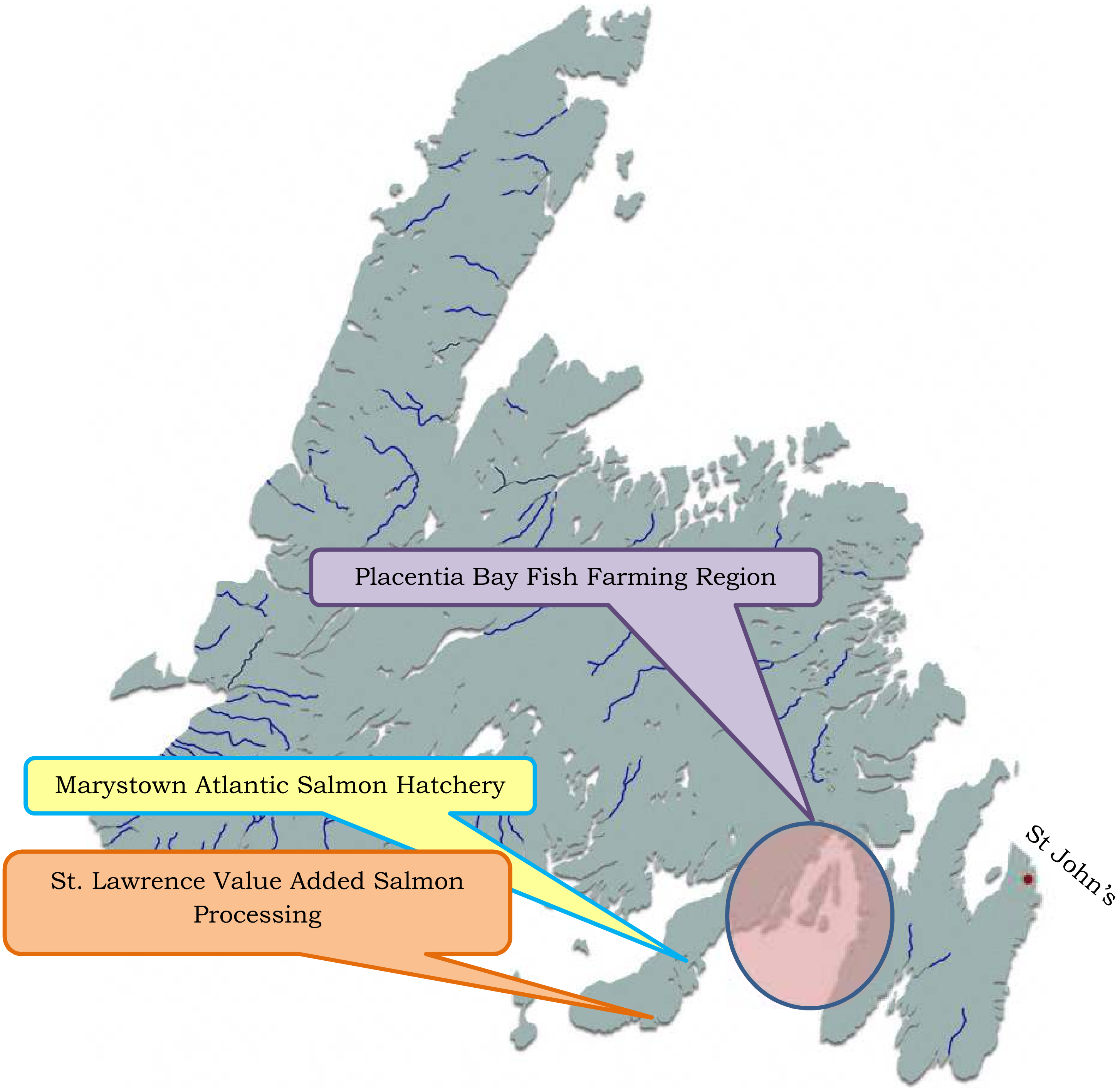


Figure 14 – Location Marine Operations Regional Perspective

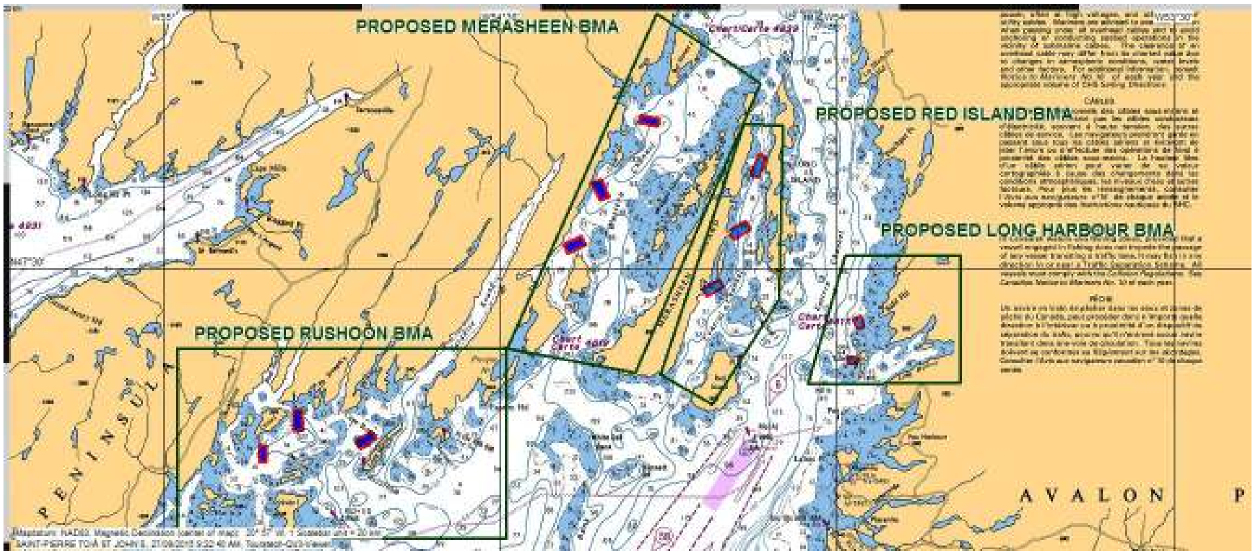
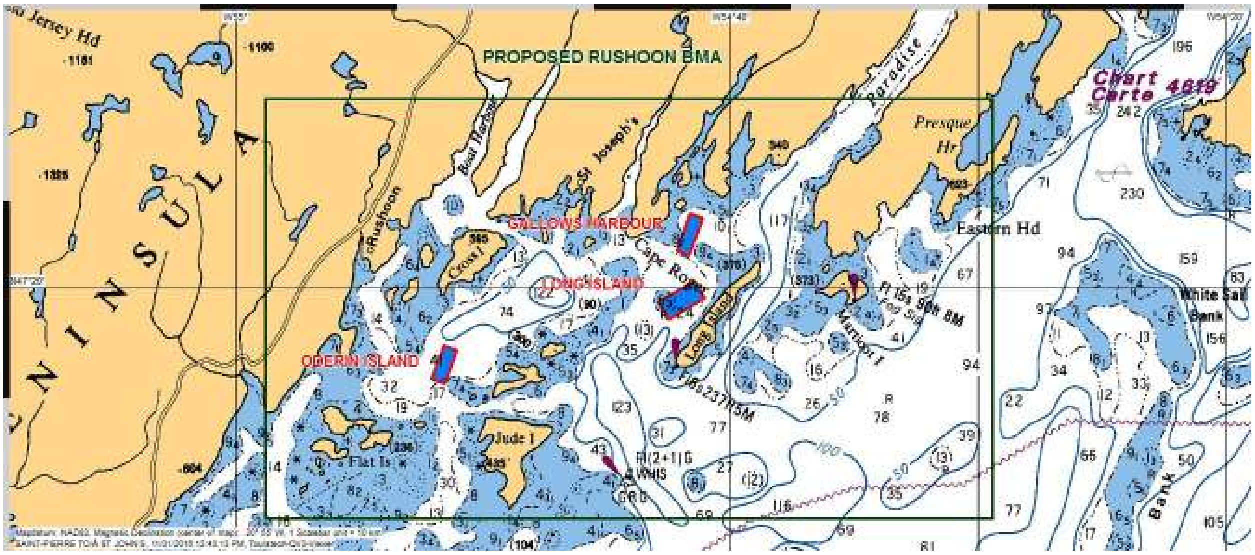
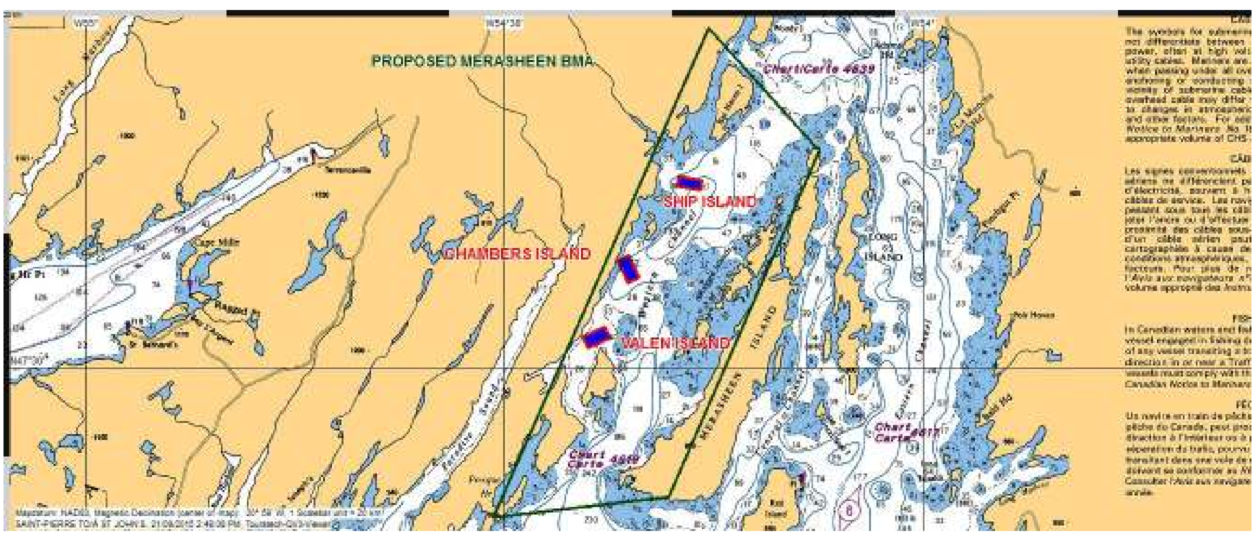
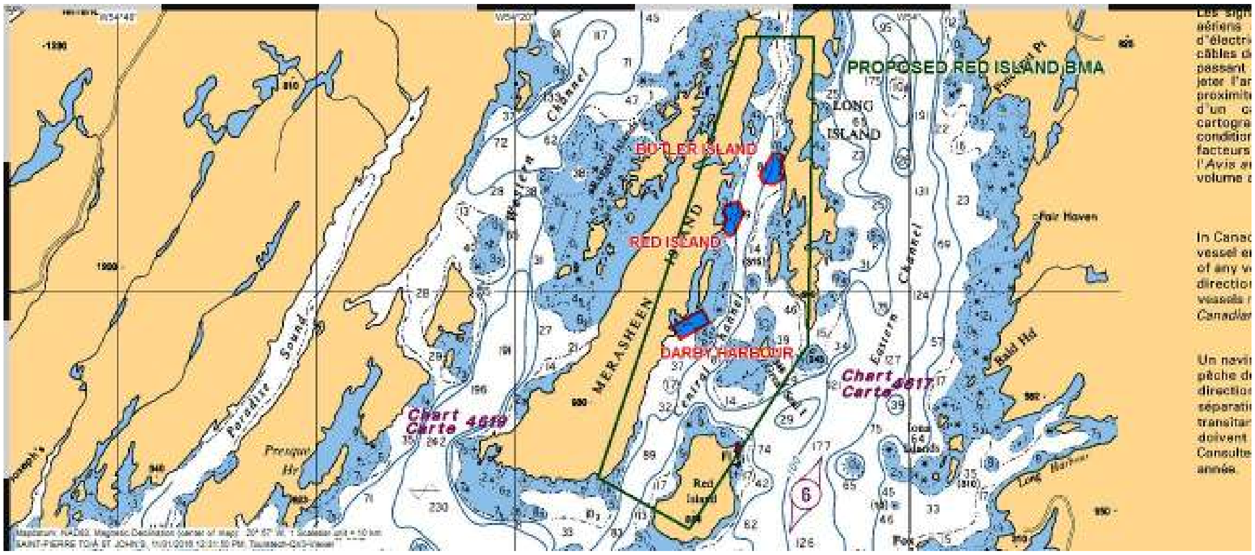


Figure 15 – Location Bay Management Area Perspective






PROPOSED RED ISLAND BMA
BUTLER ISLAND
RED ISLAND
DARBY HARBOUR
LONG ISLAND
MERASHEEN
Western Channel
Eastern Channel
Paradise Sound
Chart Carte 4617
Fair Haven
Bald Hd
Long Harbour
Red Island

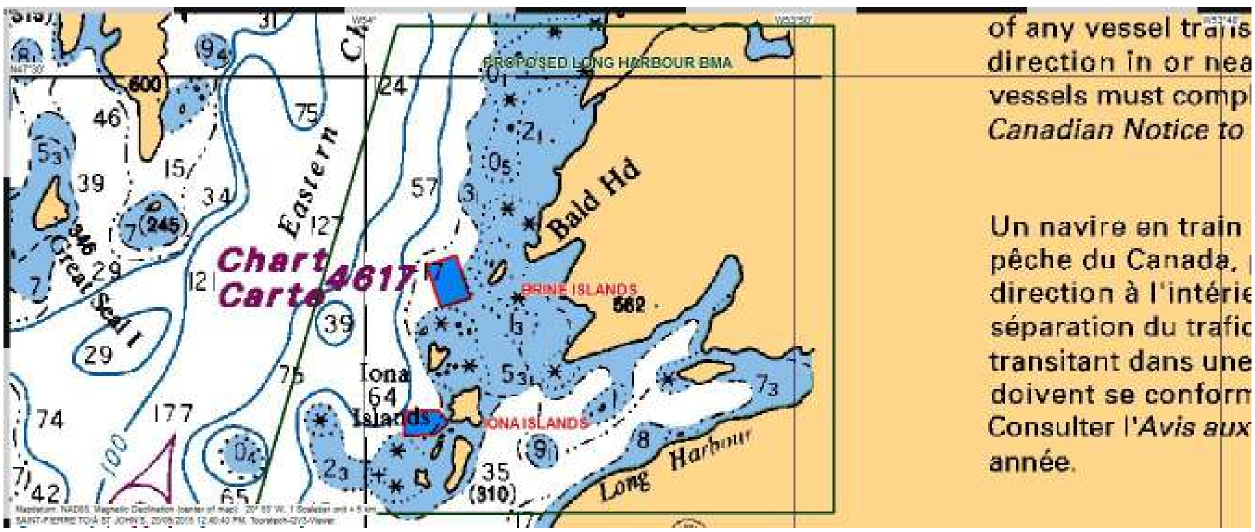
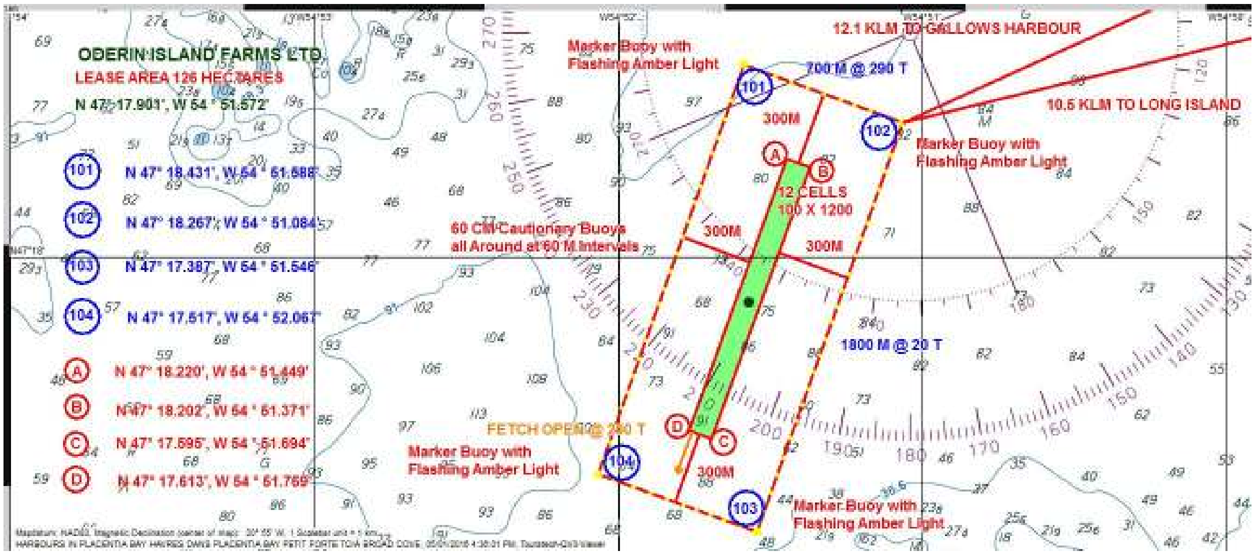
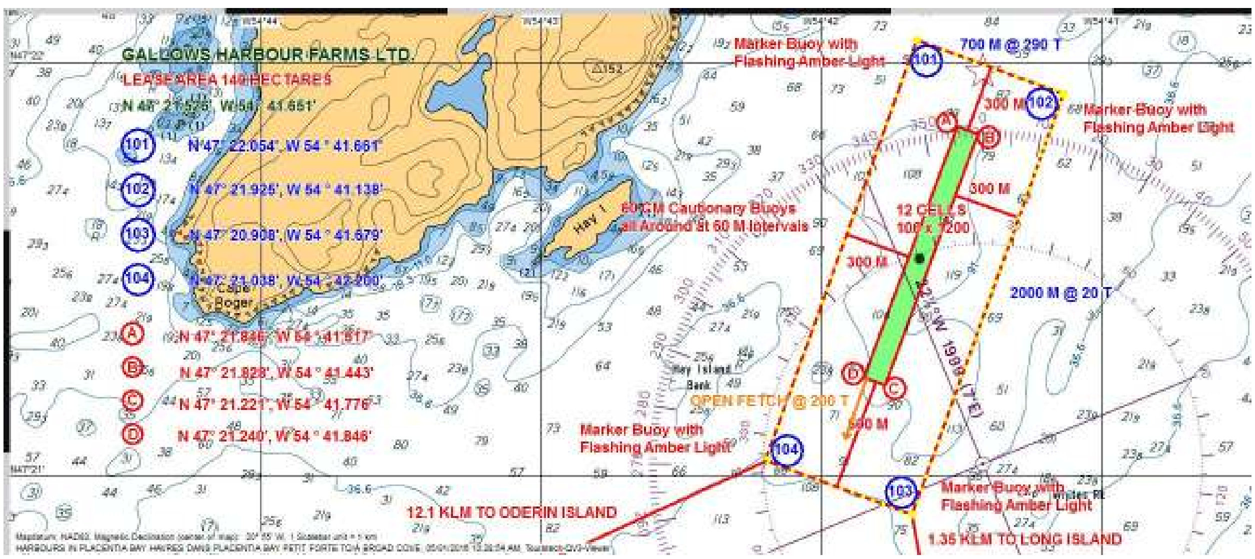
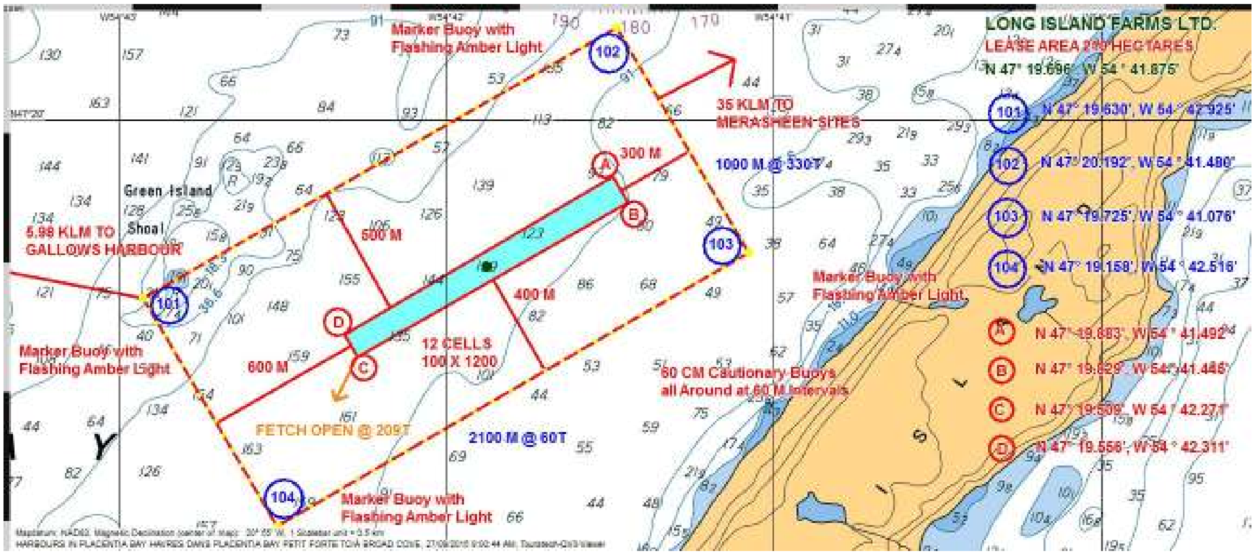
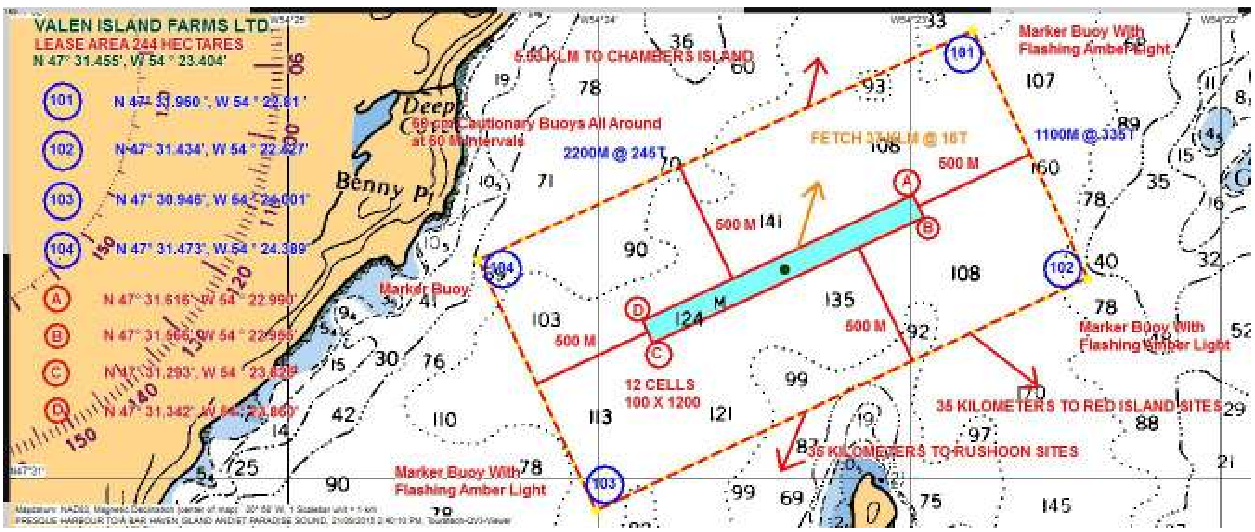

PROPOSED LONG HARBOUR BMA
BRINE ISLANDS
IONA ISLANDS
Chart Carte 4617
Eastern
Great Seal I
Bald Hd
Iona Islands
Long Harbour

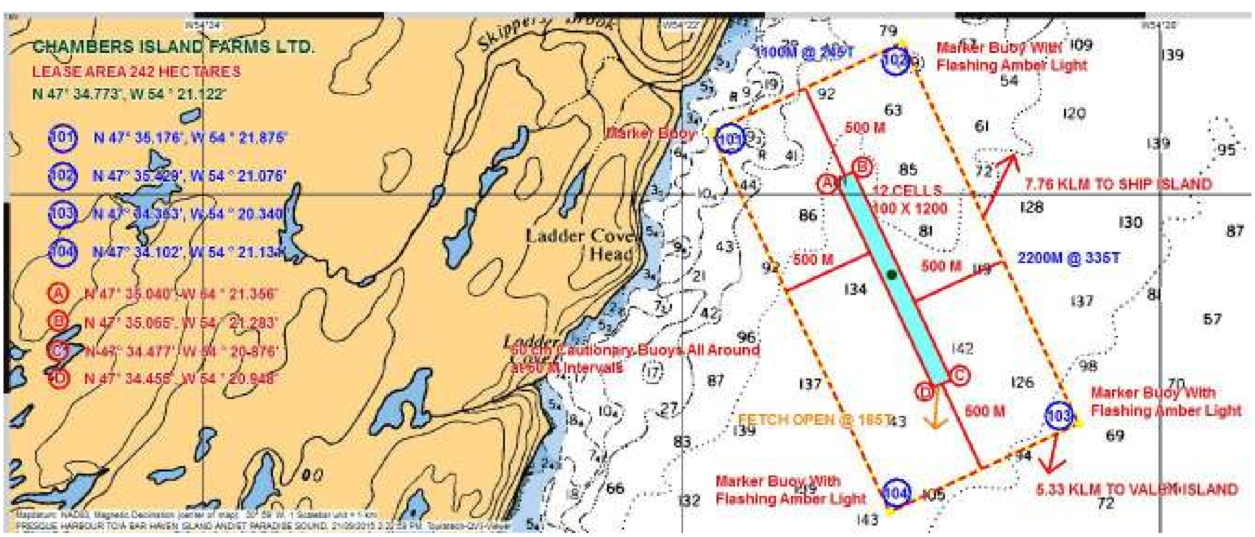
Figure 16 – Location Marine Farm Perspective

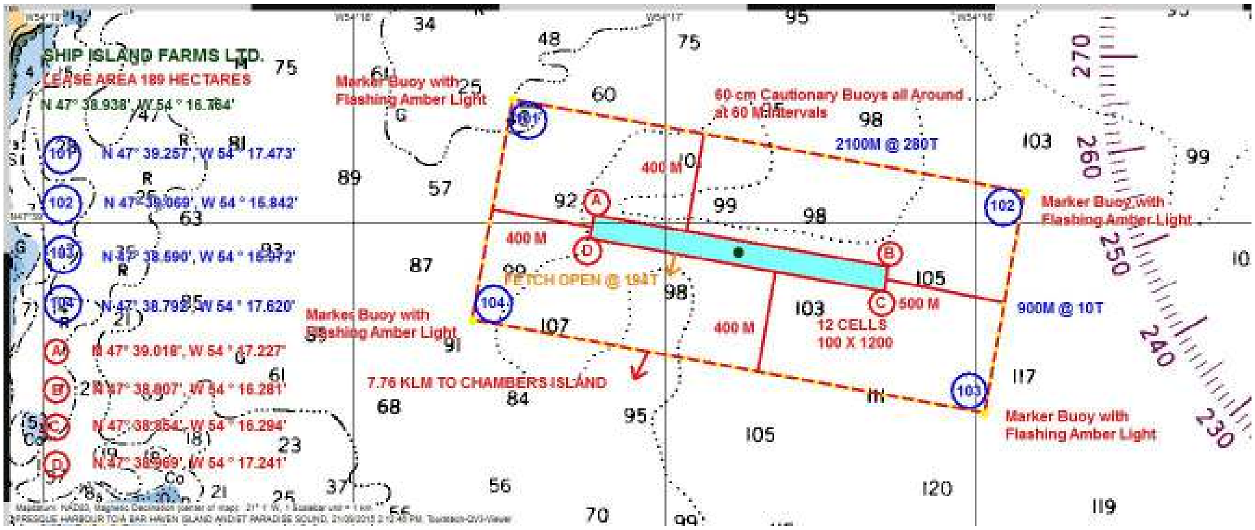


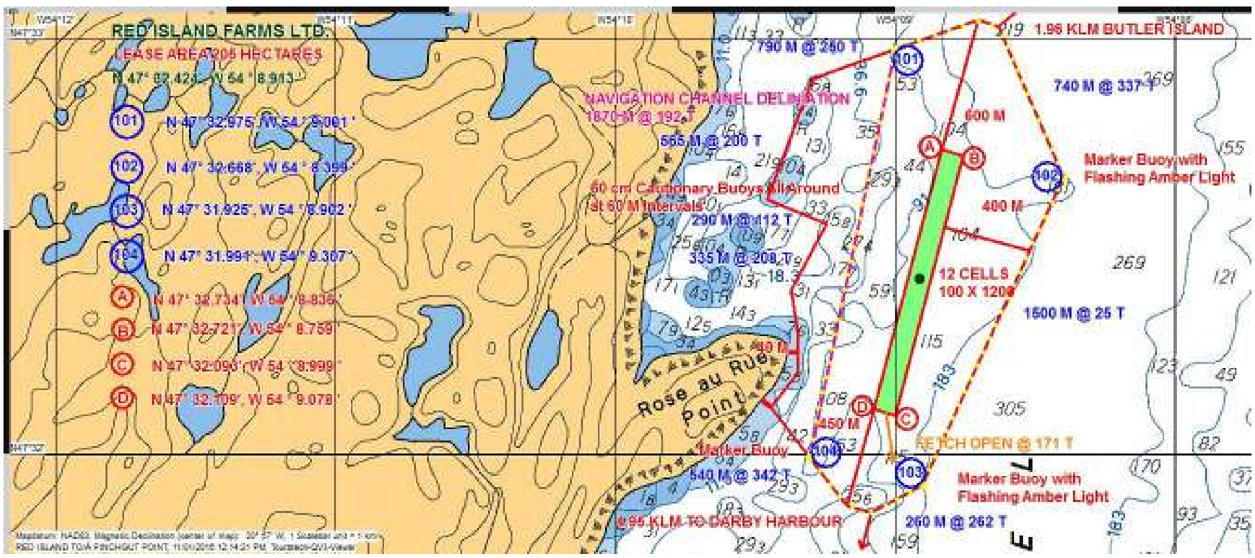


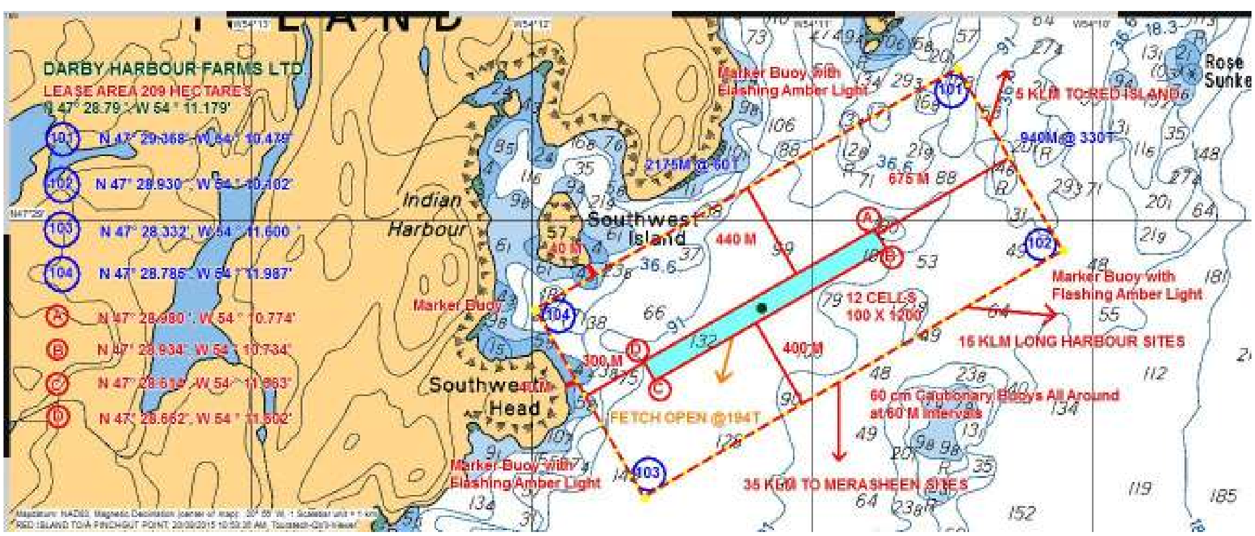

LONG ISLAND FARMS LTD.
N 47° 19.696', W 54° 41.875'
N 47° 19.630', W 54° 42.925'
N 47° 20.192', W 54° 41.480'
N 47° 19.725', W 54° 41.076'
N 47° 19.158', W 54° 42.516'
N 47° 19.883', W 54° 41.492'
N 47° 19.556', W 54° 42.311'
Marker Buoy with
Flashing Amber Light
35 KLM TO
MERASHEEN SITES
1000 M @ 330T
300 M
500 M
400 M
600 M
12 CELLS
100 X 1200
Green Island
Shoal
5.98 KLM TO
GALLOWS HARBOUR
FETCH OPEN @ 209T
2100 M @ 60T
60 CM Cautionary Buoys
all Around at 60 M Intervals

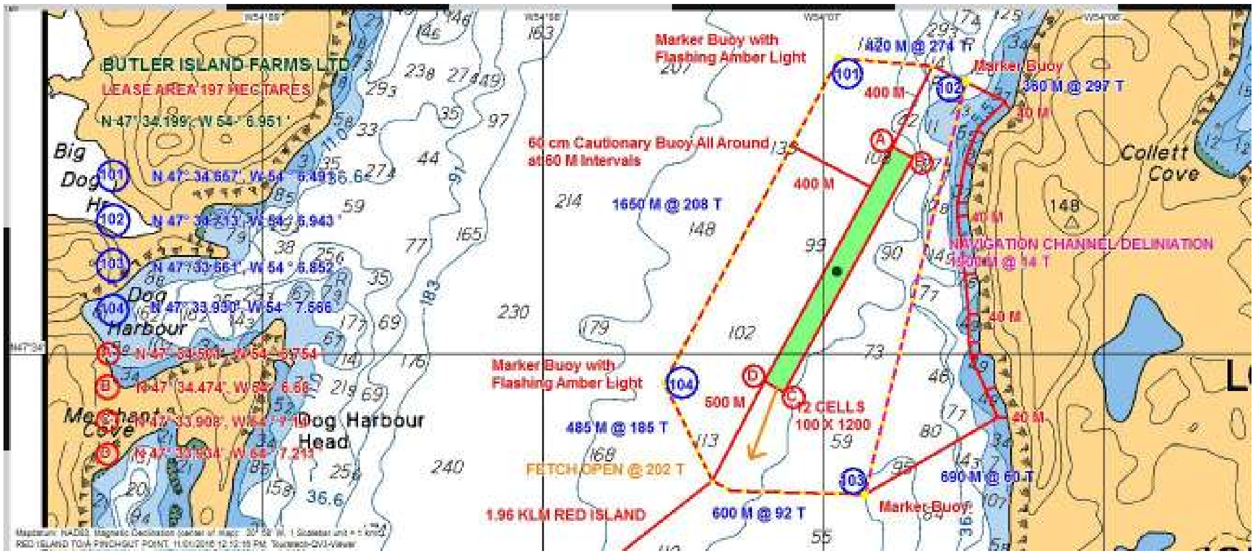

VALEN ISLAND FARMS LTD.
LEASE AREA 244 HECTARES
N 47° 31.455', W 54° 23.404'
N 47° 31.960', W 54° 22.81'
N 47° 31.434', W 54° 22.427'
N 47° 30.946', W 54° 24.001'
N 47° 31.473', W 54° 24.389'
N 47° 31.616', W 54° 22.990'
N 47° 31.566', W 54° 22.955'
N 47° 31.293', W 54° 23.828'
N 47° 31.342', W 54° 23.860'
5.55 KLM TO CHAMBERS ISLAND
60 cm Cautionary Buoys All Around
at 60 M Intervals
2200M @ 245T
1100M @ 335T
Marker Buoy With
Flashing Amber Light
Marker Buoy
500 M
12 CELLS
100 X 1200
35 KILOMETERS TO RED ISLAND SITES
35 KILOMETERS TO RUSHOON SITES
Benny Pt

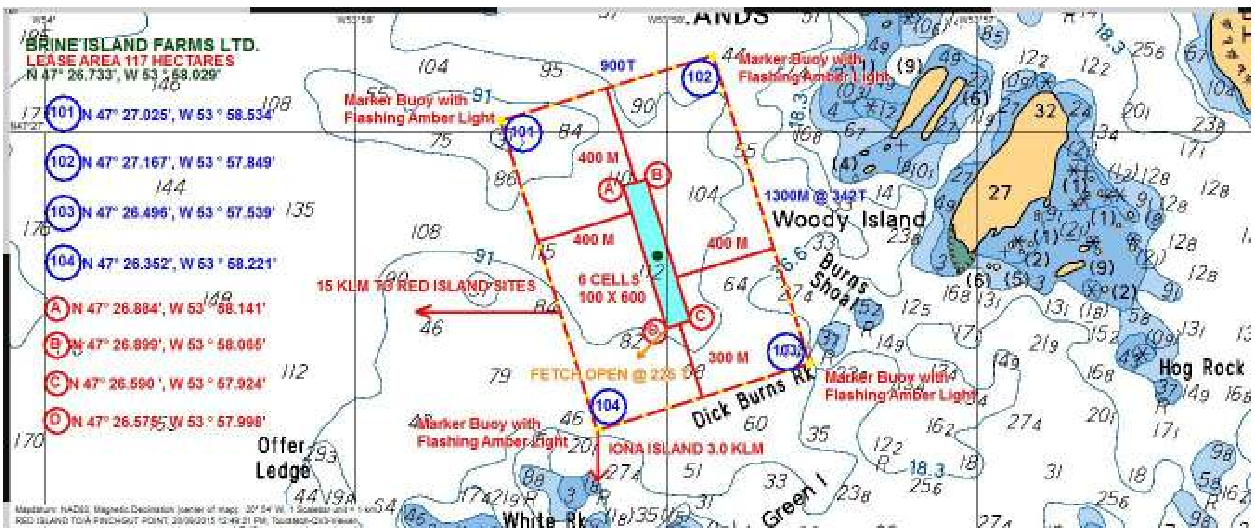

CHAMBERS ISLAND FARMS LTD.
LEASE AREA 242 HECTARES
N 47° 34.773', W 54° 21.122'
N 47° 35.176', W 54° 21.875'
N 47° 35.429', W 54° 21.076'
N 47° 34.383', W 54° 20.340'
N 47° 34.102', W 54° 21.13
N 47° 35.040', W 54° 21.356'
N 47° 35.065', W 54° 21.283'
N 47° 34.477', W 54° 20.876'
N 47° 34.455', W 54° 20.948'
Marker Buoy With
Flashing Amber Light
Marker Buoy
500 M
12 CELLS
100 X 1200
7.76 KLM TO SHIP ISLAND
2200M @ 335T
60 cm Cautionary Buoys All Around
at 60 M Intervals
FETCH OPEN @ 185T
5.33 KLM TO VALEN ISLAND
Ladder Cove
Head

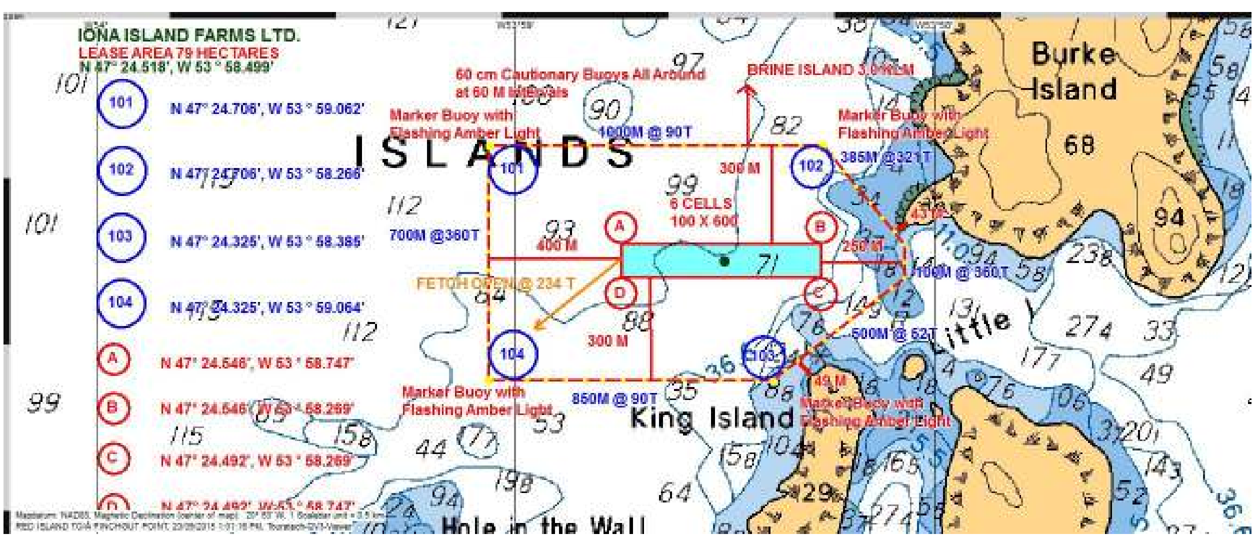

SHIP ISLAND FARMS LTD.
LEASE AREA 189 HECTARES
N 47° 38.938', W 54 ° 16.784'
101 N 47° 39.257', W 54 ° 17.473'
102 N 47° 39.069', W 54 ° 16.842'
103 N 47° 38.590', W 54 ° 16.372'
104 N 47° 38.792', W 54 ° 17.620'
A N 47° 39.018', W 54 ° 17.227'
B N 47° 38.807', W 54 ° 16.281'
C N 47° 38.854', W 54 ° 16.294'
D N 47° 38.969', W 54 ° 17.241'
Marker Buoy with Flashing Amber Light
60 cm Cautionary Buoys all Around at 60 M Intervals
2100M @ 280T
400 M
FETCH OPEN @ 194T
12 CELLS 100 X 1200
500 M
900M @ 10T
7.76 KLM TO CHAMBERS ISLAND


RED ISLAND FARMS LTD.
LEASE AREA 205 HECTARES
N 47° 32.424', W 54 ° 8.913'
101 N 47° 32.975', W 54 ° 9.001'
102 N 47° 32.668', W 54 ° 8.399'
103 N 47° 31.925', W 54 ° 8.902'
104 N 47° 31.991', W 54 ° 9.307'
A N 47° 32.734', W 54 ° 8.836'
B N 47° 32.721', W 54 ° 8.759'
C N 47° 32.090', W 54 ° 8.999'
D N 47° 32.109', W 54 ° 9.078'
790 M @ 280 T
1.96 KLM BUTLER ISLAND
NAVIGATION CHANNEL DELINEATION 1870 M @ 192 T
555 M @ 200 T
740 M @ 337 T
600 M
60 cm Cautionary Buoys All Around at 60 M Intervals
Marker Buoy with Flashing Amber Light
290 M @ 112 T
335 M @ 208 T
400 M
12 CELLS 100 X 1200
1500 M @ 25 T
Rose au Rue Point
450 M
FETCH OPEN @ 171 T
Marker Buoy
540 M @ 342 T
2.95 KLM TO DARBY HARBOUR
260 M @ 262 T


DARBY HARBOUR FARMS LTD.
LEASE AREA 209 HECTARES
N 47° 28.79', W 54 ° 11.179'
101 N 47° 29.368', W 54 ° 10.479'
102 N 47° 28.930', W 54 ° 10.102'
103 N 47° 28.332', W 54 ° 11.600'
104 N 47° 28.785', W 54 ° 11.987'
A N 47° 28.980', W 54 ° 10.774'
B N 47° 28.934', W 54 ° 10.734'
C N 47° 28.614', W 54 ° 11.663'
D N 47° 28.662', W 54 ° 11.602'
Marker Buoy with Flashing Amber Light
5 KLM TO RED ISLAND
940M @ 330T
2175M @ 60T
675 M
Indian Harbour
Southwest Island
440 M
12 CELLS 100 X 1200
Marker Buoy
15 KLM LONG HARBOUR SITES
300 M
400 M
Southwest Head
FETCH OPEN @194T
60 cm Cautionary Buoys All Around at 60 M Intervals
35 KLM TO MERASHEEN SITES


BUTLER ISLAND FARMS LTD.
LEASE AREA 197 HECTARES
N 47° 34.199', W 54 ° 6.951'
101 N 47° 34.657', W 54 ° 6.493'
102 N 47° 34.213', W 54 ° 5.943'
103 N 47° 33.661', W 54 ° 6.852'
104 N 47° 33.930', W 54 ° 7.566'
Big Dog Hr
Dog Harbour
Merchant Cove
Dog Harbour Head
Marker Buoy with Flashing Amber Light
420 M @ 274 T
Marker Buoy
360 M @ 297 T
400 M
60 cm Cautionary Buoy All Around at 60 M Intervals
1650 M @ 208 T
NAVIGATION CHANNEL DELINIATION
Collett Cove
12 CELLS 100 X 1200
500 M
485 M @ 185 T
FETCH OPEN @ 202 T
690 M @ 60 T
600 M @ 92 T
1.96 KLM RED ISLAND


BRINE ISLAND FARMS LTD.
LEASE AREA 117 HECTARES
N 47° 26.733', W 53 ° 58.029'
101 N 47° 27.025', W 53 ° 58.534'
102 N 47° 27.167', W 53 ° 57.849'
103 N 47° 26.496', W 53 ° 57.539'
104 N 47° 26.352', W 53 ° 58.221'
A N 47° 26.884', W 53 ° 58.141'
B N 47° 26.899', W 53 ° 58.065'
C N 47° 26.590 ', W 53 ° 57.924'
D N 47° 26.575', W 53 ° 57.998'
900T
Marker Buoy with Flashing Amber Light
400 M
1300M @ 342T
Woody Island
Burns Shoal
6 CELLS 100 X 600
15 KLM TO RED ISLAND SITES
FETCH OPEN @ 225 T
300 M
Dick Burns Rk
IONA ISLAND 3.0 KLM
Offer Ledge
Hog Rock
White Rk
Green I


IONA ISLAND FARMS LTD.
LEASE AREA 79 HECTARES
N 47° 24.518', W 53 ° 58.499'
101 N 47° 24.706', W 53 ° 59.062'
102 N 47° 24.706', W 53 ° 58.266'
103 N 47° 24.325', W 53 ° 58.385'
104 N 47° 24.325', W 53 ° 59.064'
A N 47° 24.546', W 53 ° 58.747'
B N 47° 24.546', W 53 ° 58.269'
C N 47° 24.492', W 53 ° 58.269'
60 cm Cautionary Buoys All Around at 60 M Intervals
BRINE ISLAND 3.0 KLM
Marker Buoy with Flashing Amber Light
1000M @ 90T
ISLANDS
300 M
385M @321T
Burke Island
6 CELLS 100 X 600
700M @360T
400 M
250 M
100M @ 360T
FETCH OPEN @ 234 T
500M @ 52T
850M @ 90T
King Island
Little I
Hole in the Wall

11.2 Physical Features Part 2:

11.2.1 Major Features of Part 2 of the Undertaking:

The main features of the undertaking will be a full marine environment with cage collars at the surface and nets extending down to 43 meters. Mooring anchorages extend from the bottom and perimeter of the proposed lease area and towards the surface at a targeted scope of 3:1 of length to water depth. The water column is variable seasonally and also spatially and layered by density differentials of salinity and temperatures to form pycnoclines. The incline areas of the site are typically hard bottoms rock and cliff while the deep basins at 100 meters and deeper are silt sediments.

11.2.2 Area to be Affected by Part 2 of the Undertaking:

The 11 sites have the following areas in hectares:

1. Oderin Island Farms 126;
2. Gallows Harbour 140;
3. Long Island 210;
4. Valen island 244;
5. Chambers Island 242;
6. Ship Island 189;
7. Red Island 205;
8. Darby Harbour 209;
9. Butler Harbour 197;
10. Brine Island 117; and,
11. Iona Island 79.

The total lease area proposed is 1,958 hectares. The area occupied by the sea cages is 24 hectares and approximately 1.23% of the total lease area. The northern end of Placentia Bay encompassing the Merasheen archipelago is approximately 245,000 hectares. The farm leases would occupy less than 1% of the area. The sea cages will occupy less than 0.01% of the region's available space.

11.2.3 Existing Biophysical Environment of Part 2:

11.2.3.1 Marine Topography and Bathometry

The Geological Survey of Canada and the Bedford Institute of Oceanography have captured much of the bathometry of Placentia Bay via multibeam scanner and the various files are available for download viewing. The link directly below is a fly through short video of Placentia Bay:

http://www.smartatlantic.ca/PlacentiaBay/mapping.php

Presented below are pictures of the bathometry at the areas proposed for the Atlantic salmon farming operations.

Figure 17 -- Bathometry Map of Northern Placentia Bay

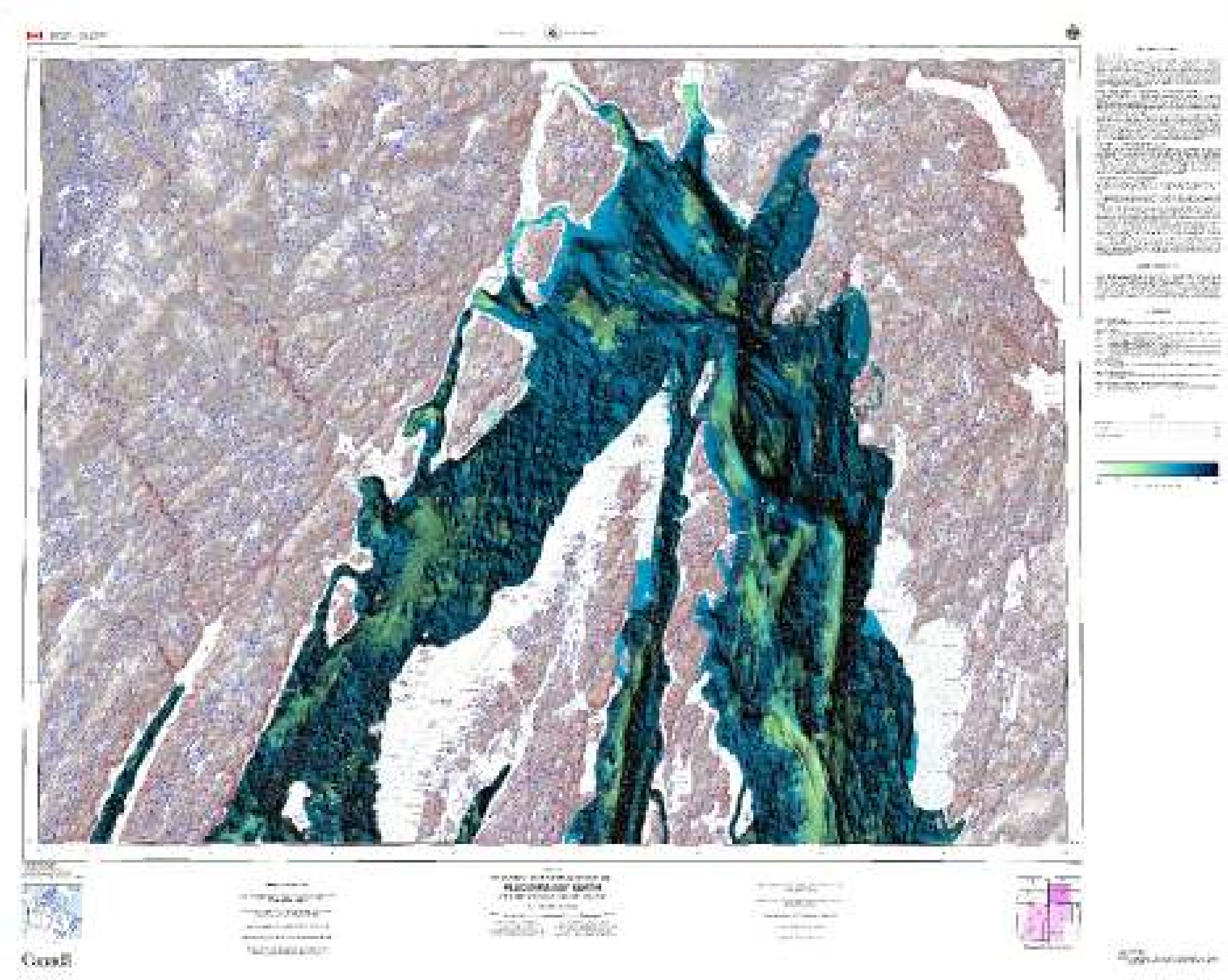
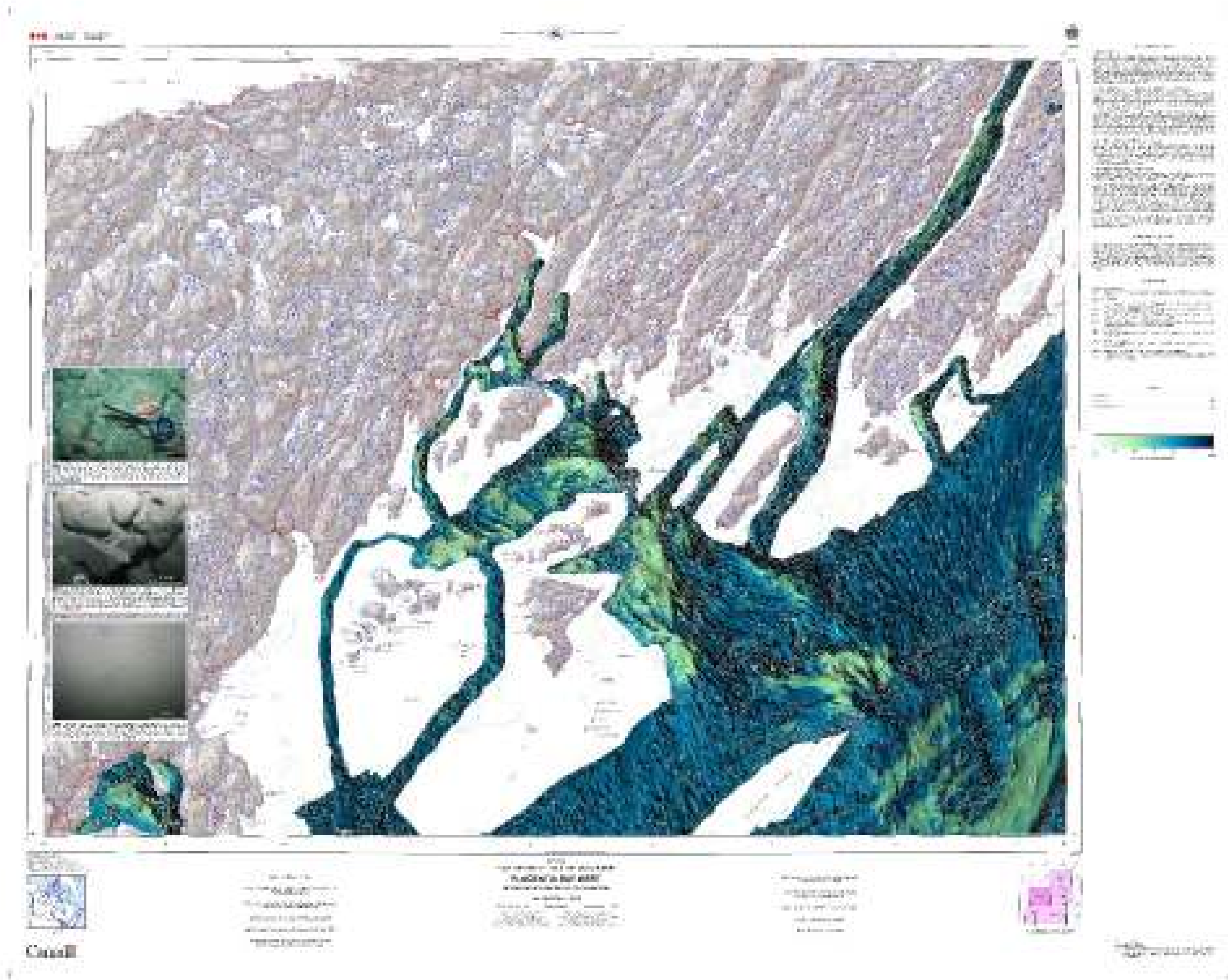


Figure 18 -- Bathometry Map of Western Placentia Bay



11.2.3.2 Marine Climate and Oceanography

SMARTBAY data is sea surface temperature from the Mouth of Placentia Bay buoy and are averaged monthly. Sample years were randomly chosen with 12 months of data were available for 2010 and 2013 with minimum temperatures in February and March and maximum in August and September with highs slightly warmer in 2013. The data is presented in the tables below:

Table 3 – Annual Monthly Average Sea Surface Temperatures for SmartBay Bouy: Mouth of Placentia Bay 2010. 46° 58.6025N 54 ° 41.0459W, Minimum Temperatures in Blue, Maximum Values in Red

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
1	1481	1.14	2.490	.065	1.02	1.27	0	93
2	1035	-.12	.153	.005	-.13	-.11	0	0
3	1480	.28	.230	.006	.27	.29	0	1
4	1427	1.49	.574	.015	1.46	1.52	0	3
5	1460	3.82	.896	.023	3.77	3.87	2	7
6	1427	6.64	7.921	.210	6.23	7.05	4	303
7	1469	12.06	11.102	.290	11.50	12.63	8	302
8	1470	16.71	10.509	.274	16.17	17.24	14	294
9	1406	15.52	13.393	.357	14.82	16.22	10	309
10	1476	10.18	7.314	.190	9.80	10.55	8	287
11	1244	6.52	.644	.018	6.49	6.56	6	8
12	1486	4.54	.604	.016	4.50	4.57	3	6
Total	16861	6.71	8.797	.068	6.58	6.84	0	309

Table 4 – Annual Monthly Average Sea Surface Temperatures for SmartBay Buoy: Mouth of Placentia Bay 2013. 46° 58.6025N 54 ° 41.0459W, Minimum Temperatures in Blue, Maximum Values in Red

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
1	1482	1.5082	.68326	.01775	1.4734	1.5431	.10	3.16
2	1329	.2407	.19191	.00526	.2304	.2510	-.21	.85
3	1482	.3567	.26060	.00677	.3434	.3700	-.16	2.05
4	1436	1.2827	.62557	.01651	1.2503	1.3151	.39	3.33
5	1413	4.0991	.88974	.02367	4.0526	4.1455	2.44	6.96
6	1434	7.7000	1.14624	.03027	7.6406	7.7594	5.92	10.24
7	1498	12.9383	1.61938	.04184	12.8562	13.0204	9.18	15.70
8	1484	16.3517	.53459	.01388	16.3245	16.3789	15.18	17.38
9	1430	15.3550	.73484	.01943	15.3169	15.3931	12.33	16.42
10	1484	10.9794	1.51587	.03935	10.9023	11.0566	8.72	14.59
11	1430	7.0765	1.04203	.02756	7.0225	7.1306	5.43	9.41
12	1484	2.8409	1.56586	.04065	2.7612	2.9206	.51	6.03
Total	17386	6.7867	5.77246	.04378	6.7009	6.8725	-.21	17.38

The data above provides a rough estimate of temperatures but they are at the surface and Atlantic salmon are rarely at that depth except in the event of rising temperatures in the spring. Atlantic salmon experience mortality in extreme cold conditions and superchill at -0.7°C. While the tables above do not indicate these conditions; it is very likely that conditions are much more favourable even than that indicated above. The conditions in the water column are such that the water is layered by density created by temperature differentials and salinity differentials or pycnoclines. The data below from Placentia Bay near Long Island in 2012 was collected by the Department of Fisheries and Oceans (DFO). It illustrates the point perfectly where surface temperatures are greater than the ideal while between 10 meters and 25 meters optimal conditions are available. Below 25 meters the water temperature is less than the 14°C optimal and falling away to about 6°C at 32 meters:

Figure 19 – Graph of Temperatures at Depth for Placentia Bay Near Long Island in August 2012

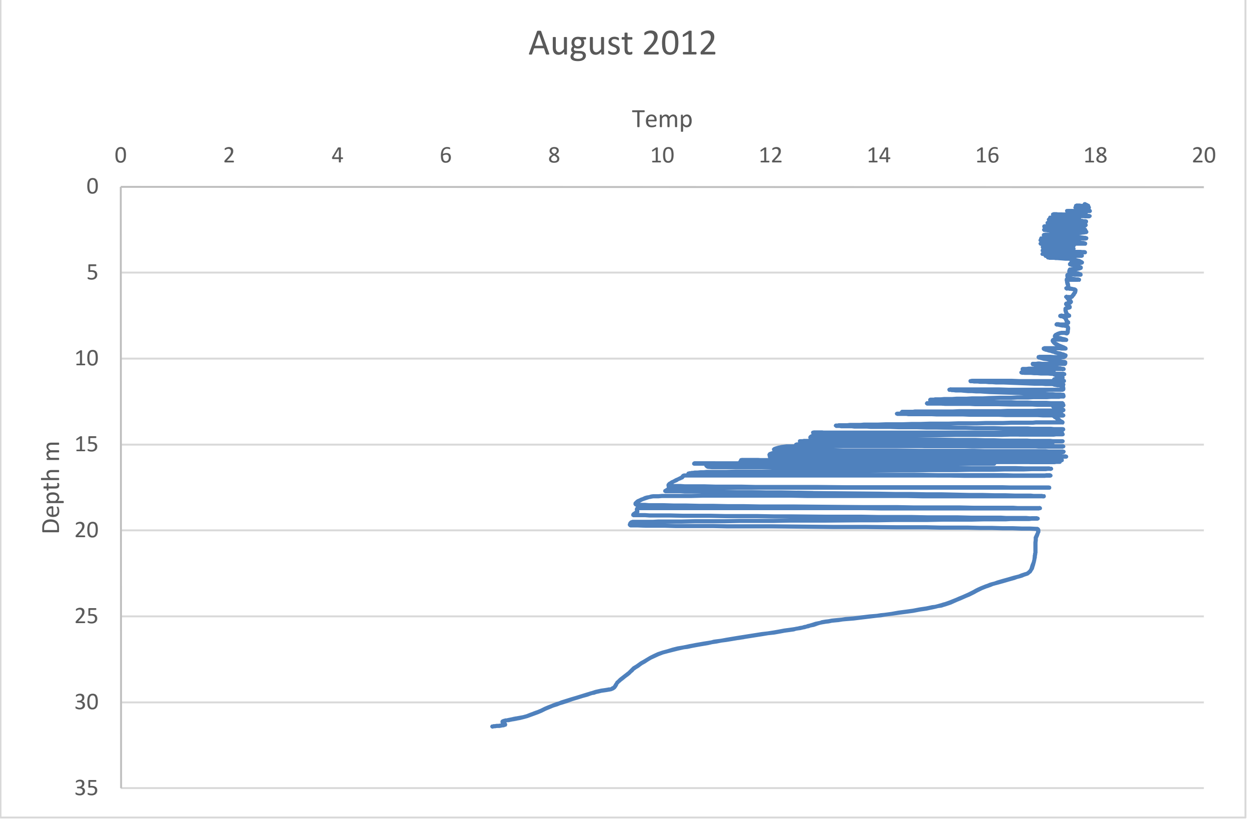


Figure 20 – Graph of Temperatures at Depth for Placentia Bay Near Oderin Island, Gallows Harbour and Long Island in December 2015

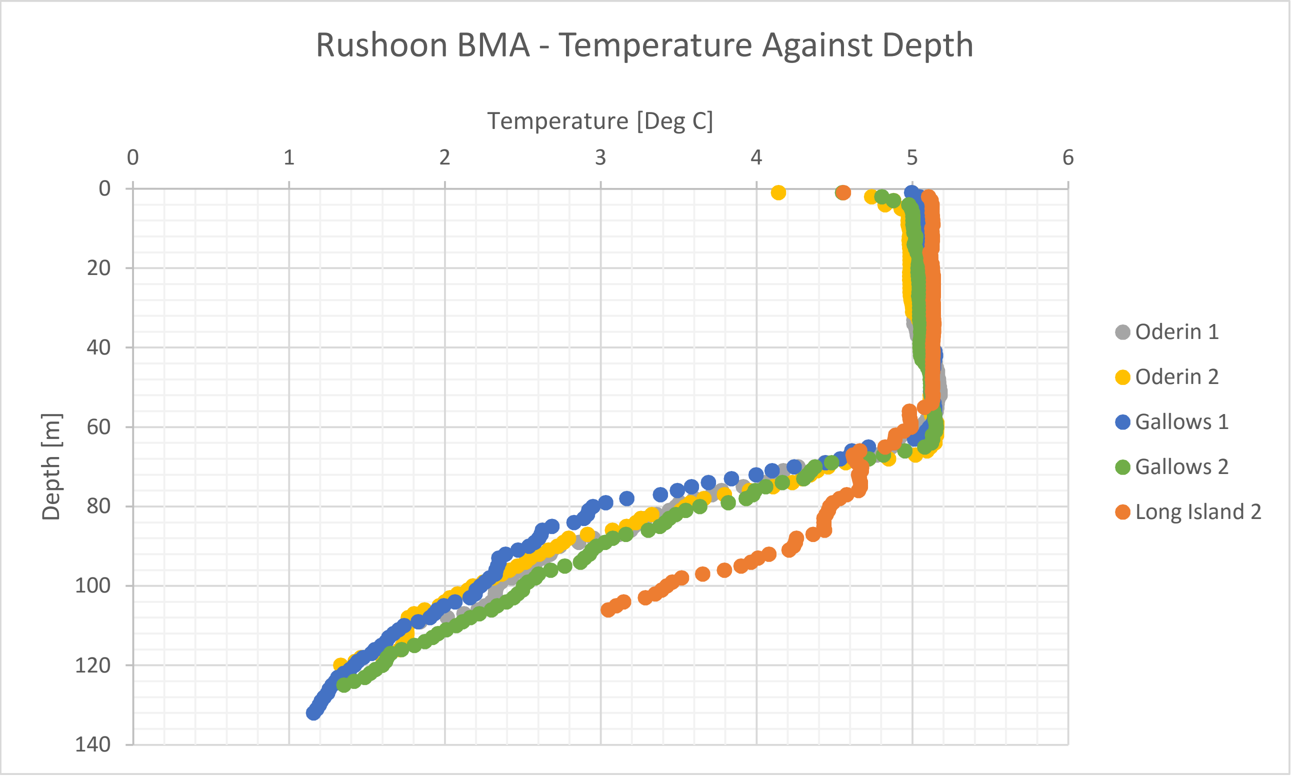


Figure 21 – Graph of Temperatures at Depth for Placentia Bay Near Brine Island, and Iona Island in December 2015

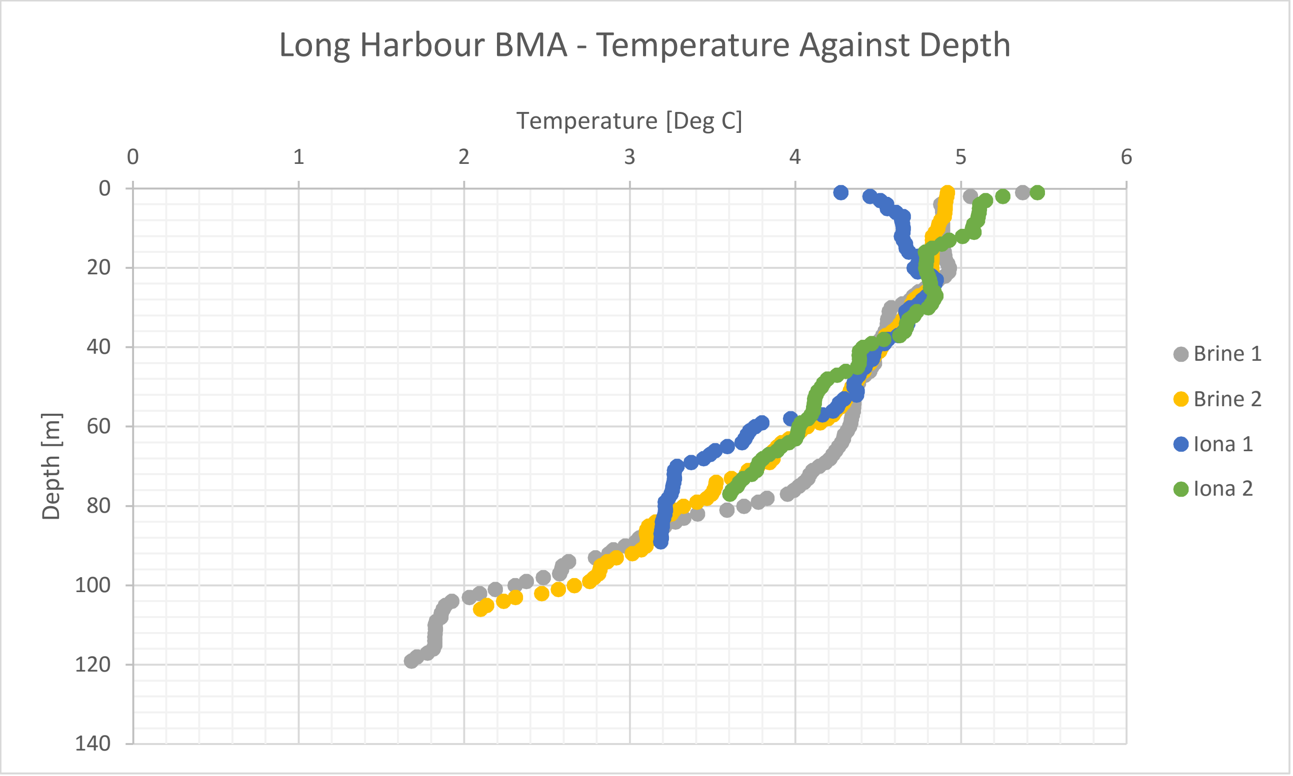
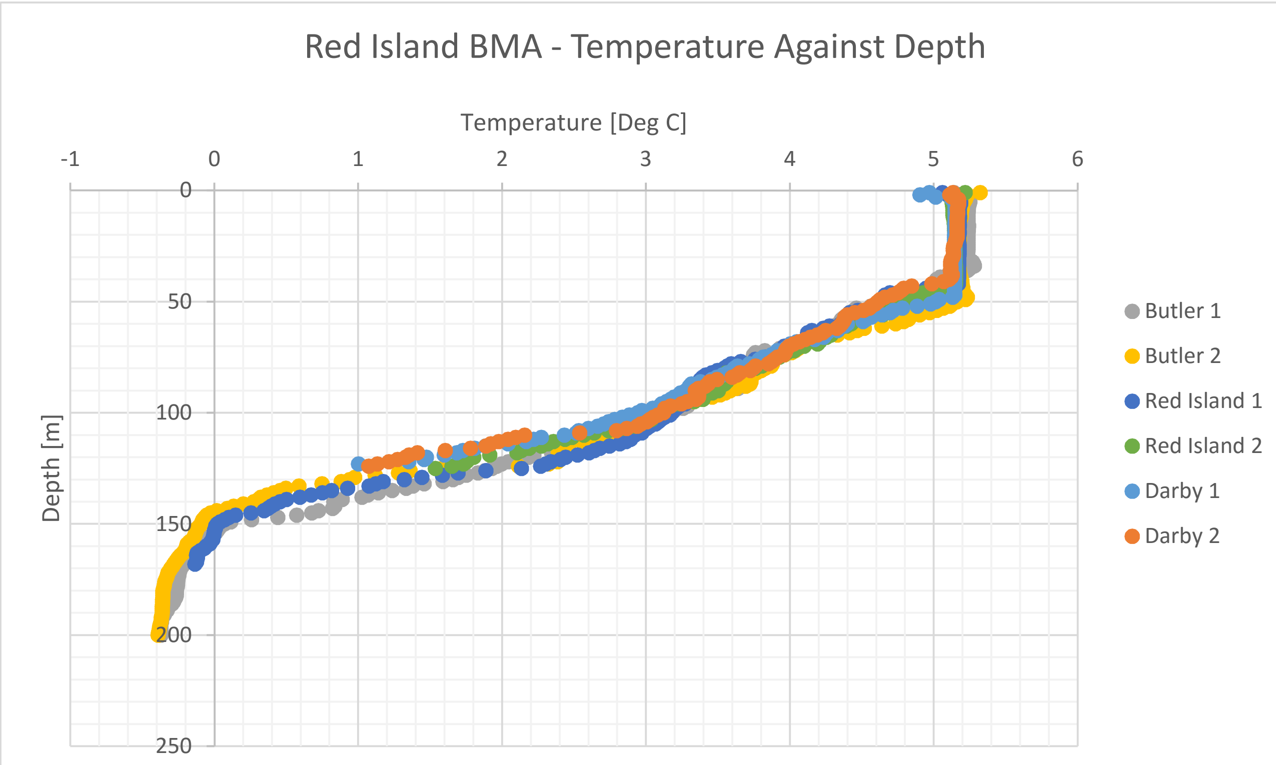


Figure 22 – Graph of Temperatures at Depth for Placentia Bay Near Red Island, Darby Harbour and Butler Island in December 2015



The December depth profiling conducted by DHI for the Company indicates the presence of a thermocline / pycnocline at about 50 meters on the western side of Placentia Bay while the eastern side shows the layer separation at about 20 meters.

The Department of Fisheries and Aquaculture (DFA) have provided an amalgamation of data for Placentia Bay at different depths and locations with the purpose of defining growing conditions for the region. Temperature Units (TU) are calculated on a monthly basis. As an example a month with 30 days and an average temperature of 10^{o}C provides 300 TU. Growth Factor 3 (GF3) is a standard coefficient used in calculating the growth of Atlantic salmon and is sometime termed the Temperature Growth Coefficient (TGC). In models projecting growth the GF3 or TGC is often stated more conservatively at 2.7. The calculation to model growth is $\{(\text{End Weight})^{1/3} - (\text{Start Weight})^{1/3}\}$ X TU/1000 = GF3. The following table highlights the expected growth of a 300 gram Atlantic salmon entering Placentia Bay in May. The assumption is that the fish will maximize conditions towards the surface and at depth such that the fish will maximize towards the ideal at 14°C degrees and thereafter seek cooler conditions to maintain internal metabolic states at 14°C. This is highlighted in yellow in the table.

Table 5 – Calculation of Temperature Units and Projected Atlantic Salmon Growth for Placentia Bay

MONTH	Average Temperature	Days	Temperature Units	GF3	Start Wt. Grams	End Wt. Grams
May	4.4	31	135	2.7	300	352
June	7.0	30	211	2.7	352	444
July	12.0	31	373	2.7	444	645
August	14.0	31	434	2.7	645	944
Sept	13.4	30	403	2.7	944	1294
Oct	11.3	31	351	2.7	1294	1661
Nov	7.5	30	226	2.7	1661	1932
Dec	4.6	31	143	2.7	1932	2117
Jan	2.1	31	64	2.7	2117	2203
Feb	0.8	28	22	2.7	2203	2233
March	0.3	31	9	2.7	2233	2245
April	0.8	30	23	2.7	2245	2278
May	4.4	31	135	2.7	2278	2473
June	7.0	30	211	2.7	2473	2799
July	12.0	31	373	2.7	2799	3444
August	14.0	31	434	2.7	3444	4309
Sept	13.4	30	403	2.7	4309	5232
Oct	11.3	31	351	2.7	5232	6135
	Total Temperature Units		4303			

11.2.3.3 Historical Resources Part 2

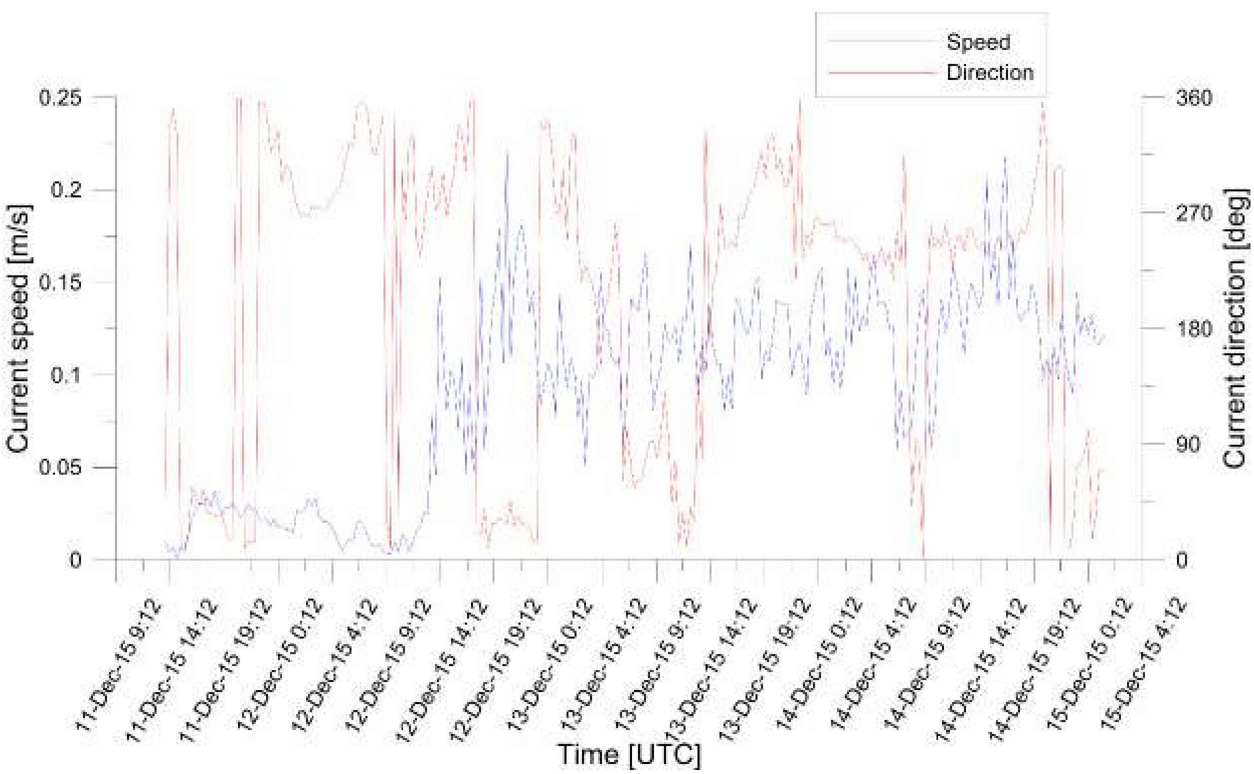
The assessments to date of the sites have not revealed any significant cultural or historic resources within the lease areas to be developed into Atlantic salmon aquaculture sites. Typically, with an Atlantic salmon sea cage installation there is concern that the site may impact a wreck of a ship that is of historical importance. The sites considered for this undertaking are in deep water and away from shore activity and reefs and very unlikely to impact or encounter artifacts of historical significance.

11.2.3.4 Marine Resources

The key to having a sustainable Atlantic salmon farm is adequate oxygen for the fish at all times. During late November and early December, the Company hired DHI to conduct measurements of marine environment in the region of the various planned Atlantic salmon farms. Please refer to Appendix F December 2015 DHI Placentia Bay Data Report.

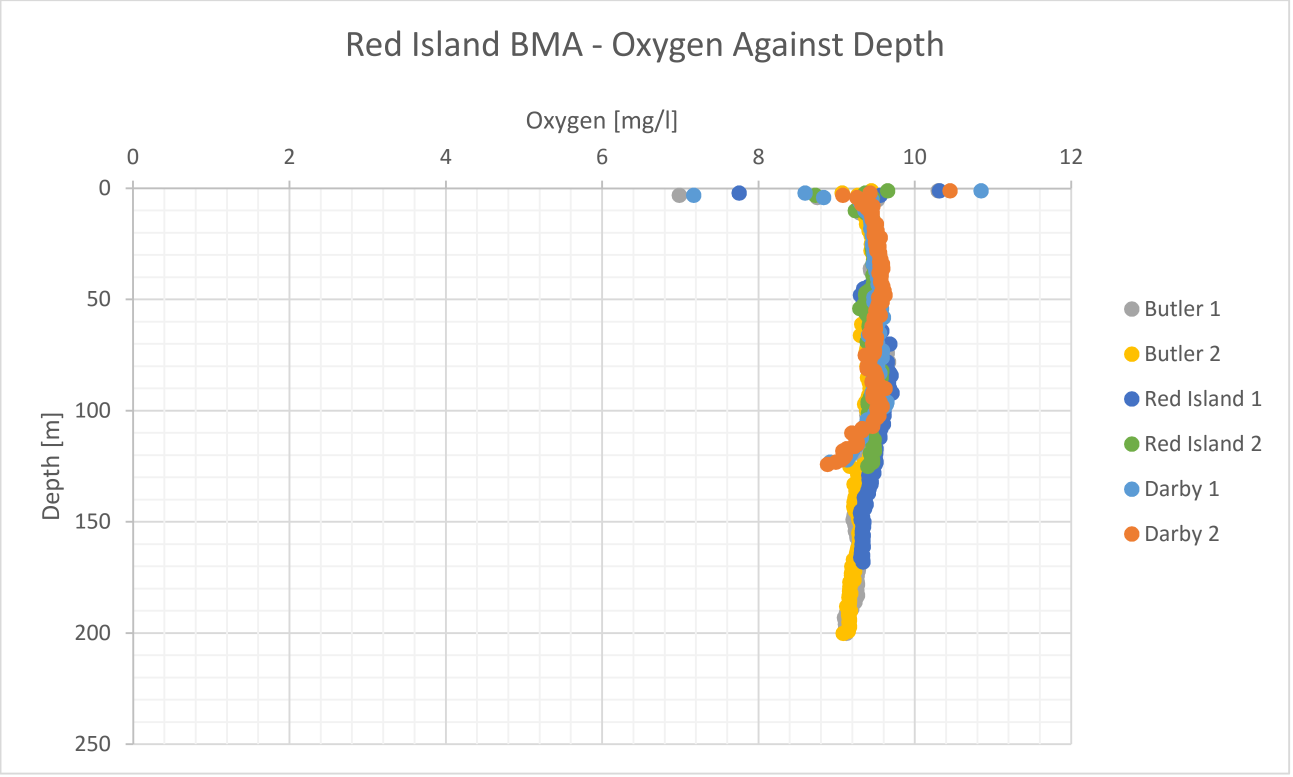
The DHI report indicates that there is a gentle current in the surface layers of Placentia Bay in the Middle Channel and the Red Island BMA as indicated in the graph below. The current is running at about 15 to 20 cm per second and the direction variable but generally north and south.

Figure 23 – Graph of Current Speed and Direction for Placentia Bay Near Darby Harbour in December 2015



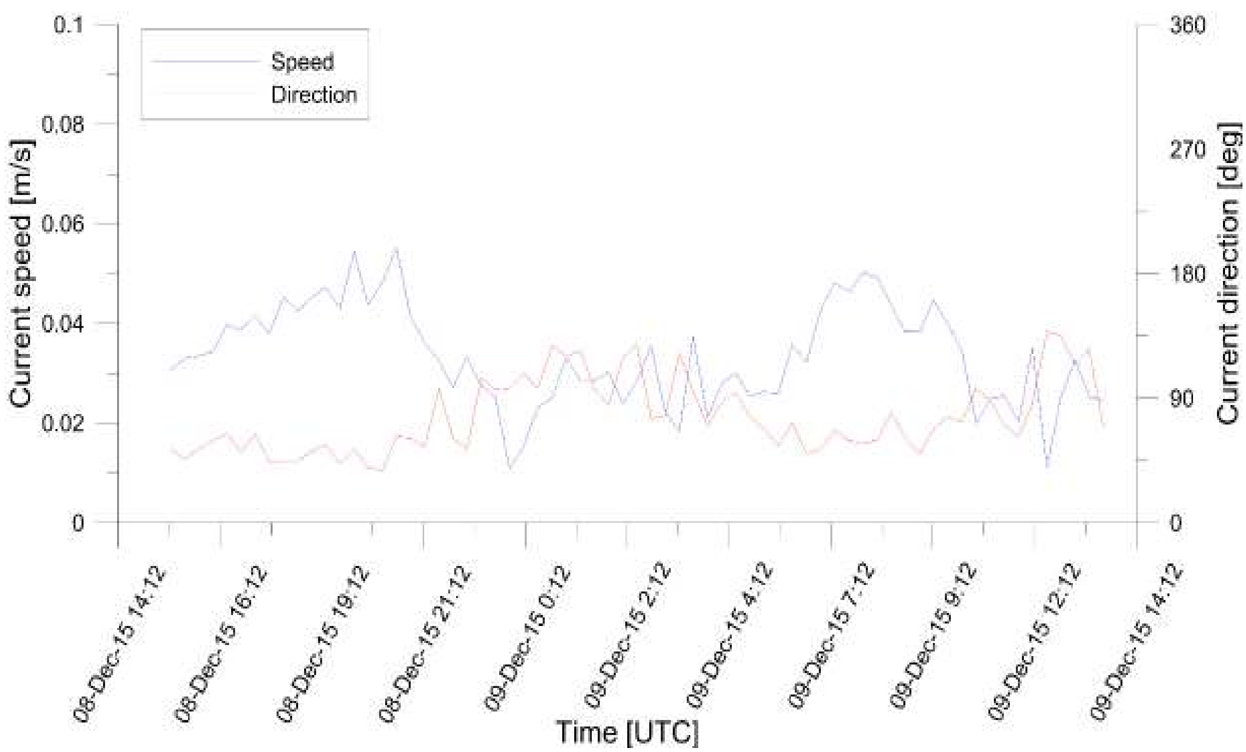
The water column in the Red Island BMA is also fully saturated with oxygen from the surface and to depth. Thus with gentle currents and full saturation of oxygen the sites in the Red Island BMA of the Middle Channel on the eastern side of Merasheen look very adequate for the purpose of Atlantic salmon farming.

Figure 24 – Graph of Oxygen Concentration in Placentia Bay Near Darby Harbour, Red Island and Butler Island in December 2015



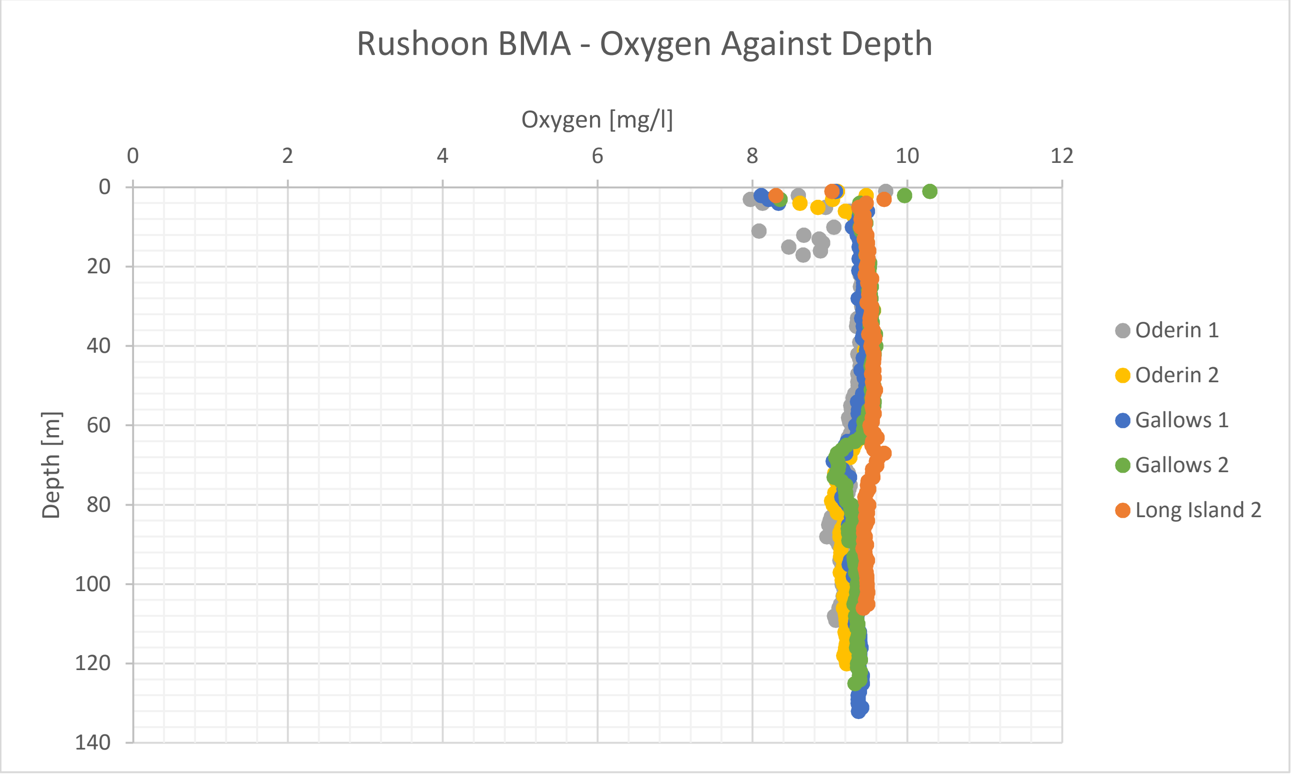
The DHI report indicates that there is a gentle current in the surface layers of Placentia Bay on the western side and the Rushoon BMA as indicated in the graph below. The current is running at about 4 to 6 cm per second and the direction fairly consistent and running east to west.

Figure 25 – Graph of Current Speed and Direction for Placentia Bay Near Oderin Island in December 2015



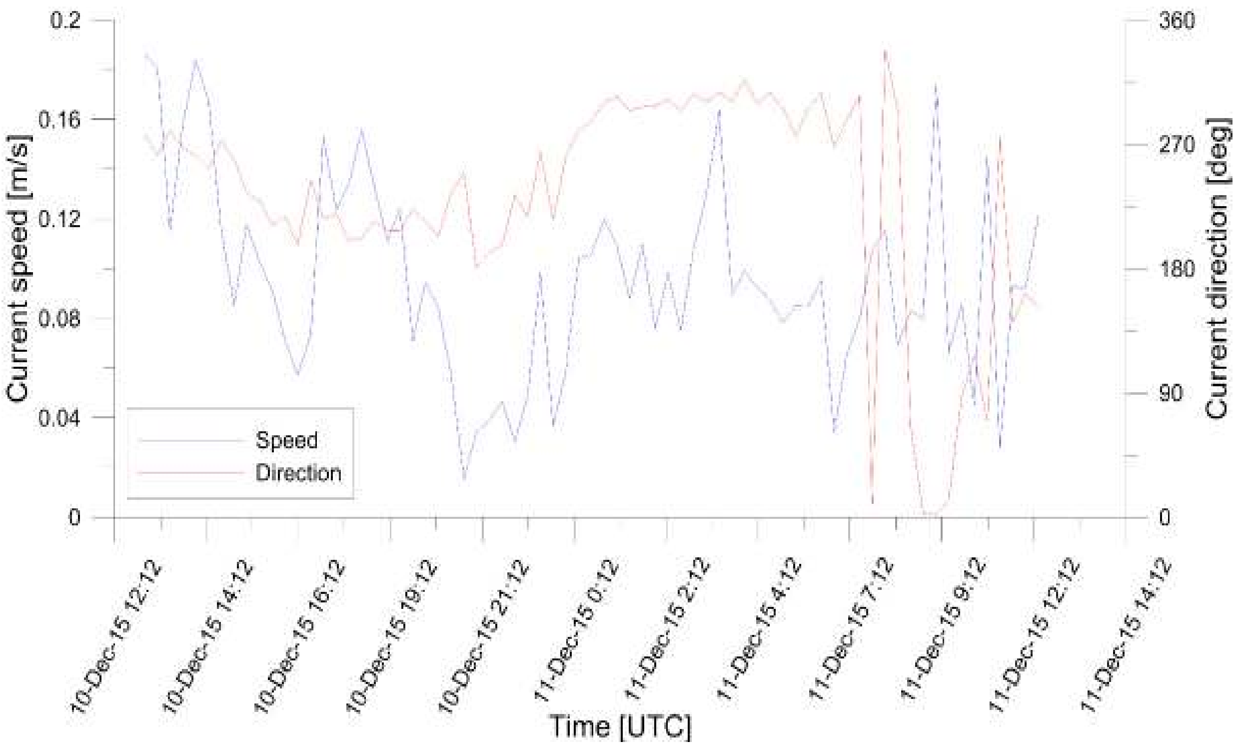
The water column in the Rushoon BMA is also fully saturated with oxygen from the surface and to depth. Thus with gentle currents and full saturation of oxygen the sites in the Rushoon BMA of the western side look very adequate for the purpose of Atlantic salmon farming.

Figure 26 – Graph of Oxygen Concentration in Placentia Bay Near Oderin Island, Gallows Harbour and Long Island in December 2015



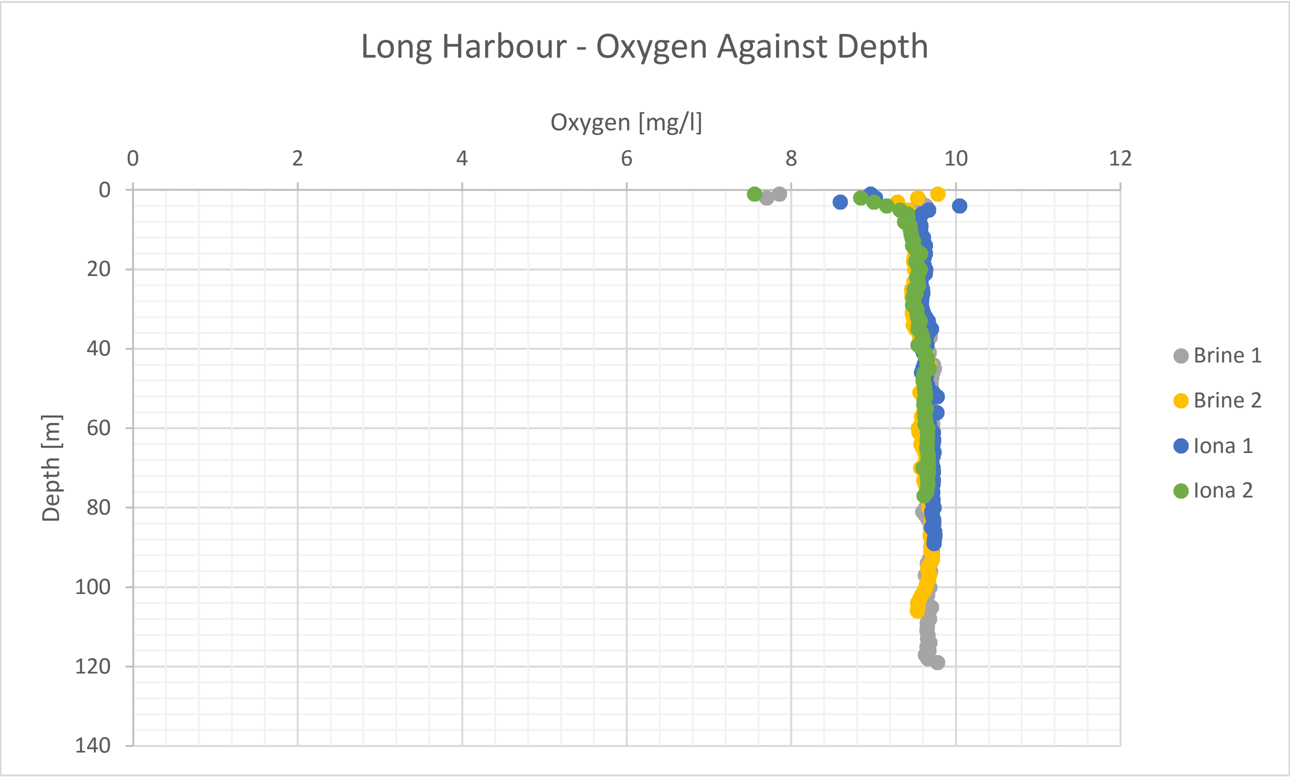
The DHI report indicates that there is a gentle current in the surface layers of Placentia Bay on the eastern side and the Long Harbour BMA as indicated in the graph below. The current is running at about 5 to 20 cm per second and the direction variable but generally east and west.

Figure 27 – Graph of Current Speed and Direction for Placentia Bay Near Darby Harbour in December 2015



The water column in the Long Harbour BMA is also fully saturated with oxygen from the surface and to depth. Thus with gentle currents and full saturation of oxygen the sites in the Long Harbour BMA of the eastern side look very adequate for the purpose of Atlantic salmon farming.

Figure 28 – Graph of Oxygen Concentration in Placentia Bay Near Oderin Island, Gallows Harbour and Long Island in December 2015



11.2.3.5 Species at Risk near Part 2 of the Undertaking

All activities in Newfoundland and Labrador must comply with Canada's Species at Risk Act (SARA) and then further provincially with Newfoundland and Labrador's Endangered Species Act. The "Species at Risk" are collectively a part of SARA's Public Registry, the list of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and the list of Newfoundland and Labradors Species Status Advisory Committee (SSAC). There is a general overlap of prohibitions under both jurisdictions for Species at Risk; however, there are some differences in terminology or definitions. In Federal terminology species are referred to as Extirpated or Extinct, Endangered, Threatened or Special Concern. The Provincial definitions are the same with the exception of Special Concern and are referred to as Vulnerable.

The Federal and Provincial governments have joint and layered approach to management of Placentia Bay. The encompassing management planning is done through the auspices of the Integrated Coastal and Oceans Management Newfoundland and Labrador http://www.icomnl.ca . Underneath this structure is the Placentia Bay Integrated Management Committee and they are guided by the "Placentia Bay Integrated Management Plan" http://www.icomnl.ca/files/PBIMC%20Integrated%20Management%20Plan.PDF . Placentia Bay is considered Coastal Management Area 4 (CMA). All of Placentia Bay is considered and managed as an Ecologically and Biologically Significant Area (EBSA) http://www.icomnl.ca/files/CSAS%20Report%20PBGB%20EBSAs.PDF . The CMA4 that is Placentia Bay is nestled within the more significant Large Ocean Management Area and the management secretariat prepared a guidance document "Placentia Bay / Grand Banks Large Ocean Management Area Integrated Management Plan (2012-2017)" http://www.icomnl.ca/files/PBGB%20LOMA%20IM%20Plan.PDF . On page 45 the document states:

> "*Aquatic species at risk that currently occur in the LOMA include: the '**Endangered**' Ivory Gull, Piping Plover, and Eskimo Curlew, the '**Threatened**' Northern Wolffish, Spotted Wolffish, and Beluga Whale* (St. Lawrence Estuary Population), and the '**Endangered**' Blue Whale, North Atlantic Right Whale, and Leatherback Turtle. Fin whale, Atlantic (striped) Wolffish, Harlequin Duck, Barrow's Goldeneye, and Banded Killifish, have also been identified as '**Special Concern**'.*"

*Note the Beluga Whale was reassessed "**endangered**" in November 2014.

COSEWIC also declared the south Newfoundland group of Atlantic salmon as "**threatened**" in November 2010. They include the population breeds in rivers from the southeast tip of the Avalon Peninsula, Mistaken Point, westward along the south coast of Newfoundland to Cape Ray. This species was not included in the LOMA for Placentia Bay / Grand Banks Integrated Management Plan (2012-2017).

COSEWIC's update status report on the Ivory Gull is as follows:

> **"*Ivory Gull***
>
> *Scientific Name*: *Pagophila eburnea*
> *Range: Northwest Territories, Nunavut, Newfoundland and Labrador*
> *Assessment Date: April 2006*
> *COSEWIC Designation:* ***Endangered***
>
> ***Description***
>
> *The Ivory Gull is a small seabird with black legs. It is distinctive at all ages but it is particularly striking in its pure white adult plumage. Juveniles have a dusky face and chin and black spots on the breast and along the flanks and tail. In adults, the bill is generally slate blue at the base, becoming pale yellow and tipped with red; in juveniles the bill is darker. Its round chest, short legs, and rolling gait give the Ivory Gull a pigeon-like appearance when on the ground. However, despite its stocky body, in the air it has a graceful and agile flight.*"

The Department of Environment and Conservation describe the Ivory Gull as follows:

Figure 29 – DEC Information Sheet of the Ivory Gull

Ivory Gull

(Pagophila eburnea)

- The Ivory Gull is a small seabird with black legs and dark eyes. It has a slate blue bill that becomes pale yellow to dark orange at the tip.
- It is the only gull with pure white plumage as an adult.
- Immature birds have a dusky face, and black spots on the breast, flanks, tail, and outer wings.
- Ivory Gull lay 1 to 2 eggs per nest.

Provincial Distribution

Habitat/ Range
Ivory Gulls breed in the High Arctic and winter in the Arctic seas and along the Atlantic coast, including the coast of Newfoundland and Labrador. They are found most often among the pack ice of the Davis Strait, Labrador Sea, Strait of Belle Isle, and northern Gulf of St. Lawrence. They are more rarely seen on the coast of the Great Northern Peninsula of Newfoundland and ashore.

Population Trends
Breeding colony surveys suggest that Ivory Gulls have declined by 85% in Canada since the 1980s. A 2004 survey on the pack ice off the coast of this Province observed 0.02 Ivory Gulls/10 min watch, a decline from 0.69 Ivory Gulls/10 min watch observed in 1978.

Limiting Factors and Threats
Ivory Gull populations are limited by disturbance on the breeding ground, illegal hunting, climate change, and oil spills and toxic pollutants in wintering areas.

Special Significance
In Newfoundland and Labrador they are often referred to as the "ice partridge" and have been hunted for food. Harvest of Ivory Gulls was likely opportunistic and they were not a major food source.

It would be very uncommon to encounter the Ivory Gull in Placentia Bay as it is not the bird's preferred range or habitat. To ensure that chance encounter does not disturb further this animal, the containment net for the sea cages has mesh size that is sufficiently small at 35 mm to prevent the bird from entering the net and accidentally entrapping itself. The top of the sea cage is covered by netting as well preventing entry by that route. Further impacts to this species from this project are unlikely.

COSEWIC's update status report on the Piping Plover is as follows:

> ***"Piping Plover***
> *Scientific name -- <u>Charadrius melodus circumcinctus</u>*
> *Assessment Summary-- November 2013*
> *COSEWIC Status – **Endangered***
>
> *Reason for designation -- The interior subspecies of this shorebird is projected to decline over the longer term, particularly if concerted conservation efforts are relaxed. Overall numbers remain low and adult survival has been poor over the last decade. Threats from predation, human disturbance, and declines in habitat extent and quality continue. Occurrence Alberta, Saskatchewan, Manitoba, Ontario*
>
> *Status history -- The species was considered a single unit and designated Threatened in April 1978. Status re-examined and designated Endangered in April 1985. In May 2001, the species was re-examined and split into two groups according to subspecies. The <u>circumcinctus</u> subspecies was designated Endangered in May 2001. Status re-examined and confirmed in November 2013.*

The Department of Environment and Conservation describe the Piping Plover as follows:

Figure 30 – DEC Information Sheet of the Piping Plover

Piping Plover

(Charadrius melodus melodus)

- A small, thrush-sized shorebird.
- Piping Plover are the colour of dry sand, with a distinctive black breast band, a black band above the forehead, and a partially black tail.
- They have a white rump, bright orange legs, and a short bill that is orange with a black tip.
- Piping Plover winter along the southern Atlantic coast of the United States and in the Caribbean.

Provincial Distribution

Habitat/ Range
This rare shorebird nests on sandy beaches in all four Atlantic provinces and Québec. In this province it is only found on beaches on the southwest and west coasts of Newfoundland.

Population Trends
The 2006 census counted 48 adult Piping Plovers nesting in Newfoundland, an increase from 39 birds counted in 2001. Piping Plovers use to be found on the northeast coast but have not been seen there since 1987. In 2009, a pair of Piping Plovers nested in Gros Morne National Park for the first time since 1975.

Limiting Factors and Threats
Piping Plovers are affected by disturbances to beaches. Nests and eggs are destroyed by off-road vehicles, dogs, and sometimes deliberately by humans. Predators, such as mink, can also prey on nests and predation rates seem to have increased in recent years.

Special Significance
Piping Plover is one of the few shorebirds which nest on sandy beaches and in dune systems. They are endemic to North America.

It would be very uncommon to encounter the Piping Plover in Placentia Bay as it is not the bird's preferred range or habitat. To ensure that chance encounter does not disturb further this animal the containment net for the sea cages has mesh size that is sufficiently small at 35 mm to prevent the bird from entering the net and accidentally entrapping itself. The top of the sea cage is covered by netting as well preventing entry by that route. Further impacts to this species from this project are unlikely.

COSEWIC's update status report on the Eskimo Curlew is as follows:

*"**Eskimo Curlew***
Scientific name -- Numenius borealis
Assessment Summary – November 2009
*COSEWIC Status – **Endangered***

Reason for designation -- This bird is a species of shorebird with 100% of its known breeding range in Arctic Canada. Formerly abundant, the population collapsed in the late 1800s, primarily owing to uncontrolled market hunting and dramatic losses in the amount and quality of spring stopover habitat (native grasslands). The population has never recovered, and there have been no confirmed breeding records for over 100 years, nor any confirmed records of birds (photographs/ specimens) since 1963. As such, less than 50 years have elapsed since the last confirmed record. However, there are some recent sight records that suggest the possibility that a very small population (fewer than 50 mature individuals) may still persist in remote arctic landscapes. The primary factors limiting recovery are the very low population size, no known chance of rescue from outside populations, and the historic and ongoing conversion of native grasslands on its spring staging areas in Canada and the U.S. and on its wintering grounds in Argentina.

Occurrence -- Yukon, Northwest Territories, Nunavut, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador

Status history -- Designated Endangered in April 1978. Status re–examined and confirmed Endangered in May 2000 and November 2009"

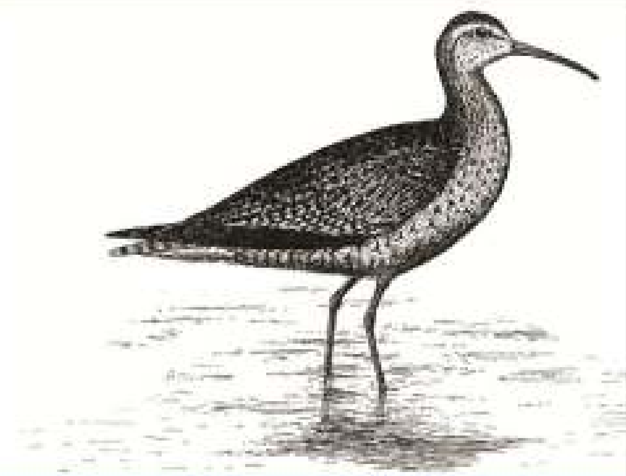
The Department of Environment and Conservation describe the Eskimo Curlew as follows:

Figure 31 – DEC Information Sheet of the Eskimo Curlew

Eskimo Curlew

(Numenius borealis)

- The Eskimo Curlew is a pigeon-sized shorebird.
- It has long legs and a fairly long, thin, slightly down-curving bill.
- Its upper parts are brown, its breast and abdomen are rusty-yellow or buff, and it has solid brown/cinnamon under-wings.



Provincial Distribution

Habitat/ Range
Eskimo Curlew nest in the Northwest Territories. During their fall migration, they use coastal barrens on the coasts of Newfoundland and Labrador before a non-stop flight to their wintering ground in South America.

Population Trends
The Eskimo Curlew once numbered in the hundreds of thousands, but declined rapidly after the 1870s. Sightings, even unconfirmed sightings, of the Eskimo Curlew are extremely rare and no specimen has been collected since the 1960s. Many people believe that this bird may be extinct.

Limiting Factors and Threats
Historically this bird was shot in large numbers. Currently, their extremely low population size puts them at risk from stochastic events.

Special Significance
The Eskimo Curlew was similar to the Passenger Pigeon in that it was the subject of a large commercial hunt which was not stopped until 1916. Thousands were shot each fall providing a source of food and income.

It would be very uncommon to encounter the Eskimo Curlew in Placentia Bay as it is not the bird's preferred range or habitat. To ensure that chance encounter does not disturb further this animal; the containment net for the sea cages has mesh size that is sufficiently small at 35 mm to prevent the bird from entering the net and accidentally entrapping itself. The top of the sea cage is covered by netting as well preventing entry by that route. Further impacts to this species from this project are unlikely.

There are three species of marine fish, and they are all wolfish, on COSEWIC's Schedule 1 list for the Atlantic Ocean that have the ability to frequent the project area. They are the Atlantic Wolfish (**Special Concern**) *Anarhichas lupus*, Northern Wolfish (**Threatened**) *Anarhichas denticulatus*, and Spotted Wolfish (**Threatened**) *Anarhichas minor*. COSEWIC's update status report on the three species of wolffish is as follows:

> ***"Atlantic Wolffish***
> *Scientific name -- Anarhichas lupus*
> *Assessment Summary – November 2012*
> *Status --* ***Special Concern***
>
> *Reason for designation -- This species underwent steep declines in both abundance and area of occupancy over much of its range from the 1980s until the mid-1990s, including its historical stronghold in waters east and north of Newfoundland. Since then it has been increasing in abundance and area of occupancy. While these recent increases are encouraging, the species remains at low abundance compared to the early 1980s. Population increases have probably been aided by reduced commercial fisheries, which take wolffish as bycatch. There have been continuing declines in abundance on the Scotian Shelf and in the Southern Gulf of St. Lawrence, where historically there were fewer individuals than in areas to the east and north.*
>
> *Occurrence -- Arctic Ocean, Atlantic Ocean*
>
> *Status history -- Designated Special Concern in November 2000. Status re-examined and confirmed in November 2012*
>
> ***Northern Wolffish***
> *Scientific name -- Anarhichas denticulatus*
> *Assessment Summary – November 2012*
> *Status --* ***Threatened***
>
> *Reason for designation -- This species underwent strong declines in both abundance and in range size during the 1980s. For the next decade there was little change, but since about 2002 there have been small increases in both range size and abundance. These have been in parallel with recovery measures, including mandatory release of individuals taken as bycatch. While these recent increases are encouraging, the species is still at very*

low levels compared with the beginning of research surveys in the 1970s. Although there has been a general decrease in the level of fishing over its range, its recovery may still be limited by bycatch in fisheries in the deep waters in which it occurs.

Occurrence -- Arctic Ocean, Atlantic Ocean

Status history -- Designated Threatened in May 2001. Status re-examined and confirmed in November 2012.

Spotted Wolffish
Scientific name -- Anarhichas minor
Assessment Summary – November 2012
Status -- ***Threatened***

Reason for designation -- This species underwent strong declines from the late 1970s until the mid-1990s, but since then there has been some recovery over most of its Canadian range. This is indicated by both increases in abundance and area of occupancy. These increases parallel a reduction in bottom fisheries that had a high incidental catch of this species, as well as introduction of recovery measures including mandatory release. While these recent increases are encouraging, the species is still at low levels compared with the beginning of the research surveys.

Occurrence -- Arctic Ocean, Atlantic Ocean

Status history -- Designated Threatened in May 2001. Status re-examined and confirmed in November 2012."

The habitat and range of these three species of wolffish is outside that considered for this undertaking. These fish are benthic and often cave dwelling and would not have occasion to be accidently entrapped during the deployment of the net during setup. The Standard Operating Practice (SOP) of net inspection after setting would look for and detail any species accidently trapped. Should any species at risk be accidently entrapped they will be immediately released and the incident reported to the Department of Fisheries and Oceans (DFO) and the Department of Fisheries and Aquaculture (DFA). It would be very unlikely that this project would have any impact on these species of wolffish.

There are four marine mammals from COSEWIC's Schedule 1 list for the Atlantic Ocean that are in the Large Ocean Management Area that includes Placentia Bay and have the ability to frequent the project area. They are the Fin Whale (**Special Concern**) *Balaenoptera physalus*, the Blue Whale (**Endangered**) *Balaenoptera musculus,* the Atlantic Right Whale (**Endangered**) and the Beluga Whale (**Endangered**). COSEWIC's update status report on the four whale species is as follows:

> ***"Beluga Whale*** *(St. Lawrence Estuary population)*
> *Scientific name -- Delphinapterus leucas*
> *Assessment Summary – November 2014*
> *COSEWIC Status –* ***Endangered***
>
> *Reason for designation -- This population, endemic to Canada, is at the southernmost limit of the species' distribution, and is reproductively and geographically isolated from other populations. This population of a long-lived, slowly reproducing species was severely reduced by hunting, which continued until 1979. Since population monitoring surveys began in the 1980s, the total population size has remained at around 1000 individuals -- less than 20% of the population size in the late 1800s or early 1900s. The major threats currently affecting this population include pathogens, toxic algal blooms, pollution, noise disturbance, and other human intrusions and disturbance. The impacts of these threats are likely amplified by the low number of mature individuals remaining in the population. Since the mid-2000s, the population has shown evidence of major demographic changes including increased neonate mortality and a decline in the proportion of young individuals in the population. These trends, together with past and ongoing habitat degradation, and projected increases in threats, suggest that the status of this population has worsened and is at considerably greater risk than when it was previously assessed by COSEWIC in 2004.*
>
> *Occurrence -- Quebec, Atlantic Ocean*
>
> *Status history -- Designated Endangered in April 1983. Status re-examined and confirmed in April 1997. Status re-examined and designated Threatened in May 2004. Status re-examined and designated Endangered in November 2014.*

North Atlantic Right Whale
Scientific name -- Eubalaena glacialis
Assessment Summary - November 2013
*Status – **Endangered***

Reason for designation -- This long-lived, slowly reproducing whale species was driven nearly to extinction by commercial whaling but has been protected from whaling since 1935. The whales found in Canada are part of a single global population of the species, which is endemic to the North Atlantic Ocean. Since 1990, the total population has been increasing at a rate of approximately 2.4% per year. The total population in 2010, including all age classes, was estimated at 468 individuals, of which between 122 and 136 were adult females. The estimated number of mature individuals, after accounting for a male-biased sex ratio among adults, and for a small number of females that are incapable of reproducing, is between 245 and 272. The rate of population growth is lower than would be predicted based on the biology of the species and is limited by ship strikes and entanglements in fishing gear. Although measures have been implemented in both Canada and the United States to lessen ship strikes, they continue to occur and ship traffic is expected to increase significantly within the range of the species in coming decades. Further, adult females appear to be more prone to being struck than males. Limited efforts have also been made to reduce the incidence and severity of entanglements, but these events remain a major cause of injury and mortality.

Occurrence -- Atlantic Ocean. The population typically congregates in the lower Bay of Fundy and on the Scotian Shelf during summer and fall, and small numbers occur in two areas of the Gulf of St. Lawrence—one north and east of the Gaspé Peninsula, and the other southeast of the Gaspé Peninsula in the mouth of Chaleur Bay (Baie-des-Chaleurs).

Status history -- The Right Whale was considered a single species and designated Endangered in 1980. Status re-examined and confirmed in April 1985 and in April 1990. Split into two species in May 2003 to allow a separate designation of the North Atlantic Right Whale. North Atlantic Right Whale was designated Endangered in May 2003 and November 2013.

Blue Whale *(Atlantic population)*
Scientific name **--** *Balaenoptera musculus*
Assessment Summary – May 2012
Status **–** *Endangered*

Reason for designation **--** *Whaling reduced the original population of this species. The population size is unknown but there are likely fewer than 250 mature individuals in Canada. There are also strong indications of a low calving rate and a low rate of recruitment into the population. The known causes of human-induced mortality of this species in Canada and elsewhere are ship strikes and entanglements in fishing gear. The species may also be vulnerable to disturbances due to increased noise in the marine environment and to changes in the abundance of its prey (zooplankton) through, for example, long-term changes in the climate.*

Occurrence **--** *Atlantic Ocean. A total of 16 Blue Whales (5 off Newfoundland and 11 in the Gulf of St. Lawrence and Scotian Shelf) were sighted during a 2007 DFO survey of Atlantic Canadian shelf waters from northern Labrador (60°N) to the US border. The survey was designed to increase the likelihood of sighting Blue Whales by apportioning higher effort to areas where they had been sighted previously (Lawson and Gosselin 2009). Too few sightings were obtained to derive an estimate of abundance but the low number of sightings is consistent with previous estimates suggesting there are < 250 mature individuals. There have been few sightings of Blue Whales in the Gully area of the Scotian Shelf over the past 20 years and no trend has been evident (Whitehead 2011). Researchers in the Gulf of St. Lawrence report that only 21 calves have been recorded in over 32 years of annual sighting effort (Ramp 2011). Although Blue Whales are present off Newfoundland and Nova Scotia, no cow-calf pairs have been sighted there (Lawson 2011).*

Status history **--** *The species was considered a single unit and designated Special Concern in April 1983. Split into two populations in May 2002. The Atlantic population was designated Endangered in May 2002. Status re-examined and confirmed in May 2012.*

Fin Whale *(Atlantic population)*
Scientific name -- Balaenoptera physalus
Assessment Summary – May 2005
Status -- ***Special Concern***

Reason for designation -- The size of this population was reduced by whaling during much of the 20th century. However, sightings remain relatively common off Atlantic Canada, and they have not been hunted

> *since 1971. The current abundance and level of depletion compared with pre-whaling numbers are uncertain. The whales face a number of current threats including ship strikes and entanglement in fishing gear, but none is believed to seriously threaten the population.*
>
> *Occurrence -- Atlantic Ocean Fin whales are found in all oceans of the world and generally make seasonal migrations from low-latitude wintering areas to high-latitude summer feeding grounds. Winter distribution appears to be less concentrated. The locations of the wintering grounds are poorly known. Summer concentrations in the western North Atlantic are in the Gulf of St. Lawrence, on the Scotian Shelf, in the Bay of Fundy, in the nearshore and offshore waters of Newfoundland, and off Labrador.*
>
> *Status history* **--** *This species was considered a single unit and designated Special Concern in April 1987. Split into two populations (Atlantic and Pacific) in May 2005. The Atlantic population was designated Special Concern in May 2005. Last assessment based on an update status report."*

The habitat and normal distribution of two species of these whales are well outside that considered for this undertaking; the Beluga and the Right whales are generally to be found in the Bay of Fundy and the Gulf of St. Lawrence. The Blue and Fin whales have a normal distribution that might place them in vicinity of this project. These whales are sufficiently large that it should not be possible to be accidently entrap them during the deployment of the net during setup. The mooring, grids and bridles are straight lines and entanglement should not be possible. The Standard Operating Practice (SOP) of net inspection after setting would look for and detail any species accidently trapped. Should any species at risk be accidently entrapped they will be immediately released and the incident reported to the Department of Fisheries and Oceans (DFO) and the Department of Fisheries and Aquaculture (DFA). It would be very unlikely that this project would have any impact on these species of whales.

There is one reptile on COSEWIC's Schedule 1 list for the Atlantic Ocean that has the ability to frequent the project area. This is the Leatherback Sea Turtle (**Endangered**) *Dermochelys coriacea*. COSEWIC's update status report on the Leatherback Sea Turtle is as follows:

> ***"Leatherback Sea Turtle*** *- Atlantic population*
> *Scientific name --* <u>*Dermochelys coriacea*</u>

Assessment Summary – May 2012
*Status – **Endangered***

Reason for designation -- Globally, this species is estimated to have declined by more than 70%. In the Atlantic, this species continues to be impacted by fisheries bycatch, coastal and offshore resource development, marine pollution, poaching of eggs, changes to nesting beaches and climate change. Canadian waters provide an important foraging area for these turtles. There they are threatened by entanglement in longline and fixed fishing gear.

Occurrence -- Atlantic Ocean. Leatherbacks in Atlantic Canada occur in both offshore and coastal waters (range 2 to 5,033 m depth). Most sightings are from continental shelf (waters inside the 200 m isobath). Median depth of sightings is 113 m and mean sea surface temperature (SST) is 16.6°C.

Status history -- The species was considered a single unit and designated Endangered in April 1981. Status re-examined and confirmed in May 2001. Split into two populations in May 2012. The Atlantic population was designated Endangered in May 2012."

The Leather Back Sea Turtle has a normal distribution that might place it in vicinity of this project. It may be possible to accidently entrap them during the deployment of the net during setup or net changes. The mooring, grids and bridles are straight lines and entanglement should not be possible. The mesh of the net is sufficiently small at 35 mm that entanglement should not be possible. The Standard Operating Practice (SOP) of net inspection after setting or changing would look for and detail any species accidently trapped. Should any species at risk be accidently entrapped they will be immediately released and the incident reported to the Department of Fisheries and Oceans (DFO) and the Department of Fisheries and Aquaculture (DFA). It would be very unlikely that this project would accidently entrap a Leather Back Sea Turtle or have any impact on this animal.

COSEWIC's Schedule 1 list for the Atlantic Ocean indicates that the Harlequin Duck (**Special Concern**) *Histrionicus histrionicus* have the ability to frequent the project area. The COSEWIC status report for the Harlequin Duck is as follows:

***"Harlequin Duck** (Eastern population)*
Scientific name -- Histrionicus histrionicus
Assessment Summary - November 2013

*Status -- **Special Concern***

Reason for designation -- Though increases have been recorded in southern parts of its breeding range, the population size of this sea duck remains relatively small. Its tendency to congregate in large groups when moulting and on its marine wintering areas makes it susceptible to catastrophic events such as oil spills. Such threats are substantial and are likely increasing, and are of particular significance for populations of long-lived species such as this sea duck, which can be slow to recover. Its population also appears to rely on continued management efforts, particularly those involving restrictions on hunting.

Occurrence -- Nunavut, Quebec, New Brunswick, Nova Scotia, Newfoundland and Labrador. In Canada, there are two widely disjunctive populations: one in the east and one in the west. The western population breeds in Alberta and British Columbia. The eastern population breeds in Québec, Newfoundland and Labrador, New Brunswick, and Nunavut. Based largely on wintering ranges, the eastern population can be segregated into two management units: an Eastern North American Wintering Population (EWP); and, a Greenland Wintering Population (GWP). Individuals within the EWP breed in northern New Brunswick, the Gaspé Peninsula of Québec, and on rivers emptying into the Québec North Shore, southern and central Labrador, and Newfoundland. Adults within the GWP breed in northern Québec, northern Labrador, Nunavut, and southern areas of western and eastern Greenland. The EWP wintering areas are situated primarily in coastal Atlantic Canada, Saint-Pierre-et-Miquelon (Territory of France), and the eastern seaboard of the United States as far south as Virginia. The GWP overwinters off the southwestern coast of Greenland.

Status history -- The Eastern population was designated Endangered in April 1990. Status re-examined and designated Special Concern in May 2001 and November 2013."

The Department of Environment and Conservation describe the Harlequin Duck as follows:

Figure 32 – DEC Information Sheet of the Harlequin Duck

Harlequin Duck

(Histrionicus histrionicus)

- The Harlequin Duck is a small subarctic sea duck.
- Males have slate blue plumage, chestnut sides, and streaks of white on their head and body. Their head has a black stripe with a chestnut stripe on either side.
- Females are plain brownish-grey with patches of white behind, below, and in front of their eyes.

Provincial Distribution

Habitat/ Range
The eastern population of Harlequin Duck breeds mostly in fast flowing rivers in Québec and Newfoundland and Labrador. Wintering habitat consists of rocky coastline, subtidal ledges, and exposed headlands. Cape St. Mary's is the main wintering site in this Province.

Population Trends
About 200 Harlequin Ducks winter off the coast of Newfoundland and Labrador as the eastern population. While population levels of this rare duck are increasing at the four key wintering locations in eastern North America, the eastern population has still not reached sustainable levels.

Limiting Factors and Threats
In breeding habitats timber harvest and hydroelectric development may pose a threat to Harlequin Ducks. In wintering and moulting locations, fishing nets, aquaculture development, illegal/incidental harvest, disturbance, and chronic and catastrophic oiling are potential threats.

Special Significance
This little, colourful duck occupies a unique and harsh environment similar to its extinct cousin, the Labrador Duck.

The mesh of the fish containment net is sufficiently small at 35 mm to prevent the Harlequin Duck from entering the net. The top of the pen is covered by netting as well preventing entry. Under the both SARA and ESA the prohibitions do not apply to species of Special Concern or Vulnerable. Further impacts to this species from this project are unlikely.

COSEWIC's Schedule 1 list for the Atlantic Ocean indicates that the Barrow's Goldeneye (**Special Concern**) *Bucephala islandica* have the ability to frequent the project area. The COSEWIC status report for the Barrow's Goldeneye is as follows:

"Barrow's Goldeneye *(eastern population)*
Scientific name **--** *Bucephala islandica*
Assessment Summary – November 2000
Status **--** ***Special Concern***

Reason for designation **--** *Numbers of individuals in this eastern population are limited. Although threats such as limited habitat availability and oil spill potential have been identified, none is currently at a scale that would impact negatively on the population.*

Occurrence **--** *Quebec, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland. The eastern Canadian population of Barrow's Goldeneyes is centered in Québec where probably over 90-95% of the birds breed and winter.*

Status history **--** *Designated Special Concern in November 2000.*

The Department of Environment and Conservation describe the Barrow's Goldeneye as follows:

Figure 33 – DEC Information Sheet of the Barrow's Goldeneye

Barrow's Goldeneye

(Bucephala islandica)

- The Barrow's Goldeneye is a medium-sized sea duck with a large rounded head and yellow eyes.
- Males have a black back and wings, a white belly and breasts, a purplish-black head, and a white crescent-shaped patch at the base of their bill.
- Females have a chocolate brown head, a greyish brown back, and a whitish belly and flanks.
- They form monogamous pairs and have strong fidelity to breeding and wintering areas.

Provincial Distribution

Habitat/ Range
While this rare duck is most common in Québec, Newfoundland and Labrador is also used by the Barrow's Goldeneye as a molting and wintering area. Groups of molting birds have been found as far north as Little Ramah Bay, Labrador, but have more commonly been reported from the north coast of Newfoundland.

Population Trends
The world distribution of Barrow's Goldeneye consists of three separate populations. There are approximately 4500 Barrow's Goldeneye in the eastern North America population.

Limiting Factors and Threats
Because the Barrow's Goldeneye population congregates in a relatively small geographic areas in important shipping corridors, it is a risk of being limited by oil spills and bioacculmulation of environmental contaminants. Barrow's Goldeneye are also incidentally killed each year by hunters.

Special Significance
These rare ducks dive for their food and are able to stay underwater for up to 70 seconds.

The mesh of the fish containment net is sufficiently small at 35 mm to prevent the Barrow's Goldeneye from entering the net. The top of the pen is covered by netting as well preventing entry. Under the both SARA and ESA the prohibitions do not apply to species of Special Concern or Vulnerable. Further impacts to this species from this project are unlikely.

The LOMA Placentia Bay / Grand Banks Management Plan indicates that the Banded Killifish *Fundulus diaphanous* may occur near the project sites. The COSEWIC status report for the Banded Killifish is as follows:

> ***Banded Killifish*** *(Newfoundland populations)*
> *Scientific name -- <u>Fundulus diaphanous</u>*
> *Assessment Summary -- May 2014*
> *Status* **-- *Special Concern***
>
> *Reason for designation* **--** *This species has a scattered distribution in insular Newfoundland and occupies a small area of occupancy. The species can be impacted negatively by turbidity and hydrological alterations that result from road, forestry, cottage, and hydrological development. It could become Threatened if these impacts are not managed or reversed with demonstrable effectiveness.*
>
> *Occurrence -- Newfoundland and Labrador. The Banded Killifish is distributed throughout much of eastern North America including the Atlantic provinces and most of the Great Lakes-St. Lawrence basin. In Newfoundland, the species has a scattered distribution but is concentrated along the southwest coast (Grand Bay West, Loch Leven, St. George's Bay, Bay of Islands, and Cow Head). Other apparently disconnected populations in Newfoundland are present on Ramea Island, the northeast coast (Indian Bay Watershed), the Burin Peninsula (Freshwater Pond, Winterland, and Garnish Pond) and in the headwaters of the Exploits River (Star Pond). An introduced population is present in Burton's Pond, St. John's. Ten locations are known, although recent survey work suggests the possibility of additional unknown locations.*
>
> *Status history -- Designated Special Concern in April 1989. Status re-examined and confirmed in May 2003 and May 2014.*

The Department of Environment and Conservation describe the Banded Killifish as follows:

Figure 34 – DEC Information Sheet of the Banded Killifish

Banded Killifish

(Fundulus diaphanus)

- Banded killifish are a small fish, about 75 mm in length that live for 3 to 4 years.
- They have an elongated and slender body that is slightly flattened at the back of the head.
- Banded killifish have a dark brown to olive-green back and silvery or yellowish sides.
- They have white bands on their belly and numerous black, vertical bands on their back.

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Provincial Distribution

Habitat/ Range
Banded killifish are found throughout southeastern Canada. In this Province they are only known from several locations on the west coast, northeast coast, and Burin Peninsula of Newfoundland. These locations represent the eastern most extent of this species' range and a unique Canadian population. Banded killifish are most often seen in the shallow areas of clear ponds with a muddy/sandy substrate, high detrital content, and submerged aquatic vegetation.

Population Trends
They are abundant within the confined regions of the watersheds in which they are found, but these regions are widely scattered.

Limiting Factors and Threats
Banded killifish are limited by small numbers of available habitat and barriers, such as steep gradients, impassible rapids, and water falls, which restrict access to some of this habitat. Any habitat loss or pollution associated with forestry or land use/development would put these rare fish at further risk.

Special Significance
The population of banded killifish in Newfoundland and Labrador is isolated from mainland populations and research is ongoing to determine if it is a distinct subspecies.

The species occurs in freshwater or estuarine habitats. These types of habitats are not in vicinity of the sea cage project areas. Under the both SARA and ESA the prohibitions do not apply to species of Special Concern or Vulnerable. Further impacts to this species from this project are unlikely.

COSEWIC placed Atlantic salmon *Salmo salar* - South Newfoundland population (DU4) on its list of **threatened** species. The COSEWIC Technical Summary is as follows:

Demographic Information: Generation time (average age of parents in the population) 4.1 yrs.

Estimated percent decline in total number of mature individuals in 2007 versus 1993 (3 generations) 36%

[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 or 5 years, or 3 or 2 generations]. Unknown

[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 or 5 years, or 3 or 2 generations] period, over a time period including both the past and the future. N/A

Are the causes of the decline clearly reversible? No

Are the causes of the decline understood? No

Have the causes of the decline ceased? No

Observed trend in number of populations: Stable

Are there extreme fluctuations in number of mature individuals? No

Are there extreme fluctuations in number of populations? No

Extent and Area Information Estimated extent of occurrence >20,000 km^2.

Observed trend in extent of occurrence: Stable

Are there extreme fluctuations in extent of occurrence? No

Index of area of occupancy (IAO) >2,000 km2

Observed trend in area of occupancy: Stable

Are there extreme fluctuations in area of occupancy? No

Is the total population severely fragmented? No

Number of current locations 104 known rivers.

Trend in number of locations: Stable

Are there extreme fluctuations in number of locations? No

Trend in [area and/or quality] of habitat: Stable

Quantitative Analysis:

> *Threats (actual or imminent, to populations or habitats): Recreational and illegal fisheries, commercial fishery in St. Pierre and Miquelon, ecological and genetic interactions with escaped domestic Atlantic Salmon, poorly understood changes in marine ecosystems resulting in reduced survival during the marine phase of the life history.*

Rescue Effect (immigration from an outside source): Status of outside population(s)? Nearby Labrador and Newfoundland populations are stable or increasing.

Is immigration known? No

Would immigrants be adapted to survive in Canada? Unknown

Is there sufficient habitat for immigrants in Canada? Yes

Is rescue from outside populations likely? No

Current Status COSEWIC: Threatened (Nov 2010)

Status and Reasons for Designation Status: Threatened

Alpha-numeric code: A2b

Reasons for designation: This species requires rivers or streams that are generally clear, cool and well-oxygenated for reproduction and the first few years of rearing, but undertakes lengthy feeding migrations in the North Atlantic Ocean as older juveniles and adults. This population breeds in rivers from the southeast tip of the Avalon Peninsula, Mistaken Point, westward along the south coast of Newfoundland to Cape Ray. The numbers of small (one-sea-winter) and large (multi-sea-winter) salmon have both declined over the last 3 generations, about 37% and 26%, respectively, for a net decline of all mature individuals of about 36%. This decline has occurred despite the fact that mortality from commercial fisheries in coastal areas has greatly declined since 1992; this may be due to poor marine survival related to substantial but incompletely understood changes in marine ecosystems. Illegal fishing is a threat in some rivers.

The presence of salmon aquaculture in a small section of this area brings some risk of negative effects from interbreeding or adverse ecological interactions with escaped domestic salmon. Genetic heterogeneity among the many small rivers in this area is unusually pronounced, suggesting that rescue among river breeding populations may be somewhat less likely than in other areas.

Applicability of Criteria Criterion A (Decline in Total Number of Mature Individuals): Meets Threatened, A2b. The decline over the last 3 generations has been 36%. Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Criterion D (Very Small Population or Restricted Distribution): Not applicable. Criterion E (Quantitative Analysis): Not applicable.

In subsequent years since the designation the Department of Fisheries and Oceans have been very active quantifying the extent of the problem. In 2013 the Canadian Science Advisory Secretariat issued Report 2012/007 "Recovery Potential for the South Newfoundland Atlantic Salmon (*Salmo salar*) Designatable Unit" http://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2012/2012_007-eng.pdf and summarizing as follows:

- *The South Newfoundland Atlantic salmon (Salmo salar L.) DU 4 comprises Salmon Fishing Areas (SFAs) 9-12 and the population is estimated to have declined by 42.4% over the last three generations (1996-2010; small salmon 41.5% and large salmon 48.3%).*
- *The most substantial estimated decline occurred in SFA 11 which strongly influenced the total abundance for DU 4.*
- *Marine survival (smolts to adult) is variable in DU 4, averaging 4% (± 2%), and seems to have declined more in SFA 11 than in SFA 9, as evidenced by Conne River's (SFA 11) decline of 61.6% from 1987-2010; Northeast Brook's (SFA 9) 18% decline (1986-2010); and Rocky River's increase of 33.5% (1991-2010).*
- *Population projections over three generations (15 years) and under different recreational fishery management scenarios were undertaken for the South Newfoundland (DU 4) Atlantic salmon population to estimate the probabilities of: (1) maintaining current population levels, (2) achieving the Conservation Requirement, and (3) achieving the Pre-Decline Mean (1981-1995).*

- *According to these projections, under contemporary marine and angling mortality rates, there is a 50% chance that the DU 4 population will drop below its current size. There is a 23% chance of achieving the Conservation Requirement and 12% chance of achieving the Pre-decline mean.*
- *Under a "no-angling" scenario and a contemporary marine survival rate of 4% (± 2%), there is a 74% chance that the population will remain at or exceed its current size. There is a 52% chance of achieving the Conservation Requirement and 27% chance of achieving the Pre-decline mean.*
- *Under a "catch-and-release only" angling scenario and a contemporary marine survival rate of 4% (± 2%), there is a 70% chance that the population will remain at or exceed its current size. There is a 42% chance of achieving the Conservation Requirement and 26% chance of achieving the Pre-decline mean.*
- *According to these projections, over the next three generations (15 years) a minimum 5% average marine survival, at contemporary angling levels, would be required to have a 75% chance of maintaining or exceeding the current population size. To achieve the Conservation Requirement, marine survival would need to increase to an average of 6% and increase to an average of 7% to achieve the Pre-decline mean.*
- *Under a "no-angling" scenario, a minimum 5% average marine survival would be required to have a 75% chance of maintaining or exceeding the current population size. To achieve the Conservation Requirement, marine survival would need to be an average of 5% and increase to an average of 6% to achieve the Pre-decline mean.*
- *Under a "catch-and-release only" angling scenario, a minimum 5% average marine survival would be required to have a 75% chance of maintaining or exceeding the current population size. To achieve the Conservation Requirement marine survival would need to be an average of 5% and increase to an average of 6% to achieve the Pre-decline mean.*
- *Freshwater habitat quality and quantity are not thought to be limiting the production or recovery of DU 4 salmon.*
- *The greatest threat to the recovery of the South Newfoundland Atlantic salmon population is continued low marine survival. Factors influencing marine survival may include: illegal fisheries, mixed-stock marine fisheries and by-catch, ecological and genetic interactions with escaped domestic Atlantic salmon, and changes in marine ecosystems. The degree of influence of these factors is unknown and many have the potential to*

affect salmon in other DUs where populations have been stable or increasing.

- *Understanding the possible unique factors that impact the biological condition of Atlantic salmon during the marine phase of their life-cycle and marine habitat quality within the DU 4 area are key knowledge gaps that need to be addressed.*

In 2013 DFO looked deeply into available data to scientifically model the South Newfoundland Population of Atlantic salmon "Population viability analysis for the South Newfoundland Atlantic Salmon (*Salmo salar*) designatable unit" http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2013/2013_090-eng.pdf . The Abstract of that paper is as follows:

> *"Analyses of recent status and trends as well as a population viability analysis (PVA) were conducted for the South Newfoundland Atlantic Salmon designatable unit (DU 4). Trend analyses were conducted for each South Coast Salmon Fishing Area (SFAs 9-12), four currently monitored rivers (Conne River, Little River, Northeast Brook and Rocky River) and the composite index of these rivers. For individual rivers, only Conne River and Little River in SFA 11 had statistically significant declines in salmon abundance since 1996 (56% and 71% respectively). Population viability analyses were conducted using eight average marine survival values (2% to 9%) and four fishing mortality rates: no angling, catch-and-release only angling, half of current angling and current angling (includes retention and catch-and-release mortality). All possible combinations of marine survival values and fishing mortality rates were assessed to estimate the probability of meeting or exceeding each of three population abundance levels in the next 15 years: current population size, conservation requirement/recovery target and the pre-decline mean. Under current conditions (1996-2010) the probability of DU 4 Atlantic Salmon meeting or exceeding the conservation requirement/recovery target in the next 15 years was 27%. Removing angling mortality increased this probability to 50%. As expected, marine survival has a very strong influence on the potential recovery of DU 4 salmon. An increase in average marine survival from 4% to 5% over the next 15 years improved the probability of achieving the conservation requirement/recovery target from 27% to 66% under current angling rates. This probability reaches 85% with no angling. Given that estimated catch-and-release fishing mortality was relatively low, population projections were generally similar to no angling. The probability of DU 4 Atlantic Salmon remaining at their current population*

size over the next 15 years was 48% under current angling rates and 72% under no angling. These proportions increase to 87% and 96%, respectively, if average marine survival increased from 4% to 5% over the next 15 years. ***In general, the probability that DU 4 Atlantic Salmon abundance will increase was greatly improved with higher marine survival rates and management measures to reduce angling mortality****.*

In 2015 COSEWIC provided a clarification to DFO with regard to farm raised Atlantic salmon vis-à-vis wild salmon "Clarification note for: COSEWIC assessments and update status reports conducted on Atlantic salmon (Salmo salar) in 2010".
http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/CosClarificationNoteSauAtlSln-v00-2015Dec02-Eng.pdf The main statement from COSEWIC on the question is as follows: "**Aquaculture Atlantic Salmon are raised for commercial purposes, not for conservation of the wildlife species, and are genetically distinct from wild salmon and are thus excluded from assessments under this guideline."**

The proponent fully acknowledges of the seriousness of the risk / threat of extirpation of South Newfoundland Atlantic salmon which encompasses the region of Placentia Bay as proposed in this undertaking. It is with this acknowledgement that the proponent will reduce the risk or threat of its operations to local wild stocks of Atlantic salmon to that of insignificance. The proponent will reduce the risk potential of harm to insignificance by engaging directly to eliminate risk by compounding a number of initiatives that individually should suffice to eliminate risk. The proponent will actively employ in its Placentia Bay Management Plan (Appendix K) detailed initiatives to manage risk. The risks that sea cage salmon farming can pose to local wild stocks if not managed are as follows:

- Hybridization or colonization of local stocks of salmon by breeding with escaped farmed fish – genetic practices;
- Incomplete containment practices that provide escape risk; and,
- Incomplete husbandry practices that provide disease risk.

The proponent will reduce risk and threat to local stocks as stated above in the following manner:

Genetic Practices:

Genetic interactions will be eliminated by utilizing farmed stocks of Atlantic salmon that have been made sterile. The proponent will use reproductively incapacitated from SalmoBreed/Stofinfiskur landbase broodstock facilities in Iceland (Appendix J). The eggs to be used will be of European origin and sterile using pressure techniques for rendering salmon triploid. In 2015 DFO under the auspices of the Canadian Science Advisory Secretariat undertook a detailed examination of the case for importing European-origin salmon "Biocontainment measures to reduce/mitigate potential post-escape interactions between cultured European-origin and wild native Atlantic salmon in Newfoundland" http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2015/2015_003-eng.pdf . The abstract for the paper is as follows:

> *"This paper reviews the literature and makes recommendations on biocontainment measures to reduce or mitigate potential post-escape interactions between farmed European-origin and wild native Atlantic salmon in the south coast of Newfoundland. In the absence of effective measures to prevent the escape of farmed salmon or to recapture them post-escape, the only effective method to minimize their impacts on wild populations is to ensure that farmed populations are comprised solely of sterile fish through the use of all-female triploids. The technology for producing all-female triploid populations is simple and easily applied on a commercial scale, and routinely results in populations that are entirely female and more than 98% triploid. Aside from sterility, there are no population-wide phenotypic effects of triploidy, although triploids do tend to perform less well than diploids with respect to commercial culture characteristics and, if released to the wild, are not likely to outcompete or displace native salmon. Some uncertainties do exist with respect to their disease resistance and their potential to become reservoirs for the spread of pathogens to wild populations. If the spawning potential of escaped European-origin Atlantic salmon is deemed to pose an unacceptable risk to native Atlantic salmon populations in the south coast of Newfoundland, then all-female triploid populations could be used to reduce risk. Research should continue to focus on improvement of triploid performance through breeding programs and optimization of husbandry, including nutrition, rearing environment, and fish health."*

The following is a summation of triploid information for Atlantic salmon:

What is a triploid fish?

How do they become triploid and how effective is the process?

What is a "triploid" fish?

A triploid animal is one that has three sets of chromosomes instead of two. Triploids, as they are called, do occasionally occur in nature. Their survival differs between species; however, there have proven to be viable individuals in many finfish and shellfish species. Immediately after fertilization, the fertilized egg usually ejects the second set of maternal DNA, leaving two sets- one maternal, one paternal. In a triploid individual, though, this doesn't happen. Both sets of maternal DNA are retained in addition to the paternal DNA. Triploid fish are genetically identical to diploid fish of the same stock, but are sterile.

How do fish become triploid?

Aside from the rare naturally-occurring case of spontaneous triploidy, producers may choose to make their fish triploid by physical or chemical means. There are multiple ways of inducing triploidy in fish: paternal genome duplication, maternal genome duplication, and breeding tetraploids (4 sets of chromosomes) with diploid fish. Of these, maternal genome duplication is the widest used method due to relative ease of application in large scale. This is the case of triploid where there are two maternal sets of DNA and one paternal.

There are multiple ways of inducing triploidy through maternal duplication, including:

- Exposure to low temperature
- Use of a cell division inhibitor
- Application of heat
- Application of hydrostatic pressure

Application of hydrostatic pressure is one of the most common technologies used, as it is much easier to ensure an even application of pressure than it is heat. There is no specific pressure regime prescribed, but an industry standard is the application of 65,500kPa for 5 minutes, at approximately 300 degree-minutes post-fertilization (Benfey). Hydrostatic pressure application has been proven to have upwards of 100% success rate. In a large-scale commercial trial "Salmotrip", for example, a 100% success rate was consistently achieved with their regime of 9,500 PSI for 5 minutes at 10^{o}C beginning at 300 degree-minutes post-fertilization. O'Flynn reported a 100% success rate in 1997, and AquaBounty reported 99.5% success in 2012.

Soon after fertilization, the fertilized egg typically ejects the second set of maternal DNA from the cell. With the application of pressure, this DNA stays within the cell. The cells are then considered triploid. They can be male or female. In order to produce all female triploids, there is another step to the process. Females of the parent generation are treated with androgens, or male sex hormones. This makes them appear to be male, while they carry all female DNA. When the "neomales", as they are called, mate with natural females, the resulting eggs are 100% female.

Triploid fish are biologically sterile fish that are incapable of producing viable offspring. Male triploid fish, however, may be capable of developing functional testes that can produce sperm capable of fertilizing eggs. The resulting embryos, however, are not viable and die early in development. This is not generally seen as an issue in terms of impacts if they escape as the triploid stocks planned for use in NL are multi sea winter fish and will be harvested well before they begin to mature. Female triploid fish do not generally mature. Given the considerably lower chance of triploid females reaching maturity (estimated at a maximum of 0.1%- Benfey), combined with their non-viable offspring, all-female triploidy is seen as a very effective means of reducing risk of genetic impacts of salmon farming. It is necessary to induce triploidy in each generation of fish to be stocked, as they cannot be bred.

In batches where success is not 100%, there is a small proportion of "failed triploids", typically diploid females. In these fish, the maternal DNA has been duplicated, but the paternal DNA is not preserved. These fish develop as females, but tend to be inbred and therefore less fit. Often, their chromosomes are not balanced, and they die early in development.

How is triploidy confirmed?

Due to the added DNA content of triploid cells, they are inherently larger than diploid cells. Unlike human blood cells, fish red blood cells (erythrocytes) have a nucleus. Because of this, it is possible to confirm individual triploid success with a minimally invasive procedure: a blood sample. There are two approaches to assessing whether or not a fish is triploid: measuring the erythrocyte DNA content, or measuring the erythrocyte dimensions.

It would be impractical to test every single smolt for triploid success before placement in sea cages. Therefore, producers test samples of each egg batch in order to confirm triploidy. Triploid cells should, in theory, have 1.5 times the DNA of diploid cells; however, this is not always the case in practice. That being said, there is consistently more DNA in triploid cells than diploid, and it can be measured significantly. Because red blood cells exist as single cells suspended in a fluid, it is relatively easy to measure their dimensions. Cells of triploid fish are consistently larger than diploid cells. A study by Fjelldal et al., for example, found no overlap between diploid erythrocyte dimensions (15.3-17.3um) and those of triploids (18.7-20.6um).

Why culture triploid fish?

Historically, triploid Atlantic salmon have had high incidences of deformities and cataracts in commercial-scale culture, as well as sub-optimal performance on some sites. More recent studies have determined that a diet inadequate in phosphorus was responsible for many of the spinal deformities observed. High rates of cataracts in triploid culture fish can also be counteracted by a diet with higher levels of histidine. Ongoing research trials (AquaGen) include research on optimizing triploid diets. Proper siting of farms planning to use triploid fish, including those with cold, oxygen-rich water, can be used to mitigate the issues with poor performance. The first commercial trial of triploids is currently underway in Norway with reports on performance pending in 2016.

There are many perceived benefits to culturing triploid fish. Recent studies in Ireland and Norway have seen an improvement in flesh quality at harvest, when compared to diploid fish of the same families (Salmotrip). There is also a wider harvest window, as producers are not limited by stock maturation times. As fish mature, their flesh quality deteriorates, as energy reserves are directed toward gamete production instead of overall growth. Maturing fish are also under considerable stress in saltwater environments, and this can lead to increased disease susceptibility (http://www.dfo-mpo.gc.ca/Library/346785.pdf) .

There may be a reduction in the cost of production associated with using triploid fish. Because they do not mature, there is no need to use artificial lighting regimes in sea pens to delay maturation. The use of underwater lights is employed by some producers in some regions in order to delay or stop maturation of fish on their sites. Although there have been advances in light technologies, such as low-energy LED lights, there is a cost associated with acquiring and running this equipment. If using non-maturing triploid fish, this cost would not be incurred.

Research on the use of triploid fish is consistent with North Atlantic Salmon Conservation Organization (NASCO) standards. NASCO has promoted the research on, and use of, sterile fish since 1992. The movement of reproductively viable fish across intercontinentally is prohibited by NASCO unless it is deemed low risk. As triploid fish are not reproductively viable, their use would be low risk.

There are many products currently available in the marketplace that are triploid. These include bananas, blueberries, trout, oysters, and watermelon. These products have been developed because of their desirable qualities, generally a larger size. The seedless watermelon is a common example of triploid produce that is widely available and accepted in the marketplace.

Containment Practices:

The Department of Fisheries and Aquaculture and the Department of Fisheries and Oceans and the provincial salmonid industry manages and conducts its practices using and the Code of Containment as a minimum standard. http://www.fishaq.gov.nl.ca/aquaculture/public%20reporting/Salmonid%20Code%20of%20Containment%202014.pdf . The proponent will meet these Code of Containment standard's and where feasible exceed them. One of the areas where the proponent intends to exceed these standards is on the complete engineering of its cages, nets and mooring systems to meet the Norwegian Standard for "escape proofing" NS9415 (Appendix I). The engineering concepts around escape proofing marine installations comes from Aqualine AS and their Midgard system (Appendix H). the Midgard system as supplied by Aqualine can be described as follows:

The Midgard System

Standards and Regulations

NS9415:2009, is a governing technical Standard for floating fish farming installations. NS9415 is based on extensive work from Norwegian Authorities as well as research and key vendors in the industry. This Standard gives recommendations and regulations on important aspects as:

- *Material Specifications*
- *Design Approach with respect to analyses methods and testing*
- *Material and Load factors for Serviceability Limit State (SLS), Ultimate Limit State (ULS) and Accidental Limit State (ALS). Fatigue Limit State (FLS) is also specified.*
- *Net Specifications*
- *Environmental Specifications*

The design approach achieved by applying NS9415 results in systems with high reliability and good integrity. Furthermore, extensive in-house *experience at Aqualine also contribute to even higher reliability on the installations.*

General Information – Aqualine Design

Floating fish farming installations are complex structures including a large number of components for floating collars, mooring, nets and other accessories. Hence, experience and good knowledge on design, operation and risk assessment is very important in order to understand concepts and make designs with highest reliability. Furthermore, mutual understanding between Aqualine and the customer on how to operate the systems is a key for low service costs and reliable operation phase.

Aqualine has delivered equipment to the fish farming industry in the toughest and most demanding oceans in the world for more than 35 years.

In Aqualine, the maritime understanding is in the marrow. Aqualine respects the ocean and know the forces of nature.

Therefore, Aqualine does not confine themselves to formulas and calculations, but do what is possible to ensure that the equipment will withstand the applied loads. Aqualine subjects the equipment to tough tests; they tear and pull it, in order to find out whether the theoretical calculations correspond to reality. In this manner Aqualine ensures a sustainable environment and safety for fish and men.

The Aqualine design focuses on robust solutions and concepts that integrate floating collars, mooring and nets into one system. This philosophy is based on several years of research and evaluations, e.g. extensive work at the model basin at Marintek in Trondheim. Hence, Aqualine ensure our customers a redundant structural design with respect to the following design criteria (ref NS9415):

1. *Serviceability Limit State*
2. *Ultimate Limit State*
3. *Accidental Limit State*
4. *Fatigue Limit Stage*

The floating collars are designed with a structural circumferential bearing system consisting of steel tendons connected to the steel brackets by bolts. This main structural system is very important in order to withstand the *mooring loads acting on the cages. Furthermore, there is redundancy in the buoyancy of the pipes with polystyrene blocks inside the pipes.*

The nets are fabricated at our partner factories at King Chou in China and Vietnam. This factory has extensive competence on net production, and the Aqualine nets are developed through years of testing and follow-up for qualification.

The mooring systems and components are developed through many years of experience with design, testing and operation of such systems. All components are of the best quality. Analyses are performed in-house in the Marine Engineering Department.

For more information on all equipment see www.aqualine.no.

Environmental Conditions

The dimensions of floating collars, nets and moorings in this description may change when detailed environmental conditions for the sites are presented.

Marine Operations

There are numerous different marine operations related to installation and operation of the fish farming sites. At project execution Aqualine will work with Grieg NL Seafarms LTD on risk assessments related to these operations. This will also include redundancy positioning for well boats close to the barges.

Midgard® System Design

Aqualine® Midgard System is the result of several years of determined work to find new and better solutions within aquaculture cage technology; floating collar, sinker tube and fish net. Special attention has been given to reduce the risk of fish escape, but also to find solutions for more improved and safer working conditions for the fish farm workers. Furthermore, Aqualine finds solutions which make it easier for the fish farmer to farm fish in more exposed locations.

In addition to the work Aqualine have initiated themselves, they have also, in close co-operation with Lerøy, Marine Harvest and Salmar, participated and carried out several projects to find improved cage solutions. From 2012 to 2016, several rounds of Model Testing at the ocean basin at

Marintek in Trondheim have been performed. This has been important to fully test and verify the proposed solutions and, to identify the best design and combination of floating collar, sinker tube and fish net. Several full-scale commercial tests have also been carried out with very good results.

Aqualine AS recently achieved an award from NHO (Confederation of Norwegian Enterprise) in Norway for the development and implementation of the Midgard® System. This is a great recognition for Aqualine AS and our customers, as the award was given because of our work on reducing risk for fish escape and making daily operations easier for the customer. More information about the award can be found at the Press Release on NHO homepage. It is written in Norwegian.

The Midgard® System is now patented.

The Midgard® System consists of the following key attributes:

- *Newly designed fish net in which the sinker tube is connected directly to the net's baseline rope, with the total weight of the sinker tube coming onto the net. Additionally, the sinker tube lifting and lowering ropes when not in use are completely loose and independent of the net tensioning system. This totally eliminates the risk of these ropes coming in contact with the net and potentially causing net wear or damage.*

- *A system where power winches are built into the cage for lifting and lowering the sinker tube with fish net connected. This can be done at a fully synchronised gradual and constant lifting speed for the full circumference of the cage, all done in a totally controllable operation. This operation can easily be performed in a fast and efficient manner, without endangering the fish stocks contained within the net or most importantly not putting the farm workers operating the system at a safety risk. To power this winching system only requires one portable electric generator (mounted on a boat) to power all the winches involved, with no requirement for numerous service boats with hydraulic cranes fitted.*

- *An improved customised fish net design and net tensioning system where all components complement one another to provide a total integrated cage solution. This provides for optimal interaction and interplay between an adapted sinker tube i.e. correctly ballasted with increased structural rigidity and the Midgard fish net and cage collar.*

Husbandry Practices:

The husbandry practices the proponent intends to adopt are outlined in its Placentia Bay Management Plan (Appendix K). These husbandry practices can be summarized as follows:

Production Philosophy:

- Using triploid eggs – this provides access to world class commercial broodstock/egg supplier(s) and thus eliminating possibilities of shortness of egg supply. The sterile salmon provide other benefits as well including 100% reduction of risk to local wild stock should they escape;
- Using a state of the art AquaMaof RAS system – this provides for a number of enhancements to sustainability including:
    - Cost effective operations and smolt production by using gravity based internal flows. 100 % recirculation reducing water chemistry management costs and pumping costs. Providing for a saline environment in the final stages to maintain the smoltification window and eliminate smolt regression;
    - Using a unique oxygen dissolving system (ODS) with a vacuum oxygen generator for provision of ultra-low cost oxygen;
    - Increased production flexibility of smolt size and times for entering the sea;
    - Reducing significantly growth time in the sea/cages and further reducing exposure to risk of diseases, sea lice and other parasites and escapes;
- Programmed production will enable the company to supply market year round with fresh product;
- Using of modern wellboats for transport of both smolt and live harvest salmon. This will provide for minimal handling of fish from the hatchery to the marine sites and live hauling of harvest fish to the plant. The live hauling of live fish to the plant ensures that there is no accidental blood spillage at sea. The live fish at the processing plant permits control of fish temperature and lactic acid management. Swimming to the processing line for humane slaughtering (concussion stunning) without struggle (temperature control). Processing immediately and before rigor sets in and full value added to all production where possible with an aim towards 100%;
- Using holding tanks on land at the processing facility for live salmon will give the processing plant flexibility for timing and temperature control of production as well as enabling to a 100% pre rigor production (increasing shelf life); hence, a significant improvement in quality and value for all concerned;

- The processing plant will provide for complete utilization of all fish products including silage, offal, heads, bones, and trimmings. The processing of this raw material will be for established markets for fish oils, fish protein and calcium; and,
- All value from the salmon will be created and processed in Newfoundland;

Marine production will be based on the Newfoundland Code of Containment http://www.fishaq.gov.nl.ca/aquaculture/public%20reporting/Salmonid%20Code%20of%20Containment%202014.pdf and adaptation of the principle of the Norwegian "green" license philosophy to Canadian environs. This will include access to broodstock with consistent availability and consistent growth and conformation.

The salmon will be sterile triploid to alleviate all risk of genetic interaction with local salmon stocks in the event of escapement.

Sea lice will be managed using lumpfish (*Cyclopterus lumpus*) at 15 fish per 100 smolt. They require continuously clean nets to be effective. This will be a very significant transfer of Norwegian technology and pest management tools.

The intention is to use Aqualine's "escape proofing" systems Midgard for nets, cages and moorings. This will involve using new materials such as Dyneema over nylon for nets and design to avoid contact with net anchors and hydraulic steady lifting. This in turn delivers a net that limits fouling and is more conducive to in situ cleaning which also reduces the opportunity for escape events proportionally. Nets will typically be 43 meters at the center – significantly deeper than typical nets in use in the region (15 meters). This will provide 70,000 M^3 of space per cage at a terminal stocking density of 11.8 kg/M^3.

The cages themselves will be Aqualine 160-meter circumference with working platforms on the pontoons. These nets and cages are entirely a new technology transfer from Norway that will provide for a much safer working environment for the workers on the cage and a more humane space for the fish to grow.

Mooring frames or grids will be Aqualine designed for off shore conditions. Compensation buoys on the frames will be 4000 liters at 400% the current industry standard. The plough anchors will be 5 MT with 100 MT of holding power each; there will be 1 at each side node and 2 at end nodes with combined holding power at a minimum of 200 MT.

Mortality removal will be done daily via a lift-up pumping system. This is a significant improvement over the current Standard Operating Practice (SOP) whereby mortalities are removed only on a weekly basis and only by diver. The current system provides for opportunities to increase bacterial load and risk and the divers provide for significant vectors of risk transfer. All mortalities will be ensilaged with 3% by weight of formic acid to reduce all infectious and spoilage agents on site. The silage will be processed at the processing plant for protein, oils and calcium.

The current depth requirement in the region is 30 meters and the farms in proposal here will be mostly in waters deeper than 60 meters with the majority of the sites in 100 meters and greater. This ensures that benthic impacts are minimized.

The current standard for site separation is 1000 meters and the planned production will increase this twofold in the majority of cases.

Economies of scale are created on the size and volume of cages, nets, and moorings by approximately 200% above the current SOP in use in the region.

Feed used will contain significant marine ingredients to maximize flesh levels of omega 3 fatty acids to the benefit of the health of the fish and the subsequent benefit of the consumers of the product. This will be accomplished with the use of algae and fish waste by-products of the traditional fishery to the extent that FIFO (Fish In - Fish Out) is reduced to 1:1 – a goal of sustainable production.

There will be 11 sites with approximately 200 hectares each. Each site will be licensed as separate entities under Grieg NL Seafarms Ltd.

The company will manage the production areas under its farming control. There will be three full cycle management areas of Rushoon, Merasheen, and Red Island. All sites in the full cycle management areas will have the capacity for twelve 160 meter cages and nets with a depth of 43 meters. The fish capacity at each site will be stated at 2,000,000 smolt. Fish entry will be at a minimum of 300 grams average to ensure that there is no swim-through on a mesh of 35 mm (the smolt size as entered by average weight encompasses a bell curve of sizes from smaller to larger. By utilizing the much larger smolt the possibility of entering a fish so small on the bell curve of size that it can pass through the mesh is eliminated). The final capacity at each site may vary below this as the production experience progresses and each site's limits are defined. Entry of the fish to the sites is targeted for April, May, July and

October; this staggering is done to manage supplies to the market year round. The company will only gradually build to the expected capacity to ensure limits are not exceeded that would be detrimental to the welfare of the fish. In each full cycle management area there will be three sites as follows:

- Rushoon
  - Oderin Island Farms Ltd.
  - Gallows Island Farms Ltd.
  - Long Island Farms Ltd.
- Merasheen
  - Valen Island Farms Ltd.
  - Chambers Island Farms Ltd.
  - Ship Island Farms Ltd.
- Red Island
  - Red Island Farms Ltd.
  - Darby Harbour Farms Ltd.
  - Butler Island Farms Ltd.

The will be one seasonal management area by Long Harbour with two sites Iona Island Farms Ltd. and Brine Island Farms Ltd. These are 1,000,000 fish sites that will enter at 1,500 grams in the spring as soon as temperatures start to rebound from the winter; this is expected to be towards the end of April or early in May of each year. This production will be harvested in December and January.

The Rushoon management area will use Baine Harbour and Petit Forte as inflow mustering points for supplies and personnel. The Merasheen management area will use North Harbour and Arnold's Cove as its inflow mustering area. The Red Island and Long Harbour management areas will use Long Harbour. The following principles will guide operational procedures with the various management areas:

- All operational procedures will have Standard Operating Practices (SOPs) written for an Operational Manual for the company. These SOPs will be vetted through the Province's Aquatic Animal Health Division (AAHD). These SOPs will contain the minutiae of detail for each procedure and all aspects of biosecurity related to it;
- Vessels assigned to specific management areas will not cross or enter other management areas;
- No equipment or employees will travel from one management area to another without following proper biosecurity procedures and SOPs for cleaning and disinfection;

- The feed delivery vessel will not contact the feed barge but will transfer the feed via a coupling. The feed delivery vessel will not travel from one management area to another without having been first brought back to its docking station and pass through procedures of a biosecurity SOP of cleaning and disinfection;
- The well boat will be dedicated to either harvesting operations or other outflow activities. If the well boat is to be used to deliver smolt or to be used in bath treatments, it will be passed through a SOP for ensuring that biosecurity is maintained;
- All mortalities will be collected daily via an air lifting system and ground and placed into silage with a 3% of formic acid by weight. All mortalities will be ensilaged on site so that no infectious material is accidently transported to other sites or management areas;
- Nets will be on a rotation of continuous in situ cleaning for provision of optimal water quality and animal welfare to the fish. The always clean nets also encourage proper feeding attention in cleaner fish. The nets will not have copper based antifoulant;
- All smolt entering the site will be disease free and will be vaccinated against *Vibrio anguilarum, ordalii,* and s*almonicida* as well as *Furunculosis salmonicida* in an oil based adjuvant;
- Cleaner fish such as lumpfish will be used for sea lice control. Vaccines as they become available for deterrence of sea lice will also be used. Functional feeds will also be used to help manage sea lice. Only as a last resort will therapeutants be used to control sea lice. Animal welfare will not be compromised;
- Outflow activities will include harvest operations, removal of silage, and removal of nets or any equipment from the site;
- Inflow activities will include smolt, day to day site personal, entry of new nets or newly recertified nets, feed and any equipment intended for use at the site;
- All personnel entering the site will be controlled, monitored and documented; and,
- All vessels entering the site will be controlled, monitored and documented.

In summary, the project will eliminate risk or threat to the continued well-being of local South Newfoundland Atlantic salmon stocks. Furthermore, and considering all these factors as presented above, it is very unlikely that the project will pose further impacts to Species at Risk or other flora and fauna from the area not deemed to be at risk. The project is designed to be maximally sustainable to the environment in which it finds itself.

11.2.3.6 Potential Sources of Resource Conflict in Part 2:

Placentia Bay is considered both by LOMA Management Plan and the Placentia Bay Integrated Management Plan to be an Ecologically and Biologically Sensitive Area and ranked second in the order priority within the LOMA. Sensitive areas most of concern within the EBSA are habitat for young cod especially kelp fields and ell grass beds. This project does not negatively impact the EBSA.

In 2007 DFA and DEC commissioned an Issues Scan of Selected Coastal and Oceans Areas of Newfoundland and Labrador http://www.icomnl.ca/files/issues_scan_number_one.PDF . The Issues Scan included Placentia Bay and there were a number of recommendations from the scan to promote aquaculture development in Placentia Bay:

Aquaculture

- *Address concerns and perceptions surrounding the aquaculture industry in the province. The Department of Fisheries and Aquaculture should take the lead role on this task (in collaboration with DFO and DEC);*
- *Develop and implement pre-emptive conflict resolution mechanisms between aquaculture operations and other users of the marine area, associated marine and community infrastructure (e.g. roads, waste management).*

11.2.4 Artist's Conceptual Drawings of a Marine Site (Typical):

The conceptual drawings of a typical Sea Cage Marine Farm are as follows:

Figure 35 – Typical Seasonal Site Layout

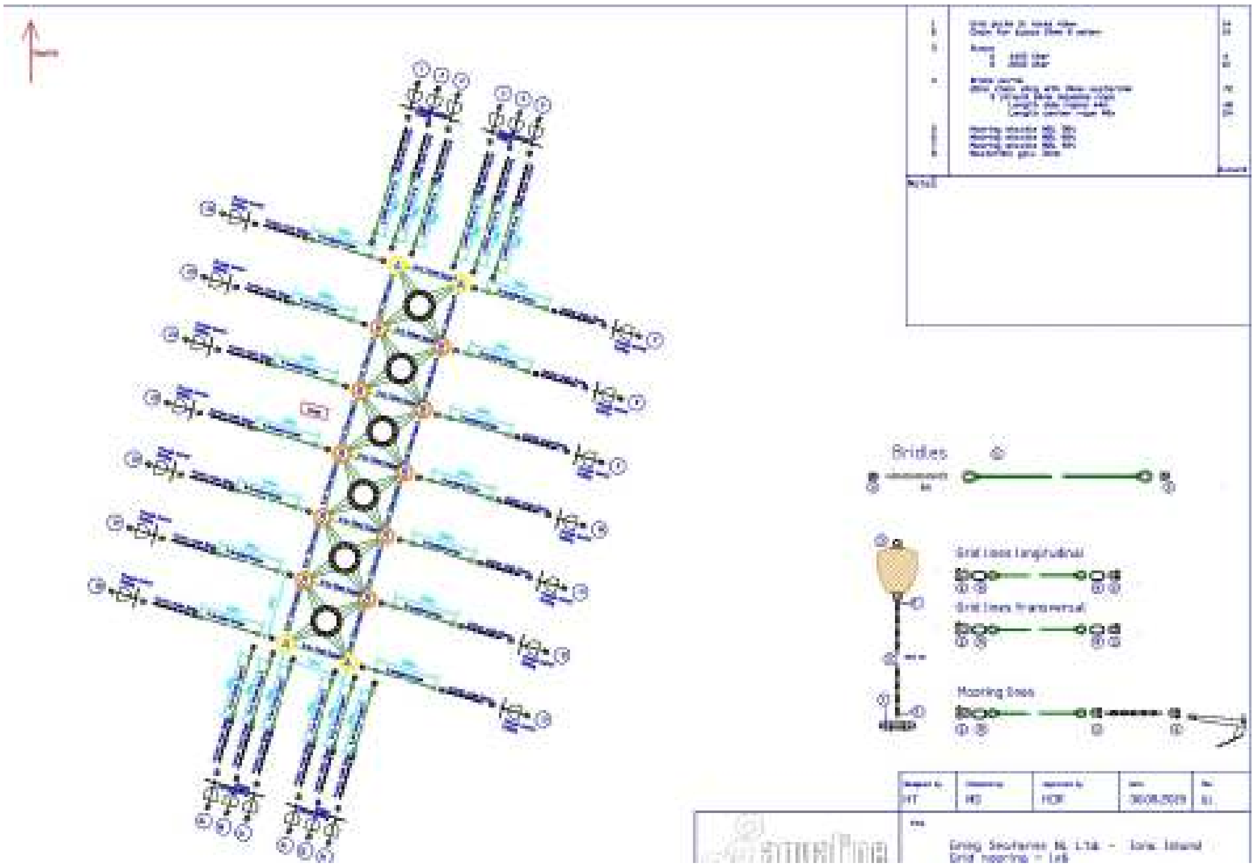
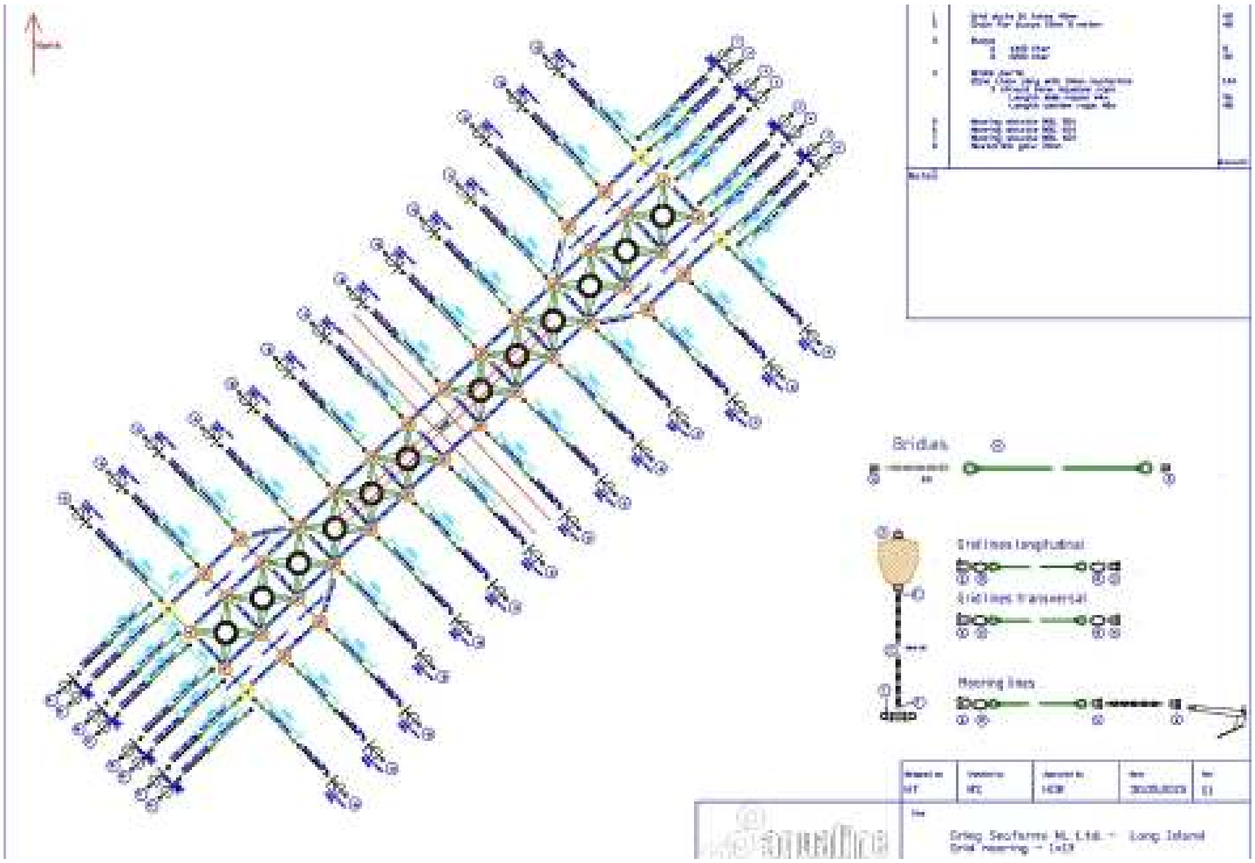


Figure 36 – Typical Full Cycle Site Layout

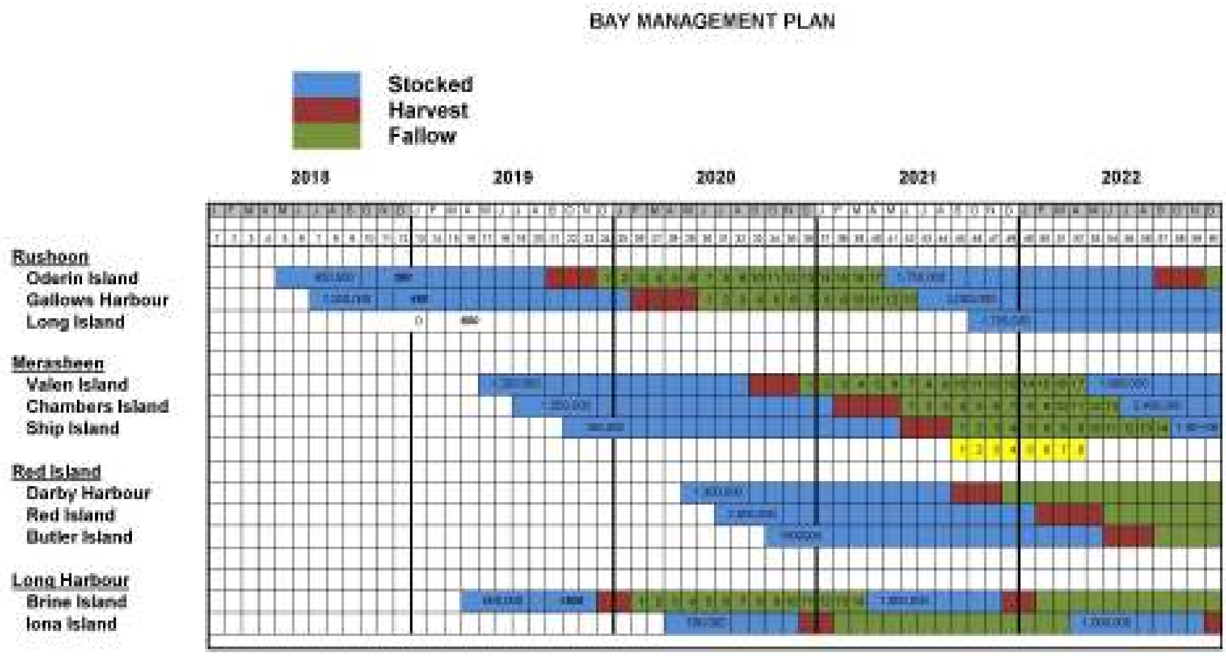


11.3 Part 2 Installations:

11.3.1 The Approximate Installation Period for Part 2:

The Project installation period is over a three-year period beginning in the fall of 2017. The installations take place approximately one season ahead of stocking scenarios for the fish. The stocking scenario is as follows:

Figure 37 – The Approximate Installation Period for Part 2



11.3.2 The Proposed Date of Physical Installations Part 2:

The proposed date of first physical installations is fall of 2017 ahead of spring entries of smolt in 2018. This is provided that all other licenses, permits, authorizations and titles are in place including the release of the undertaking in this process. Other licenses would include the Aquaculture License, the Water Use Authorization, the Permit to Occupy or Crown Lands Lease, Navigation Protection Act permit, and the Permit to Transfer and Transport.

11.3.3 Potential Sources of Pollutants Part 2 Installation Period:

There is some potential that vessels could spill diesel fuel and or gear oil. Cranes, rollers and winches have potential for hydraulic line failure and spilling hydraulic oil. Federal guidelines for fuel storage and handling will be followed. Equipment used during installation will be visually inspected daily before starting work to monitor for minor fuel leaks. All minor leaks will be attended to immediately and absorptive material on hand for cleaning the bilge. A spill kit will be on hand to absorb minor spillages. There will be ropes ends from preparation of moorings. There will be human waste that will be maintained aboard the vessel. There will be household type garbage. The rope ends, the household garbage and human wastes will be disposed of at the Burin Peninsula Waste Management facility near Jean de Baie. It is anticipated that the sources of pollutants during the installation period will be finite and short lived.

Consideration is given to the following sources of pollution during the construction period:

Noise: Load engine noises will be generated by the vessel during site installation. The installation activity is not taking place adjacent any residential or active commercial properties and it is not anticipated that noise will be a concern. It is not anticipated that noise generated by this part of the project will impact the surrounding environment or human, animal, avian or aquatic life.

Dust: Dust and particulate matter will be not generated by this part of the project installation.

11.3.4 Potential Causes of Resource Conflicts Part 2 Installations:

There is a potential that during installation there will be disruption to vessel navigation. This will be managed according to Transport Canada's regulations http://www.laws-lois.justice.gc.ca/eng/acts/N-22/FullText.html . The installation will only commence after approval is given by Transport Canada. The project is at sea and marked according to the Navigation Protection Act (NPA) and will be preceded by a "Notice to Mariners".

11.4 Operations Part 2:

11.4.1 Description of the Operations Part 2:

The operation will be a sea cage operation for Atlantic salmon. The management will monitor and control the operation's employee safety protocols, environmental sustainability, and production traceability under a recognized international certification referred to as Best Aquaculture Practices (BAP) http://bap.gaalliance.org/ .

11.4.1.1 Operation Processes Part 2:

The proposed sea cage operation will utilize three Bay Management Areas (BMA's) for full cycle production (Appendix K – Placentia Bay Management Plan). There will be three sites within each BMA with 2,000,000 fish capacity each. There will be one BMA with 2 sites with 1,000,000 fish capacity each. The full cycle BMA's will be rotated to allow 12 months or better of fallowing for sites and 8 months for the entire BMA. The seasonal BMA will have 14 to 15 month's fallow between sites and 2 to 3 month for the BMA. Each full cycle BMA when stocked will received 3 lots of fish per year. At peak production the full cycle lots will receive 1,750,000 300 gram fish in May, 1,750,000 450 gram fish in July and 2,500,000 600 gram fish in October. The seasonal site will receive 1,000,000 1,500 gram fish in late April or early May depending on sea temperatures (5^{o}C minimum). These fish will be transported to the sites via well boat from the Marystown Hatchery. The production growth will utilize Placentia Bay's temperature units estimated at 2400 plus per annum. The feed will be a compete ration of high quality extruded salmon feed fed to satiation via an automatic feeding system situated on a floating barge. The optimal size at harvest will be 5.5 kilograms of live weight. The harvestable fish will be transported to the processing plant via well boat alive. Slaughtering and processing will take place on land.

11.4.2 Estimated Period of Operations Part 2:

The facilities will remain in continuous operation once operations have commenced.

11.4.3 Potential Sources of Pollutants Part 2 Operational Period:

There is some potential that vessels and barges could encounter a fuel, hydraulic oil and or gear oil spillage. A spill kit will be on hand to absorb minor spillages. The smaller boats will use gasoline and diesel and will release carbon dioxide into the atmosphere. There will be human waste with this operation that will be rendered chemically inert with the use of chemical toilets. The human waste along with household waste and administrative paper waste and some industrial packaging wastes is to be handled by the Burin Peninsula Waste Management facility in Jeanne de Baie.

Mortalities will be collected daily where weather conditions permit to allow fresh processing into silage. The dead fish are lifted from the bottom of the net via an air lift system and then ground into a paste and mixed with 3% food grade formic acid by weight. The silage will be transported to the processing plant for rendering into proteins, oils and minerals.

The fish themselves will produce faeces that will accumulate on the bottom in vicinity of the net pens. The accumulation during production will be consumed naturally by benthic organisms during the fallow period. These middens are monitored by DFO under their Aquaculture Activities Regulations http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/aar-raa-gd-eng.htm .

11.4.4 Potential Causes of Resource Conflicts Part 2 Operations:

It is fully anticipated that there may be some resource conflicts as a result of this project. The sea cage sites are adjacent to fisheries for lobster, scallops, cod, herring, and snow crab. The greatest opportunity for resource conflict is with snow crab fisheries. The sea cage sites are relatively deep with most sites around 100 meters or 54 fathoms and during various consultations with fishers it was noted that on the eastern shore in the Rushoon BMA that snow crab fisheries may be prosecuted in waters as shallow as 60 fathoms. As a result of various private consultations and public consultations the various sites have been oriented in the BMAs to work around overlaps in resource access. Please refer to Appendix G -- Consultations.

11.5 Occupations Part 2:

11.5.1 Estimated Number of Employees Part 2:

11.5.1.1 Installation Phase Part 2

During the assembly and installation of the sea cages, nets and moorings the proponent estimates the workers will include captains, deck hands, supervisors, divers and laborers. There is a potential need for up to 12 full-time and part-time workers during the installation period.

11.5.1.2 Operational Phase Part 2

The operational phase is projected to generate 137 full time positions from captains, deck hands, site management, mechanics, electricians, crane operators, divers, labourers and site technicians.

11.5.2 Enumeration and Breakdown of Occupations in Part 2:

11.5.2.1 Installation Phase Part 2

This particular undertaking will require workers from various trades and management. These workers will be the management responsibility of the General Contractor that submits the most competitive bid for the installation of the equipment. The occupations and their numbers below are an estimation by the proponent. The proponent of the undertaking will bear the responsibility of ensuring that all assembly and installation are done to the rules, policies, and laws of the jurisdiction. The occupations are described according to the National Occupational Classification 2011:

Captains (8261) 1
Engineering (0211) 1
Deck Hands (8441) 6
Electrical Industrial (7242) 1
Welder Operator (7237) 1
Heavy Equipment Mechanic (7312) 1
Crane Operator (7371) 1

11.5.2.2 Operational Phase Part 2

The operational phase of the undertaking is projected to have 137 full time positions. The occupations are described below according to the National Occupational Classification 2011:

Senior Managers (0016) 2
Supervisor General Office (1211) 1
Supervisor Financial (1212) 1
Human Resources Officer (1223) 1
Administrative Assistant (1241) 1
Maintenance Manager (0714) 1
Production Manager (0911) 1
Aquaculture Managers (0823) 7
Aquaculture Technicians (2221) 33
Crane Operator (7371) 2
Captains (8261) 16
Deck Hands (8441) 36
Welder (7237) 1
Heavy Equipment Mechanics (7312) 6
Power Systems Electrician (7202) 3
Aquaculture Labourers (8613) 25

11.5.3 Delineation of Work Carried Out in Part 2:

The installation of the sea cages will be carried out by a General Contractor and hired by Aqualine AS as part of the “turnkey” purchase agreement. The proponent intends to maintain responsibility to ensure that all installation rules and codes, policies, and laws of the jurisdiction are followed.

The operational work will be completed directly by the proponent.

11.5.4 Employment Equity Part 2 of the Project:

The Company has an equal opportunity hiring policy and does not hire relative to age, gender, race or sexual orientation. These employment conditions will be maintained internally and with suppliers and contractors to the project.

11.6 Part 2 Project Related Documents:

The Company has a Business Plan and Marketing Plan in support of the undertaking. There a proposal by Aqualine for the facilities at sea in Appendix H, a Consultations Report in Appendix G, Norwegian Standard's for Sea Cage Installations in Appendix I, Triploid Egg Supply Proposal from Stofnfiskur / SalmoBreed in Appendix J and a Placentia Bay Management Plan in Appendix K. The Aquaculture Licensing process is outlined in Appendix L. Various letters of Support are available in Appendix M. The scientific information in the document is supported by scientific papers and reports listed in the Bibliography. Federal and Provincial government regulations, reports, and management plans are hyperlinked to the internet throughout the document.

12 APPROVAL OF THE UNDERTAKING PART 2

The sea cage undertaking requires a number of licenses, permits, releases, leases and authorizations. These include:

Environmental Assessment Registration of an Undertaking Release

Aquaculture License

Water Use Authorization

Transfer and Transport License

Land Title: Permit to Occupy or Crown Land Lease

Navigation Protection Act Permit

13 SCHEDULE PART 2

This project will commence only after it is “Released” from the Environmental Registration of the Undertaking. The installation of sea cages is scheduled for October, 2017 or the season prior to smolt introductions. Operations are scheduled to begin in May, 2018 with the first smolt transfers. The installations will be staged in such a manner that they will ramp up to peak usage of sites over three years. These operations will only proceed with relevant approvals, licenses, permits and authorizations for Water Use, Crown Land Leases, Aquaculture, Navigation, and Transportation and Transfer of smolt.

14 FUNDING PART 2

The capital costs of this project are $100,000,000. The Province of Newfoundland and Labrador are anticipated partners in the project with preferred shareholdings. The government of Canada is anticipated assisting this project through the Atlantic Canada Opportunities Agency.

Date: January 31st, 2016

Signature of Director ____________________

FINAL

Aquifer Testing Report
Grieg Seafarm NL Ltd.
Marystown
Newfoundland and Labrador

Submitted to:

DS Drilling Services Limited

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4 Hops Street
Conception Bay South, NL
A1W 0E8

Submitted by:

Amec Foster Wheeler Environment & Infrastructure,
a Division of Amec Foster Wheeler Americas Limited

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PO Box 13216
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3 August 2015

Amec Foster Wheeler Project #: TF1563106

IMPORTANT NOTICE

This report was prepared exclusively for DS Drilling Services Limited by Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler). The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in Amec Foster Wheeler's services and based on: i) information available at the time of preparation, ii) data supplied by outside sources and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by DS Drilling Services Limited only, subject to the terms and conditions of its contract with Amec Foster Wheeler. Any other use of, or reliance on, this report by any third party is at that party's sole risk.

EXECUTIVE SUMMARY

Amec Foster Wheeler Environment & Infrastructure (Amec Foster Wheeler) was retained by DS Drilling Services Limited (DSD) to evaluate the results of aquifer pumping tests conducted for a new drilled water supply well for Grieg Seafarms NL Ltd. (Grieg) in Marystown, Newfoundland and Labrador (NL), herein referred to as “the Site”. It is understood that the bedrock groundwater well will be mainly used to service an aquaculture project in Marystown and is not intended for potable water. Amec Foster Wheeler was not on-Site during drilling of the well or the aquifer pumping tests and therefore this report is based solely on information and data collected and provided by DSD.

The results of the document review, pumping test analyses, and water quality data indicate:

- The average transmissivity of the well calculated from the 72 hour pumping test is 2.3×10^{-4} m^2/s.
- Quantitative evaluation of the pumping test indicates that the well is capable of producing approximately 1208 L/min (265 IGPM).
- The turbidity value of 5.9 NTU and 0.60 NTU detected in the 1 and 72 hour water samples, respectively, exceeded the GCDWQ of 0.1 NTU for treated water. Turbidity typically decreases with time as a new well goes into production. It is also noted that the GCDWQ is for treated water and not for untreated raw water pumped during the pumping test.
- A phosphorus concentration of 150 μg/L exceeded a CCME trigger value for the hyper eutrophic range.

The following recommendations are proposed should the well be used as a water supply well or for aquaculture water source:

- **Well Yield:** The well can sustain a safe pumping rate of 1208 L/min (265 IGPM).
- **Water Level:** Water level within the well should be monitored to ensure sustainable use, and the pumping rate may need to be adjusted to avoid over use.
- **Turbidity**: Filtration is recommended to address the elevated turbidity levels or further water samples should be collected to show that turbidity levels decrease below guidelines.
- **Regulations**: It is recommended that applicable guideline and regulations be followed for design, construction and operation of the water system.

All conclusions and recommendations are based on the results of the document review, aquifer tests, and water quality results.

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1.0 INTRODUCTION

Amec Foster Wheeler Environment & Infrastructure (Amec Foster Wheeler) was retained by DS Drilling Services Limited (DSD) to evaluate the results of aquifer pumping tests conducted for a new drilled water supply well for Grieg Seafarms NL Ltd. (Grieg) in Marystown, Newfoundland and Labrador (NL), herein referred to as “the Site”. It is understood that the bedrock groundwater well will be mainly used to service an aquaculture project in Marystown and is not intended for potable water. Amec Foster Wheeler was not on-Site during drilling of the well or the aquifer pumping tests and therefore this report is based solely on information and data collected and provided by DSD.

1.1 Site Description and Use

Marystown is located on the east side of the Burin Peninsula, approximately 300 km southwest of the City of St. John’s, NL (refer to Figure 1, Appendix A). The Site is located near the intersection of McGettigan Boulevard and Centennial Road and approximately 45 m north of McGettigan Boulevard. The following is a description of the adjacent land use in the vicinity of the well (refer to Figure 2, Appendix A).

- North: Wooded undeveloped area and a stream
- South: McGettigan Boulevard.
- East: Recreation Centre, Interpretation Centre, Softball Park and stream.
- West: Walmart.

2.0 SCOPE OF WORK

The aquifer testing was conducted to meet the Aquifer Testing Guidelines from the Water Resources Management Division (WRMD) of the Department of Environment and Conservation (DOEC), Government of Newfoundland and Labrador (GNL). As described in Section 22 of the guidelines, wells constructed in fractured bedrock and intended for public use at a rate exceeding 45 litres per minute (L/min) must be tested (pumped) for a minimum of 72 hours (DOEC WRMD, 2013).

As per the Amec Foster Wheeler proposal, dated June 11, 2015, the scope of work included the following:

1. Analyse data from a step drawdown test to determine an optimum pumping rate that may be sustained by the well for an extended period of time.

2. Analyse data from a 72 hour pumping test at the rate determined from the step drawdown test to determine hydraulic properties of the aquifer and potentially a long-term safe yield of the well.

3. Summarize bacteria, general chemistry and metals analytical data for water samples collected at 1 hour and 72 hours during the pumping test to assess water quality.

4. Analyze recovery water level measurements collected immediately following the 72 hour pumping test to support the aquifer pumping test analyses.

A separate observation well is recommended for a 72 hour pumping test since the additional data may provide more useful information to use in the pumping test interpretations described herein. However, an observation was not available for the current pumping test.

3.0 WELL DETAILS AND REQUIRED YIELD

The 0.02 m (8 inch) diameter well was drilled to an approximate depth of 128 m (420 ft) and completed with 11.8 m (38.7 ft) of steel casing and bentonite grout. The water well record indicates that the bedrock in the well consists of alternating layers of reddish green and green volcanic/sedimentary rock. Water bearing zones were identified at 15 m, 39.6 m, 49 m and 128 m. The stick up casing in the well was installed approximately 0.88 m above ground surface (mags). A copy of the water well record is presented in Appendix B.

4.0 METHODOLOGY

4.1 Document Review

Available documentation (i.e., climate information, bedrock and surficial geology maps and hydrogeological information/reports) was reviewed, which included the following:

- Geology of the Marystown Map Sheet (E/2), Burin Peninsula, Southeastern Newfoundland, Memorial University of Newfoundland, Master's Thesis (Taylor, 1978).
- St. Lawrence, Burin district, Newfoundland. Map 77-021. Scale: 1:50 000. In Geology of the Marystown (1M/3) and St Lawrence (1L/14) Map Areas, Newfoundland. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 77-08, 89 pages, enclosures (2 maps). GS# NFLD/1492b (Strong et al., 1997).
- Surficial Geology of the Marystown map sheet (NTS 1M/03). Geological Survey, Department of Natural Resources, Government of Newfoundland and Labrador, Map 2007-18, Open File 001M/03/0586 (Batterson and Taylor, 2007).
- Hydrogeology of Agricultural Development Areas, Newfoundland and Labrador (Jacques Whitford Environmental Limited (JWEL), 2008).
- Hydrogeology of Eastern Newfoundland (AMEC, 2013).
- Eco-regions of Newfoundland: Maritime Barrens Eco-region (DOEC, 2015a), accessed July, 2015: http://www.nr.gov.nl.ca/nr/forestry/maps/mbarrens_eco.html.
- Online Historical Climate Data (Environment Canada, 2015), accessed July, 2015: http://climate.weather.gc.ca/.
- Water Resources Portal (DOEC, 2015b), accessed July 2015: http://maps.gov.nl.ca/water/.

4.2 Aquifer Testing and Safe Yield Calculations

A step drawdown test was conducted on June 28, 2015. The test was completed in two 60 minute duration steps at pumping rates of 454.6 and 568.3 L/min, based on the estimated yield of the airlift test (464 to 680 L/minute). Only two steps were conducted because the maximum pumping rate for the pump was reached at approximately 568 L/min. Using the results of the step draw down test, a 72 hour pumping test was conducted between June 29 and July 2, 2015 at a constant pumping rate of approximately 568.3 L/min. Immediately following the 72 hour pumping test, the submersible pump was turned off and recovery measurements were collected until the well reached at least 80% recovery. Representatives of DSD were on-Site for the duration of the step drawdown test, 72 hour pumping test and recovery period.

The 1.5 horsepower Goulds (model 10SB) submersible pump used during the step drawdown test and 72 hour pumping test was installed and operated by DSD at a depth of 66 m (217 ft). The discharge rate was measured on the dial gauge of a factory calibrated 1 inch diameter Neptune flow meter. The discharge pipe was extended approximately 150 m from the well to direct discharge away from the pumping well. Various isolation valves were installed on the discharge pipe to control pumping and collect water samples.

Water level measurements were collected manually and recorded as metres below top of stick up casing (mbtoc), using an electronic water level meter generally following the intervals:

Step Drawdown Test

- Every 1 minute until 10 minutes
- Every 2 minutes from 10 - 20 minutes
- Every 5 minutes from 20 - 60 minutes

For two steps.

72 hour Pumping Test

- Every 1 minute for the first 15 minutes
- Every 5 minutes from 15 - 60 minutes (1 hour)
- Every 30 minutes from 60 - 300 minutes (1 - 5 hours)
- Every 60 (1 hour) minutes from 300 - 1440 minutes (5 - 24 hours)
- Every 360 minutes (6 hours) from 1440 - 4320 minutes (24 - 72 hours)

Recovery Test

- Every 1 minute for the first 15 minutes
- Every 5 minutes from 15 minutes - 60 minutes (1 hour)
- Every 30 minutes from 60 - 210 minutes (1 - 3.5 hours)

Water levels were also measured during aquifer testing using a pressure transducer set at one minute intervals. The transducer measurements were not corrected for barometric pressure.

The transmissivity of the well was calculated using the Hantush groundwater flow solution. The long term safe yield of the well was calculated using the calculated/modelled transmissivity values using the following equation:

$$Q = 0.7 \times T \times \Delta s / 0.183 \times \log t$$

Where Q is the safe pumping rate, T is the transmissivity, Δs is the total drawdown during the test, and t is the time that the pumping rate will be used.

4.3 Water Quality Analyses

Water samples were collected by DSD during the first (1 hour) and last hour (72 hours) of the pumping test. Water samples were submitted to Maxxam Analytics Laboratory (Maxxam) in St. John's, NL for general chemistry and metals analyses at their Bedford, Nova Scotia Laboratory. The first water sample was submitted for Maxxam's RCAP-30 limited analysis package, whereas, the 72 hour sample was submitted for Maxxam's comprehensive RCAP-MS package. The water samples were also submitted to the NL Public Health Laboratory in St. John's, NL (Miller Center) for Bacteria (*Escherichia Coli (E. Coli*) and total coliforms) analysis.

5.0 DOCUMENT REVIEW

5.1 Eco-Region and Climate

The Site is part of the ocean climate influenced Southeastern Barrens Subregion of the Maritime Barrens Eco-region, which is marked by cool summers, mild winters and high frequencies of fog and strong southerly winds. Slope bogs, basin bogs and fens are scattered throughout the barrens, reflecting poor drainage and wet climate (DOEC, 2015a).

The most recent data (2000) provided by Environment Canada's monitoring station in St. Lawrence, NL indicated a monthly mean temperature high of 14.7°C in August and a low of -5.0°C in February. Annual monthly precipitation ranged from 106 millimeters (mm) in August to 157.4 mm in September and October (Environment Canada, 2015).

5.2 Topography and Drainage

The topography of the Site is generally flat with a slight to moderate downward gradient to the south toward McGettigan Boulevard. The topography of the overall area is rugged and has an overall moderate upward slope to the northwest and an overall downward slope to the southeast toward Mortier Bay. Based on local topography and surface water elevations, groundwater flow direction is anticipated to be southeast toward Mortier Bay.

5.3 Chemistry of Nearby Potable Water Supplies

Water quality analytical data reports for the surface water body (Fox Hill Reservoir/Clam Pond; WS-S-0448) currently servicing Marystown were downloaded from the DOEC Water Resources portal (DOEC, 2015b) (Appendix C). The reports include nutrient, metal, physical parameter and major ion concentrations in water collected from WS-S-0488 between 1985 and 2014. No groundwater water supply wells were identified in the area near the Site from the DOEC Water Resources Portal mapping. Water chemistry data is presented in Appendix C. Concentrations were compared to Health Canada's Guidelines for Canadian Drinking Water Quality (GCDWQ) (Health Canada, 2015), summarized as follows:

Nutrients and Metals

Concentrations of nutrients (ammonia, dissolved organic carbon, nitrate, kjeldahl nitrogen and phosphorus) and metals detected in the water samples collected from WS-S-0448 were below the GCDWQ between 1985 and 2012.

Physical Parameters and Major Ions

Concentrations of physical parameters (alkalinity, conductivity, hardness, total dissolved solids and total suspended solids) and major ions (boron, bromide, calcium, chloride, fluoride, potassium, sodium and sulphate) detected in the water samples collected from WS-S-0448 were below the GCDWQ between 1985 and 2012. Colour detected in the water samples collected from WS-S-0448 exceeded the GCDWQ aesthetic objective (AO) in 1991 and between 1995 and 2012. pH detected in the water samples collected from WS-S-0448 exceeded the GCDWQ AO in 1999 and 2001. Turbidity detected in water collected from WS-S-0448 exceeded the GCDWQ in 1991, 1998, 2001, 2002, 2006 and 2012.

5.4 Surficial Geology

The surficial geology underlying the Site consists of vegetation concealed thin veneer (<1.5 m) of glacial till and angular frost-heaved bedrock (Batterson and Taylor, 2007).

5.5 Bedrock Geology

Marystown lies within the Avalon tectonostratigraphic zone and is underlain by mafic to acidic volcanic rocks and minor sedimentary rocks of the Mortier Group. Rocks in the area have undergone regional-scale folding related to Devonian Acadian orogenesis and form the core of a broad regional northeast – southwest trending anticline, referred to as the Burin Anticline. A series of joint sets and fracture zones occur within rocks underlying Marystown and are related to deformation (JWEL, 2008).

The Creston Formation of the Mortier Group underlies the Site and is dominated by approximately 500 m of basaltic flows with subordinate acidic pyroclastic and sedimentary rocks with an estimated thickness of 550 m. The basalts are highly amygdaloidal and dark green to purple. The pyroclastic and sedimentary rocks of the Mortier Group are acidic; although locally they have high concentrations of mafic debris giving the rocks a greenish colour and intermediate composition (Strong et al., 1977).

Rocks of the Cashel Lookout Formation underlie the area north of the site and include undivided acidic pyroclastics, flow banded rhyolite (and/or ignimbrite) and volcaniclastic sediments (Strong et al., 1977).

5.6 Hydrogeology

A study entitled 'The Hydrogeology of Agricultural Development Areas (ADA), Newfoundland and Labrador', was conducted for Winterland which borders Marystown to the west (JWEL, 2008). The groundwater potential of the various geological units underlying the Winterland ADA was assessed using available records for water wells completed within each unit obtained from the DEOC WRMD Drilled Water Well Database for wells drilled between 1950 and March, 2008.

No well records were available for wells drilled in the Mortier Group, however, a total of 23 well records from the community of Winterland were used to characterize the groundwater potential of the geologically similar Marystown Group in the ADA. Based on well data, the Marystown Group strata are considered capable of providing wells with low to moderate yields with water yields ranging from 4 to 90 L/min at well depths of 15 to 132 m, and an average yield of 39 L/min at 71 m depth. However, median yield and depth estimates of 34 L/min at 76 m depth are more likely representative of the typical groundwater potential of this unit.

A study entitled 'Hydrogeology of Eastern Newfoundland' was completed in 2013. A total of 1819 well records were available for a geological unit called Volcanic Strata of eastern Newfoundland. Well yields ranged from 0.3 to 455 L/min with a median value of 9 L/min and averaged 25 L/min. Well depth ranged from 8 to 228 m and averaged 67 m. The available data indicate that wells in Volcanic Strata in Eastern Newfoundland generally have a low to moderate potential yield (AMEC, 2013).

6.0 DISCUSSION OF RESULTS

The depth to water measurements for the step drawdown test, the 72 hour pumping test and recovery test are presented in Appendix D. The following is a summary of the various tests conducted between June 28 and July 2, 2015.

6.1 Air Lift Test

An airlift test was conducted by DSD upon completion of the well, which indicated a potential yield of approximately 454 to 680 L/min.

6.2 Step Drawdown Test

A step drawdown test was conducted in two 60 minute duration steps at pumping rates of 454.6 and 568.3 L/min, based on the estimated yield of the airlift test. Drawdowns of approximately 42.7 and 53.2 m were measured for each of the two steps/respective pumping rates identified above. Results of the step draw down test analysis, which used the Theis unconfined aquifer model solution, suggested that transmissivity of the well was 0.000571 m2/sec and could sustain a pumping rate of approximately 568 L/min. A graph of the step drawdown test (Figure E-1) is provided in Appendix E.

6.3 72 Hour Pumping Test

The 72 hour pumping test was conducted between July 29 and August 2, 2015 at a constant rate of approximately 568 L/min (determined from the step drawdown test). At the beginning of the pumping test the static water level was 5.33 mbtoc.

During the first hour, the water level decreased approximately 10 m. The water level decreased steadily from the beginning of the pumping test until approximately 200 minutes. Drawdown levelled to 12 m at 600 minutes (10 hours) and decreased less than 2 m during the remainder of the pumping test. A total drawdown of 13 m was measured over the 72 hour duration of the pumping test.

Based on the shape of the drawdown curve, the Hantush leaky aquifer solution was used to interpret the test. A leaky aquifer is interpreted to be over or underlain by a semi-impermeable confining layer (aquitard) which leaks to some extent. Therefore water is pumped from not only the aquifer but also the aquitard. In a leaky aquifer during early pumping times the water level drops relatively quickly as water is pumped from the aquifer. During medium pumping times, more and more water from the aquitard is assumed to be reaching the aquifer. At late pumping times, a significant or dominant portion of water is from leakage through the aquitard, as flow towards the well reaches a steady state (Kruseman and de Ridder, 1991). Though the fractured bedrock conditions on Site may not physically represent leaky conditions, as water is mainly flowing through fractures in the rock, the high estimated yield values indicate that limited primary porosity exists within the rock allowing limited storage that could mimic leaky conditions.

A time – drawdown graph of the 72 pumping test (Figure E-2) is provided in Appendix E.

6.4 Recovery Test

Immediately following the 72 hour pumping test, the submersible pump was turned off and recovery measurements were collected. The water level increased approximately 7 m during the first hour of recovery. Recovery reached over 90% of the original static water level in approximately 3.5 hours. A time – drawdown graph of the recovery test (Figure E-2) is provided in Appendix E.

6.5 Aquifer Test Analyses

- The 72 hour pumping test and recovery data were analyzed using the Hantush leaky aquifer solution. The transmissivity value from the data analyzed was 2.3×10^{-4} m^2/s for the 72 hour pumping test and recovery data. Pumping test results are summarized in Table 1.

Table 1. Pumping Test Results

Data Type	Method	Transmissivity (m^2/s)	Comments
Pumping Test	Hantush with aquitard storage	2.3×10^{-4}	72 hour and recovery data

6.6 Safe Well Yield

Safe yield values were calculated using the transmissivity value calculated from the long term pumping test and an available drawdown of 128 m (Table 2). Calculated values range from approximately 3887 L/min (855 Imperial gallons per minute (IGPM)) for one hour of pumping to 984 L/min (216 IGPM) for 20 years of continuous pumping. For one year of continuous pumping, 1208 L/min (265 IGPM) is considered reasonable. A pumping rate of 265 IGPM is therefore recommended for the Grieg Seafarm well in Marystown.

Table 2. Safe Yield Values for the Well.

Time	Time (min)	Q (m^3/s)	Q (L/min)	Q (Igpm)
1 hour	60	6.48E-02	3887	855
8 hours	480	4.30E-02	2578	567
1 day	1440	3.65E-02	2188	481
30 days	43200	2.49E-02	1491	328
100 days	4320000	1.74E-02	1041	229
1 year	525600	2.01E-02	1208	265
20 years	10512000	1.64E-02	984	216

7.0 WATER QUALITY RESULTS

Water quality results were compared to both potable water and aquatic life guidelines due to the intended water usage.

7.1 Compared to Potable Water Guidelines

The following section provides a summary of the water quality results compared to the Health Canada GCDWQ (Health Canada, 2015). Analytical tables are presented in Appendix F and the certificates of analyses are presented in Appendix G. Results of the water quality results are summarized below:

- *E. coli* and total coliforms were not detected in the 72 hour water samples and therefore did not exceed the GCDWQ value of 0 detected per 100 ml (refer to Table 1, Appendix G). Water samples were collected within the first hour of the test; however, it was a holiday (July 1st) and the lab was not open and holding times were therefore unintentionally exceeded for the first sample.

- The turbidity value of 5.9 NTU and 0.60 NTU detected in the 1 and 72 hour water samples, respectively, exceeded the GCDWQ of 0.1 NTU for treated water.
- Concentrations of other metal and general chemistry parameters were below the GCDWQ.

It is also noted that the GCDWQ is for treated water and not for untreated raw water pumped during the pumping test. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU. Particles can harbour microorganisms, protecting them from disinfection, and can entrap heavy metals and biocides; elevated or fluctuating turbidity in filtered water can indicate a problem with the water treatment process and a potential increased risk of pathogens in treated water (Health Canada, 2014). The turbidity value decreased with time between the 1 hour and 72 hour samples and is anticipated to continue to decrease over time as the well goes into production.

7.2 Compared to Aquatic Life Guidelines

Grieg requested that the water quality data be compared to applicable guidelines for the protection of freshwater and marine aquatic life since the water will be used for aquaculture. It is understood, however, that for approval the DOEC WRMD will assume that the well will be used for potable water.

The following section provides a summary of the water quality results compared to the Canadian Council of Ministers of Environment (CCME) Water Quality Guidelines for the protection of freshwater and marine aquatic life (CCME, 2015). Analytical tables are presented in Appendix F and the certificates of analyses are presented in Appendix G. Results of the water quality results are summarized below:

- A phosphorus concentration of 150 μg/L exceeded the CCME trigger value for the hyper eutrophic range.
- Concentrations of other metal and general chemistry parameters were below the CCME guidelines for the protection of freshwater and marine aquatic life.

Phosphorus is an essential nutrient for all living organisms; living matter contains about 0.3 percent dry weight phosphorus. Water bodies containing low phosphorus concentrations (i.e., unimpacted sites) typically support relatively diverse and abundant aquatic life that are self-sustaining and support various water uses. However, elevated phosphorus concentrations can adversely affect aquatic ecosystems if ionic phosphorus encounters oxygen to form phosphate. The elevated phosphorus is not considered a concern at this site, as it will be operated as a contained system and the phosphorus is expected to precipitate out of the solution as a salt in the presence of magnesium, calcium and sodium.

It should also be noted that the rocks of the Creston Group underlying the Site contains up to 0.44 weight percent (%) P_2O_5 (4400 mg/kg) and 1.15 % apatite. Apatite is a phosphate mineral with chemical formula $Ca_5(PO_4)_3(F,Cl,OH)$. Thus, the source of the phosphorus in the water may be the bedrock (Taylor, 1978).

8.0 CONCLUSIONS

The results of the document review, pumping test analyses, and water quality data indicate:

- The average transmissivity of the well calculated from the 72 hour pumping test is 2.3×10^{-4} m^2/s.
- Quantitative evaluation of the pumping test indicates that the well is capable of producing approximately 1208 L/min (265 IGPM).
- The turbidity value of 5.9 NTU and 0.60 NTU detected in the 1 and 72 hour water samples, respectively, exceeded the GCDWQ of 0.1 NTU for treated water. Turbidity typically decreases with time as a new well goes into production. It is also noted that the GCDWQ is for treated water and not for untreated raw water pumped during the pumping test.
- A phosphorus concentration of 150 ug/L exceeded a CCME trigger value for the hyper eutrophic range.

All conclusions are based on the results of the document review, aquifer tests, and water quality results.

9.0 RECOMMENDATIONS

The following recommendations are proposed should the well be used as a water supply well or for aquaculture water source:

- **Well Yield:** The well can sustain a safe pumping rate of 1208 L/min (265 IGPM).
- **Water Level:** Water level within the well should be monitored to ensure sustainable use, and the pumping rate may need to be adjusted to avoid over use.
- **Turbidity**: Filtration is recommended to address the elevated turbidity levels or further water samples should be collected to show that turbidity levels decrease below guidelines.
- **Regulations**: It is recommended that applicable guideline and regulations be followed for design, construction and operation of the water system.

All recommendations are based on the results of the document review, aquifer tests, and water quality results.

10.0 CLOSURE

This report has been prepared for the exclusive use of DS Drilling Services Limited. The hydrogeological assessment was conducted using standard practices and in accordance with written requests from the client. No further warranty, expressed or implied, is made. The conclusions presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Amec Foster Wheeler Environment & Infrastructure accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. The limitations of this report are attached in Appendix H.

Yours sincerely,

Amec Foster Wheeler Environment & Infrastructure,
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11.0 REFERENCES

AMEC Environment and Infrastructure. 2013. Hydrogeology of Eastern Newfoundland. Prepared for the Department of Environment and Conservation, Government of Newfoundland and Labrador, St. John's, NL. (TF9312728).

Batterson, M.J. and Taylor, D.M. 2007. Surficial geology of the Marystown map sheet (NTS 1M/03), Newfoundland. Geological Survey, Department of Natural Resources, Government of Newfoundland and Labrador, Map 2007-18, scale 1:50,000. Open File 001M/03/0586.

Canadian Council of Ministers of the Environment (CCME). 2015. CCME Summary Table. Accessed July 2015: http://st-ts.ccme.ca/en/index.html.

Canadian Council of Ministers of the Environment (CCME). 2004. Canadian water quality guidelines for the protection of aquatic life: Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems. In: Canadian environmental quality guidelines, 2004, Canadian Council of Ministers of the Environment, Winnipeg.

Environment Canada. 2015. National Climate Data and Information Archive, St. Lawrence Monitoring Station, Newfoundland and Labrador. Accessed June, 2015: http://climate.weather.gc.ca/.

Health Canada. 2015. Guidelines for Canadian Drinking Water Quality-Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

Jacques Whitford Environmental Limited (JWEL). 2008. Hydrogeology of Agricultural Development Areas, Newfoundland and Labrador. Newfoundland and Labrador Department of Environment and Conservation – Water Resources Management Division. Report No. 1034406.

Kruseman, G.P. and Ridder, N.A. 1991. Analysis and Evaluation of Pumping Test Data. Second Edition. International Institute for Land Reclamation and Improvement (ILRI) Publication 47.

Newfoundland and Labrador Department of Environment and Conservation (DOEC). 2009. Groundwater Supply Assessment and Reporting Guidelines for Subdivisions Serviced by Individual Private Wells. Online: http://www.env.gov.nl.ca/env/waterres/regulations/appforms/unserviced_subdivision_gw_assessment_guidelines_dwh_revisions.pdf.

Newfoundland and Labrador Department of Environment and Conservation – Water Resources Management Division (WRMD). July, 2013. Aquifer Testing Guidelines.

Newfoundland and Labrador Department of Environment and Conservation (DOEC). 2015a. Eco-regions of Newfoundland: Maritime Barrens Eco-region. Accessed July, 2015: http://www.nr.gov.nl.ca/nr/forestry/maps/mbarrens_eco.html.

Newfoundland and Labrador Department of Environment and Conservation (DOEC). 2015b. Newfoundland and Labrador Water Resources Portal. Accessed July, 2015: http://maps.gov.nl.ca/water.

Strong, D.F., O'Brien, S.J., Taylor, P.G., Strong, P.G. and Wilton, D.H. 1997. St. Lawrence, Burin district, Newfoundland. Map 77-021. Scale: 1:50 000. In Geology of the Marystown (1M/3) and St Lawrence (1L/14) Map Areas, Newfoundland. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Report 77-08, 89 pages, enclosures (2 maps). GS# NFLD/1492b.

Taylor, S.W. 1978. Geology of the Marystown Map Sheet (E/2), Burin Peninsula, Southeastern Newfoundland, Memorial University of Newfoundland, Master's Thesis.

APPENDIX A: FIGURES

Source:

This figure based on 1:50,000 Topographic Map 1M03

Amec Foster Wheeler 133 Crosbie Road St. John's, NL, A1B 4A5 (709) 722-7023	DWN BY: J. ABBOTT	PROJECT NAME: AQUIFER TEST, GREIG'S SEA FARM, MARYSTOWN, NL	DATE: JULY 2015
CLIENT: DS DRILLING SERVICES LTD	CHKD BY: T. PRAAMSMA	PROJECT TITLE: SITE LOCATION MAP	PROJ No. TF1563106
	SCALE: AS SHOWN		DRAWING No. 1

NOTES:
1. DO NOT SCALE FROM DRAWING.
2. ALL LOCATIONS, DIMENSIONS, AND ORIENTATIONS ARE APPROXIMATE.
3. THIS DRAWING IS INTENDED TO SHOW RELATIVE LOCATIONS AND CONFIGURATION IN SUPPORT OF THIS REPORT.

Client: DAVE SULLIVAN'S DRILLING

AMEC Foster Wheeler
Environment & Infrastructure
133 Crosbie Road
St. John's, NL A1B 4A5
709-722-7023

amec foster wheeler

Drawn by: J. Abbott
Approved by: T. Praamsma
Scale: NTS

Project: AQUIFER TEST, GRIEG'S SEA FARM, MARYSTOWN, NL

Title: SITE PLAN

Date: July 2015
Project No. TF1563106
Rev. No. 0
Figure No. 2

APPENDIX B: WELL RECORD

Newfoundland Labrador

Well Identification Number (WIN)

Department of Environment and Conservation
Water Resources Management Division
Well Construction Record

Measurements: ☒ Metric ☐ US

Well Owner Information (must be the final owner of well or borehole)

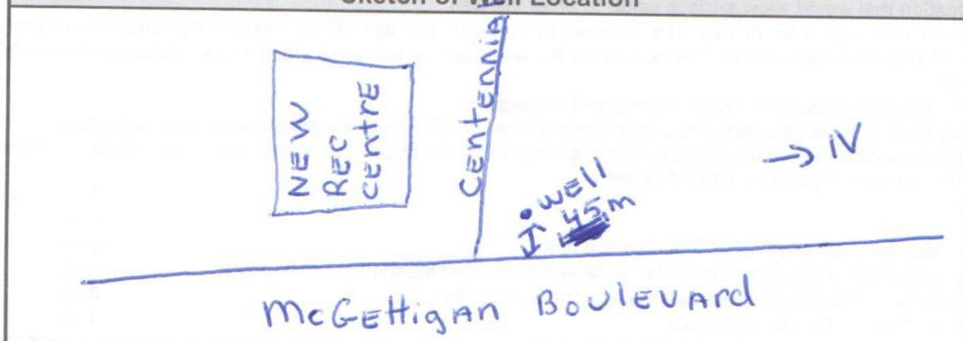
First Name	Last Name	Street Address		
Grieg Seafarms (NL) Ltd		5 Popular Place, P.O. Box 98		
Town/City	**LGID**	**LGID Name**	**Postal Code**	**Telephone**
St. Alban's	For Office Use Only	For Office Use Only	A0H 2E0	538-7413

Well/Borehole Location

Town/City	Street Address/Lot Number	Land Owner (Developer, Private, etc.)
Marystown	McGettingan Blvd	Town of Marystown

GPS Coordinates — Latitude N 47° 10' 37.0" — Longitude W 055° 09' 06.1"

Sketch of Well Location



Show distances from at least two landmarks and indicate North
Include street / road name / and house / lot number if available

Water Bearing Zones

Depth	Rate	Type
15 m	8 LPM	
39.6 m	90 LPM	
49 m	180 LPM	
128 m	454-	680 LPM

Type of Water Encountered

☒ Fresh ☐ Odourous ☐ Salt
☐ Cloudy ☐ Clear ☐ Coloured
☐ Other (Specify) ____

Borehole Lithology

Depth	Colour	Lithology
0-3m	Brown	Sand + Gravel
3-48m	Redish Green	Volcanic/Sedimentary
48m-91m	Green	Volcanic/Sedimentary
91-128	Redish Green	" "

Depth to Bedrock: 3 **Depth of borehole containing casing:** 12.8 **Total depth of borehole:** 128 m

Casing Information - recommended Sch 40, .280 Wall

Casing should be finished 0.60 metres (2 feet) above grade

Depth From	Depth To	Inside Diameter	Type	Thickness
0	12.8	200 mm	Sch40	6.25

Height of the casing finished above grade: ____

Annular Space and Sealant

The annulus of the well should be sealed with an impermeable sealant from the bottom of the casing/drive shoe to the surface.

Depth From	Depth To	Type of Sealant Used
12.8	1 m	Bentonite Grout

Reason why annulus was not sealed: ____

Screen Information

Was a screen installed? ☐ Yes ☒ No

From	To	Slot	Diameter	Material

Drilling Method

☒ Rotary (Air) ☐ Hammer ☐ Reverse Rotary
☐ Other ____
Drive Shoe installed? ☐ Yes ☐ No

Final Status of Well/Borehole

☐ Domestic ☐ Municipal ☐ Exploration ☐ Sealed Well
☐ Dewatering ☐ Geothermal ☐ Observation ☒ Other Industrial

Pumping Test Results

Flowing Well: ☐ Yes ☐ No
If flowing, rate:

Static Water Level: 12

Recommended Pumping Rate:

Method:
☒ Air Lift ☐ Pump
☐ Other ____

Pump Intake at: Duration:

Recommended Pump Depth:

Pumping Rate during Test:

Estimated Safe Yield: 680 LPM

Licenced Water Well Construction Contractor Information

Comments:

Well Construction Company	Licence Number	Well Completed on: (Day – Month – Year)
DS Drilling Services	020	7/6/2015

Driller: [signature] (Sign) — Dave Sullivan (Print)
Driller Assistant: [signature] (Sign) — Matthew White (Print)

This is a Legal Document

Safeguard with Home Owner's Documents

If you have any questions regarding this document, please call Water Resources Management at 709-729-2563

White Copy – Department of Environment and Conservation **Yellow Copy – Drilling Company** **Pink Copy – Well Owner**

APPENDIX C: NEARBY WATER QUALITY DATA

Source Water Quality for Public Water Supplies
Nutrients and Metals

Sample Date	Ammonia	DOC	Nitrate(ite)	Kjeldahl Nitrogen	Total Phosphorus	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Selenium	Uranium	Zinc
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Guidelines for Canadian Drinking Water Quality			10				0.006	0.01	1.0	0.005	0.05	1.0	0.3	0.01		0.05	0.001		0.01	0.02	5.0
Aesthetic(A) Parameter or Contaminant (C)			C				C	C	C	C	C	A	A	C		A	C		C	C	A

Community Name: **Marystown**
Service Area: **Marystown**
Source Name: **Fox Hill Reservoir / Clam Pond**

Sample Date	Ammonia	DOC	Nitrate(ite)	Kjeldahl Nitrogen	Total Phosphorus	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Selenium	Uranium	Zinc
Sep 20, 2012	0.000	10.0	0.000	0.120	0.000	0.120	0.00000	0.000	0.000	0.00000	0.00000	0.000	0.180	0.000	0.000	0.130	0.0000	0.000	0.000	0.0000	0.000
Nov 17, 2009	0.000	8.0	0.000	0.200	0.000	0.140	0.00000	0.000	0.000	0.00000	0.00000	0.000	0.180	0.000	0.600	0.032	0.0000	0.000	0.000	0.0000	0.000
Jun 03, 2009	0.000	5.4	0.000	0.200	0.000	0.080	0.00000	0.000	0.000	0.00000	0.00000	0.000	0.050	0.000	0.700	0.013	0.0000	0.000	0.000	0.0000	0.006
Aug 28, 2007	0.060	6.3	0.000	0.300	0.000	0.100	0.00000	0.000	0.005	0.00000	0.00000	0.000	0.090	0.000	0.700	0.028	0.0000	0.000	0.000	0.0000	0.000
Feb 14, 2007	0.060	10.1	0.000	0.810	0.020	0.090	0.00000	0.000	0.000	0.00000	0.00000	0.006	0.120	0.000	0.000	0.030	0.0000	0.000	0.000	0.0000	0.040
Aug 29, 2006	0.000	8.3	0.000	0.190	0.000	0.120	0.00000	0.000	0.000	0.00000	0.00000	0.000	0.180	0.000	0.000	0.080	0.0000	0.000	0.000	0.0000	0.000
Sep 13, 2005	0.000	6.1	0.000	0.230	0.000	0.080	0.00000	0.000	0.000	0.00000	0.00000	0.000	0.080	0.000	0.000	0.040	0.0000	0.000	0.000	0.0000	0.000

Sample Date	Ammonia	DOC	Nitrate(ite)	Kjeldahl Nitrogen	Total Phosphorus	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Selenium	Uranium	Zinc
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Guidelines for Canadian Drinking Water Quality			10				0.006	0.01	1.0	0.005	0.05	1.0	0.3	0.01		0.05	0.001		0.01	0.02	5.0
Aesthetic(A) Parameter or Contaminant (C)			C				C	C	C	C	C	A	A	C		A	C		C	C	A
Nov 16, 2004	0.050	7.6	0.000	0.220	0.000	0.120	0.00000	0.000	0.000	0.00000	0.00000	0.000	0.130	0.000	0.000	0.030	).0000	0.000	0.000	0.0000	0.000
Jun 08, 2004	0.060	5.9	0.000	0.350	0.000	0.110	0.00000	0.000	0.000	0.00000	0.00000	0.000	0.100	0.000	0.000	0.020	).0000	0.000	0.000	0.0000	0.000
Nov 12, 2003	0.050	5.9	0.050	0.220	0.010	0.120	0.00050	0.001	0.005	0.00005	0.00050	0.001	0.130	0.001	0.500	0.040	).0000	0.003	0.001		0.005
May 27, 2003	0.010	4.2	0.050	0.210	0.010	0.160	0.00050	0.001	0.010	0.00020	0.00050	0.001	0.110	0.001	1.000	0.036	).0000	0.003	0.001		0.003
Jan 29, 2002	0.010	4.7	0.150	0.240	0.005	0.120	0.00050	0.001	0.005	0.00005	0.00050	0.001	0.130	0.001	1.000	0.020	).0000	0.005	0.001	0.0005	0.005
Nov 20, 2001	0.100	7.6	0.050	0.290	0.005	0.150		0.001	0.005	0.00005	0.00050	0.001	0.170	0.001	0.500	0.050	).0000	0.001	0.001		0.005
Sep 12, 2001	0.010	4.7	0.050	0.270	0.005	0.290		0.001	0.010	0.00005	0.00050	0.001	0.090	0.001	0.500	0.060	).0001	0.005	0.001		0.005
Jun 19, 2001		6.2	0.003	0.300	0.005	0.025		0.005	0.025	0.00100	0.00500	0.005	0.050	0.001	1.170	0.030	).0005	0.005	0.005		0.010
Mar 06, 2001		5.6	0.003	0.350	0.005	0.080				0.00100	0.00500	0.005	0.050	0.001	1.310	0.010	).0005	0.005			0.005
Nov 22, 2000		8.4	0.003	0.200	0.005	0.120				0.00100	0.00500	0.005	0.120	0.001	0.760	0.030	).0005	0.005			0.005
Sep 06, 2000		6.1	0.003	0.220	0.005	0.060				0.00100	0.00500	0.005	0.160	0.001	1.720	0.060	).0005	0.005			0.005

Sample Date	Ammonia	DOC	Nitrate(ite)	Kjeldahl Nitrogen	Total Phosphorus	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Selenium	Uranium	Zinc
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Guidelines for Canadian Drinking Water Quality			10				0.006	0.01	1.0	0.005	0.05	1.0	0.3	0.01		0.05	0.001		0.01	0.02	5.0
Aesthetic(A) Parameter or Contaminant (C)			C				C	C	C	C	C	A	A	C		A	C		C	C	A
Jun 06, 2000		5.2	0.003	0.260	0.005	0.025				0.00100	0.00500	0.005	0.005	0.001	0.600	0.005	).0005	0.005			0.005
Feb 23, 2000		5.0	0.003																		
Oct 19, 1999		8.5	0.003	0.360	0.005	0.025						0.005	0.130	0.001		0.070					0.005
Jul 27, 1999		3.2																			
Jun 01, 1999		5.9	0.003	0.200	0.005	0.025						0.005	0.050	0.001		0.020					0.005
Feb 08, 1999		5.8																			
Oct 20, 1998		7.6	0.003	0.250	0.005	0.080						0.005	0.140	0.001		0.040					0.005
May 27, 1998		6.2	0.003	0.110	0.005	0.110						0.020	0.110	0.001		0.010					0.020
Nov 01, 1995	0.005	6.9	0.025	0.100	0.005	0.110				0.00010	0.00025	0.005	0.104	0.001	0.990	0.060					0.005
Jun 13, 1995	0.008	4.9	0.010	0.160	0.002	0.060				0.00020	0.00025	0.004	0.039	0.001	1.000	0.019					0.005
Oct 23, 1991		6.3				0.130		0.000		0.00050	0.00010	0.001	0.110	0.001	1.030	0.120	).0000	0.001			0.005

Sample Date	Ammonia	DOC	Nitrate(ite)	Kjeldahl Nitrogen	Total Phosphorus	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Selenium	Uranium	Zinc
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Guidelines for Canadian Drinking Water Quality			10				0.006	0.01	1.0	0.005	0.05	1.0	0.3	0.01		0.05	0.001		0.01	0.02	5.0
Aesthetic(A) Parameter or Contaminant (C)			C				C	C	C	C	C	A	A	C		A	C		C	C	A
Jun 04, 1991		3.4				0.063				0.00050	0.00010	0.001	0.050	0.001	0.980	0.020	).0000	0.001			0.005
Nov 07, 1985		5.1	0.030			0.070		0.000		0.00050	0.00010	0.001	0.105	0.001	1.000	0.080	).0000	0.001			0.005
Jun 20, 1985		3.8	0.020			0.015		0.000		0.00100	0.00010	0.001	0.004	0.002	1.060	0.005	).0000	0.001			0.005

Sample Date	Ammonia	DOC	Nitrate(ite)	Kjeldahl Nitrogen	Total Phosphorus	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Selenium	Uranium	Zinc
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Guidelines for Canadian Drinking Water Quality			10				0.006	0.01	1.0	0.005	0.05	1.0	0.3	0.01		0.05	0.001		0.01	0.02	5.0
Aesthetic(A) Parameter or Contaminant (C)			C				C	C	C	C	C	A	A	C		A	C		C	C	A

Source water samples are collected directly from the source such as a groundwater well, lake, pond, or stream prior to disinfection or other treatment. The source water quality is analyzed to determine the quality of water that flows into your water treatment and distribution system. The quality of the water this water is a direct indicator of the health of the ecosystem that makes up the natural drainage basin, well head recharge area or watershed area. Monitoring of source water quality is the most important tool to assess the impact of land use changes on source water quality, the presence of disinfection by-product (DBP) pre-cursors and to ensure the integrity of a public water supply. The values for each parameter are as reported by the lab and verified by the department.

Quality Assurance / Quality Control (QA/QC) - The department is striving to improve the quality of the data using standard QA/QC protocols. This is an evolving process which many result in minor changes to the reported data.

LTD - Less Than Detection Limit - The detection limit is the lowest concentration of a substance that can be determined using a particular test method and instrument. Detection limits vary from parameter to parameter and change from time to time due to improvements in analytical procedures and equipment.

The exceedence report for source water provides a brief discussion and interpretation of health related water quality parameters, if any, that exceed the acceptable limits as set out in the Guidelines for Canadian Drinking Water Quality, Sixth Edition (GCDWQ). This comparison is only for screening purposes since at present there are no guidelines for untreated source water. The GCDWQ applies to water at the consumers tap. However in the absence of water treatment these guidelines could be applicable to source water quality.

Aesthetic (A) Parameters - Aesthetic parameters reflect substances or characteristics of drinking water that can affect its acceptance by consumers but which usually do not pose any health effects.

Contaminants (C) - Contaminants are substances that are known or suspected to cause adverse effects on the health of some people when present in concentrations greater than the established Maximum Acceptable Concentrations (MACs) or the Interim Maximum Acceptable Concentrations (IMACs) of the GCDWQ. Each MAC has been derived to safeguard health assuming lifelong consumption of drinking water containing the substance at that concentration. IMACs are reviewed periodically as new information becomes available. Please consult your Medical Officer of Health for additional information on the health aspects of contaminants.

Contaminants

Nitrate(ite) - The maximum acceptable concentration for nitrate(ite) in drinking water is 10 mg/L expressed as nitrate-nitrogen. Nitrate and nitrite are naturally occurring ions that are widespread in the environment. High levels of this contaminant can cause adverse health effects for some people.

Arsenic - The interim maximum acceptable concentration for arsenic in drinking water is 0.01 mg/L. Arsenic is introduced into water through the dissolution of minerals and ores, from industrial effluents and via atmospheric deposition. High levels of this contaminant can cause adverse health effects for some people.

Barium - The maximum acceptable concentration for barium in drinking water is 1.0 mg/L. Barium is not found free in nature but occurs as in a number of compounds. High levels of this contaminant can cause adverse health effects for some people.

Cadmium - The maximum acceptable concentration for cadmium in drinking water is 0.005 mg/L. Cadmium that is present as an impurity in galvanized pipes, a constituent of solders used in fitting water heaters or incorporated into stabilizers in black polyethylene pipes may contaminate water supplies during their distribution. High levels of this contaminant can cause adverse health effects for some people.

Chromium - The maximum acceptable concentration for chromium in drinking water is 0.05 mg/L. High levels of this contaminant can cause adverse health effects for some people.

Lead - The maximum acceptable concentration for lead in drinking water is 0.010 mg/l. Lead is present in tap water as a result of dissolution from natural sources or from the distribution systems and plumbing containing lead in pipes, solder or service connections. High levels of this contaminant can cause adverse health effects for some people.

Mercury - The maximum acceptable concentration for mercury in drinking water is 0.001 mg/L. High levels of this contaminant can cause adverse health effects for some people.

Selenium - The maximum acceptable concentration for selenium in drinking water is 0.01 mg/L. High levels of this contaminant can cause adverse health effects for some people.

Uranium - The interim maximum acceptable concentration for uranium in drinking water is 0.02 mg/L. Uranium may enter drinking water from naturally occurring deposits or as a result of human activity, such as mill tailings and phosphate fertilizers. High levels of this contaminant can cause adverse health effects for some people.

Antimony - The interim maximum acceptable concentration (IMAC) for antimony in drinking water is 0.006 mg/L. It is a naturally occurring metal that is introduced into water through the natural weathering of rocks, runoff from soils, effluents from mining and manufacturing operations, industrial and municipal leachate discharges and from household piping and possibly non-leaded solders. High levels of this contaminant can cause adverse health effects for some people.

Aesthetic Parameters

Copper - The aesthetic objective for copper in drinking water is 1.0 mg/L. Copper is widely distributed in nature and is found frequently in surface water and in some groundwater. Usually, copper in tap water is the result of dissolution of copper piping within the distribution system. The aesthetic objective was set to ensure palatability and to minimize staining of laundry and plumbing fixtures. Copper is an essential element in human metabolism and copper deficiency results in a variety of clinical disorders. At extremely high doses copper intake can result in adverse health effects. High levels of copper in tap water may result in blue-green staining on some fixtures.

Iron - The aesthetic objective for iron in drinking water is 0.3 mg/L. Usually, iron in tap water is the result of high iron content in the raw water and dissolution of iron piping within the distribution system. Iron is an essential element in nutrition. High levels of iron in tap water can cause staining of laundry and plumbing fixtures, unpleasant taste, colour and promote biological growths in the distribution system.

Manganese - The aesthetic objective for manganese in drinking water is 0.05 mg/L. Usually, manganese in drinking water is the result of high amounts of manganese in the source water supply's bedrock. Manganese is an essential element in humans and is regarded as one of the least toxic elements. High levels of manganese may cause staining of plumbing and laundry and undesirable tastes in beverages.

Zinc - The aesthetic objective for zinc in drinking water is 5.0 mg/L. Zinc in water can be naturally occurring or due to zinc in plumbing materials. Zinc is an essential element for human nutrition. Long term ingestion of zinc has not resulted in adverse effects. Water with zinc concentrations higher than the aesthetic objective has an astringent taste and may be opalescent and develop a greasy film on boiling.

mg/L = milligrams per litre or parts per million µS/cm = micro Siemens per centimeter NTU = nephelometric turbidity units TDS = total dissolved solids TSS = total suspended solids TCU = true colour units
DOC = dissolved organic carbon Nitrate(ite) = Nitrate + Nitrite WS # = water supply number SA# = serviced area number GCDWQ = Guidelines for Canadian Drinking Water Quality
Notes : Guidelines for Canadian Drinking Water Quality have not been developed for all the parameters listed in this report.
pH has no units

Source Water Quality for Public Water Supplies
Physical Parameters and Major Ions

Sample Date	Alkalinity	Color	Conductivit	Hardness	pH	TDS	TSS	Turbidity	Boron	Bromide	Calcium	Chloride	Fluoride	Potassium	Sodium	Sulphate
Units	mg/L	TCU	µS/cm	mg/L		mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Guidelines for Canadian Drinking Water Quality		15			6.5 - 8.5	500		1.0	5.0			250	1.5		200	500
Aesthetic(A) Parameter or Contaminant (C)		A			A	A		C	C			A	C		A	A

Community Name: Marystown
Service Area: Marystown
Source Name: Fox Hill Reservoir / Clam Pond

Sample Date	Alkalinity	Color	Conductivit	Hardness	pH	TDS	TSS	Turbidity	Boron	Bromide	Calcium	Chloride	Fluoride	Potassium	Sodium	Sulphate
Sep 20, 2012	0.00	66	43.0	7.00	6.5	28		1.10	0.00	0.00	3.00	7	0.000	0.000	4	0
Nov 17, 2009	5.00	64	42.0	9.00	6.4	21		0.70	0.00	0.00	2.30	7	0.000	0.200	5	0
Jun 03, 2009	6.00	35	46.0	9.00	6.3	21		0.00	0.01	0.00	2.40	7	0.000	0.300	6	0
Aug 28, 2007	5.00	28	45.0	11.00	6.8	21		0.60	0.01	0.00	3.20	6	0.000	0.300	5	0
Feb 14, 2007	7.00	55	64.0	5.00	6.4	42		0.90	0.00	0.00	2.00	12	0.000	0.000	6	4
Aug 29, 2006	7.00	54	49.0	7.00	6.5	32		1.20	0.00	0.00	3.00	8	0.000	0.000	4	3
Sep 13, 2005	13.00	30	49.0	10.00	7.2	32		0.80	0.00	0.00	4.00	8	0.000	0.000	5	3
Nov 16, 2004	12.00	57	62.0	10.00	7.1	40		1.00	0.00	0.00	4.00	10	0.000	0.000	5	4
Jun 08, 2004	8.00	41	60.0	5.00	6.4	39		0.60	0.00	0.00	2.00	9	0.000	0.000	7	3

Sample Date	Alkalinity	Color	Conductivit	Hardness	pH	TDS	TSS	Turbidity	Boron	Bromide	Calcium	Chloride	Fluoride	Potassium	Sodium	Sulphate
Units	mg/L	TCU	µS/cm	mg/L		mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Guidelines for Canadian Drinking Water Quality		15			6.5 - 8.5	500		1.0	5.0			250	1.5		200	500
Aesthetic(A) Parameter or Contaminant (C)		A			A	A		C	C			A	C		A	A
Nov 12, 2003	17.00	42	66.0	7.00	6.4	43		0.70	0.01	0.03	3.00	12	0.050	0.500	7	4
May 27, 2003	18.00	26	67.0	22.00	6.8	44		0.90	0.03	0.03	7.00	13	0.050	0.500	7	4
Jan 29, 2002	10.00	41	63.0	14.00	6.5	41		1.10	0.03	0.03	4.00	11	0.050	0.500	6	4
Nov 20, 2001	10.00	58	54.0	10.00	6.8	36		0.80	0.03	0.03	4.00	9	0.050	0.500	7	4
Sep 12, 2001	11.00	50	61.0	10.00	6.5	36		1.50	0.01	0.03	4.00	9	0.050	0.500	5	4
Jun 19, 2001	7.50	48	60.5	14.00	6.9	46		0.15	0.03	0.03	3.74	15	0.005	0.240	8	2
Mar 06, 2001	9.50	43	72.5		6.4	47	1	0.11		0.03	3.49	11	0.005	0.270	9	2
Nov 22, 2000	8.00	69	50.5		6.6	38	1	0.31		0.03	3.18	7	0.005	0.280	6	2
Sep 06, 2000	8.60	50	58.0		7.1	43	1	0.21		0.03	5.09	8	0.005	0.200	8	2
Jun 06, 2000	7.60	47	59.0		7.2	38	1	0.54		0.03	2.83	8	0.005	0.240	6	2
Feb 23, 2000		38	63.4		6.5			0.32		0.03		10				2
Oct 19, 1999	4.20	75	65.6		6.3	46	1	0.47		0.03	2.91	11	0.025	0.480	6	2

Sample Date	Alkalinity	Color	Conductivit	Hardness	pH	TDS	TSS	Turbidity	Boron	Bromide	Calcium	Chloride	Fluoride	Potassium	Sodium	Sulphate
Units	mg/L	TCU	µS/cm	mg/L		mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Guidelines for Canadian Drinking Water Quality		15			6.5 - 8.5	500		1.0	5.0			250	1.5		200	500
Aesthetic(A) Parameter or Contaminant (C)		A			A	A		C	C			A	C		A	A
Jul 27, 1999		32	63.7		7.1			0.12		0.03						
Jun 01, 1999	5.40	52	55.5		6.8	37	1	0.40		0.03	2.76	8	0.025	0.150	5	2
Feb 08, 1999		27	66.5		6.3			0.30								
Oct 20, 1998	6.70	70	50.1		6.8	34	1	1.10			3.29	7		0.210	5	2
May 27, 1998	4.50	60	43.7		6.6	32	2	0.50			2.33	7		0.150	4	2
Nov 01, 1995	8.59	50	59.0		7.0	40		0.80			3.85	9	0.050	0.260	6	2
Jun 13, 1995	8.81	5	65.7		7.0	50		0.55			4.20	12	0.083	0.300	7	3
Oct 23, 1991		33	67.0		7.0			1.05			4.15	13	0.030	0.410	7	3
Jun 04, 1991		20	69.0		7.0			0.40			4.00	13	0.030	0.380	8	3
Nov 07, 1985	8.80	13	68.0		6.9			1.00			4.10	12	0.030	0.340	7	3
Jun 20, 1985	7.95	5	75.0		7.0			0.35			3.90	14	0.030	0.320	7	4

	Sample Date	Alkalinity	Color	Conductivit	Hardness	pH	TDS	TSS	Turbidity	Boron	Bromide	Calcium	Chloride	Fluoride	Potassium	Sodium	Sulphate
Units		mg/L	TCU	µS/cm	mg/L		mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Guidelines for Canadian Drinking Water Quality			15			6.5 - 8.5	500		1.0	5.0			250	1.5		200	500
Aesthetic(A) Parameter or Contaminant (C)			A			A	A		C	C			A	C		A	A

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Aesthetic (A) Parameters - Aesthetic parameters reflect substances or characteristics of drinking water that can affect its acceptance by consumers but which usually do not pose any health effects.

Contaminants (C) - Contaminants are substances that are known or suspected to cause adverse effects on the health of some people when present in concentrations greater than the established Maximum Acceptable Concentrations (MACs) or the Interim Maximum Acceptable Concentrations (IMACs) of the GCDWQ. Each MAC has been derived to safeguard health assuming lifelong consumption of drinking water containing the substance at that concentration. IMACs are reviewed periodically as new information becomes available. Please consult your Medical Officer of Health for additional information on the

Contaminants:

Turbidity - The maximum acceptable concentration for turbidity is 1 NTU. Turbidity refers to the water's ability to transmit light or the cloudiness of the water. Turbidity in tap water can be the result of turbid raw water and influences within the distribution system. Turbidity is usually the result of fine organic and inorganic particles which do not settle out. Increased turbidity of drinking water results in it being less aesthetically pleasing, and may interfere with the disinfection process.

Boron - The interim maximum acceptable concentration for boron in drinking water is 5.0 mg/L. Boron is widespread in the environment, occurring naturally in over 80 minerals and in the earth's crust. Levels in well water have been reported to be more variable and often higher than those in surface waters, most likely due to erosion from natural resources. High levels of this contaminant can cause adverse health effects for some peopleTurbidity - The maximum acceptable concentration for turbidity is 1 NTU. Turbidity refers to the water's ability to transmit light or the cloudiness of the water. Turbidity in tap water can be the result of turbid raw water and influences within the distribution system. Turbidity is usually the result of fine organic and inorganic particles which do not settle out. Increased turbidity of drinking water results in it being less aesthetically pleasing, and may interfere with the disinfection process.

Fluoride - The maximum acceptable concentration for fluoride in drinking water is 1.5mg/L.The fluoride concentration in natural water varies widely as it depends on such factors as the source of the water and the geological formations present. Trace amounts of fluoride may be essential for human nutrition and the presence of small quantities leads to a reduction of dental caries. High levels of this contaminant can cause adverse health effects for some people.

mg/L = milligrams per litre or parts per million µS/cm = micro Siemens per centimeter NTU = nephelometric turbidity units TDS = total dissolved solids TSS = total suspended solids
TCU = true colour units
DOC = dissolved organic carbon Nitrate(ite) = Nitrate + Nitrite WS # = water supply number SA# = serviced area number GCDWQ = Guidelines for Canadian Drinking Water Quality
Notes : Guidelines for Canadian Drinking Water Quality have not been developed for all the parameters listed in this report.
pH has no units

Asthetic Parameters

Colour - An aesthetic objective of 15 true colour units (TCU) has been established for colour in drinking water. Colour in drinking water may be due to the presence of coloured organic substances or metals such as iron, manganese and copper. Highly coloured industrial wastes also contribute to colour. The presence of colour is not directly linked to health but it can be aesthetically displeasing.

pH -The acceptable range for drinking water pH is 6.5 - 8.5. The control of pH is primarily based on minimizing corrosion and encrustration in the distribution system. Tap water with low pH may accelerate the corrosion process in the distribution system, and contribute to increased levels of copper, lead and possibly other metals. Incrustation and scaling problems may become more frequent above pH 8.5

TDS - The aesthetic objective for TDS in drinking water is 500 mg/L. The term "total dissolved solids"(TDS) refers mainly to the inorganic substances that are dissolved in water. At low levels TDS contributes to the palatability of water. At high levels it may cause excessive hardness, taste, mineral deposition and corrosion.

Chloride - The aesthetic objective for chloride in drinking water is 250 mg/L. Chloride can be in water from a variety of sources, including the dissolution of salt deposits and salting of roads for ice control. No evidence has been found suggesting that ingestion of chloride is harmful to humans. However, high levels of chloride in water can impart undesirable tastes to water and beverages prepared from water.

Sodium - The aesthetic objective for sodium in drinking water is 200 mg/L. Since the body has very effective means to control levels of sodium, sodium is not an acutely toxic element in the normal range of environmental or dietary concentrations. At extremely high dosages it has adverse health effects. Sodium levels may be of interest to authorities who wish to prescribe sodium restricted diets for their patients..

Sulphate - The aesthetic objective for sulphate in drinking water is 500 mg/L. Sulphates, which occur naturally in numerous minerals, are used in the mining and pulping industries and in wood preservation. Large quantities of sulphate can result in catharsis and gastrointestinal irritation. The presence of sulphate above

APPENDIX D: DRAWDOWN MEASUREMENTS

Pumping Well – Step Test Recovery

Location: Marystown **Project: Greig SeaFarms**

Total depth of Well: 420' Cased To: 42' **Screened/Open Hole to: 8"**

Inside Diameter: 8" **Static Water Level: 17.5'**

Measuring Point Above Ground level: 2'9" **Date: June 29, 2015**

GPS Coordinates:47 10' 37" N 55 09' 06" W

Start Time: 8:45 a.m. June 29, 2015 **Pump Test Phase: 72 Hour Pumping Test**

Pump Set@ 217' + 17.2"

Step	Elapsed Time (min)	Water Level	Flow
	1	45.8	
	2	41.15	
	3	38.8	
	4	37.25	
	5	36.15	
	6	35.1	
	7	34.4	
	8	33.75	
	9	33.2	
	10	32.7	
	11	32.25	
	12	31.9	
	13	31.55	
	14	31.2	
	15	30.9	
	20	29.7	
	25	28.8	
	30	28.1	
	35	27.5	
	40	27	
	45	26.55	
	50	26.15	
	55	25.8	
	60	25.5	
	90	24.1	
	120	23.2	
	150	22.4	
	180	22	
	210	21.8	
	240		
	270		
	300		

Pumped Well Record

Location: Marystown **Project: Greig SeaFarms**

Total depth of Well: 420' Cased To: 42' **Screened/Open Hole to: 8"**

Inside Diameter: 8" **Static Water Level: 17.5'**

Measuring Point Above Ground level: 2'9" **Date: June 29, 2015**

GPS Coordinates:47 10' 37" N 55 09' 06" W

Start Time: 8:45 a.m. June 29, 2015 **Pump Test Phase: 72 Hour Pumping Test**

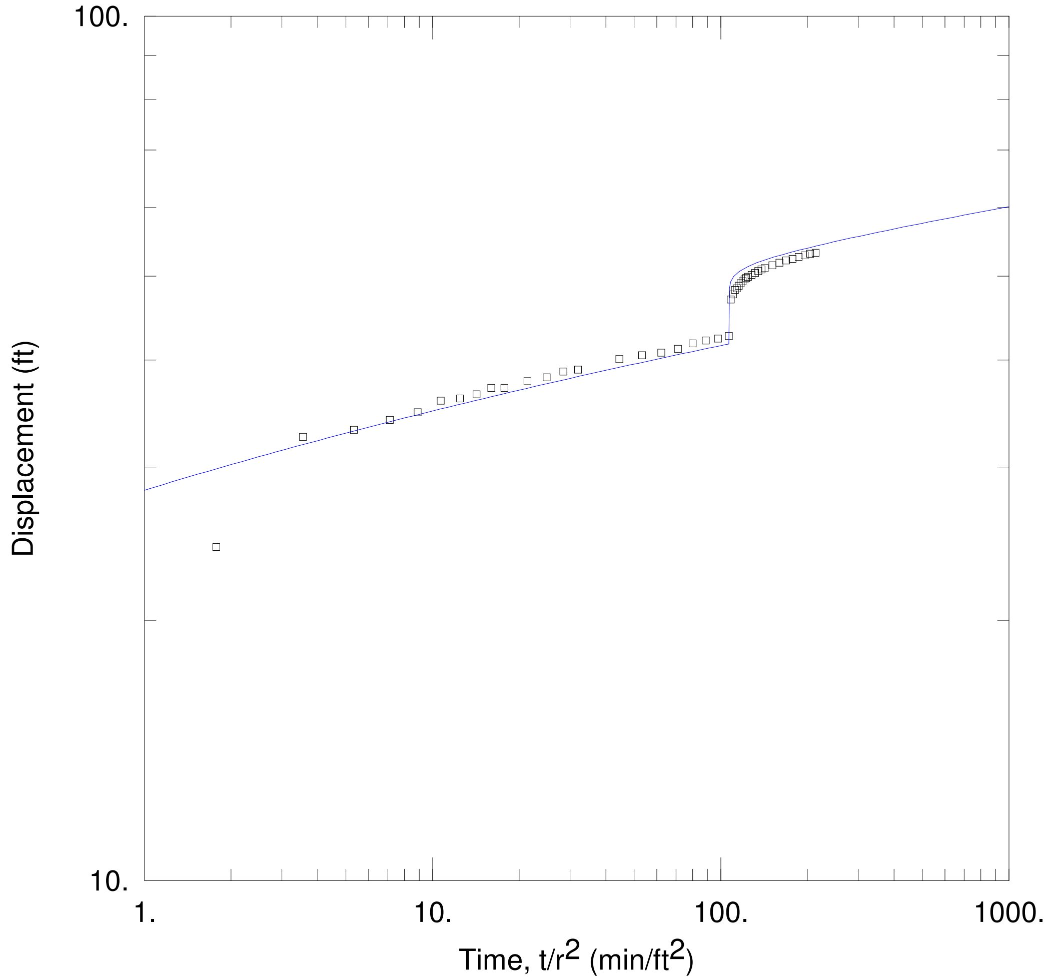
Pump Set@ 217' + 17.2"

Elapsed Time (Min)	Water Level (ft)	Pump Rate (GPM)
0	17.4	125
1	29.9	
2	33	
3	35	
4	36.5	
5	37.9	
6	38.9	
7	39.3	
8	40.4	
9	41	
10	41.5	
11	41.8	
12	42.3	
13	42.72	
14	43.23	
15	43.6	
20	44.75	
25	45.65	
30	46.3	
35	47.15	
40	47.75	
45	48.25	
50	48.6	
55	48.94	
60	49.25	
90	50.8	
120 (2hrs)	53.7	
150	54.55	
180	54.85	
210	55.3	
240 (4 hrs)	55.71	
270	56.1	
300	56.3	
360 (6hrs)	56.75	

420	**57.05**	
480 (8hrs)	**57.3**	
540	**57.47**	
600 (10 hrs)	**57.6**	
660	**57.75**	
720 (12 hrs)	**57.9**	
780	**58.0**	
840 (14 hrs)	**58.15**	
900	**58.2**	
960	**NA**	
1020	**NA**	
1080	**58.45**	
1140	**NA**	
1200	**NA**	
1260	**58.73**	
1320	**58.71**	
1380	**58.75**	
1440 (24 hrs)	**58.7**	
1800 (30 hrs)	**58.43**	
2160 (36 hrs)	**58.7**	
2520 (42 hrs)	**59**	
2880 (48 hrs)	**59.3**	
3240 (54 hrs)	**59.25**	
3600 (60 hrs)	**60.05**	
3960 (66 hrs)	**59.75**	
4320 (72 hrs)	**59.85**	

APPENDIX E: AQUIFER PUMPING TEST ANALYSES

Figure E-1



WELL TEST ANALYSIS

Data Set: P:\...\Griegsseafarm.aqt
Date: 08/03/15 Time: 09:44:42

PROJECT INFORMATION

Company: DS Drilling
Test Well: Grieg Sea Farm
Test Date: June 28, 2015

AQUIFER DATA

Saturated Thickness: 378. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ PW	0	0

SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Step Test)

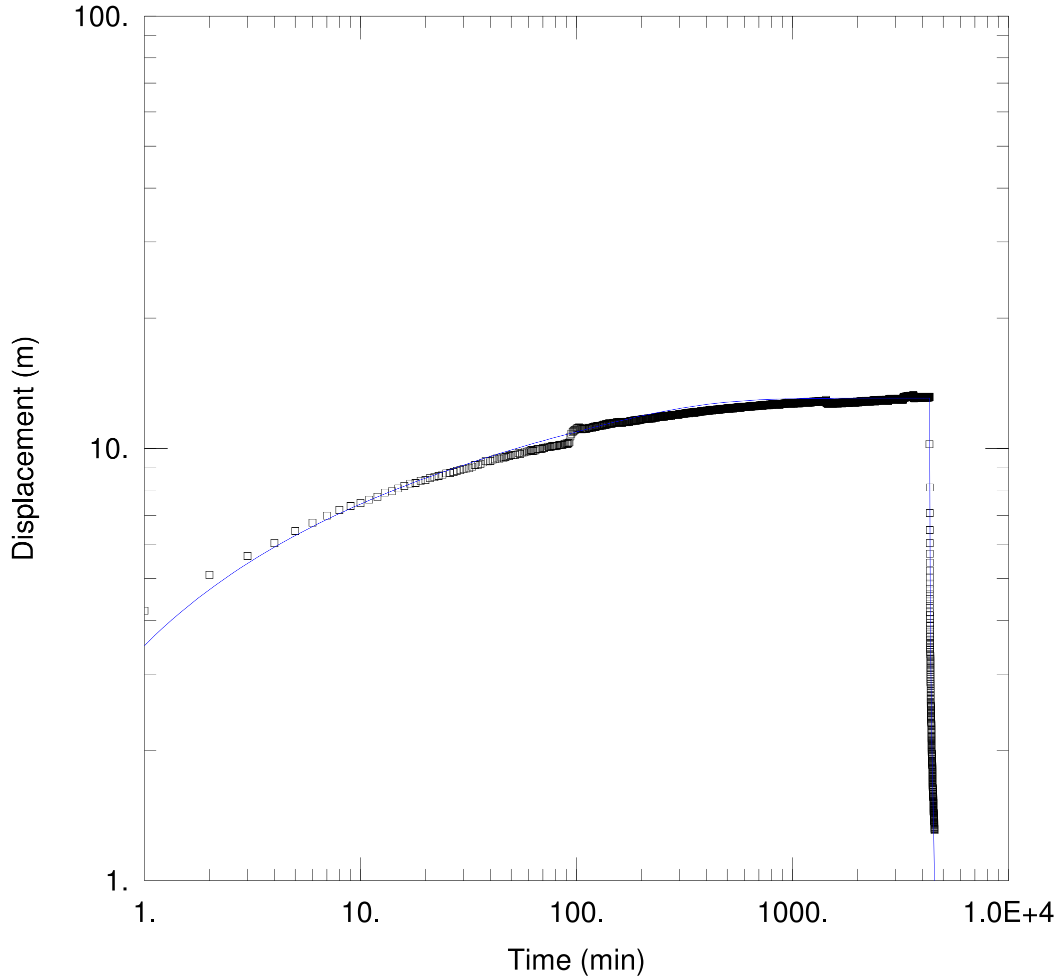
T = 0.0005711 m^2/sec
Sw = 0.
P = 2.

S = 4.579E-5
C = 0. min^2/ft^5

Step Test Model: Jacob-Rorabaugh
Time (t) = 1. min Rate (Q) in cu. ft/min

$s(t) = 2.239Q + 0.Q^{2.}$
W.E. = 100.% (Q from last step)

Figure E-2



72 HOUR PUMPING TEST

Data Set: P:\...\72 Hour Pumping Test.aqt
Date: 08/03/15 | Time: 09:42:43

PROJECT INFORMATION

Company: AMEC Foster Wheeler
Client: Dave Sullivan Drilling
Project: TF1563106
Location: Marystown
Test Well: Well #1
Test Date: June 29 to July 2, 2015

AQUIFER DATA

Saturated Thickness: 122.6 m
Anisotropy Ratio (Kz/Kr): 0.001
Aquitard Thickness (b'): 1. m
Aquitard Thickness (b"): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
Well #1	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ Well #1	0	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush

T = 0.0002335 m^2/sec
S = 0.1612
r/B' = 0.1
ß' = 0.1
r/B" = 0.
ß" = 0.

APPENDIX F: ANALYTICAL DATA TABLES

TABLE F-1: TOTAL COLIFORM AND *E. Coli* in GROUNDWATER

Parameter	Unit	GCDWQ	GS2
		Sample Date (D/M/Y)	02/07/2015
Escherichia Coli (E. Coli)	CFU/100mL	0 per 100 ml	Not Detected
Total Coliforms	CFU/100mL	0 per 100 ml	Not Detected

Notes:

CFU/mL: Colony Forming Unit per mililitre

ND: Not Detected

GCDWQ: Health Canada Guidelines for Canadian Drinking Water Quality (Health Canada, August 2012)

Concentration exceeds GCDWQ

TABLE F-2: GENERAL CHEMISTRY IN GROUNDWATER

Parameter	Units	GCDWQ	CCME		SAMPLE 1	GS2
	Sample Date (D/M/Y)		Freshwater	Marine	29/06/2015	02/07/2015
Calculated Parameters						
Anion Sum	me/L	NG	-	-	5.62	5.73
Bicarbonate Alkalinity (calc. as $CaCO_3$)	mg/L	NG	-	-	120	130
Calculated TDS	mg/L	500 [A]	-	-	310	310
Carbonate Alkalinity (calc. as $CaCO_3$)	mg/L	NG	-	-	1.1	1.1
Cation Sum	me/L	NG	-	-	5.57	5.56
Hardness (as $CaCO_3$)	mg/L	500[B]	-	-	180	200
Ion Balance (% Difference)	%	NG	-	-	0.450	1.51
Langelier Index (20°C)	N/A	NG	-	-	0.350	0.368
Langelier Index (4°C)	N/A	NG	-	-	0.101	0.119
Nitrate (N)	mg/L	10	13	200	-	0.52
Saturation pH (20°C)	N/A	NG	-	-	7.65	7.60
Saturation pH (4°C)	N/A	NG	-	-	7.90	7.85
Inorganics						
Total Alkalinity (Total as $CaCO_3$)	mg/L	NG	-	-	120	130
Dissolved Chloride (Cl)	mg/L	250 [A]	120	-	110	110
Colour	TCU	15 [A]	narritive[D]	narritive[D]	<5.0	<5.0
Nitrate+Nitrite	mg/L	NG	-	-	0.38	0.52
Nitrite (N)	mg/L	1	0.197[E]	-	-	<0.010
Nitrogen (Ammonia Nitrogen)	mg/L	NG	0.588[F]	0.588[F]	0.056	<0.050
Total Organic Carbon (C)	mg/L	NG	-	-	<0.50	<0.50
Orthophosphate (P)	mg/L	NG	-	-	<0.010	<0.010
pH	units	6.5 - 8.5 [A]	6.5 - 9.5	7.0 - 8.7	8.00	7.96
Reactive Silica (SiO_2)	mg/L	NG	-	-	7.6	7.5
Dissolved Sulfate ($S0_4$)	mg/L	500 [A]	-	-	7.0	6.7
Turbidity	NTU	0.1[C]	narritive[G]	narritive[G]	**5.9**	**0.60**
Conductivity	µS/cm	NG	-	-	570	590
Dissolved Fluoride (F-)	mg/L	1.5	0.120	-	-	-
Dissolved Organic Carbon (C)	mg/L	NG	-	-	-	-
Salinity	N/A	NG	-	narritive[H]	-	-
Total Kjeldahl Nitrogen	mg/L	NG	-	-	-	-
Bromide (Br-)	mg/L	NG	-	-	-	-

Notes:

me/L: milliequivalent per litre
mg/L: miligram per litre
TCU: True Colour Units
NTU: Nephelometric Turbidity Unit
µS/cm: microsiemens per centimetre
N/A: Not Applicable
NG: No guideline available
GCDWQ: Health Canada Guidelines for Canadian Drinking Water Quality (Health Canada, August 2012)
CCME: Canadian Council of Ministers of Environment Water Quality Guidelines for the Protection of Aquatic Life

Concentration exceeds GCDWQ

Concentration exceeds the CCME Guideline for Freshwater or Marine Aquatic Life

[A] Guideline is an Aesthetic Objective (AO) and is not a health-based guideline.

[B] Public acceptance of hardness varies considerably. Hardness levels in excess of 500 mg/L are normally considered unacceptable. Hardness levels between 80 and 100 mg/L (as CaCO3) provide acceptable balance between corrosion and incrustation.

[C] Turbidity levels should be less than 0.1 NTU; however, chemically assisted filtration </= 0.3 NTU; slow sand or diatomaceous filtration </= 1.0 NTU and membrane filtration </= 0.1 NTU.

[D] **True Colour**
The mean absorbance of filtered water samples at 456 nm shall not be significantly higher than the seasonally adjusted expected value for the system under consideration.

Apparent Colour
The mean percent transmission of white light per metre shall not be significantly less than the seasonally adjusted expected value for the system under consideration.

[E] Guideline is 60 NO_2-N which can be expressed as µg nitrite-nitrogen/L. This value is equivalent to 197 µg nitrite/L.

[F] Ammonia guideline: Expressed as µg un-ionized ammonia/L. This would be equivalent to 16 µg ammonia-N /L (=19*14.0067 / 17.35052, rounded to two significant figures). Guideline for total ammonia is temperature and pH dependent, please consult factsheet for more information.

[G] **Clear Flow**
Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g., 24-h period). Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g., 30-d period).

High Flow or Turbid Waters
Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs. Should not increase more than 10% of background levels when background is > 80 NTUs.

[H] Human activities should not cause the salinity (expressed as parts per thousand [‰]) of marine and estuarine waters to fluctuate by more than 10% of the natural level expected at that time and depth. Note Interim guideline.

TABLE F-3: METAL CONCENTRATIONS IN GROUNDWATER

Parameter	Unit	GCDWQ	CCME		Sample 1	GS2
		Sample Date	Freshwater	Marine	29/06/2015	02/07/2015
Aluminum (Al)	ug/L	100 [B]	5 or 100[D]	-	-	6.8
Antimony (Sb)	ug/L	6	-	-	-	<1.0
Arsenic (As)	ug/L	10	5	12.5	-	3.9
Barium (Ba)	ug/L	1000	-	-	-	290
Beryllium (Be)	ug/L	NG	-	-	-	<1.0
Bismuth (Bi)	ug/L	NG	-	-	-	<2.0
Boron (B)	ug/L	5000	1500	-	-	<50
Cadmium (Cd)	ug/L	5	0.26[E]	0.12	-	<0.010
Calcium (Ca)	ug/L	NG	-	-	49000	53000
Chromium (Cr)	ug/L	50	1/8.9[F]	1.5/56[F]	-	<1.0
Cobalt (Co)	ug/L	NG	-	-	-	<0.40
Copper (Cu)	ug/L	1000 [C]	3.91[G]	4[G]	<2.0	<2.0
Iron (Fe)	ug/L	300 [C]	300	-	170	<50
Lead (Pb)	ug/L	10	6.72[H]	-	-	<0.5
Magnesium (Mg)	ug/L	NG	-	-	14000	16000
Manganese (Mn)	ug/L	50[C]	-	-	45	42
Molybdenum (Mo)	ug/L	NG	73	-	-	<2.0
Nickel (Ni)	ug/L	NG	149.4[I]	-	-	<2.0
Phosphorus (P)	ug/L	NG	>100 = hyper-eutrophic	-	-	**150**
Potassium (K)	ug/L	NG	-	-	720	660
Selenium (Se)	ug/L	50	1	-	-	<1.0
Silver (Ag)	ug/L	NG	0.1	-	-	<0.10
Sodium (Na)	ug/L	200,000 [C]	-	-	44,000	36000
Strontium (Sr)	ug/L	NG	-	-	-	1100
Thallium (Tl)	ug/L	NG	0.8	-	-	<0.10
Tin (Sn)	ug/L	NG	-	-	-	<2.0
Titanium (Ti)	ug/L	NG	-	-	-	<2.0
Uranium (U)	ug/L	20	15	-	-	1.2
Vanadium (V)	ug/L	NG	-	-	-	<2.0
Zinc (Zn)	ug/L	5000 [C]	30	-	16	<5.0

Notes:
µg/L: micrograms per litre
NG: No guideline available
GCDWQ: Health Canada Guidelines for Canadian Drinking Water Quality (Health Canada, August 2012)
CCME: Canadian Council of Ministers of Environment Water Quality Guidelines for the Protection of Aquatic Life
Concentration exceeds GCDWQ
Concentration exceeds the CCME Guideline for Freshwater or Marine Aquatic Life

[A] Sample was analyzed for Total Metals

[B] Guidelines for aluminum apply only to drinking water treatment plants using aluminum-based coagulants and are therefore not applicable to groundwater samples collected from the on-site well.

[C] Guideline is an Aesthetic Objective (AO) and is not a health-based guideline.

[D] = 5 µg/L if pH < 6.5; = 100 µg/L if pH ≥ 6.5

[E] The CWQG for cadmium (i.e. long-term guideline) of 0.09 µg·L-1 is for waters of 50 mg $CaCO_3$·L-1 hardness.
The CWQG for cadmium is related to water hardness (as CaCO3):
When the water hardness is > 0 to < 17 mg/L, the CWQG is 0.04 µg/L
At hardness ≥ 17 to ≤ 280 mg/L, the CWQG is calculated using this equation (see calculator below)
CWQG (µg/L) = $10^{\{0.83(\log[\text{hardness}]) – 2.46\}}$
At hardness > 280 mg/L, the CWQG is 0.37 µg/L

[F] Guidelines are for hexavalent (Cr(VI)) and trivalent chromium (Cr(III)), respectively.

[G] The CWQG for copper is related to water hardness (as $CaCO_3$):
When the water hardness is 0 to < 82 mg/L, the CWQG is 2 µg/L
At hardness ≥ 82 to ≤ 180 mg/L the CWQG is calculated using this equation (see calculator below)
CWQG (µg/L) = 0.2 * $e^{\{0.8545[\ln(\text{hardness})]-1.465\}}$
At hardness >180 mg/L, the CWQG is 4 µg/L
If the hardness is unknown, the CWQG is 2 µg/L

[H] The CWQG for lead is related to water hardness (as $CaCO_3$):
When the hardness is 0 to ≤ 60 mg/L, the CWQG is 1 µg/L
At hardness > 60 to ≤ 180 mg/L the CWQG is calculated using this equation (see calculator below)
CWQG (µg/L)= $e^{\{1.273[\ln(\text{hardness})]-4.705\}}$
At hardness >180 mg/L, the CWQG is 7 µg/L
If the hardness is unknown, the CWQG is 1 µg/L

[I] The CWQG for nickel is related to water hardness (as $CaCO_3$):
When the water hardness is 0 to ≤ 60 mg/L, the CWQG is 25 µg/L
At hardness > 60 to ≤ 180 mg/L the CWQG is calculated using this equation (see calculator below)
CWQG (µg/L) = $e^{\{0.76[\ln(\text{hardness})]+1.06\}}$
At hardness >180 mg/L, the CWQG is 150 µg/L
If the hardness is unknown, the CWQG is 25 µg/L

[J] Canadian Guidance Framework for Phosphorus is for developing phosphorus guidelines (does not provide guidance on other freshwater nutrients). It provides Trigger Ranges for Total Phosphorus (µg/L) (see Guidance Framework for Phosphorus factsheet):
ultra-oligotrophic <4
oligotrophic 4-10
mesotrophic 10-20
meso-eutrophic 20-35
eutrophic 35-100
hyper-eutrophic >100

APPENDIX G: LABORATORY CERTIFICATES OF ANALYSES (COAS)

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Site Location: GREIG SEAFOODS MARYSTOWN
Your C.O.C. #: B 153519

Attention:Elaine Sullivan

Geothermal Solutions
54 Vineyard Dr
Paradise, NL
CANADA A1L 3W5

Report Date: 2015/07/10
Report #: R3569413
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5C8754
Received: 2015/07/03, 09:43

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Carbonate, Bicarbonate and Hydroxide (1)	1	N/A	2015/07/10	N/A	SM 22 4500-CO2 D
Alkalinity (1)	1	N/A	2015/07/07	ATL SOP 00013	EPA 310.2 R1974 m
Chloride (1)	1	N/A	2015/07/09	ATL SOP 00014	SM 22 4500-Cl- E m
Colour (1)	1	N/A	2015/07/08	ATL SOP 00020	SM 22 2120C m
Conductance - water (1)	1	N/A	2015/07/09	ATL SOP 00004	SM 22 2510B m
Hardness (calculated as CaCO3) (1)	1	N/A	2015/07/09	ATL SOP 00048	SM 22 2340 B
Metals Water Total MS (1)	1	2015/07/07	2015/07/09	ATL SOP 00058	EPA 6020A R1 m
Ion Balance (% Difference) (1)	1	N/A	2015/07/10		Auto Calc.
Anion and Cation Sum (1)	1	N/A	2015/07/10		Auto Calc.
Nitrogen Ammonia - water (1)	1	N/A	2015/07/08	ATL SOP 00015	EPA 350.1 R2 m
Nitrogen - Nitrate + Nitrite (1)	1	N/A	2015/07/09	ATL SOP 00016	USGS SOPINCF0452.2 m
pH (1, 2)	1	N/A	2015/07/09	ATL SOP 00003	SM 22 4500-H+ B m
Phosphorus - ortho (1)	1	N/A	2015/07/08	ATL SOP 00021	EPA 365.2 m
Sat. pH and Langelier Index (@ 20C) (1)	1	N/A	2015/07/10	ATL SOP 00049	Auto Calc.
Sat. pH and Langelier Index (@ 4C) (1)	1	N/A	2015/07/10	ATL SOP 00049	Auto Calc.
Reactive Silica (1)	1	N/A	2015/07/08	ATL SOP 00022	EPA 366.0 m
Sulphate (1)	1	N/A	2015/07/09	ATL SOP 00023	EPA 375.4 R1978 m
Total Dissolved Solids (TDS calc) (1)	1	N/A	2015/07/09		Auto Calc.
Organic carbon - Total (TOC) (1, 3)	1	N/A	2015/07/08	ATL SOP 00037	SM 22 5310C m
Turbidity (1)	1	N/A	2015/07/10	ATL SOP 00011	EPA 180.1 R2 m

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Maxxam Bedford
(2) The APHA Standard Method require pH to be analyzed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the APHA Standard Method holding time.
(3) TOC / DOC present in the sample should be considered as non-purgeable TOC / DOC.

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax: 709-754-8612 www.maxxamanalytics.com

Site Location: GREIG SEAFOODS MARYSTOWN
Your C.O.C. #: B 153519

Attention:Elaine Sullivan

Geothermal Solutions
54 Vineyard Dr
Paradise, NL
CANADA A1L 3W5

Report Date: 2015/07/10
Report #: R3569413
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5C8754
Received: 2015/07/03, 09:43

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Keri Mackay, Project Manager - Bedford
Email: kmackay@maxxam.ca
Phone# (902)420-0203 Ext:294
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Maxxam Job #: B5C8754
Report Date: 2015/07/10

Geothermal Solutions
Site Location: GREIG SEAFOODS MARYSTOWN

ATLANTIC RCAP TOTAL METALS IN WATER (WATER)

Maxxam ID		AOB999		
Sampling Date		2015/06/29		
COC Number		B 153519		
	Units	**SAMPLE 1**	**RDL**	**QC Batch**
Calculated Parameters				
Anion Sum	me/L	5.62	N/A	4092060
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	120	1.0	4092057
Calculated TDS	mg/L	310	1.0	4092063
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.1	1.0	4092057
Cation Sum	me/L	5.57	N/A	4092060
Hardness (CaCO3)	mg/L	180	1.0	4092058
Ion Balance (% Difference)	%	0.450	N/A	4092059
Langelier Index (@ 20C)	N/A	0.350		4092061
Langelier Index (@ 4C)	N/A	0.101		4092062
Saturation pH (@ 20C)	N/A	7.65		4092061
Saturation pH (@ 4C)	N/A	7.90		4092062
Inorganics				
Total Alkalinity (Total as CaCO3)	mg/L	120	25	4094585
Dissolved Chloride (Cl)	mg/L	110	1.0	4094590
Colour	TCU	ND	5.0	4094593
Nitrate + Nitrite	mg/L	0.38	0.050	4094596
Nitrogen (Ammonia Nitrogen)	mg/L	0.056	0.050	4094520
Total Organic Carbon (C)	mg/L	ND	0.50	4096103
Orthophosphate (P)	mg/L	ND	0.010	4094594
pH	pH	8.00	N/A	4098117
Reactive Silica (SiO2)	mg/L	7.6	0.50	4094592
Dissolved Sulphate (SO4)	mg/L	7.0	2.0	4094591
Turbidity	NTU	5.9	0.10	4100238
Conductivity	uS/cm	570	1.0	4098121
Metals				
Total Calcium (Ca)	ug/L	49000	100	4092997
Total Copper (Cu)	ug/L	ND	2.0	4092997
Total Iron (Fe)	ug/L	170	50	4092997
Total Magnesium (Mg)	ug/L	14000	100	4092997
Total Manganese (Mn)	ug/L	45	2.0	4092997
Total Potassium (K)	ug/L	720	100	4092997
Total Sodium (Na)	ug/L	44000	100	4092997
Total Zinc (Zn)	ug/L	16	5.0	4092997

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	6.7°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
4092997	BAN	Matrix Spike	Total Calcium (Ca)	2015/07/09		96	%	80 - 120
			Total Copper (Cu)	2015/07/09		99	%	80 - 120
			Total Iron (Fe)	2015/07/09		105	%	80 - 120
			Total Magnesium (Mg)	2015/07/09		104	%	80 - 120
			Total Manganese (Mn)	2015/07/09		101	%	80 - 120
			Total Potassium (K)	2015/07/09		103	%	80 - 120
			Total Sodium (Na)	2015/07/09		105	%	80 - 120
			Total Zinc (Zn)	2015/07/09		100	%	80 - 120
4092997	BAN	Spiked Blank	Total Calcium (Ca)	2015/07/09		97	%	80 - 120
			Total Copper (Cu)	2015/07/09		101	%	80 - 120
			Total Iron (Fe)	2015/07/09		106	%	80 - 120
			Total Magnesium (Mg)	2015/07/09		105	%	80 - 120
			Total Manganese (Mn)	2015/07/09		104	%	80 - 120
			Total Potassium (K)	2015/07/09		104	%	80 - 120
			Total Sodium (Na)	2015/07/09		108	%	80 - 120
			Total Zinc (Zn)	2015/07/09		101	%	80 - 120
4092997	BAN	Method Blank	Total Calcium (Ca)	2015/07/09	ND, RDL=100		ug/L	
			Total Copper (Cu)	2015/07/09	ND, RDL=2.0		ug/L	
			Total Iron (Fe)	2015/07/09	ND, RDL=50		ug/L	
			Total Magnesium (Mg)	2015/07/09	ND, RDL=100		ug/L	
			Total Manganese (Mn)	2015/07/09	ND, RDL=2.0		ug/L	
			Total Potassium (K)	2015/07/09	ND, RDL=100		ug/L	
			Total Sodium (Na)	2015/07/09	ND, RDL=100		ug/L	
			Total Zinc (Zn)	2015/07/09	ND, RDL=5.0		ug/L	
4094520	ARS	Matrix Spike	Nitrogen (Ammonia Nitrogen)	2015/07/08		NC	%	80 - 120
4094520	ARS	Spiked Blank	Nitrogen (Ammonia Nitrogen)	2015/07/08		105	%	80 - 120
4094520	ARS	Method Blank	Nitrogen (Ammonia Nitrogen)	2015/07/08	ND, RDL=0.050		mg/L	
4094520	ARS	RPD	Nitrogen (Ammonia Nitrogen)	2015/07/08	4.3		%	25
4094585	MCN	Matrix Spike	Total Alkalinity (Total as CaCO3)	2015/07/07		97	%	80 - 120
4094585	MCN	Spiked Blank	Total Alkalinity (Total as CaCO3)	2015/07/07		102	%	80 - 120
4094585	MCN	Method Blank	Total Alkalinity (Total as CaCO3)	2015/07/07	ND, RDL=5.0		mg/L	
4094585	MCN	RPD	Total Alkalinity (Total as CaCO3)	2015/07/07	NC		%	25
4094590	MCN	Matrix Spike	Dissolved Chloride (Cl)	2015/07/09		105	%	80 - 120
4094590	MCN	QC Standard	Dissolved Chloride (Cl)	2015/07/09		106	%	80 - 120
4094590	MCN	Spiked Blank	Dissolved Chloride (Cl)	2015/07/09		110	%	80 - 120
4094590	MCN	Method Blank	Dissolved Chloride (Cl)	2015/07/09	ND, RDL=1.0		mg/L	
4094590	MCN	RPD	Dissolved Chloride (Cl)	2015/07/09	4.6		%	25
4094591	ARS	Matrix Spike	Dissolved Sulphate (SO4)	2015/07/09		111	%	80 - 120
4094591	ARS	Spiked Blank	Dissolved Sulphate (SO4)	2015/07/09		98	%	80 - 120
4094591	ARS	Method Blank	Dissolved Sulphate (SO4)	2015/07/09	ND, RDL=2.0		mg/L	
4094591	ARS	RPD	Dissolved Sulphate (SO4)	2015/07/09	NC		%	25

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
4094592	ARS	Matrix Spike	Reactive Silica (SiO2)	2015/07/08		98	%	80 - 120
4094592	ARS	Spiked Blank	Reactive Silica (SiO2)	2015/07/08		100	%	80 - 120
4094592	ARS	Method Blank	Reactive Silica (SiO2)	2015/07/08	ND, RDL=0.50		mg/L	
4094592	ARS	RPD	Reactive Silica (SiO2)	2015/07/08	NC		%	25
4094593	NRG	Spiked Blank	Colour	2015/07/08		100	%	80 - 120
4094593	NRG	Method Blank	Colour	2015/07/08	ND, RDL=5.0		TCU	
4094593	NRG	RPD	Colour	2015/07/08	NC		%	20
4094594	NRG	Matrix Spike	Orthophosphate (P)	2015/07/08		97	%	80 - 120
4094594	NRG	Spiked Blank	Orthophosphate (P)	2015/07/08		99	%	80 - 120
4094594	NRG	Method Blank	Orthophosphate (P)	2015/07/08	ND, RDL=0.010		mg/L	
4094594	NRG	RPD	Orthophosphate (P)	2015/07/08	NC		%	25
4094596	ARS	Matrix Spike	Nitrate + Nitrite	2015/07/09		100	%	80 - 120
4094596	ARS	Spiked Blank	Nitrate + Nitrite	2015/07/09		96	%	80 - 120
4094596	ARS	Method Blank	Nitrate + Nitrite	2015/07/09	ND, RDL=0.050		mg/L	
4094596	ARS	RPD	Nitrate + Nitrite	2015/07/09	NC		%	25
4096103	MCY	Matrix Spike	Total Organic Carbon (C)	2015/07/08		100	%	80 - 120
4096103	MCY	Spiked Blank	Total Organic Carbon (C)	2015/07/08		100	%	80 - 120
4096103	MCY	Method Blank	Total Organic Carbon (C)	2015/07/08	ND, RDL=0.50		mg/L	
4096103	MCY	RPD	Total Organic Carbon (C)	2015/07/08	5.7		%	20
4098117	KSR	QC Standard	pH	2015/07/09		101	%	97 - 103
4098117	KSR	RPD	pH	2015/07/09	0.13		%	N/A
4098121	KSR	Spiked Blank	Conductivity	2015/07/09		103	%	80 - 120
4098121	KSR	Method Blank	Conductivity	2015/07/09	1.1, RDL=1.0		uS/cm	
4098121	KSR	RPD	Conductivity	2015/07/09	0.28		%	25
4100238	KSR	QC Standard	Turbidity	2015/07/10		96	%	80 - 120
4100238	KSR	Method Blank	Turbidity	2015/07/10	ND, RDL=0.10		NTU	
4100238	KSR	RPD	Turbidity	2015/07/10	0.92		%	25

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B5C8754
Report Date: 2015/07/10

Geothermal Solutions
Site Location: GREIG SEAFOODS MARYSTOWN

VALIDATION SIGNATURE PAGE

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

Mike MacGillivray, Scientific Specialist (Inorganics)

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Site Location: GREIG SEAFARMS-MARYSTOWN
Your C.O.C. #: B 111807

Attention:Elaine Sullivan

Geothermal Solutions
54 Vineyard Dr
Paradise, NL
CANADA A1L 3W5

Report Date: 2015/07/10
Report #: R3569418
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5C9180
Received: 2015/07/03, 09:42

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Carbonate, Bicarbonate and Hydroxide (1)	1	N/A	2015/07/10	N/A	SM 22 4500-CO2 D
Alkalinity (1)	1	N/A	2015/07/08	ATL SOP 00013	EPA 310.2 R1974 m
Chloride (1)	1	N/A	2015/07/09	ATL SOP 00014	SM 22 4500-Cl- E m
Colour (1)	1	N/A	2015/07/08	ATL SOP 00020	SM 22 2120C m
Conductance - water (1)	1	N/A	2015/07/09	ATL SOP 00004	SM 22 2510B m
Hardness (calculated as CaCO3) (1)	1	N/A	2015/07/09	ATL SOP 00048	SM 22 2340 B
Metals Water Total MS (1)	1	2015/07/07	2015/07/08	ATL SOP 00058	EPA 6020A R1 m
Ion Balance (% Difference) (1)	1	N/A	2015/07/10		Auto Calc.
Anion and Cation Sum (1)	1	N/A	2015/07/10		Auto Calc.
Nitrogen Ammonia - water (1)	1	N/A	2015/07/08	ATL SOP 00015	EPA 350.1 R2 m
Nitrogen - Nitrate + Nitrite (1)	1	N/A	2015/07/09	ATL SOP 00016	USGS SOPINCF0452.2 m
Nitrogen - Nitrite (1)	1	N/A	2015/07/08	ATL SOP 00017	SM 22 4500-NO2- B m
Nitrogen - Nitrate (as N) (1)	1	N/A	2015/07/09	ATL SOP 00018	ASTM D3867
pH (1, 2)	1	N/A	2015/07/09	ATL SOP 00003	SM 22 4500-H+ B m
Phosphorus - ortho (1)	1	N/A	2015/07/08	ATL SOP 00021	EPA 365.2 m
Sat. pH and Langelier Index (@ 20C) (1)	1	N/A	2015/07/10	ATL SOP 00049	Auto Calc.
Sat. pH and Langelier Index (@ 4C) (1)	1	N/A	2015/07/10	ATL SOP 00049	Auto Calc.
Reactive Silica (1)	1	N/A	2015/07/08	ATL SOP 00022	EPA 366.0 m
Sulphate (1)	1	N/A	2015/07/09	ATL SOP 00023	EPA 375.4 R1978 m
Total Dissolved Solids (TDS calc) (1)	1	N/A	2015/07/09		Auto Calc.
Organic carbon - Total (TOC) (1, 3)	1	N/A	2015/07/06	ATL SOP 00037	SM 22 5310C m
Turbidity (1)	1	N/A	2015/07/10	ATL SOP 00011	EPA 180.1 R2 m

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Maxxam Bedford
(2) The APHA Standard Method require pH to be analyzed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the APHA Standard Method holding time.
(3) TOC / DOC present in the sample should be considered as non-purgeable TOC / DOC.

Site Location: GREIG SEAFARMS-MARYSTOWN
Your C.O.C. #: B 111807

Attention:Elaine Sullivan

Geothermal Solutions
54 Vineyard Dr
Paradise, NL
CANADA A1L 3W5

Report Date: 2015/07/10
Report #: R3569418
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5C9180
Received: 2015/07/03, 09:42

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Keri Mackay, Project Manager - Bedford
Email: kmackay@maxxam.ca
Phone# (902)420-0203 Ext:294
==
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Maxxam Job #: B5C9180
Report Date: 2015/07/10

Geothermal Solutions
Site Location: GREIG SEAFARMS-MARYSTOWN

ATLANTIC RCAP-MS TOTAL METALS IN WATER (WATER)

Maxxam ID		AOE091		
Sampling Date		2015/07/02 06:15		
COC Number		B 111807		
	Units	**GS2**	**RDL**	**QC Batch**
Calculated Parameters				
Anion Sum	me/L	5.73	N/A	4092060
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	130	1.0	4092057
Calculated TDS	mg/L	310	1.0	4092063
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.1	1.0	4092057
Cation Sum	me/L	5.56	N/A	4092060
Hardness (CaCO3)	mg/L	200	1.0	4092058
Ion Balance (% Difference)	%	1.51	N/A	4092059
Langelier Index (@ 20C)	N/A	0.368		4092061
Langelier Index (@ 4C)	N/A	0.119		4092062
Nitrate (N)	mg/L	0.52	0.050	4092065
Saturation pH (@ 20C)	N/A	7.60		4092061
Saturation pH (@ 4C)	N/A	7.85		4092062
Inorganics				
Total Alkalinity (Total as CaCO3)	mg/L	130	25	4094598
Dissolved Chloride (Cl)	mg/L	110	1.0	4094600
Colour	TCU	ND	5.0	4094604
Nitrate + Nitrite	mg/L	0.52	0.050	4094606
Nitrite (N)	mg/L	ND	0.010	4094607
Nitrogen (Ammonia Nitrogen)	mg/L	ND	0.050	4094528
Total Organic Carbon (C)	mg/L	ND	0.50	4093199
Orthophosphate (P)	mg/L	ND	0.010	4094605
pH	pH	7.96	N/A	4098124
Reactive Silica (SiO2)	mg/L	7.5	0.50	4094603
Dissolved Sulphate (SO4)	mg/L	6.7	2.0	4094601
Turbidity	NTU	0.60	0.10	4100286
Conductivity	uS/cm	590	1.0	4098125
Metals				
Total Aluminum (Al)	ug/L	6.8	5.0	4094129
Total Antimony (Sb)	ug/L	ND	1.0	4094129
Total Arsenic (As)	ug/L	3.9	1.0	4094129
Total Barium (Ba)	ug/L	290	1.0	4094129
Total Beryllium (Be)	ug/L	ND	1.0	4094129
Total Bismuth (Bi)	ug/L	ND	2.0	4094129

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable
ND = Not detected

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Maxxam Job #: B5C9180
Report Date: 2015/07/10

Geothermal Solutions
Site Location: GREIG SEAFARMS-MARYSTOWN

ATLANTIC RCAP-MS TOTAL METALS IN WATER (WATER)

Maxxam ID		AOE091		
Sampling Date		2015/07/02 06:15		
COC Number		B 111807		
	Units	**GS2**	**RDL**	**QC Batch**
Total Boron (B)	ug/L	ND	50	4094129
Total Cadmium (Cd)	ug/L	ND	0.010	4094129
Total Calcium (Ca)	ug/L	53000	100	4094129
Total Chromium (Cr)	ug/L	ND	1.0	4094129
Total Cobalt (Co)	ug/L	ND	0.40	4094129
Total Copper (Cu)	ug/L	ND	2.0	4094129
Total Iron (Fe)	ug/L	ND	50	4094129
Total Lead (Pb)	ug/L	ND	0.50	4094129
Total Magnesium (Mg)	ug/L	16000	100	4094129
Total Manganese (Mn)	ug/L	42	2.0	4094129
Total Molybdenum (Mo)	ug/L	ND	2.0	4094129
Total Nickel (Ni)	ug/L	ND	2.0	4094129
Total Phosphorus (P)	ug/L	150	100	4094129
Total Potassium (K)	ug/L	660	100	4094129
Total Selenium (Se)	ug/L	ND	1.0	4094129
Total Silver (Ag)	ug/L	ND	0.10	4094129
Total Sodium (Na)	ug/L	36000	100	4094129
Total Strontium (Sr)	ug/L	1100	2.0	4094129
Total Thallium (Tl)	ug/L	ND	0.10	4094129
Total Tin (Sn)	ug/L	ND	2.0	4094129
Total Titanium (Ti)	ug/L	ND	2.0	4094129
Total Uranium (U)	ug/L	1.2	0.10	4094129
Total Vanadium (V)	ug/L	ND	2.0	4094129
Total Zinc (Zn)	ug/L	ND	5.0	4094129

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
ND = Not detected

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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	13.1°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
4093199	MCY	Matrix Spike	Total Organic Carbon (C)	2015/07/06		105	%	80 - 120
4093199	MCY	Spiked Blank	Total Organic Carbon (C)	2015/07/06		99	%	80 - 120
4093199	MCY	Method Blank	Total Organic Carbon (C)	2015/07/06	ND, RDL=0.50		mg/L	
4093199	MCY	RPD	Total Organic Carbon (C)	2015/07/06	NC		%	20
4094129	MLB	Matrix Spike	Total Aluminum (Al)	2015/07/08		103	%	80 - 120
			Total Antimony (Sb)	2015/07/08		112	%	80 - 120
			Total Arsenic (As)	2015/07/08		100	%	80 - 120
			Total Barium (Ba)	2015/07/08		103	%	80 - 120
			Total Beryllium (Be)	2015/07/08		102	%	80 - 120
			Total Bismuth (Bi)	2015/07/08		105	%	80 - 120
			Total Boron (B)	2015/07/08		112	%	80 - 120
			Total Cadmium (Cd)	2015/07/08		104	%	80 - 120
			Total Calcium (Ca)	2015/07/08		97	%	80 - 120
			Total Chromium (Cr)	2015/07/08		96	%	80 - 120
			Total Cobalt (Co)	2015/07/08		97	%	80 - 120
			Total Copper (Cu)	2015/07/08		95	%	80 - 120
			Total Iron (Fe)	2015/07/08		102	%	80 - 120
			Total Lead (Pb)	2015/07/08		102	%	80 - 120
			Total Magnesium (Mg)	2015/07/08		103	%	80 - 120
			Total Manganese (Mn)	2015/07/08		101	%	80 - 120
			Total Molybdenum (Mo)	2015/07/08		107	%	80 - 120
			Total Nickel (Ni)	2015/07/08		96	%	80 - 120
			Total Phosphorus (P)	2015/07/08		107	%	80 - 120
			Total Potassium (K)	2015/07/08		106	%	80 - 120
			Total Selenium (Se)	2015/07/08		100	%	80 - 120
			Total Silver (Ag)	2015/07/08		106	%	80 - 120
			Total Sodium (Na)	2015/07/08		NC	%	80 - 120
			Total Strontium (Sr)	2015/07/08		104	%	80 - 120
			Total Thallium (Tl)	2015/07/08		104	%	80 - 120
			Total Tin (Sn)	2015/07/08		109	%	80 - 120
			Total Titanium (Ti)	2015/07/08		102	%	80 - 120
			Total Uranium (U)	2015/07/08		109	%	80 - 120
			Total Vanadium (V)	2015/07/08		97	%	80 - 120
			Total Zinc (Zn)	2015/07/08		96	%	80 - 120
4094129	MLB	Spiked Blank	Total Aluminum (Al)	2015/07/08		108	%	80 - 120
			Total Antimony (Sb)	2015/07/08		110	%	80 - 120
			Total Arsenic (As)	2015/07/08		101	%	80 - 120
			Total Barium (Ba)	2015/07/08		103	%	80 - 120
			Total Beryllium (Be)	2015/07/08		103	%	80 - 120
			Total Bismuth (Bi)	2015/07/08		104	%	80 - 120
			Total Boron (B)	2015/07/08		114	%	80 - 120
			Total Cadmium (Cd)	2015/07/08		104	%	80 - 120
			Total Calcium (Ca)	2015/07/08		98	%	80 - 120
			Total Chromium (Cr)	2015/07/08		99	%	80 - 120
			Total Cobalt (Co)	2015/07/08		100	%	80 - 120
			Total Copper (Cu)	2015/07/08		99	%	80 - 120
			Total Iron (Fe)	2015/07/08		104	%	80 - 120
			Total Lead (Pb)	2015/07/08		103	%	80 - 120
			Total Magnesium (Mg)	2015/07/08		106	%	80 - 120
			Total Manganese (Mn)	2015/07/08		104	%	80 - 120
			Total Molybdenum (Mo)	2015/07/08		105	%	80 - 120
			Total Nickel (Ni)	2015/07/08		99	%	80 - 120
			Total Phosphorus (P)	2015/07/08		108	%	80 - 120

Maxxam Analytics International Corporation o/a Maxxam Analytics 49-55 Elizabeth Ave, Suite 101A, St.John's, NL, Canada A1A 1W9 Tel: 709-754-0203 Toll Free: 888-492-7227 Fax: 709-754-8612 www.maxxamanalytics.com

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Total Potassium (K)	2015/07/08		105	%	80 - 120
			Total Selenium (Se)	2015/07/08		101	%	80 - 120
			Total Silver (Ag)	2015/07/08		109	%	80 - 120
			Total Sodium (Na)	2015/07/08		101	%	80 - 120
			Total Strontium (Sr)	2015/07/08		104	%	80 - 120
			Total Thallium (Tl)	2015/07/08		103	%	80 - 120
			Total Tin (Sn)	2015/07/08		107	%	80 - 120
			Total Titanium (Ti)	2015/07/08		104	%	80 - 120
			Total Uranium (U)	2015/07/08		110	%	80 - 120
			Total Vanadium (V)	2015/07/08		100	%	80 - 120
			Total Zinc (Zn)	2015/07/08		98	%	80 - 120
4094129	MLB	Method Blank	Total Aluminum (Al)	2015/07/08	ND, RDL=5.0		ug/L	
			Total Antimony (Sb)	2015/07/08	ND, RDL=1.0		ug/L	
			Total Arsenic (As)	2015/07/08	ND, RDL=1.0		ug/L	
			Total Barium (Ba)	2015/07/08	ND, RDL=1.0		ug/L	
			Total Beryllium (Be)	2015/07/08	ND, RDL=1.0		ug/L	
			Total Bismuth (Bi)	2015/07/08	ND, RDL=2.0		ug/L	
			Total Boron (B)	2015/07/08	ND, RDL=50		ug/L	
			Total Cadmium (Cd)	2015/07/08	ND, RDL=0.010		ug/L	
			Total Calcium (Ca)	2015/07/08	ND, RDL=100		ug/L	
			Total Chromium (Cr)	2015/07/08	ND, RDL=1.0		ug/L	
			Total Cobalt (Co)	2015/07/08	ND, RDL=0.40		ug/L	
			Total Copper (Cu)	2015/07/08	ND, RDL=2.0		ug/L	
			Total Iron (Fe)	2015/07/08	ND, RDL=50		ug/L	
			Total Lead (Pb)	2015/07/08	ND, RDL=0.50		ug/L	
			Total Magnesium (Mg)	2015/07/08	ND, RDL=100		ug/L	
			Total Manganese (Mn)	2015/07/08	ND, RDL=2.0		ug/L	
			Total Molybdenum (Mo)	2015/07/08	ND, RDL=2.0		ug/L	
			Total Nickel (Ni)	2015/07/08	ND, RDL=2.0		ug/L	
			Total Phosphorus (P)	2015/07/08	150, RDL=100		ug/L	
			Total Potassium (K)	2015/07/08	ND, RDL=100		ug/L	

Maxxam Job #: B5C9180
Report Date: 2015/07/10

Geothermal Solutions
Site Location: GREIG SEAFARMS-MARYSTOWN

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Total Selenium (Se)	2015/07/08	ND, RDL=1.0		ug/L	
			Total Silver (Ag)	2015/07/08	ND, RDL=0.10		ug/L	
			Total Sodium (Na)	2015/07/08	ND, RDL=100		ug/L	
			Total Strontium (Sr)	2015/07/08	ND, RDL=2.0		ug/L	
			Total Thallium (Tl)	2015/07/08	ND, RDL=0.10		ug/L	
			Total Tin (Sn)	2015/07/08	ND, RDL=2.0		ug/L	
			Total Titanium (Ti)	2015/07/08	ND, RDL=2.0		ug/L	
			Total Uranium (U)	2015/07/08	ND, RDL=0.10		ug/L	
			Total Vanadium (V)	2015/07/08	ND, RDL=2.0		ug/L	
			Total Zinc (Zn)	2015/07/08	ND, RDL=5.0		ug/L	
4094129	MLB	RPD	Total Aluminum (Al)	2015/07/08	1.8		%	20
4094528	ARS	Matrix Spike	Nitrogen (Ammonia Nitrogen)	2015/07/08		90	%	80 - 120
4094528	ARS	Spiked Blank	Nitrogen (Ammonia Nitrogen)	2015/07/08		104	%	80 - 120
4094528	ARS	Method Blank	Nitrogen (Ammonia Nitrogen)	2015/07/08	ND, RDL=0.050		mg/L	
4094528	ARS	RPD	Nitrogen (Ammonia Nitrogen)	2015/07/08	NC		%	25
4094598	MCN	Matrix Spike	Total Alkalinity (Total as CaCO3)	2015/07/08		NC	%	80 - 120
4094598	MCN	Spiked Blank	Total Alkalinity (Total as CaCO3)	2015/07/07		100	%	80 - 120
4094598	MCN	Method Blank	Total Alkalinity (Total as CaCO3)	2015/07/07	ND, RDL=5.0		mg/L	
4094598	MCN	RPD	Total Alkalinity (Total as CaCO3)	2015/07/08	0.74		%	25
4094600	MCN	Matrix Spike	Dissolved Chloride (Cl)	2015/07/09		NC	%	80 - 120
4094600	MCN	QC Standard	Dissolved Chloride (Cl)	2015/07/09		105	%	80 - 120
4094600	MCN	Spiked Blank	Dissolved Chloride (Cl)	2015/07/09		106	%	80 - 120
4094600	MCN	Method Blank	Dissolved Chloride (Cl)	2015/07/09	ND, RDL=1.0		mg/L	
4094600	MCN	RPD	Dissolved Chloride (Cl)	2015/07/09	0.017		%	25
4094601	ARS	Matrix Spike	Dissolved Sulphate (SO4)	2015/07/09		NC	%	80 - 120
4094601	ARS	Spiked Blank	Dissolved Sulphate (SO4)	2015/07/09		100	%	80 - 120
4094601	ARS	Method Blank	Dissolved Sulphate (SO4)	2015/07/09	ND, RDL=2.0		mg/L	
4094601	ARS	RPD	Dissolved Sulphate (SO4)	2015/07/09	1.5		%	25
4094603	ARS	Matrix Spike	Reactive Silica (SiO2)	2015/07/08		97	%	80 - 120
4094603	ARS	Spiked Blank	Reactive Silica (SiO2)	2015/07/08		99	%	80 - 120
4094603	ARS	Method Blank	Reactive Silica (SiO2)	2015/07/08	ND, RDL=0.50		mg/L	
4094603	ARS	RPD	Reactive Silica (SiO2)	2015/07/08	NC		%	25
4094604	NRG	Spiked Blank	Colour	2015/07/08		104	%	80 - 120
4094604	NRG	Method Blank	Colour	2015/07/08	ND, RDL=5.0		TCU	
4094604	NRG	RPD	Colour	2015/07/08	NC		%	20
4094605	NRG	Matrix Spike	Orthophosphate (P)	2015/07/08		96	%	80 - 120

Maxxam Job #: B5C9180
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Geothermal Solutions
Site Location: GREIG SEAFARMS-MARYSTOWN

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
4094605	NRG	Spiked Blank	Orthophosphate (P)	2015/07/08		99	%	80 - 120
4094605	NRG	Method Blank	Orthophosphate (P)	2015/07/08	ND, RDL=0.010		mg/L	
4094605	NRG	RPD	Orthophosphate (P)	2015/07/08	NC		%	25
4094606	ARS	Matrix Spike	Nitrate + Nitrite	2015/07/09		97	%	80 - 120
4094606	ARS	Spiked Blank	Nitrate + Nitrite	2015/07/09		99	%	80 - 120
4094606	ARS	Method Blank	Nitrate + Nitrite	2015/07/09	ND, RDL=0.050		mg/L	
4094606	ARS	RPD	Nitrate + Nitrite	2015/07/09	NC		%	25
4094607	NRG	Matrix Spike	Nitrite (N)	2015/07/08		97	%	80 - 120
4094607	NRG	Spiked Blank	Nitrite (N)	2015/07/08		104	%	80 - 120
4094607	NRG	Method Blank	Nitrite (N)	2015/07/08	ND, RDL=0.010		mg/L	
4094607	NRG	RPD	Nitrite (N)	2015/07/08	NC		%	25
4098124	KSR	QC Standard	pH	2015/07/09		101	%	97 - 103
4098124	KSR	RPD	pH	2015/07/09	0.65		%	N/A
4098125	KSR	Spiked Blank	Conductivity	2015/07/09		106	%	80 - 120
4098125	KSR	Method Blank	Conductivity	2015/07/09	1.2, RDL=1.0		uS/cm	
4098125	KSR	RPD	Conductivity	2015/07/09	0.80		%	25
4100286	KSR	QC Standard	Turbidity	2015/07/10		94	%	80 - 120
4100286	KSR	Method Blank	Turbidity	2015/07/10	ND, RDL=0.10		NTU	
4100286	KSR	RPD	Turbidity	2015/07/10	0.34		%	25

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B5C9180
Report Date: 2015/07/10

Geothermal Solutions
Site Location: GREIG SEAFARMS-MARYSTOWN

VALIDATION SIGNATURE PAGE

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

Mike MacGillivray, Scientific Specialist (Inorganics)

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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LOCATION

LABORATORY MEDICINE REPORT
EASTERN HEALTH REGIONAL AUTHORITY
PUBLIC HEALTH LABORATORY

Name: CW,DS DRILLING SERVICES **U#:** S00000014811 **hcn:**
Acct#: LL000956/15 **Unit#:** S00000014811 **Status:** REG REF **Location:** PL-MISC
Reg: 02/07/15 **Disch:** **Age/Sex:** 1Y 00M/U **Attend Dr:** NL PUBLIC HEALTH LABORA

Pt Address: 4 HOPS STREET,CONCEPTION BAY SOUTH,NL A1W 0E8 709-781-6038
BIRTHDATE: **MAIDEN / OTHER NAME:**

Order Site: NEWFOUNDLAND PUBLIC HEALTH LAB

Specimen: 15:E0001763R **Collected:** 02/07/15-0620 **Status:** COMP **Req#:** 16569625
Received: 02/07/15-1437 **Source:** WATER PRIV **Sp Desc:** DRILLED WE
Subm Dr: NL PUBLIC HEALTH LABORATORY
Collected by: U

Ordered: PRIVATE WATER
Comments: SOURCE:MCGETTINGAN BLVD MARYSTOWN
LAB SITE: NFPHL
NL PUBLIC HEALTH LABORATORY

Procedure	Result	Site
> ENVIRONMENTAL PHL PRIVATE WAT	Final	PHL
Total Coliforms	Not Detected	
E.coli	Not Detected	

@PHL - NEWFOUNDLAND PUBLIC HEALTH LAB
100 Forest Road, St John's, NL, A1A 4E5

APPENDIX H: LIMITATIONS

LIMITATIONS

1. The work performed in this report was carried out in accordance with the Standard Terms of Conditions made part of our contract. The conclusions presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract.

2. The report was prepared in accordance with generally accepted hydrogeological study and/or engineering practices for the exclusive use of DS Drilling Services Limited. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of our contract and included in this report.

3. Third party information reviewed and used to develop the opinions and conclusions contained in this report is assumed to be complete and correct. This information was used in good faith and Amec Foster Wheeler Environment & Infrastructure does not accept any responsibility for deficiencies, misinterpretation or incompleteness of the information contained in documents prepared by third parties.

4. The services performed and outlined in this report were based, in part, upon visual observations of the site and attendant structures. Our opinion cannot be extended to portions of the site which were unavailable for direct observation, reasonably beyond our control.

5. The objective of this report was to assess hydrogeological properties at the site, within the context of our contract and existing regulations within the applicable jurisdiction. Evaluating compliance of past or future owners with applicable local, provincial and federal government laws and regulations was not included in our contract for services.

6. Our observations relating to the condition of environmental media at the site are described in this report. It should be noted that compounds or materials other than those described could be present in the site environment.

7. The findings and conclusions presented in this report are based exclusively on the field parameters measured and the chemical parameters tested at specific locations. It should be recognized that subsurface conditions between and beyond the sample locations may vary. Amec Foster Wheeler Environment & Infrastructure cannot expressly guarantee that subsurface conditions between and beyond the sample locations do not vary from the results determined at the sample locations. Notwithstanding these limitations, this report is believed to provide a reasonable representation of site conditions at the date of issue.

8. The contents of this report are based on the information collected during the monitoring and investigation activities, our understanding of the actual site conditions, and our professional opinion according to the information available at the time of preparation of this report. This report gives a professional opinion and, by consequence, no guarantee is attached to the conclusions or expert advice depicted in this report. This report does not provide a legal opinion in regards to Regulations and applicable Laws.

9. Any use of this report by a third party and any decision made based on the information contained in this report by the third party is the sole responsibility of the third party. Amec Foster Wheeler Environment & Infrastructure will not accept any responsibility for damages resulting from a decision or an action made by a third party based on the information contained in this report.

DESCRIPTION

LandGazette No. BND8JQ

October 6, 2015
Revised: December 23, 2015

All that piece or parcel of land situate and being in the Town of Marystown, in the Provincial Electoral District of Burin-Placentia West, in the Province of Newfoundland and Labrador, abutted and bounded as follows, that is to say:

Beginning at a point in the southwesterly limit of Kaetlyn Osmond Drive, twenty meters wide, the said point having grid coordinates, NAD 83, of North 5227013.799 meters and East 369775.081 meters for the Modified Three Degree Transverse Mercator Projection System for the Province of Newfoundland and Labrador;

Thence along the said southwesterly limit of Kaetlyn Osmond Drive South sixty-two degrees forty-six minutes zero zero seconds East eighty decimal six eight two meters;

Thence curving, concave to the north, along the southerly limit of Kaetlyn Osmond Drive for a distance of one hundred ninety decimal three two six meters to a point, the said point being distant one hundred seventy-nine decimal three zero two meters as measured on a bearing of North eighty-three degrees zero nine minutes twenty seconds East from the last mentioned point;

Thence along the southeasterly limit of Kaetlyn Osmond Drive North forty-nine degrees zero four minutes forty seconds East two hundred sixty-nine decimal two five nine meters;

Thence curving, concave to the southeast, along the southerly limit of Kaetlyn Osmond Drive for a distance of thirty-four decimal six six two meters to a point, the said point being distant thirty-four decimal six one three meters as measured on a bearing of North fifty-four degrees eighteen minutes fourteen seconds East from the last mentioned point;

Thence along the sinuosities of the Ordinary High Water Mark for the Waters of Mortier Bay for a distance of twenty-nine decimal two meters, more or less, to a point, the said point being distant twenty-nine decimal zero zero five meters as measured on a bearing of South twenty-six degrees thirty-seven minutes thirty-eight seconds West from the last mentioned point;

Thence through a Shoreline Reservation, fifteen meters wide, for the Waters of Mortier Bay North seventy-seven degrees zero seven minutes forty-two seconds West fifteen decimal four two three meters;

Thence along the sinuosities of the said Shoreline Reservation, fifteen meters wide, for the Waters of Mortier Bay for a distance of five hundred decimal seven meters, more or less, to a point, the said point being distant four hundred seventy-eight decimal seven nine one meters as measured on a bearing of South fourteen degrees forty-three minutes fifteen seconds West from the last mentioned point;

Thence along the sinuosities of a Shoreline Reservation, fifteen meters wide, for the Waters of Jones Brook for a distance of five hundred eleven decimal six meters, more or less, to a point, the said point being distant four hundred thirty-eight decimal seven four four meters as measured on a bearing of North seventy degrees fifty-nine minutes twenty-seven seconds West from the last mentioned point;

Thence along other land of the Town of Marystown North twenty-seven degrees fourteen minutes zero zero seconds East one hundred eighty-one decimal seven nine seven meters, more or less, to the point of beginning;

The above described piece or parcel of land being subject to a sewer system easement in favour of the Town of Marystown, the said sewer system easement being abutted and bounded as follows that is to say:

Beginning at a point in the southeasterly limit of Katelyn Osmond Drive, twenty meters wide, the said point having grid coordinates, NAD 83, of North 5227160.883 meters and East

370212.451 meters for the modified Three Degree Transverse Mercator Projection System for the Province of Newfoundland and Labrador;

Thence along the said southeasterly limit of Katelyn Osmond Drive North forty-nine degrees zero four minutes forty seconds East twelve decimal two nine nine meters;

Thence through land to be acquired by Grieg NL Nurseries Ltd. South forty degrees nineteen minutes thirty-eight seconds East eight decimal one five five meters;

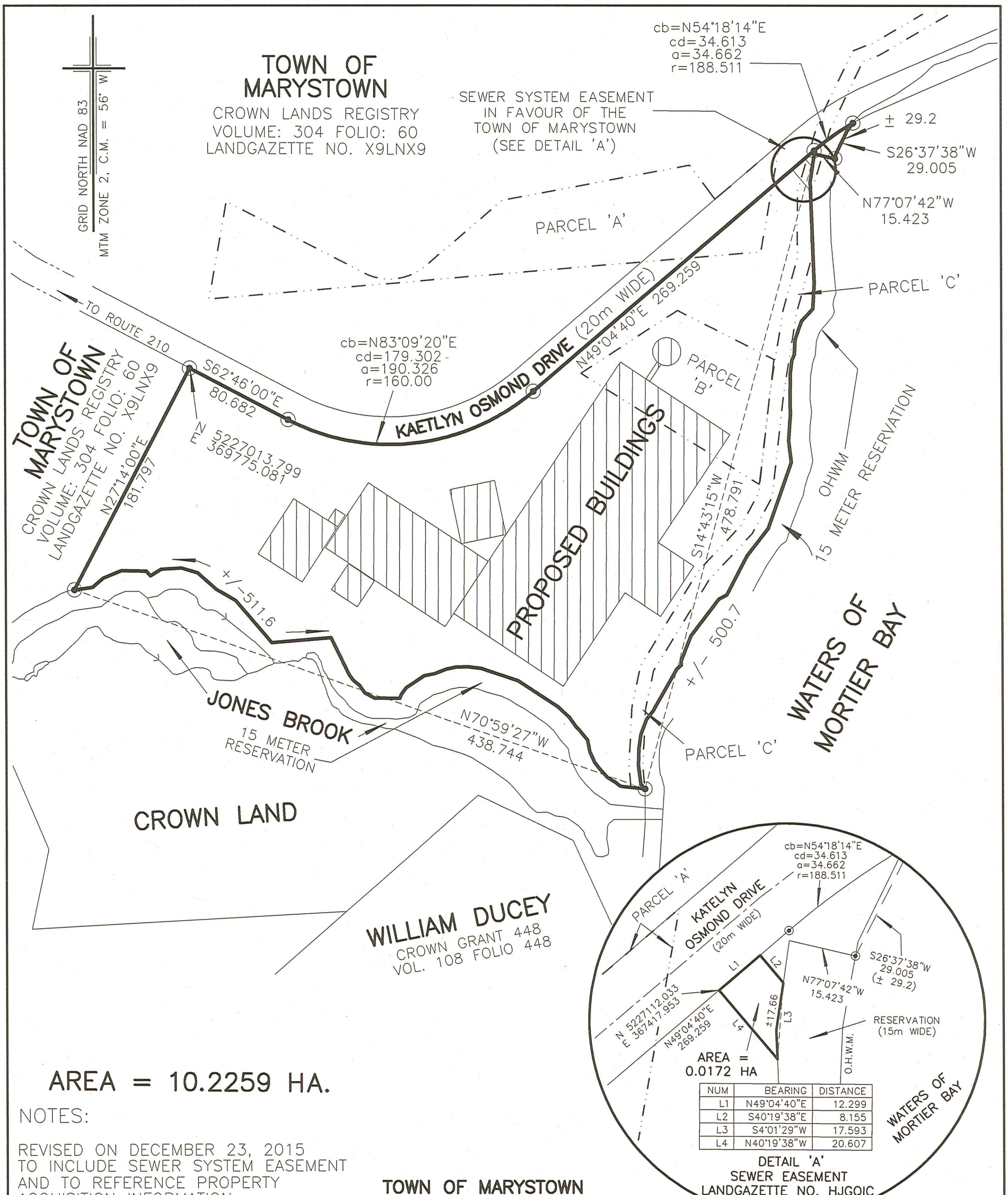
Thence along the sinuocities of a Shoreline Reservation, fifteen meters wide, for the waters of Mortier Bay, for a distance of seventeen decimal six six meters, more or less, to a point, the said point being distant seventeen decimal five nine three meters as measured on a bearing of South four degrees zero one minutes twenty-nine seconds West from the last mentioned point;

Thence through said land to be acquired by Grieg NL Nurseries Ltd. North forty degrees nineteen minutes thirty-eight seconds West twenty decimal six zero seven meters, more or less to the point of beginning;

The above described piece or parcel of land containing an area of ten decimal two two five nine hectares, more or less, and being more particularly shown and delineated on the attached plan;

All bearings being referred to the central meridian of fifty-six degrees west longitude, zone two, of the above mentioned projection system.

IAN G. EDWARDS
NEWFOUNDLAND SURVEYOR
PROVINCE OF NEWFOUNDLAND
Dec 23/15



AREA = 10.2259 HA.

NOTES:

REVISED ON DECEMBER 23, 2015 TO INCLUDE SEWER SYSTEM EASEMENT AND TO REFERENCE PROPERTY ACQUISITION INFORMATION.

ALL DISTANCES ARE METRIC

—x— FENCE
⊙ CAPPED IRON BAR
Fd. EXISTING IRON BAR
○ IRON BAR

TOWN OF MARYSTOWN
PROPERTY ACQUISITION INFORMATION

PARCEL 'A' : EXPROPRIATION: REGISTRATION NO. 579082 (PAULA MANNING)
PARCEL 'B' : EXPROPRIATION: REGISTRATION NO. 465047 (ARTHUR FITZPATRICK AND THOMAS REID)
PARCEL 'C' : CONVEYANCE REGISTRATION NO. TW TRIM CAN/2015/0308 (GOVERNMENT OF NEWFOUNDLAND AND LABRADOR)

CROWN GRANT NO. 49260

COORDINATE TABLE
NAD 83 CONTROL SURVEY DATABASE

STATION	NORTHING	EASTING
94G4024	5 227 954.878	370 555.221
94G4023	5 228 267.825	370 469.913

SCALE FACTOR 0.999949

IAN G. EDWARDS NEWFOUNDLAND SURVEYOR PROVINCE OF NEWFOUNDLAND
Dec 23/15

EDWARDS AND ASSOCIATES LTD.
LAND SURVEYING, ENGINEERING, CONSULTING, INFORMATION MANAGEMENT
BOX 158, MARYSTOWN, NF, AOE 2MO, TEL 709-279-1990, FAX 709-279-2185

PROPERTY SURVEY
LAND TO BE ACQUIRED BY *GRIEG NL NURSERIES LTD.*
FROM LAND OF THE *TOWN OF MARYSTOWN*
MARYSTOWN, NEWFOUNDLAND AND LABRADOR

SCALE: 1:4000	LANDGAZETTE # BND8JQ	SURVEY BY: I.E./R.B.
DATE: OCTOBER 6, 2015	JOB NO. 6297	

Stage 1 Historic Resources Impact Assessment
of the
Mortier Bay -North Atlantic Marine Service Center,
Powers Cove, NL.

Report prepared for: Town of Marystown, NL
Report prepared by: Aardvark Archaeology Ltd.
Date: October14, 2005

Signed: Stephen Mills

HRIA Archaeological Permit Number 05.53

1. Credit Sheet

The HRIA of the Mortier Bay -North Atlantic Marine Service Center and right-of-way between Route 210 and Powers Cove, NL. was conducted and reported upon by Mr. Stephen Mills and Dr. James A. Tuck. Ms. Jackie McDonald was the project conservator. The authors wish to acknowledge the assistance provided by Barry Gaulton for scanning some of the images; Mr. Ken Reynolds of the Provincial Archaeology Office for provided copies of the relevant archaeological reports and maps; and Mr. Dennis Kelly, Town Manager for Marystown for providing assistance while in the field. Thanks also to Mr. James Kelly and Mrs. Ernistine Kelly for sharing their recollections of Powers Cove.

2. Management Summary

The HRIA of the area proposed for the Mortier Bay -North Atlantic Marine Service Center and right-of-way between Route 210 and Powers Cove was conducted in September 2005. Historical research, informant interviews and archaeological survey failed to uncover significant cultural resources within the impact area. The right-of-way traverses a route that does not lend itself to settlement, or even sporadic habitation. Other than a 150m long expanse of cobble beach, the area within Powers Cove is open to the sea and doesn't appear to provide protection from the north, south and easterly winds. The area to the rear of the barrier beach at the front of the cove is primarily low-lying, marshy and, no doubt, susceptible to inundation from heavy seas. The ground surrounding the north and south approaches to the cove consists of near vertical cliff faces ranging from three to fifteen or more metres in height. The lack of protection from the elements, together with the wet, marshy environment of the cove itself were probably primary factors in the lack of human settlement or even resource exploitation of this part of Mortier Bay.

The HRIA did not uncover any reasons to delay construction of the Mortier Bay - North Atlantic Marine Service Center in Powers Cove and the construction of an access route to the cove from Route 210.

Table of Contents

3. List of Figures

4. Introductory Statement

Powers Cove is located on the west side of Mortier Bay, near the southwest tip of Placentia Bay. It lies within the town boundaries of Marystown (Figures 1 and 2). The Town of Marystown, proponent for the Mortier Bay -North Atlantic Marine Service Center in Powers Cove, contracted Aardvark Archaeology Ltd. to conduct the Stage 1 Historic Resources Impact Assessment of the project. The development would see construction of a 305m long wharf facility at Powers Cove, capable of servicing oil rigs and offshore supply ships, and a 1.2 km long assess road from Route 210 and Powers Cove (Figures 3 to 4). The width of the right-of-way for the access road is approximately 50m wide. The impact area at the north end of the cove, adjacent to the proposed wharf is approximately 45m square.

The objectives and general scope of the HRIA were to research the cultural history of Powers Cove through archival and archaeological survey to determine whether the North Atlantic Marine Service Center would negatively impact cultural resources in the area.

Dr. James Tuck and Mr. Stephen Mills conducted the HRIA. Dr. Tuck holds a PhD in archaeology, has over 40 years experience in the profession and has directed major archaeological projects within Newfoundland and Labrador, in mainland Canada and the United States. Dr. Tuck was the Head of the Archaeology Unit at Memorial University from 1968 to 2005 and is currently Professor Emeritus at Memorial. Mr. Mills holds a M.A. in archaeology and has 28 years experience in the archaeological profession. He has directed archaeological projects in Newfoundland and Labrador, Quebec and Ontario.

The preliminary background research was carried out between September 22nd and 23rd, field reconnaissance was conducted on September 24th and the historical review, informant interviews and report writing carried out between September 26th and 27th, 2005.

The organization follows the guidelines set out by the Provincial Archaeology Office.

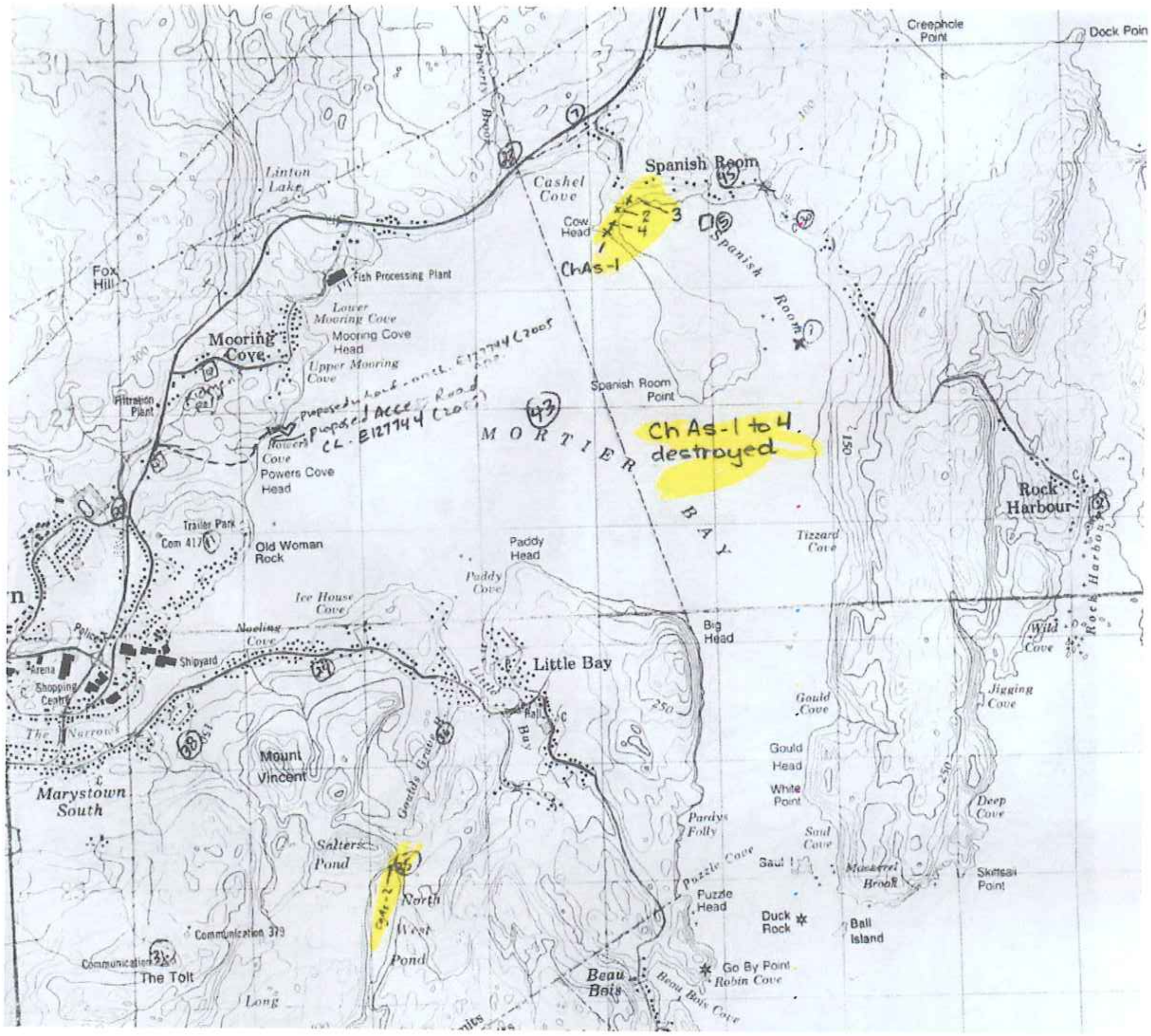


Figure 1 *Map of Mortier Bay showing Powers Cover (at left) with broken line showing the right-of-way between Route 210 and Powers Cove. Map courtesy of Ken Reynolds, Provincial Archaeology Office.*

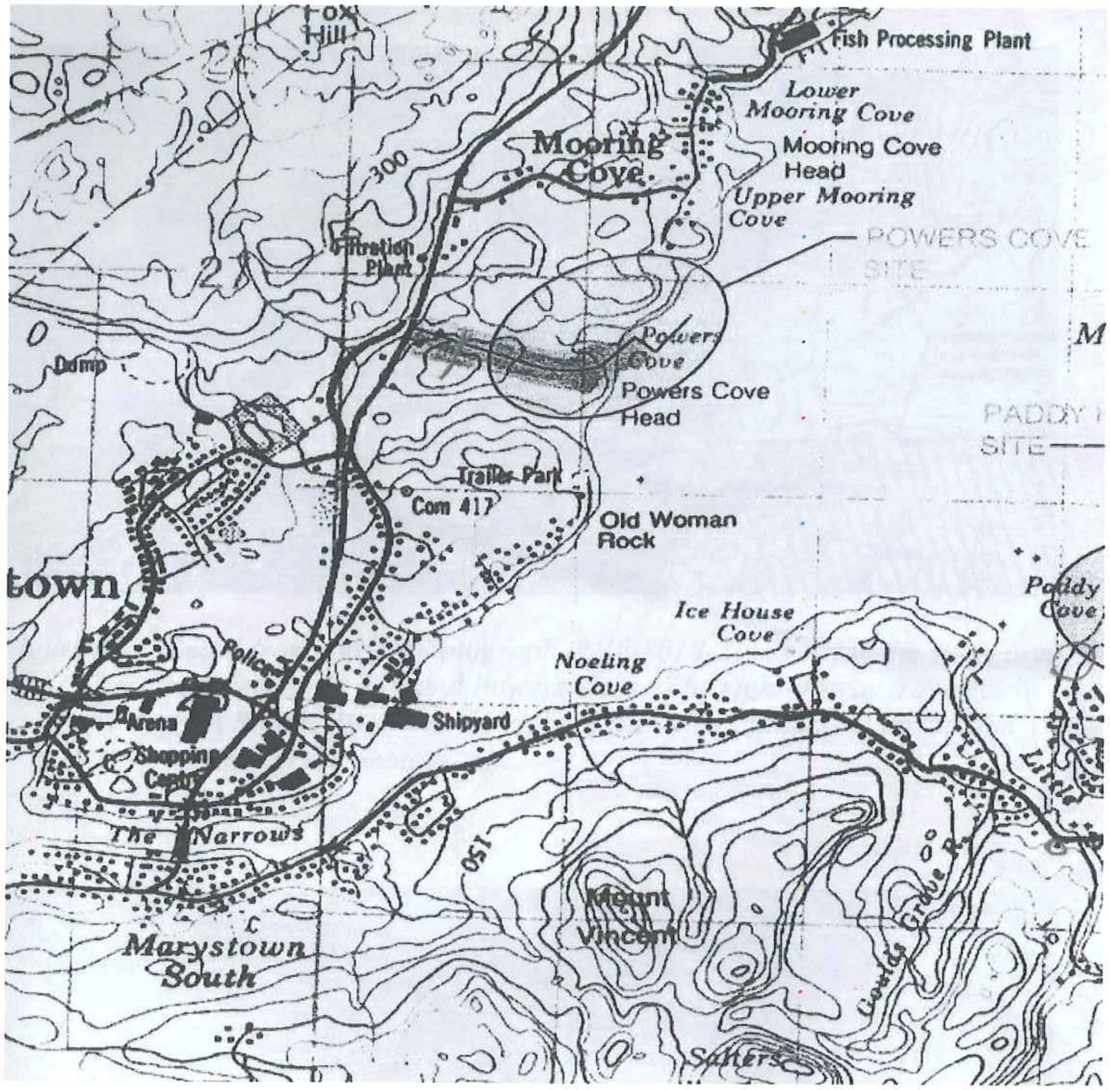


Figure 2 *Detail of the west side of Mortier Bay showing the Powers Cove Site (inside circle) with the study area shaded. Map courtesy of the Town of Marystown.*

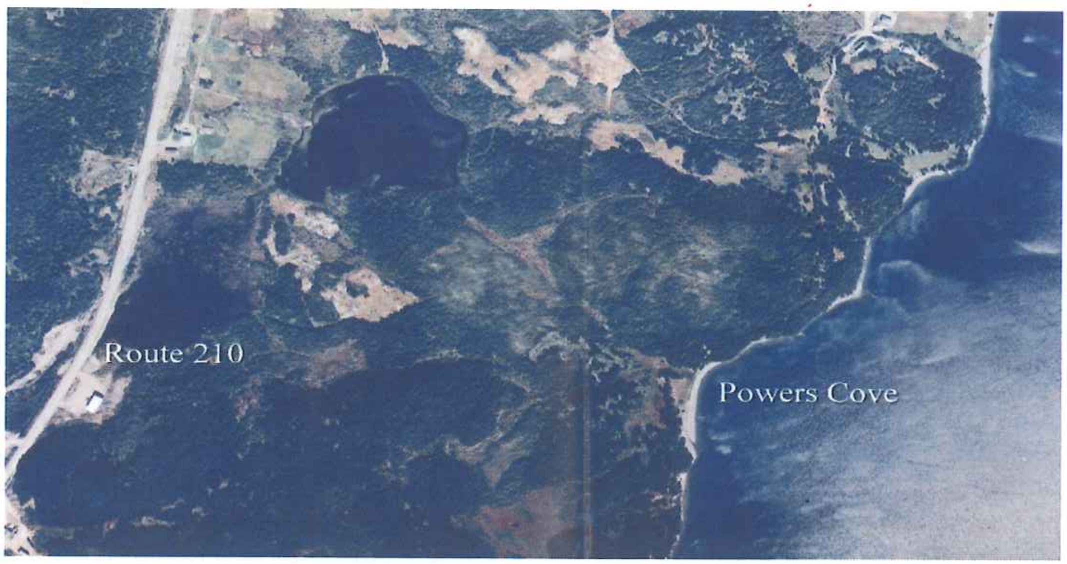


Figure 3 *Detail from Aerial photograph (#NF 8018-21) showing the study area between Route 210 and Powers Cove. The right-of-way traverses in from Route 210 just to the right of the white building at the bottom left side of the photograph.*

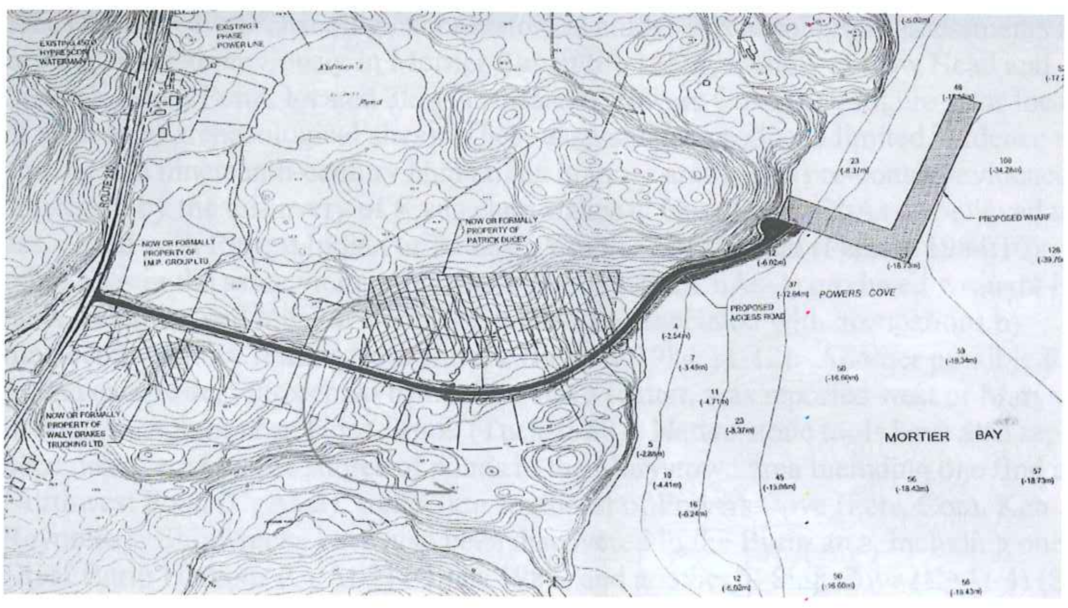


Figure 4 *Topographic map of Powers Cove showing the study area in heavy black line. Map courtesy of the Town of Marystown.*

5. Proposed Development Project

The proposed Mortier Bay -North Atlantic Marine Service Center in Powers Cove is designed to service ships and other offshore oil-related vessels through the construction of a wharf facility accessed by a new road between Route 210 and Powers Cove.

6. Study Area

The study area included the 1.2 km by 50m right-of-way between Route 210 and Powers Cove and the area within Powers Cove from the high water mark back approximately 45m back from the beach (Figures 3 and 4). Figures 5-9 show various views of the right-of-way and Powers Cove taken during the assessment.

7. Methodology

Prior to conducting the field survey, a review of maps, aerial photographs, historical references and archaeological reports was undertaken. Following the literature and cartographic review, the entire study area was traversed on foot. Tree falls were inspected for signs of cultural activity and test pits were judgementally dug along the right-of-way and within Powers Cove.

8. Results

8.1 Archival Search

The literature and cartographic review indicated that Powers Cove has never been the focus of intensive archaeological or historical study. Archaeological assessments have been conducted previously in Mortier Bay in the 1980s, namely at Cow Head and Spanish Room Point, located 3km northeast of Powers Cove (See Figure 1 for locations of registered archaeological sites). These assessments produced limited evidence of pre-contact and nineteenth-century habitations in those areas. The pre-contact evidence was suggested by the discovery of seven chert flakes at Cow Head (ChAs-1) believed to be associated with Recent Indian or Paleo-Eskimo use of the area (Penney 1984:10). Three other sites in the same vicinity (ChAs-2, ChAs-3 and ChAs-4) produced wrought iron nails, ceramics and other artifacts believed to be associated with occupations by nineteenth-century settlers from Europe (Penney 1984:11-12). Another possible Recent Indian camp site, represented by a minor flake scatter, was reported west of Marystown in southwest Arm near Tides Brook (Tuck 1988). Native stone tools have also reportedly been discovered on the shores of ponds in the Marystown area including one find at Northwest Pond (CgAs-2), some 3km southeast of Powers Cove (Pers. Com. Ken Reynolds). Shipwrecks have also been discovered in the Burin area, including one at Great Burin Harbour (CgAt-2) (Ginns 1983) and another at Ship Cove (CgAt-4) (Skanes 1999).

In 1985, Gerald Penney prepared an evaluation of historical resources for this part of Placentia Bay. Penney reported that, although fishers visited the area from southern Europe since the sixteenth century, it was not until the nineteenth century that Irish families settled in Mortier Bay (Penney 1985). Using various census documents and other sources, from 1836 onwards, Penney was able to trace a gradual settlement of the area to the late-twentieth century. Importantly, for this study, Penney did not uncover any documents relating to settlement in Powers Cove.

8.2 Informant Interviews

The current HRIA included interviews with two residents of nearby Mooring Cove: Mr. James Kelly (age 83) and his wife, Mrs. Ernistine Kelly (age 73). Mrs. Kelly was familiar with the study area, but referred to her husband as the one who knew more about the cove than most people. Mr. James Kelly has known Powers Cove since he was a child growing up in Mooring Cove in the 1920s. He walked through Powers Cove to attend school in Marystown for years beginning in 1929. When asked whether anyone lived there, Mr. Kelly recalled that there were no houses in the cove, but some families, including the Flahertys, kept cattle in meadows located some distance behind the cove, towards Route 210. Regarding any activities in the area, the Kellys both recalled that people only went to the area to pick berries and cut wood. Mr. Kelly added that wood-cutting ceased in the area "about 20 years ago". When asked why the cove was not used in his lifetime, he responded that it was never suitable for either fishing or habitation owing to its deep water and the lack of protection from winds. He also noted that when storms hit the area, the sea would wash over the low barrier beach where the "road" passed through the cove. Today, this "road" is a footpath not more than a few metres wide.

8.3 Archaeological Survey

The survey and test pitting within the study area failed to uncover evidence of any cultural activity in the study area older than recent times. Two fire pits, containing melted beer cans and other modern refuse were noted in Powers Cove. Five upright posts were located within a few metres of one of these fire pits. It appears that these posts were associated with a modern structure, perhaps some sort of tilt or other impermanent building. Test pits around these posts did not produce artifacts. The only artifact noted in over 40 test pits dug in Powers Cove was a 410-caliber shotgun shell from the sod layer. It was not retrieved.

Figure 5 *Typical section through the right-of-way, looking west. The water in the foreground is just behind the barrier beach in Powers Cove.*

Figure 6 *The beach at Powers Cove looking north.*

Figure 7 The beach at Powers Cove looking south.

Figure 8 Test pitting on a terrace at the north end of Powers Cove

Figure 9 *Test pitting along the right-of-way, Powers Cove in the background.*

9. Evaluation and Discussion

Previous archaeological assessments and minor discoveries in the Mortier Bay area indicated minor evidence of pre-contact occupation of the bay; however, rising sea levels in this part of the province may have inundated sites from ancient occupations along the shores. Historical documentation fails to mention any specific references to Powers Cove. It appears that people choosing to settle the bay preferred coves with better anchorage and more protection from the winds than Powers Cove could offer. Mooring Cove and Marystown are less than a kilometre from Powers Cove and both these places were chosen for settlement.

The absence of settlement in the Powers Cove study area, as suggested from the informant's interviews, is corroborated by a lack of historic or pre-contact cultural resources from the archaeological survey. It is speculated that the reasons for this relate to the wet, low-lying nature of the ground in the cove and most importantly, the lack of protection from the elements. Although the aerial photographs of the area, taken in the early 1980s, show what appears to be a grassy area behind the barrier beach, upon investigation, this area turned out to be wet and swampy and therefore uninhabitable. The 1-1.5m high barrier beach surrounding the lowest part of the cove appeared to be no match for heavy seas. This observation was confirmed by one of the informant's recollections of the seas frequently washing over the barrier during big storms. Similarly, the study area bounded by the right-of-way between Route 210 and Powers Cove is a combination of rocky, hilly and wet terrain that is also not conducive to settlement.

10. Recommendations

It is recommended that the development of the Mortier Bay -North Atlantic Marine Service Center in Powers Cove proceed. It should be noted that, as the archaeological survey did not involve a total excavation of the study area, there is always a possibility that evidence of past cultural activity could be uncovered. Should the construction activity uncover artifacts or archaeological features, the Provincial Archaeological Office should be notified immediately.

11. References Cited

Ginns, J. 1983 Newfoundland and Labrador Archaeological Site Record Form for CgAt-2, Great Burin Harbour. On file at the Provincial Archaeology Office, Department of Tourism Recreation and Culture, St. John's, NL.

Penney, G. 1984 Cow Head/Spanish room Oil Rig Repair Facility Historic Resources Impact Assessment. On file at the Provincial Archaeology Office, Department of Tourism Recreation and Culture, St. John's, NL.

1985 Placentia Bay Environmental Impact Study Evaluation of Historic Resources. On file at the Provincial Archaeology Office, Department of Tourism Recreation and Culture, St. John's, NL.

Skanes, R. 1999 Newfoundland and Labrador Archaeological Site Record Form for CgAt-4, Ship Cove Wreck. On file at the Provincial Archaeology Office, Department of Tourism Recreation and Culture, St. John's, NL.

Tuck, J. 1988 Newfoundland and Labrador Archaeological Site Record Form for CgAt-1, South East Arm. On file at the Provincial Archaeology Office, Department of Tourism Recreation and Culture, St. John's, NL.

Proposal for Establishing an Atlantic Salmon Smolt Production Facility for Grieg Nurseries NL Ltd.

Aqua Maof Group / June 2015

Table of Contents

Project Description

Introduction

AquaMaof Aquaculture Technologies is pleased to submit this proposal for the development of a salmon hatchery, smoltification, and Atlantic salmon smolt growing facility. The proposal is based upon general discussions on requirements for Grieg Nurseries NL project development. AquaMaof is providing a full facility design that will enable production of 7 million smolt per year on a production schedule that results in 300 gram smolt and large size smolt at 1.4 to 1.8 kg (Table 1). The 300 gram smolt will be produced on a schedule to enable harvest of market fish from the cage systems every month of the year. The large 1.4 kg smolt will enable harvest of market salmon after one summer of growth in the sea cages, significantly reducing the production risk of winter months at sea. The 1 million 1.4 kg smolt in November are smolt held in the land based growing system primarily to enable continuous operation of the RAS.

Table 1. Facility annual smolt production schedule in 1000's.

Smolt size	April	May	June	July	October	November
300 grams	1,000	1,000	1,000	1,000		
1.0 kgs					1,000	
1.5 kgs	500					1,000
1.8 kgs		500				

The project is divided into three stages of production: the hatchery from egg through first feeding, the smoltification from approximately 2.5 grams to 50 gram smolt, and nursery growing from 50 grams to 300 grams or 1.5 kg. The total facility is designed for low water use and optimum use of electrical energy resulting in a low total cost of production.

Hatchery

Description and General Specifications

The hatchery capacity is designed to hold 2 monthly batches of salmon eggs. The batches resulting in 300 gram smolt in April, May and June are each 1 million and the smolt batch for July is 3 million.

Therefore the hatchery capacity required is 4 million. Each batch of 1 million eggs requires 3 units of Alvestad CompHatch 8-level systems (Table 2). The hatchery includes 4-1 million egg hatching systems for a total of 12 CompHatch units. Each of the 1 million egg systems has an AquaMaof water treatment system for two first-feeding tanks. The first-feeding tanks have a separate AquaMaof water treatment system described below.

Table 2. Alvestad CompHatch specifications.

CompHatch	
Capacity	360,000 roe / unit
Liters of water / minute	0.8 liter / liter roe
Water exchanges / hour	7 to 12
Outer measurements	Height 1750 mm, length 1650 mm, depth 800 mm
Material	Aluminum and plastic
Option	Light proof cover

Water circulated through the CompHatch trays will flow into Alvestad Kube Hatch treatment systems and recirculated through the trays. The hatchery will use 2 Kube hatch units to supply water treatment for 12 CompHatch units (see Figure 1). Water temperature is maintained at the proper set points from 8 C to 12 C with a heat exchanger. Specifications for the Kube hatch systems are listed in Table 3.

Table 3. Alvestad Kube hatch specifications.

Kube Hatch 8000	
Capacity	7 CompHatch units
Bioreactor	800 liters / min
Foam fractionator	800 liters / min
Hydrotech HT801	30 micron mesh
UV	40 mJ/cm2
Heating and cooling	8-12 C
Degassing	vacuum

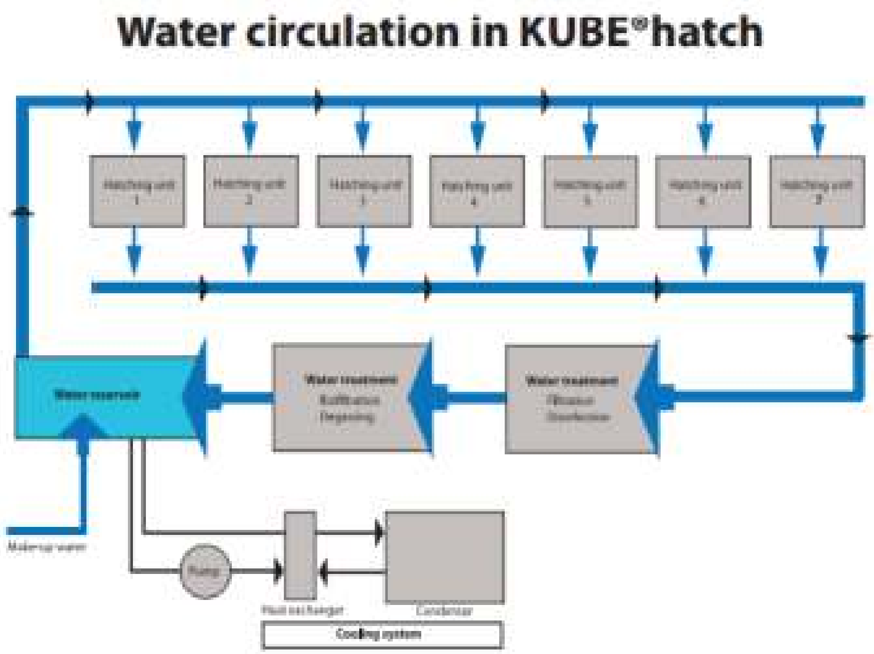


Figure 1. Diagram of water-flow through the hatching water treatment system (source Alvestad)

The first-feeding tanks are an AquaMaof 8 tank module with separate water treatment systems for each 2 tanks. The AquaMaof tank module is comprised of the fish tank, solids separation settler, biofilter, pumping sump, and ODS (oxygen dissolving system) (Table 4). There are also openings in each tank into the harvest channel. This channel is used to move fry by swimming from the fish tanks to the area adjacent to the fish transfer tank. Fry are then transferred by net from the harvest channel into the fish transfer tank. The fish transfer tank is filled with nursery system water and when a batch of fry are moved into the nursery the water and fish are then transferred by gravity flow from the hatchery transfer tank into the nursery. The fish transfer tank will be in a separate room from the hatchery production system to aid in maintaining biosecurity between the hatchery and nursery systems.

Table 4. Specifications of the tank system for each 1 million hatching unit.

Component	Size	Number
Water circulation pumps	75 m3/hour	2
Tank water exchange	26.5 minutes	
AquaMaof solids settler	10 m x 3.8 m	1
Biofilter	10 m x 3.4 m x 3 m	1
Daily feed capacity	70 kg	
Tanks	6.4m x 1.0m	2
AquaMaof ODS	75 m3/hr x 5m depth	2
Harvest channel	1m x 10m	1
Water temperature control	8 to 12 C	central heat pump

Process Concept Review

The hatchery system is designed for water recirculation rather than flow through, therefore requires high quality water treatment. The hatching trays are standard Alvestad CompHatch systems integrated with the Alvestad Kube hatch treatment system used in the salmon industry. The water circulation rate is as suggested for this hatching system.

The first-feeding tank system is designed with 2 tanks for each egg hatching unit. This system is temperature controlled ranging from 8 to 12 C and has the capability to feed 70 kg/day to the 1 million batch of fry at an average weight of 2.5 grams. This system includes the solids settlers (Brentwood ACCU-PAC IFR 6036-36 inches of depth), trickling biofilter (also for degassing), oxygen dissolving systems, and pumps. The trickling biofilter (Brentwood ACCU-PAC CF 1200 crossflow media) has been selected to provide the highest level of degassing without vacuum and this combined with the water circulation rate will result in carbon dioxide concentrations less than 10 mg/liter in the fish tanks. There is also a harvest channel for moving fish by swimming from each tank to the fish transfer tank. Fry are netted from the harvest channel into the transfer tank to avoid moving hatchery water into the nursery. The transfer tank is filled with water from the nursery and then water and fish are gravity flowed from the hatchery into the nursery.

The hatchery building will be placed at an elevation on the property to allow for gravity movement of fish and water from the hatchery to the nursery. The building will be a steel framed insulated building (Table 5).

Table 5. Specifications for the hatchery building

Component	Size	Number
Dimensions	36 m x 43 m	
Building height	6 m	
Office space	10 m2	1
Biosecure entrance / restroom	20 m2	1
Conference / break room	15 m2	1
HVAC	14 C production	

Nursery

The nursery is designed to grow each of the 5 batches of smolt to 50 grams completing smoltification and vaccination. The total growth time will be 4 months, therefore four batches of smolt at various stages can be grown in the facility at one time.

Description and General Specifications

The nursery has 2 production modules with 11 large tanks and 4 small tanks (Table 7). Batches of 1 million fry will be stocked from the hatchery into the nursery in November, December, and January of each year followed by a 3 million batch in February. Then the last batch of 1 million fry will be stocked in July. This last batch will be sent to the land-based smolt growing facility in October. These smolt will then be 1.3 kg in April and 1.8 kg in May for stocking into sea cages. These smolt will then reach harvest size with only one summer and fall in the sea cages.

Each nursery tank will have tent type covers and lighted individually to control smoltification. The lighting system will be installed at multiple water depths around the circumference of the tank walls to provide uniform light throughout each tank preventing shadows. These lights have the capability to simulate natural daylight including dusk and dawn gradual reductions and increases in light intensity.

Table 7. Specifications for the smolt nursery facility.

Component	Size	Number
Water circulation pumps	1053 m3/hour	4
Pump for fish transfer tank	175 m3/hour	2
Tank water exchange	24 minutes	
AquaMaof solids settler	12 m x 33 m	2
Biofilter and gas stripping	1620 m3 x 6 m depth	2
Carbon dioxide maximum	15 mg/liter free CO2	
Daily feed capacity	3032 kg	
Maximum fish density	100 kg/m3	
Tanks, large	10 m dia. x 1.8 m depth	11
Tanks, small	5 m dia. x 1.8 m depth	4
AquaMaof ODS	350 m3/hr x 15 m depth	12
AquaMaof ODS	88 m3/hr x 15 m depth	4
Harvest channel	1 m wide x 66 m long	1
Fish transfer tank	10 m dia. x 1.8 m depth	1
Denitrification / water reuse	20 m3/hour	1
Sludge discharge, 20% solids	0.25 m3/day	
Water discharge, fish tank water	25 liters/min annual average	
Water temperature control	8 to 12 C	central

The process flow diagram is shown in Figure 2. This shows the water recirculation for 4210 m3/hour and 20 m3/hour through the water reuse and denitrification treatment process. This represents 99.5% recirculation with 0.5% sent through the waste treatment process and returned to the fish production system. The alkalinity adjustment buffer system will be used primarily during startup phases. Once the total treatment system stabilizes most alkalinity will be returned to the system through the bacterial processes in the solids settler and the denitrification system.

The AquaMaof aquaculture recirculation system includes several design concepts that are duplicate systems and some used only for emergencies. A summary the characteristics of the AquaMaof design includes:

1. The total system is divided into independent production modules, should there be a catastrophic factor that disables a single module then all other modules will remain in full operation.
    a. Multiple and independent fish production modules
    b. Fish transfer channel to quickly move fish between modules
2. The water circulation system is installed in duplicate. Many designs have multiple pumps, however piping can fail and few have duplicate water circulation systems.

   a. Duplicate water pumps
   b. Duplicate circulation piping systems
   c. Duplicate valves
3. The oxygenation system has several points of duplication.
   a. The main oxygenation is through the ODS with backup oxygen diffusers in each fish production tank
   b. The oxygen pipe delivery system is duplicated, the main oxygen supply and the emergency supply. Either pipe system can be used for regular or emergency oxygen supply changing with control valves.
   c. The main oxygen supply is from an oxygen generator with liquid oxygen tank backup for when the oxygen generator is offline for maintenance or there is a disruption in the electrical supply. There are duplicate liquid oxygen tanks as backup for each other in the event of disrupted plumbing failure on one.
4. Electricity supply.
   a. The main electric supply has a diesel or natural gas stand-by electric generation system that automatically starts with any disruption to the public electric supply.
   b. The electric transformers are duplicated such that the duplicated water pumps are on separate electric transformers.
5. Should total electric supply disruption occur (both the main public supply and internal backup supply) all electrically supplied water circulation will then be disrupted. The following tertiary non-mechanical systems will engage. This mode of operation can be maintained as long as sufficient liquid oxygen can be supplied. Two LOX tanks with 25 tons of oxygen is sufficient for 5 hours of operation. In this emergency mode all feeding is stopped.
   a. Emergency oxygen diffusers will automatically operate in each fish production tank.
   b. The AquaMaof ODS units will automatically go into reverse flow mode and using the main oxygen supply as an air lift to circulate water and strip CO2 within each fish production tank.
6. There are 3 solid waste settlers for each fish production module. Any one of these settlers can be removed from operation and the module will continue to function normally.
7. There is 1 large CIFT biofilter for each module, overcapacity in the CIFT biofilter is such that it can operate in sections and continue to function normally with any selected portion out of service.
8. Should there be a disruption to all three settlers of a module or a full disruption of the CIFT biofilter there is a water by-pass that enables the recirculation system and oxygenation system to continue operation. This can also be used should fish treatments be necessary that could damage the biological community of the biofilter and water by-pass is necessary.
9. Overcapacity is built into the modules such that should it be necessary to remove one complete module from operation, water can then be by-passed to the two remaining modules and the overall system will continue to function normally during all months except February, March, April, and May. During these months of high fish biomass feed quantities will need to be reduced to enable safe operation.

The nursery building will be constructed downgrade from the hatchery building and will be an insulated steel-frame building (Table 8). Smolt will be transferred from the nursery to the land based smolt growing facility by gravity flow from the nursery fish transfer tank. The nursery fish transfer tank is located in a separate room of the nursery facility and smolt are transferred into the transfer through a dewatering grate that returns nursery water back to the nursery. The fish transfer tank is filled with land based facility water.

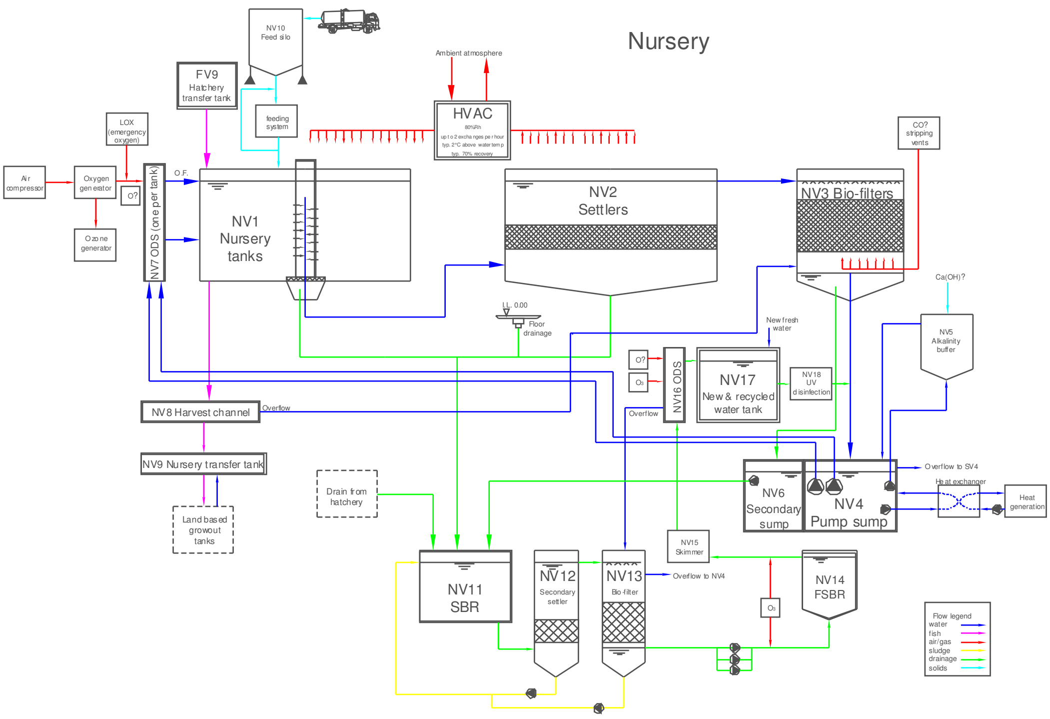


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Figure 2. Process flow for Nursery & Smolt.

Table 8. Specifications for the nursery building.

Dimensions	56 m x 80 m	1
Building height	6 m	
Office space	10 m2	2
Biosecure entrance / restroom	20 m2	1
Conference / break room	15 m2	1
HVAC	14 C production	

Process Concept Review

The proposed system design is AquaMaof's standard design adapted for salmon smolt production which includes the recirculation pump, ODS, fish production tank, solids settler, controlled intermittent flow trickling (CIFT) biofilter (which includes CO_2 gas stripping), and harvest channel. Smolt growth will require 4 months from 2.5 grams to 50 grams. After 2 months of growth the fish will be redistributed in the tanks to maintain less than 81 kg/m3 fish biomass for this first 2 months of smolt growth.

The water circulation system is designed for a single pumping step to complete the recirculation. These pumps are submerged vertical turbine type pumps. These pumps provide high efficiency pumping (80% or greater) at 9.4 meters of head. The recirculated water flows from the pump into the ODS (oxygen dissolving system).

The ODS is designed to provide high dissolved oxygen concentration with a small amount of pumped head pressure (about 0.3 m head pressure). Improved dissolving of oxygen can be attained with the following methods: 1) increase of water pressure where oxygen bubbles are dispersed; 2) increase of residence time of oxygen bubbles in the water; 3) oxygen gas bubble size, smaller bubbles result in more gas to water surface area; and 4) water temperature, colder water results in higher oxygen concentrations at 100% saturation and warmer water results in faster dissolving rate. The ODS obtains the increased pressure with the column of water and injection of the oxygen gas near the bottom of the column, thereby attaining higher water pressure without costly pumping. The residence time for allowing the oxygen bubbles to dissolve is attained in the ODS by creating a flow of water counter to the flow of oxygen bubbles. The AquaMaof ODS allows for low head requirement for dissolving oxygen and attaining oxygen concentrations sufficient to eliminate oxygen concentration as a limiting factor in design of water flow volume. This ODS design has capability to attain oxygen concentrations up to 40 mg/liter, which is an over design safety factor to assure oxygen will never be a limiting factor for the fish and capability to maintain above 90% saturation at all times.

Oxygenated water flows from the ODS directly into the fish production tank with the water added tangentially at the outer edge of the tank at a slight downward angle which creates circular water flow in the tank and distributes water from near the surface to the tank floor. Circulated water flow leaves the tank from the drain stand-pipe at the center of the tank. The stand-pipe is perforated starting 30 cm from the tank bottom to the normal operating water level. This reduces the potential for any full blockage or plugging of the exit screen.

The fish tank is the first step in solids removal. The tank acts as a clarifier and has a drain trap around and below the central drain pipe. This sediment trap collects settled solids that are moved towards the center of the tank bottom by the circular water flow in the tank. This sediment trap is not a continuous flow but is drained 1-2 times per day significantly reducing the amount of water sent out with the settled solids. The settled solids and water in the trap are sent directly to the water re-use treatment and is not part of the recirculation water flow. The main recirculation water flows into the tank main drain pipe and directly into the solid waste settler distribution channel via gravity with minimal turbulence or bends in the pipe.

The second step in the solids removal process is the solids settler with a design concept adapted from the potable water industry used for removal of fine particulates. The settling basin is rectangular with the floor sloped to a center drain. Water is evenly distributed across the basin approximately 0.5 m above the floor from the distribution channel with pipes. A large portion of the solids settle on the floor of the basin and water flows upward through the tube settler media (Brentwood ACCU-PAC IFR 6036) and into water collection launderers and by gravity is distributed through the spray nozzles of the CIFT biofilter. Solid waste accumulated in the settler basin and on the settler media is periodically drained and washed from the media and basin into the discharge waste treatment. The exact schedule depends upon solid waste loading and can range from once every 4 days to once every 10 days.

There are several advantages of this solids removal process compared to other methods. First there are no continuously moving parts that need maintenance or replacement. Second, this method has capability to remove very fine particles compared to mechanical screen methods which tend to increase the amount of fine particles. Third, this process will result in denitrification when managed on a proper draining schedule. The schedule for cleaning is adjusted after several months of operation to allow for stabilizing the denitrification process. The schedule will have longer intervals between cleaning in the early phase of operation then a regular schedule will be established which is in the range of 1 time per week.

The CIFT biofilter is the next step in the water recycle process. This is a trickling filter adapted for stripping carbon dioxide from the water and using a controlled and intermittent water flow over the media. The depth of media (Brentwood ACCU-PAC CF 1200) is 6 meters to provide maximum nitrification (removal of ammonia) with a single pass of water flow. This depth also allows for movement of carbon dioxide bound in the alkalinity buffer to free CO_2 as the carbon dioxide concentration is reduced in the water with counter flowing air. With this method we can strip more mg/liter CO_2 from the water than exists as free CO_2 in the fish tanks. The hydraulic loading across the entire biofilter for CO2 stripping is 7.8 m3/hour/m2, an order of magnitude less than hydraulic loadings typically used in CO2 stripping by other companies.

The hydraulic loading on the trickling filter is designed for the optimum wetting of all surfaces of the biofilter media (14.6 m3/hour/m2). This loading is intermittent to obtain additional treatment advantages. The use of air circulation through the biofilter from bottom to top of the media provides all required oxygen for the bacterial processes and leaves the biofilter at near 100% oxygen saturation. This ebm-papst axial flow fan provides air flow of 10 times more air volume than water flow volume. The air flow is counter current to the water with air entering the base of the CIFT biofilter and water entering through the spray nozzles at the top. The CIFT biofilter can also be used for water temperature control when outside air temperature and humidity are appropriate during many months of the year. If the culture water needs to be increased and outside air temperature is higher than the water temperature then outside air is used to supply the air fan. Also when outside humidity is low the trickling filter acts as a cooling tower. Because the facility has low water exchange rate the normal requirement for temperature control in the system water is cooling. This use for the CIFT biofilter reduces the electrical energy required for cooling fish water. Advantages for the CIFT biofilter are:

1. Water temperature increase or decrease depending upon a controlled source of air flow, inside building air or outside air. The CIFT biofilter can effectively be used as a cooling tower.
2. Can be scaled to match any nitrification quantity required by changing depth, width, and length dimensions with no change in the type of equipment used.
3. Use of solid cone spray pattern provides uniform optimal wetting of the media surfaces, much better than drip pans or the use of perforated pipes.
4. Intermittent flow provides for more effective nitrification by allowing water to more fully drain from the media surface before another water surge. This biological growth phenomenon can be observed in natural water settings of wave action (intermittent wetting or high energy areas) promoting increased biological growth.
5. Intermittent flow allows for more residence time on the media and time with thinner water film improving CO2 stripping. Average daily hydraulic loading rate is an order of magnitude less than normal CO2 strippers used in aquaculture applications.
6. Controlled intermittent water flow (control both the amount of time a nozzle is flowing and the interval between flow cycles) enables development of a biofilter of any required nitrification rate, maintain a specified media depth, and most importantly maintain optimum hydraulic loading. Many traditional trickling filter designs cannot attain optimum hydraulic loading with continuous flow regimes; the recirculation system water flow rate is not sufficient to enable proper hydraulic loading because the square meter footprint area is too large resulting in much less than optimum hydraulic loading. The water flow volume rate is not sufficient to properly wet the bacterial surface area of the media.

Requirements of the CIFT biofilter include:

1. Requires a larger footprint for construction, however this biofilter also provides for CO2 stripping, temperature control capabilities, and water storage pumping basin.
2. Requires water pumping energy to allow water to gravity flow through the media with the counter current flow of air. Submerged biofilter design concepts require less energy for pumping but increased energy for oxygenation, gas stripping, and mixing. The total energy required for the complete recirculation cycle must be considered, and this is where the combination of AquaMaof system components results in lower total energy required for operation.

The water basin below the CIFT biofilter is used as a surge tank for holding a supply of water for the total system, one third of the fish production tank volume. This allows for capacity to drain a fish tank for harvest and retain all water in the operating system.

Waste water is drained from each tank secondary drain (from the sediment trap in the tank center) and from the solid waste settlers directly to the waste treatment / denitrification system (Figure 2). This water treatment system returns the water back to original quality standards. The process includes sequencing batch reactors, decanting and solids settler, trickling biofilter for aeration and gas stripping, followed by fluidized bed reactor, ozone, and UV. One day supply of new water is held in storage for use as continuous addition or in larger quantities in a short time for refilling the system. This one day supply of water will also ensure the facility will remain within the 300 liter per minute regulated water use for the facility in case of any increase in water need.

The sequencing batch reactors are chosen because of the capability to process varying flow rates and allow for control flexibility. The fluidized bed reactor and ozone are selected for final polishing and breakdown of complex organic compounds that can build in aquaculture systems with very low to no water exchange. UV treatment is the final step in the waste treatment and this assures no residual ozone will reach fish production water. Waste water treatment is the only area where ozone is required or used in the salmon production facility.

Land Based Smolt—Growing

The land based smolt growing facility is designed for growing smolt in seawater from 50 grams to large smolt of 300 grams for stocking sea cages. There will be one batch of smolt that will be grown to 1.3 to 1.4 kg for early spring stocking with the plan for attaining market size with one summer and fall of growth time. This significantly reduces the risk related to holding salmon over the winter season in sea cages. Since this land based unit is best operated continuously to maintain the biofilters, the plan is to hold some fish for later stocking dates which will result in some fish being moved to sea cages at 1 kg and 1.8 kg sizes.

Description and General Specifications

The land based smolt growing facility has 3 production modules with 18 tanks (Table 10). The smolt will be grown for 3 months to reach 300 grams and be ready for stocking sea cages. This facility will be lighted but follow normal seasonal light cycles to coincide with the day / night cycles of the sea cages. The lighting system will be installed at multiple water depths around the circumference of the tank walls to provide uniform light throughout each tank preventing shadows. These lights have the capability to simulate natural daylight including dusk and dawn gradual reductions and increases in light intensity.

Batches of smolt from the nursery will be stocked into the land based growing system in February, March, April, May, and October. The last batch of smolt will then be 1.3 kg in April and 1.8 kg in May for stocking into sea cages.

Table 10. Specifications for the land based smolt growing facility.

Component	Size	Number
Water circulation pumps	4417 m3/hour	6
Pump for fish transfer tank	735 m3/hour	2
Tank water exchange	51 minutes	
AquaMaof solids settler	27 m x 63 m	3
Biofilter and gas stripping	5653 m3 x 6 m depth	3
Carbon dioxide maximum	15 mg/liter free CO2	
Daily feed capacity	19,080 kg	
Maximum fish density	91 kg/m3	
Tanks	20 m dia. x 4.3 m depth	18
AquaMaof ODS	491 m3/hr x 15 m depth	55
Harvest channel	1 m wide x 190 m long	1
Fish transfer tank	20 m dia. x 4 m depth	1
Denitrification / water reuse	125 m3/hour	1
Sludge discharge, 20% solids	1 m3/day	
Water discharge, fish tank water	175 liters/min annual average	
Water temperature control	8 to 12 C	central

The process flow diagram is shown in Figure 2, the same process concept as for the nursery. Water recirculation in the land based smolt system is 26,500 m3/hour and 125 m3/hour through the water reuse and denitrification treatment process. This represents 99.5% recirculation with 0.5% sent through the waste treatment process and returned to the fish production system approximately one day later. The alkalinity adjustment buffer system will be used primarily during startup phases. Once the total treatment system stabilizes most alkalinity will be returned to the system through the bacterial processes in the solids settler and the denitrification system.

The AquaMaof aquaculture recirculation system includes several design concepts that are duplicate systems and some used only for emergency. A summary the characteristics of the AquaMaof design includes:

1. The total system is divided into independent production modules, should there be a catastrophic factor that disables a single module then all other modules will remain in full operation.
   a. Multiple and independent fish production modules
   b. Fish transfer channel to quickly move fish between modules
2. The water circulation system is installed in duplicate. Many designs have multiple pumps, however piping can fail and few have duplicate water circulation systems.
   a. Duplicate water pumps
   b. Duplicate circulation piping systems
   c. Duplicate valves
   d. Multiple ODS units for each fish production tank
3. The oxygenation system has several points of duplication.
   a. The main oxygenation is through the ODS with backup oxygen diffusers in each fish production tank
   b. The oxygen pipe delivery system is duplicated, the main oxygen supply and the emergency supply. Either pipe system can be used for regular or emergency oxygen supply changing with control valves.
   c. The main oxygen supply is from an oxygen generator with liquid oxygen tank backup for when the oxygen generator is offline for maintenance or there is a disruption in the electrical supply. There are duplicate liquid oxygen tanks as backup for each other in the event of disrupted plumbing failure on one.
4. Electricity supply.
   a. The main electric supply has a diesel or natural gas stand-by electric generation system that automatically starts with any disruption to the public electric supply.
   b. The electric transformers are duplicated such that the duplicated water pumps are on separate electric transformers.
5. Should total electric supply disruption occur (both the main public supply and internal backup supply) all electrically supplied water circulation will then be disrupted. The following tertiary non-mechanical systems will engage. This mode of operation can be

maintained as long as sufficient liquid oxygen can be supplied. Two LOX tanks with 25 tons of oxygen is sufficient for 5 hours of operation. In this emergency mode all feeding is stopped.

   a. Emergency oxygen diffusers will automatically operate in each fish production tank.
   b. The AquaMaof ODS units will automatically go into reverse flow mode using the main oxygen supply as an air lift to circulate water and strip CO2 within each fish production tank.

6. There are 3 solid waste settlers for each fish production module. Any one of these settlers can be removed from operation and the module will continue to function normally.
7. There is 1 large CIFT biofilter for each module, overcapacity in the CIFT biofilter is such that it can operate in sections and continue to function normally with any selected portion out of service.
8. Should there be a disruption to all three settlers of a module or a full disruption of the CIFT biofilter there is a water by-pass that enables the recirculation system and oxygenation system to continue operation. This can also be used should fish treatments be necessary that could damage the biological community of the biofilter and water by-pass is necessary.
9. Overcapacity is built into the modules such that should it be necessary to remove one complete module from operation, water can then be by-passed to the two remaining modules and the overall system will continue to function normally during all months except October, April, and May. During these months of high fish biomass feed quantities will need to be reduced to enable safe operation.

The land based smolt growing building will be constructed downgrade from the nursery building and will be an insulated steel frame building (Table 11). The fish transfer tank will be outside of the land based growing facility and filled with seawater. Post smolt will be transferred over a dewatering system prior to entering the transfer tank.

Table 11. Specifications for land based smolt growing building.

Component	Size	Number
Dimensions	100 m x 230 m	1
Building height	7 m	
Office space	10 m2	3
Biosecure entrance / restroom	40 m2	1
Conference / break room	40 m2	1
HVAC	14 C production	

AquaMaof aquaculture production modules operate as independent systems in part for increased biosecurity but also water temperature and salinity can be adjusted in each module. The AquaMaof system is also unique in that individual solid waste settlers can be taken off-line and the system continue to operate normally. The complete settler and biofilter can also be by-passed and taken out of the water recirculation if necessary for special fish treatments.

In addition, any single tank can be taken off the recirculation system for special treatment for these fish such as, medical treatments, a temperature adjustment for preparation of moving fish, or salinity adjustments. The isolation and special water treatment for any single tank is accomplished by closing the incoming water valves bringing system water to the tank and closing the tank drain pipe at the beginning of the solids settler (slide gate valves located in the distribution channel). Then water is circulated through the ODS unit in reverse flow direction using the air lift principle to create air lift in the center tube of the ODS and water then flows from the ODS overflow into the tank with the water source being the normal tank inlet pipe. Air is temporarily used to create this air lift water flow as well as strip CO_2 from the water. Oxygen can be supplied either from the emergency oxygen diffusers or in the ODS. If oxygen is used for the air lift in the ODS then the air source is temporarily off. New water can be added and drained either to the recirculation system or directly to the waste water treatment system. This concept can also be adapted for depuration of fish if needed prior to marketing of full size fish.

Process Concept Review

The proposed system design is AquaMaof's standard design adapted for salmon smolt production which includes the recirculation pump, ODS, fish production tank, solids settler, controlled intermittent flow trickling (CIFT) biofilter (which includes CO_2 gas stripping), and harvest channel. Smolt growth will require 3 months from 50 grams to 300 grams and 7 months to 1.3 kg. After 2, 4, and 6 months of growth the fish will be redistributed in the tanks to maintain less than 100 kg/m3 fish biomass.

The water circulation system is designed for a single pumping step to complete the recirculation. These pumps are submerged vertical turbine type pumps. The pumps provide high efficiency pumping at 9.4 meters of head. The recirculated water flows from the pump into the ODS (oxygen dissolving system).

The ODS is designed to provide high dissolved oxygen concentration with a small amount of pumped head pressure (about 0.3 m head pressure). Improved dissolving of oxygen can be attained with the following methods: 1) increase of water pressure where oxygen bubbles are dispersed; 2) increase of residence time of oxygen bubbles in the water; 3) oxygen gas bubble size, smaller bubbles result in more gas to water surface area; and 4) water temperature, colder water results in higher oxygen concentrations at 100% saturation and warmer water results in faster dissolving rate. The ODS obtains the increased pressure with the column of water and injection of the oxygen gas near the bottom of the column, thereby attaining higher water pressure without costly pumping. The residence time for allowing the oxygen bubbles to dissolve is attained in the ODS by creating a flow of water counter to the flow of oxygen bubbles. The AquaMaof ODS allows for low head requirement for dissolving oxygen and attaining oxygen concentrations sufficient to eliminate oxygen concentration as a limiting factor in design of water flow volume. This ODS design has capability to attain oxygen concentrations up to 40 mg/liter, which is an over design safety factor to assure oxygen will never be a limiting factor for the fish and capability to maintain above 90% saturation at all times.

Oxygenated water flows from the ODS directly into the fish production tank with the water added tangentially at the outer edge of the tank at a slight downward angle which creates circular water flow in the tank and distributes water from near the surface to the tank floor. There will be 3 ODS for each tank and each ODS will discharge water at a different depth in the tank. Circulated water flow leaves the tank from the drain stand-pipe at the center of the tank. The stand-pipe is perforated starting 30 cm from the tank bottom upward to the normal operating water level. This reduces the potential for any full blockage or plugging of the exit screen.

The fish tank is the first step in solids removal. The tank acts as a clarifier and has a drain trap around and below the central drain pipe. This sediment trap collects settled solids that are moved towards the center of the tank bottom by the circular water flow in the tank. This sediment trap is not a continuous flow but is drained 1-2 times per day significantly reducing the amount of water sent out with the settled solids. The settled solids and water in the trap are sent directly to the water re-use treatment and is not part of the recirculation water flow. The main recirculation water flows into the tank main drain pipe and directly into the solid waste settler distribution channel via gravity with minimal turbulence or bends in the pipe.

The second step in the solids removal process is the solids settler, with a design concept adapted from the potable water industry used for removal of fine particulates. The settling basin is rectangular with the floor sloped to a center drain. Water is evenly distributed across the basin approximately 0.5 m above the floor from the distribution channel with pipes. A large portion of the solids settle on the floor of the basin and water flows upward through the tube settler media (Brentwood ACCU-PAC IFR 6036) and into water collection launderers and by gravity is distributed through the spray nozzles of the biofilter. Solid waste accumulated in the settler basin and on the settler media is periodically drained and washed from the media and basin into the discharge waste treatment. The exact schedule depends upon solid waste loading and can range from once every 4 days to once every 10 days.

There are several advantages of this solids removal process compared to other methods. First there are no continuously moving parts that need maintenance or replacement. Second, this method has capability to remove very fine particles compared to mechanical screen methods with increase the amount of fine particles during the process of collecting larger particles. Third, this settling process will result in denitrification when managed on a proper draining schedule. The schedule for cleaning is adjusted after several months of operation to allow for stabilizing the denitrification process. The schedule will have longer intervals between cleaning in the early phase of operation then a regular schedule will be established which is in the range of 1 time per week.

The CIFT biofilter is the next step in the water recycle process. This is a trickling filter adapted for stripping carbon dioxide from the water and using a controlled and intermittent water flow over the media. The depth of media (Brentwood ACCU-PAC CF 1200) is 6 meters to provide maximum nitrification (removal of ammonia) with a single pass of water flow. This depth also allows for movement of carbon dioxide bound in the alkalinity buffer to free CO_2 as the carbon dioxide concentration is reduced in the water with counter-current flowing air. With this method we can strip more mg/liter of CO_2 from the water than exists as free CO_2 in the fish tanks. The hydraulic loading across the entire biofilter for CO_2 stripping is 7.8 m^3/hour/m^2, an order of magnitude less than hydraulic loadings typically used in CO_2 stripping by other companies.

The hydraulic loading on the trickling filter is designed for the optimum wetting of all surfaces of the CIFT biofilter media (14.6 m^3/hour/m^2). This loading is intermittent to obtain additional treatment advantages. The use of air circulation through the CIFT biofilter from bottom to top of the media provides all required oxygen for the bacterial processes and leaves the biofilter at near 100% oxygen saturation. This Megafan axial flow fan provides air flow of 10 times more air volume than water flow volume. The air flow is counter current to the water with air entering the base of the trickling filter and water entering through the spray nozzles at the top. The biofilter can also be used for water temperature control when outside air temperature and humidity are appropriate during many months of the year. If the culture water needs to be increased and outside air temperature is higher than the water temperature then outside air is used to supply the air fan. Also when outside humidity is low the trickling filter acts as a cooling tower. Because the facility has low water exchange rate the normal requirement for temperature control in the system water is cooling. The CIFT biofilter reduces the electrical energy required for cooling fish water. Advantages for the CIFT biofilter are:

1. Water temperature increase or decrease depending upon a controlled source of air flow, inside building air or outside air. The CIFT biofilter can effectively be used as a cooling tower.

2. Can be scaled to match any nitrification quantity required by changing depth, width, and length dimensions with no change in the type of equipment used.
3. Use of solid cone spray pattern provides uniform optimal wetting of the media surfaces, much better than drip pans or the use of perforated pipes.
4. Intermittent flow provides for more effective nitrification by allowing water to more fully drain from the media surface before another water surge. This biological growth phenomenon can be observed in natural water settings of wave action (intermittent wetting or high energy areas) promoting increased biological growth.
5. Intermittent flow allows for more residence time on the media and time with thinner water film improving CO_2 stripping. Average daily hydraulic loading rate is an order of magnitude less than normal CO_2 strippers used in aquaculture applications.
6. Controlled intermittent water flow (control both the amount of time a nozzle is flowing and the interval between flow cycles) enables development of a biofilter of any required nitrification rate, maintain a specified media depth, and most importantly maintain optimum hydraulic loading. Many traditional trickling filter designs cannot attain optimum hydraulic loading with continuous flow regimes; the recirculation system water flow rate is not sufficient to enable proper hydraulic loading because the square meter footprint area is too large resulting in much less than optimum hydraulic loading. The water flow volume rate is not sufficient to properly wet the bacterial surface area of the media.

Requirements of the CIFT biofilter include:

1. Requires a larger footprint for construction, however this biofilter also provides for CO_2 stripping, temperature control capabilities, and water storage pumping basin.
2. Requires water pumping energy to allow water to gravity flow through the media with the counter current flow of air. Submerged biofilter design concepts require less energy for pumping but increased energy for oxygenation, gas stripping, and mixing. The total energy required for the complete recirculation cycle must be considered, and this is where the combination of AquaMaof system components results in lower total energy required for operation.

The water basin below the CIFT biofilter is used as a surge tank for holding a supply of water for the total system, a volume equal to the volume of 1 fish tank. This enables the operator to drain a fish tank for harvest and retain all water in the operating system. If necessary the water levels in each production tank can be adjusted up or down to store or make additional water available.

Waste water is drained from each tank secondary drain (from the sediment trap in the tank center) and from the solid waste settlers directly to the waste treatment/ denitrification system (Figure 2). This water treatment system returns the water back to original quality standards. The process includes sequencing batch reactors, decanting and solids settler, trickling biofilter for aeration and gas stripping, followed by fluidized bed reactor, ozone, and UV. One day supply of new water is held in storage for use as continuous addition or in larger quantities in a short time for refilling the system. This one day supply of water will also ensure the facility will remain within the 300 liter per minute regulated water use for the facility in case of any increase in water need.

The sequencing batch reactors are chosen because of the capability to process varying flow rates and allow for control flexibility. The fluidized bed reactor and ozone are selected for final polishing and breakdown of complex organic compounds that can build in aquaculture systems with very low to no water exchange. UV treatment is the final step in the waste treatment and this assures no residual ozone will reach fish production water. Waste water treatment is the only area where ozone is required or used in the salmon production facility.

Control and Monitoring

Hatchery

Table 13. Monitoring and automatic control for the Hatchery.

Factor	Monitored	Controlled
Water temperature egg hatching	X	X
Sump water level egg hatching	X	X
Dissolved oxygen	X	X
ORP and pH	X	X
Pump water flow	X	X
UV lamp operation	X	X
Sump water level first feeding tanks	X	X
Dissolved oxygen first feeding tanks	X	X
Water temp first feeding tanks	X	X
Biofilter valves and tank water level	X	X
Room air temperature	X	X
Room humidity	X	X

Nursery and Land Based Smolt Growing

Table 14. Monitoring and automatic control for the Nursery and Land Based Smolt.

Factor	Monitored	Controlled
Water temperature in each module	X	X
Room air temperature	X	X
Room humidity	X	X
Sump water level	X	X
Dissolved oxygen in each tank	X	X
Pump water flow	X	X
Biofilter valves and tank water level	X	X
ORP (used to regulate ozone) and pH	X	X
Ozone generation in waste treatment		X
UV lamp operation, waste treatment	X	X
Water levels in waste treatment	X	X
Dissolved oxygen waste treatment	X	X
Water temperature waste treatment	X	X
ORP & pH in waste treatment	X	X
Alkalinity	X	
Total suspended solids	X	
Nitrate	X	
Nitrite	X	
Hydrogen sulfide	X	
Aeration blowers waste treatment	X	X
Pumps in waste treatment	X	X

Capital Cost

The project capital costs are separated into two major categories. AquaMaof technology cost and all the civil works (site development, building, concrete, etc. costs). AquaMaof technology cost includes aquaculture design, equipment, installation, and commissioning. The site development cost in this proposal is an estimate and final costs will be determined only after the final design. This category includes site civil engineering, site excavation, fencing, roads, building, and all concrete structures (including fish tanks and water holding basins).

No.	Description	Unit Price USD	Qty	Total USD
1.	**Aquamaof scope (fixed price):**			
	I. – Smolt Hatchery	2,545,000	1	
	II – Salmon Smolt Nursery	8,747,000	1	
	III – Salmon Smolt Land Based	30,380,000	1	
2.	Subtotal			41,672,000
3.	**Buildings, Concrete, earth and all the civil works at Site Preparations (estimated only)**:			
	I. – Smolt Hatchery	892,000	1	
	II – Salmon Smolt Nursery	2,522,000	1	
	III – Salmon Smolt Land Based	10,985,000	1	
4.	Subtotal			14,399,000

5.	**Total Project (estimated)**			56,071,000

Site Layout and Design Concept Drawings

Introduction

The site is located with a down slope from the site entrance to the water front. The site plan is for the fish to move down from the hatchery to the nursery, to the land based smolt growing, and then to well boats for transporting to sea cages.

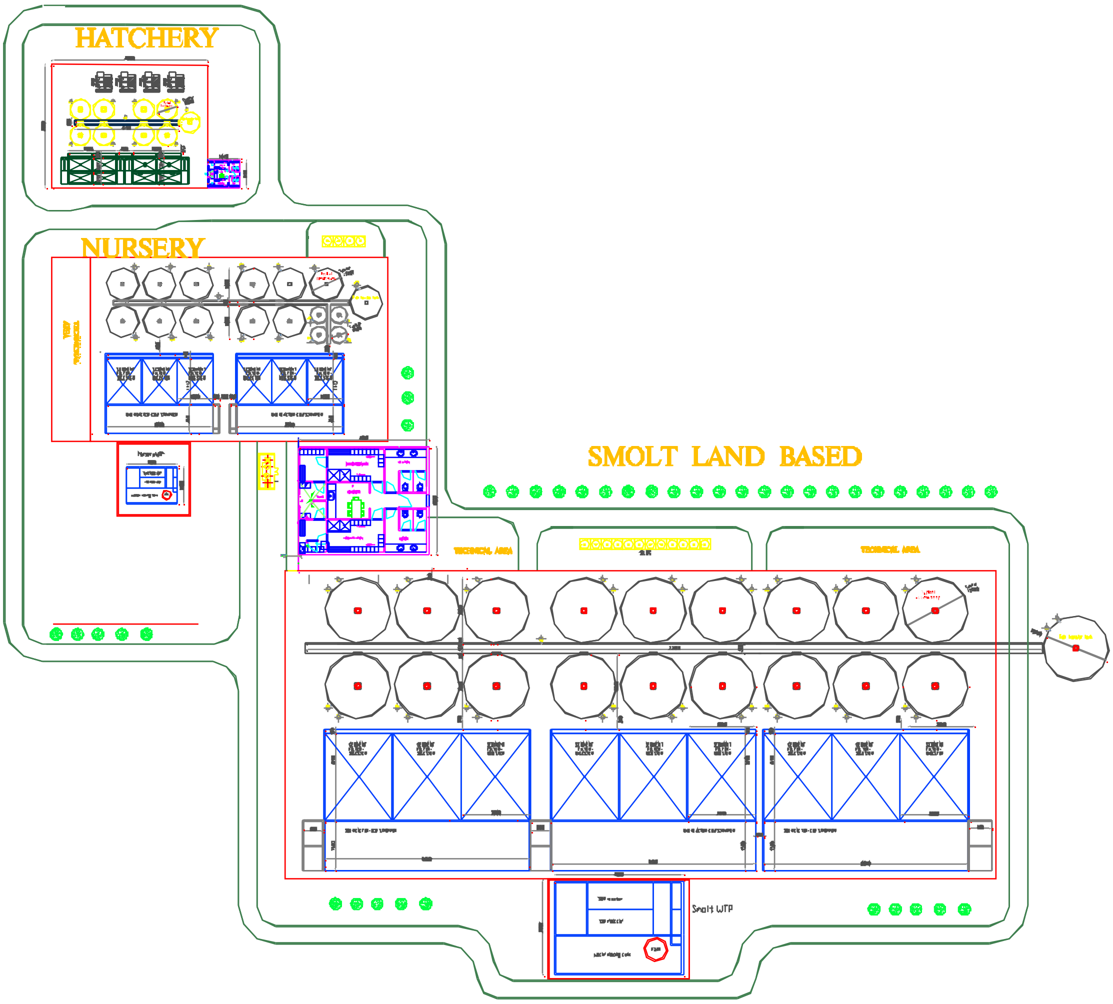


Figure 2 Layout of entire Facility

Hatchery

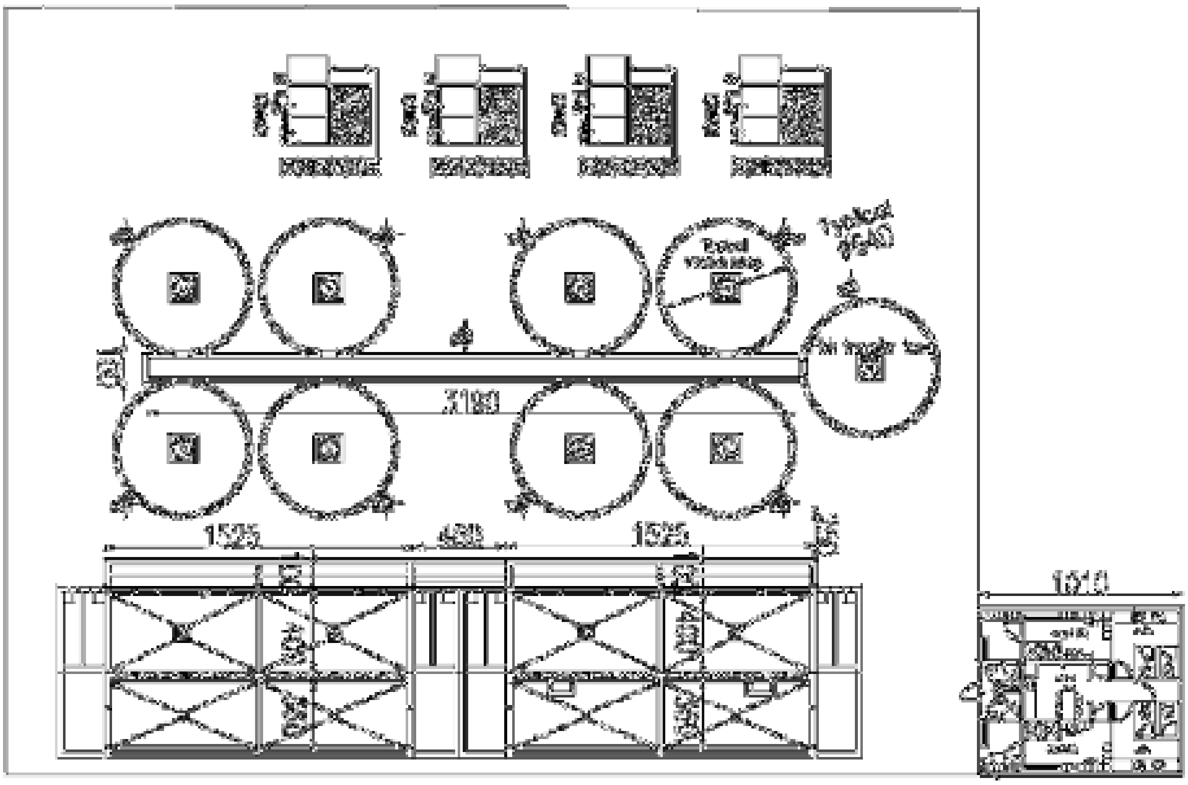


Figure 3 Hatchery layout

Nursery

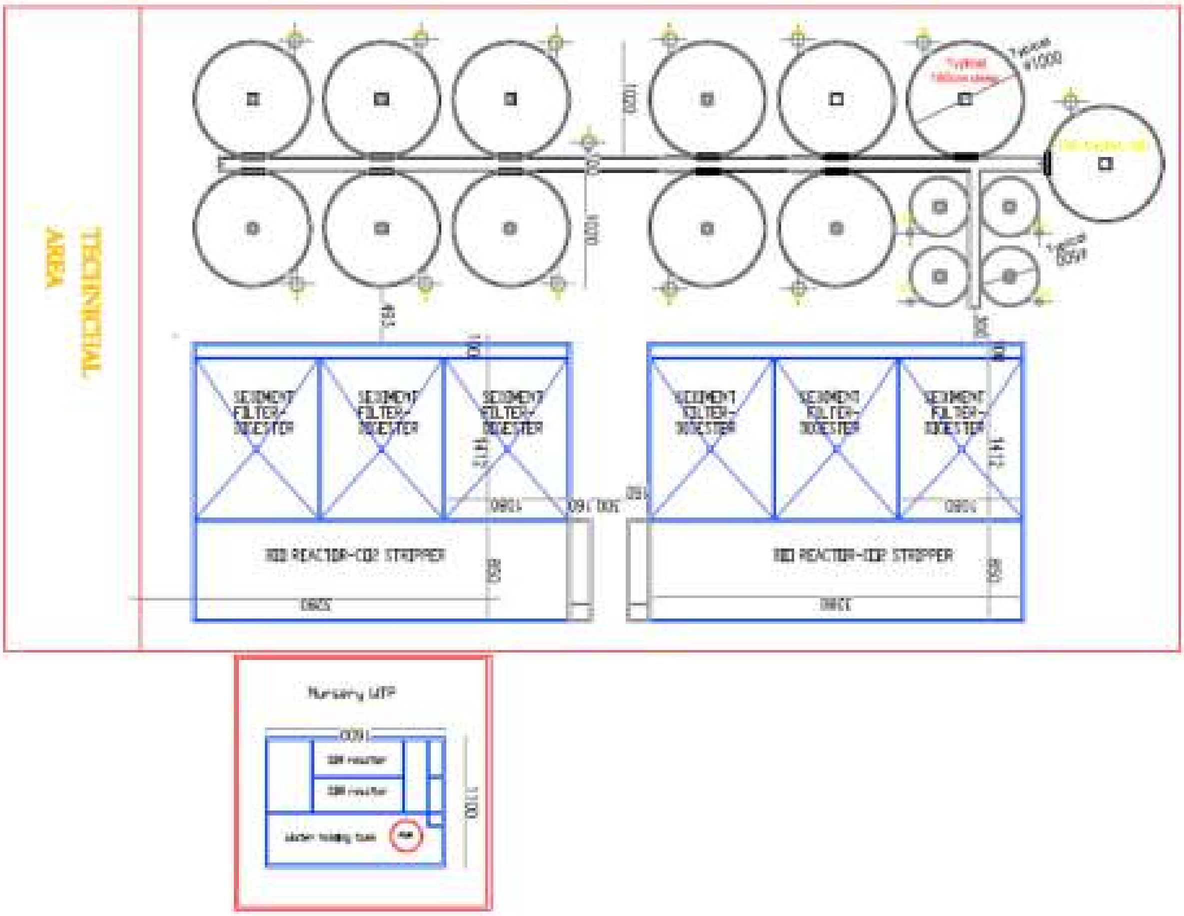


Figure 4 Nursery Layout

Land Based Smolt-Growing

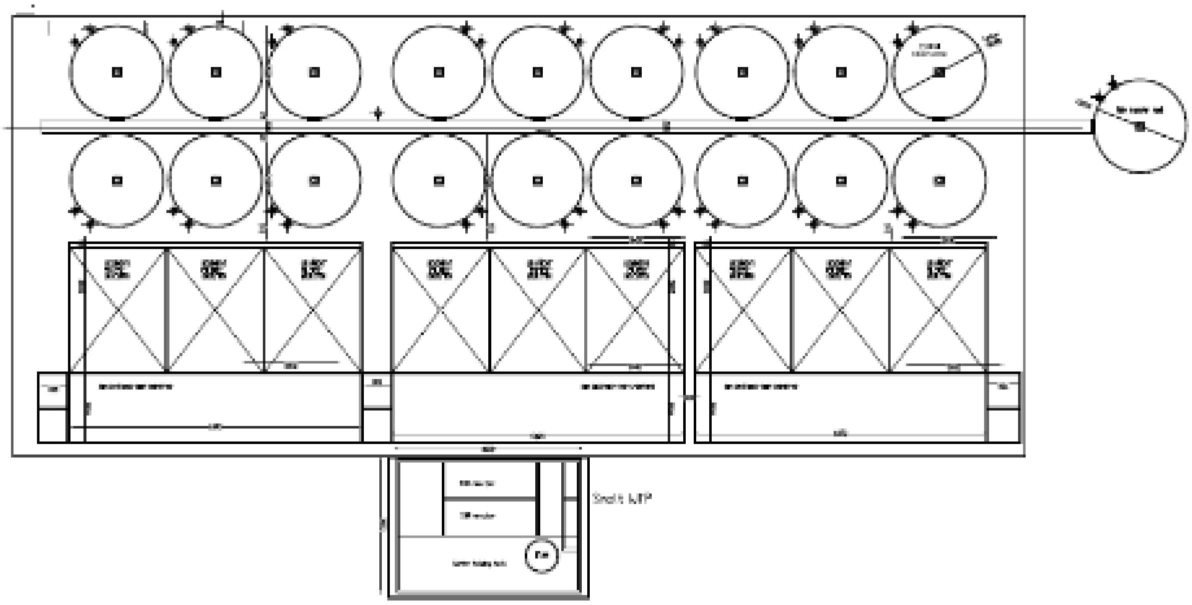
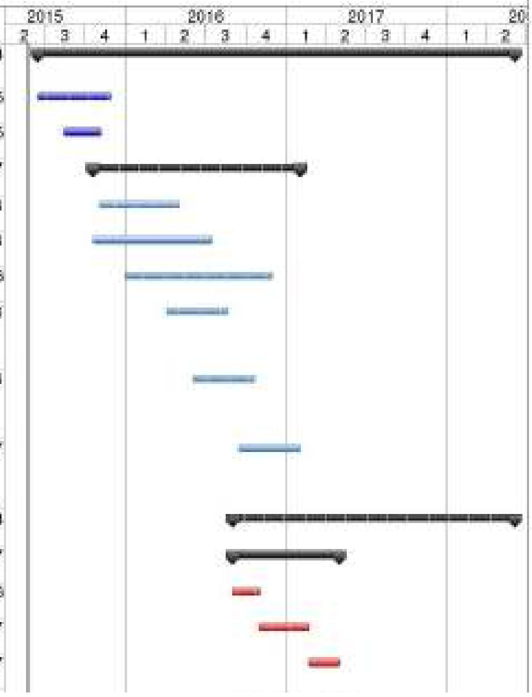


Figure 5 Smolt Layout

Design and Construction Schedule



Design, construction and growing schedule

מזהה	Task Name	Start	Finish
1	**Smolt project**	**15/06/15**	**05/06/18**
2	Design Project	15/06/15	27/11/15
3	Project permits	14/08/15	05/11/15
4	**Project erection**	**19/10/15**	**01/02/17**
5	Civil works for the Hatchery	03/11/15	02/05/16
6	Civil works for the Nursery	19/10/15	15/07/16
7	Civil works for the land based	01/01/16	30/11/16
8	Installation works and equipments for the Hatchery	04/04/16	19/08/16
9	Installation works and equipments for the Nursery	03/06/16	20/10/16
10	Installation works and equipments for the Land based	15/09/16	01/02/17
11	**Growing**	**01/09/16**	**05/06/18**
12	**first batch**	**01/09/16**	**01/05/17**
13	first batch in the Hatchery	01/09/16	01/11/16
14	first batch in the Nursery	01/11/16	20/02/17
15	first batch in the land based	21/02/17	01/05/17

Appendix A-Equipment Specifications

Hatchery, Nursery, Land Based Smolt-Growing

Appendix A - Newfoundland Equipment predesign

Equipment specifications	building	number	size		Specs	Manufacture	Model
Vertical turbine pump	nursery	4	1,053 m3/hr	292.5 l/s	9.4 m	Flygt (Xylem)	P7035.180; 40KW, column diameter 550 mm
Vertical turbine pump	smolt	6	4,418 m3/hr	1,227 l/s	9.4 m	Flygt (Xylem)	P7065; 160KW, column diameter 800 mm
UV inline treatment	nursery	1	40 m3/hr	11.11 l/s	90 kJ/cm2	must remove ozone	Trojen - 06AS20
UV inline treatment	smolt	1	250 m3/hr	70 l/s	90 kJ/cm2	must remove ozone	Trojen - 18AL40
Oxygen generator	nursery	1	2,000 kg/day		3 bars	Adsorptech USA	E40-43
Oxygen generator	smolt	1	11,000 kg/day		3 bars	Adsorptech USA	E210-43
CO2 air blowers	hatchery	4	750 m3/hr	208.33 l/s	6 mm	ebmpapst	
CO2 air blowers	nursery	4	10,530 m3/hr	2,925 l/s	6 mm	ebmpapst	

CO2 air blowers	smolt	6	44,180 m3/hr	12,272 l/s	6 mm	Megafan	
Ozone generator	nursery	1	200 g/h		2 bars	Wedeco (Xylem)	OCS-GSO 40 generator only
Ozone generator	smolt	1	1,250 g/h		2 bars	Wedeco (Xylem)	OCS-GSO 40 generator only
Fluidized Bed Reactor	nursery denitrification	1	20 m3/hr			Aquaneering	
Fluidized Bed Reactor	smolt denitrification	1	125 m3/hr			Aquaneering	

Equipment specifications	building	number	size		head pressure	Manufacture	Model
Electrical generator	hatchery	1	40 kW			caterpillar	
Electrical generator	nursery	1	250 kW			caterpillar	
Electrical generator	smolt	1	1500 kW			caterpillar	
Settler media	all	5507	36 inch			Brentwood	
Bio-filter media	all	20,533	CF-1200			Brentwood	
Control System	hatchery	1	Complete			Siemens + Nave	ET200S + Vuiniq

						Cohen	
Control System	nursery	1	Complete			Siemens + Nave Cohen	ET200S + Vuiniq
Control System	smolt	1	Complete			Siemens + Nave Cohen	S7-316 + ET200S + Vuiniq
Electrical technological cabinets	hatchery	1	Complete			Schneider Electric componnets	
Electrical technological cabinets	nursery	1	Complete			Schneider Electric componnets	
Electrical technological cabinets	smolt	1	Complete			Schneider Electric componnets	
ORP + PH	hatchery	4				Hach Lange	
ORP + PH for water re-use	nursery	3				Hach Lange	
ORP + PH for water re-use	smolt	3				Hach Lange	
ORP Sensor	nursery denitrification	5	(+2000 /-2000 mV)			Hach Lange	
ORP Sensor	smolt denitrification	5				Hach Lange	
Equipment	**building**	**number**	**size**		**head**	**Manufacture**	**Model**

specifications					pressure		
Oxygen and temperature	hatchery	12				Hach Lange	
Oxygen and temperature	nursery	15				Hach Lange	
Oxygen and temperature	smolt	18				Hach Lange	
Oxygen/temp water re-use	nursery	3				Hach Lange	
Oxygen/temp water re-use	smolt	3				Hach Lange	
Oxygen and temperature	nursery denitrification	4	0-20 ppm			Hach Lange	
Oxygen and temperature	smolt denitrification	4	0-20 ppm			Hach Lange	
Oxygen and temperature	nursery denitrification	4	0 - 70 ppm			Hach Lange	
Oxygen and temperature	smolt denitrification	4	0 - 70 ppm			Hach Lange	
Alkalinity Analyser	nursery denitrification	1	0 - 200 mg/l	0-2 bar		Hach Lange	
Alkalinity Analyser	smolt denitrification	1	0 - 200 mg/l	0-2 bar		Hach Lange	

TSS Sensor	nursery denitrification	1	0 - 15000 mg/litter			Partech	
TSS Sensor	smolt denitrification	1	0 - 15000 mg/litter			Partech	
NO3 - N sensor	nursery denitrification	1	0 - 1000 mg/litter			Hach Lange	
NO3 - N sensor	smolt denitrification	1	0 - 1000 mg/litter			Hach Lange	

Equipment specifications	**building**	**number**	**size**		**head pressure**	**Manufacture**	**Model**
NO2 sensor	nursery denitrification	1	0 - 50 mg/litter				
NO2 sensor	smolt denitrification	1	0 - 50 mg/litter				
Hydrogen sulfide (h2s) analyser	nursery denitrification	2	0.005 - 2.0 mg/litter			ATI	
Hydrogen sulfide (h2s) analyser	smolt denitrification	2	0.005 - 2.0 mg/litter			ATI	

Humidity & Temp Analysers	hatchery	2	10+50 Deg.C	0-100% rh		Rotronic	
	hatchery	1	-25+50 Deg.C	0-100% rh		Rotronic	
	nursery	1	10+50 Deg.C	0-100% rh		Rotronic	
	nursery	1	-25+50 Deg.C	0-100% rh		Rotronic	
	smolt	2	10+50 Deg.C	0-100% rh		Rotronic	
	smolt	1	-25+50 Deg.C	0-100% rh		Rotronic	
Oxygen & Ozone Impeller flowmeter	hatchery	24				Flowtech + Stubbe	
	nursery	48				Flowtech + Stubbe	
	smolt	95				Flowtech + Stubbe	

Equipment specifications	building	number	size		head pressure	Manufacture	Model
Level transmitter - Pressure	hatchery	1	0-6 / 0-10 m			Siemens	
	nursery	2	0-6 / 0-10 m			Siemens	
	smolt	3	0-6 / 0-10 m			Siemens	
Magnetic flowmeter	hatchery	1	0 - 200,000 kg/h , 8" Pipe			Siemens	
	nursery	1	0 - 200,000 kg/h , 12" Pipe			Siemens	
	smolt	2	0 - 200,000 kg/h , 12" Pipe			Siemens	
Pressure transmitter	hatchery	4				Siemens	
	nursery	6				Siemens	
	smolt	9				Siemens	
Temperature transmitter	hatchery	1	PT-100			Siemens	
	nursery	2	PT-100			Siemens	
	smolt	3	PT-100			Siemens	
CompHatch	hatchery	12				Alvestad	
Kube Hatch	hatchery	2				Alvestad	

Appendix B-Equipment Brochures and Data Sheets

All relevant datasheets are available to view & download from the following link:

https://www.dropbox.com/s/kk0u3gufwclujfw/Appendix%20B%20-%20Datasheets.pdf?dl=0

Appendix C-Company Profile

AQUA MAOF GROUP

Group Overview / May 2015

AQUA MAOF

THE WORLD'S MOST ADVANCED INDOOR AQUACULTURE FACILITIES

AQUA MAOF

INNOVATIVE
EXPERIENCED
PASSIONATE
TEAM

AQUA MAOF

DELIVERING SUSTAINABLE AND OPTIMAL RESULTS YEAR-ROUND

AQUA MAOF

GLOBAL PRESENCE: RUSSIA, POLAND, SLOVAKIA, ISRAEL, INDONESIA, CHINA AND THE US

AQUA MAOF

Comprehensive integrated aquaculture solutions for the entire fish production cycle, is the heart of Aqua Maof's expertise. Providing a complete package from business development concept, through system and production line, engineering design and set-up, operation and maintenance.

Aqua Maof establishes a truly integrated approach for business success. For more than 20 years, the company's large team of technology and aquaculture experts has been providing research and development, professional consulting and outsourcing services for aqua farming in over 50 locations around the world. Aqua Maof's total package approach is the key to its ongoing project management success.

To date, many client sites have become self-sufficient profit-making projects due to Aqua Maof's dedication to superior technology development, service and support.

AQUA MAOF

The Indoor Recirculating Aquaculture System, a land-based RAS, allows fish growers complete year round control over all growing conditions.

The advantage of a well-designed and well-executed Indoor Recirculating Aquaculture System cannot be underestimated. In areas where the amount of available water is low or for projects where the cost of warm or cold water is high, this model excels. Aqua Maof is the leader in Industrial RAS technology, equipment, and system set-up.

Gaining in popularity over the last 20 years, the rate of adoption in the aquaculture industry has been growing. Indoor RAS systems are flexible and energy efficient, and can be used as a tool in every phase of production from hatcheries and nurseries through the growing out phase.

Aqua Maof provides a specific design for each project to attain optimum fish production economics. The modular equipment can be purchased as a basic equipment package with add-ons for monitoring and automatic feeding.
The Mini Indoor RAS is a perfect solution for utilizing existing facilities as well as nursery for fry and fingerling production.

Optimum water conditions, simplicity of design, and low energy consumption remain key features of Aqua Maof's technology. The specialized water treatment components are modular and the water treatment capacity can be adjusted to the specific requirements of each fish species and production volume. One pumping cycle provides water circulation, bio filtration, aeration or pure oxygen, degassing and solids removal.

This design uses "off-the-shelf" components from Aqua Maof for fast response in project development. These "off-the-shelf" components are of a standard size, however the number of each component is increased or decreased according to the requirements of each project.

Aqua Maof Aquaculture Technologies' extensive worldwide experience has resulted in the development of our acclaimed AOPS facilities. The modular engineering design is easily and effectively adapted to local requirements so as to reduce owner's initial cost as well as to ensure the highest fish output at the lowest operating cost on the market.

Aqua Maof Aquaculture Technologies' in-house team has all the know-how and hands-on experience to supply a comprehensive A-Z turn-key package starting from project concept through product marketing. Of course we can provide any part of the program under warranty to suit your particular situation if you do not need us to supply the complete facility.

We are a proven company that is capable of delivering the full range of services and equipment needed for implementing a successful project

AQUA MAOF

AQUA MAOF

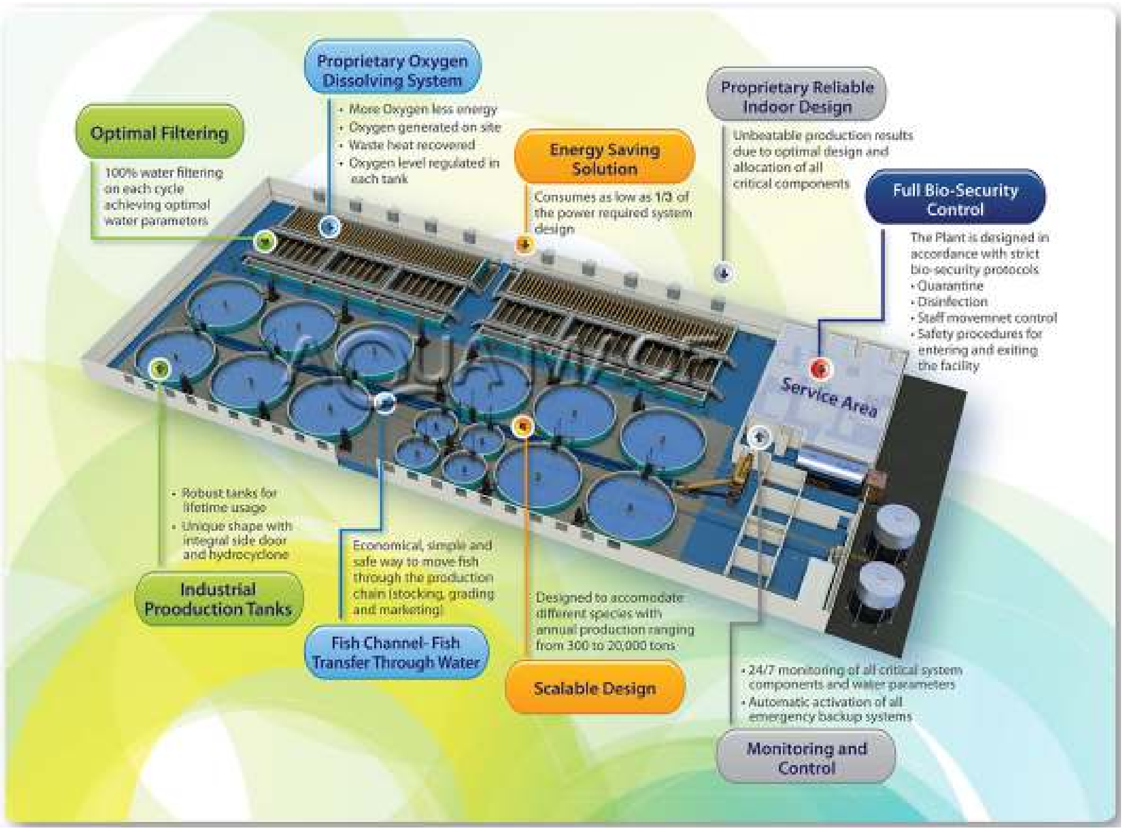
AQUACULTURE BUSINESSES

info@aquamaof.com

Appendix D-AquaMaof System Descriptions

View of aquaculture complex with offices, production, feed silos, and liquid oxygen tanks.

Interior view of an AquaMaof trout facility in Russia.



Components of the AquaMaof indoor aquaculture system.

Concrete fish production tanks with dimensions designed for the specific production capacity and stock management plan of each project. Interior walls are coated as required for each fish species.

AquaMaof oxygen dissolving system (ODS) showing duplicate water supply from the pipes on lower portion. The duplicate water supply pipes are connected separately to duplicate water pumps. The pipe extending to the top is for adding new water as required. Oxygenated water flows from the ODS through the tank sidewall. The pipe extending from the ODS over the tank sidewall is an overflow pipe.

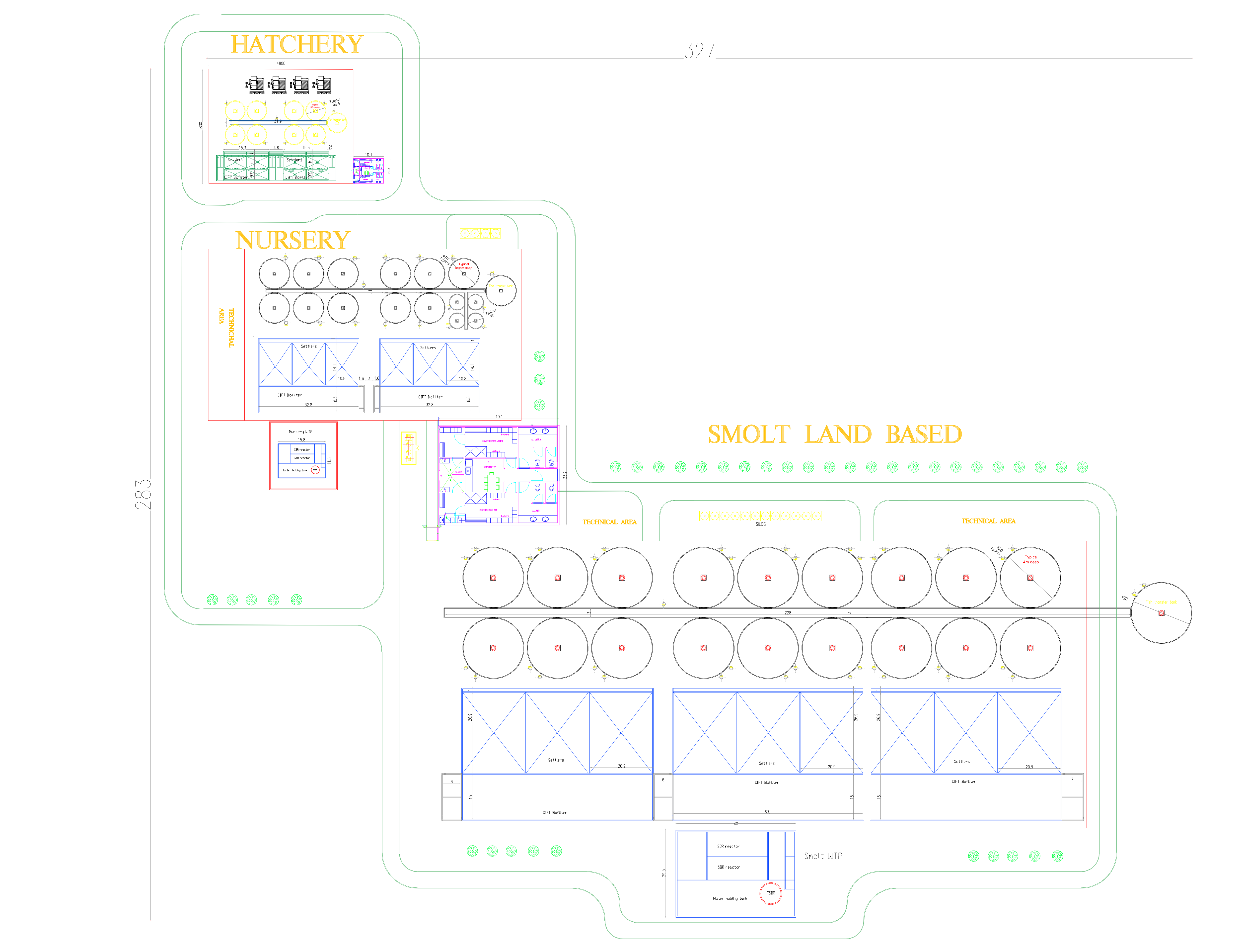
Example of water circulation pumps used in AquaMaof systems.

Water circulation pumps can be coated with ceramic coating for stability in seawater applications and also improving pumping efficiency.

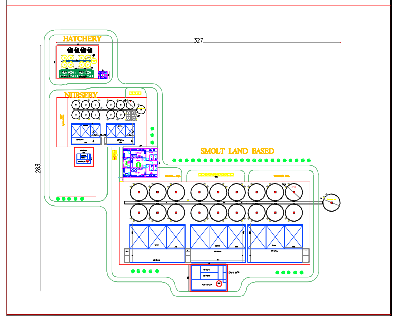
AquaMaof solid waste settler in operation. The pipes visible below the water surface are the water collection pipes distributing water to the biofilter spray nozzles. Water pressure for the spray nozzles is supplied by gravity flow.

Entrance to fish production hall, biosecurity planning and design are important for AquaMaof indoor aquaculture facilities.

Biofilter spray nozzles distributing water over media of the trickling filter in a trout production facility. Note the air blower for CO2 degassing at middle left side of biofilter. Multiple blower fans supply water to an air space below the media stack. Technicians adjusting the controls for water flow to the biofilter nozzles. View of the tube settler on the far right that supplies water to the nozzles with gravity flow.



KEY PLAN



GENERAL NOTES

A. CONTRACTOR SHALL FIELD VERIFY ALL EQUIP. LOCATIONS, ELEVATIONS AND DIMENSIONS IT IS THE CONTRACTOR'S RESPOSIBILITY TO NOTIFY OF AN MISSMATCH TO THE PLAN

B. ALL DIMENSIONS ARE IN METERS, UNLESS OTHERWISE NOTED.

C. ALL LEVELS ARE IN METERS, UNLESS OTHERWISE NOTED.

REV. NO.	REVISION DESCRIPTION	APPROVED	DATE	BY
V2	PRILIMINAARY-FOE APPROVAL	NEDER	2015.04.26	AQUAMAOF
P0	PRILIMINAARY-FOE APPROVAL	YOAV	2014.02.27	AQUAMAOF

SIGNATURE

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APPROVALS		DATE
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CHECKED	NEDER	26.04.2015
CROSSCHECK		
SAFETY		
PLANNING		
ENGINEERING		
APPROVED		
EQT CODE		

AQUAMAOF
NEWFOUNDLAND
ARCHITECTURAL
CONCEPTUAL LAYOUT

WORK ID NO.	FILE NAME	DRAWING NO.
	165-pl-010	165-PL-010-VER2

SHEET	PLOT SCALE	DRAWING SCALE	SHEET OF
	1:1	N/A	

Grieg NL Seafarms Ltd., Placentia Bay, Newfoundland

Hydrographic surveys

Grieg NL Seafarms Ltd.

Survey report

January 2016

The expert in **WATER ENVIRONMENTS**

This report has been prepared under the DHI Business Management System
certified by Bureau Veritas to comply with ISO 9001 (Quality Management)

ISO 9001
Management System Certification
BUREAU VERITAS
Certification Denmark A/S

Grieg NL Seafarms Ltd.

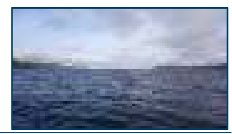
Survey Report

January 2016

The expert in **WATER ENVIRONMENTS**

Grieg NL Seafarms Ltd., Placentia Bay, Newfoundland

Survey, December 2015



Prepared for	Grieg NL Seafarms Ltd.
Represented by	Mr Perry Power

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Project number	11819009
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Revision	1.0
Classification	Restricted

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CONTENTS

1 Introduction

Grieg NL Seafarms Ltd. has contracted with DHI to undertake hydrographic surveys in connection with application for establishment of new sites in Placentia Bay, Canada.

The hydrographic survey will be done in several steps. This report covers task undertaken in December 2015 and includes:

- Current measurements
- CTD casts

The core delivery is the data collected. This report is a documentation of the work undertaken and shows some examples of the data.

2 Data collected

The present chapter provides an overview of the sites visited during the survey. Due to poor weather conditions and a restricted time plan, profile and current data was not collected from the Merasheen BMA.

These as well as additional profiles and longer current deployments will be conducted in January and February 2016 when the additional current readings will be collected as requested by the DFO.

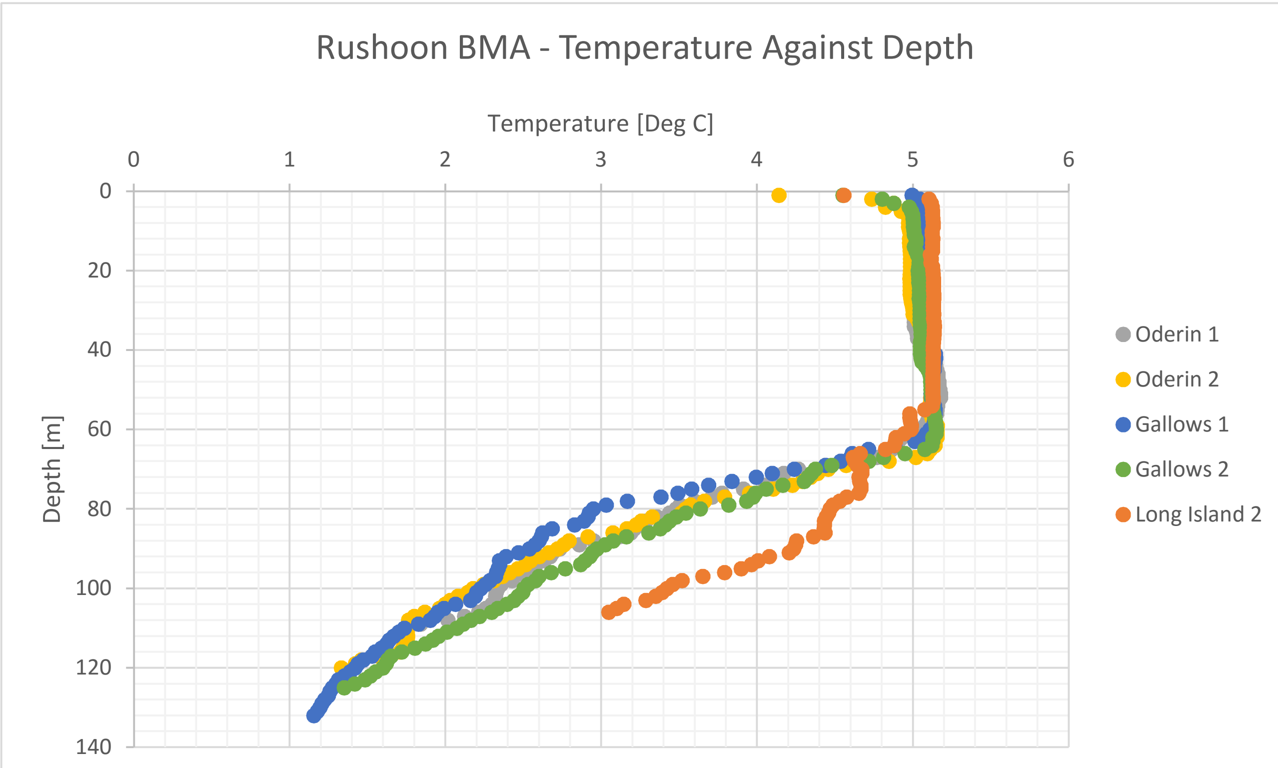
2.1 Rushoon BMA

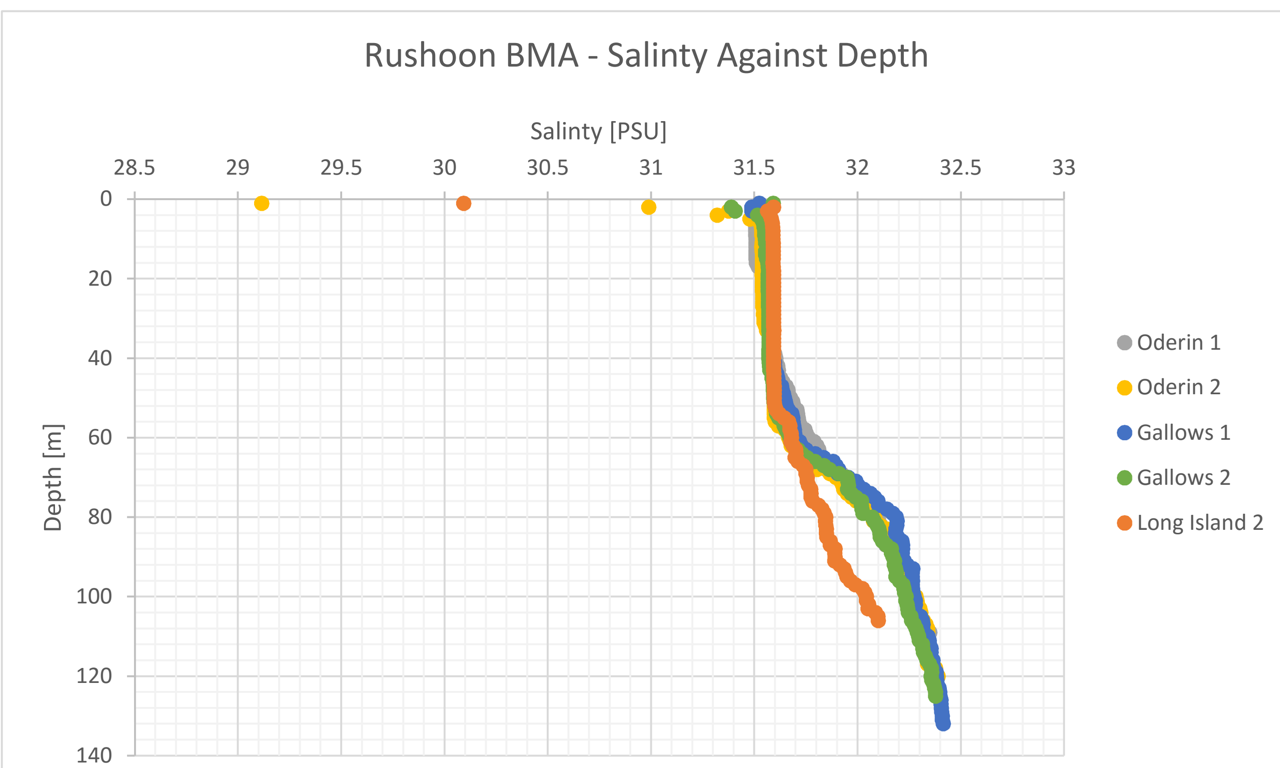
2.1.1 Profile Data

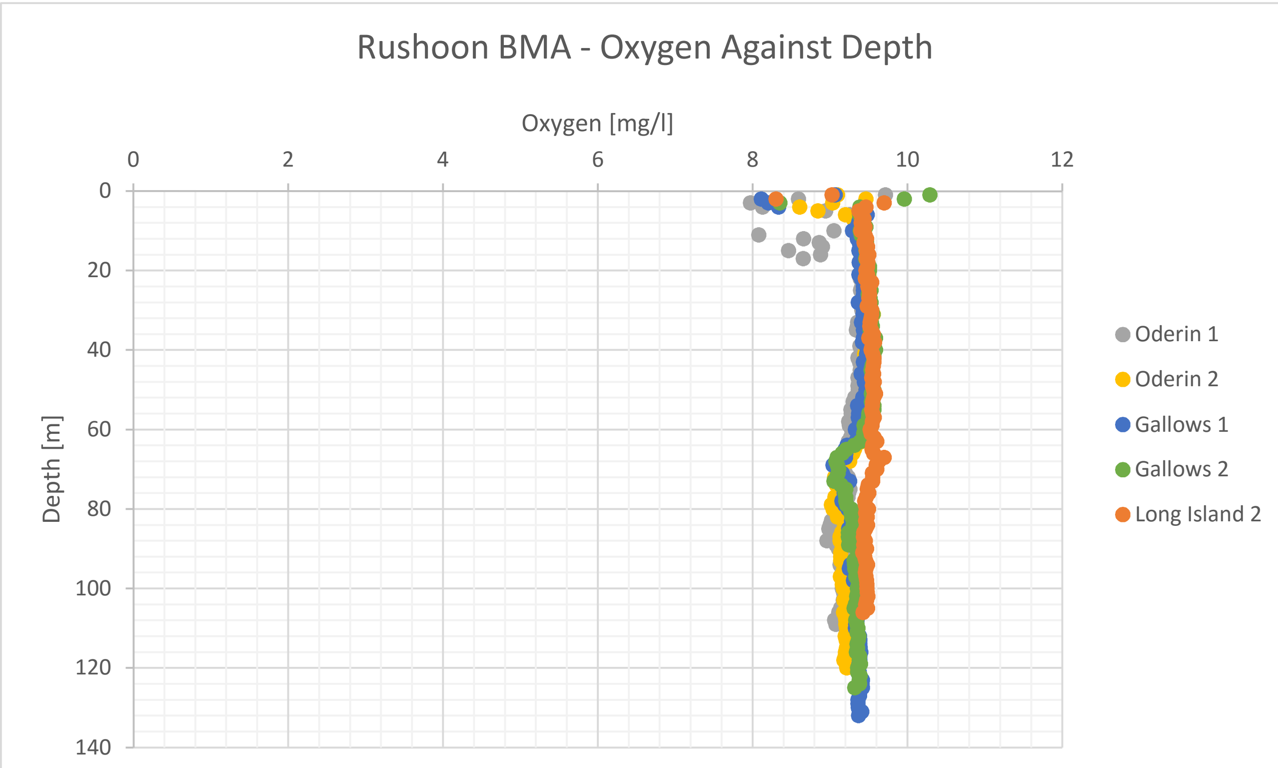
Profiles of the water column at the centre of each site were conducted on the following dates, all times are given in UTC.

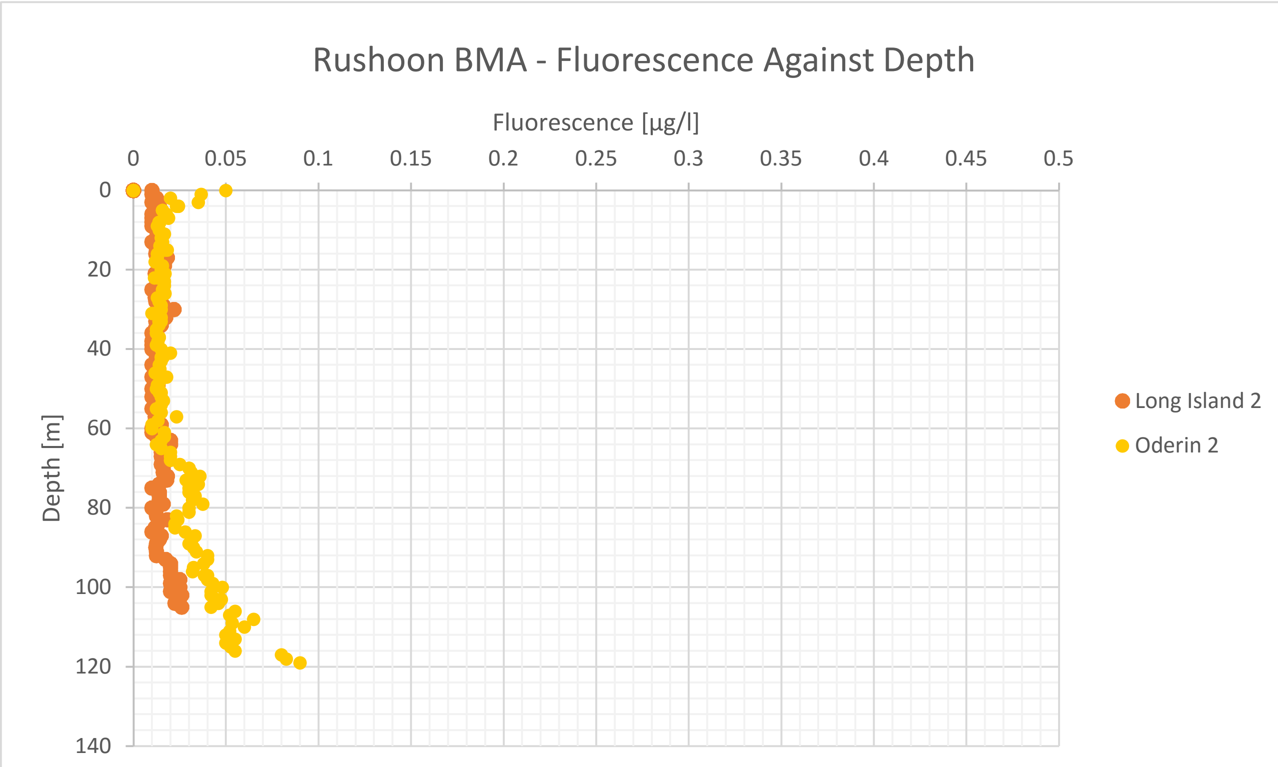
Times of casts:

Oderin Island 1: 08 Dec 2015 16:50:30
Oderin Island 2: 09 Dec 2015 13:03:01
Gallows Harbour 1: 08 Dec 2015 17:21:10
Gallows Harbour 2: 09 Dec 2015 12:23:29
Long Island 1: 08 Dec 2015 15:51:02 - Not presented due to poor data quality
Long Island 2: 09 Dec 2015 14:34:44


Rushoon BMA - Temperature Against Depth
Temperature [Deg C]
0
1
2
3
4
5
6
0
20
40
60
80
100
120
140
Depth [m]
Oderin 1
Oderin 2
Gallows 1
Gallows 2
Long Island 2


Rushoon BMA - Salinty Against Depth
Salinty [PSU]
28.5
29
29.5
30
30.5
31
31.5
32
32.5
33
0
20
40
60
80
100
120
140
Depth [m]
Oderin 1
Oderin 2
Gallows 1
Gallows 2
Long Island 2


Rushoon BMA - Oxygen Against Depth
Oxygen [mg/l]
0
2
4
6
8
10
12
Depth [m]
0
20
40
60
80
100
120
140
Oderin 1
Oderin 2
Gallows 1
Gallows 2
Long Island 2



Fluorescence readings from day 1 and Gallows Harbour on day 2 have been not been presented due to poor data quality.

2.1.2 Current Data

To represent current in the Rushoon BMA area the ADCP was placed at the follow coordinates.

Latitude: 47º 19.256' N
Longitude: 54º 44.274' W

The ADCP was deployed on the 8th of December 2015 at 15:30 UTC and recovered on the 9th of December at 13:30 UTC.

Unfortunately the deployment depth exceeded the planned depth so current data is only collected from 57m to 17m below sea level.

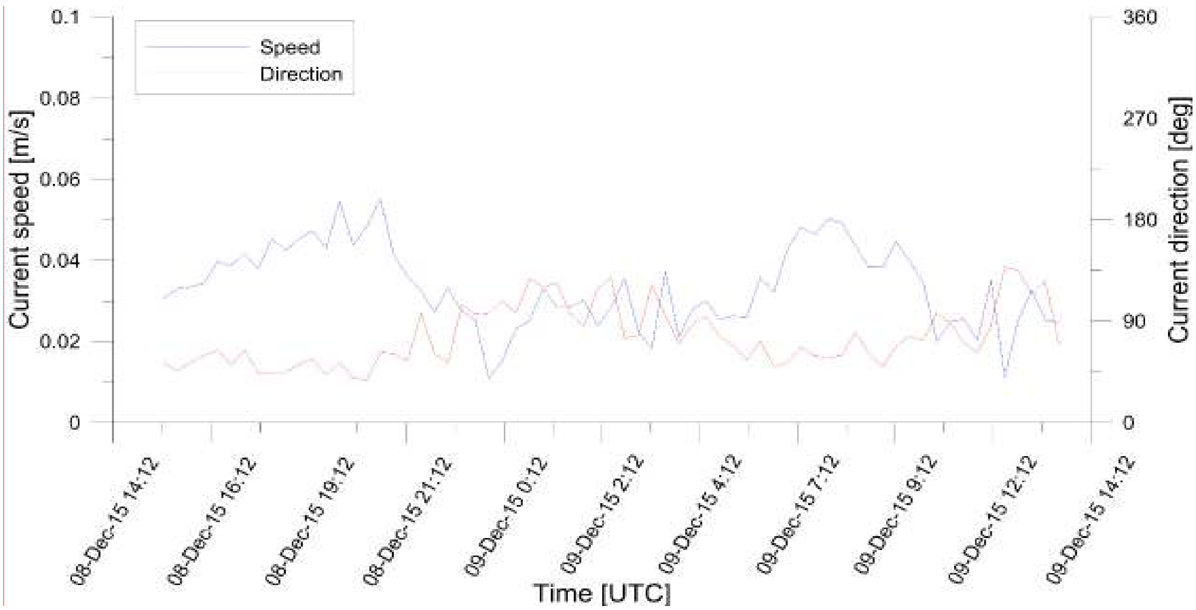


Figure 2-1 Current speed and direction for Rushoon site

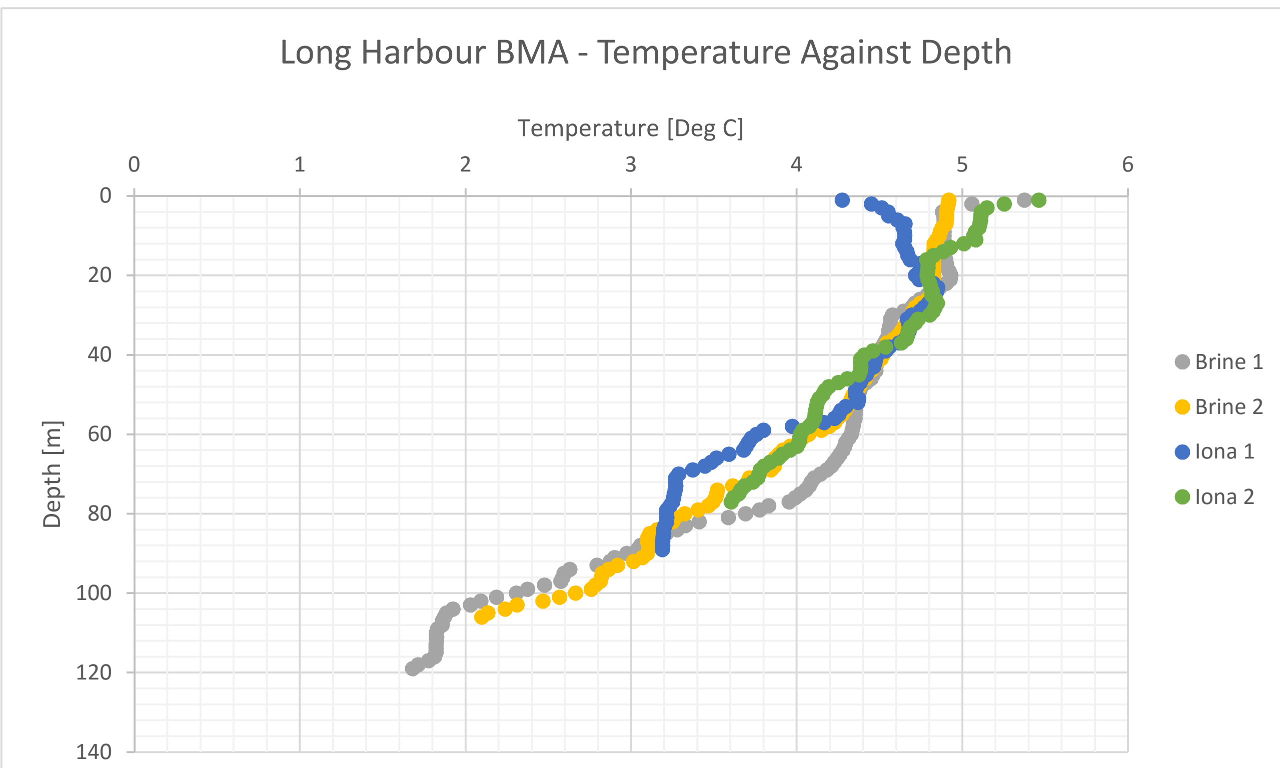
2.2 Long Harbour BMA

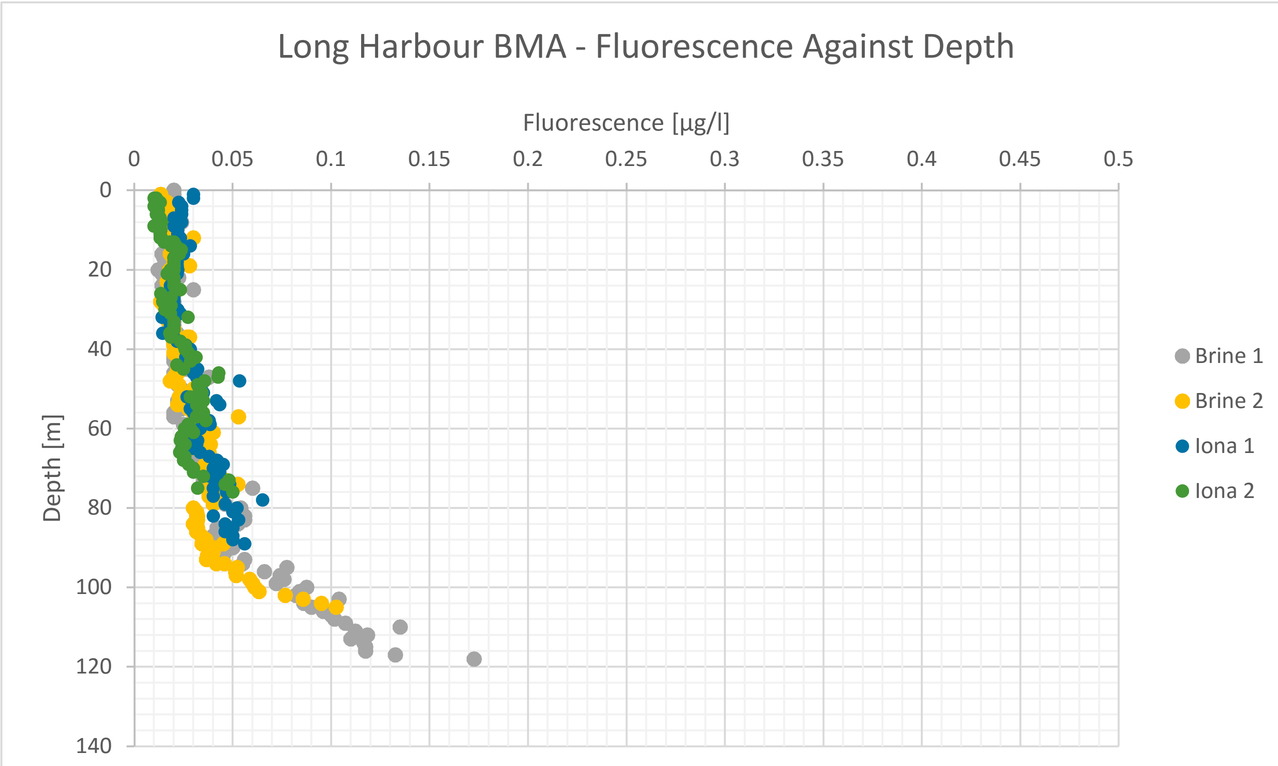
2.2.1 Profile Data

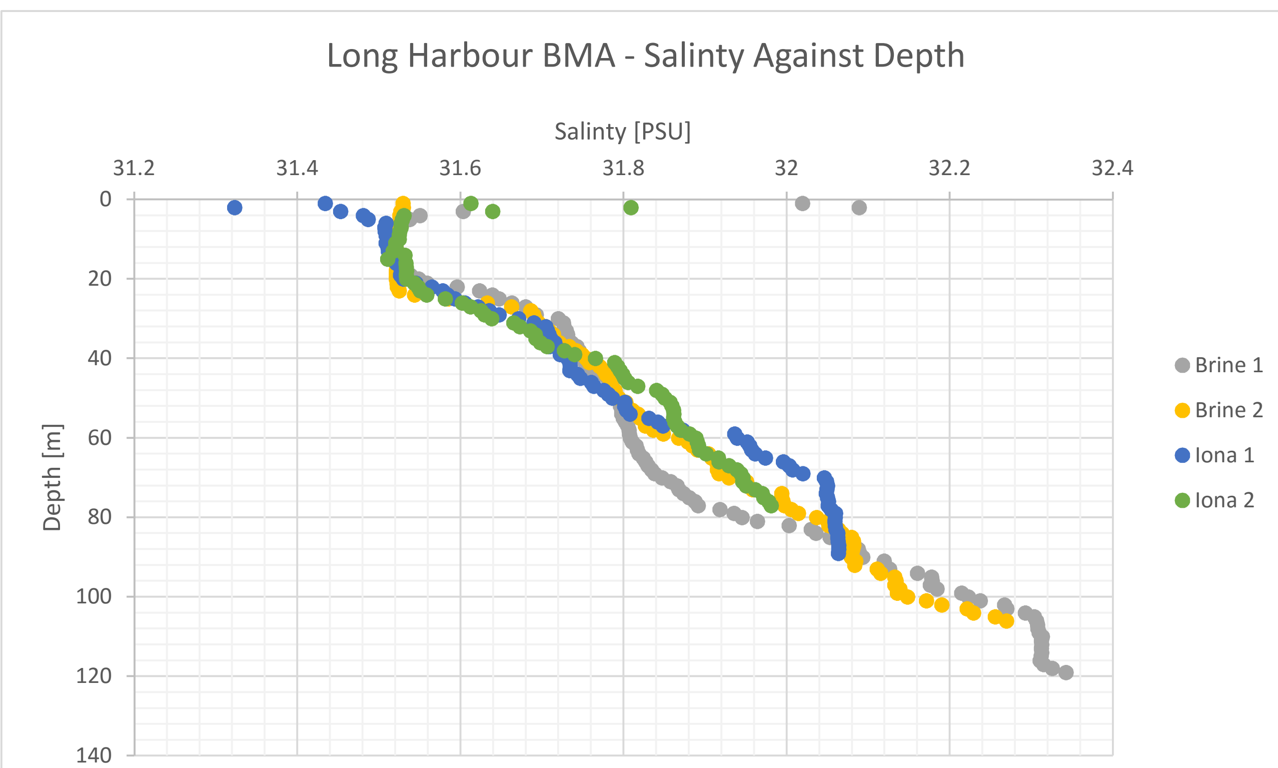
Profiles of the water column at the centre of each site were conducted on the following dates, all times are given in UTC.

<u>Times of casts:</u>

Brine Islands 1: 10 Dec 2015 12:49:26
Brine Islands 2: 11 Dec 2015 11:49:16
Iona Islands 1: 10 Dec 2015 13:21:18
Iona Islands 2: 11 Dec 2015 11:17:18




Long Harbour BMA - Fluorescence Against Depth
Fluorescence [µg/l]
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
Depth [m]
0
20
40
60
80
100
120
140
Brine 1
Brine 2
Iona 1
Iona 2


Long Harbour BMA - Salinty Against Depth
Salinty [PSU]
31.2
31.4
31.6
31.8
32
32.2
32.4
Depth [m]
0
20
40
60
80
100
120
140
Brine 1
Brine 2
Iona 1
Iona 2

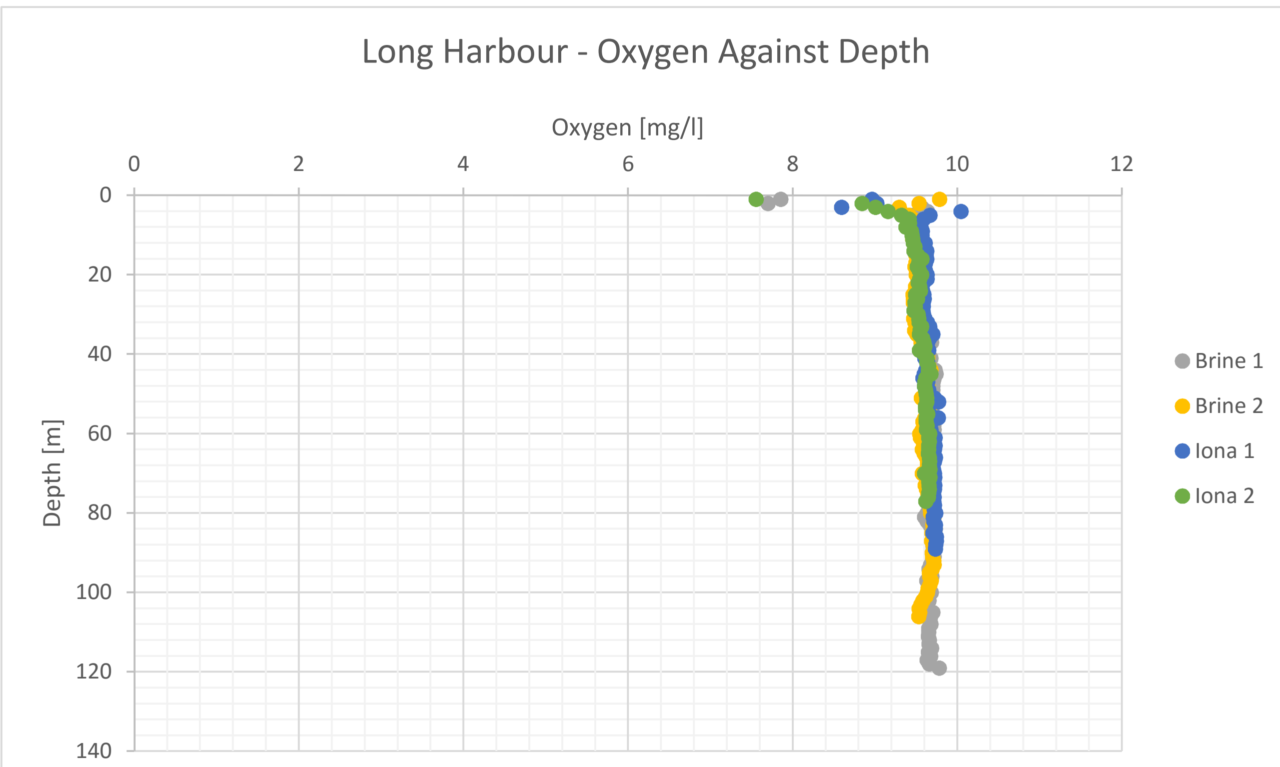
2.2.2 Current Data

To represent current in the Long Harbour BMA area the ADCP was placed at the follow coordinates.

Latitude: 47º 27.168’ N
Longitude: 53º 58.899’ W

The ADCP was deployed on the 10th of December 2015 at 12:30 UTC and recovered on the 11th of December at 11:30 UTC.

Current data is collected from 20m to the surface.



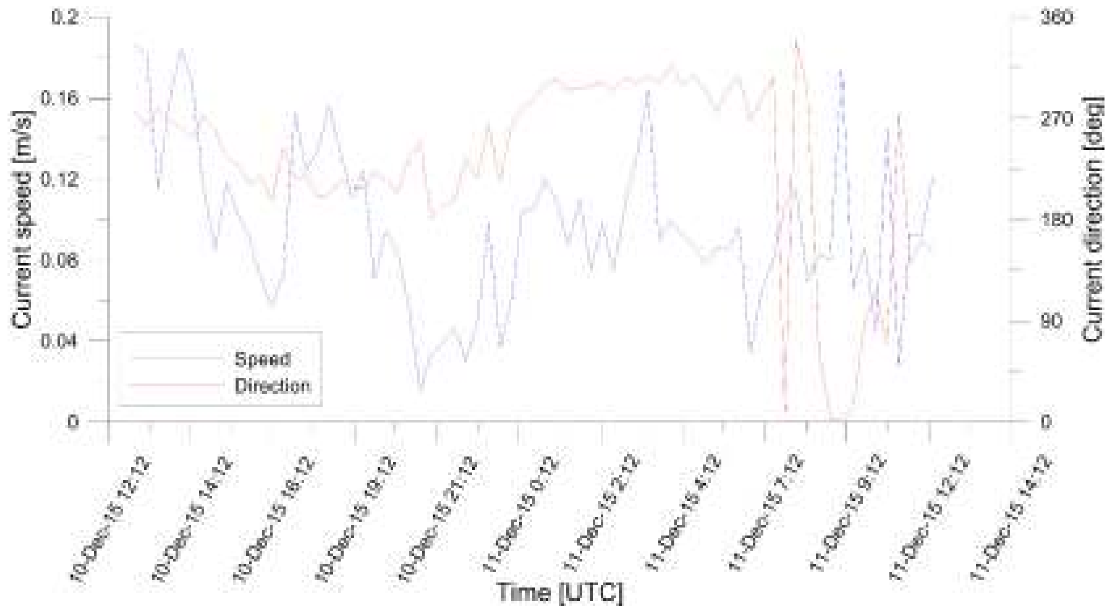


Figure 2-2 Current speed and direction for the Long harbour site

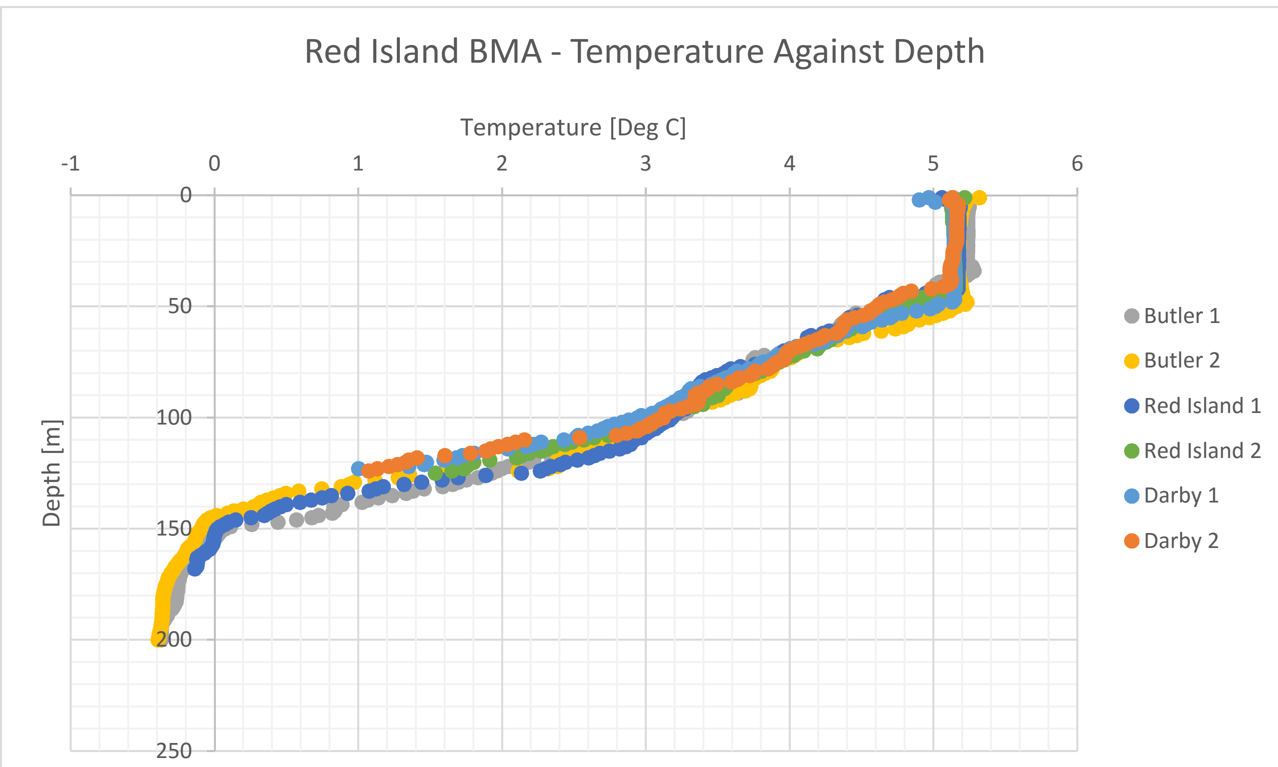
2.3 Red Island BMA

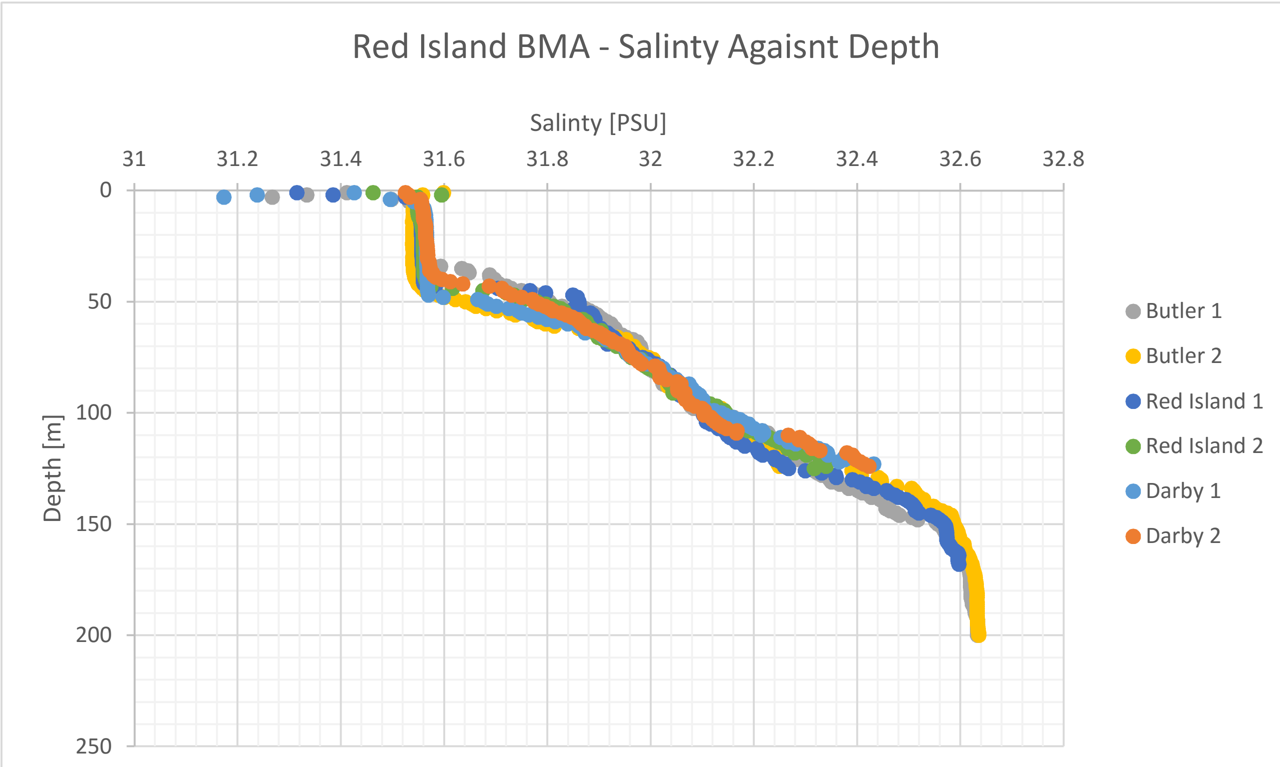
2.3.1 Profile Data

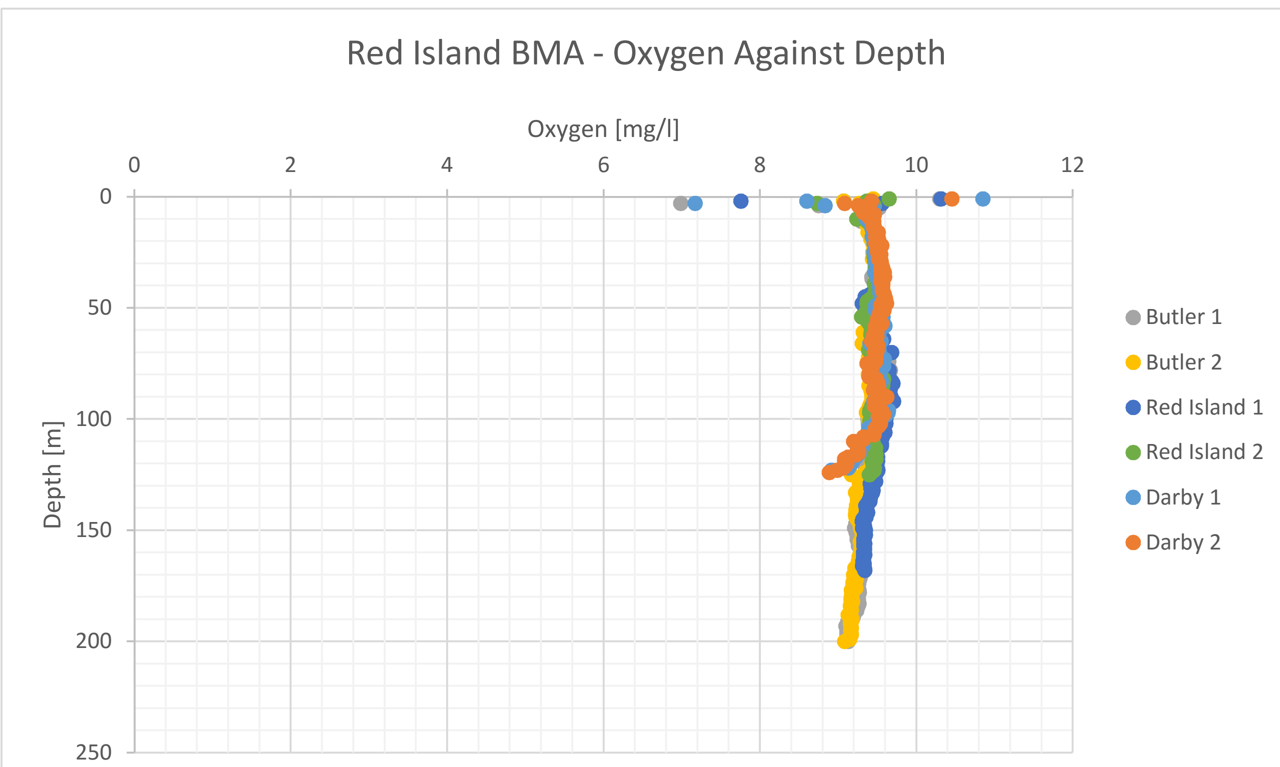
Profiles of the water column at the centre of each site were conducted on the following dates, all times are given in UTC.

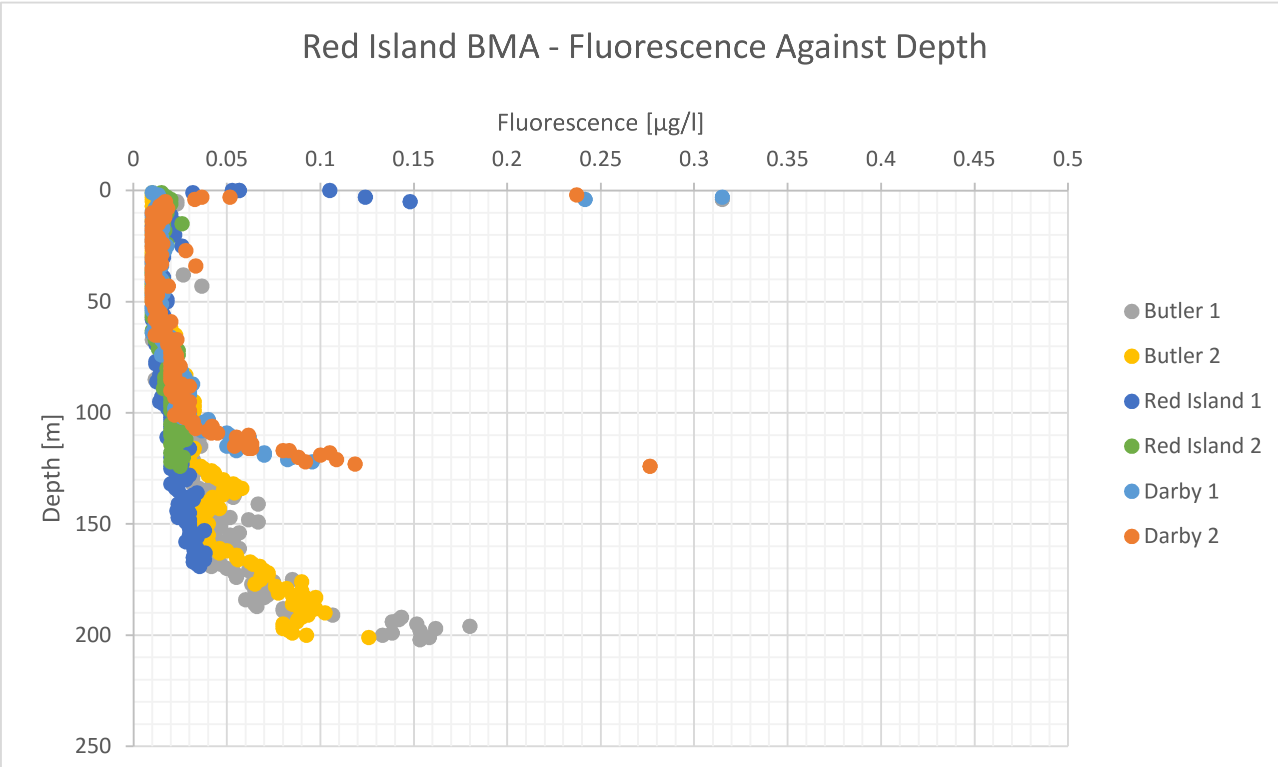
<u>Times of casts:</u>

Butler Island 1: 10 Dec 2015 15:18:35
Butler Island 2: 11 Dec 2015 15:24:07
Red Island 1: 10 Dec 2015 16:18:08
Red Island 2: 11 Dec 2015 14:39:36
Darby Harbour 1: 10 Dec 2015 17:09:44
Darby Harbour 2: 11 Dec 2015 13:55:00




Red Island BMA - Salinty Agaisnt Depth
Salinty [PSU]
31
31.2
31.4
31.6
31.8
32
32.2
32.4
32.6
32.8
0
50
100
150
200
250
Depth [m]
Butler 1
Butler 2
Red Island 1
Red Island 2
Darby 1
Darby 2


Red Island BMA - Oxygen Against Depth
Oxygen [mg/l]
0
2
4
6
8
10
12
0
50
100
150
200
250
Depth [m]
Butler 1
Butler 2
Red Island 1
Red Island 2
Darby 1
Darby 2



2.3.2 Current Data

To represent current in the Long Harbour BMA area the ADCP was placed at the follow coordinates.

Latitude: 47º 28.939' N
Longitude: 54º 11.200' W

The ADCP was deployed on the 11th of December 2015 at 12:30 UTC and recovered on the 15th of December at 11:30 UTC.

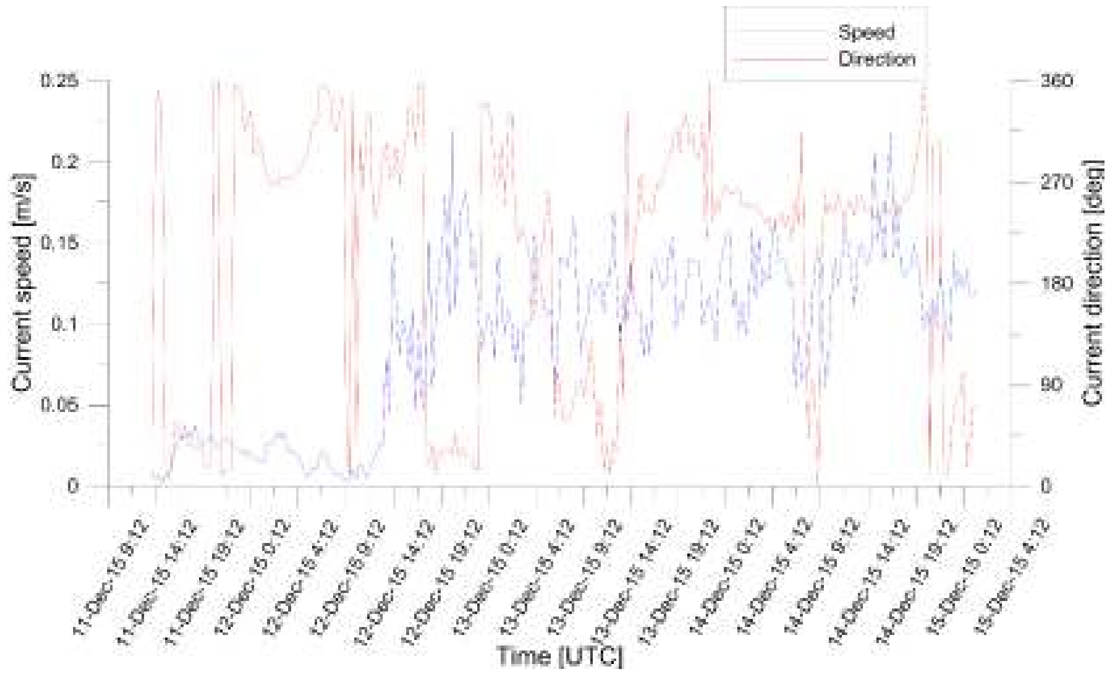


Figure 2-3 Current speed and direction for Red Island site

Consultations Report

Part I

April to October, 2015

Part II

November to December, 2015

Summary

The following is a brief overview of meetings held between April and October 2015 with various town councils, groups and organizations to introduce and discuss the proposed project by Grieg NL Seafarms Ltd. It is presented in chronological order and is the precursor to the private and public consultations formally undertaken by Grieg NL Seafarms in November and December of that year. *, ***, and *** below.

Initial Outreach Initiative – April - October, 2015

A meeting with the Town of Marystown was held to outline project basics to the Town Executive and ACOA and DBTCRD local representatives on April 14th, 2015.

A meeting in Boat Harbour took place with the Placentia West Development Association and Minister Clyde Jackman to outline the project on May 8th, 2015.

A meeting with fishers in Baine Harbour was held at the Harbour Authority to present the project and seek advice on the site plans on May 14th, 2015.

A meeting with fishers in Petit Forte at the former School now meeting hall happened to present the project and seek advice on the site plans on June 12th, 2015.

On June 19th, 2015, a meeting took place with fishers in Parkers Cove at the gear shed on the Harbour Authority wharf to present the project and seek advice on the site plans.

Meetings took place in Marystown June 24th to 25th, 2015 with the Burin Peninsula Chamber of Commerce. Presentation of the project took place at "Opportunity Placentia Bay". GNLSL became acquainted with representatives of the FFAW at that convention.

On June 25th, 2015 a meeting with the Town of Long Harbour took place to present the project and discuss a proposed mustering area and to arrange to meet fishermen of the area.

A meeting was held with the Town of Placentia on July 3rd, 2015 to present the project and request assistance to meet fishermen from the area.

A telephone conversation and an email was exchanged with Roland Hedderson of the FFAW on July 23rd, 2015. The email contained an attachment was the presentation to the Burin Peninsula Chamber of Commerce and the Site Plans. The email requested feedback from the FFAW on the site plans.

There was no response to this request to facilitate a response on these site proposals until after the meeting in Arnold's Cove. Then that was to meet the FFAW Executive.

A meeting took place in Arnold's Cove on September 15th at the Placentia Bay Integrated Management Committee. The company presented its' plans and took questions from the floor – all to a standing ovation at the end. In attendance was DFA, DFO and FFAW representatives as well as other interested groups. Grieg NL Seafarms had a side meeting and discussion with the two FFAW representatives with a special request to meet the FFAW Executive in St. John's which was agreed to.

A meeting was held in Boat Harbour on October 29th, 2015 with the Placentia West Development Association and representatives of the Burin Peninsula Chamber of Commerce to update on the progress of the project.

From the last meeting in Arnold's Cove to a meeting with the Executive of the FFAW on October 20th Grieg NL Seafarms was fully engaged in presenting its hatchery application, environmental assessment registration and business plans to the Provincial government. At the October 20th meeting Grieg NL Seafarms agreed to coordinate further direct engagement of fishers through the FFAW and it was agreed the union would arrange the meeting. These meetings at various mustering areas around Placentia Bay were set for the first week of December. (see part II)

*Not included on this list were various meetings with ACOA, DBTCRD, DFA, OSC, MI and DFO.

**Not included in the list are various meetings with the Town of Marystown to negotiate the well drilling and the purchase of hatchery property in the Marine Industrial Perk or the tax agreement.

***Not included in the list are various facilitation meetings between local supply and service companies with Aqualine and AquaMaof.

Part II

November to December, 2015

Summary

Over the course of November and December of 2015, Grieg NL Seafarms Ltd undertook a series of private and public consultations concerning the proposed aquaculture hatchery and 11 salmon aquaculture sites and 4 Bay Management Areas (BMAs) in Placentia Bay, Newfoundland, Canada. The requirements were threefold:

1. Conduct a scan of the employment resources and capacity available in the area to both inform and assess by means of a Community Outreach Exercise with the assistance of a consultant;
2. Conduct private consultations with area fishermen in conjunction with the Fisheries Food Allied Workers Union (FFAW [UNIFOR]) to provide a project overview and receive feedback on the sites and BMAs; and,
3. To fulfill the Department of Fisheries and Aquacultures' (DFA) requirement for Public Consultations in three designated locations covering the aquaculture sites in the Placentia Bay area.

Community Outreach Initiative – November, 2015

The community outreach program was implemented as a means of introducing Grieg NL Seafarms Ltd. to a number of communities in the Placentia Bay region of Newfoundland. These communities have the potential of being impacted by the proposed development of Grieg NL Seafarms Ltd operations in Marystown as well as from the four Bay Management Areas. A Consultant, Mr. Joe Bennet, was contracted to undertake a series of community engagements. He was given well defined parameters to operate within so as to ensure focus and success. The following summarizes his findings.

The Communities:

This phase of the community outreach initiative included the communities of:

- Petite Forte
- Baine Harbour
- Rushoon
- Parkers Cove
- Red Harbour
- South East Bite
- North Harbour
- Arnolds Cove
- Long Harbour

Also included in the mix were representative fishers from:

- Boat Harbour
- Come-By-Chance

Participants:

Overall 45 people participated in the first- round of the community outreach sessions and an additional 33 fishers from the region were noted who were unable to attend the sessions. The objective was to build a data base to assist with future communications and messaging.

The Approach:

The objective of the Community Outreach program was four-fold. The presentation was structured to introduce GNLSL to the residents, discuss the size and scope of the project and finally to introduce the opportunity as it relates to career and employment opportunities. The final element was a Q & A session. The Consultant made himself available to respond to any questions or objections and to allay concerns.

Consultant's Impressions:

Overall the project is being very well received by the communities that were visited. Fishers and community residents see and understand both the commerce as well as the community benefits that will be derived from the project. All communities expressed their appreciation that an effort was made by the company to come to the communities and meet with the fishers and to explain the project and the opportunities as well as answer questions.

Community Reports:

Petite Forte:

From all indications, the community is very supportive of the project. Two sessions were held in the community. One with private interviews and the other a town hall type meeting.

South East Bite:

Three fishers from South East Bite were invited to attend the Town Hall meeting in Petite Forte. The South East Bite fishers were supportive of the project and they value the employment opportunities.

Red Harbour:

This group is supportive of the project. They discussed the location of the sites and BMAs but in the end offered no objection to the location or the presence of the operation.

Baine Harbour:

The Baine Harbour meeting was held in the Community Centre. Once again the project was well received with questions surrounding the sites and BMA locations being responded to.

North Harbour:

The Consultant met with this group at the government wharf in North Harbour. This is a small quiet community and they are very keen to see economic activity located in their village. All the local fishers are excited about the possibilities and see the potential opportunity.

Arnolds Cove:

The consultant made a visit to Arnolds Cove. Nine people attended the session in Arnold's Cove of Saturday Nov. 28 at the Community Centre. Encroachment seemed to be the biggest issue. The consultant responded with an explanation of how small the actual project footprint is relative to the bay.

Rushoon:

There is only one commercial fisher in Rushoon and he is totally supportive of the project and is looking forward to opportunities.

Parkers Cove:

A meeting was held with the Mayor of Parkers Cove who informed the consultant that there are no commercial fishers operating out of the town. The town is fully supportive of the project and recognizes the potential economic of the project on the total area.

Long Harbour:

There are a limited number of fishers in the Community of Long Harbour. The Community is very supportive of the project and has written a letter of support.

Summation

The consultant's work was completed before the FFAW private consultations commenced. It was a very valuable exercise in that it provided a sketch of the communities Grieg NL Seafarms Ltd will be operation around. Perhaps the most valuable piece of information acquired from these sessions was the positive way the various communities perceive the project. These communities have been hard hit in recent years with declining populations, a reduction in the fishery and an aging population. The prospect of a stable industry bringing jobs and hope is being embraced by a large percentage of the people in these villages.

Private Consultations with fishermen in conjunction with the FFAW

The following is a brief overview of the sessions held with FFAW members in various locations around Placentia Bay. These sessions were held in conjunction with the union at their request.

Attendance:

- Marystown 6
- Baine Harbour 5
- Petite Forte 21
- Arnold's Cove 8
- Placentia 1

Observations:

Each session began with an overview presentation by Clyde Collier, Project Manager for Grieg NL Seafarms Ltd. Clyde explained the scope of the proposed project and answered concerns about aquaculture and it's affects on the wild fishery. He then screened an Aqualine video to show the type of sea cage installations would be used on the sites. Finally, Clyde showed the fishermen the locations of the sites and held discussions and addressed concerns.

The two FFAW representatives were observers for the most part taking notations and commenting during the last portion of the sessions. Overall the interaction with them was cordial and professional.

For the most part the first three sessions in Marystown, Baine Harbour and Petite Forte were of a positive nature with good project support expressed. Concerns expressed centered mostly around navigation close to the sites. Clyde Collier eased their concerns with clear explanations of how to approach sites and that Grieg NL Seafarms Ltd will not obstruct travel. The fishermen were very keen on hearing about employment opportunities with the company.

The session in Arnold's Cove was a little more vocal in nature but still quite civil. Mr. Collier answered questions mostly based on media and internet "opinion" by responding with factual and science based explanations. The main concerns surrounded encroachment in the bay area in general citing the oil industry, transport Canada anchorages, Vale and the need for compensation. Mr. Collier responded by contextualizing our footprint relative to the bay size and highlighting the positive aspects of the project.

The Placentia session was attended by a single fisherman but was quite beneficial on the whole as he was very knowledgeable about the region. He owns the largest enterprise out of Placentia and fishes outside Placentia Bay in 3PS. He informed us of a number of small craft fishermen who operate on the Eastern side of Placentia Bay based out of Fox Harbour, Ship Harbour and Fair Haven. He also noted they were aware of the meeting but still did not attend. The frequently used grounds do not appear to clash with the two proposed seasonal sites near Long Harbour based on his observations.

Grieg NL Seafarms Ltd employees noted that while these sessions were for all harvesters under the FFAW umbrella, many individuals were encountered after these meetings who claimed they were not notified. Grieg NL Seafarms Ltd undertook to accommodate as many of these harvesters by providing informal sessions within the time frame.

The primary observation taken from these very intensive three days is that none of the Harvesters met with could raise a compelling or valid reason why we should move any proposed sites. The concerns expressed seemed to be more based on the unknown and rumor than on fact.

Public Consultations – December 15, 16, 17, 2015

The Department of Fisheries and Aquaculture has a mandatory requirement for discourse in the form of Public Consultation as a precursor to licensing. The requirement is specifically to provide an avenue for the public to be informed about the project and to ask questions. Initially a single public consultation was required and scheduled for Marystown on December 15, 2015. A week before this date Grieg NL Seafarms Ltd was advised by DFA that they required three sessions in Marystown, Arnold's Cove and Long Harbour. The Marystown session had been advertised with local media sources. The mayors of Arnold's Cove and Long Harbour were contacted and Public Consultations were scheduled and advertised locally for the 16th and 17th respectively. The DFA also required consultation with town councils around the coastal area which was accomplished by the presence of the Burin Peninsula Joint Council at the Marystown Public Consultation. With the completion of these sessions, all DFA requirements have been met by Grieg NL Seafarms Ltd.

Consultation Format

Given the size of the sessions, it was decided to adopt a marketplace format to maximize access for the attendees. Ms. Lisa McLeod played host for the Consultation on behalf of the Marystown Chamber of Commerce. Perry Power of Grieg NL Seafarms Ltd hosted the two subsequent consultations in Arnold's Cove and Long Harbour.

The format involved brief overview presentations by Clyde Collier for GNLSL and Håkon Tønne for Aqualine with question and answer opportunity later. After the presentations, the public moved towards individual kiosks which afforded attendees the opportunity to ask questions and discuss issues. Clyde Collier hosted the environmental kiosk, Perry Power centered on employment and business opportunities and Håkon Tønne represented Aqualine at their kiosk to speak on the escape-proofing of cages. This ensured a timely process which gave proponents and opponents alike the opportunity to ask questions on an equal footing.

Various information posters were also formulated comprised of the following:

- Sites
- Vessels and Barges
- Hatchery
- Aqualine
- Triploids
- Sea lice Management

These were designed to provide the attendees with visual representations of aspects of the project.

Marystown – December 15, 2015

The Marystown Public Consultation held at the Marystown Hotel had 80 attendees. A large showing was demonstrated by the business community as well as local government. DFO and DFA employees were in attendance to observe. Grieg NL Seafarms Ltd canvased fishermen in the near communities who showed in good numbers. Information and the opportunity for questions were provided fulfilling the DFA requirement.

Arnold's Cove – December 16, 2016

There was a turnout of 10 people at the Arnold's Cove Consultation including one rep from DFO and one from DFA. The remainder comprised of the mayor, a manager from the local fish plant, two representatives from North Atlantic with the remainder being from the fishing community. The presentations went very well and given the very small turnout, a discussion was held afterwards which was cordial with many good questions. T hen it broke off with Perry power speaking to 4 people about employment and business opportunities

Mayor Basil Daley expressed his interest in the Grieg NL proposals and would like a meeting with council at some point in the new year with a tour of the town's capacity.

A fishing couple was encountered with whom Grieg NL Seafarms Ltd had not made contact with before. They provided valuable information on fishing locations and depths and indicating that the shallowest the fished crab was 80 fathoms.

Long Harbour – December 17, 2015

The Public Consultation Process requirement was completed with a session in Long Harbour. This was preceded with a meeting with the town council. The response to both sessions were very positive with 48 people attending the consultation portion. Representatives from DFO and DFA were once again in attendance. It is notable that the marketplace strategy was again employed and the DFA representative expressed that she felt it worked well. Once again, very little opposition was expressed at this session and the tone was extremely positive.

Subsequent Meetings with Fishermen – December 21 and 22, 2015

As a result of contact outside the FFAW Private Consultations, meetings were held with fishermen from Southern Harbour and Boat Harbour on successive nights. Both meetings were cordial and very informative for both parties.

Global Conclusion

The primary conclusion to be drawn from all these sessions is that the Grieg NL Seafarms Ltd proposal is a very welcome development for the Placentia Bay area. Towns and the Business Community are encouraged by the opportunities that might develop. Fish harvesters have presented some concerns around encroachment but they seem to be around the totality of activity in the bay as opposed to the project specifically. No viable reasons were presented to withdraw site proposals or BMA's. Valuable information was received around orientation of the sites which Grieg NL Seafarms Ltd has acted upon. Government representatives have been most encouraging and cooperative. Grieg NL Seafarms Ltd has established a positive image through these consultations. The information gathered will be very useful as the project moves forward.

Project Description

GRIEG NL SEAFARMS LTD.

This document describes technical solutions proposed for Grieg NL Seafarms LTD fishfarms at Newfoundland.

Date/Location: 18.01.2016 / Trondheim

Written by: Hans-Olav Ruø / Håkon Tønne / Martin Søreide

Revision number: 04

aqualine
Strength counts

Strength Counts

Contents

Strength Counts

General Info

Standards and Regulations

NS9415:2009, which is a governing technical Standard for floating fish farming installations. NS9415 is based on extensive work from Norwegian Authorities as well as research and key vendors in the industry. This Standard gives recommendations and regulations on important aspects as:

- Material Specifications
- Design Approach with respect to analyses methods and testing
- Material and Load factors for Serviceability Limit State (SLS), Ultimate Limit State (ULS) and Accidental Limit State (ALS). Fatigue Limit State (FLS) is also specified.
- Net Specifications
- Environmental Specifications

The design approach achieved by applying NS9415 results in systems with high reliability and good integrity. Furthermore, extensive in-house experience at Aqualine also contribute to even higher reliability on the installations.

General Information – Aqualine Design

Floating fish farming installations are complex structures including a large number of components for floating collars, mooring, nets and other accessories. Hence, experience and good knowledge on design, operation and risk assessment is very important in order to understand concepts and make designs with highest reliability. Furthermore, mutual understanding between Aqualine and the customer on how to operate the systems is a key for low service costs and reliable operation phase.

Aqualine has delivered equipment to the fish farming industry in the toughest and most demanding oceans in the world for more than 35 years.

In Aqualine, the maritime understanding is in the marrow. We respect the ocean and know the forces of nature.

Therefore, we do not confine ourselves to formulas and calculations, but do what is possible to ensure that the equipment will withstand the applied loads. We subject the equipment to tough tests; we tear and pull it, in order to find out whether the theoretical calculations correspond to reality. In this manner, we ensure a good environment and safety for fish and men.

The Aqualine design focuses on robust solutions and concepts that integrate floating collars, mooring and nets into one system. This philosophy is based on several years of research and evaluations, e.g. extensive work at the model basin at Marintek in Trondheim. Hence, Aqualine ensure our customers a redundant structural design with respect to the following design criteria (ref NS9415):

1. *Serviceability Limit State*
2. *Ultimate Limit State*
3. *Accidental Limit State*
4. *Fatigue Limit Stage*

The floating collars are designed with a structural circumferential bearing system consisting of steel tendons connected to the steel brackets by bolts. This main structural system is very important in order to withstand the mooring loads acting on the cages. Furthermore, there is redundancy in the buoyancy of the pipes with polystyrene blocks inside the pipes.

The nets are fabricated at our partner factories at King Chou in China and Vietnam. This factory has extensive competence on net production, and the Aqualine nets are developed through years of testing and follow-up for qualification.

The mooring systems and components are developed through many years of experience with design, testing and operation of such systems. All components are of the best quality. Analyses are performed in-house in the Marine Engineering Department.

For more information on all equipment see www.aqualine.no.

Environmental Conditions

The dimensions of floating collars, nets and moorings in this description may change when detailed environmental conditions for the sites are presented.

Marine Operations

There are numerous different marine operations related to installation and operation of the fish farming sites. At project execution Aqualine will work with Grieg NL Seafarms LTD on risk assessments related to these operations. This will also include redundancy positioning for well boats close to the barges.

Strength Counts

Midgard® System Design

Aqualine® Midgard System is the result of several years of determined work to find new and better solutions within aquaculture cage technology; floating collar, sinker tube and fish net. Special attention has been given to reduce the risk of fish escape, but also to find solutions for more improved and safer working conditions for the fish farm workers. Furthermore, we want to find solutions which make it easier for the fish farmer to farm fish in more exposed locations.

In addition to the work we have initiated ourselves, we have also, in close co-operation with Lerøy, Marine Harvest and Salmar, participated and carried out several projects to find improved cage solutions. From 2012 to 2016, several rounds of Model Testing at the ocean basin at Marintek in Trondheim have been performed. This has been important to fully test and verify the proposed solutions and, to identify the best design and combination of floating collar, sinker tube and fish net. Several full-scale commercial tests have also been carried out, with very good results.

Aqualine AS recently achieved an award from NHO (Confederation of Norwegian Enterprise) in Norway for the development and implementation of the Midgard® System. This is a great recognition for Aqualine AS and our customers, as the award was given because of our work on reducing risk for fish escape and making daily operations easier for the customer. More information about the award can be found at the Press Release on NHO homepage. It is written in Norwegian.

The Midgard® System is now patented.

Strength Counts

Strength Counts

The Midgard® System consists of the following key attributes:

- Newly designed fish net in which the sinker tube is connected directly to the net's baseline rope, with the total weight of the sinker tube coming onto the net. Additionally the sinker tube lifting and lowering ropes when not in use are completely loose and independent of the net tensioning system. This totally eliminates the risk of these ropes coming in contact with the net and potentially causing net wear or damage.

- A system where power winches are built into the cage for lifting and lowering the sinker tube with fish net connected. This can be done at a fully synchronised gradual and constant lifting speed for the full circumference of the cage, all done in a totally controllable operation. This operation can easily be performed in a fast and efficient manner, without endangering the fish stocks contained within the net or most importantly not putting the farm workers operating the system at a safety risk. To power this winching system only requires one portable electric generator (mounted on a boat) to power all the winches involved, with no requirement for numerous service boats with hydraulic cranes fitted.

- An improved customised fish net design and net tensioning system where all components complement one another to provide a total integrated cage solution. This provides for optimal interaction and interplay between an adapted sinker tube i.e. correctly ballasted with increased structural rigidity and the Midgard fish net and cage collar.

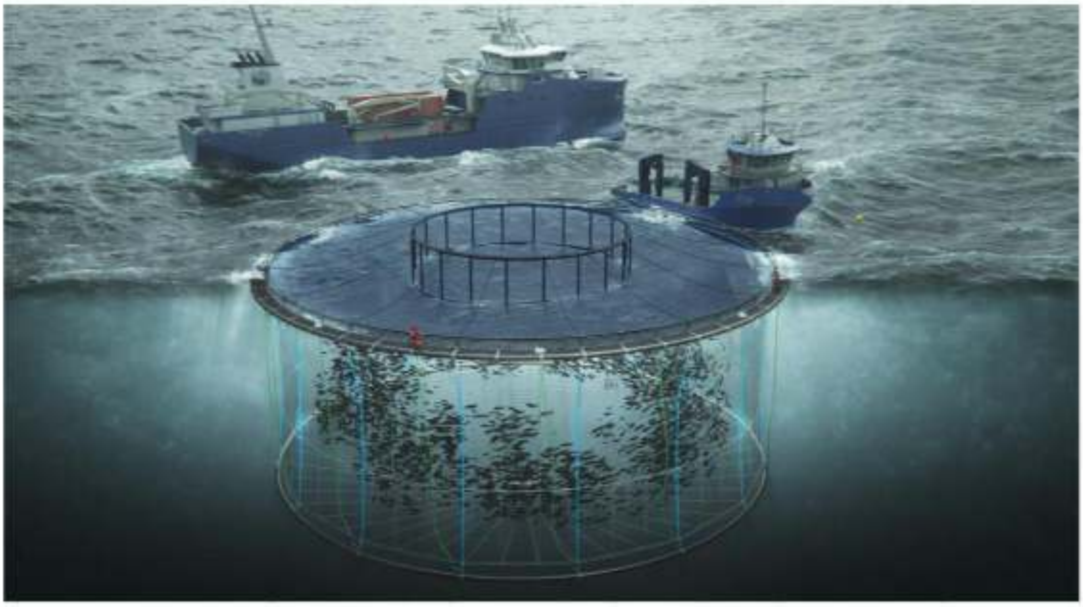


FIGURE 1 Aqualine Midgard® System

Strength Counts

Reference List and Commercial Information

Until 2016 Aqualine AS has sold about 450 Midgard® Systems, which we feel is a good recognition of the work we have done. A lot of the Midgard® Systems are installed at very exposed locations. This is because of the detailed qualification work that has been done with respect to feasibility check and dimensioning of components and the total configuration. Here is an updated reference list for the Midgard® System:

- Lerøy
- Salmar
- Salmar Nord
- Marine Harvest Midt Norway
- Bjørøya Fiskeoppdrett
- Ervik Laks & Ørret
- Marine Harvest Faeroe Islands
- Marine Harvest Scotland
- Luna, Faeroe Islands
- Sulefisk

Complete reference list is given below:

Alsaker Fjordbruk	Knutshaugfisk	Røvær Fjordbruk
Aqua Gen	Kobbevik & Furuholmen	Salmar
Atlantic Halibut	Kvamsdal Fiskeoppdrett	Salmar Nord
Ballangen Sjøfarm	Lerøy Hydrotech	Salmar Rauma
Bjørnøya Fiskeoppdrett	Lerøy Midnor	Salmones Humboldt, Chile
Bolstad Fjordbruk	Lerøy Austevoll	Salmones Pacific Star, Chile
Bremnes Seashore	Lighthouse Caledonia, Scotland	Scottish Sea Farms
Brilliant Fisekopprett	Marine Harvest Norway	Senja Sjøfarm
Claire Island Seafarms, Ireland	Marine Harvest Canada	Sinkaberg-Hansen Fiskeoppdrett
Erfjord Stamfisk	Marine Harvest Færøyene	Sjøtroll Havbruk
Ervik Laks & Ørret	Marine Harvest Ireland	Svanøy Havbruk
EWOS Innovation	Marine Harvest Scotland	Toftøysund Laks
Firda Sjøfarmer	Midt-Norsk Havbruk	Tombre Fiskeanlegg
Fjellberg Fordbruk	Måsøval Fiskeoppdrett	Tysnes Fjordbruk
Fjord Marin Cod	NRS Feøy Fiskeoppdrett	Vestles, Faroe Islands
Fjord Seafood	Open Blue Sea Farms Panama	Vest Marin Produksjon
Grieg Cod Farming	Pan Fish P/F Luna	Veststar
Grieg Seafood	Petuna Aquaculture, Tasmania	Aakvik Settefisk
Hjaltland Seafarms, Shetland	Phuket Aquaculture Research Station, Tailand	Åmøy Fiskeopprett
Huon Aquaculture, Tasmania	Russian Salmon	

As an example, Marine Harvest is one of our biggest customers worldwide. Aqualine AS has delivered about 80% of the total cage demand for Marine Harvest Worldwide the last 10 years.

Aqualine AS sells a large number of cages every year with circumferences from 120m to 200m to salmon producers worldwide. About 15-25% of the total sale is export.

Strength Counts

Strength Counts

Cages

Two different Cages are presented:

1. FR500-160m with Midgard® Sinker Ring System
2. FR630-200m with Midgard® Sinker Ring System

FR500-160m General Specifications

- Each Cage consists of Double Floating Rings
- Material PE100
- Floating Tubes Outer Diam. 500mm
- SDR13.6 – Wall Thickness 36.8mm
- Internal Circumference 160m for cage
- Walkway Sections
- Steel Hot Dip Galvanized Brackets for Tube Connections, 48 pcs.
- Steel Mooring Brackets for Anchoring Connections, 12 pcs
- Structural Load Bearing System all around the circ, unique Aqualine
- Including Hand rails, PE80, Diam. 140mm, SDR11 (12.7mm)
- Plastic Fenders attached to brackets to avoid damages on workboats
- Inside Fenders to prevent net abrasion
- Full set of Hook Protector made of HDPE (HSE device)

Sinker Tube Specification fo FR500-160

- PE80, Diam. 400mm, SDR11 (36.4mm)
- Hanging in 20pcs Dyneema Suspension Ropes
- “Dead weight” approx. 60kg/m

FR630-200m General Specifications

- Each Cage consists of Double Floating Rings
- Material PE100
- Floating Tubes Outer Diam. 630mm
- SDR13.6 – Wall Thickness 46.3mm
- Internal Circumference 200m for cage
- Walkway Sections
- Steel Hot Dip Galvanized Brackets for Tube Connections, 60 pcs.
- Steel Mooring Brackets for Anchoring Connections, 12 pcs
- Structural Load Bearing System all around the circ, unique Aqualine
- Including Hand rails, PE80, Diam. 160mm, SDR11 (14.5mm)
- Plastic Fenders attached to brackets to avoid damages on workboats
- Inside Fenders to prevent net abrasion
- Full set of Hook Protector made of HDPE (HSE device)

Sinker Tube Specification for FR630-200

- PE80, Diam. 500mm, SDR11 (45.45mm)
- Hanging in 24pcs Dyneema Suspension Ropes
- “Dead weight” approx. 100kg/m

Strength Counts

Mooring System, 1 Million Salmon Site

For detailed drawings on 1x6 grid mooring see attachment G.

For detailed drawings on Barge mooring see attachment I.

Grid Mooring and Barge Mooring

The grid mooring is based on 6 cages in line.

The Barge mooring is based on worst case for the 400T barge and 1000T barge.

The mooring system configuration and prices are based on preliminary dimensions on this stage and will be changed when more detailed environmental data is presented to Aqualine.

Mooring Analyses

The Mooring Analyses are performed according to NS9415.

By applying the reported significant wave height of 2.5m and current of 0.5m/s the evaluated site is Long Island.

Measured current velocity of 0.5m/s implies a 50 year return current velocity of 0.925m/s. This current is applied for directions at the site which are typical with respect to the present topographic landscape available. For other directions, a current velocity of 0.5m/s is applied in addition to waves calculated according to methods from NS9415. These assumptions are conservative and result in heavy mooring systems with Aqualine double grid mooring system.

Drawings

The grid mooring calculations are based on Midgard cylindrical nets. The barge mooring drawings is applicable both for 400T and 1000T barge.

Strength Counts

Strength Counts

Mooring System, 2 Million Site

For detailed drawings on 1x13 grid mooring see attachment H.

For detailed drawings on Barge mooring see attachment I.

Grid Mooring and Barge Mooring

The grid mooring is based on 1x13 grid as requested, with an empty frame for the barge.

The Barge mooring is based on worst case for the 400T barge and 1000T barge.

The mooring system configuration and prices are based on preliminary dimensions on this stage and will be changed when more detailed environmental data is presented to Aqualine.

Mooring Analyses

The Mooring Analyses are performed according to NS9415.

By applying the reported significant wave height of 2.5m and current of 0.5m/s the evaluated site is Long Island.

Measured current velocity of 0.5m/s implies a 50 year return current velocity of 0.925m/s. This current is applied for directions at the site which are typical with respect to the present topographic landscape available. For other directions, a current velocity of 0.5m/s is applied in addition to waves calculated according to methods from NS9415. These assumptions are conservative and result in heavy mooring systems with Aqualine double grid mooring system.

Drawings

The grid mooring calculations are based on Midgard cylindrical nets. The barge mooring drawings is applicable both for 400T and 1000T barge.

Strength Counts

Midgard® Fish Net (Cylindrical)

Midgard® Net, 160 m circumference

Data on 30m deep net (base rope) is given herein.

For detailed specification of 23m deep net (base rope) see Appendix B attached.

For detailed specification of 30m deep net (base rope) see Appendix C attached.

Specifications

• Note type	Cylindrical (Wall side and cone)
• Netting material	AL Ultra (Dyneema)
• Mesh Size	17.5 mmsq (measured knot centre to knot centre)
• Colour	White, UV Stabilized
• Breaking strength NET MESH	106 kg
• Weight per m^2	180 grams
• Estimated weight, complete net	3116kg
• Antifouling	Not Required

Overall Dimensions

• Waterline Circumference	160m
• Side wall depth	30m
• Jump fence height	1.2m
• Cone base Depth	13m
• Total Depth net	43m
• Calculated Cubic Capacity	69 945m^3

Frame Rope Dimensions

• Tope Rope	1 pcs 160m, 24mm hard laid PP AL Blue
• Main Rope	1 pcs 160m, 24mm hard laid PP AL Blue
• Waistline Ropes	5 pcs 160m, 24mm hard laid PP AL Blue
• Base Rope	1 pcs 160m, 24mm hard laid PP AL Blue
• Suspension Ropes	20 pcs 28.6m, 30mm hard laid PP AL Blue
• Vertical Ropes	40 pcs, 24mm hard laid PP AL Blue
• Cross Ropes (fish net base)	20 pcs, 30mm hard laid PP AL Blue

Strength Counts

Midgard® Net, 200 m circumference

Data on 30m deep net (base rope) is given herein.

For detailed specification of 23m deep net (base rope) see Appendix D attached.

For detailed specification of 30m deep net (base rope) see Appendix E attached.

Specifications

• Note type	Cylindrical (Wall side and cone)
• Netting material	AL Ultra (Dyneema)
• Mesh Size	17.5 mmsq (measured knot centre to knot centre)
• Colour	White, UV Stabilized
• Breaking strength NET MESH	106 kg
• Weight per m^2	180 grams
• Estimated weight, complete net	3923kg
• Antifouling	Not Required

Overall Dimensions

• Waterline Circumference	200m
• Side wall depth	30m
• Jump fence height	1.2m
• Cone base Depth	13m
• Total Depth net	43m
• Calculated Cubic Capacity	109 289m^3

Frame Rope Dimensions

• Tope Rope	1 pcs 160m, 24mm hard laid PP AL Blue
• Main Rope	1 pcs 160m, 24mm hard laid PP AL Blue
• Waistline Ropes	5 pcs 160m, 24mm hard laid PP AL Blue
• Base Rope	1 pcs 160m, 24mm hard laid PP AL Blue
• Suspension Ropes	24 pcs 28.6m, 30mm hard laid PP AL Blue
• Vertical Ropes	48 pcs, 24mm hard laid PP AL Blue
• Cross Ropes (fish net base)	24 pcs, 30mm hard laid PP AL Blue

Strength Counts

Bird Net

Bird Net, 160m circumference and 200m circumference

Specifications

• Note type	Bird net
• Netting material	HDPE
• Mesh Size	250 x 250 mmsq.
• Colour	Blue
• Dimension	160m and 200m circumference
• Poles	20 pcs. GFRP Net Poles for 160m cage 24 pcs. GFRP Net Poles for 200m cage

FIGURE 2 Bird Nets and Poles

Strength Counts

Midgard® Winch System (accessories)

Winches and Control Unit for 160m Cage and 200m Cage

Specifications

• Number of Winches	10 pcs (160m) / 12 pcs (200m)
• Power and Effect	240 Volt / 500 W each
• Lifting Ropes	10 pcs (160m) / 12 pcs (200m), 14mm Dyneema Blue
• Brackets	Steel Galvanized Brackets fitted
• Control Unit for winches	Including Remote Control and Cabinet

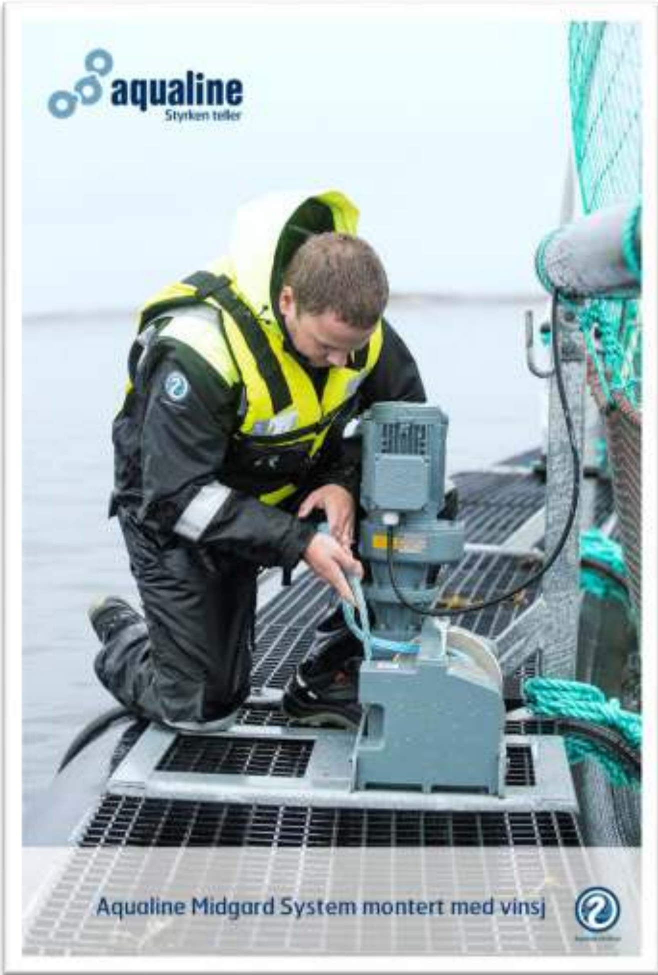


FIGURE 3 Midgard® Winch System

Strength Counts

Barge and Accessories

A number of accessories and a barge is also proposed. Some of this equipment is listed below.

Feed Barge (400t)

The 400 T feed barge is delivered in cooperation with company Steinsvik.

Reference is made to Appendix F “Barge Drawings 300 Canada”.

Please note that the Barge drawings here is for 300T Barge. Detailed drawings for 400T barge will be sent.

Mort Handling System

The Mort Handling System is delivered by company LiftUp.

For detailed information on the system see www.liftup.no.

Feed Spreaders

Feed Spreaders and accessories are delivered by company Steinsvik.

Feeding Hose

Feeding hoses are produced by Hallingplast in Norway on Aqualine specification. These hoses are fully tested on Sintef in Trondheim and approved.

The hoses are 90mm SDR 13.6 anti-static in white colour.

Ensilage System

The ensilage system is delivered by Steinsvik.

Detailed specification is given in Appendix J “Ensilage System”.

Documentation at Delivery

Aqualine will emphasize the importance of good documentation of all phases and subjects including:

- Engineering and design
- Production
- Certificates
- Test reports
- Logistics and components lists
- User Manuals
- Drawings

All documentation is written according to NS9415 in English.

Strength Counts

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Strength Counts

Strength Counts

Company Information

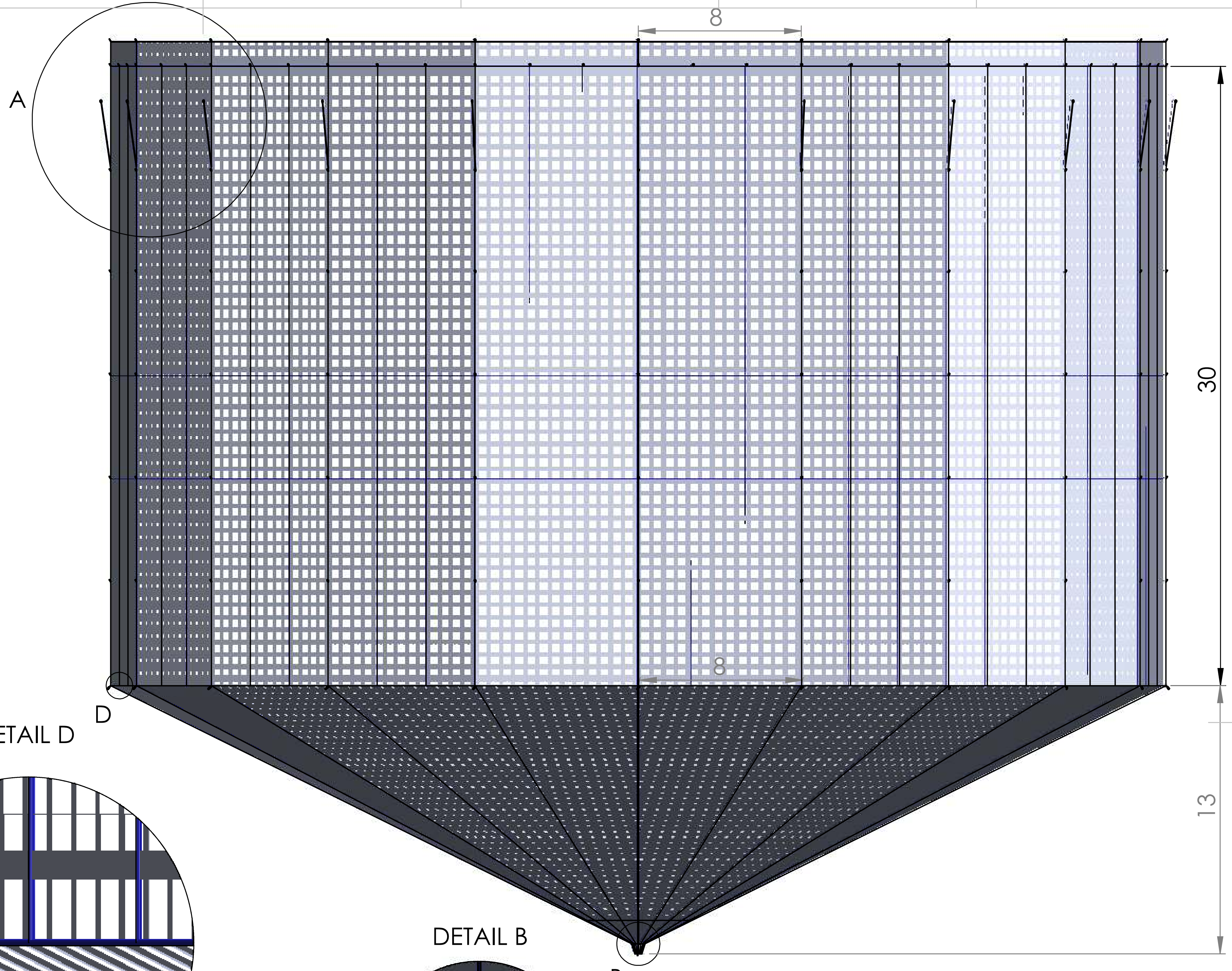
Aqualine AS

Trondheim / Hammarvika

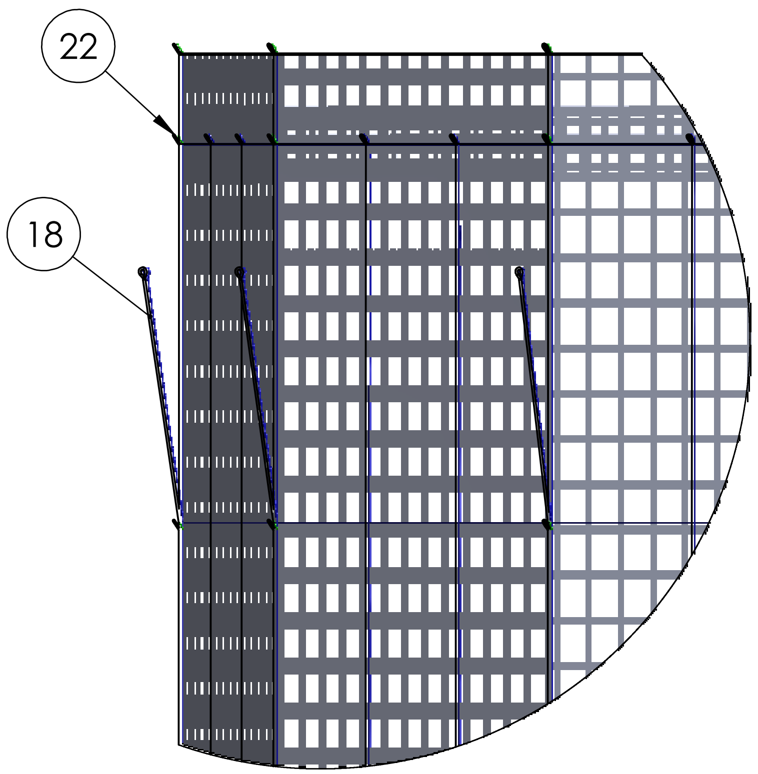
Tlf. +47 73 80 99 30

www.aqualine.no

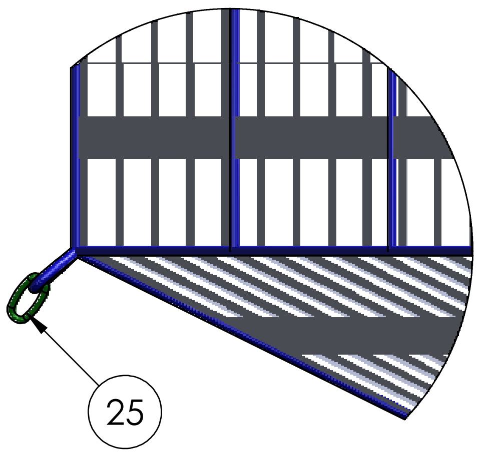
ITEM NO.	PART NUMBER	QTY.
1	Jump fence Panel	20
2	Side panel	20
3	Base Panel	20
4	Reinforcing Panel Main Rope	20
5	Reinforcing Panel Bottom Rope	20
6	Reinforcing Pane Base Center	20
7	Gyro AISI 316L 340x210x25x25x20mm	1
8	Top Rope 24mm	1
9	Main Rope 24mm	1
10	5m waistline Rope 24mm	1
11	10m Waistline Rope 24mm	1
12	15m waistline Rope 24mm	1
13	20m waistline Rope 24mm	1
14	25m waistline Rope 24mm	1
15	Bottom Rope 24mm	1
16	Rope ring base 24mm	1
17	Long Lifting Rope 30mm	20
18	Suspension rope 30mm	20
19	Short vertical Rope 24mm	20
20	Vertical Rope 24mm	40
21	Base Cross Rope 30mm	20
22	Soft eye Ø24mmx150mm, Green for lifting	140
23	Soft eye Ø24mmx150mm, Blue	40
24	Soft eye Ø24mmx150mm, Blue	20
25	Rope ring	20



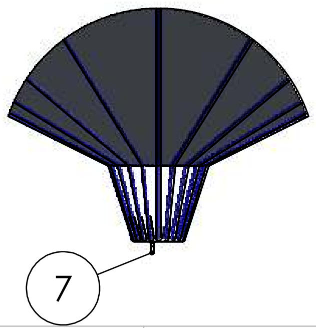
DETAIL A



DETAIL D



DETAIL B



MANUFACTURED ACCORDING TO:
-NS9415:2009
-Dimension grade in accordance with Table 8.
-Breaking strength of twine in accordance with Table 9.

	NAME	SIGNATURE	DATE
DRAWN	Anders		2016.01.19
CHK'D	Martin		2016.01.19
APPV'D	Martin		2016.01.19
MFG			

Circumference: **160m**

MATERIAL:
Aqualine Ultra (Dyneema)

WEIGHT:

DO NOT SCALE DRAWING

REVISION A

Aqualine AS
Dyre Halses gate 1A, Portalen
N-7042 Trondheim, Norway

TITLE:
ALMNC 160 30+1.2 (43) 60 - Aqualine Ultra

DWG NO.
ALMNC 160 30+1.2 (43) 60 - Aqualine Ultra - 19.01.2016-A

A3

SCALE:

SHEET 1 OF 1

Client : Grieg Seafarms Newfoundland

Cage Net Specification : Midgard 160m Cage Net AL Ultra x 17.5mmsq (23m sidewall)

Cage Numbers :

Version : 1
Date prepared : 2-des-2015
Prepared by : Barry McClure
Checked by : Hans Olav Ruø

Purchase Order Number (AL)	
Product Number (AL)	
Provisional Invoice Number	
Net description	160m Midgard Net (160x23(36)+1.2
Mesh size	17.5mmsq
Net design - environmental criteria	
Quantity required	11 Nets
Delivery requirement	2016

Netting Material	Cage Net	
Netting material	AL Ultra Rachel (Dyneema)	
Colour	White	UV Stabilised
Mesh size	17.5	mmsq measured knot centre to knot centre
Mesh orientation	Hung on the square	#####
Breaking strength as tested through the net material mesh	106	kgs
Weight per m^2	180	grams

Overages	Cage Net
Framing rope	0 %
Netting material (both in horizontal and vertical)	1 %

Key Dimensions	Cage Net	
Top rope circumference	160	m
Main line circumference (waterline rope)	160	m
5m Waistline rope	160	m
10m Waistline rope	160	m
15m Waistline rope	160	m
19m Waistline rope	160	m
Base rope circumference	160	m
Jump fence height	1.2	m
Side wall depth	23	m
Cone base depth	13	m
Depth at centre of cage net (water depth)	36	m
Sidewall construction	20	net panels
Cone base construction	20	net panels
Angle of cone base	27	degree angle
Estimated cubic capacity of cage net	55 684	m^3 production capacity

Weight of Complete Net		
Estimated	2 835	kgs

Framing Ropes	Number psc	Length	Size	Quantity	Description
Top rope	1	160	24mm	160	Manho hard laid polypropylene AL blue
Main rope (waterline)	1	160	24mm	160	Manho hard laid polypropylene AL blue
5m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
10m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
15m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
19m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
Base rope	1	160	24mm	160	Manho hard laid polypropylene AL blue
Sort vertical ropes	20	6.2	24mm	124	Manho hard laid polypropylene AL blue
Long vertical ropes	40	23	24mm	920	Manho hard laid polypropylene AL blue
Suspension ropes	20	21.4	30mm	428	Manho hard laid polypropylene AL blue
Cross ropes in cone base	20	28.6	30mm	572	Manho hard laid polypropylene AL blue
Total vertical side ropes	60				

Attachments	Number psc	Length	Size	Quantity	Description
Top rope green plastic sleeved rope eyes	20		24mm		
Main rope green plastic sleeved rope eyes (outside net)	20		24mm		
Main rope blue plastic sleeved rope eyes (outside net)	20		24mm		
Top of suspension ropes green plastic sleeved eye	20		30mm		
5m Waistline rope green plastic sleeved rope eyes (outside net)	20		24mm		
10m Waistline rope green plastic sleeved rope eyes (outside net)	20		24mm		
15m Waistline rope green plastic sleeved rope eyes (outside net)	20		24mm		
19m Waistline rope green plastic sleeved rope eyes (outside net)	20		24mm		
Base rope green plastic sleeved rope eyes (outside net)	20		24mm		
Rope rings	20		22mm		Polypropylene - blue
Net tags	5				
Gyro (stainless steel)	1				Gyro AISI 316L 340x210x25x25x20mm
Short lifting ropes	20	5	18mm	100	Polypropylene - blue
Long net lifting ropes	20	29	18mm	580	Polypropylene - blue
Mortality cone lifting rope - no SS ring supplied	1	109.2	18mm	109.2	Polypropylene - blue

Reinforcing	Location on cage net
Main rope cage net (waterline)	0.5m above and below main rope, AL Ultra Rachel 17.5mmsq - white colour (outside main net)
Base rope cage net	0.5m above and below base rope, AL Ultra Rachel 17.5mmsq - white colour (outside main net)
Centre of fish net base	10m diameter, HDPE 4.5mm braid (285 kg BL), single knot 35mmsq - black colour (inside the main net)

General	
Lacing twine - netting to netting	AL Ultra braided twine - KK 1000d/1x8 - white colour - not pre-shrunk (BL = 144 kgs)
Lacing twine - netting to rope	Nylon 210/10x16 braided twine - white colour - pre-shrunk (BL = 195 kgs)

Additional comments...

- Netting to rope (vertical and horizontal) = lock-off on every second mesh = X / X / X / X
- When joining diamond mesh netting to netting, pick-up 2 meshes of each net panel = 2+2=4, locking-off on all meshes
- When joining square mesh netting to netting, pick-up 2 meshes of each net panel = 2+2=4, locking-off on all meshes
- Reinforcing net panels - pick up 1 mesh of the reinforcing panel and pick up 1 mesh bar of the main fish net

Client : Grieg Seafarms Newfoundland

Cage Net Specification : Midgard 160m Cage Net AL Ultra x 17.5mmsq (30m sidewall)

Cage Numbers :

Version : 1
Date prepared : 2-des-2015
Prepared by : Barry McClure
Checked by : Hans Olav Ruø

Purchase Order Number (AL)	
Product Number (AL)	
Provisional Invoice Number	
Net description	**160m Midgard Net (160x30(43)+1.2**
Mesh size	**17.5mmsq**
Net design - environmental criteria	
Quantity required	11 Nets
Delivery requirement	2016

Netting Material	Cage Net	
Netting material	AL Ultra Rachel (Dyneema)	
Colour	White	UV Stabilised
Mesh size	17.5	mmsq measured knot centre to knot centre
Mesh orientation	Hung on the square	#####
Breaking strength as tested through the net material mesh	106	kgs
Weight per m^2	180	grams

Overages	Cage Net
Framing rope	0 %
Netting material (both in horizontal and vertical)	1 %

Key Dimensions	Cage Net	
Top rope circumference	160	m
Main line circumference (waterline rope)	160	m
5m Waistline rope	160	m
10m Waistline rope	160	m
15m Waistline rope	160	m
20m Waistline rope	160	m
25m Waistline rope	160	m
Base rope circumference	160	m
Jump fence height	1.2	m
Side wall depth	30	m
Cone base depth	13	m
Depth at centre of cage net (water depth)	43	m
Sidewall construction	20	net panels
Cone base construction	20	net panels
Angle of cone base	27	degree angle
Estimated cubic capacity of cage net	69 945	m^3 production capacity

Weight of Complete Net		
Estimated	3 116	kgs

Framing Ropes	Number psc	Length	Size	Quantity	Description
Top rope	1	160	24mm	160	Manho hard laid polypropylene AL blue
Main rope (waterline)	1	160	24mm	160	Manho hard laid polypropylene AL blue
5m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
10m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
15m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
20m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
25m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
Base rope	1	160	24mm	160	Manho hard laid polypropylene AL blue
Sort vertical ropes	20	6.2	24mm	124	Manho hard laid polypropylene AL blue
Long vertical ropes	40	30	24mm	1200	Manho hard laid polypropylene AL blue
Suspension ropes	20	28.4	30mm	568	Manho hard laid polypropylene AL blue
Cross ropes in cone base	20	28.6	30mm	572	Manho hard laid polypropylene AL blue
Total vertical side ropes	60				

Attachments	Number psc	Length	Size	Quantity	Description
Top rope green plastic sleeved rope eyes	20		24mm		
Main rope green plastic sleeved rope eyes (outside net)	20		24mm		
Main rope blue plastic sleeved rope eyes (outside net)	20		24mm		
Top of suspension ropes green plastic sleeved eye	20		30mm		
5m Waistline rope green plastic sleeved rope eyes (outside net)	20		24mm		
10m Waistline rope green plastic sleeved rope eyes (outside net)	20		24mm		
15m Waistline rope green plastic sleeved rope eyes (outside net)	20		24mm		
20m Waistline rope green plastic sleeved rope eyes (outside net)	20		24mm		
25m Waistline rope green plastic sleeved rope eyes (outside net)	20		24mm		
Base rope green plastic sleeved rope eyes (outside net)	20		24mm		
Rope rings	20		22mm		Polypropylene - blue
Net tags	5				
Gyro (stainless steel)	1				Gyro AISI 316L 340x210x25x25x20mm
Short lifting ropes	20	5	18mm	100	Polypropylene - blue
Long net lifting ropes	20	36	18mm	720	Polypropylene - blue
Mortality cone lifting rope - no SS ring supplied	1	123.2	18mm	123.2	Polypropylene - blue

Reinforcing	Location on cage net
Main rope cage net (waterline)	0.5m above and below main rope, AL Ultra Rachel 17.5mmsq - white colour (outside main net)
Base rope cage net	0.5m above and below base rope, AL Ultra Rachel 17.5mmsq - white colour (outside main net)
Centre of fish net base	10m diameter, HDPE 4.5mm braid (285 kg BL), single knot 35mmsq - black colour (inside the main net)

General	
Lacing twine - netting to netting	AL Ultra braided twine - KK 1000d/1x8 - white colour - not pre-shrunk (BL = 144 kgs)
Lacing twine - netting to rope	Nylon 210/10x16 braided twine - white colour - pre-shrunk (BL = 195 kgs)

Additional comments...

- Netting to rope (vertical and horizontal) = lock-off on every second mesh = X / X / X / X
- When joining diamond mesh netting to netting, pick-up 2 meshes of each net panel = 2+2=4, locking-off on all meshes
- When joining square mesh netting to netting, pick-up 2 meshes of each net panel = 2+2=4, locking-off on all meshes
- Reinforcing net panels - pick up 1 mesh of the reinforcing panel and pick up 1 mesh bar of the main fish net

Client : Grieg Seafarms Newfoundland

Cage Net Specification : Midgard 200m Cage Net AL Ultra x 17.5mmsq (23m sidewall)

Cage Numbers :

Version : 1
Date prepared : 2-des-2015
Prepared by : Barry McClure
Checked by : Hans Olav Ruø

Purchase Order Number (AL)	
Product Number (AL)	
Provisional Invoice Number	
Net description	**200m Midgard Net (200x23(36)+1.2**
Mesh size	**17.5mmsq**
Net design - environmental criteria	
Quantity required	1 Net
Delivery requirement	2016

Netting Material	**Cage Net**	
Netting material	AL Ultra Rachel (Dyneema)	
Colour	White	UV Stabilised
Mesh size	17.5	mmsq measured knot centre to knot centre
Mesh orientation	Hung on the square	#####
Breaking strength as tested through the net material mesh	106	kgs
Weight per m^2	180	grams

Overages	**Cage Net**
Framing rope	0 %
Netting material (both in horizontal and vertical)	1 %

Key Dimensions	**Cage Net**	
Top rope circumference	200	m
Main line circumference (waterline rope)	200	m
5m Waistline rope	200	m
10m Waistline rope	200	m
15m Waistline rope	200	m
19m Waistline rope	200	m
Base rope circumference	200	m
Jump fence height	1.2	m
Side wall depth	23	m
Cone base depth	13	m
Depth at centre of cage net (water depth)	36	m
Sidewall construction	24	net panels
Cone base construction	24	net panels
Angle of cone base	22	degree angle
Estimated cubic capacity of cage net	87 007	m^3 production capacity

Weight of Complete Net		
Estimated	3 572	kgs

Framing Ropes	**Number psc**	**Length**	**Size**	**Quantity**	**Description**
Top rope	1	160	24mm	160	Manho hard laid polypropylene AL blue
Main rope (waterline)	1	160	24mm	160	Manho hard laid polypropylene AL blue
5m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
10m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
15m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
19m Waistline rope water depth	1	160	24mm	160	Manho hard laid polypropylene AL blue
Base rope	1	160	24mm	160	Manho hard laid polypropylene AL blue
Sort vertical ropes	24	6.2	24mm	148.8	Manho hard laid polypropylene AL blue
Long vertical ropes	48	23	24mm	1104	Manho hard laid polypropylene AL blue
Suspension ropes	24	21.4	30mm	513.6	Manho hard laid polypropylene AL blue
Cross ropes in cone base	24	28.6	30mm	686.4	Manho hard laid polypropylene AL blue
Total vertical side ropes	72				

Attachments	**Number psc**	**Length**	**Size**	**Quantity**	**Description**
Top rope green plastic sleeved rope eyes	24		24mm		
Main rope green plastic sleeved rope eyes (outside net)	24		24mm		
Main rope blue plastic sleeved rope eyes (outside net)	24		24mm		
Top of suspension ropes green plastic sleeved eye	24		30mm		
5m Waistline rope green plastic sleeved rope eyes (outside net)	24		24mm		
10m Waistline rope green plastic sleeved rope eyes (outside net)	24		24mm		
15m Waistline rope green plastic sleeved rope eyes (outside net)	24		24mm		
19m Waistline rope green plastic sleeved rope eyes (outside net)	24		24mm		
Base rope green plastic sleeved rope eyes (outside net)	24		24mm		
Rope rings	24		22mm		Polypropylene - blue
Net tags	5				
Gyro (stainless steel)	1				Gyro AISI 316L 340x210x25x25x20mm
Short lifting ropes	24	5	18mm	120	Polypropylene - blue
Long net lifting ropes	24	29	18mm	696	Polypropylene - blue
Mortality cone lifting rope - no SS ring supplied	1	109.2	18mm	109.2	Polypropylene - blue

Reinforcing	**Location on cage net**
Main rope cage net (waterline)	0.5m above and below main rope, AL Ultra Rachel 17.5mmsq - white colour (outside main net)
Base rope cage net	0.5m above and below base rope, AL Ultra Rachel 17.5mmsq - white colour (outside main net)
Centre of fish net base	10m diameter, HDPE 4.5mm braid (285 kg BL), single knot 35mmsq - black colour (inside the main net)

General	
Lacing twine - netting to netting	AL Ultra braided twine - KK 1000d/1x8 - white colour - not pre-shrunk (BL = 144 kgs)
Lacing twine - netting to rope	Nylon 210/10x16 braided twine - white colour - pre-shrunk (BL = 195 kgs)

Additional comments...

- Netting to rope (vertical and horizontal) = lock-off on every second mesh = X / X / X / X
- When joining diamond mesh netting to netting, pick-up 2 meshes of each net panel = 2+2=4, locking-off on all meshes
- When joining square mesh netting to netting, pick-up 2 meshes of each net panel = 2+2=4, locking-off on all meshes
- Reinforcing net panels - pick up 1 mesh of the reinforcing panel and pick up 1 mesh bar of the main fish net

Client : Grieg Seafarms Newfoundland

Cage Net Specification : Midgard 200m Cage Net AL Ultra x 17.5mmsq (30m sidewall)

Cage Numbers :

Version : 1
Date prepared : 2-des-2015
Prepared by : Barry McClure
Checked by : Hans Olav Ruø

Purchase Order Number (AL)	
Product Number (AL)	
Provisional Invoice Number	
Net description	**200m Midgard Net (200x30(43)+1.2**
Mesh size	**17.5mmsq**
Net design - environmental criteria	
Quantity required	1 Net
Delivery requirement	2016

Netting Material	Cage Net	
Netting material	AL Ultra Rachel (Dyneema)	
Colour	White	UV Stabilised
Mesh size	17.5	mmsq measured knot centre to knot centre
Mesh orientation	Hung on the square	#####
Breaking strength as tested through the net material mesh	106	kgs
Weight per m^2	180	grams

Overages	Cage Net	
Framing rope	0	%
Netting material (both in horizontal and vertical)	1	%

Key Dimensions	Cage Net	
Top rope circumference	200	m
Main line circumference (waterline rope)	200	m
5m Waistline rope	200	m
10m Waistline rope	200	m
15m Waistline rope	200	m
20m Waistline rope	200	m
25m Waistline rope	200	m
Base rope circumference	200	m
Jump fence height	1.2	m
Side wall depth	30	m
Cone base depth	13	m
Depth at centre of cage net (water depth)	43	m
Sidewall construction	24	net panels
Cone base construction	24	net panels
Angle of cone base	22	degree angle
Estimated cubic capacity of cage net	109 289	m^3 production capacity

Weight of Complete Net		
Estimated	3 923	kgs

Framing Ropes	Number psc	Length	Size	Quantity	Description
Top rope	1	200	24mm	200	Manho hard laid polypropylene AL blue
Main rope (waterline)	1	200	24mm	200	Manho hard laid polypropylene AL blue
5m Waistline rope water depth	1	200	24mm	200	Manho hard laid polypropylene AL blue
10m Waistline rope water depth	1	200	24mm	200	Manho hard laid polypropylene AL blue
15m Waistline rope water depth	1	200	24mm	200	Manho hard laid polypropylene AL blue
20m Waistline rope water depth	1	200	24mm	200	Manho hard laid polypropylene AL blue
25m Waistline rope water depth	1	200	24mm	200	Manho hard laid polypropylene AL blue
Base rope	1	200	24mm	200	Manho hard laid polypropylene AL blue
Sort vertical ropes	24	6.2	24mm	148.8	Manho hard laid polypropylene AL blue
Long vertical ropes	48	30	24mm	1440	Manho hard laid polypropylene AL blue
Suspension ropes	24	28.4	30mm	681.6	Manho hard laid polypropylene AL blue
Cross ropes in cone base	24	28.6	30mm	686.4	Manho hard laid polypropylene AL blue
Total vertical side ropes	72				

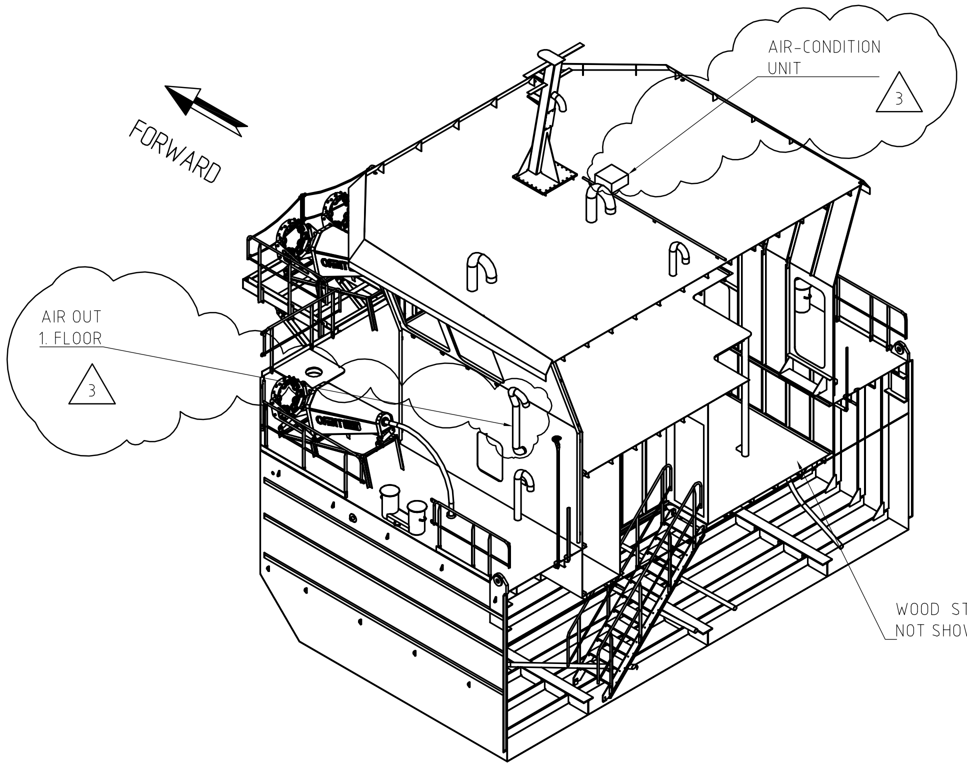
Attachments	Number psc	Length	Size	Quantity	Description
Top rope green plastic sleeved rope eyes	24		24mm		
Main rope green plastic sleeved rope eyes (outside net)	24		24mm		
Main rope blue plastic sleeved rope eyes (outside net)	24		24mm		
Top of suspension ropes green plastic sleeved eye	24		30mm		
5m Waistline rope green plastic sleeved rope eyes (outside net)	24		24mm		
10m Waistline rope green plastic sleeved rope eyes (outside net)	24		24mm		
15m Waistline rope green plastic sleeved rope eyes (outside net)	24		24mm		
20m Waistline rope green plastic sleeved rope eyes (outside net)	24		24mm		
25m Waistline rope green plastic sleeved rope eyes (outside net)	24		24mm		
Base rope green plastic sleeved rope eyes (outside net)	24		24mm		
Rope rings	24		22mm		Polypropylene - blue
Net tags	5				
Gyro (stainless steel)	1				Gyro AISI 316L 340x210x25x25x20mm
Short lifting ropes	24	5	18mm	120	Polypropylene - blue
Long net lifting ropes	24	36	18mm	864	Polypropylene - blue
Mortality cone lifting rope - no SS ring supplied	1	123.2	18mm	123.2	Polypropylene - blue

Reinforcing	Location on cage net
Main rope cage net (waterline)	0.5m above and below main rope, AL Ultra Rachel 17.5mmsq - white colour (outside main net)
Base rope cage net	0.5m above and below base rope, AL Ultra Rachel 17.5mmsq - white colour (outside main net)
Centre of fish net base	10m diameter, HDPE 4.5mm braid (285 kg BL), single knot 35mmsq - black colour (inside the main net)

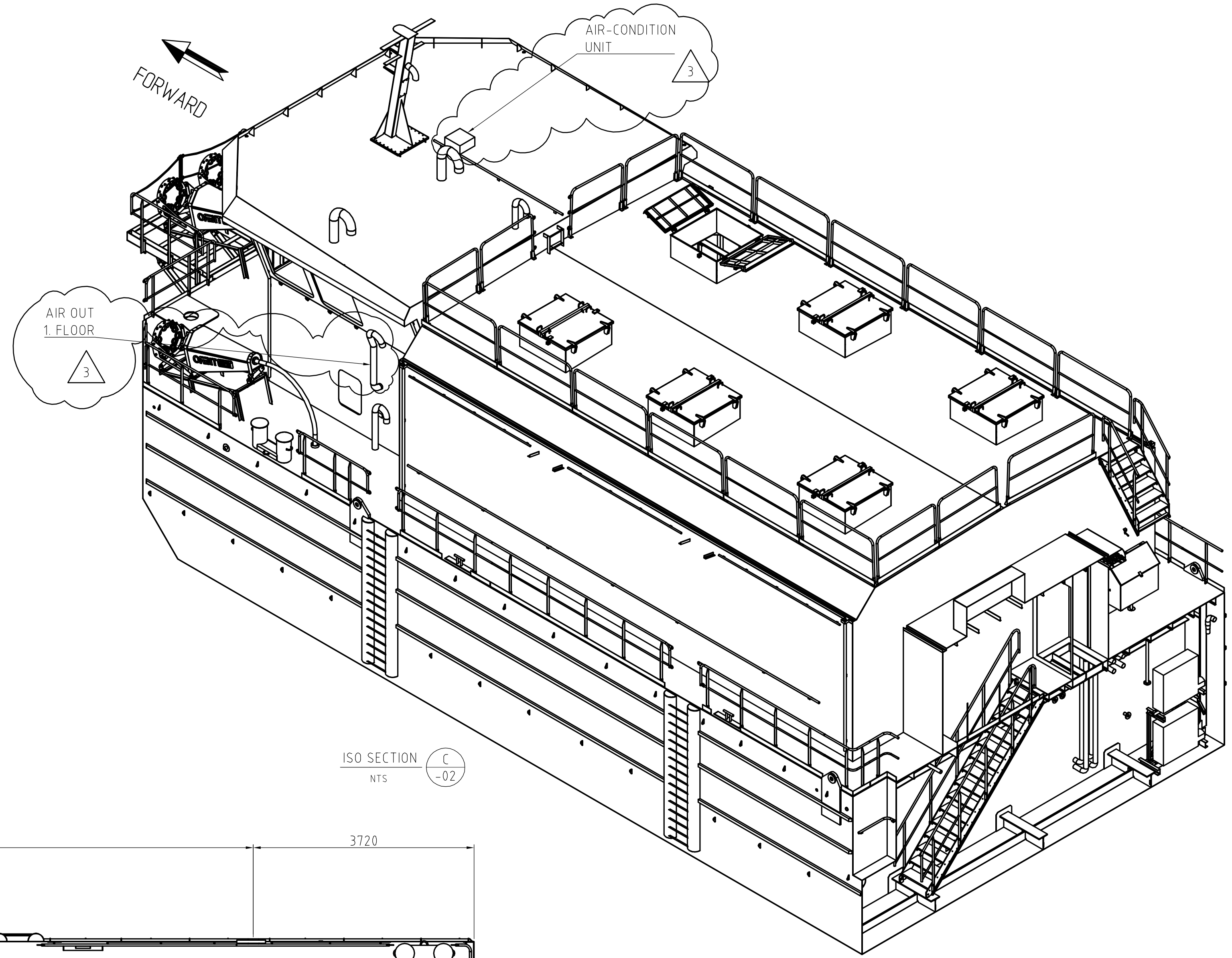
General	
Lacing twine - netting to netting	AL Ultra braided twine - KK 1000d/1x8 - white colour - not pre-shrunk (BL = 144 kgs)
Lacing twine - netting to rope	Nylon 210/10x16 braided twine - white colour - pre-shrunk (BL = 195 kgs)

Additional comments...

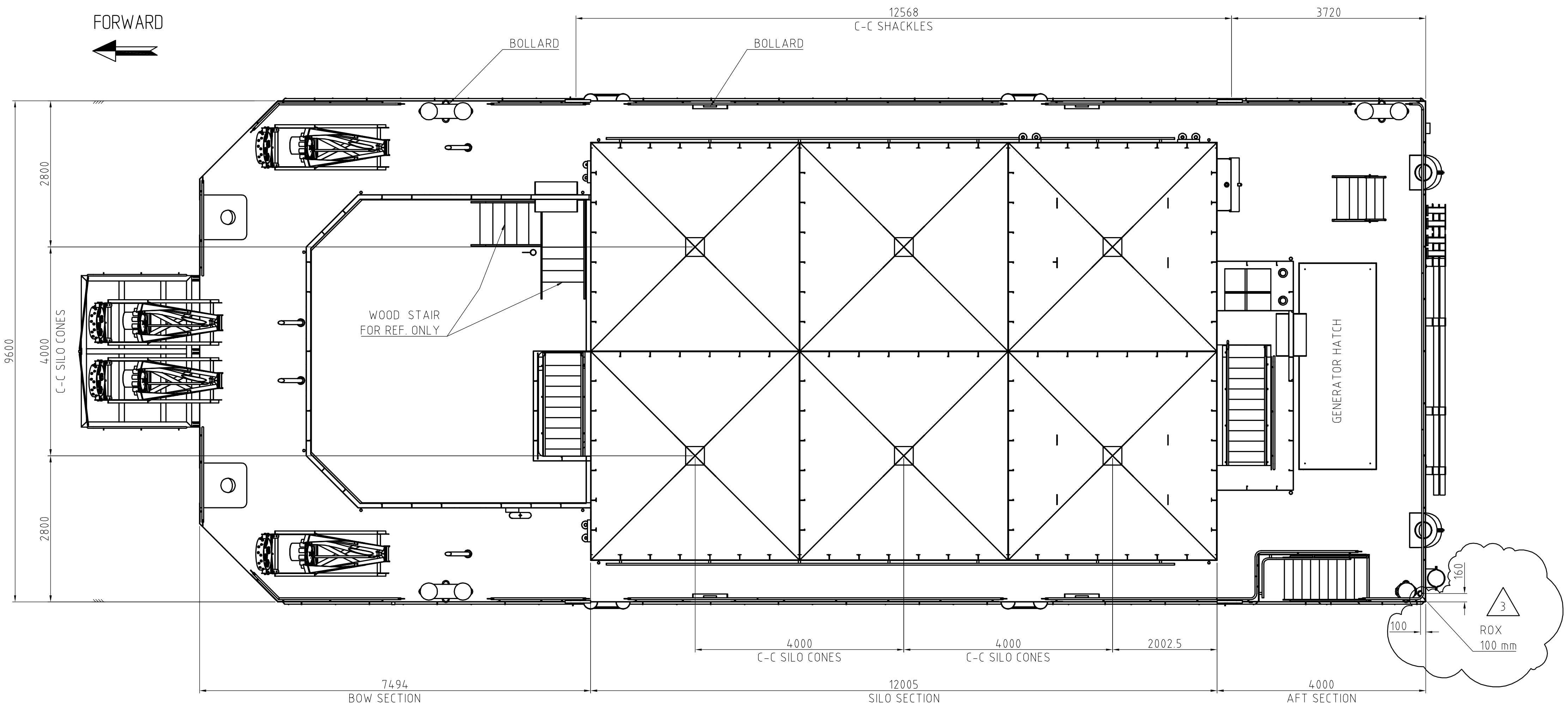
- Netting to rope (vertical and horizontal) = lock-off on every second mesh = X / X / X / X
- When joining diamond mesh netting to netting, pick-up 2 meshes of each net panel = 2+2=4, locking-off on all meshes
- When joining square mesh netting to netting, pick-up 2 meshes of each net panel = 2+2=4, locking-off on all meshes
- Reinforcing net panels - pick up 1 mesh of the reinforcing panel and pick up 1 mesh bar of the main fish net



ISO SECTION B -02
NTS



ISO SECTION C -02
NTS



SECTION E -02 LOOKING DOWN

FOR NOTES SEE SHEET 1

REV	DATE	DESCRIPTION	DRN BY	CHKD BY	APPR. BY
3	14.04.15	REVISED AS SHOWN	GEO	JV	
2	04.03.15	REISSUED FOR APPROVAL	GEO	JV	
1	08.12.14	ISSUED FOR APPROVAL	GEO	HB	

PDS PROTEK

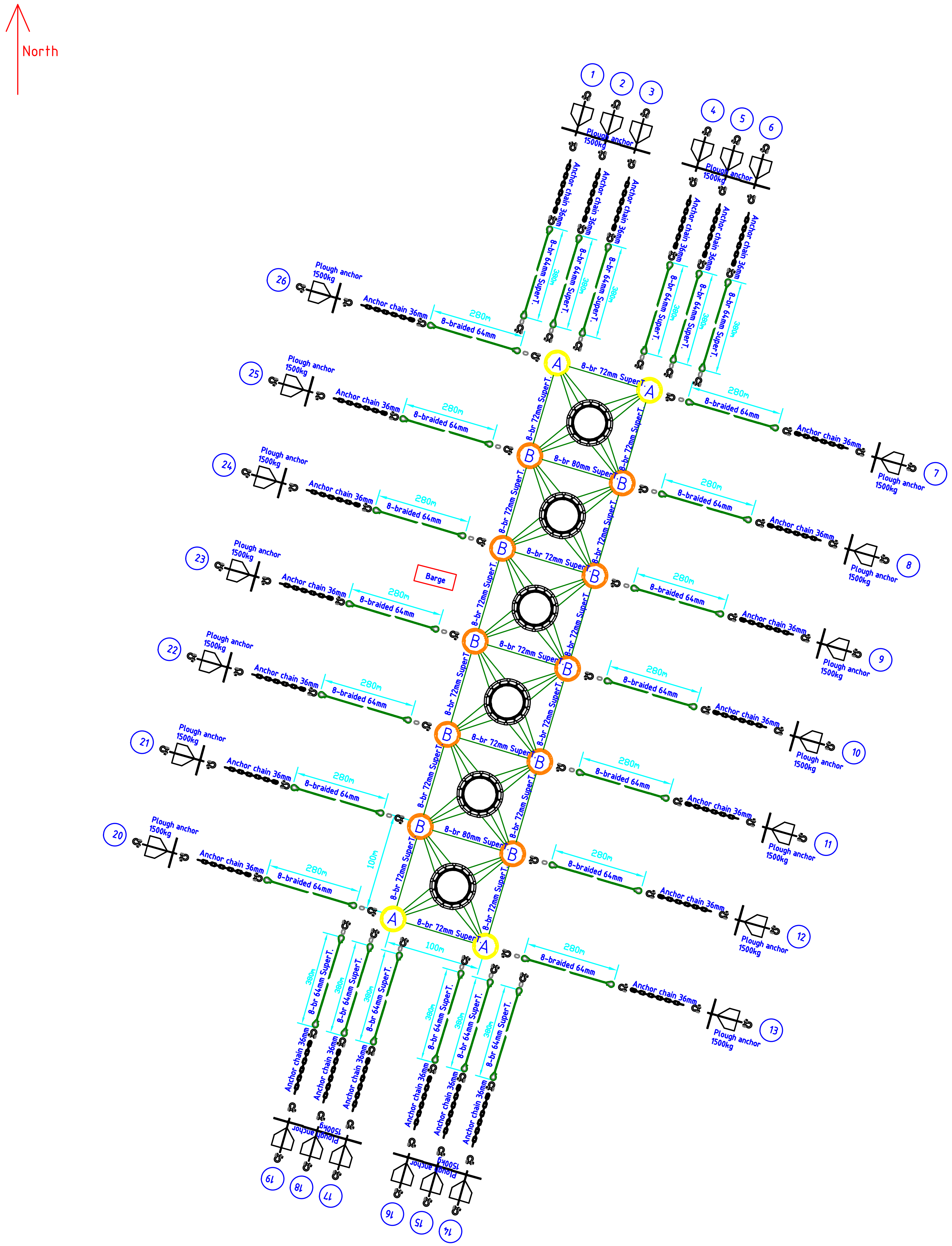
CLIENT: FRAM CONSULTING AS

PROJECT: PDS PROTEK AS PROJECT NO: 3014096
FRAM 25

AREA CODE: NA

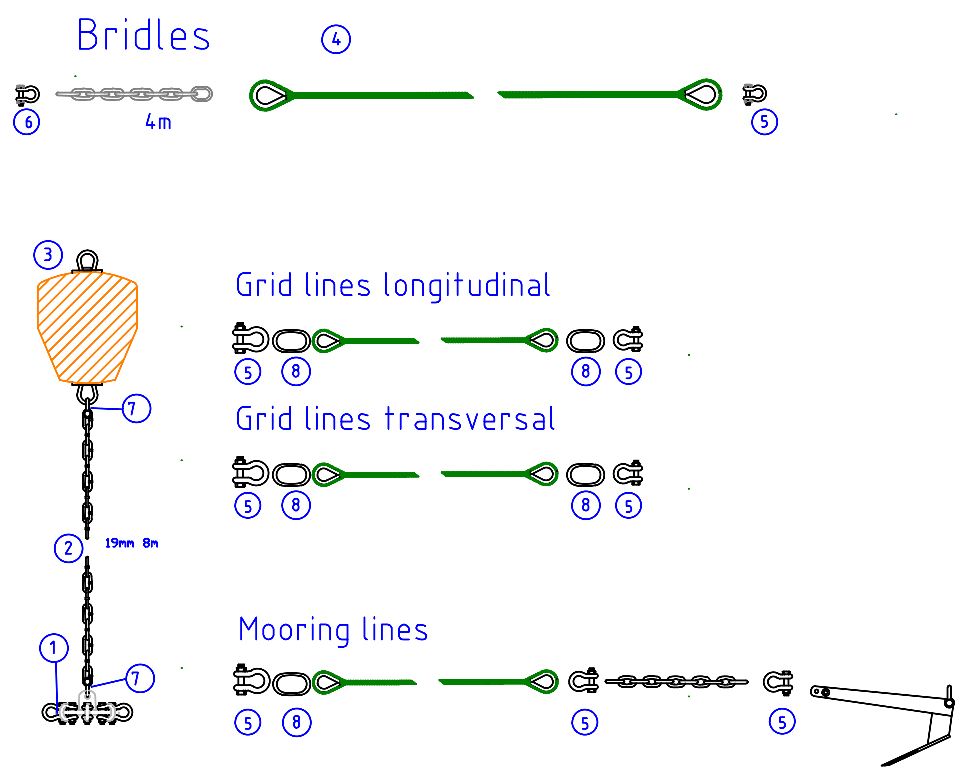
TITLE: FEED BARGE - 6 SILOS
ASSEMBLY
SECTIONS
SHEET 5 OF 8

SCALE: 1:50 | SIZE: A1 | DRAWING NUMBER: 3014096-NA-001.05 | REV: 3



1	Grid plate 16 holes 40mm	14
2	Chain for buoys 19mm 8 meter	14
3	Buoys	
	A 4400 liter	4
	B 2200 liter	10
4	Bridle parts	
	22mm chain sling with 34mm masterlink	72
	3 strand 64mm Aqualine rope	
	Length side ropes 44m	48
	Length center rope 40m	24
5	Mooring shackle MBL 90t	
6	Mooring shackle MBL 60t	
7	Mooring shackle MBL 40t	
8	Masterlink galv. 34mm	
		Amount

Notes

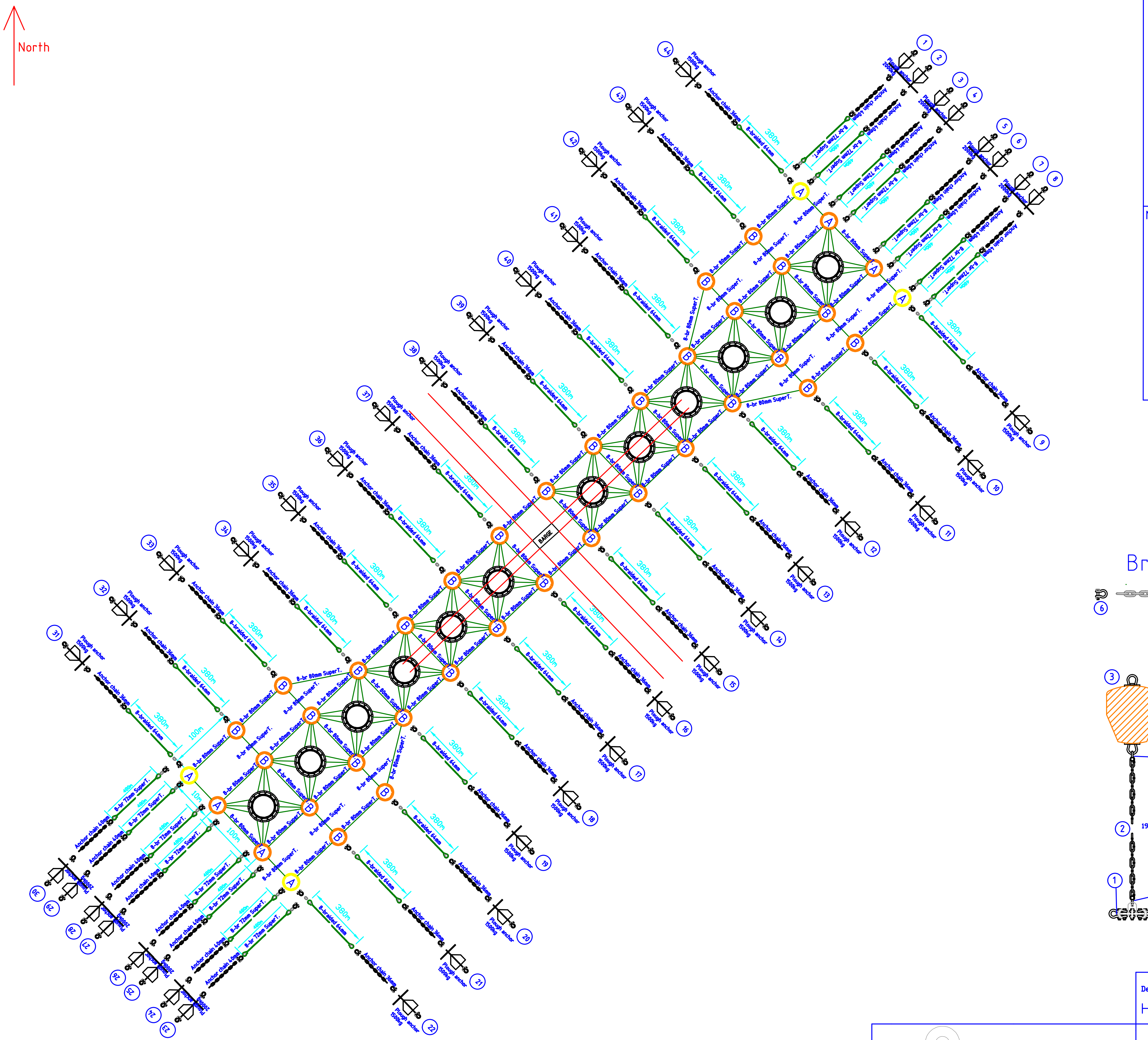


Designed by	Checked by	Approved by	Date	Rev
HT	MS	HOR	30.05.2015	01

aqualine

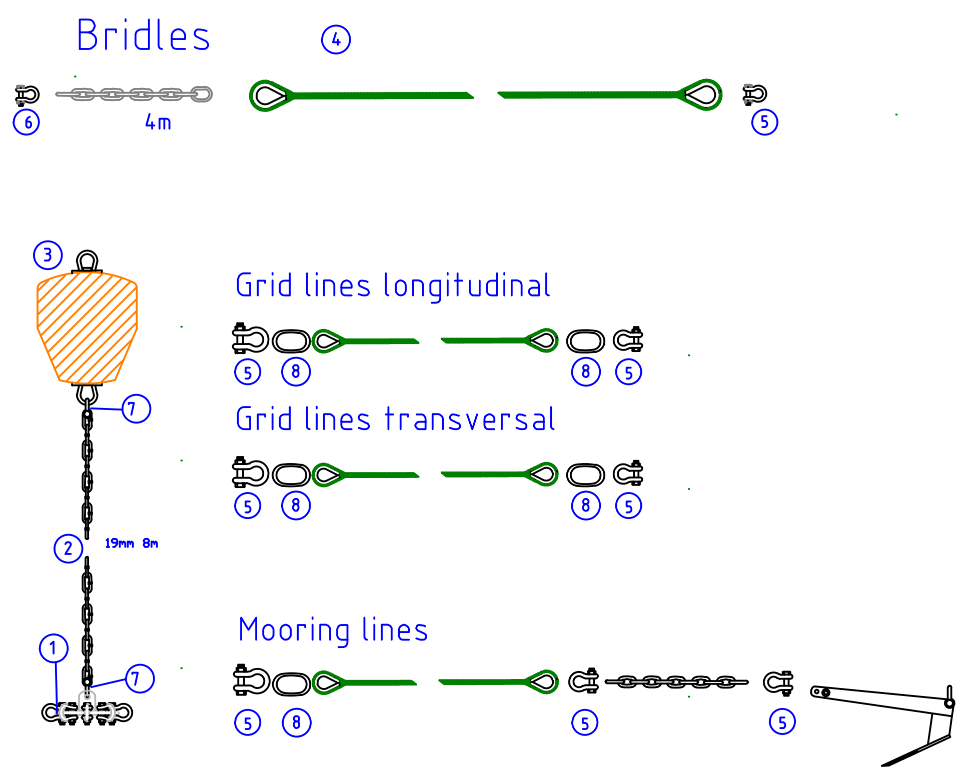
Title

Grieg Seafarms NL Ltd. – Iona Island
Grid mooring – 1x6



		Amount
1	Grid plate 16 holes 40mm	40
2	Chain for buoys 19mm 8 meter	40
3	Buoys	
	A 4400 liter	8
	B 2200 liter	32
4	Bridle parts	
	22mm chain sling with 34mm masterlink	144
	3 strand 64mm Aqualine rope	
	Length side ropes 44m	96
	Length center rope 40m	48
5	Mooring shackle MBL 90t	
6	Mooring shackle MBL 60t	
7	Mooring shackle MBL 40t	
8	Masterlink galv. 34mm	

Notes



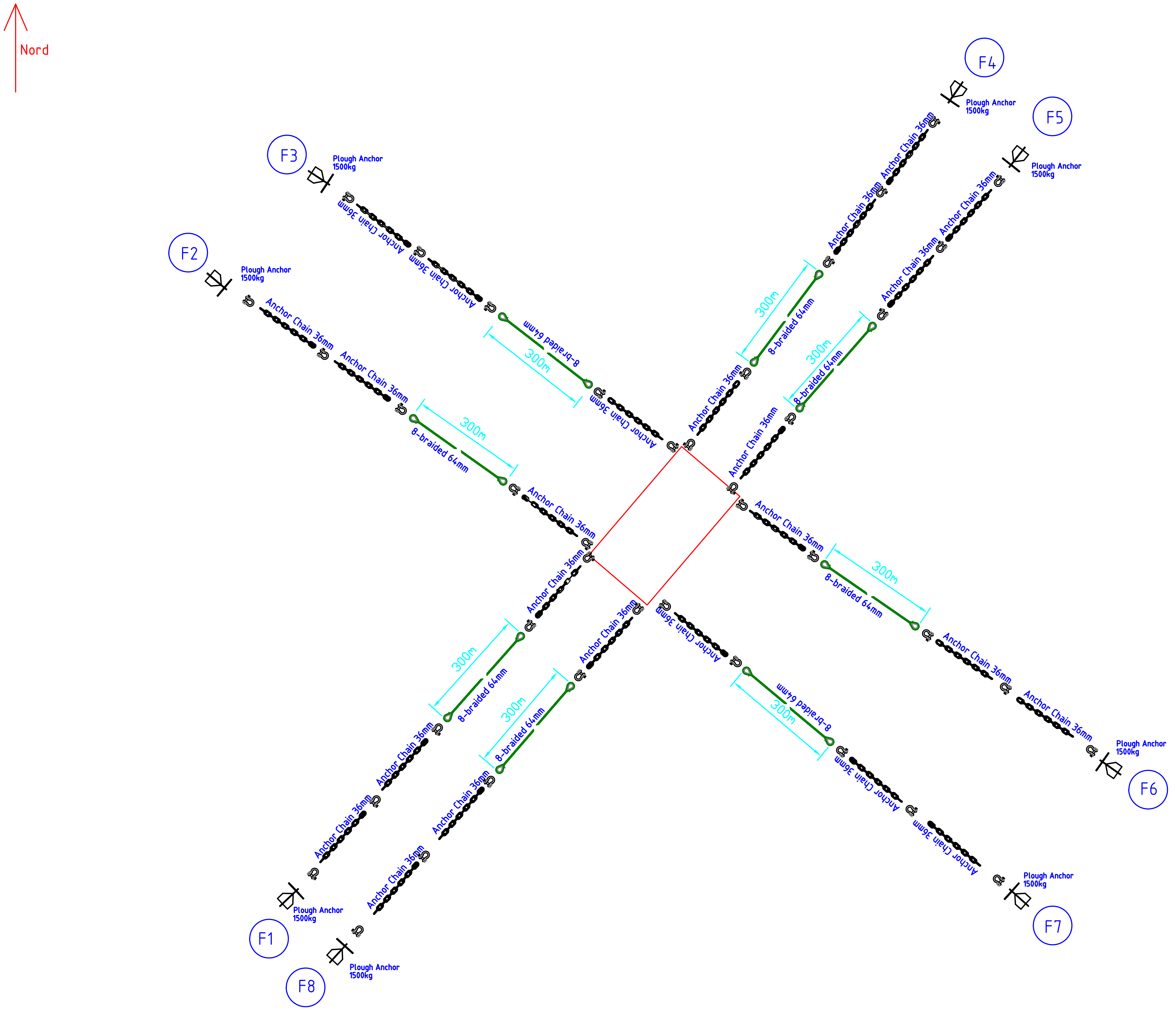
Designed by	Checked by	Approved by	Date	Rev
HT	MS	HØR	30.05.2015	01

aqualine

Title

Grieg Seafarms NL Ltd. – Long Island
Grid mooring – 1x13

K.		Amount
1	Mooring Shackle MBL 90t	40



Mooring lines

Designed by	Checked by	Approved by	Date	Rev
HT	MS	HØR	30.05.2015	01

Title

Grieg Seafarms NL Ltd. - Long Island Barge Mooring

PICTURES, AQUALINE CAGES

standard norge

Norwegian Standard
NS 9415.E:2009

ICS 65.150; 67.260
Language: English

Marine fish farms
Requirements for site survey, risk analyses, design, dimensioning, production, installation and operation

Flytende oppdrettsanlegg
Krav til lokalitetsundersøkelse, risikoanalyse, utforming, dimensjonering, utførelse, montering og drift

This is a translation of NS 9415:2009. All reasonable measures have been taken to ensure the accuracy of this translation, but no responsibility can be accepted for any error, omission or inaccuracy.

The English translation was published in April 2010.

This translation has not been adopted as Norwegian Standard.

Norwegian Standard NS 9415.E:2009

Marine fish farms – Requirements for site survey, risk analyses, design, dimensioning, production, installation and operation

Contents

Foreword

NS 9415:2009 was adopted in November 2009.

NS 9415:2009 replaces NS 9415:2003.

This standard is produced and revised by *SN/K 156, Standardiseringskomiteen for rømmingssikre oppdrettsanlegg / SN/K 509 Sluttføring av arbeidet med pr NS 9415*, with participation by:

- the Fisheries and Environmental authorities;
- research and development institutions;
- consultancy companies;
- fish farmers and
- suppliers of equipment.

The development is based on reports and studies from the above-mentioned interested parties, as well as experiences in the industry. The Secretariat function for the work has been performed by Standards Norway, and has been partly financed by the Ministry of Fisheries and Coastal Affairs. The revision has been based on the experiences which have been obtained from the 1st Edition of the Standard, as well as a separate research project.

It is assumed that users utilise the whole of the Standard and not just individual chapters of it. Chapters 1 – 7 specify requirements regarding marine fish farms and general requirements regarding its main components, while Chapters 8 – 11 specify requirements for each individual main component.

1 Scope

The purpose of the Standard is to reduce the risk of escape as a result of technical failure and wrong use of marine fish farms. The Standard sets requirements regarding design of marine fish farms and how it shall be documented, including calculation and planning rules. The Standard gives parameters which shall be used to indicate the condition of the site.

Requirements regarding design include requirements for all main components of marine fish farms, such as net pens, floating collars and rafts as well as requirements for functionality of the marine fish farm as a whole, including any extra equipment. A description is given of how marine fish farms shall be placed based on the site conditions at the given site. The Standard also sets requirements as to how marine fish farms shall be operated in order to be acceptably escape-proof.

Technical requirements or operational tasks which are not relevant to escape of farmed fish are not included in this Standard. The Standard does not completely cover all the circumstances which can be relevant for escape. However, it is assumed that such elements are included in the risk analyses, even though they are not explicitly mentioned in this Standard.

2 Normative references

The following referred documents are necessary for the application of this document. For dated references only the edition mentioned applies. For undated references the last edition of the referred document (including corrigendum) applies.

NS 416-1	Operators for welding of polyethylene (PE) and polypropylen (PP) pipes and fittings - Part 1: Certification
NS 416-2:2008	Operators for welding of polyethylene (PE) and polypropylene (PP) for pipes and fittings - Part 2: Training schedule
NS 470	Welded steel structures - Rules for design and fabrication
NS-EN 1990	Eurocode - Basis of structural design
NS-EN 1991-1-4	Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions
NS-EN 1992-1-1	Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings
NS-EN 1993-1-1	Design of steel structures - Part 1-1: General rules and rules for buildings
NS-EN 1999-1-1	Eurocode 9: Design of aluminium structures - Part 1-1: General structural rules
NS 5814	Requirements for risk assessment
NS 6082	Marine industry - Deck and bulkhead pieces of pipe with threads for plastic pipes
NS 9425-1	Oceanography – Part 1: Current measurements at fixed points
NS 9425-2	Oceanography - Part 2: Current measurement using ADCP
NS-EN 287-1	Qualification test of welders - Fusion welding - Part 1:Steels
NS-EN ISO 15607	Specification and qualification of welding procedures for metallic materials - General rules (ISO 15607:2003)
NS-EN 473	Non-destructive testing - Qualification and certification of NDT personnel - General principles
NS-EN 1677-1	Components for slings - Safety - Part 1: Forged steel components, Grade 8
NS-EN 1677-2	Components for slings - Safety - Part 2: Forged steel lifting hooks with latch, Grade 8
NS-EN 1677-3	Components for slings - Safety - Part 3: Forged steel self-locking hooks - Grade 8
NS-EN 1677-4	Components for slings - Safety - Part 4: Links, Grade 8
NS-EN 10204	Metallic products - Types of inspection documents

NS-EN 12201-2	Plastics piping systems for water supply - Polyethylene (PE) - Part 2: Pipes
NS-EN 13173	Cathodic protection for steel offshore floating structures
NS-EN 13889	Forged steel shackles for general lifting purposes - Dee shackles and bow shackles - Grade 6 – Safety
NS-EN 14687	Mixed polyolefin fibre ropes
NS-EN ISO 1107	Fishing nets - Netting - Basic terms and definitions (ISO 1107:2003)
NS-EN ISO 1140	Fibre ropes - Polyamide - 3-, 4- and 8-strand ropes (ISO 1140:2004)
NS-EN ISO 1141	Fibre ropes - Polyester - 3-, 4- and 8-strand ropes (ISO 1141:2004)
NS-EN ISO 1346	Fibre ropes - Polypropylene split film, monofilament and multifilament (PP2) and polypropylene high tenacity multifilament (PP3) - 3-, 4- and 8-strand ropes (ISO 1346:2004)
NS-EN ISO 1805	Fishing nets - Determination of breaking force and knot breaking force of netting yarns (ISO 1805:2006)
NS-EN ISO 1806	Fishing nets - Determination of mesh breaking force of netting (ISO 1806:2002)
NS-EN ISO 2307	Fibre ropes - Determination of certain physical and mechanical properties (ISO 2307:2005)
NS-EN ISO 9606-2	Qualification test of welders - Fusion welding - Part 2: Aluminium and aluminium alloys (ISO 9606-2:2004)
NS-EN ISO 12944-2	Paints and varnishes - Corrosion of steel structures by protective paint systems - Part 2: Classification of environments (ISO 12944-2:1998)
NS-EN ISO 12944-3	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 3: Design considerations (ISO 12944-3:1998)
NS-EN ISO 14731	Welding coordination - Tasks and responsibilities (ISO 14731:2006)
NS-EN ISO 15609-1	Specification and qualification of welding procedures for metallic materials - Welding procedure specification - Part 1: Arc welding (ISO 15609-1:2004)
NS-EN ISO 15614-1	Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)
NS-EN ISO 15614-2	Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 2: Arc welding of aluminium and its alloys (ISO 15614-2:2005)
ISO 1704	Ships and marine technology - Stud-link anchor chains

3 Definitions

The following definitions apply in this Standard in addition to those that appear in NS-EN ISO 1107:

3.1
analysis
calculation of load effects on a construction
[NS 3472]

3.2
seizing
klass of knots

3.3
ultimate limit state
limit state connected to fracture or other similar forms of constructional failure

NOTE The ultimate limit state is usually equivalent to the maximum load-carrying capacity of a construction or a part of a construction.

3.4
user handbook
a document that describes the correct identification of parts, transport, storage, handling, assembly, interface, operation of and limitations regarding main components of a fish farm

3.5
serviceability limit states
limit state for when a construction or a construction part no longer meets designated requirements for normal use

3.6
bottom rope
horizontal rope between the side and bottom in a net pen

3.7
wave height
vertical distance between a wave crest and the previous wave trough

3.8
wave length
horizontal distance between a wave crest and the previous wave crest

3.9
wave period
the time a wave takes to move one wave length, defined between two zero lines of mean water level

NOTE The wave period is equivalent to the time between two consecutive wave crests passing through a fixed point.

3.10
wave direction
the direction the waves come from

EXAMPLE Waves with a direction of 270° come from the west.

3.11
buoy body
part of a buoy having the function of keeping floating elements in place in the buoy

3.12
dartdrop-testing
determination of the impact resistance of a material by a specified body falling towards the material at a specified force per area unit under specified conditions whereafter the effects are assessed

3.13
diffraction and refraction analysis
calculation of wave height and period based on how local topographical conditions cause reflections, deflections and slowing down of ocean swells

3.14
design working life
lifetime
the expected time period a construction or part of it, with an intended purpose and with expected maintenance, shall be able to be used without extensive repairs being necessary

3.15
design load
load which shall be used in examination of a construction in the limit state indicated
[NS 3472]

3.16
design load effects
load effects calculated on the basis of design loads
[NS 3472]

3.17
dimensioning
determination of dimensions or establishment that the dimensions are sufficient to satisfy the requirements of the limit states
[NS 3472]

EXAMPLE An example of dimensions is stretching in a certain direction for a component. Length, breadth, thickness, height, depth, diameter or stretching along a certain line such as circumference.

3.18
documented competence
written evidence that practical and theoretical skills are satisfied in relation to the requirements in an existing curriculum or training plan

3.19
operation
fish farming at a site, including all operations which are performed at the site while fish farming is in progress, and which are relevant to escape

3.20
dynamic analysis
analysis where a calculation is done of loads from wind, current and waves as well as acceleration as a result of wave movements in addition to mass, damping and rigidity of the construction

NOTE Load/response analysis where mass, damping and rigidity of the construction are included.

3.21
dynamic magnification factor
factor which indicates the relationship between response when mass, damping and rigidity are taken into consideration, and response when only the rigidity of the construction is taken into consideration

3.22
dead fish collector
dead fish scoop
tool for removal of dead fish from the net pen

3.23
depth of net pen
vertical distance from the waterline to the deepest point in the net pen in stretched condition

3.24
extra equipment
technical equipment, fixed or movable, which is used to perform certain operations at a fish farm

3.25
empirical design
design that has been based on experience with previously developed equipment

NOTE Empirical design only builds on strict engineering methods to a small degree.

3.26
re-examination
re-examination of documentation, planning, design and assembly of a marine fish farm with its main components and any extra equipment at the site

3.27
inspection
examination
systematic inspection/examination, usually visual, to see that the equipment satisfies the requirements that are set

3.28
stitching
seam for connection of rope and net

3.29
stitching rope
rope which is a part of the construction of the net pen, and which is stitched to the net pen

3.30
filament
fibre or strands which are used as a main component in net twine or rope

3.31
flexible installation
marine fish farm where the floating collar is primarily made of polymers, first and foremost plastic

NOTE There can also be marine fish farms where rubber is used as the most important material.

3.32
floating collar
frame which provides buyancy and attachment for one or more net pens

NOTE A floating collar is a complete unit consisting of a buoyancy pipe, clamps and the necessary extra equipment.

3.33
marine fish farms
total installation
floating or submersible floating fish farm composed of main components, where live fish are fed, treated or stored

3.34
raft
barge
floating work station having a gross weight of over 50 tonnes, detached or integrated, with technical equipment for performing certain functions connected to fish farming

NOTE Such functions can be storage, feeding, electricity supply, crewing and monitoring of the site

3.35
transfer
moving of equipment internally on the site or between sites

3.36
mooring
system of lines and bottom attachments for keeping the floating collar in the desired position

3.37
mooring line
part of the mooring and includes frame stretch and crowfoot as well as a line to the bottom attachment

3.38
fully developed sea state
sea state with a wave height which does not increase even though the wind continues at the same strength

3.39
operability inspection
inspection which is undertaken at given intervals to discover any weaknesses connected to the equipment's operability or stability, particularly with regard to wear

NOTE Intervall for funksjonsettersyn kan for eksempel være månedlig. Interval for operability inspections can be monthly, for example.

3.40
walkway
device where operations personnel can move on foot

3.41
global analysis
determination, in a construction, of a consistent set of either internal forces or stresses which are in equilibrium with a determined set of effects on the construction, and which depend on geometrical characteristics, the construction's characteristics and the characteristics of the materials
[NS 3490]

3.42
chafing
weakening of strength of equipment as a result of cut or friction

3.43
limit state
condition defining the limit for when a construction no longer meets the dimensioning criteria

3.44
GZ curve
curve which describes a floater's or raft's stability in relation to the heeling angle

3.45
ocean swell
heavy sea
breakers
waves that are generated over and which penetrate from open sea

3.46
jump catch net
part of the net pen placed between the top rope and main rope

3.47
main component
one of four components which a marine fish farm consists of, namely net pen, floating collar, raft and mooring

3.48
main rope
horizontal rope placed under the top rope, where the net pen is attached to the floating collar

3.49
instruction
detailed description of how an operation shall be performed

NOTE An instruction cannot be derogated from

3.50
irregular sea
sea state where the waves have heterogeneous wave characteristics

3.51
JONSWAP wave spectrum
theoretical distribution of the energy in waves based on measurements taken in shallow areas in the North Sea, near land

NOTE The spectrum is based on significant wave height, peak period and the peak parameter

3.52
capacity
mechanical characteristic of a part, a transverse section or a construction part connected to the ultimate limit state
[NS 3472]

3.53
characteristic load
load with a fixed probability, based on years' extremes, so that it shall not exceed one single year. For loads which are specified with maximum values which are not allowed exceeded, the maximum value is used as the characteristic load
[NS 3472]

3.54
characteristic capacity
value for a construction's resistance or strength based on a fixed probability so that the mentioned value is not reached during the dimensioned useful life of the construction

3.55
eyelet
device to protect a rope bow

3.56
impact
possible result of a undesirable event. Impacts can be expressed with words or as a numerical value for the scope of damage/injury to people, environment or material values
[NS 5814]

3.57
impact-reducing measures
measures aimed at reducing impacts of an undesirable event
[NS 5814]

3.58
construction calculation
calculation showing that the requirements regarding the limit states are met
[NS 3472]

3.59
cross rope
continuation of a vertical rope, which on its own or together with others crosses the bottom of the opposite vertical rope

NOTE Any other ropes which are to be installed on the bottom are not regarded as cross ropes in this Standard

3.60
quasi-static analysis
analysis where calculation is made of loads from wind, current and waves, whilst accelerations on the construction as a result of waves and current are neglected

NOTE Load/response analysis where rigidity of the construction is included together with a dynamic magnification of load.

3.61
storage
storage of the whole or parts of a main component which is not in use

3.62
load
applied concentrated and distributed forces which act upon the construction and applied displacement or strains in the construction

NOTE The term "load" is used mainly in the same meaning as the form "effect". "Load" is often used to describe only the effects of force, but in this Standard also includes the effects of applied displacements and strains.

[NS 3472].

3.63
load factor
load coeffisient
partial factor for load, which expresses possible deviation for the loads in relation to the characteristic capacities, reduced probability for different loads to act at the same time with their characteristic capacities, and uncertainties in modeling and analysis in the determination of load effects

3.64
load effect
the results of effects on the construction, such as action-effect, moment, stress, strain or displacement [NS 3472]

3.65
plumb
weight or other device fixed directly or indirectly to a net pen in order to stretch it

3.66
log
written documentation that records actions taken, as well as the time, and the persons performing them

3.67
local analysis
determination in a construction detail of a consistent set of either internal forces and moments or stresses which are in equilibrium with a certain set of effects on the construction, and which depend on geometrical characteristics, the characteristics of the construction and the characteristics of the materials

3.68
lifting rope
vertical rope which continues as cross rope at the bottom of the net pen

3.69
maximum wave height
highest wave registered within a period of three hours

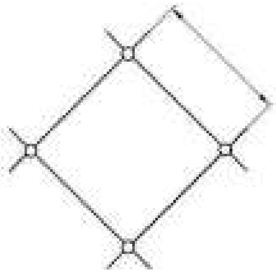
3.70
mesh
opening in the fishing net, including the twine that form the limits of the opening

NOTE In net pen there are two mesh types which are used, determined by the geometry of the mesh, namely, square mesh and hexagonal mesh.

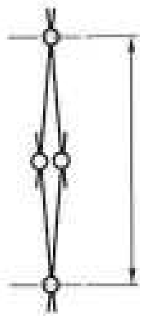
3.71
size of mesh [NS-EN ISO 1107]

NOTE In NS-EN ISO 1107 the mesh size is only defined by sub-terms (see 3.69.1, 3.69.2 and 3.69.3).

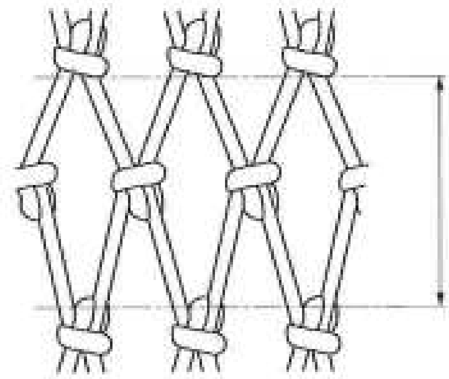
3.71.1
length of the mesh side
half-mesh
Length of the mesh side measured from centre to centre of two consecutive joins
[NS-EN ISO 1107]



3.71.2
mesh length
whole mesh
distance between the centre of two opposing knots/joins in the same mesh when the mesh is fully stretched
[NS-EN ISO 1107]



3.71.3
mesh opening
distance between two opposing knots/joins in the same mesh when the mesh is fully stretched
[NS-EN ISO 1107]



3.72
material factor
material coefficient
factor expressing possible deviation in strength of materials in relation to characteristic values, possible strength reduction of materials in the construction as a whole in relation to characteristic values derived from tests and uncertainties with modelling and the determination of the construction's capacity, including specified tolerances

3.73
cage
floating collar with fixed net pen

3.74
marking
unambiguous identifier on a main component or parts of it, in order to simplify retrieval and traceability

3.75
environmental load
load on a marine fish farm from wind, current, waves, ocean swell, tide and ice

3.76
assembly
installation
composition of a main component or parts of it or composition of main components and/or extra equipment of a marine fish farm at a site

3.77
net buoyancy
total buoyancy with a deduction of the weight of all parts of the system

3.78
net
fishing net used in a net pen

3.79
net pen
net
fish farming net
completely assembled bag of net to keep farmed fish in place

3.80
partial coefficient
load factor or material factor

3.81
partial coefficient method
dimensioning method which leads to the desired safety level by application of partial coefficients together with characteristic values for loads and the construction's resistance

3.82
permeability
measure for water penetration

3.83
peak period
wave period where the energy in the wave spectrum is greatest

NOTE This period is equivalent to the period for the highest waves.

3.84
production documentation
work descriptions and drawings that personel shall have in order to be able to perform the work in relation to planning assumptions
[NS 3472]

3.85
produktspesifikasjon
technical documentation of equipment

3.86
procedure
description of how an operation is normally performed

NOTE A procedure can be derogated from if certain conditions indicate it.

3.87
planning
design, dimensioning and planning of performance

3.88
reliability
the capability of the construction or part of the construction to meet the designated requirements they are dimensioned for, including design working life. Reliability is usually expressed by the use of terms for probability
[NS 3490]

NOTE Reliability includes the safety, use characteristics and durability of the construction.

3.89
reliability factor
factor used to grade the requirements regarding equipment based on expected impacts in the event of failure or destruction

3.90
redundance
further capacity in addition to the safety factors operated with

NOTE This can be formed by the difference between yield stress and breaking stress, plastic utilisation of cross section, or transfer of storage of forces due to constructive design. Regardless of redundance the capacity is exceeded when breaking stress is exceeded.

3.91
regular sea
sea state where the waves have uniform wave characteristics

3.92
railing
device to prevent personnel from falling into the sea, and for attaching jump catch nets and bird nets

3.93
repair
operation to restore the function, capacity and strength of equipment

3.94
risk
danger that undesirable events represent for humans, environment and material values. The risk is expressed by the probability for, and impact of, undesirable events
[NS 5814]

3.95
risk analysis
systematic procedure to describe and/or calculate risk. The risk analysis is performed by mapping undesirable events and the causes and impact of them
[NS 5814]

3.96
risk-reducing measures
measures with the aim of reducing the probability for and/or impacts of undesirable events
[NS 5814]

3.97
risk evaluation
comparison of results of the risk analysis with acceptance criteria for risk and other decision criteria
[NS 5814]

3.98
routine inspections
inspections that are made frequently, such as at given intervals or after special events, in order to discover any faults or defects which can be attributed to use, weather conditions, vandalism etc.

NOTE Intervals for routine inspection can be weekly.

3.99
probability
measurement for how often an event is expected to take place per unit of time

3.100
probability for exceeding
measurement for how often a given threshold is exceeded on average during a given time period

NOTE When a significant wave height is said to have an annual probability for exceeding of 0.02 (1/50), it means that this wave height on average is exceeded once every 50 years. This wave has a return period of 50 years. The wave is referred to as the 50-year wave.

3.101
probability-reducing measures
measures for reducing the frequency of an undesirable event

3.102
sequential main inspection
inspection which is undertaken at fixed intervals in order to determine the equipment's level in relation to loads, function, stability, capacity and strength

NOTE Interval for sequential main inspections can be semi-annual.

3.103
vertical rope
vertical rope in the net pen

3.104
significant wave height
average wave height for the highest third of the waves in one registration

3.105
significant wave period
average wave period for the highest third of the waves in one registration

3.106
safe knot
knot that does not loosen or cause the rope to be broken because of function or imposed loads in mooring or net pen

NOTE A knot that reduces the strength of the rope as little as possible shall be sought used.

3.107
solidity
the relationship between the planned net area and total area on a net panel

3.108
peak parameter
indicates the width of the JONSWAP spectrum around the peak period

3.109
fetch
distance from the site to closest land, calculated in the wind direction

3.110
velocity of current
vectorial average of velocity of current over a ten-minute measurement period

3.111
direction of current
direction in which the current is flowing

NOTE Current with 90° flows towards east. Current is stated in the opposition direction in which waves and wind move, because of the different oceanographic conventions.

3.112
additional information
disseminated information
extra information which describes a measurement

NOTE This can be time, position, measuring depth, calibration data, type of instrument, institution and operator for a current measurement series.

3.113
top rope
uppermost horizontal rope on a net pen

3.114
transport
moving of equipment from producer/supplier to fish farmer

3.115
twine
spun filament

3.116
accident limit state
limit state resulting when a construction is put under an accidental load

NOTE Accidental load can be caused by collision or a break in moorings

3.117
accidental load
load, usually short-term, but of a considerable size, which a given construction with little probability will be exposed to during the design working life

NOTE An accidental load can in many cases be expected to lead to serious impact unless suitable measures are taken

3.118
design
determination of the structure of main components

3.119
production
production of components at a workshop and factory as well as installation of them or parts of them at the site

NOTE Components here can mean main components or parts of them.

3.120
fatigue limit state
limit state quantifying the danger of fracture during the useful life of the marine fish farm because of repeated loads

3.121
replacement
replacement of a main component or parts of it by removing it and replacing it with another

3.122
stretching system
extra equipment which shall contribute to keeping the net pen in the desired three-dimensional form

NOTE This can be weights, bottom ring, etc.

3.123
undesirable event
an event or condition which can entail injury to humans, or damage to the environment or material values [NS 5814]

3.124
maintenance
operation which shall prevent that equipment is weakened in relation to the intended function, capacity, and strength

3.125
wind velocity
average wind velocity in a defined direction over a ten-minute interval, measured at ten metres above ground level

3.126
wind direction
direction from which the wind is coming

NOTE A wind with the direction of 180° comes from the south.

3.127
wind sea
waves which are generated by wind locally in relation to the site

4 Symbols

a	Number of cycles in a cyclic course
B	Width
D	Depth
D	Diameter of a pipe
DAF	Dynamic amplification factor
DH	Artificial shear deformation
DH_{char}	Characteristic shear deformation
$DH_{char,n\ cages}$	Characteristic shear deformation in a double line of net pens with *n* cages in line
E	Elasticity module
E_{sig}, E_{rel}	Viscous elasticity factors
EPS	Expanded polystyrene
F	Occurring load on cages in newton
F_b	Load due to fouling on the net pen
F_e	Effective fetch length in metres, corrected distance from the site to the nearest land calculated in the direction of the wind
F_e	Cracking stress
F_e	Self- load of net pen
F_h	Load on net pen upon handling
F_s	Maximum load from current on the net pen
F_w	Load from waves on the net pen
FEM	Finite Element Methods
GZ	Curve for stability in relation to heeling angle
H	Ocean swell
H	Regular wave height in metres (ocean generated)
H_{maks}	Maximum wave height in metres in a measurement of three hours duration and a return period of 50 years
H_s	Dimensjoning, significant wave height in a measurement of three hours duration and a return period of 50 years
I	Ice formation in kg/m^2 during a 48-hour period
ID	Identification

IMO	International Maritime Organization
JONSWAP	Joint North Sea Wave Project
k_1, k_2	Freeboard requirement
K2	Specified chain quality in relation to the stress level
L	Length
L	Design working life in number of years
L	Load on the net pen
L_p	Characteristic peak length
LOA	Largest length of a raft, given in metres
MBL	Minimum breaking load
n, N	Number of cycles to fracture
N_l	Number of cycles to fracture
NDT	Non-destructive testing
P	Return period
PA	Nylon
PE	Polyethylene (polythene)
PM	Pierson Moskowitz spectrum
PP	Polypropylene
PU	Hardened polyurethane foam
PVC	Hardened polyvinylchloride foam
Q	Pump capacity
R	Strength of a (main) component
S_f	Design load effect
SCF	Stress concentration factor
SN	Curve indicating stress in relation to the number of cycles
T	Regular wave height
T_p	Peak period in the wave spectrum for a measurement period of three hours duration
T_{p2}	Defined peak period in the spectrum
T	Thickness of pipe wall
U	Wind velocity
U_{10}	Wind velocity measured 10 metres above water surface, averaged over a ten-minute period
UV	Ultraviolet radiation
U_A	Adjusted wind velocity
V	Wind sea
V	Average wind velocity for a ten-minute interval measured 10 metres above ground level
V_c	Current velocity averaged over a ten minutes measurement period and a return period of 10 years
V_s	Current velocity
WPS	Approved welding procedure
XC3	Defined exposure class
Ø	Diameter of waste pipe
Ψ	Reduction factor

$\Delta\sigma$	Difference between the highest and lowest stress level in a cyclical course
γ	Peak parameter
γ_f	Load factor
γ_m	Material factor
σ_{flyt}	Yield stress of the material
σ_s	Nominal stress range of the material
σ_{maks}	Maximum stress level of the chain in a cycle
σ_{min}	Minimum stress level of the chain in a cycle

5 Site surveys

5.1 General

The site shall be surveyed and described based on topography and degree of exposure in the form of parameters that shall form the basis for calculation of environmental loads on an installation. Measurements shall be performed on empty sites, i.e. a site without an installation, if possible. When measurements are taken with an installation in place at the site, they shall be taken into consideration in the determination of the environmental parameters.

See otherwise information Annex A for more background information concerning site surveys.

All assessments which are made during the site survey shall be documented.

5.2 Determination of velocity of current

5.2.1 General

Either para. 5.2.2, 5.2.3, or 5.2.4, shall be used in determining current velocities.

Measurements shall be done at a minimum of two levels, 5 m and 15 m respectively below sea level, where topography allows.

Measurements shall be undertaken at a place at the site which is expected to have the highest current velocities and shall be representative of the areas where the fish farm is to be located. The measurement site shall be indicated and justified. Logging of current shall take place at least every 10 minutes and form the basis for the dimensioning current velocity at the site. Previous measurements which are logged every 30 minutes can be used when current data is to be collated for a complete year.

Measurement of current velocity entails registration of both time, velocity and direction during the whole of the measurement period. Current measurements shall take place in accordance with NS 9425-1 and/or NS 9425-2, dependent on the bottom depth of the site and exposure.

Which critical current components contribute to the total current overview shall be assessed and documented:

- tidewater current;
- wind-induced surface current;
- outbreak from the coastal current;
- spring flood because of snow and ice melting.

Quality assessment of measurement data of current measurements shall be performed, and include:

- credibility;
- factors during the measurement period that can have affected the measurements.

5.2.2 Measurements of current for one year and use of long-term statistics

Data for current velocity shall be obtained by measurements of at least 12 months' duration at the site. The data shall be processed by using harmonic analysis with subsequent harmonisation of long-term statistics. It is possible to assemble several partial measurements of at least 4 weeks' consecutive duration which together cover one calendar year.

5.2.3 Measurement of current for one month

In order to determine dimensioning current velocity with a specified return period, the multiplication factors in Table 2 shall be used.

Table 2 – Multiplication factor as a result of return period, used with one month's current measurement

Return period years	Multiplication factor
10	1,65
50	1,85

If the highest dimensioning current velocity with a return period of 50 years, based on a measurement over one month is lower than 50 cm/s, the dimensioning current velocity (50 years' return period) at the site shall regardless be set at 50 cm/s. The other values in the current rose shall be increased equivalently percentage-wise. If it can be substantiated that the current measurement over one month has captured maximum current for twelve months, the requirement for setting the dimensioning current at 50 cm/s can be waived. A further description of the various current components (see 5.2.1) shall be included in the assessment. The assessments shall be documented.

5.2.4 Use of previous current measurements

Existing current measurements can be used if they meet the requirements stated in para. 5.2.2 or 5.2.3. Measurements at other depths than those specified in para. 5.2.1 may be used, provided that it is possible to use them to estimate the current velocity at the stated depths by interpolation.

NOTE By using measurements undertaken at depths other than 5 m and 15 m respectively, extrapolation cannot be used to estimate the current velocity at the mentioned depths.

5.3 Determination of waves

5.3.1 Determination of wind-induced waves

5.3.1.1 General

The method for determination of waves shall be documented. Wind-induced waves shall either be determined by wave measurements or by calculation in accordance with para. 5.3.1.4. Wave measurements shall be further processed in accordance with para. 5.3.1.2 or 5.3.1.3.

NOTE 10-years' wind and 50-years' wind for determination of waves can be decided in accordance with NS-EN 1991-1-4.

In addition to the methods described below, a wave chart can be based on long-term wave measurements if they cover the relevant site.

Re-examination of the measurement data of wave measurements shall be performed, and shall include:

- credibility;
- factors during the measurement period that can have affected the measurements.

5.3.1.2 Irregular sea

In the event of irregular sea, the JONSWAP spectrum shall be used with $\gamma = 2.5$ for wind sea and $\gamma = 6.0$ for swells. Alternatively, in fjords or in other partly sheltered sites, a 2-parameter PM spectrum (Pierson Moskowitz spectrum) can be used. A fully developed sea state shall be assumed.

5.3.1.3 Regular sea

With the use of regular sea, regular wave height shall be assumed, equal to:

$H = H_{max} = 1{,}9 \cdot H_s$

Regular wave period shall be set at the peak period T_p

5.3.1.4 Calculation of waves based on effective fetch length

Wind-induced waves shall be calculated based on wind data from para. 5.4.2 and fetch length measured on a sea chart. Dimensioning, significant wave height shall be determined based on effective fetch length and 10-minute average wind at 10 m height, and such that the wave height increases (approximately) proportionally with the wind velocity and proportionally with the square root of effective fetch length. The 50-year wave shall be determined based on the site's 50-year wind. The 10-year wave shall be detemined based on the site's 10 year wind.

Calculate the adjusted wind velocity U_A by using the wind velocity U_{10} (m/s):

$$U_A = 0{,}71\ U_{10}^{1.23}$$

Significant wave height H_s and equivalent peak period in the wave spectrum T_p as well as effective fetch length F_e is given by:

$$H_s = 5{,}112\ 10^{-4}\ U_A\ F_e^{1/2}$$

$$T_p = 6{,}238\ 10^{-2}\ (U_A\ F_e)^{1/3}$$

Effective fetch length shall be found by the use of a recognized method, and used together with an angle opening of maximum ± 12°. Peak period and dimensioning, significant wave height are found by using Annex C or the formulas stated above.

5.3.1 Determination of ocean swells

An assessment shall be made and documented of whether ocean swells occur at the site. If ocean swells occur at the site, the wave height and period are calculated by using one of the following:

- diffraction and refraction analysis;
- measurements for determining swells with a return period of 10 years and 50 years;
- other recognised methods which can document safety, validity and accuracy.

In the case of ocean swells at the site, the combined sea state shall also be determined by combining calculated ocean swells with calculated, wind-induced waves.

5.3.2 Other wave conditions at the site

If para. *5.3.1.4 Calculation of waves based on effective fetch length* is used to determine the waves, the following effects shall be assessed and documented to see how far they can affect the wave spectrum:

- ship-generated waves
- wave reflection (such as if the site is located near a steep mountainside or similar);
- effect of several wave trains (such as if two fjord systems meet or by combination of wind-induced sea and ocean swell);
- wave / current interaction (changes of wave spectrum at the site with a lot of current).

These conditions can contribute to changing the wave spectrum in the form of an increased significant wave height or changed peak period. The result of the analyses can lead to providing several wave spectra for the site.

5.4 Determination of wind velocity

5.4.1 General

NS-EN 1991-1-4 shall be used in order to determine the wind velocity for calculation of wind-induced waves.

To find the wind conditions for calculation of the wind load on rafts, extra equipment or ice-covered marine fish farms, either NS-EN 1991-1-4 or 5.4.2 shall be used, with a 50-year return period.

5.4.2 Use of wind data from meteorological stations

Measurements from the nearest or the nearest two weather stations[3)] shall be used. Long-term statistics shall be prepared if they are not available from the weather station's data. Long-term statistical mean wind velocity shall be determined with a return period of 10 years and 50 years respectively.

Use of wind data from weather stations shall always be accompanied by a documented assessment of the site in question in relation to the weather stations. Elements which shall be taken into consideration are the distance between weather stations and the site, degree of sheltering of the site in relation to the weather stations and critical wind directions.

5.5 Determination of the effects of ice

5.5.1 Icing, particularly in combination with bad weather and reduced accessibility

Danger of icing on marine fish farms and appurtenant fixed equipment shall be documented. That shall be done on the basis of the following meteorological data for the site:

- air temperature;
- wind and exposure to wind;
- waves and exposure to waves;
- sea temperature.

If nothing else is documented 850 kg/m^3 up to 10 m above sea level shall be used for mass density of ice.

In total, this will give an icing potential giving a dimensioning icing over a defined time interval. The period for continuous accumulation of ice shall be assessed based on the possibility of removal of ice and documented measures for icing prevention. If nothing else is documented, three 24-hour periods shall be used.

Determination of ice and icing potential shall be done based on recognised methods. Use of numerical methods shall be documented. Possible experiences regarding the site shall be collected for the assessment.

5.5.2 Drift ice

The danger of drift ice at the site shall be assessed and documented. Sources of drift ice can be fresh water reservoirs (lakes), rivers and river estuaries, river mouths and brackish water areas, sheltered fjords and sounds with sea ice. An indication shall also be given of which parts of the year drift ice can occur. The assessments shall be performed based on meteorological data and possible sources compared to any local knowledge.

5.5.3 Freezing over

The danger of the site freezing over shall be assessed and documented, with an indication of a possible time of year that this can occur. This shall be performed by assessing meteorological data compared to local knowledge of the site.

[3)] The Norwegian Meteorological Institute has several weather stations that cover the whole country.

5.6 Description of water depth, bottom type and topography

Bottom topography and type at bottom attachments and along mooring lines shall be charted. Bottom depth in the relevant area for the marine fish farm, including mooring, shall be charted in a grid with the greatest distance of 10 m × 10 m between the registered points. Large irregularities, such as large stones, spines, fissures or larger object, shall be especially noted.

5.7 Direction of current, waves and wind

Values for current, waves and wind shall be indicated in at least 8 concurrent directions.

5.8 Documentation of site inspections and site reports

5.8.1 Documentation of measured parameters, calculations and conclusions

5.8.1.1 General

All information which characterises the site shall be presented so that the user can utilise them easily. All procedures shall be described or contain references to a separate description. The connection between processed data and supporting raw data and additional information shall appear. The documentation shall treat all the points below, where this is relevant. An inspection of the site shall be documented through a separate site reports.

5.8.1.2 Instruments

The following shall be included:

- instrument description for sensors, including producer, serial number and measurement principle in the form of reference to publication or short description;
- any modifications of the instruments;
- accuracy, resolution capability, and area of response for each sensor;
- calibration standard (such as procedures, quality and dates);
- conversion constants;
- any resolution in relevant dimensions;
- instrument log with relevant historical information.

5.8.1.3 Data collection and data processing

The following shall be included:

- type of measurement, including instantaneous value, average value and registration of disruption;
- measurement interval;
- duration of determination of each average period;
- number of raw data measurements for each presented data value;
- real measurement period for processed data;
- procedures for reduction of noise, filtering and data compression.

5.8.1.4 Data editing and quality control

The following shall be included:

- short description of procedures for data editing;
- short description of procedures for quality control;
- reference to type of quality control.

5.8.1.5 Data quality

The following shall be included:

- report on data quality and errors or uncertainties, such as fouling on instruments;
- report on correction of data, including treatment of errors and deviations.

5.8.2 Basis for charts

A detailed chart showing moorings lines and cages, with given scales, shall be made.

6 Load and load combinations

6.1 Dimensioning situations

A marine fish farm shall be dimensioned so that farming can be carried out without farmed fish escaping as a result of technical failure. The dimensioning situations shall be sufficient and at the same time be so varied that they include relevant circumstances which can occur during installation, operation, repair and maintenance of the marine fish farms.

The following sequences shall be included in a dimensioning analysis:

- determination of the loads;
- determination of effects of the loads;
- determination of resistance to the effects of loads;
- control in relation to defined limit states.

Sufficiently great probability shall be proved that the marine fish farm functions as it should in limit states.

6.2 Partial co-efficient method

Partial co-efficient method means defining limit states to which the marine fish farm can be exposed, based on load factor and material factor.

The load factor, γ_f, shall take the following into consideration:

- possible unfavourable deviation for the loads in relation to the equivalent characteristic values;
- reduced probability for different loads behaving at the same time with their characteristic values;
- uncertainties in modelling and analyses in the determination of load effects.

The material factor, γ_m, shall take the following into consideration:

- possible unfavourable deviation from the strength of the materials in relation to the equivalent characteristic values;
- possible reduced strength of materials in the marine fish farm as a whole in relation to characteristic values connected to individual parts;
- uncertainties in modelling and determination of strength of the marine fish farm, including specified tolerances.

NOTE Uncertainty in the yield strength values of the material can be an impact of erroneous production and damage and weakening which can occur during installation and use, including reduction of yield strength values as a result of temperature (variations), corrosion, ageing, photochemical oxidizing, UV rays etc.

The material factor shall also be based on the requirements described in para. 7.5.

Design load effect, S_f, is the load effect from characteristic loads multiplied by load factor γ_f.

Design load factor, S_f, shall fulfill the following expression for each (main) component:

$$S_f \leq \frac{R}{\gamma_m}$$

where

S_f is the design load effect; average force, or stress

R is the strength of a (main) component

γ_m is the material factor

See also NS-EN 1990.

6.3 Characteristic values

Characteristic values shall be determined as loads which the marine fish farm with a defined probability will not exceed during its design working life.

Characteristic capacity for resistance shall be based on a defined probability that they will not be under-reached during the dimensioned useful life of the fish farm.

6.4 Limit states

Dimensioning shall be done in relation to two limit states:

- serviceability limit state;
- ultimate limit state.

Fatigue and accident situations shall be seen in regard to the ultimate limit state. The limit states shall be treated in accordance with NS-EN 1990.

6.5 Loads

6.5.1 General

During dimensioning, all load categories which can occur during the design working life of the marine fish farm, shall be assessed and documented, such as:

- permanent loads;
- variable function loads;
- deformation loads;
- environmental loads;
- accidental loads.

6.5.2 Permanent loads

The permanent loads represent loads which will not be removed during the design working life of the marine fish farm. These consist of:

- the weight of the marine fish farm in air, including permanent ballast;
- the weight of fixed equipment which cannot, or shall not, be removed;
- static buoyancy forces.

The permanent loads shall be determined based on accurate data regarding the density of the materials multiplied by the appurtenant volume and/or measured weight.

6.5.3 Variable function loads

Variable function loads are maximum loads which can be removed or relocated. They can be applied to the marine fish farm by:

- mechanical, movable equipment;
- personnel;
- stored goods, such as feed;
- variable ballast;
- mutual load between main components, such as floating collar and raft;
- normal boat impact, fendering and mooring of adjacent floating units;
- movable parts, as well as extra loads applied as a result of certain work operations.

6.5.4 Deformation loads

Deformation loads are loads which occur at forced deformation. This includes deformation which is due to the marine fish farm's function or circumstances in the surroundings, such as:

- pre-tensioning;
- mooring;
- temperature.

6.5.5 Environmental loads

Environmental loads are loads which are applied to the marine fish farm by environmental circumstances, such as:

- wind;
- waves;
- current;
- ice.

Unequally distributed ice shall be allowed for with the greatest ice load both on horisontal and vertical surfaces in accordance with para. 5.5.1 on the one side and no ice on the other side. In calculations, ice shall be treated as accidental load.

6.5.6 Accidental conditions / damage conditions

6.5.6.1 General

As a minimum accidental conditions / damage conditions shall be calculated, assessed and documented, and the impact of them shall be evaluated. This includes conditions such as:

- breaks in mooring lines;
- puncturing, disappearance or loss of floating parts.

Dead fish can also be regarded as accidental load. The calculations shall then be performed without combination with environmental loads.

6.5.6.2 Breaks in mooring lines

A marine fish farm shall be assessed for breaks in the mooring system. Progressive breaks shall be especially assessed. Breaks in each line shall be assessed. Breaks which weaken the stability of the mooring and functionality of the floating collar shall be assessed.

In particular, an assessment shall be made and documented, if necessary supported by calculations, of breaks in the following:

- breaks in lines carrying the largest load;
- breaks in lines which are critical for strength in the marine fish farm, especially the floating collar;
- breaks in the connecting points, such as coupling disc. Possible breaks in connecting points (including coupling discs) will vary based on the design of the connecting point. The break/tear form which gives the least capacity shall be regarded as broken. If the connecting point has probable break sections which entail that several mooring lines are out of function, this shall be regarded as accidental load;
- breaks in lines that are critical for positioning of single or groups of cages with common moorings, where relocation can lead to damage to adjacent cages.

6.5.6.3 Puncturing

The following situations shall be dimensioned for:

- water penetration in one floating element or between two bulkheads (when using hollow floating elements).
- loss of one floating element at a most critical place (when using floating elements filled with buoyancy materials).

6.6 Load factors

For different main components, the load factors in Tables 3, 4 and 5 shall be used.

Table 3 – Load factors for floating collars of steel and plastic in a serviceability limit state

Dimensioning situation	Permanent load	Variable functional load	Deformation load	Environmental load
Establishment of floating ability	1,0/0,9[1)]	1,0	1,0	1,0[2)]
Establishment of capacity	1,0	1,0	1,0	1,3
Accident situation - Damaged condition [3)]	1,0	1,0	1,0	1.0

1) Favourable load (buoyancy) and unfavourable load (weight) shall be regarded as separate loads. The favourable part has a load factor of 0,9, and the unfavourable part has a factor of 1.0.

2) Applies to loads from ice and snow.

3) Applies to breaks in mooring lines, puncturing and ice and snow

Regarding serviceability limit states, all load factors are set at 1.0.

The values in Table 3 are used in dynamic analyses. In the event of quasi-static analysis, the stated load factors in Table 3 are multiplied by a dynamic amplification factor greater than or equal to 1.1. The basis for the factor shall be justified and documented. In order to establish the dynamic factors it is necessary to know the resonant frequencies of the construction and the load's variation in time and space. The analyses shall be performed in accordance with NS-EN 1990.

The load factors in Table 3 shall also be used for surfaces of steel and concrete respectively.

Table 4 – Load factors for mooring lines

Type of analysis	Load factor
Static analysis	1,6
Quasi-static analysis	1,15×DAF[1)]
Dynamic analysis	1,15
Accident limit (break in mooring line)	1,0
Spring flood	1,0

[1)] Here is used a factor of 1.15 multiplied by dynamic amplification factor (DAF). Dynamic amplification factor ≥1.1. Choice of value of DAF shall be justified and documented.

Table 5 – Load factor for rope in net pens, dimension Grade 0

Various components	Load factor
Net pen, dimension Grade 0	1,3
Net pen, dimension Grade 0, manual lifting equipment	1,5
Net pen, dimension Grade 0, mechanical lifting equipment	3,0

6.7 Load combinations

Table 6 indicates combinations of current, wind and waves for controls in ultimate limit states.

Table 6 – Combinations of environmental loads

Combinations	Return period, environmental load year		
	Current	Wind	Wave
1	50	10	10
2	10	50	50

For controls in serviceability limit states a reduction factor, $\psi = 0.7$, is used for the loads in Table 6, see also NS-EN 1990.

Table 6 indicates combinations of current, wind and waves for control in ultimate limit states. In accident limit states the individual events shall be controlled under stress from the most unfavourable of the two environmental load combinations in Table 6. An assessment shall be made of which environmental load combination is the most unfavourable for each accidental event.

6.8 Calculation of the effects of load

Construction calculations shall be based on a suitable choice of stress-strain conditions for materials and connections. In general, it is assumed that the constructions will be linear elastic. Non-linear models can be used where indicated in the planning standards for the various materials.

If the dynamic loads can be regarded as quasi-static, the dynamic load variations can be taken into consideration, either directly in the static values or by multiplying the static loads by calculated dynamic factors.

7 General requirements regarding main components and marine fish farms

7.1 General

A marine fish farm shall have an appropriate technical design, and the fish farm shall be operated in an appropriate manner in order to avoid technical failure.

Planning of a marine fish farm shall be based on risk evaluation and ensure that it is adapted to the environmental conditions at the site. The requirements in this chapter regarding planning includes both the marine fish farm as a whole and its components.

7.2 Risk analysis

A risk evaluation shall be performed in connection with planning, production, delivery, installation and operation.

A risk analysis, broken down into probability and impact (degree of seriousness), shall be included.

The risk analysis shall be based on NS 5814 or equivalent. The various stages shall be documented so that they can be re-examined.

A risk evaluation shall be as complete as possible and also cover relevant conditions for escape which are not explicitly mentioned in this Standard.

NOTE An example of a partly performed risk analysis for operation is given in table form in Annex F.

7.3 Planning of main components and composition of marine fish farms

7.3.1 Reliability and control

NOTE Reliability class is used to determine requirements regarding control of planning and production in NS-EN 1990.

The reliability class for the main components and for the marine fish farm shall be determined by the number of fish that can escape in the event of failure or collapse. A main component can have a lower or higher reliability class than the rest of the marine fish farm, according to the impact of failure.

Marine fish farms in Reliability Class 2 normally require *normal inspections,* which entail an internal, systematic control by other personnel in the company than the/those person(s) who originally performed the work. Control of planning shall include random sample control of load effects and of the capacity of main elements.

Marine fish farms in Reliability Class 3 normally require *extended inspections* of planning and production. These shall be performed by another company than the one performing the work. Inspection of planning shall in that case include independent analyses and capacity controls. So that analyses and capacity controls performed by a certifying body shall be regarded as extended inspection, previous calculations must be available from the Supplier.

Reference is also made to NS-EN 1990 regarding what the inspections shall include.

NOTE Risk of escape varies according to which main component fails. Collapse of mooring could lead to all fish in the marine fish farm escaping, and collapse of the net pen to escape of the fish in the net pen.

Table 7 – Reliability factor for floating collar/net pen and mooring respectively in relation to the number of fish

Number of fish in the floating collar/net pen	Number of fish in common mooring	Reliability class
n < 500 000 individuals	n < 1 000 000 individuals	2
n ≥ 500 000 individuals	n ≥ 1 000 000 individuals	3

If one of the criteria for that is present, the reliability class is set at 3, if relevant.

If one of the criteria for that is present, the reliability class is set at 3, if relevant. For net pens, differentiation shall be made between the probability of failure in the form of small cracks and collapse in the form of breaks in the rope attached to the twine or progressive tears.

NOTE Reliability classes for other social constructions are given in NS-EN 1990. Here the fish farming installations are designated "fishing harbours" and placed in Reliability Class 2.

7.3.2 Planning of (the whole) marine fish farm

A marine fish farm shall be sufficiently reliable to prevent the impact of undesirable events. In order to achieve sufficient reliability, the marine fish farm shall be planned in accordance with the requirements set forth in NS-EN 1990 or equivalent.

In order to avoid potential damage, recorded during risk analyses, one shall seek to reduce the impact of an undesirable event and the probability for its occurrence. The following shall be done:

- avoid, eliminate, or reduce dangerous events to the marine fish farm installation;
- choose a load-bearing system which has a small risk of exposure to dangerous events;
- choose a load-bearing system which has little sensitivity to dangerous events;
- choose load-bearing systems which do not break down without warning;
- choose main components which are suitable for each other, which are well connected to each other, and which have defined interfaces where mutual effects between them are within defined limit values;
- choose suitable materials, perform professional design and detailing, choose skilled manufacturing and establish appropriate control procedures for planning, production and operation;
- provide sufficient information regarding expected use;
- store production documentation which unambiguously describes geometry, materials and other technical requirements;
- undertake new evaluations and describe requirements for changes if a marine fish farm is changed, the useful life changes in relation to design working life, or damage occurs, provided that this is significant to the escape risk.

7.3.3 Connecting points

A local analysis of critical connecting points shall be performed. Any testing shall be performed with the aid of applied loads, three-dimensional if necessary. The connecting points shall include, but not be limited to:

- coupling discs (between mooring lines and frames, etc.);
- attachment points (net pen and mooring to floating collar);
- attachment rings;
- knots;
- hinges;
- rock bolts.

A fatigue analysis shall be performed. An analysis regarding the ultimate limit state shall also be performed.

Coupling discs in moorings will experience forces from several directions. Analyses shall be performed which document the capacity in relation to this for all applicable loads to which such plates can be exposed.(See 11.3.3).

7.3.4 Planning and use of materials

Installations of steel shall be dimensioned in accordance with NS-EN 1993-1-1. Corrosion protection of steel installations shall be undertaken in accordance with NS-EN ISO 12944-2 and NS-EN ISO 12944-3. Any cathodic protection shall satisfy the requirements in NS-EN 13173.

Aluminium constructions shall be dimensioned in accordance with NS-EN 1999-1-1.

Concrete constructions shall be dimensioned in accordance with NS-EN 1992-1-1. Other materials shall be calculated and dimensioned in accordance with recognised standards.

7.4 Planning and production of main components

7.4.1 General

Planning and production shall be in accordance with NS-EN 1990.

The basis for the requirements regarding main components is that they shall be able to withstand the loads to which they will be exposed at a site.

The main components shall be dimensioned according to calculations regarding waves, wind and current in eight directions, as specified in para. 5.7. Deviations from the requirements for calculations in relation to the number of directions shall be justified based on a risk analysis, as described in para. 7.2. Single parts or main components or joining of single parts to the main components shall be dimensioned to tolerate the forces applied to them.

A main component shall be dimensioned in order to:

- function satisfactorily based on given assumptions, such as environmental forces;
- tolerate all assumed loads, including deformations, with satisfactory protection against breaking;
- show satisfactory protection against an undesirable event triggering a more significant event than the triggering event itself;
- show satisfactory resistance to mechanical, physical, chemical and biological effects, seen in relation to design working life.

Dimensioning shall take into consideration mutual influence between the main components, such as between the floating collar and net pen, floating collar and mooring, floating collar and raft, net pen and mooring, net pen and raft, mooring and raft, and between the main components and any extra equipment.

The main components shall be calculated in relation to probable configurations/connections with other main components. Documentation of possibilities and limitations in the use of equipment as a result of these calculations shall be available.

7.4.2 Design working life and durability

The design working life shall be determined for both the whole of the marine fish farm and its main components.

User handbooks for the main components shall contain information regarding design working life and associated requirements for condition control and maintenance procedures.

The planning objective shall be that fish farms remain suitable for use during the dimensioned useful life. In order to ensure sufficient durability, the following shall be taken into consideration:

- the use area is fish farming, without the escape of farmed fish;
- the functional requirements in this Standard;
- maximum environmental forces the marine fish farm withstands;
- the composition, characteristics and performance of the materials;
- choice of load-bearing system;
- the design of the parts and constructive detailing;
- requirements as regards skilled work, both during production and operation;
- scope of inspections;
- defined protection measures;
- condition control and maintenance during operation for the entire design working life.

Planning and mooring shall in addition take into consideration the seabed conditions, including depth, topography and seabed substrate, on the basis of the results of the site survey.

7.4.3 Criteria for determining when equipment does not have sufficient quality

The criteria for determining when main components/components do not keep sufficient quality shall appear in the documentation for the components.

7.5 Material characteristics

7.5.1 General

A characteristic capacity has a given probability for not being under-reached in an unlimited series of tests. It indicates a characteristic for a material, and is defined as the mean value for rigidity parameters and as the 5 % fractile of the statistical distribution of the material characteristic for rigidity parameters.

NOTE Material characteristics are usually provided by the material producer.

If a material characteristic is not provided, it shall be found by relevant, standardised tests under defined and relevant conditions, and a conversion factor shall be used if necessary so that the test results shall be representative of the material characteristics in the relevant construction.

The planning standards for the various materials shall be used to obtain values for material characteristics. For planning where steel is to be used, NS-EN 1993-1-1 shall be applied, for planning where concrete is to be used, NS-EN 1992-1-1 shall be applied. Correspondingly, other planning standards shall be used where they are to be found for other relevant materials. See also paras. 9.10 and 9.11 for steel and plastic installations respectively.

7.5.2 Galvanic conditions

Contact between metals/alloys of different qualities shall be avoided as much as possible. Where this nevertheless takes place, increased corrosion shall be evaluated and documented as a result of galvanic conditions, either through an after-inspection programme or by loss of strength calculations based on corrosion as a function of time. Corroded components shall be replaced in accordance with the requirements indicated by the evaluations.

7.5.3 Material parameters (rigidity, strength, corrosion, strain characteristics, density and design working life)

All material parameters shall be obtained from authoritative sources, such as supplier documentation connected to certified equipment or materials.

7.6 Extra equipment

7.6.1 Loads from extra equipment

In the planning phase of the floating collar, areas for extra equipment shall be defined, and this shall be taken into consideration in the planning analyses. These areas shall be indicated with the highest allowed total load, highest distributed load per m^2 and highest allowed concentrated load as well as the possibility for attachment. In the cases where no such areas are defined, or where extra equipment is planned installed outside the defined areas, documentation shall be provided that the marine fish farm tolerates the extra equipment which is to be installed. Extra equipment shall not lead to exceeding the marine fish farm's capacity, stability and strength. Separate evaluations shall be performed with appurtenant documentation for fixed and movable equipment respectively.

There shall be a user handbook and installation description for extra equipment which represents a danger of escape. See also Annex D. Extra equipment with self-buoyancy, which is moored as a part of or in connection with the installation, shall have documented buoyancy capacity for full-load condition in the event of puncture. Mooring loads for marine extra equipment shall be stated, so that they can be taken into consideration in other analyses.

7.6.2 Requirements for equipment for collection of dead fish

Equipment for collection of dead fish shall:

- have a user handbook and installation description;
- be designed so that its parts under no wave or current conditions lead to chafing on the net pen. If the design does entail danger of chafing, this shall be compensated for by a choice of material that withstands chafing, reinforcements, double protection or other solutions which do not lead to holes during the course of a normal operational cycle for the net pen;
- have recommended and maximum loads in air and water from the equipment for collection of dead fish in the net pen.

7.7 Requirement for stretch system for net pens

Equipment that stretches the net pen shall:

- be documented through calculations together with floating collar and net pen;
- have a user handbook and installation description which shall clearly state how the stretching system shall be assembled and disassembled;
- be attached so that energy from the equipment shall be handled in a proper manner without exceeding the dimensioning capacities of the main components;
- be designed so that its parts do not chafe against the net pen under any wave or current conditions. If the design nevertheless entails danger of chafing, it shall be compensated for by a choice of material which is resistant to chafing, reinforcements, double safeguarding etc. which which do not lead to holes during the course of a normal operational cycle of the net pen.

7.8 Tests

Tests can be an alternative to analysis in order to document capacity. The tests shall take place in accordance with NS-EN 1990. Tests alone or combined with calculations are done to dimension marine fish farms or parts of them, or to find the characteristics of existing marine fish farms. Testing shall be carried out and evaluated as the basis for dimensioning of the marine fish farm installation with a sufficient reliability level based on the relevant limit state and dimensioning situation. Testing and testing conditions shall be representative for marine fish farms in operation.

Testing types are distinguished in order to:

- decide the use characteristics of a construction part or breaking capacity direct;
- find special material characteristics;
- reduce uncertainties in parameters in load or capacity models;
- control the quality of delivered products or uniformity in a production;
- be able to take into consideration factual circumstances which are observed during production;
- inspect the marine fish farm installation or main component after it is at the site.

7.9 Delivery

The main components and extra equipment shall be packed, transported to the site, stored, unpacked and moved at the site in such a manner that the equipment is not damaged or deteriorates.

7.10 Inspections of marine fish farms

7.10.1 General

A marine fish farm shall be inspected as a whole. Loads which are applied to various parts of an installation, depend on design of the floating collar, mooring, net, extra equipment and any raft. The following shall be done:

- an analysis shall be completed of the whole of the marine fish farm so that one finds which forces affect all parts of the installation. This analysis shall include the effects of mutual influence between the main components and extra equipment;
- capacity shall be checked in relation to the loads acting upon the installation. No main component shall have loads applied that exceed capacity. The limit states that shall be checked are those indicated in this Standard;
- completed analyses and capacity controls shall be documented.

Inspections to ascertain whether a marine fish farm is sufficient regarding strength shall be performed at the site. The main components shall not affect one another so that the capacity or tolerance limit of any of the main components is exceeded.

Relevant technical documentation specifying the main components and how they withstand environmental loads, as well as detailed planning, calculation and production procedures, shall be presented. As a main rule, relevant assumptions and limitations in the use of the equipment shall appear clearly in the user handbook for each main component. If not, it shall appear in the user handbook for the marine fish farm installation. Each of the following aspects shall be included in an assessment, in order of priority:

- the complete marine fish farm;
- each of the main components;
- assembly of extra equipment;
- secure placing of extra equipment in relation to the rest of the marine fish farm;
- technical specification of the main components.

7.10.2 Loads and interface between main components

Environmental loads which act on the main components shall be documented. Loads which the main components (mutually) act on each other under all conditions at the site shall be documented:

- force from rafts on the floating collar shall be within the tolerance limits for the latter;
- net drag from the net pen on the floating collar shall be within the tolerance limits for the latter;
- horizontal and vertical forces from the mooring on the floating collar shall be within its tolerance limits;
- the forces on the floating collar from the mooring shall not transfer moments to the floating collar that will damage it;
- horizontal and vertical forces from the floating collar on moorings, including additional forces from the net pen and raft, shall be within the tolerance limits of mooring, including the capacity of the bottom attachment;
- forces from the floating collar on the net pen shall be within the latter's tolerance limits under all wave and current conditions.

7.10.3 Dimensioning

Dimensioning shall be reviewed during the assessment and the documentation of the main components. Consideration shall be taken of extra loads one main component receives from the others, and it shall be established by calculations, research or modelling that each main component has the capacity to withstand these loads. The loads one main component is dimensioned to withstand from other main components shall be specified.

7.10.4 Composition of main components

The composition of main components shall primarily be based on the dimensioning, described in this chapter and in the chapters for the respective main components. In addition controls shall be performed of the following:

- Three-dimensional geometry of the main components shall be such that they do not cause chafing on any of the other main components;
- Materials in and protective coating on parts which connect the various main components, shall be such that they do not cause one another extra corrosion due to galvanic conditions;
- Connecting points between main components shall cause as little wear on adjacent equipment as possible;
- Connecting points between two main components shall be such that connection and disconnection is simple, at the same time as strength and reliability on the connecting function itself is sufficiently good;
- The main components shall be designed so that they do not complicate or impede inspection, maintenance, repairs, cleaning and replacements of other main components or parts of them;
- The composition of main components shall be in accordance with environmental loads such as they appear in the site survey.

7.11 Inspection of marine fish farms after installation at the site

It shall be established through assessment and documentation of marine fish farms at the site, that the main components and any extra equipment are suitable for each other, and that the marine fish farm can withstand the real loads such as they appear in the site survey.

An inspection of the completed installation of the marine fish farm at the site shall be performed. This inspection shall consist of the following at a minimum:

- checks that the marine fish farm installation and its main components are placed at the site as planned, and which all calculations are based on;
- checks that all bottom attachments are placed in accordance with the specifications;
- checks that all the parts are in accordance with the parts lists;
- checks that all the main components are connected in accordance with technical specifications;
- checks that the main components are undamaged after transport and assembly;
- checks that the user handbook is available for further daily operation.

This inspection shall be documented.

Manoeuvring of boats and placing of mooring attachments on the marine fish farm shall be assessed and documented in relation to construction and stability.

The placing of the total system shall be drawn in on a map with the placing of floating collar, any rafts, and mooring.

In the event of deviation between the planned marine fish farm after it has been placed at the site, an assessment shall be made and documented of whether a new analysis is necessary or not.

7.12 Operation

7.12.1 Requirements regarding daily operation

Operation shall take place in accordance with the user handbook as described in para. 7.14.

An operational procedure shall be available which describes activities that are relevant to escape in the operational phase, and which involves participants who do not usually work on the marine fish farm.

NOTE An operational procedure can include unloading of feed or slaughtering.

The procedure shall especially describe the voyage out to sea and mooring in the marine fish farm , in order to avoid damage to the floating collar, mooring or net pen. If necessary, corridors for voyages with vessels shall be defined.

There shall be a log to record actions and results of them, connected to daily operation, inspection, maintenance, tests and replacements, see para. 7.14.3.

The fish farmer shall assess the operational procedures annually and suggest any changes to them based on experience. Changes shall take place in co-operation with the supplier of the main components.

7.12.2 Requirements regarding inspection

Inspection shall be performed in accordance with an inspection programme based on the requirements in the user handbook. The inspection programme shall be divided into:

- routine inspections;
- functional inspections;
- sequential main inspections.

Routine inspections shall discover any faults or defects which are due to use, weather conditions, weakened parts, vandalism etc. Routine inspections shall be undertaken at fixed time intervals, such as daily, and before and after special occurrences, such as storms.

Functional inspections shall discover any weaknesses connected to the performance or stability of the equipment, particularly with regard to wear. Functional inspections shall be undertaken at fixed time intervals, such as monthly.

Sequential main inspections shall establish the level of the equipment in relation to function, stability, capacity and strength. This shall be in relation to weather conditions, visible signs of rot, modifications, replacements or impairment of weld seams, as well as all changes in the equipment's ability to withstand loads. All necessary disassembly or tests in order to complete this inspection shall be undertaken. Skilled persons shall be brought into this process if it is regarded as professionally justified and is specified in the user handbook. The main inspection shall be undertaken at fixed time intervals, such as semi-annually.

The intervals for inspection shall be determined on the basis of the characteristics of the components.

7.12.3 Requirements regarding maintenance and replacements

7.12.3.1 General

Routine maintenance shall take place in accordance with a separate maintenance plan on the basis of specifications in the user handbook. Corrective maintenance, repairs and replacements shall take place immediately when conditions that require it are discovered through the various types of inspection.

Maintenance, repairs and replacements shall take place in accordance with the user handbook.

7.12.3.2 Routine maintenance

Situations which shall be especially assessed and documented in connection with routine maintenance are:

- tightening of attachment points;
- painting and treatment of surfaces;
- lubrication of bearings;
- cleaning and removal of fouling;
- removal of destroyed or obsolete equipment;
- inspection and any maintenance of the site outside the marine fish farm itself.

7.12.3.3 Corrective maintenance

Circumstances which shall be especially assessed and documented in connection with corrective maintenance are:

- replacement of attachments;
- welding, inspection and maintenance of welds;
- replacement of worn parts or defective parts;
- replacement of load-bearing parts that are defective.

7.12.4 Criteria for when equipment is not of satisfactory quality

Criteria for when main components/components are not of satisfactory quality shall appear in the documentation for the components.

7.12.5 Changes and handling of changes

Changes to the marine fish farm which can increase the danger of escape, shall not be made before the necessary measurements, calculations, tests or modeling have taken place. These shall document that the change does not entail undesirable impacts.

This means changes which can lead to overrun of limits of planning, and can be:

- changed configuration of the marine fish farm;
- change of stretching system, such as increased lead weights;
- changed mesh length in the net pen;
- size and design of the net pen;
- extension of the number of cages on one mooring;
- turning of steel installations.

If an emergency change has been necessary, such as to salvage equipment or farmed fish as a result of an unforeseen event, the new situation shall be described as soon as possible based on measurements, calculations, tests or modeling. If the change has led to an unacceptable danger of escape, the acceptable situation shall be reinstated as soon as practically possible.

7.13 Requirements regarding product specification

7.13.1 Requirements regarding documentation of main components

7.13.1.1 Calculations

All calculations shall be available. Methods used shall be described, either directly or with reference to an authoritative document. Design working life which is used as a basis for the calculation shall be stated.

7.13.1.2 Material parameters

All material parameters in capacity, strength and dimensioning calculations shall be available and refer to the source (such as supplier documentation), or what reasoning, method or calculations they are based on.

7.13.1.3 Certificates for parts

All certificates for certified parts shall be traceable.

NOTE It will often be so that the fish farmer has certificates available for the main components, while the equipment supplier has certificates available for smaller parts.

7.13.1.4 Traceability

All parts shall be entered on a parts list which ensures traceability.

7.13.1.5 Documentation of production

The documentation of production of the main components shall contain at a minimum:

- documentation of raw materials, including product and material documentation as well as material certificates which specify the minimum breaking load, fatigue characteristics and any other characteristic values;
- documentation that the production processes, including proof that cutting, forming, etc., are done within given tolerance limits;
- documentation of connections, including that welding has been performed by certified personnel, that welding and heat treatment are based on recognised procedures, and that screws and bolts are tightened to the correct tension;
- documentation concerning surface treatment, including that grinding, sandblasting, lacquering and galvanising have been carried out in accordance with the correct procedures;
- documentation concerning installation, including that assembly of parts for a main component has been carried out within approved tolerances.

7.13.2 Drawings

7.13.2.1 Planning drawings

The following drawings shall be prepared for each marine fish farm:

- the arrangement drawings for the installation;
- placing of the area of use on nautical charts and detailed charts;
- mooring plan.

7.13.2.2 Construction drawings

The following construction drawings shall be prepared for a marine fish farm and its main components, where it is relevant:

- main construction and dimension drawings;
- detailed drawings of parts;
- attachment between main components.

7.13.2.3 Drawings for raft

The drawings shall include system drawings for ballast, draining, cooling water, fuel oil, compressed air/plant air, hydraulics, air and sounding, fire and hosing, to the degree it is relevant for the raft concerned. System drawings for electrical installation, including low voltage, shall also be available.

7.14 Requirements regarding user handbook

7.14.1 User handbook for marine fish farms

A user handbook shall be available for the marine fish farm. The handbook shall be a grouping of user handbooks for the individual main components, as described in para. 7.14.2. The handbook shall also include all the relevant circumstances which are not covered by the user handbooks for the main components, such as description of interface/connections between main components. Use and handling of extra equipment and procedures with relevance for escape shall be described. A user handbook shall be designed so that the main components can be replaced by other main components which satisfy the requirements in the user handbook without the necessity of further calculations.

A user handbook for marine fish farms shall have the following main chapters:

- key finds from the site survey;
- net pen;
- floating collar;
- mooring;
- raft;
- extra equipment.

The two last chapters contain only requirements for marine fish farms that have rafts or extra equipment. The same concerns other main components such as in the event of new construction types where certain main components are not applicable.

The contents of the handbook shall reflect the basic risk evaluation which is the basis for the individual main component, and for the marine fish farm installation and site as a whole. The handbook shall be formulated so that it contains as much traceability as possible, both for parts and their producer, important events and players concerned.

The language in a user handbook shall be simple, and difficult technical expressions shall be avoided. However, where they are used, they shall be defined. Theoretical descriptions and complicated explanations shall be avoided. The handbook shall describe the construction of the equipment and carefully considered and simple feasible solutions in as simple a manner as possible. Illustrations should be used where they shall contribute to simplifying the understanding of the construction and procedures.

The user handbook shall be revised at regular intervals or when significant changes take place. It shall form the basis for traceability and system for deviation handling.

7.14.2 User handbook for main components

7.14.2.1 General

A user handbook containing all main components shall accompany the installation. The user handbook shall be systematised under the following headings:

- producer and product identification;
- main component and its constituent parts;
- transport and storage;
- assembly;
- interface between other main components;
- operation;
- maintenance.

7.14.2.2 Producer and product identification

At a minimum there shall be a description of:

- factual information about the producer/supplier as well as contact information;
- identification of product/brand name/type/equipment/constituent parts;
- requirements for change, modification etc. in consultation with the producer.

7.14.2.3 The main component and its constituent parts

At a minimum there shall be a description of:

- necessary definitions to make the handbook unambiguous;
- drawings to ease assembly, operation and maintenance;
- traceability information;
- assumptions and limitations in the use of the equipment;
- greatest allowed loads and load distribution, both as direct environmental loads on the main component and as a load imposed by other main components;
- critical number of dead fish before it represents a danger of failure in the construction. Volumes of dead fish shall be indicated both as weight in the sea and weight in the air for the species of fish concerned;
- deviation: handling of errors.

7.14.2.4 Transport and storage

At a minimum a description shall be given of:

- requirements for how the equipment shall be packed, transported, unpacked, moved and stored;
- requirements for handling of equipment when loading and unloading;
- requirements for any towing with and without connection to the other main components, including maximum values for velocity, wind and waves;
- requirements regarding storage on shore.

7.14.2.5 Assembly

At a minimum this shall give a description of:

- circumstances which one must be aware of before the product is taken into use;
- qualification requirements for those undertaking assembly, such as in the form of welding certificates;
- assembly instructions for constituent parts in main components, including any sequence of assembly, space requirements and requirements as to weather conditions;
- requirements for any application of protection coating after assembly, such as to splices/welds;
- necessity for extra tools for assembly as well as the use of them, including removal of them after assembly;
- requirements regarding inspections/controls before fish are set out and in the operational phase;
- programme for inspection of marine fish farms, including functional tests, as well as inspection of completed work results which shall be especially inspected after assembly and launching, and how the inspection shall be performed.

7.14.2.6 Interface between extra equipment and between other main components

At a minimum a description shall be given of:

- assembly instructions towards other main components;
- limitations in choice and use of extra equipment and other main components including dimensions of and loads imposed by them, especially to avoid danger of chafing on net pens;
- interface between other main components, with specification of which loads one main component tolerates from other main components, including the greatest load (distribution) and angles of loads, distributed between any attachments points;
- possibilities and limitations in the use of mobile extra equipment;
- requirements and limitations for attaching and use of fixed extra equipment
- use of extra equipment, for instance, truck, and rules for it, such as connected to stability and the danger of heeling.

7.14.2.7 Requirements regarding operation of main components

Where it is relevant for a main component in relation to risk of escape, the following description shall be given:

- requirements regarding training of personnel;
- requirements regarding reception of boat;
- requirements regarding documentation of the size of the fish upon setting out;
- requirements regarding loading and unloading of live fish;
- requirements regarding calls and mooring of boats;
- greatest weight on and distribution of ice;
- procedures for normal handling and operation of main component;
- instructions for normal operational settings;
- requirements regarding cleaning/removal of fouling in sea;
- requirements regarding handling, including lifting and lowering;
- requirements for handling of special environmental conditions, such as drift ice, freezing over, icing or snow;
- description of how short-term, extraordinary loads which are imposed by feedboats, wellboats and other vessels, can be avoided.

7.14.2.8 Maintenance

General:

At a minimum a description shall be given of:

- requirements regarding planned maintenance, such as lubrication, tightening up of bolts, tightening of ropes etc.;
- overview of checkpoints and placing of them;
- overview of parts which shall be replaced, with given replacement intervals or requirements for remaining strength as well as procedures for replacement;
- criteria for when a main component as such shall be scrapped;
- requirements regarding testing, inspection and protection of equipment which is temporarily taken ashore;
- procedure for each type of inspection, such as whether it is visual inspection or NDT;
- plan for routine inspection with intervals for each type of inspection included, such as connected to welds, wear on protective coating, wear on load-carrying parts due to friction and degree of fouling;
- procedure for inspection and replacement after unforeseen events;
- procedures for handling and identification of spare parts, such as investigate of compliance with the producer's specifications;
- requirements regarding removal of obsolete parts and materials;
- requirements regarding removal of used parts.

Inspection programme:

All inspections shall be collected in a detailed inspection programme. At a minimum this shall include an overview of which types of inspection are required, at what times during the calendar year they shall be performed, and at what intervals they shall be performed.

The main philosophy of the inspection programme shall be that the person responsible for the daily operation shall also perform the necessary inspections. The handbook shall give clear rules for how an inspection that has been performed shall be entered into a log, or documented in another manner.

The inspection programme shall be based on a risk analyses. This means that the plan shall be directed towards the elements and parts which are most likely to fail, as well as the elements and parts that will result in the most serious impacts if they fail.

Procedures for inspection shall be so well described that competent personnel shall be able to perform them without access to other information than that given in the handbook. A description shall be given of what type of competence is required of personnel performing the various types of inspections.

At a minimum the following shall be included:

- inspection after change of a main component, any assembly of a new marine fish farm;
- inspection after change of a main component with impacts for other main components and the capacity of the whole of the marine fish farm;
- periodic inspections;
- inspections or testing for specially defined purposes or by specially defined equipment.

The inspection programme shall be related to the parts list. All parts in the overview shall be marked with what type of inspection they require, and how often this shall take place.

Maintenance plan:

All maintenance shall be described in a detailed maintenance plan. The maintenance plan shall at a minimum contain an overview of what types of maintenance are required, at which times they shall be performed during the calendar year, and at which time intervals they shall be performed.

The main philosophy of the maintenance plan shall be that the person responsible for the daily operation shall perform the necessary maintenance of the marine fish farm with its main components. The handbook shall give clear rules for how maintenance performed shall be entered into a log, or documented in another manner.

The maintenance plan shall be based on a risk analysis. This means that the plan shall be directed towards the elements/parts which will result in the most serious impacts if they should fail.

The maintenance routines shall be so well described that competent personnel shall be able to perform them without access to other information than that provided in the handbook. A description shall be given of what type of competence is required for personnel performing the various types of maintenance.

The maintenance plan shall be related to the parts list. All parts in the overview shall be marked with what type of maintenance they require, and how often this shall take place.

7.14.3 Log

During operation a separate log shall be kept which at a minimum shall include:

- action performed (type of inspection, maintenance or repair), with a reference to plan and procedure;
- result after action performed;
- necessary follow-up as a conclusion after action performed;
- date;
- person/institution performing the action;
- signature.

8 Requirements regarding net pens

8.1 General

The requirements in this chapter assume that one also knows the requirements in the other chapters in the Standard.

A net pen shall be suitable for the species it is to be used for.

8.2 Relationship to the floating collar

The net pen shall be suitable for the floating collar it is to be used in, and shall at a minimum have the number of attachment points to the floating collar in accordance with Table 10.

If the net pen is to be attached to the floating collar at points between the attachment points themselves so that it retains its planned three-dimensional design, and to prevent chafing between the floating collar and the net pen, these attachment points shall be so that they do not impose extra forces on the net.

NOTE A fastening rope with a considerably lower breaking strength than the net twine itself is used. The twine can also be reinforced.

8.3 Floating collar parameters

All characteristics of the net pen which can be of significance to the floating collar and planning of it, shall be specified. Including:

- number and placing of all attachment points;
- maximum allowed forces in the attachment points;
- total weight of net pen;
- solidity.

8.4 Requirements regarding the net pen which is to be used together with the stretching system

The net pen which is to be used together with the stretching system shall:

- be suitable for the floating collar and the stretching system it shall be used with;
- be designed so that it will under no wave or current conditions lead to chafing on the net pen. If the design nevertheless does entail danger of chafing, this shall be compensated for by the choice of materials which resist chafing, reinforcements, double safeguarding or other which will avoid holes during the normal operational cycle for the net pen;
- attachment points on the net pen shall be suitable for the stretching system, and the largest force shall be stated for each attachment point. Likewise, limitations in the direction of them shall be stated;
- the user handbook for the net pen shall clearly state how the net pen shall be stretched without risking chafing or other damage.

Analyses or tests shall document what loads the net pen tolerates from the stretching system. The loads tolerated by the net pen must be clearly stated in the user handbook or product information in the form of the greatest load on the attachment points on the net pen.

8.5 Use of environmental parameters

The calculations of the net pen shall at a minimum include a volume of fouling which gives up to 50 % increase of the twine diameter in the net pen as a whole.

The calculations of forces on the net pen caused by current shall include the dimensioning current velocity of the whole of the water column if no documentation is provided on varying current velocity at the relevant site. Net pens shall be calculated for the combination of environmental loads in accordance with Table 6.

8.6 Dimensioning principles

8.6.1 General

Dimensioning of net pens has traditionally been empirical design. This is the main principle in this Standard and assumes use of traditional materials for nets, twine and rope. The requirements are set out in Tables 8, 9 and 10. Other dimensioning principles can be used if it is documented that the intention of the Standard is satisfied.

8.6.2 Design working life in seawater

A net pen shall have a design working life of at least 36 months. This assumes that the net pen is used, inspected and maintained in accordance with the requirements contained this Standard, as well as the user handbook from the producer.

8.6.3 Determination of dimension grade

For sites with dimensioning, significant wave height lower than 2.5 metres and dimensioning current velocity of less than 0.75 m/s the dimension grade shall be determined on the basis of the net pen's circumference and the total depth in accordance with Table 8.

Table 8 – Dimension grades for net pens

Depth of net pen m	Circumference m							
	< 49	50-69	70-89	90-109	110-129	130-149	150-169	170<
0 – 15	I	II	III	IV	V	V	VI	0
15,1 – 30	II	II	IV	IV	V	VI	VII	0
30,1 – 40	III	III	IV	V	V	VI	VII	0
40 <	0	0	0	0	0	0	0	0

The net pen shall be suitable for the floating collar it is used with.

For sites with dimensioning, significant wave height over 2.5 metres the dimension grade is set at 0. For sites with dimensioning current velocity of over 0.75 m/s the dimension grade is set at 0.

8.6.4 Determination of dimensioning requirements

TWINE: For dimension grades I – VII in Table 8 the breaking strength requirements are set out in Table 9.

Table 9 – Dimension grades for and breaking strength of twine

Half-mesh [1)] mm	Dimension grades							
	I	II	III	IV	V	VI	VII	0
	Minimum mesh strength in net pen kg							
≤ 6,0	21	21	25	25	25	25	25	25
6,0 – 8,0	25	31	31	39	39	39	39	39
8,1 – 12,0	31	39	47	55	55	55	55	55
12,1 – 16,5	39	47	55	63	71	71	79	79
16,6 – 22,0	47	63	79	79	79	95	95	95
22,1 – 29,0	63	71	95	95	117	136	136	136
29,1 – 35,0	95	95	117	117	136	136	151	151

[1)] Half mesh in twine with square mesh shall be measured in accordance with NS-EN ISO 1107. With the use of twine with hexagonal mesh, the conversion table J.1 in Annex J shall be used.

Requirements regarding breaking strength in Table 9 are to be regarded as minimum requirements for twine in the production of new net pens.

Regarding net pens which are older than 24 months, it shall be documented that the twine has a strength of at least 65 % of Table 9. Twine in jump catch nets shall have at least 60 % remaining strength.

Requirements regarding ropes on net pens in accordance with dimension grade appear in Table 10.

Table 10 – Dimension grade requirements regarding ropes

		Dimension grades						
		I	II	III	IV	V	VI	VII
Minimum breaking strength all ropes		1900 kg	1900 kg	2800 kg	3400 kg	4100 kg	4100 kg	5000 kg
Top rope	Min. no:	1	1	1	1	1	1	1
Main rope	Min. no:	1	1	1	1	1	1	1
Bottom rope	Min. no:	1	1	1	1	1	1	1
Vertical rope/ attachment point	Max. distance:	7.5 m	7.5 m	6.5 m	6.5 m	5.0 m	5.0 m	5.0 m
Of which lifting rope	Max. distance:	15.0 m	15.0 m	19.5 m	13.0 m	15.0 m	15.0 m	10.0 m
Cross rope bottom	Requirements:	All lifting ropes SHALL continue as cross ropes at the bottom						

Vertical ropes include all vertical ropes. A lifting rope is a vertical rope that continues as a cross rope at the bottom. All lifting ropes shall be clearly marked. All lifting ropes, even though there are more than the Standard's minimum requirements, shall continue as a cross rope. The material factor is 3.0 for knotless rope and 5.0 for rope with knots.

With the use of a stretching system that can entail forces into the bottom of the net pen, all attachment points at the bottom rope shall continue as cross ropes.

Requirements regarding the number of attachment points between the floating collar and net pen in accordance with the dimension grade appear in Table 10.

The crossing point between the vertical rope and main rope (at the waterline) is the attachment point for the net pen. The greatest load from the stretching system shall be stated.

8.6.5 Net pens in dimension grade 0

8.6.5.1 General

The following procedure shall be used in calculations and inspections of net pens that do not fall under the requirements in Tables 9 and 10, or that fall into dimension grade 0 in accordance with Table 8:

Inspections shall be made to check that the strength of the twine and framework (rope) has sufficient strength and integrity to tolerate loads during use and handling as well as the environmental forces which can be imposed at the relevant site. Twine and rope shall have a strength which is greater than or equal to the requirements regarding strength in Grade VIII given in Table 9 and Table 10.

8.6.5.2 Planning

Net pens in dimension grade 0 shall be planned in relation to the floater and stretching system by calculating forces which occur in the net pen and comparing to capacity.

Loads in Chapter 6 shall be imposed on the system, and the forces in twine and rope shall be found. For rope in the net, material factors in accordance with para. 8.6.4. shall be used, and the mesh strength for twine is found in Table 9.

8.6.5.3 Assessment of reinforcement of certain parts of the net pen

Net pens in dimension grade 0 shall be assessed reinforced in the following manner:

- the probability for chafing damage to the net pen at the waterline shall be assessed and the twine protected or reinforced if necessary;
- necessary reinforcement of the net construction as a whole shall be based on the site and operational requirements;
- net reinforcement of both the side and bottom of the net pen in the area against the bottom rope, in accordance with para. 8.7.

For documentation of strength in a net pen, Annex E shall be used as far as it is applicable.

8.7 Requirements for design

Net pens shall be made of twine and ropes which satisfy the following:

- the net pen shall be constructed in accordance with the dimension grades in Tables 8 – 10, based on the net pen's size and strength requirements regarding mesh and ropes;
- the net pen shall be assembled so that forces are transferred through ropes attached to twine, and the rope shall, during the whole of the design working life, have less extension (elasticity) than the twine used;
- lifting ropes shall tolerate the load when the net pen is lifted such as it is specified in the user handbook;
- the net pen shall be produced without tears and shall be inspected for this after production;
- splices shall not reduce strength significantly;
- for net pens in dimension grade III and higher, the bottom shall be reinforced with double twine, at least 0.5 m into the bottom and 0.5 m out to each side of all vertical ropes that are not lifting ropes or equivalent reinforcement;
- the bottom shall be constructed so that it stands taut and ensures that dead fish are collected in the dead fish scoop when the bag is stretched in accordance with the user handbook;
- areas at the bottom of the net pen, where a dead fish scoop is used, shall be reinforced with double twine or equivalent.

When cutting twine and assembling net parts, the following requirements shall be satisfied:

- with hand sewing on twine with a half-mesh size less than 25 m, the thread(s) shall be threaded through each mesh and knotted at a distance of maximum 12 cm;
- with hand sewing on twine with a mesh size of 25 mm half-mesh or larger, the thread(s) shall be threaded through each mesh twice and knotted at a distance of maximum 12 cm. Secure knots shall be used;
- with machine sewing, stitching shall be done twice over the splice on the twine to avoid unravelling. Start/stop of the seam shall be properly secured to avoid unravelling.

Assembly:

- with hand sewing on twine with a half-mesh size less than 25 m, the thread(s) shall be threaded through each mesh and knotted at a distance of maximum 12 cm;
- with hand sewing on twine with a mesh size of 25 mm half-mesh or larger, the thread(s) shall be threaded through each mesh twice and knotted at a distance of maximum 12 cm. Secure knots shall be used;
- with splicing the lacing thread one secure knot shall be used.

When lacing net pens (attachment of rope to twine) the following requirements shall be met:

- when lacing /attachment of rope to twine it shall be ensured that the twine is sufficiently slack and is evenly stretched. It shall also be ensured that the rope takes the strain, and not the twine. Net parts shall be joined before rope is laced;
- all lacings shall be on the outside of the net pen unless special functional requirements require attaching on the inside;
- the seam between the rope and twine (the lacing) shall have a breaking strength of at least the same level as the twine;

- when lacing by machine the rope shall be sewn to the twine consecutively, in relation to the first stretch point in this overview. Start/stop of the seam shall be properly secured against unravelling;
- when lacing rope to net pens with a mesh size of less than 15.5 mm half-mesh the thread(s) shall be wound over the rope and twine through every second mesh, and there shall be a maximum of 12 cm between each attachment point (knot). There shall be at least three hitches or equivalent secure knots per attachment point (knot);
- when lacing rope by hand to net pens with half-mesh sizes of, or greater than 15.5 mm, the thread(s) shall be wound over the rope and twine through each mesh, and there shall be a maximum of 12 cm between each attachment point (knot). There shall be at least three hitches or equivalent secure knots per attachment point ((knot/clamp knot) if lacing is done by hand.

8.8 Materials

8.8.1 General

By materials is understood filament, twine, fibre and rope used in the making of net pens. The materials shall be in accordance with documentation provided by the producer, and shall be of such quality that they meet the requirements set out in this Standard. The producers shall provide documentation indicating producer, trade name, type of material, characteristics and marking of the product. The characteristics shall appear as the result of documented tests.

Material factors for rope in net pens shall be set in accordance with para. 8.6.4.

8.8.2 Filament

The following requirements regarding characteristics of the filament yarn shall be documented through tests:

- the filament yarn shall have the characteristics which make it suitable for meeting the requirements made for the completed net pen;
- the filament yarn shall be protected against UV radiation. Protection shall be sufficient in relation to a design working life of at least 36 months;
- only certified filament yarn shall be used. The chemicals used for treatment of filament yarn and rope, and which can affect the strength of the net pen, shall be specified. All relevant parameters connected to the strength and characteristics of the net pen shall be documented.

8.8.3 Twine

Twine shall be produced from filament which meets the requirements set out in para. 8.8.2.

It shall be documented through tests that the twine's strength characteristics satisfy the following requirements:

- knot strength shall be measured with an overhand knot in accordance with NS-EN ISO 1805 and NS-EN ISO 1806;
- elongation at break shall be satisfactory for the product it is to be used in;
- twine used in knotted nets shall have characteristics suitable for the knot and the finishing process which is necessary for good knot strength;
- when determining twine diameter and appurtenant solidity, the basis shall be the relationship between the projected twine area and total area of the net panel;
- the twisting degree shall be such that the twine is balanced.

8.8.4 Net pens

Twine for use in net pens shall be manufactured of twine or filament that satisfies the requirements stated in para. 8.6 and Table 9. As net for fish farming purposes both knotted and knotless net can be used.

The following requirements are made regarding net:

- during the whole of the design working life it shall possess an elasticity which is greater than the rope that is used in the net pen;
- net and rope shall not shrink so that forces are transferred from rope to net ;
- testing of net shall be carried out in accordance with NS-EN ISO 1806;
- it shall be documented that the net satisfies the requirements laid down by the Standard.

8.8.5 Rope

Rope for use in net pens shall be produced from filament that satisfies the requirements in para. 8.6 and Table 10. The following requirements are made regarding rope:

- during the whole of the design working life it shall possess an elasticity which is less than the net which is used in the net pen;
- testing of rope shall be performed in accordance with NS-EN ISO 2307;
- it shall be documented that the rope satisfies the requirements laid down by the Standard.

Mixed polyolefine rope shall also satisfy the requirements in NS-EN 14687.

8.8.6 Other materials

Other materials can be used if it is documented that at a minimum they satisfy the functional requirements in this Standard.

8.8.7 Controls of materials

In all deliveries of materials, the producer shall control and confirm:

- that the delivery is in accordance with the order;
- that the producer's routine tests confirm that the characteristics of the product are in accordance with those that are stated;
- that the net pen is produced from materials in accordance with this Standard.

Control of materials for net pens produced and repaired according to this Standard with regard to material quality, material use, dimensions, and production shall be documented.

8.9 Operation and maintenance

8.9.1 General

Operation and maintenance shall take place in accordance with the user handbook. The design requirements in para. 8.6 apply to new and used net pens.

After 24 months, a net pen shall have a valid service card as an attachment to the certificate for the dimension grade the net pen is certified for. The service card can have a period of validity of up to 24 months. A net pen shall not be taken into use before a valid product certificate or service card has been received. A service card shall always show the quality of the net pen. The service card shall provide information regarding the condition of the net pen and period of validity by showing the last date for use in seawater.

Handling of the net pen shall be planned so that it only takes place in the period of weak current. Handling of the net pen in strong current shall only take place in emergency cases, and great care shall be shown.

8.9.2 Lift and tow

In the event of towing where the net pen is connected to the floating collar, the velocity shall never exceed the relative velocity of the net pen in relation to the water masses which are identical to the maximum current the net pen is certified for.

Lifting of the net pen by the mesh shall never take place, it shall only take place by the use of lifting ropes, and then in such a manner as to avoid unequal loads on the net pen.

8.9.3 Requirement regarding service station

A service station shall at a minimum have the following documented:

- knowledge and understanding of the net pen's design and function, with appurtenant material qualities;
- documented requirements regarding design of the service card with appurtenant ID marking on the net pen, and archive which provides the possibility of traceability;
- suitable area for inspection and handling of the net pen;
- procedure for reception and delivery of net pen;
- procedures for a testing programme of the net pen with suitable tools and documentation of results;
- procedures for various repairs, mending net pens, and replacement of twine.

8.9.4 Inspection and repair of net pens

Service cards that confirm that inspection and maintenance have been performed in accordance with the user handbook, and that the net pen satisfies the requirements set forth in the Standard, shall only be issued by a service station that meets the requirements set out in para. 8.9.3.

Net pens which do not meet the requirements for remaining strength in twine as described in this Standard, shall no longer be used for fish farming.

The log from the history of the net pen shall be made available to the service station that performs inspection and testing.

Attachment points shall be inspected, and all ropes shall be examined, assessed and documented with regard to chafing and wear. In addition, stretch tests shall be performed of the twine with suitable tools. Regarding stretch tests the requirements in NS-EN ISO 1806 shall be used as far as they are applicable. The net pen shall satisfy the requirements regarding breaking strength as they appear in Table 9, in order for the net pen to be issued a valid service card.

At least 9 stretch tests shall be performed on the sides of the net pen. The tests shall be distributed evenly around the net pen with 3 stretch tests on the jump catch net, 3 stretch tests just under the main rope and 3 stretch tests at half the depth. In addition, at least 3 stretch tests shall be taken evenly distributed over the bottom. In dimension grades VII and 0 the number of stretch tests shall be doubled. It shall be stated whether the twine has been tested under wet or dry conditions.

Stretch tests of twine shall be performed before any anti-fouling etc. is performed on the net pen.

The chemicals that are used to treat the net pen, and which can affect the strength and characteristics of the net pen, shall be specified.

A service card shall be issued for inspection, stretch tests and repair of the net pen. This will, together with the product certificate, be the documentation that the net pen still satisfies the requirements of the Standard.

8.9.5 Period of validity of the service card

A service card can have a period of validity of up to 24 months' use. This applies as long as the strength of the twine is 100% or more in relation to the dimension grade in Table 9. When the remaining strength of the twine is between 100 % and 65 % of the requirements regarding breaking strength (between 100% and 60 % for the jump catch net), the service card can have a period of validity of up to 12 months. In special cases, where the validity of the service card expires before the net pen is taken up, the service station can assess whether a further 3 months' extension of the period of validity can be given on the basis of the net pen's documentation as well as visual assessment of the net pen. This shall be documented.

The validity period of the service card starts when the net pen is lowered into the sea, but maximum 12 months after the date of issue. This assumes that the net pen is handled and stored in accordance with requirements in the user handbook. This shall be documented in accordance with para. 8.10.1. A possible extension may only be allowed in cases where there is greater risk of fish escaping when the net pen is changed in this phase, than by an extension of the period of validity by up to 3 months at a time for a net pen of expected good quality.

The last valid service card should be available and present for the service station that is to perform service on the net pen. At a minimum, a service card shall contain:

- ID number of the net pen;
- measurements of the net pen cage;
- dimension grade and requirements for strength;
- materials and dimensions for twine and rope;
- the result of stretch testing with the basis in requirements;
- description of maintenance performed;
- date of issue and period of validity;
- service performed in accordance with NS 9415 or equivalent.

NOTE A service card shall be retained together with the log, see 7.14.3.

8.10 Requirements for documentation

8.10.1 Materials and processes

Documentation of material quality, material use, dimensions, production and repair of each net pen shall be in accordance with the Standard's provisions and shall be stored for any subsequent inspection and documentation.

Documentation of own inspections performed shall be stored in a systematic manner in order to ensure traceability. At a minimum the documentation shall include:

- a copy of all material orders accompanied by documentation, control report from receipt, marking of materials and reports from any testing of materials from this delivery;
- control report from any own production of twine, rope and net;
- copy of documentation of any own-produced twine and net, as well as that supplied by others;
- copy of documentation of net pen shall accompany the service card.

8.10.2 Planning

At a minimum the following shall be documented for planning of the net pen:

- assembly sketch of the net pen, including jump catch net, with all the relevant measurements shown;
- all allowed net designs, sizes and stretching systems or mooring lines attached to the net pen;
- choice of materials and dimensions for the various parts, including twine diameter for rope and net;
- twine number, mesh length, mesh type, rope type and size of the mesh in the form of a half-mesh in accordance with NS-EN ISO 1107;
- which functional requirements shall be met;
- description of any redundance.

8.10.3 Design

In connection with the design of net pens the following shall be documented at a minimum:

- purchased raw materials, including requirements regarding the suppliers of material certificates which specify the minimum breaking load, shrinking characteristics, ageing characteristics, UV resistance and any other characteristics for the relevant raw material or part;
- that the production processes such as knotting, splicing, sewing and binding are performed by personnel with the necessary competence or under the supervision of personnel with the necessary competence. Competence shall be documented;
- that the production processes such as impregnation are performed with substances/chemicals recommend in accordance with provisions given by the authorities/suppliers;
- that the assembly of the various parts for one component is done within stated tolerances and with the indication of assembly lacquer;

8.10.4 Marking

Net pens shall be marked by the producer. Marking shall be permanently attached to the top rope, and shall be clearly visible and legible for the duration of the design working life of the net pen. The net pen shall have at least two permanent labels, of which at least one shall be attached to the top rope. The label shall be designed and attached so that it does not lead to chafing of the net pen.

In packing and transportation of net pen, the marking should be well visible.

The producer of the net pen shall store an overview of numbers for product documentation which is issued, and to whom the delivery was made.

8.10.5 Documentation which shall accompany the product: Product documentation

Net pens which are delivered in accordance with this Standard, shall be delivered with product documentation from the producer. Product documentation for the net pen shall specify a design working life of 36 months and thereafter as long as it is documented that inspection and maintenance have been performed and that the net pen is in accordance with the requirements of the Standard.

The product documentation shall at a minimum contain the following information:

- producer;
- date of issue and period of validity;
- number of product documentation;
- measurements of the net pen;
- dimension grade;
- size of mesh in the form of half-mesh in accordance with NS-EN ISO 1107;
- species of fish for which the net pen is intended;
- materials and dimensions for net and rope, including reinforcements;
- recommended and greatest force imposed by the stretching system;
- confirmation that the net pen is in accordance with the order, and that it is produced and controlled in accordance with the requirements in the Standard;
- reference to user handbook for the net pen;
- reference to any enclosures to the product documentation;
- that the information in the product documentation is only valid as long as the requirements in the user handbook and this Standard are complied with.

NOTE The specifications of design working life in the product documentation start from the time of lowering the net pen into the sea, but no longer than 12 months after the date of issue. This assumes that the net pen is handled and stored in accordance with the requirements in the user handbook.

In special cases, where the product documentation's period of validity expires before the net pen is taken up, the service station can assess whether a three-month extension of the period of validity can be granted on the basis of the documentation for the net pen, as well as visual assessment of the net pen. This shall be documented.

9 Requirements regarding the floating collar

9.1 General

The requirements in this chapter assume that one also knows the requirements in the other chapters in the Standard.

9.2 Planning

Floating collars shall be dimensioned in accordance with para. 7.3.

9.3 Mooring parameters

All characteristics of the floating collar which can be relevant to mooring and planning of it, shall be specified. Hereunder:

- requirement regarding pre-tensioning. This shall be defined where it is relevant;
- number and placing of all attachments points;
- maximum force and three-dimensional direction for relevant points. Largest angle size at attachment of crowfoot shall be stated where it is relevant in order to avoid unequal load on the clamps or railing supports;
- maximum allowed moment from moorings, where it is relevant.

NOTE The greatest strain on the floating collar is normally applied through the mooring system. The variations in the different forces and line characteristics can impose great loads. This concerns large, marine fish farms, i.e. long platform installations, in particular. Here several lines run parallel. In such a case it is especially important that the floating collar does not have too great local or global loads imposed.

9.4 Net parameters

All characteristics of the floating collar which can be of relevance to the net pen and planning of it, shall be specified. Hereunder:

- number of net suspension points for the stretching system with placing, capacity and specification. The net suspension points shall be placed so that all vertical ropes in the net pen can be attached to the floating collar;
- load effects from the net pen, normally net depth;
- greatest total net weights;
- how fouling is taken into consideration when forces on the net pen are calculated, solidity including fouling shall be stated.

NOTE Usually, 50% increase of the twine diameter is used so that solidity shall include fouling.

9.5 Requirements regarding floating collars which are used together with stretching system

Floating collars which are used together with a stretching system shall:

- be suitable for the stretching system it is to be used with, so that the stretching system does not lead to chafing of the net pen under any type of wave or current conditions. If the design nevertheless does entail a danger of chafing, this shall be compensated for by the choice of material which resists chafing, reinforcements, double safeguarding etc. which means that holes are avoided during the net pen's normal operational cycle;
- describe in the user handbook how the floating collar and stretching system shall be assembled together in order to avoid chafing or other damage to the relevant net pen.

9.6 Requirement regarding construction parts

All construction parts in the floating collar shall be able to absorb forces imposed. The construction parts shall be able to absorb forces from loads on the part and loads from adjacent parts, including mooring, net pen, feed dispensers and other equipment.

There shall be calculated and documented that connections such as welds, bolts or hinges have the necessary capacity to transfer forces. Materials which wear more quickly than the rest of the construction, such as washers, shall be inspected and replaced when the wear tolerance has been exceeded. Requirements regarding this shall be stated in the user handbook.

All construction parts in the floating collar shall be marked in such a manner that there is good traceability in relation to the design and purchase of the single parts.

The floating collar shall be constructed such that:

- it is simple to install net pen and bird net. Placing of attachment points shall comply with the requirements regarding net pens, see Chapter 8;
- there is no chafing on the net pen;
- it is easy to keep clean;
- it is easy to keep clean in seawater;
- it is easy to install any extra equipment;
- there are no hollows etc. where liquids and shells can collect.

9.7 Requirements relating to welds and welder

All welds in metal shall be performed in accordance with approved procedures (WPS) as indicated in NS-EN ISO 15607 and NS-EN ISO 15609-1, NS-EN ISO 15614-1 and NS-EN ISO 15614-2. All welders shall possess an approved certificate in accordance with NS-EN 287-1 and NS-EN ISO 9606-2. Welding co-ordination shall be in accordance with NS-EN ISO 14731. The testing and quality plan shall be drawn up in co-operation with an approved welding co-ordinator and inspector in accordance with NS 470.

All welds in plastic shall be in accordance with NS 416-2, Annex C. Certificate of plastic welders shall be in accordance with NS 416-1.

9.8 Installation and repair

Correct and suitable welding equipment shall be used. Certified welders shall be used for installation and repair of vital parts.

Installation shall be undertaken during favourable external conditions, i.e. that the weather situation is such that installation takes place in accordance with regulations. The technician shall at all times ensure that the external conditions are satisfactory to perform proper installation.

9.9 Specification of floating collar for towing

The following documentation shall be prepared for towing:

- plan for attachment of towing hawsers and auxiliary system for towing;
- maximum towing velocity and allowed wave and wind loads when towing is in progress;
- controls that damage has not occurred after towing has been completed.

9.10 Special requirements for steel installations

9.10.1 Strength calculation

Strength calculation of marine fish farms shall be documented. Based on information regarding loads, the following calculations shall be performed:

- global strength analysis, including the forces from mooring;
- local strength analysis;
- fatigue analysis.

Local analysis of construction parts of steel shall be performed in accordance with NS-EN 1993-1-1.

9.10.2 Materials

Requirements regarding material factors shall be in accordance with NS-EN 1993-1-1 and safety factors in accordance with NS-EN 1990. Material factors for steel installations shall be in accordance with Table 11. The capacity of the material shall be regarded as given by the yield strength.

Table 11 – Material factors for steel installations

Limit states	Parameters	Material factor
Breaking strength	Cross-section capacity	1,1
Breaking strength	Screw, bolt, friction and welding connections	1,25
Fatigue limit	All material factors	1,0
Accident limit	All material factors	1,0

Assessment and documentation of screw and bolt connections shall be performed. This includes an assessment and documentation of capacity of bolts, screw shanks, hole edge, ripping out of the basic material and cracks in the basic material.

9.10.3 Fatigue in parts of steel

A fatigue calculation shall be performed for all critical parts. Loads which vary in the wave frequency area shall be taken into consideration.

The fatigue analysis shall be performed in accordance with NS-EN 1993-1-1.

Regarding installations having dimensions within limits where experience data is found, a simplified fatigue analysis based on Weibull distribution can be performed. The Weibull factor shall then be set at 1.0 unless another distribution can be documented. The danger of natural frequencies in the construction shall be assessed and documented, and natural frequencies shall be taken into consideration in calculations in relation to design working life. The starting point shall be 20 years' design working life in the event of fatigue.

9.11 Special requirements for flexible marine fish farms

9.11.1 General

By flexible fish farm installations is understood in this Standard to be marine fish farms produced of polymers, first and foremost plastic. Certain sequences can also be relevant where rubber is used as material.

Dimensioning shall take place for all relevant limit states, and the loads and load combinations, load factors and material factors that are used shall be stated. The loads, load combinations and limit states used during dimensioning shall also be stated.

The capacity of a plastic pipe shall be regarded as exceeded in one of the following events, whichever occurs first:

- flow occurs in the cross-section;
- local cracking occurs in the cross-section.

9.11.2 Planning and development

9.11.2.1 Calculation of strength of the plastic installation

Stresses in the plastic floating collar shall be calculated based on the equipment's geometry, natural frequency situation and external forces. For this purpose, the classic formulas or FEM analysis shall be used according to the following principles:

- in the event of small displacements and/or unchanged geometry or linear visco-elasticity, classic formulas shall be used;
- in the event of non-linear material deformation and/or large geometrical changes, non-linear FEM analysis shall be used.

Calculation of strains, displacements and danger of cracking shall be performed based on the material's visco-elastic characteristics (elastic factors, E_{sig}, E_{rel}, etc.).

In the event of strong anisotropy, first and foremost in reinforced plastic, consideration shall be paid to the material's visco-elastic characteristics in the calculation of strains, displacements, danger of cracking and breaking.

The aim during planning of floating collars of plastic shall be to keep the shear stresses low by avoiding great concentrated loads or surface pressure.

In the event of combined stresses the following breaking hypotheses shall be used:

- danger of brittle fractures: normal stress hypothesis
- danger of ductile fractures: shear stress hypothesis

The requirements regarding allowed strength loads in plastic installations shall be in accordance with the stretch and shear strength data for the various materials, and shall be obtained from the plastic producer's supplier documentation. Requirements in relation to assessment and documentation of shrinkage in the construction shall be set based on typical values for allowed stretching and stresses, as indicated in the plastic producer's supplier documentation. Further calculation of this, where the stress time, temperature and type of force (stress condition, static or dynamic situation, environmental conditions etc.) shall be included, shall be performed based on the supplier data based on material tests.

The strength characteristics of the installation, especially in relation to long-term loads, shall be documented.

The material factor for plastic shall be set at 1.25 for ultimate limit state and 1.0 for accident limit state.

9.11.2.2 Local cracking

Local cracking in plastic pipes usually occurs where the pipes are exposed to extensive bending forces, such as in areas with locally concentrated loads. If the capacity for cracking is less than for flow, the crack capacity shall be dimensioning.

Cracking is calculated as follows:

$$F_e = 0,5\, t \cdot D^{-1} \cdot E$$

where:

F_e = cracking stress;

t = thickness of pipe wall;

D = diameter of pipe;

E = elasticity module.

9.11.2.3 Dimensioning of plastic against fatigue (danger of brittle fracture)

Fatigue shall be assessed and documented for all plastic materials which are exposed to high and varying stresses. This shall be seen in connection with cracking processes which result in brittle fractures with static stretch forces.

Assessment and documentation of fatigue shall take the following conditions into consideration:

- increasing temperature leads to less fatigue strength;
- thick-walled pipes lead to quicker fatigue fractures because of potentially strong temperature increases;
- fatigue is a result of frequency and high strain.

9.11.2.4 Use of polyethylene

Characteristics for pressure pipes of polyethylene shall be in accordance with NS-EN 12201-2.

All material which is used, shall be UV stabilised in accordance with NS-EN 12201-2

9.11.2.5 Production

9.11.2.5.1 Control of production of pipes

Production of pipes shall be in accordance with NS-EN 12201-2.

9.12 Special requirements regarding combined marine fish farms

For combined marine fish farms, such as marine fish farms where rafts together with floating collars form a unit (the raft is integrated in the floating collar), the same characteristics shall be able to be documented with regard to escape, such as strength, stability and buoyancy capacity, as for rigid, articulated and flexible marine fish farm installation. The movement characteristics for the raft module against the floating collar shall be documented

9.13 Special requirements regarding other types of floating collars

For other types of floating collars, full documentation is required for all measurements, calculations, tests and simulations. Risk and safety levels shall be the same as for steel installations and flexible installations

9.14 Requirements regarding documentation

9.14.1 Requirements regarding documentation of the floating collar's planning and production

At a minimum the following documentation shall be available:

- assembly sketch of the floating collar with all relevant measurements drawn on;
- specification of which functional requirements shall be met;

NOTE This can e.g. be whether it is possible to drive a truck on the floating collar, or the size of boat which can come alongside it.

- description of any redundance;
- description of the environmental loads which the floating collar shall tolerate, at a minimum loads from wind, current, waves, temperature, ice and snow;
- description of the functional loads which the floating collar is dimensioned for, particularly connected to direct operation of the marine fish farm installation, such as load from equipment, feed, personnel, etc.
- description of the permanent loads on the floating collar in the form of weight/buoyancy, and the distribution of them on the collar;
- description of accidental loads, such as negative loads because of breaks in the mooring lines and loss of buoyancy;

- maximum weight and distribution on ice;
- indication of limit conditions which are assumed, in the form of size, weight, solidity of the net pen, maximum net pen drag and attachment of the net pen to the floating collar;
- description of the mooring system, at a minimum the number of lines, pre-tension, rigidity of the mooring system, and how the lines shall be led in and attached to the floating collar;
- indication of mooring line forces, such as maximum allowed load on the mooring lines with regard to both the whole of the marine fish farm installation, and each attachment point, as well as maximum allowed vertical force with regard to drawing down of the marine fish farm installation;
- design working life.

9.14.2 Marking of floating collars

All floating collars shall be supplied with an identification plate located in a well visible and easily accessible place.

The identification plate shall contain the following information:

- satisfaction of the requirements in this Standard;
- circumference;
- highest wave and current exposure;
- maximum load;
- any drivable axle load;
- design working life;
- date of production;
- journal number;
- order number or project number;
- producer.

EXAMPLE NS 9415, maximum wave height: 1.5 m, max. current 1.0 m/s, maximum load 50 tonnes, drivable axle load 4 tonnes, 20 years' design working life, 2003-03-17, journal number 0001, order number 68745, name of producer.

The identification plate shall accompany the floating collar for the entire design working life, including after changes and modifications. All modifications and repairs shall be logged and referenced against the number on the identification plate.

9.14.3 Assembly/repair log

After assembly is completed an assembly log shall be kept which confirms that the assembly has been performed in accordance with the order and in accordance with this Standard. The log shall show the journal number, order number and production date for each part. It shall be signed by the responsible technician. The same applies to repair work. Together with the identification plate, the log shall facilitate traceability in regard to applicable requirements.

10 Requirements regarding rafts

10.1 General

The requirements in this chapter assume that one also knows the requirements in the other chapters in the Standard.

10.2 Planning

10.2.1 General

Dimensioning of rafts shall be suitable for the material from which it is made, as well as the loads which occur for this type of vessel.

In general, dimensioning shall deal with the raft's global strength capacity as well as local strength, particularly for the attachment points towards other main components, such as mooring.

The superstructure shall be dimensioned for loads from waves which could occur at a site. It shall be documented that hatches, doors and windows shall satisfy the same requirements. Alternatively, it shall be documented that the buoyancy capability of the raft is present after water penetration has occurred.

Maximum load for the raft shall be stated.

10.2.2 Dimensioning of steel rafts

Dimensioning shall take place in accordance with recognised methods, such as NS-EN 1993-1-1.

NOTE Other examples of recognised methods are described in the rules laid down by ships' classification companies.

The results of dimensioning shall appear on a profile and plan drawing where all dimensions shall be stated. Further, the following documentation shall be prepared as a basis for production:

- profile, plan and section giving dimensions of parts;
- welding table specifying welding details and subsequent inspection of welding joins with the use of NDT.

Dimensioning waterline in calculations shall be in accordance with the calculated maximum draught. The raft shall be dimensioned according to which of the following two criteria gives the highest requirements regarding the parts:

- the dimensioning waterline shall be used, and reinforcements in the bow and stern shall be ignored;
- bow and stern are calculated with the draught equivalent to a light ship condition.

10.2.3 Dimensioning of rafts of concrete

The dimensioning basis and use of materials shall meet the following requirements:

- reliability Class 2, medium impacts in the case of failure in accordance with NS-EN 1990;
- planning control in category normal in accordance with NS-EN 1990.

Dimensioning shall also take place in accordance with NS-EN 1992-1-1, with the following material factors and exposure class:

- the material factor γ_m is set at 1.40 for concrete, and γ_m is set at 1.25 for reinforcement;
- the exposure class shall be XC3 in accordance with NS-EN 1992-1-1.

10.2.4 Dimensioning of rafts of other materials

Dimensioning shall be performed in accordance with recognised methods.

In the use of recognised methods for strength calculation of the relevant material, the raft's strength capacity shall be documented for all construction parts when adding the above-mentioned loads.

10.2.5 Foundations for extra equipment

The foundations for equipment with unladen weight or a load of over one ton shall be documented in separate calculations. Further, a drawing shall be available of such foundations with an added capacity for appurtenant equipment.

10.3 Stability

10.3.1 General

Here it must be distinguished between intact stability and stability in the event of damage. Stability shall be documented with the aid of calculations. Heeling tests shall be performed in order to verify the placing of the centre of gravity, as well as light ship weight. For serial productions, the heeling test can be dropped if it can be documented that the light ship's weight does not deviate more than 5% from the tested example, and that no changes have been made which can affect the placing of the centre of gravity. Heeling tests can be dropped if it can be documented that:

- the type of construction does not allow a heeling test to be performed;
- the stability is calculated with an adequate margin;
- placing of the centre of gravity and light ship's weight is determined with certainty in another manner.

10.3.2 Intact stability

In the event of intact stability, the raft shall meet the following minimum requirements:

- The area under the GZ curve from 0.00 degrees to the righting arm at a maximum, shall not be less than 0.08 m-rad;
- 0.05 m-rad is used if the raft is unmanned or the raft shall only be placed at a site with dimensioning, significant wave height equivalent to 2.0 m. By an unmanned raft is meant a vessel where there are no arrangements for overnighting;
- Static heeling caused by an evenly distributed load of 0.54 kPa (equivalent to a wind velocity of 30 m/s), shall not exceed a heeling angle equivalent to half the freeboard in the relevant conditions. The arm in the wind element shall be measured from the centre of the area on which the wind acts to half the draught;
- GZ shall be positive to 15 degrees as a minimum.

At a minimum, and where it is relevant, these requirements shall be verified for the following conditions:

- light ship
- light ship with full water tanks and diesel tanks;
- fully laden with the intended type of load;
- half-laden with the intended type of load.

If the raft is intended to operate in seas where there is danger of icing, this shall be clearly stated. Loads from ice in calculations shall be obtained from para. 5.5. At a minimum, and where it is relevant, the following conditions shall be verified:

- light ship with load from ice;
- light ship with full water tanks and diesel tanks as well as load from ice;
- fully laden with the intended type of load as well as load from ice;
- half-laden with the intended type of load as well as load from ice.

The calculation shall show the raft's maximum draught and trim area. Instructions shall be given in the user handbook regarding allowable load distribution. Instructions for allowable load distribution shall be posted on board and published to the relevant users.

Beyond this, it shall be assessed and documented whether there is a requirement to investigate special conditions adapted to the individual construction.

10.3.3 Damage stability

Under the freeboard deck the raft shall be divided into three or more watertight sections. These shall be arranged so that the raft in the event of the puncturing of a random watertight section shall still retain sufficient buoyancy under all load conditions:

Definitions of damage:

1) Damage is anticipated to be able to occur anywhere over the whole length of the raft between watertight transverse bulkheads.
2) Vertical extent of damage is anticipated to be equal to the depth of the raft calculated from the freeboard deck, but without this deck being regarded as damaged.
3) Transverse extent of damage is anticipated to be equal to 0.76 m measured inwards from the side of the raft perpendicularly on the centre plane at the level of the load line.
4) A watertight longitudinal bulkhead with a depth of 0.76 m or more from the side of the raft and which stretches between watertight transverse bulkheads and which has a depth of 0.76 m or more inside the side of the raft, shall be regarded as a watertight transverse bulkhead in relation to damage. The ends of the raft shall not be regarded as bulkheads.
5) If damage of a lesser extent than mentioned under paras. 2 and 3 results in a more critical condition, this damage shall be anticipated.
6) If pipes, channels or tunnels are placed in the anticipated damage area, the arrangement shall be such that it does not entail filling beyond that which is anticipated in the calculations in each damage event.
7) The following permeability figures are used:

– fittings for spaces and dry cargo	0,95
– empty spaces and tanks	0,95
– engine room	0,85
– stores	0,60.

10.3.4 Watertight integrity

A drawing shall be prepared showing the division into watertight sections.

Doors and routings in these bulkheads shall meet the requirements set out in NS 6082 and have sufficient watertight integrity documented. Openings in the freeboard deck towards underlying volume shall be of weather-tight design. Doors in to the stairwell shall have a threshold in accordance with the load line convention. Breather tubes from tanks which can cause pollution, shall have an approved automatic shut-off valve installed.

All ventilation of tanks, ventilation shafts and other openings which lead to rooms under the freeboard deck shall:

- have a minimum height over the freeboard deck of 760 mm;
- have opening heights above deck which with a 15-degree heel in a fully loaded condition does not come under water.

If openings to rooms under the freeboard deck have heights of between 760 mm and 2300 mm above the freeboard deck, a closing valve shall be installed.

Bulkheads shall be able to be fitted with flush hatches. These shall be marked and kept closed in high seas.

10.3.5 Loads from ice in the stability assessment

Calculations shall include unequal distribution of ice with the greatest load from ice both on the horizontal and vertical surfaces in relation to the ice class at the relevant site (see para. 5.5) on the one side and no ice on the other side. In calculations, ice shall be treated as accidental load.

10.3.6 Freeboard

The freeboard mid-ships shall be determined based on stability, trim and hull strength. This is the design waterline of the freeboard.

The following requirements apply to the freeboard, F_{min}:

$F_{min} > 17 \times LOA + k_1 + k_2$ [mm]

where:

LOA *is the raft's greatest length expressed in metres;*

k_1 *is determined by the wave height in accordance with Table 12;*

k_2 *is extra freeboard requirement at cross-mooring,* set at 2000/B where B is the raft's greatest width in metres.

Table 12 – Freeboard requirements in relation to wave height

Dimensioning, significant wave height, H_s **m**	**k_1** **mm**
$H_s < 0,5$	300
$0,5 \leq H_s < 1,0$	400
$1,0 \leq H_s < 2,0$	500
$2,0 \leq H_s < 3,0$	600
$H_s \geq 3,0$	700

10.3.7 Load line

Each longitunal side of the raft will be appended a mark in the form of a white stripe, 400 mm long and 25 mm wide. The mark shall be placed so that the distance from the upper edge of the mark to the upper edge of the deck is at a minimum equivalent to the minimum requirement for freeboard. Further, under no circumstances shall the line be placed higher vertically than that the upper edge of the mark is lower than, or equal to, the dimensioning waterline indicated in the paragraph dealing with freeboard. The mark shall be well visible and not covered by fendering etc.

When the raft is in use, it is the user's responsibility always to ensure that the raft is not loaded higher than the load line.

10.3.8 Pump and hosing systems

It shall be documented that the raft is equipped with sufficient pumping capacity for each of the watertight sections. There shall be separate systems for pumping of watertight sections and hosing.

Pumping capacity should be ensured with at least two pumps, each with a capacity, Q, of:

$Q = Ø^2 \cdot 5,75/1000$

were

$$Ø = 1,68 \cdot \sqrt{L(B+D)} + 25$$

and

L is the length of the section (m);

B is the width of the section (m);

D is the depth of the section (m);

Q is the pumping capacity (m^3/h);

Ø is the pipe bore (mm).

Each watertight section shall have a permanent possibility for pumping. The requirement for pumping may nevertheless be waived if the number of watertight sections is so many that the risk of filling with water is negligible in relation to buoyancy and heeling.

10.3.9 Hull penetrations

Hull penetrations for pipes and hoses shall be watertight. It shall be documented that the feed hoses cannot function as water carrying hoses with the appurtenant danger of filling rooms and reduction of buoyancy. The safeguarding systems may also be documented in the user handbook. In addition, the feed hoses or other equipment shall not penetrate the hull lower than 400 mm under the freeboard deck.

10.4 Fire and safety

A safety plan shall be drawn up showing the placing of fire, rescue and safety equipment. A valve shall be installed on the fuel system which shall be able to be operated outside the engine room.

10.5 Production

10.5.1 Competence

All welders and installation technicians shall possess documented competence to perform the processes they actually perform. The same applies to inspectors and those performing tests, i.e. in the form of NDT. All welds on the hull shall be performed in accordance with approved procedures. Welders shall possess an approved certificate in accordance with NS-EN 287-1 and NS-EN ISO 9606-2. This also applies to welders performing repairs.

10.5.2 Inspection of steel rafts

NDT in the form of x-ray examinations of weld connections shall be undertaken in accordance with NS 470 and NS-EN 473.

10.6 Mooring and towing

As a main rule, a raft shall not be constructed so that it is moored directly on to the floating collar. Any connections between raft and floating collar shall be the weakest link. Rafts can be exempt from the first requirement if it can be shown through calculations that the floating collar with appurtenant mooring is dimensioned for mooring of rafts.

Mooring of the rafts shall take place on the basis that all mooring parameters with appurtenant specifications are given. This includes that the number and placing of the attachment points are given. The greatest strength and three-dimensional direction (or limit values for three-dimensional direction) for each attachment point shall be given. Material and planning of all attachment points shall be specified. .

NOTE The variations in the line characteristics of the various mooring lines can give large loads.

For towing, the following documentation shall be drawn up:

- attachment point for towing hawsers;
- maximum towing velocity and allowed wave and wind loads when under tow.

10.7 Requirement for documentation of planning and production:

The requirements for documentation are as follows:

- assembly drawing of the raft showing all relevant measurements;
- specification of functional requirements which shall be met;

NOTE For example, this can be if it is possible to drive a truck on the raft, or how large a boat can come alongside.

- description of the environmental loads it shall tolerate, at a minimum, wind, current, waves, temperature, ice and snow, particularly in relation to stability;
- description of the functional loads it is dimensioned for, particularly connected to direct operation, such as load from equipment, feed, personnel, etc.;
- description of the permanent loads on the raft, in the form of weight/buoyancy, and distribution of them;
- description of accidental loads, for example unequal load because of a break in the mooring line, no buoyancy in a watertight section, etc.;
- statement of limit states that are assumed, in the form of size, weight, maximum load, etc.
- greatest weight and distribution of ice;
- description of requirements for the mooring system;
- statement of the force of the mooring lines, i.e. maximum allowed force of mooring lines with regard to the whole raft and each part, as well as the largest allowed vertical force with regard to drawing down or heeling of the raft;
- design working life.

Each raft shall be equipped with a stability log, which at a minimum shall contain the following:

- the main dimensions and capacities of the raft;
- general arrangement;
- tank plan;
- watertight integrity plan;
- results of heeling tests, or results from heeling tests of a prototype with confirmation of accordance;
- any instructions regarding loading;
- calculation of ice load;
- intact stability, state 1 – 7;
- damage stability;
- hydrostatics;
- cross curves.

The stability log shall be available with drawings of the raft's overall dimensions, such as built, and with stability updated with the results of the heeling tests.

10.8 Marking of rafts

The equipment shall be marked with the following information:

- reference to this standard;
- maximum load;
- any drivable axle load (use of truck or similar);
- date of production;
- producer.

EXAMPLE NS 9415, maximum load 50 tonnes, drivable axle load 4 tonnes, 2003-03-17, Omvega A/S

Each raft shall be delivered with a rigidly mounted unique identification number.

Parts which are included shall be entered on to a parts list which ensures traceability.

11 Requirements for mooring

11.1 General

The requirements in this chapter assume that one also knows the requirements in the other chapters in this Standard.

11.2 Planning and production

11.2.1 General

A mooring shall keep the marine fish farm in the correct position and in a three-dimensional position. The mooring shall not affect the remainder of the marine fish farm in such a manner that it increases the danger of fish escaping. This means that the mooring shall be designed based on the site's environmental conditions and use, as well as the characteristics provided by the designer of the floating collar. The mooring shall be designed based on the information regarding additional loads from the net pen and any extra equipment, as well as information regarding how these will move during use and under all environmental circumstances that can occur.

The starting point for the requirements for mooring shall be the dimensioning values given in site surveys.

Loads from the mooring system on the floating collar shall be within the limitations given by the supplier of the floating collar.

11.2.2 Dimensioning of the mooring

The accidental limit state shall be set based on the following events: progressive breaks, drifting, capsize or sinking in the event of special loads such as collision with a boat, raft or extra equipment. Two aspects shall be checked:

- breaks in a mooring line: Conditions i para. 6.5.6.2 shall be calculated and documented. The material factor in Table 13 shall be divided by 1.5;
- spring tide: The marine fish farm shall tolerate a rise in water level of 1 meter in addition to current and waves. The material factor shall be divided by 1.5.

The requirements shall be regarded as met if the following types of error are documented with sufficient certainty:

- rise in water level: The water level rises to one metre above the upper tide water level (storm surge). Sufficient strength and flexibility shall be documented for the mooring lines and attachments for them. The effects of wind, waves and current shall be incorporated in the load combination;
- drifting: The conditions in para.6.5.6.2 shall be used as a basis. The planned strength in these conditions and their resistance to drifting as a result of further progressive breaks in mooring lines and the attachments for them shall be checked. The effects of wind, waves and currents shall be incorporated in the load combination.

The serviceability limit state shall be evaluated and documented based on the danger of reduced functional capability or reduced durability under normal conditions.

NOTE Examples of this are undesirable movements of the marine fish farm, local damage without further impact, and damage which affects the marine fish farm in relation to design working life.

11.2.3 Specifications for floating collar with net pen

The mooring shall be adjusted to the specifications from the producer of the floating collar.

11.2.4 Principles for planning and dimensioning

11.2.4.1 Characteristics

The mooring system shall be dimensioned to:

- tolerate all expected loads and deformations with satisfactory safeguarding against breaking;
- function satisfactorily based on the environmental conditions at the locality and use as well as the chosen floating collar with net pen and extra equipment;
- be sufficiently safeguarded against an unforeseen event developing into an accident of larger proportions than the causing event;
- possess sufficient durability against destructive effects of a mechanical, chemical, physical or biological nature (corrosion, rotting, crumbling away, photochemical oxidisation etc.).

11.2.4.2 Arrangement and three-dimensional geometry

During planning of the mooring system, consideration shall be paid to both the character of the site and the specifications of the marine fish farm itself. The following requirements shall be met:

- the size and three-dimensional direction of the forces exercised by the mooring on the floating collar shall be in relation to the specifications set by the designer of the floating collar;
- the aim shall be have the individual mooring line approximately the same length where this is possible based on the marine fish farm installation's placing and the (bottom) topography of the site;
- the mooring lines shall be laid so that they follow the bottom topography. This also means that they shall not be exposed to chafing against rocks, stones or other hard objects on the bottom;
- no chafing shall take place between different lines, and lines crossing one another shall be avoided as far as possible;
- the mooring lines shall be laid so that the mooring system shall not lead to chafing on the net pen or other main components, and documentation for this shall be provided.

11.3 Requirements for construction parts

11.3.1 Chains

The choice of chains shall take place based on requirements for strength in relation to the mooring calculation.

When chains are used for the bottom attachment, both stud link chain and studless chain can be used. Used chain can be used, but with a material factor in accordance with Table 13. Consideration shall be paid to a reduction in nominal diameter due to previous wear. This chain shall satisfy the requirements stated in ISO 1704, however, this requirement can be waived if it can be documented through the mooring analysis that it is appropriate. At a minimum the chain shall be delivered with Test Certificate 3.1 in accordance with NS-EN 10204.

In other parts of the mooring it will be appropriate to use lighter chain with a higher tensile strength. This shall be protected against corrosion, tempered, and maximum Class 7. The chain shall have an inward link length of maximum 6.58 x diameter.

All chains shall be load tested under production for welding and material faults. Corrosion protection shall consist of hot-dip galvanizing or methods giving equally good protection. Load testing shall be performed on all chains after corrosion protection, and the method of this shall be described. The chain and its components shall be tested in accordance with the requirements in NS-EN 1677-1, NS-EN 1677-2, NS-EN 1677-3 and NS-EN 1677-4. Load testing in the form of tensile testing shall be done up to 62.5 % of the breaking load on each part.

For information regarding hydrogen embrittlement and stress corrosion, see informative Annex 1.

The chain shall be delivered with a test certificate, at a minimum 3.1 in accordance with NS-EN 10204, which confirms compliance with the testing regime of the above-mentioned standards.

NOTE: By "test certificate in accordance with the NS-EN 1677 series" is meant the same as "the producer's self-declaration/producer certificate".

When laying out moorings, consideration shall be taken to the chain's characteristics, i.e. applied force and minimum diameter of the chain drum. Any requirements and limitations for laying out shall be specified by the chain supplier and included in the mooring user handbook.

11.3.2 Shackles

Shackles for use in the moorings shall meet the requirements stated in NS-EN 13889.

Shackles especially developed for fish farming can be used if they meet the general requirements for shackles that are mentioned above. The producer shall then be able to document accordance between breaking load / deformation load in accordance with para. 6.5 and Table 13 in this standard.

Shackle bolts shall be doubly secured.

NOTE 1 Double securing can be in the form of nuts and cotter pin.

The cotter pin shall be of a corrosion-resistant material / surface coated and must not contribute to increased corrosion of other parts of the shackle.

NOTE 2 The cotter pin can be made of plastic-covered and/or galvanised steel wire.

All shackles shall be documented with a traceable material certificate for bow and bolt. The minimum breaking load (MBL) of the shackle shall appear in the documentation.

For connection and splicing of the stud link chain, shackles which meet the requirements in ISO 1704 can be used. They shall be dimensioned as chain parts in accordance with Table 13.

11.3.3 Connecting elements

Connecting elements of different designs are allowed to be used. The condition is that sufficient strength can be documented for the area of use in the mooring system. This means evaluation of three-dimensional strength.

Lifting lugs at the connecting point shall be dimensioned as lifting equipment in accordance with NS-EN 1677. Consideration shall be paid to pre-tension when the connecting point is lifted. Connecting points (coupling discs) of steel shall be dimensioned so that the first yield will always occur in one of the attachment points for the mooring lines and never in the plate itself.

Capacity shall be calculated in all possible break sections, and yield stress shall be regarded as capacity criterion. Flow capacity shall not be higher than 270 MPa. A material factor of 1,5 shall be used. It shall be stated whether probable crack sections are found which result in fractures, such that several mooring lines loosen from the connecting point.

For coupling elements of rope, a safety factor shall be used as for regular knots. Chafing shall be especially assessed for the specific solutions. In addition, outgoing ropes shall be clearly marked with codes so that the placing of the respective ends in the system is stated. For such connections, all possible breaks having a capacity of less than 1.8 times the break surface with minimum break capacity shall be anticipated as accidental load (see para. 6.5.6.2).

11.3.4 Fibre rope

3-strand rope and/or hawsers (braided) of various fibres shall be used for moorings where there is a requirement for fibre ropes. They shall meet the requirements in NS-EN ISO 1346, NS-EN ISO 1140 and NS-EN ISO 1141 for polypropylene (PP), nylon (PA) and polyester respectively. Other types of fibre rope can be used, provided that they satisfy the requirements which can be derived from the mooring analysis. All fibre ropes shall be accompanied by a test certificate certifying compliance with the above-mentioned standards.

Synthetic rope shall not be laid over sharp edges which can cause wear and chafing when the rope is under load. When using knots, consideration shall be paid to the weakness in the rope that the knot represents.

NOTE A synthetic rope is greatly weakened in areas with knots, with a strength reduction of approximately 50%. There must be a curvature diameter of approximately three times the rope diameter in order for the rope not to be weakened considerably.

11.3.5 Buoys

Only buoys that are dimensioned to tolerate submersion with the greatest load on the moorings lines shall be used. The minimum breaking strength shall be stated. The buoy and attachment shall tolerate external forces from: waves, current, icing, drift ice, flotsam and boats. Connection to the buoy shall be dimensioned as lifting equipment in NS-EN 1677. Steel details shall be sufficiently protected against corrosion to be able to prevent corroding throughout the buoy's dimensioned useful life.

11.3.6 Bottom anchor points

11.3.6.1 General

Dimensioning of bottom anchor points shall be based on thorough charting of the bottom conditions at the site, see para. 5.6. All bottom anchor points shall be suited to the site's depth, topography and type of bottom, including assessment and documentation of the holding power of the bottom substrate. The holding power of the bottom shall be assessed and documented both as regards ultimate limit states and accidental load limit state.

11.3.6.2 Anchors

Dimensioning of anchors shall be undertaken with regard to the geological conditions at the site and/or on the basis of the results of test loads. It shall be established that the holding power of the bottom is sufficient in relation to the mooring analysis. The holding power of the anchor shall exceed the dimensioning force in the mooring line in order to take into consideration that the anchor is exposed to constant stretching combined with cyclical load.

11.3.6.3 Rock bolts

Rock bolts shall be tempered and protected against corrosion.

All rock bolts shall be documented with a traceable material certificate, at a minimum 3.1 in accordance with NS-EN 10204. The minimum breaking load (MBL) of the rock bolts shall be stated on the documentation.

Installation procedure shall be available and be followed.

The producer shall be able to document consistency between the smallest breaking load / deformation load in accordance with Table 4 and Table 13 in this Standard. The producer shall then be able to document consistency with the minimum breaking load / deformation load.

11.3.6.4 Dead weight moorings

By the use of dead weight moorings, the slide resistance and resistance to rising as well as the combinations of them shall be calculated. It shall be substantiated that the holding power of the dead weight mooring is at least twice the dimensioning force in the mooring.

11.3.7 Attachment points to floating collar

The holding power of all attachment points shall be documented. This shall be done either by empirical data from the supplier or carrying out tests.

11.4 Materials

The materials shall be in accordance with the documentation from the supplier. The producers shall have documentation which states producer, trade name, material type, characteristics and marking of the product. The characteristics shall derive from the result of tests carried out in accordance with documented methods. Relevant characteristics shall be documented. For steel, the following shall be included in the documentation at a minimum:

- maximum and minimum hardness and strength;
- impact resistance at LAST (Lowest Ambient Surface Temperature);
- ambient temperature;
- chemical composition of the steel.

The documentation shall be included in a material certificate.

The material factor shall be used in accordance with Table 13.

Tabell 13 – Material factors for moringlines

Type	Material factor
Synthetic rope	3,0
Synthetic rope with knots	5,0
Chains and chain components	2,0
Used chains	5,0
Coupling discs and other connecting points of steel*	1.5
Shackles	2,0
Rock bolts and other bottom attachments	3,0
*First yield	

For parts where the material factor is not stated in Table 13, the producer shall state the product's material factor. This shall be documented.

Material factors for parts are based on installation and use in accordance with the supplier's instructions for use. In the event of load angle not included in the description in the user instructions, the material factor shall be adjusted in co-operation with the producer. Coupling discs are calculated in relation to the first yield.

11.5 Corrosion

Regarding mooring parts of steel that are not inspected annually, the thickness shall be expected to decrease by 0.4 mm per year between each inspection.

11.6 Fatigue

11.6.1 General

Fatigue is dependent on load variations over time. Consideration shall be paid to loads which vary with wave frequency.

11.6.2 Fatigue in chains of steel

A fatigue analysis shall be carried out for chains of steel. Fatigue of chains shall be calculated in accordance with SN curve methodology, with the number of cycles to break, n (s):

$$\log (N(s)) = \log(a) - m \cdot \log(s)$$

It shall be expected that no fatigue limit and m-value shall be 3.0. The following a-values shall be used:

Studless chain: $a = 6 \cdot 10^{10}$

Stud link chain: $a = 1{,}2 \cdot 10^{11}$

A starting point of 20 years design working life shall be used.

NOTE Lifetime for stud link chain is strongly dependent on how well the stud is fixed. It is therefore recommended that studless chain be used.

For more information, see Annex, DNV OS-E301.

11.6.3 Fatigue in synthetic rope

If requirements for the tension level for ordinary polypropylene rope are met (up to 170 MPa), the rope is regarded as having sufficient fatigue capacity if all other requirements regarding material, design working life and inspection are satisfied. If rope with a higher breaking stress than this is used, an equivalent fatigue capacity shall be documented through testing.

11.7 Swing mooring

It shall be documented that the mooring system for a swing mooring has a redundance which gives at least the same security as the mooring system for marine fish farms designed on the background of this Standard. Further, it shall be documented that the mooring can be placed in a site under the conditions that are described in the site survey.

11.8 Mooring of rafts

As a main rule, a raft shall not be designed so that it is moored directly to the floating collar. Any connection between the raft and floating collar shall in that case be the weakest link. Rafts can be excepted from the first-mentioned requirement if it can be proved by calculations that the floating collar with appurtenant mooring is dimensioned for mooring of rafts.

Mooring of rafts shall take place on the basis that all mooring parameters with appurtenant specifications are given. This includes that the number and placing of attachment points are given. The largest force and three-dimensional direction (or limit states for three-dimensional direction) for each attachment point shall also be stated. Material and planning of all attachment points shall be specified.

NOTE The variations in the line characteristics of the different mooring lines can put great loads on the raft.

Mooring of rafts shall be calculated and dimensioned according to the same rules as for floating collars with net pens and extra equipment.

Mooring of rafts shall not be designed so that it can cause damage to the mooring of the marine fish farm itself, floating collar or net pen. This shall be documented.

In placing the raft in relation to the rest of the marine fish farm, consideration shall be paid to the prevailing direction of wind, waves and current, as well as the danger of icing. Rafts shall preferably be laid out on the leeside of the marine fish farm.

11.9 Requirements for laying out and after-inspection

Laying out shall take place in accordance with a laying out plan. After the mooring is laid out, the requirements in the mooring calculations shall be controlled for compliance. In the case of significant deviation in positions and depths in relation to the calculations which have been used as the basis for the laying out plan, it shall be verified that the change has not led to significant weakening of the mooring.

Layout out of moorings shall take place so that none of the mooring elements are damaged during the laying out process.

NOTE Chain can be damaged by the pulley/wheel/drum that the chain moves over having a diameter that is too small, that too few (there shall be at least four) chain links have a contact surface against the wheel/pulley, or that it is exposed to great a load during the laying out phase from self-weight combined with the weight of sinkers and bottom attachments. The latter can be avoided by the bottom attachments being sunk by the use of a crane which via wires is fixed to the uphaul of the bottom attachment.

After laying out a visual control shall be performed to ensure that the result of laying out has taken place in accordance with the laying out plan. Before fish are set out in the marine fish farm, it shall be established by tests and/or after-inspection of the whole of the mooring, including anchors and rock bolts, that the mooring has the characteristics required by the mooring analysis, including holding power of the bottom attachments.

Further inspection and/or testing shall take place according to a fixed plan which includes time intervals for inspection and testing, based on risk analysis. This shall also include listing of events which shall result in any increased after-inspection and testing, as well as the plan for (periodic) replacement of parts.

11.10 Requirement for documentation

A sketch showing measurements of the mooring at the site shall be available. The producer or supplier of the mooring system shall document that the system is suitable for the site. This shall be supported by calculations and dimensioning. There shall be a documented analysis of the relevant mooring system available at all sites.

A specification shall also be available of each anchor or bottom attachment. At a minimum this shall include a product statement (concrete weight, drag anchor, rock bolt, etc.) as well as mass and weight and/or expected holding power.

A specification of each shore attachment shall be available. At a minimum this shall include dimensions of the bolt, attachment method, corrosion protection, ground conditions and other relevant data.

A documented assessment shall be available of the impact of accidental loads such as unequal loads because of a break in the mooring line, loss of floater, dragging of anchors and similar occurrences.

Documentation of the mooring system shall give a description which is good enough to be able to assess/recalculate the moorings. Requirements for documentation of the mooring system's planning:

- specification of each mooring line, at a minimum an overview of building up in segments with bottom attachment/shore attachment, line type, grommets, shackles and other extra equipment. The mooring line's diameter, breaking strength, buoy, deadweight with weight, volume and placing and material data such as elasticity and weight per unit of length shall be stated where relevant;
- fundamental assembly drawing of the marine fish farm with laying patterns, attachment points, indication of line lengths and length/depths of depth-dependent line lengths;
- expected limit states in the form of functional requirements which shall be met, i.e. whether the gangway shall be connected, or whether the wellboat shall be able to come alongside the marine fish farm;
- assumed limit conditions in the form of what loads the mooring system can tolerate, including which maximum mooring line stretch can be expected as a result of static and dynamic movements in the terminal point. Loss of a random mooring line shall not entail progressive breaks in the mooring system or resulting damage to the floating collar / net pen;
- all certificates and declarations which confirm the compliance of parts with Standards and other specifications and requirement documents;
- stated design working life on all parts.

Annex A (informative)
Background information for site survey

A.1 Introduction

The Annex provides background information for the description of the marine fish farm's exposure to waves, current and wind.

A.2 Site classification

The tables in this paragraph are used for conversion of site classes determined by the use of the first edition of the Standard and to describe the greatest exposure to wave and current in this edition of the Standard.

Table A.1 – Wave classes at the site decided by dimensioning, significant wave height and wave period (in accordance with the 1st Edition of NS 9415)

Wave classes	H_s m	T_p s	Designation
A	0,0 – 0,5	0,0 – 2,0	Little exposure
B	0,5 – 1,0	1,6 – 3,2	Moderate exposure
C	1,0 – 2,0	2,5 – 5,1	Substantial exposure
D	2,0 – 3,0	4,0 – 6,7	High exposure
E	> 3,0	5,3 – 18,0	Extreme exposure

Table A.2 – Classification of site based on midcurrent (in accordance with the 1st Edition of NS 9415)

Current classes	V_c m/s	Designation
a	0,0 – 0,3	Little exposure
b	0,3 – 0,5	Moderate exposure
c	0,5 – 1,0	Substantial exposure
d	1,0 – 1,5	High exposure
e	> 1,5	Extreme exposure

A.3 Description of parameters

A.3.1 Wind

A.3.1.1 Wind in the coastal zone

Expected extreme wind is almost the same along the coast from Lindesnes to Nordkapp (NS-EN 1991-1-4). Typically, the one-year wind lies around 28 m/s and the 50-year wind around 35 m/s along the outer coast. The wind drops off inland from the coast. This is due to the fact that the wind is reduced as a result of friction over land. A wind of 10 km – 20 km in from the coast can be 20 % – 30 % lower than the wind outermost in the skerries. After this the 50-year wind in the coastal zone typically varies between 25 m/s and 35 m/s. Generally, the onshore wind will be considerably stronger than the offshore wind.

Since the wind varies relatively little along the coast, there is little point in describing the site according to the wind climate.

Norsk Standard NS-EN 1991-1-4 indicates the 50-year wind for areas with scattered small buildings and trees (Terrain Category II) as reference velocity. For areas near the coast without trees and bushes (Terrain Category I) the wind is 17 % higher.

A.3.2 Waves

A.3.2.1 Swells

Ocean swells are waves which push in from the sea. A fish farm will usually be located in an area which is relatively well protected from direct wave occurrence from ocean swells, behind islets and skerries. The wave height for incoming ocean swells will therefore be significantly lower than for the sea outside. The wave period, however, will be almost unchanged. Incoming ocean swells (high waves) will typically have peak periods in intervals of 10 s – 18 s, increasing with the increasing wave height.

A.3.2.2 Locally generated wind sea

Locally generated wind sea is set up in the sea area around the fish farm. This sea is completely determined by wind velocity, duration of the wind and the effective fetch length. The fetch length is the distance from the fish farm to the nearest land calculated in the wind direction. The effective fetch length depends on the width of the fetch. In the case of narrow fjord arms, the effective fetch length can be significantly less than that measured.

It can be expected that the wave height increases (almost) proportionately with the wind velocity and proportionately with the square root of the fetch length. Examples of the connection between waves, wind and fetch length are given in Table A.3. It will be seen from the table that the peak period for locally generated wind sea is typically 2 s – 7 s, that is to say significantly lower than for ocean swells.

Table A.3 – Examples of calculated significant wave period and peak period in varying wind velocities and fetch length

Wind velocity	Effective fetch length					
	3 km		10 km		30 km	
	Significant wave height m	Peak period s	Significant wave height m	Peak period s	Significant wave height m	Peak period s
10	0,3	2,1	0,6	3,1	1,1	4,4
20	0,8	2,8	1,5	4,1	2,5	4,9
30	1,4	3,3	2,5	4,9	4,4	7,1

A.3.2.3 Description with regard to wave exposure

There is a great difference in the peak period for ocean swells and locally generated wind sea. This is significant for the response of various marine fish farms to wave occurrence. It seems, therefore, appropriate to differentiate between areas stated in type of sea:

- areas (H) where ocean swells prevail;
- areas (V) where wind sea prevails.

In addition to the type of sea state, one must differentiate between the degree of exposure to wave occurrence. A description is most effectively achieved by stating dimensioning, significant wave height.

A.3.2.4 Determining wave height

The wave height at the place of location of the fish farm can be determined in several ways, i.e. based on information from local area experts upon on-site inspection, calculations based on wind data, calculations based on information about incoming ocean swells, or based on measurements.

A.3.2.4.1 On-site inspection

It will often be possible to arrive at a relatively good description after an on-site inspection of the relevant fish farming location. Local area experts will as a rule be able to give an estimate of the largest waves occurring in the area during the year. This estimate can be assumed to be equivalent to the one-year significant wave height. The 50-year significant wave height for wind sea is approximately 25 % higher. Upon inspection, information will also be obtained regarding the wave height by studying how high the waves break along shore, the height of the vegetation above water level, how high driftwood, seaweed etc. is washed up along the beach, whether the waves break over quays, etc.

A.3.2.4.2 Calculation based on wind data

When the fish farming site is protected against incoming ocean swells, the wave height can as a rule be calculated based on wind data. This assumes that the long-range wind statistics from a nearby weather station are available. Significant wave height is determined based on the wind velocity and fetch length, that is to say that the free sea area over which the wind blows calculated in the wind direction. The 50-year wave is equivalent to the wave calculated based on the 50-year wind.

A.3.2.4.3 Calculations based on incoming ocean swells

When the fish farm is mainly exposed to incoming ocean swells, the wave height will be able to be calculated based on information (long-range statistics) about the wave height on the sea. This assumes that the open sea outside the fish farm installation is fairly clean, i.e. there are few underwater rocks and skerries over which the waves break. If the open sea outside is not clean, the uncertainty of such calculations will often be too great.

A.3.3 Currents

A.3.3.1 Wind-induced currents

When the wind blows over the sea, parts of the wind energy are transferred to the surface of the sea, and a wind-induced current is set up at the same time as the wind contributes to mixing the water masses. If the sea is almost homogenous (i.e. the density is about the same in the depths), larger parts of the wind energy are used for mixing and less for inducing wind currents. If there is a strong layer division in the water, which there often is in Norwegian fjords with rivers discharging, the thermocline between the layer of brackish water, and the fjord water underneath acts as an energy blockage. The wind energy will then be absorbed in the upper layer of brackish water, and the largest part of it will be used to induce current while lesser amounts will be used for mixing.

The rule of thumb that the wind-induced current on the surface is 2 % of the wind velocity is often applied. A continual storm of 25 m/s should then induce a wind current of 50 cm/s. In fjords and other layered water masses the wind-induced current is often stronger than in the open sea, especially if the wind blows over a larger area (long fetch length). Continual, strong wind that blows out over a long and fairly straight fjord, will be able to induce a significant wind-induced current. Wind in the opposite direction (in to the fjord) will not have the same effect. On the contrary, it will pile up the water up the fjord. When the wind changes direction or drops, this piling will "drop", and a strong, but short-range current directed outwards will be induced. This is called "wind-piling current". Typical duration is a couple of hours, and the velocity can be 70-80 cm/s.

The wind-induced current is strongest at the surface and reduced with depth. In strongly layered water the thermocline will form the boundary for how deep the wind energy can be noticed. In open sea the lower boundary is about 50 m in our waters.

A.3.3.2 Tidal current

The tidal current is induced by the periodic wave movement of tidal waters. It is permanent, changing and predictable.

In open sea the tidal current will be in phase with the tidal wave. Tidal currents are weakest off Jæren. There the 100-year tidal current is calculated at approx. 20 cm/s. The velocity increases southwards and northwards. Off Bodø it is anticipated to be 30 cm/s, while it is up in 40 cm/s –50 cm/s off the coast of Nord-Troms and Finnmark.

In fjords, the tidal wave will contribute to increase and decrease the water level in the fjord area inside. Here the tidal current is zero at high water and low water, and strongest in the middle. With knowledge of the surface area of the fjord and the height of the tide water, the tidal current can be calculated in every point where the cross-sectional area is known. Large fjord area, high tide and narrow inlets give strong tidal currents (cf. Saltstraumen).

A special tidal water phenomena often occurs in sounds. If the tidal wave travels outside the sound, a water level difference occurs on each side of the sound. This difference is attempted equalised by water flowing from the area with a high water level to the area with a low water level. This tidal current can be very strong, and such sounds are often called tidal sounds (jf. Rystraumen in Troms and Kvalsundet in Finnmark, both with velocities up to 2 m/s – 2,5 m/s).

Tidal currents are relatively constant with depth. Near the bottom, however, it will meet the friction and reduce in strength.

A.3.3.3 Pressure-driven current, including break-out from the coastal current

Density differences will be attempted equalised by inducing current. The same happens when the water level is different. A river discharging to a fjord causes an outward-directed brackish water current in the surface layer. The coastal current along the Norwegian coast is another example of pressure-driven current.

While the pure tidal current and (partly) the wind-induced current are determining in the sense that the velocity can be estimated for a given site, the pressure-driven currents are more complex and difficult to predict. It is known that the coastal current flows northwards along the Norwegian coast with velocities in the region of 50 cm/s. With low pressure areas over the North Sea, a south-westerly wind often starts in Skagerrak. This wind decelerates the coastal current, and an extensive wind-piling occurs. When the wind-piling drops, there is an outbreak in the coastal current. The velocity can get up to over 1 m/s, and the current can be spread in to the fjord arms, especially on the West coast, as a relatively strong intermediate in-flowing.

The topography in an area here will be of great importance. When a given volume of water flows northwards along the coast, between rocks and skerries or inwards in the fjords and meets obstacles in the form of shallow parts or narrow sounds, the velocity of the current based on a continuity view must increase so that the same volume shall be able to get through. This is in contrast to the tidal sounds where the water level difference on each side of the sound determines the velocity of the current.

The pressure-driven current, like the tidal current, is relatively depth-constant. The velocity of these currents and how often they occur, can often only be determined by direct current measurements.

A.3.3.4 Spring flood

Spring flood in connection with snow and ice melting in many cases will contribute greatly to the velocity of the current. Typically this takes place during the months April to June. This effect can at times be so great that it dominates everything else. If the site indicates that a strong current can be expected in connection with ice and snow melting, an assessment should be made as to whether current measurements should be taken during this period.

A.3.3.5 Description with regard to current exposure

The response of various marine fish farms to current exposure does not differentiate between which driving force is the cause of the current. To some degree, duration and frequency can play a role, but it is mainly the velocity and direction of the current in relation to the marine fish farm that is decisive.

A.4 Directions

The direction of the current as a rule defines the prevailing direction for the marine fish farm. The most unfavourable direction or the direction which gives the greatest load shall be used if the marine fish farm is moored so that it follows the current (weathervane effect).

Wind and wind-driven waves shall be assumed to be concurrent and most unfavourable in relation to the direction of the current. Swell shall be assumed to be the most unfavourable in relation to the marine fish farm's dimensions, that is to say in the longitudinal direction to the marine fish farm. If possible, wind sea and swell shall be combined.

Annex B (informative)
Personal safety

A fish farm shall be arranged so that the working environment is completely safe regarding the employees' safety, health and welfare. Technical devices shall be inspected, assessed and documented in relation to environmental considerations.

In order to meet this requirement in an appropriate manner for exposed equipment such as feed rafts and feed stations, it shall be required that the producer provide documented calculations of strength, buoyancy and stability under all operational conditions.

Workplaces and working environments at feed stations and feed rafts, as well as working environments on shore, shall be assessed and documented in relation to the following points:

- light, climate, ventilation and noise;
- access;
- floor area and room height;
- daylight and view;
- ladders;
- railings;
- floor – anti-skid etc;
- escape routes;
- personnel rooms such as cloakroom, toilet and break room;
- outside workplaces;
- rooms for any board and lodging.

There shall always be a boat or rescue raft in place at the feed raft when there are people on board. If anyone stays overnight on board, the feed raft shall be equipped with an alarm system which gives warning in the event of water penetration or breakdown.

Workplaces on the floating collar and raft as well as access to them shall be dimensioned and fitted based on the activity which is to be carried out. The necessary precautions shall be taken in order to prevent danger of personnel injury by falls or falling objects.

Relevant technical devices and equipment shall be designed and equipped with safety devices so that persons are protected against hazards to life and health. This shall be based on charting as well as a risk analysis of work operations carried out on cages and rafts. The necessary safety measures on the background of this shall be documented.

Amongst other things, this means measures which ensure that the marine fish farm possesses sufficient strength, buoyancy and stability. The marine fish farm shall tolerate necessary loads from wind and waves, as well as from relevant equipment such as cranes, trucks etc.

Before technical equipment is installed and taken into use, the marine fish farm with appurtenant equipment shall be inspected thoroughly to ensure that the above-mentioned requirements are met. After inspection has been performed, documentation shall be available showing that the marine fish farm sufficient buoyancy, strength and stability.

Relevant safety devices shall be installed to prevent falls and driving into the sea. At a minimum this includes railings, anti-skid protection of all gangways, driveways and working platforms, skirting boards etc. as well as longitudinal safety edges on all driveways. The inner edge of the gangway shall have a skirting board of between 3 cm and 8 cm. The outer edge of the gangway should be equipped with the same type of skirting board. All driveways shall have a safety curb installed along the sides. These shall be 30 cm high. The side along the net pen shall be equipped with a railing consisting of hand and knee skirting board, installed at 1.0 m and 0.5 m respectively over the deck. Rope shall not be used as a material for a handrail.

NOTE Gratings are often appropriate for walking and driving on. They give good protection against sliding and other accidents.

Relevant safety devices/aids shall be in place to ensure that persons who have fallen into the sea can manage to get back on land or on board the marine fish farm.

At a minimum there shall be an easily accessible life jacket in summer as well as a survival suit in the winter. On gangways etc. where one cannot reach up to the edge from sea level, a ladder or similar means of access shall be installed. It shall reach at least 50 cm down into the sea. The distance between such ladders shall not be more than 20 m, or one ladder for each cage in the marine fish farm. Gangways and working platforms which float more than 50 cm above sea level, should be equipped with life ropes, installed in bays along the outside of the floating collar.

Lifebuoys with line and rescue hook shall be placed on the outside of the marine fish farm and on the gangway. The distance between each lifebuoy shall not be over 50 m.

The marine fish farm shall be well arranged ergonomically, amongst other things by a design which ensures appropriate work positions, as well as having sufficient width on walkways etc. The width of walkways shall be at least 90 cm, and the width around the cages shall be at least 60 cm.

In all relevant places the marine fish farm shall be equipped with appropriate and good lighting. Workplaces shall have lighting with a luminous intensity of at least 20 lux. Gangways, loading/unloading places etc. shall be equipped with lighting with a luminous intensity of 100 lux.

Procedures and safety measures for personnel working alone shall be in place. Working alone on marine fish farms should be avoided. If working alone nevertheless must be performed, there must always be an agreement with another person for regular contact and preparedness if an accident should occur. In winter a survival suit shall be used. In summer, at a minimum, a life jacket shall be used. In addition to a life jacket and survival suit, an alarm system shall be available. Written instructions shall be drawn up regarding working alone, if such is performed.

The producer shall supply user guidance in easily understood written Norwegian regarding set-up, operation and maintenance. User guidance shall be stored in an easily accessible place.

All chemical substances, i.e. medicines, disinfectants and proofing compounds, shall be transported and stored properly and used in accordance with the user instructions. All necessary safety equipment for handling of chemicals shall be available and shall be used. Everyone working with hazardous or flammable substances shall have the appurtenant occupational hygiene product data sheet available.

All marine fish farms shall be equipped with first aid equipment.

When working on a quay and with other harbour work which is done in an area immediately adjacent to the marine fish farm installation, such as work with loading, unloading, mooring etc., requirements shall be made regarding the following:

- equipment on the quay such as ladders, mooring points, fendering on the quay front, and lighting;
- rescue equipment such as lifebuoy with lifeline, rescue hook and rescue ladders;
- first aid equipment;
- fire extinguishing equipment;

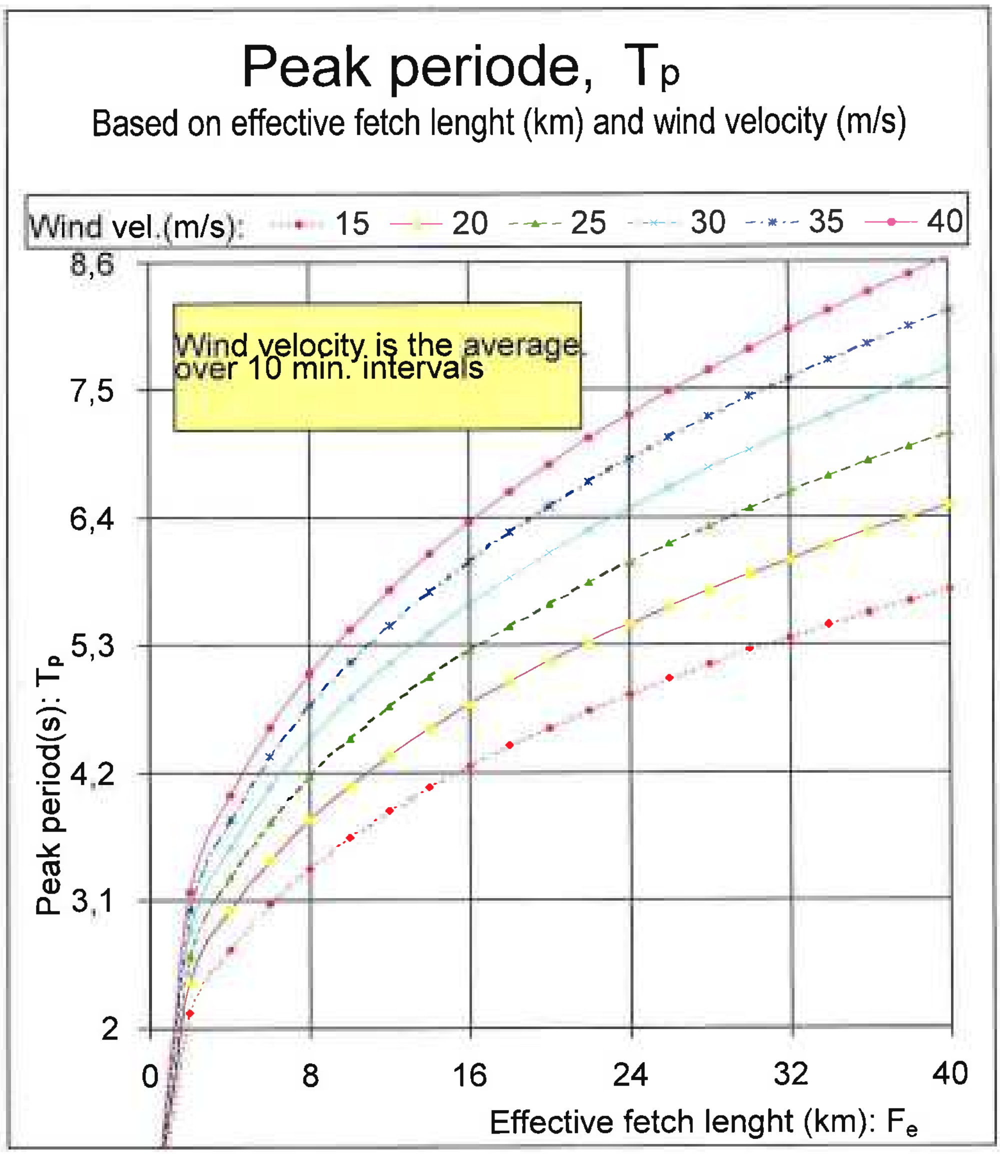
Each raft shall have a safety plan posted on board in at least A-4 format. A copy of the safety plan shall be placed in a watertight cylindrical container in a suitable place. The drawing shall show the placing and number of.

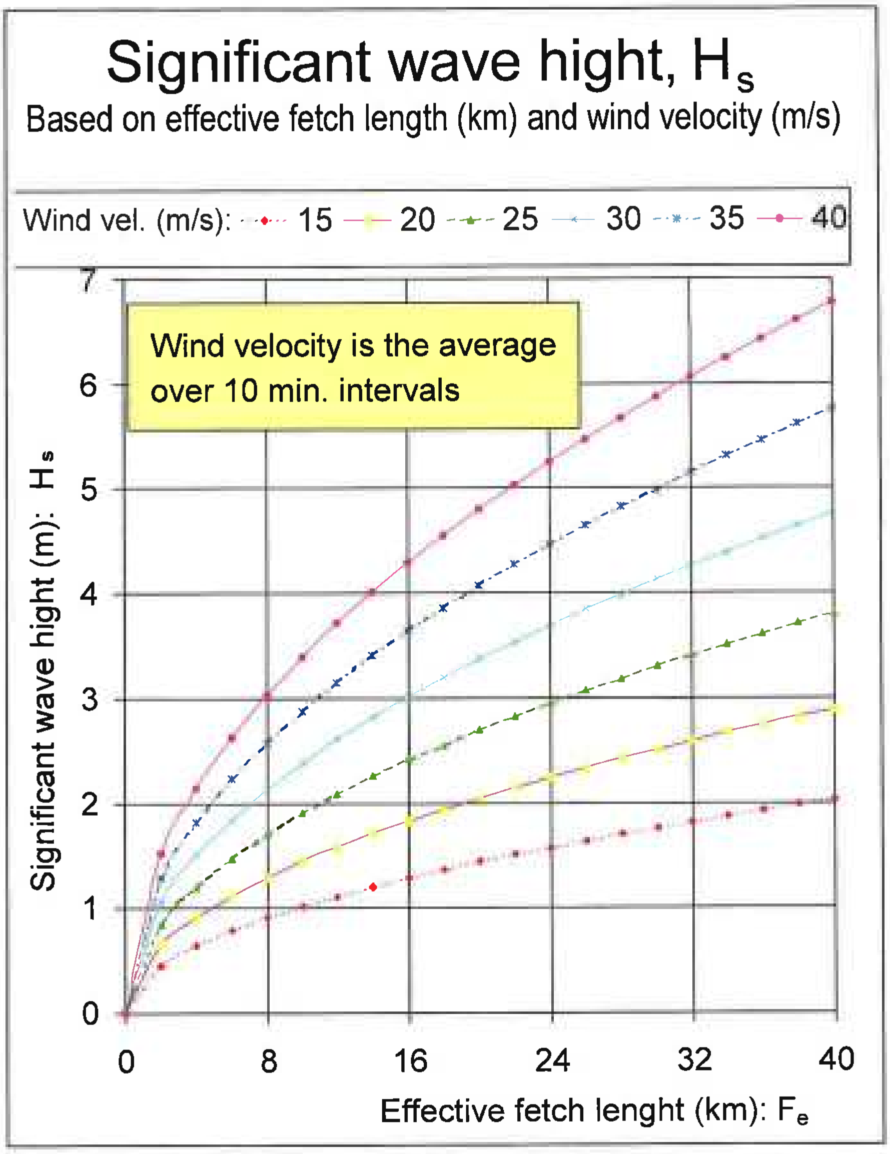
- fire alarm bells;
- switch for shutting down fuel supply;
- emergency stop switches for fuel pumps and any engine room fans;
- emergency stop switches for ventilation and fittings;
- sensors for smoke and heat detection;
- pumping equipment;
- level alarm;
- separate pumping and hosing systems;
- powder, water and CO_2 apparatus;

- fire axe;
- lifebuoys;
- life jackets;
- emergency lighting;
- first aid equipment;
- shutting down of ventilation valve;

Symbols shall be used for the equipment in accordance with the IMO Standard.

Annex C (normative)
Peak period based on effective fetch length, and dimensioning, significant wave height based on effective fetch length and wind velocity




Significant wave hight, H_s
Based on effective fetch length (km) and wind velocity (m/s)
Wind vel. (m/s): 15 20 25 30 35 40
Wind velocity is the average over 10 min. intervals
Significant wave hight (m): H_s
0
1
2
3
4
5
6
7
0
8
16
24
32
40
Effective fetch lenght (km): F_e

Annex D (informative)
Dimensioning of floating collar in relation to extra equipment

The loads imposed on the main components of a marine fish farm by extra equipment being fitting on it, shall be documented. The impact in the form of damage/breakdown shall be explained.

Extra equipment is divided into three categories:

Fitted extra equipment: this consists of system units which are intended to be permanently mounted on a main component, or which are an integral part of the main component:

NOTE 1 Examples of fitted equipment are winch, dead fish/feed collector in net pen, artificial lighting, generator, battery, light filter, protective net and feed spreader.

- detached extra equipment:

NOTE 2 Examples of detached extra equipment are feed store and service station.

- separate or connected extra equipment.

NOTE 3 Examples of separate or connected extra equipment are gangway, feed station with hose connection and floating feed dispenser.

Regarding fitted extra equipment which is fixed to or placed in direct connection with a floating collar, net pen or a mooring system, an assessment shall be made and documentation provided for mutual static and dynamic effects between the extra equipment and the movements of the relevant equipment. Possible accidental loads and impact of accidental loads shall be specified and evaluated.

Regarding detached and separate/connected extra equipment which is not directly connected to the floating collar or the other main components, an explanation shall be available with all necessary calculations of the impacts loads and accidental loads from extra equipment will have on the floating collar, net pen and/or mooring system.

Documentation of extra equipment shall give a description which is good enough to facilitate assessment/supplementary calculation of the effects on the floating collar, net pen and mooring system. Requirements for documentation of the planning of extra equipment:

- specification of category placing. For new or significantly modified systems, a new assessment and documentation of category placing shall be performed;
- fundamental assembly sketch with all relevant measurements drawn in;
- specification of extra equipment with regard to functional requirements and mode of operation;
- specification of extra equipment with regard to capacity.

Contact should be established between designer/supplier of extra equipment, and the same for the main components that are affected. Extra equipment should be accompanied by a document recommending that it can be used together with the relevant main system. Any limitation in the use or fitting of extra equipment together with the relevant main system shall be clearly defined.

The different categories of extra equipment shall be accompanied by partly different types of documentation:

- Fitted extra equipment shall have an assembly and fitting drawing with suggested placing on the relevant type of installation, as well as a document which describes the loads the system imposes on the marine fish farm installation or parts of it, including mass, volume, area, drag and drag area.
- Detached extra equipment shall carry documentation showing the assessment by the classification institution, labour inspection authorities etc., where this is relevant.
- Separate/connected marine fish farms shall carry documentation showing the assessment by the classification institution, labour inspection authorities etc., where this is relevant. It shall also be accompanied by a document describing the loads the system, including attachment and mooring shall tolerate, including environmental loads from wind, current, waves, ice, snow and temperature, functional loads such as variable loads connected to the operation of the system, including equipment, load distribution and personnel, permanent loads, i.e. own mass and buoyancy and distribution of them, and accidental loads which are caused by breaks in the mooring lines or loss of buoyancy or load shift. A document shall describe which loads the system imposes on the marine fish farm or parts of it, including forces between the system and the marine fish farm as a result of own and the marine fish farm's terminal points' static and dynamic

movements. A document shall describe the limit states that are assumed, including attachment of the system to the floating collar, the mooring system of the marine fish farm and net pen, and including the attachment of the system with its own primary mooring.

It is a requirement that drawings, calculations and performance are reviewed, and that extra equipment is assessed and documented for use within the specified limitations of a named responsible person in the company or by an expert from an external company who can document satisfactory competence to be able to undertake such documented assessment.

Annex E (normative) Strength of net pen cage in dimension class 0 in accordance with Table 11

In the case of documentation of the strength of a net pen which does not fall under the requirements in Table 2, the following should be specified:

- Which loads in the form of environmental loads the net pen is dimensioned to tolerate. At a minimum there shall be data for forces which are transferred by wave movements from the floating collar to the net pen, current forces on the net pen, and icing of the jump catch net ;
- Specification of which loads in the form of variable functional loads the net pen is dimensioned to tolerate. At a minimum, data shall be available for forces which are imposed by the use of a stretching system, from dead fish and from fouling;
- Specification of limit states which are assumed to be connected to the method of attachment of the net pen to the floating collar;
- Possible procedures for documentation of strength of a net pen which does not fit into the dimension class;
- Specification of limit states connected to size, weight, movements of the floating collar and forces imposed by handling of the net pen.

For submerged net pens, deformation and distribution of forces in the net pen from the following loads shall be calculated:

- Own loads, F_e, which is the net pen placed in a frame and with stretching system attached. A load factor of 1.25 shall be used.
  $L_1 = 1.25\ F_e$
- Loads from fouling, F_b shall be calculated.

NOTE 1 For example, mussel attacks which entail both increased weight of the net pen as well as reduced flow of water.

- Deformation of and forces on the net pen from these loads shall then be calculated with a load factor of 1.25. The following cases of load shall be checked both for deformation and forces:
  $L_2 = 1.25\ (F_b + F_e)$
- Calculation shall be made of the response effect from loads due to effects on the net pen from the maximum current the net pen can be exposed to, F_s. For this load instance a calculation shall also be made of volume change. Particular attention shall be paid to velocity reduction (shadow effect) in the control of this load instance. This is particularly important for cages since the rear edge in relation to the current direction is in shadow in relation to the forward edge, because it gives less volume. The following load instances shall be controlled for the cage having the least shadow effect in the forward edge, and for the cage having the greatest difference between shadow effect in the forward and rear edges respectively. The forces on the net pen because of current, F_s, is non-linear in relation to current velocity, V_s, and the net pen's deformation. Deformation and forces shall be calculated for the following types of load:
  $L_{3a} = 1.2\ (F_s + F_e)$
  $L_{3b} = 1.1\ (F_s + F_e + F_b)$
- For non-circular cross sections, this calculation shall be performed for current velocity in relevant directions in relation to the net pen and must be assessed and documented in relation to global shadowing;
- Response due to waves shall be calculated. Waves shall be combined with current, fouling and own weight;

NOTE 2 Waves affect both the movement of the floating collar and the net pen directly.

- The net pen shall be calculated regarding relevant dimensioning waves, $W_{(H,T)}$ or sea states where H is the wave height and T is the wave period. The net pen shall be examined for the wave giving the greatest forces and deformation in the net pen. The following load combinations shall be examined:
  L_{4a}= 1.2 (F_w + 0.8 F_s + 1.0 F_e.)
  L_{4b}= 1.1 (F_w + 0.7 F_s + Fe.+ 0.7 F_b)
- Forces on the net pen which are imposed by handling shall be calculated. It shall be documented that the net pen will not be destroyed or impaired by imposition of forces by handling, F_h.
- L_{5a} = F_h + 1.0 F_e.
  L_{5b} = F_h + 1.0 F_e. + 1.0 F_b.
- Forces by handling: The load instances include both lifting forces as well as own weights and fouling weights less any parts that are removed before handling;
- Accidental loads: Damage to the net pen which is due to floating parts, shall be inspected. Forces from drift ice or other parts shall be calculated and imposed in areas where it is probable that they will hit.
- Wear due to contact between the net pen and auxiliary systems shall be assessed and documented. In the case of large deformations, the net pens can come into contact with one another. In the event of fouling, the wear forces can be critical with regard to the material damage and resultant tearing.
- Attention shall be paid to the fact that the above-mentioned load effects can be non-linear, and loads must therefore be combined with regard to this. Ice loads shall be assessed and documented for jump catch nets.

It shall be ensured that the net pen tolerates taking up the forces which are transferred from the floating collar when waves result in vertical and horizontal movements in it.

Annex F (informative)
Example of risk analysis, broken down into main components

Table F.1: Risk matrix, used to classify events in a preliminary analysis

Probability	Impact			
	1	2	3	4
4				
3				
2				
1				

Large risk (unacceptable)
Medium risk (assess measures)
Small risk (no measures necessary)

Class	Probability
1	Once every 100 years or more infrequently
2	At least once every 10 years
3	At least once every year
4	At least once every month

Class	Impact
1	Less escape, 1 to 100 fish
2	From 100 to 10000 fisk
3	From 10000 to 150000 fish
4	Over 150000 fish

Table F.2 – Risk analysis table

Main component	No	**Undesirable event: (how)**	**Causes: (why)**	Underlying causes:	**Impact: (type damage/ loss)**	**Risk analysis: Frequ. (1-4)**	**Impact. (1-4)**	**Suggested measure:**
Quality assurance of site surveys Quality assurance of site surveys, several current measure-ment	1	Failure of mooring	Erroneous environmental data	Erroneous wave data	Breakdown	2	3/4	
				Erroneous current data	Breakdown	2	3	
				Erroneous main directions	Breakdown	2	3	Quality assurance of site surveys
				Erroneous calculation methodology (Hs, V, x, y)	Breakdown	2	3	Quality assurance of site surveys
			Erroneous strength dimensioning	Isolated forces / ideal directions	Breakdown	2	3/4	Establish one analysis methodology for connected load
				Wrong material parameters	Breakdown	2	3	Correct reading of tables
				Wrong methodology for calculation of strength				
				Without acceleration there is no pull	Breakdown	2	3	Connected analyses with interaction forces
			Wrong safety factors		Breakdown	2	3/4	Learn from other industries
			Increased load	Heavy fouling	Breakdown	2	3/4	Regular cleaning, routine inspection, correct load instances, user handb ook
				Dead fish in net pen	Breakdown	2	3	Routine inspection, correct load instances, user handbook
				Icing of marine fish farm	Breakdown	2	3	Routine inspection, user handbook
			Erroneous supporting information for dimensioning	Type certificates	Breakdown	3	4	Routine inspection, correct load instances, user handbook
			Defective assembly of marine fish farm installation	The parts are not assembled correctly				
				Defective user handbook / user interface				
			Failure of connecting point	Defective testing of technical solutions in the connecting point				
			Unforeseen load		Breakdown	2	3/4	Include the loads we wish shall be tolerated in engineering

Main component	No	Undesirable event: (how)	Causes: (why)	Underlying causes:	Impact: (type damage/ loss)	Risk analysis: Frequ. (1-4)	Risk analysis: Impact. (1-4)	Suggested measure:
	2	Contact with boat/propeller	Wrong handling of boat	Defective training, substandard procedures	Break in single line	3	2	Grating protected propeller on work boat
			Unfavourable confiiguration / design of boat		Break in single line	3	2	Placing of crane/feeding system vs. propeller
			Bad marking of mooring		Break in single line	3	2	Stricter requirements for marking / light s/lighting
			Unfavourable placing of mooring		Break in single line	3	2	Placing of marine fish farm in relation to the existing environment
	3	Collision	Running into by larger vessels	Bad marking of marine fish farm	Breakdown	2	4	Stricter requirements for marking/ / lights / lighting / reflectors
			Mooring line on water surface		Break in single line	2/3	2/3	Sink all mooring lines connected to the stretching system
			Unfavourable placing of marine fish farm		Breakdown	2	3	Placing of marine fish farm in relation to the existing environment
	4	Displacement of system	Boat or feed raft collided with marine fish farm installation		Break in single line	3	2	Separate moorings/emergency procedures in sudden bad weather
			Depth/length ratio too high		Drifting / Break in single line	3	2	Ensure dimensioning of plough anchor /weight/ bolt fixings
			Low pre-tensioning in some moorings		Drifting / Break in single line	2	2	
			Anchor attachment loosens	Attachment / wrong bolt dimension	Drifting / Break in single line	3	2	Check dimensioning of bolt attachments, check quality of rock
				Attachment / wrong anchor dimension	Drifting / Break in single line	3	2	Check dimensioning of plough anchor
				Chain rusts, i.e. because of different steel quality of chain and shackle / eyelet	Break in single line	2	2	Use tension range
				Wrong dimension for dead weight moorings	Drifting / Break in single line	3	2	Check dimensioning of weights

Main component	No	Undesirable event: (how)	Causes: (why)	Underlying causes:	Impact: (type damage/ loss)	Risk analysis: Frequ. (1-4)	Risk analysis: Impact (1-4)	Suggested measure:
	5	Rope in anchor line towards the bottom	Wear in the rope on the bottom	Slack in the rope in weak current periods, underwater knolls which get into contact with the line, sharp stones in the transfer chain/rope	Break in single line	2	2	Use chain on the bottom, Olex surveys to find any points of wear, have suitable pre-tension in the mooring line
	6	Wear against other parts	Chafing in the coupling disc / buoy		Break in single line	3	2	
			Chafing in shackle because of fouling		Break in single line	3	2	
			Attachment to floating collar		Break in single line	3	2	
	7	Progressive collapse / break of anchor system	Wrong dimensioning		Breakdown	2	3/4	Design
			Unforeseen mechanical process		Breakdown	2	3/4	User handbook
			Break in a central part		Breakdown	2	3/4	Design
			High tension level / low useful life		Breakdown	2	3	Design, obtain fatigue criteria
Floating collar	1	Failure in floating colla	Erroneous environmental data	Erroneous wave date	Breakdown	2	3/4	Quality assurance of site surveys
				Erroneous current data	Breakdown	2	3	Quality assurance of site surveys
				Wrong main directions	Breakdown	2	3	Quality assurance of site surveys
				Erroneous calculation methodology (Hs, V. x. y)	Breakdown	2	3	Quality assurance of site surveys
			Erroneous dimensioning, calculation of strength	Isolated forces / ideal directions	Breakdown	2	3/4	Establish one analysis methodology for connected load
				Oversees accelerations	Breakdown	2	3	Establish one analysis methodology for connected load
				Defects in forces from other parts of the structure				Have connected analyses
				Lack of design criteria				
				Wrong material parameters / wrong choice of parameter	Breakdown	2	3	Correct reading of tables
			Increased load	Heavy fouling	Breakdown	2	3/4	Routine inspection
				Dead fish in net pen	Breakdown	2	3	Routine inspection
				Icing of marine fish farm	Breakdown	2	3	Routine inspection
			Wrong safety factors		Breakdown	2	3/4	

Main component	No	Undesirable event: (how)	Causes: (why)	Underlying causes:	Impact: (type damage/ loss)	Risk analysis: Frequ. (1-4)	Impact (1-4)	Suggested measure:
	2	Overloading from the anchor system	Erroneously assembled design of total system		Break in single line	3	2	Analyse the total system as one unit
			Crowfeet too tight on plastic ring	Cage in frame becomes slack in relation to the crowfeet. The ring thereby absorbs forces from the whole of the marine fish farm	Fracture in floater, collapse of net pen	2	2/3	
			Unfavourable rigidity distribution		Break in single line	3	2	
			Too high pre- tensions		Break in single line	2	2	
			Anchor attachment loosens		Break in single line	3	2	
		Overload from net pen	Net pen is dimensioned differently than what the floater producer intended					
	3	Fracture of a part	Extreme current		Breakdown	2	3	Design
			Extreme wave		Breakdown	2	3	Design
			Overloading from extra equipment	Feed dispenser is not intended for extreme weather	Breakdown	3	3	Design
			Loss of buoyancy		Breakdown	2	3	Design
			Icing of marine fish farm		Breakdown	2	3	
			Fouling of floater					
			Wrong attachment of crowfeet		Breakdown	2	3	
			Wrong placing of crowfeet		Breakdown	2	3	
			Wrong design mooring		Breakdown	2	3	
	4	Fatigue	Wrong dimensioning of mooring		Breakdown	2	3	
			Not dimensioned for the event		Breakdown	2	3	
	5	Unforeseen mechanical process	Wrong placing of equipment		Breakdown	2	3	
	6	Overloading from	Wrong assembly of		Breakdown	2	3	

Main component	No	Undesirable event: (how)	Causes: (why)	Underlying causes:	Impact: (type damage/ loss)	Risk analysis: Frequ. (1-4)	Risk analysis: Impact (1-4)	Suggested measure:
		extra equipment	equipment					
			Assembly of stretching system without the floater producer taking this into consideration					
	7	Collision	Placing of the marine fish farm		Breakdown	2	3	Placing of the marine fish farm in relation to the existing environment
Net pen	1	Wrong dimensioning	Erroneous environmental data	Erroneous wave date	Breakdown	2	3/4	Quality assurance of site surveys
				Erroneous current data	Breakdown	2	3	Quality assurance of site surveys
				Wrong main directions	Breakdown	2	3	Quality assurance of site surveys
				Erroneous calculation methodology (Hs, V, x, y)	Breakdown	2	3	Quality assurance of site surveys
			Empirical, not theoretical knowledge of forces					
			Erroneous methodology for calculation of strength	Isolated forces / ideal directions	Breakdown	2	3/4	Establish one analysis methodology for load
				No accelerations in the path of forces	Breakdown	2	3	Establish one analysis methodology for load
				Wrong material parameters	Breakdown	2	3	Correct reading of tables
			Increased load	Heavy fouling	Breakdown	2	3/4	Routine inspection
				Dead fish in net pen	Breakdown	2	3	Routine inspection
				Icing of marine fish farm	Breakdown	2	3	Routine inspection
			Wrong safety factors		Breakdown	2	3/4	
			Larger loads than known knowledge		Breakdown	2	3/4	Connected analyses with interaction forces
			Unforeseen load		Breakdown	2	3/4	
	2	Interaction effects between floater and net pen						
	3	Interaction effects between net pen and stretching system						

Main component	No	**Undesirable event: (how)**	**Causes: (why)**	Underlying causes:	**Impact: (type damage/ loss)**	**Risk analysis: Frequ. (1-4)**	**Risk analysis: Impact (1-4)**	**Suggested measure:**
	4	Chafing and wear against other parts and equipment	Wrong stretching attachment		Tear in net pen	3	2	
			Wrong assembly of equipment		Tear in net pen	3	2	
			Weight on the inside of the net pen					
			Bad design of dead fish collecting system					
			Possible contact with other parts by unequal load / contact with mooring	Wrong force from the stretching system / wrong mooring	Large rip in net pen	2	3	
			Chafing from stretching rope, chain, lifting rope, crowfeet					
			Wrong assembly of net pen		Tear in net pen	3	2	
	5	Tear due to handling before and during setting out in sea	Transport					
			Handling of net pen in cage					
	6	Predators gnaw tear (seal,cod etc.)	Dead fish in scoop	Lack of strength of net pen in exposed areas	Tear in net pen	3	2	
			Dead fish in folds of net pen	Lack of stretching of net pen				
	7	Wrong handling	Wrong construction of net pen		Tear in net pen	2	3	
			Too powerful machinery / equipment		Tear in net pen	2	3	
			Bad marking of net pen		Tear in net pen	2	3	
			Lack of operational routines					
			Wrong procedures for changing of net pen , delivery, drying / disinfection of net pen					
			Wrong procedure/training		Tear in net pen	2	3	

Main component	No	Undesirable event: (how)	Causes: (why)	Underlying causes:	Impact: (type damage/ loss)	Risk analysis: Frequ. (1-4)	Impact (1-4)	Suggested measure:
	8	Wrong attachment / assembly of net pen	Defective construction of net pen		Tear in net pen	2	3	
			Bad marking of net pen		Tear in net pen	2	3	Standard marking of net pen, attachments points and lifting ropes
			Bad user handbook from the producer	Lack of knowledge on the part of the producer	Breakdown of net pen	2	3	
			Wrong procedure / training		Tear in net pen	2	3	Training of new boat operators, awareness concerning danger of escape
	9	Damage due to contact with boat propeller	Wrong boat handling		Tear in net pen	2	3	
			Wrongly dimensioned stretching system					
			Comes alongside on the leeside of current			2	3	
	10	Fouling	Forces caused by normal fouling are not included	No user handb ook / follow-up of marine fish farms				
	11	Damage to net pen due to flotsam in the sea	Objects that are floating in the sea	Storms have thrown trees into the sea or broken up ice	Tear in net pen	2	2/3	Regular inspections of net pen to find tears/rips in the net pen , especially after storms and breaking up of ice
	12	Too great forces transferred to net	Shrinkage of net	Handling of a too narrow net pen is difficult	Tear in net pen	2	2/3	Requirement in Standard regarding shrinkage of net
			Wrong design / construction of net pen			2	2	
	13	Lack of inspection and maintenance						
	14	Icing						

Main component	No	Undesirable event: (how)	Causes: (why)	Underlying causes:	Impact: (type damage/ loss)	Risk analysis:		Suggested measure:
						Frequ. (1-4)	Impact (1-4)	
Rafts	1	Breaking away from mooring	Wrong dimension of mooring			2	3	
			Chafing / rust of mooring part	Chain and concrete together makes the chain rust		2	3	
	2	Failure in dimensioning	Erroneous environmental date					
			No strength requirement					
			No stability requirements					
	3	Raft sinks and takes the rest of the marine fish farm with it	Raft splits / rusts and takes in water					
			Raft capsizes and takes in water	Wrong loading				
				Ice and snow		2	3	

Annex G (informative)
Appropriate principles for buoys

Buoys are used which are dimensioned to tolerate submerging at maximum load on the mooring lines. Minimum breaking strength shall be stated.

NOTE 1 On most mooring lines buoys are used to provide extra buoyancy in order to avoid submerging of the floating collar and to provide the mooring line with greater stability. Pressure capacity, i.e. the ability to tolerate submerging, varies from buoy type to buoy type. The capacity depends on the type of filling material.

The following can be satisfied:

- The body of the buoy provides protection for the buoyancy material against external influences such as ice, flotsam, boats, etc. The body of the buoy can be made of steel, aluminium, thermoplastic or reinforced thermoset plastic;
- Thermoplastics shall tolerate a dartdrop test of 15 Joule per millimetre thickness, with a ball diameter of 24 mm. Testing is performed at –20 °C, without causing cracks in the material;
- Steel parts which are used in the mountings of the buoy, can be hot dipped with a minimum average thickness of 120 µm;
- The main component of the buoy mountings should tolerate a breaking load of 10 times buoyancy;
- The buoy should not be included as an element in the mooring line itself;
- Buoys which delineate the fish farm installation from the area of right of way, shall be coloured in offshore yellow.

Buoyancy material used in fish farm buoys:

- The buoyancy material which is the filling of the buoy can be air, EPS (expanded polystyrene), PU foam (hardened polyurethane foam) or PVC foam;
- Air-filled buoys should only be used where the buoy is not a necessary part of the function of the mooring;
- PU foam should only be used in buoys that are completely sealed;
- EPS and PVC foam should be used in buoys where water can come into direct contact with the buoyancy material;
- EPS has a volume reduction (buoyancy reduction) of max. 8 % of submerged volume. PVC foam has a volume reduction of < 2 % in the case of permanent use;
- The density of EPS foam should be > 25kg/m^3. The foam should tolerate submersion to 5mVs.

Annex H (informative)
Method of calculation of forced deformations of hinged steel installations

The following method of calculation can be used for hinged steel installations:

For hinged installations, marine fish farms which consist of double main, outrigger and intermediate pontoons / bridges, a characteristic shear deformation shall be used for a sea state Hs, between 1 and 3 metres:

$$dh_{char} = 0,011L_p$$

where

L_p is characteristic peak length,

$L_p = 1.57 \cdot T_{p2}$, is a peak period in the range.

For cage systems consisting of single cages in a line, the largest shear deformation for outriggers and intermediate bridges is calculated as:

$$dh = \frac{dh_{char}}{4}$$

This is forced shear deformation over two bridge lengths including any deformation in hinges.

For cage systems consisting of double lines of cages, i.e. with a central middle pontoon the characteristic deformation, dh char, is increased as a function of the number of longitudinal cages as:

$$dh_{char,N\,cages} = dh_{char,Icage} \cdot N^{0,4}{}_{cages}$$

Forced shear deformation over 2 elements is thus stated as:

$$dh = \frac{dh_{char}}{2}$$

Annex I (informative)
Information on hydrogen embrittlement and stress corrosion in connection with galvanising of chains and other steel components

(Scientific contribution from the Directorate of Fisheries by Force Technology Norway regarding fractures in chains at fish farms.)

Summary

This report attempts to clarify circumstances surrounding chain material and failure mechanisms in the event of breaks in the chain.

Probable failure mechanisms are;

1) Erroneous heat treatment which results in a material that is too brittle/hard.
2) Unfavourable chemical composition. For example, too much carbon will result in a material that can be very brittle in the event of erroneous heat treatment.
3) Cold cracking created during forming of the chain at too low temperatures.
4) Hydrogen embrittlement, HE, as a result of pickling /acid treatment before galvanising.
5) ISC (Hydrogen induced stress cracking) as a result of hydrogen from cathodic protection (galvanising, for example).

In order to avoid damage as a result of items 1 – 3 it is necessary to set higher demands regarding producers and their certificates. It is important to receive documentation that the chemical components are within the limits set for them, and that the heat treatment has been carried out properly. This is paramount to obtaining a material with the characteristics one shall in fact have. It is important to ask the producer to present his procedures and routines so that any errors made can be detected, and so that an acceptance inspection can be performed of chain consignments that are received. Do not purchase chain from a producer who cannot document his production methods.

Concerning items 4 and 5, prevention is the only expedient course. In order to avoid hydrogen penetration during acid treatment, HE, a low hydrogen development must be ensured, or the hydrogen can be "baked" out in subsequent heat treatment.

If carbon steel is to be utilised under water with cathodic protection (galvanising) and one wishes to avoid HISC, it must be ensured that the material has a stress limit of under 550 MPa and that the hardness under no circumstances exceeds 350HV. It is preferable if the steel has a hardness of under 22 Rockwell/237 Brinell/248HV. It is important to also check the hardness in the welding seams, here also with 350HV as an absolute upper limit.

If it is necessary to use steel with a hardness and/or stress limit over the limits stated above, cathodic protection cannot be done. The alternative is to lay en extra corrosion layer of steel, 0.1 – 0.2 mm for each year that the chain is to be protected.

It is recommended to test load the chains to 62.5% of the breaking load since the chains will certainly experience such load during their useful life. It is important to do this after galvanising so that one can test the final strength of each chain link, since a chain is only as strong as its weakest link. In addition, hardness and minimum impact resistance must be verified through Vicker's hardness test and the Charpy test respectively.

Annex J (informative)
Conversion to sizes of hexagonal mesh

Table J.1 can be used for conversion from square mesh to regular hexagonal mesh

Table J.1: Conversion table for mesh side and mesh size from square mesh to hexagonal mesh, assuming the same mesh opening and twine thickness

Square mesh (S net)		Hexagonal mesh (H net)		
mesh side mm	mesh lenght mm	mesh side mm	mesh lenght mm	mesh width mm
42,0	84,0	28,0	112,0	56,0
40,0	80,0	26,7	106,7	53,3
39,0	78,0	26,0	104,0	52,0
38,0	76,0	25,3	101,3	50,7
37,0	74,0	24,7	98,7	49,3
36,0	72,0	24,0	96,0	48,0
35,0	70,0	23,3	93,3	46,7
34,0	68,0	22,7	90,7	45,3
33,0	66,0	22,0	88,0	44,0
31,0	62,0	20,7	82,7	41,3
30,0	60,0	20,0	80,0	40,0
28,5	57,0	19,0	76,0	38,0
27,0	54,0	18,0	72,0	36,0
26,0	52,0	17,3	69,3	34,7
25,0	50,0	16,7	66,7	33,3
24,0	48,0	16,0	64,0	32,0
23,0	46,0	15,3	61,3	30,7
22,5	45,0	15,0	60,0	30,0
22,0	44,0	14,7	58,7	29,3
21,0	42,0	14,0	56,0	28,0
20,0	40,0	13,3	53,3	26,7
19,5	39,0	13,0	52,0	26,0
18,5	37,0	12,3	49,3	24,7
17,5	35,0	11,7	46,7	23,3
16,5	33,0	11,0	44,0	22,0
15,5	31,0	10,3	41,3	20,7
15,0	30,0	10,0	40,0	20,0
14,0	28,0	9,3	37,3	18,7
13,0	26,0	8,7	34,7	17,3
12,5	25,0	8,3	33,3	16,7
12,0	24,0	8,0	32,0	16,0

Square mesh (S net)		Hexagonal mesh (H net)		
mesh side mm	mesh lenght mm	mesh side mm	mesh lenght mm	mesh width mm
11,5	23,0	7,7	30,7	15,3
11,0	22,0	7,3	29,3	14,7
10,5	21,0	7,0	28,0	14,0
10,0	20,0	6,7	26,7	13,3
9,75	19,5	6,5	26,0	13,0
9,5	19,0	6,3	25,3	12,7
9,25	18,5	6,2	24,7	12,3
9,0	18,0	6,0	24,0	12,0
8,75	17,5	5,8	23,3	11,7
8,5	17,0	5,7	22,7	11,3
8,0	16,0	5,3	21,3	10,7
7,75	15,5	5,2	20,7	10,3
7,5	15,0	5,0	20,0	10,0
7,0	14,0	4,7	18,7	9,3

Annex K (informative)
Requirement for further research and development

K.1 Environmental provision on current and wind based on measurements

At many locations along the Norwegian coast, the current varies so much over a yearly cycle that one can risk underdimensioning the current load significantly. Scientific documentation is required here.

K.2 Exemplification with the aid of calculated cases

The practical effect of parametric choice in the form of calculated examples cases should be documented.

K.3 Review and supplementary calculation of breakdown

To make a supplementary calculation of a breakdown case will provide useful information that the fish farming industry has built in the correct priorities in order to avoid large escape occurrences.

K.4 Review of safety factors, flexible/less flexible structures

The safety factors in dimensioning should be able to be supported by empirical data.

K.5 Dimensioning limit states

It is important to perform a critical evaluation of which limit states are to be given priority. This is to avoid an extensive verification which will possibly be very resource-intensive.

K.6 Wave and current loads on the net pen . Categorisation

There is no documented scientific connection between current and wave loads on the net pen and choice of dimension classes.

K.7 Reduction of net volume as a function of current velocity

It should be sought to find out how the volume of a net pen changes in relation to the forces imposed by various current velocities.

K.8 Stretching system, loads on net and rope as well as establishment of dimension class

It should be sought to find out how the stretching system affects the requirements for strength on the net twine and rope as well as establishment of dimension class.

K.9 Stability, safety and mooring of feed rafts in high seas

The requirements regarding stability are in no manner synchronised with the degree of exposure of feed rafts, i.e. the danger of water washing over, relative movements etc., is dependent on the degree of exposure.

K.10 Operation of wellboat and workboat in the vicinity of ropes and nets

A review of dangerous operations, i.e. maximum use of thrusters in the vicinity of net pens or ropes, is of great importance for prevention of escape.

K.11 Expected icing volume per 24-hour period or equivalent

Expected icing volume per 24-hour period or equivalent should be explained and be included in guidelines / assessments.

K.12 Method for calculation of dimension class in relation to net design

It should be sought to find a better basis for establishing dimension class for a net pen on the background of net design (i.e. cone shaped net or cylindrical shaped net).

K.13 Design and choice of material connected to net pens

It should be sought to find a set of tables for design of net pens, based on calculations and new developments instead of experiences from the "old industrial standard" (empirical design).

K.14 Knowledge of long-link, galvanised chain

Obtain more knowledge of long-link, galvanised chain for use in the fish farming industry. There is a necessity for a documented, scientific basis as supporting documentation for establishment of specific requirements and description of suitable testing methods which reflect the actual use, and the forces chains are exposed to in a fish farming context. I.e., not only stretch testing in relation to breaking. This will entail methodology development.

Literature

Det norske Veritas:	DNV OS-E301
Directorate of Fisheries:	Force Technology report. Breaks in chains in fish farming installations MAIN REPORT August 2009

- Norsk Standard og guider fastsettes av Standard Norge. Andre dokumenter fra Standard Norge som tekniske spesifikasjoner og workshopavtaler publiseres etter ferdigstilling uten formell fastsetting.

- Dette dokumentet er utgitt i samarbeid mellom Standard Norge og Standard Online AS.

- Standard Norge kan gi opplysninger om innholdet i dokumentet og svare på faglige spørsmål. Mer informasjon om standardisering finnes på www.standard.no.

- Inntektene fra salg av standarder som Standard Online AS står for, utgjør en stor og avgjørende del av finansieringen av standardiseringsarbeidet i Norge.

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January 15th, 2016

Grieg NL Seafarms Ltd.
P.O. Box 457
205 McGettigan Blvd.
A0E 2M0

Attn: Mr. Knut Skeidsvoll, General Manager

Dear Mr. Skeidsvoll:

STERILE, TRIPLOID ATLANTIC SALMON OVA. QUALITY AND PRODUCTION INFORMATION

Benchmark Breeding and Genetics (BBG) is the breeding division of the company Benchmark Holdings Plc. The division was established by the double acquisition of the Icelandic company Stofnfiskur and the Norwegian company SalmoBreed in December 2014. Later, in August 2015 BBG bought Akvaforsk genetic centre (AFGC) which further strengthens the breeding work both in Atlantic salmon, but also a range of fish breeding across many aquaculture species. Both companies have a long history in the breeding of Atlantic salmon. The breeding company Stofnfiskur was established in 1991 and SalmoBreed was established in 2000 with their breeding programs.

Both company's strains consist of several highly regarded strains of Atlantic salmon that merged into the program, so both strains has roots from the beginning of Atlantic salmon breeding Stofnfiskur got the stock from several imports of ova from Norway in the 1980's which were reared on several locations in Iceland. SalmoBreed consists of a merger between the highly regarded "Bolaks" and "Jakta" strains of salmon. Today, and combined, the BBG has over 1500 families of Atlantic salmon at any given time in our systems (500 families*3 year generation time).

In the breeding work, the aim has been to restrict inbreeding while selecting for several traits of importance to salmon farmers simultaneously in the breeding index. Different test groups are made for different tests to have valuable data input to the breeding calculations. Today we test families for sea lice, yield (filet quality, texture, color, filet size etc), different challenge test (SRS, PDV, IPNV, ISAV) to provide a broad background on the genetic material we work with. Lately, BBG has also implemented Genomic selection to further accelerate the speed of genetic gain.

SalmoBreed has a traditional production in open systems in sea with plans on building a land based closed facility from ova to ova. This exists already in the production of Stofnfiskur which allows the company to produce ova every week all year around. Furthermore, the water from the geothermal boreholes gives a great flexibility in production and a high degree of biosecurity.

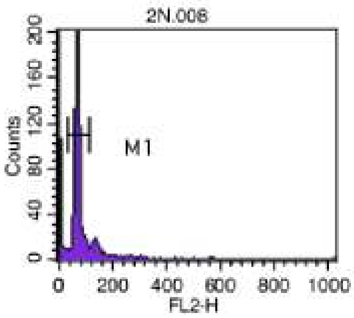
BBG delivers sterile salmon to the market today by using the triploidisation method. Stofnfiskur has from early on seen the need for sterile triploid salmon and has placed resources into standardising their protocols. The pressure device today is developed in-house by a group of specialists and the triploid ova are originating from the same genetic material as used for the diploid production. The ova in our triploid production come from females from the best multiplier individuals and the best family males in order to maintain a high ova triploid quality. On the fertilising line in the incubation is mounted a pressure chamber where the groups who are assigned for triploid are made triploid and then incubated. The pressure method is a standardised method on time, temperature and pressure.

The use of triploid salmonids in aquaculture provides a method of avoiding the problems associated with sexual maturation, reducing the possible genetic interaction with wild fish. The goal of triploidy induction is to produce sterile individuals, which can be used in commercial aquaculture to avoid loss of market value due to unwanted sexual maturation and minimize the risk of interbreeding of wild and farmed salmonids. Induced triploidy is a commercially acceptable method available for production of reproductively sterile salmonids for aquaculture. The production of non-maturing salmon has economic benefits for the aquaculture industry if precocious maturation before market size causes a problem.

Induction of triploidy occurs after the eggs are fertilized. Triploid fish have been produced by preventing the second polar body to pass out of the egg. In triploid fish two sets of chromosome are contributed by female and one set by male (2 N egg + 1N sperm = 3N). This procedure is most commonly accomplished through pressure shock on fertilized eggs. Triploidy induction in fish is commonly verified by taking a blood sample and analysing DNA content by flow cytometry.

The use of flow cytometry for measurement of cellular DNA content with high degree of resolution has in recent years been considered as a reliable and constant method. Individual ploidy investigations, eyed eggs or larvae is collected and stored deep-frozen (-80°C). For analysis, the larva is thawed and smashed by re-suspending up and down in 0.4 mL propidium iodide (PI) solution until the tissues is completely dissolved. PI binds to the cell's DNA that at the right wavelength it fluoresces. The samples are then passed through a 0.45µm filter. The DNA content of approximately 30 larvae per treatment and the same amount of larvae as control group was measured using a Becton Dickinson FACSCalibur TM (BD Biosciences, San Jose, CA, USA) flow cytometer.

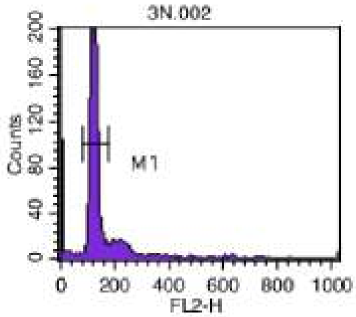
The analysis takes in account the cell population and the amount of fluorescence inside a single cell, we have to measure single cells in order to estimate the amount of DNA in diploid (2N) cells and compare it with the amount of DNA in the triploids (3N). We use the average value of the 20 – 30 control samples and we compare it with the values for the 3N samples. Sometimes due to poor preparation we are not able to obtain single clean cells and these can be misinterpreted in terms of ploidy, one can easily see when this happens in the flowcytometer, we call these samples Ambiguous although some do call these aneuploids.



File: 2N.008 Sample ID:

Mean	Geo Mean	CV
34.99	6.92	133.01
69.26	68.48	15.44

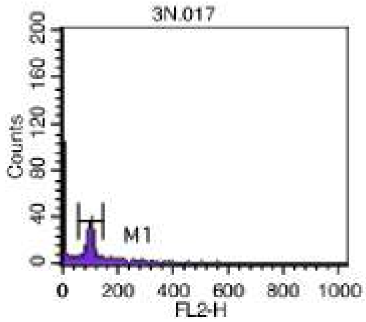
Control Diploid (2N)



File: 3N.002 Sample ID:

Mean	Geo Mean	CV
113.48	58.11	65.90
123.30	122.67	10.40

Triploid sample (3)



File: 3N.017 Sample ID:

Mean	Geo Mean	CV
9.31	1.50	364.46
98.89	97.67	15.40

Ambiguous sample

Figure 1. The fluorescence is proportional to the amount of DNA in a cell. Since diploid cells contain 2 sets of chromosomes (2N) and triploids contain three sets of chromosomes (3N), triploid cells have 1.5 times the DNA of diploid cells, and therefore more counts. Those samples that are ambiguous, fall out of range of both groups and cannot be used in the analysis as they lack the required accuracy.

For each group of triploid that we make we do provide a triploid certificate where the degree of triploids are shown. We have a very high degree of triploidisation and always 100% degree of sterile fish. The ambiguous fish will still be sterile and cannot reproduce as they have more than a normal genome.

The use of triploid salmon is not new technology, and quite some research is available in peer review journals and expert magazines on the growing of triploid fish in fresh water and seawater. Although there is much to read on growth, there is not so much research published on quality parameters in triploid salmon. On the basis of this, Stofnfiskur did a pilot study in evaluating quality parameters in triploid fish.

A total of 400 individuals where selected randomly from a group of triploids. They were pit tagged and reared among the diploid family fish. Evaluation in the family fish is for quality parameters in each year class. The triploid got no special treatment at any stage, except the pressure put on the ova at fertilization. The fish got the same feed, rearing temperature, light regime and handling as the diploids. These 400 individuals where divided randomly between the two breeding stations of Stofnfiskur. When the quality parameters where assessed in the families in one of the two breeding stations, the triploids where slaughtered, filleted and the fat and pigment assessed in the fillets. The results in table 1 are showing growth, deformities and maturation in breeding station 1.

	Diploid	Triploid	Total Group
Number of individuals	4659	163	4822
Mean of weight, Kg	3,4	3,4	3,4
Std.dev	1,1	0,9	1,1
External signs of maturation	395 (8.8%)	0%	398 (8.8%)
Deformity	77 (1.7%)	7 (3.4%)	84 (1.7%)

Table 1 Growth parameters in breeding station 1

In breeding station 1, there was minor additional deformity and no maturation in the triploid group. The growth was the same on diploids and triploids. The results displayed in table 2 are the results for the same traits measured in breeding station 2 as in breeding station 1.

	Diploid	Triploid	Total Group
Number of individuals	4928	146	5074
Mean of weight, Kg	3,3	2,9	3,3
Std.dev	0,97	0,79	0,96
External signs of maturation	229 (4.6%)	3 (2%)	232 (4.7%)
Deformity	56 (1.2%)	6 (4%)	62 (1.2%)

Table 2 Growth parameters in station 2

The quality parameters where measured in breeding station 1. The traits measured are fat percentage on averaged in the whole fillet measured using Near Infrared (NIR) machine, pigment, measured with machine using Visual spectra (VIS) to determine mg/kg of astaxanthine in the whole fillet and the last trait measured was filled yield, which is total fillet weight divided by weight of the whole fish. Result are in table 3.

	Diploid	Triploid	Total Group
Number of individuals	474	106	853
Mean of weight, Kg	4,8	4,7	4,8
Mean gutted weight, kg	4,4	4,4	4,4
Fillet %	0,6	0,7	0,6
Mean fat %	16,7	16,8	16,7
Mean colour mg/kg	7,0	7,0	7,0

Table 3 Quality parameters from breeding station 1

These preliminary results in table 3 show that there is no difference in the quality traits between the diploid and triploid fish.

A sterile/triploid salmon can escape from a farm the same way as its diploid counterparts. However, studies have shown that these fish do process a lower survival rate in nature than the diploids will. The triploid male may migrate up rivers, but if they do spawn there is no reproduction. Several studies also show that farm salmon does not handle the competition of the wild salmon at the spawning grounds. Thus we believe that an escaped sterile salmon imposes a minimal environmental concern.

Benchmark Breeding and Genetics has a high quality sterile salmon that has been well recognised by farmers and customers. In Norway alone we have so far delivered many millions of triploid ova with good feedback from customers. Although the product is of a superior quality, we always work to produce an even better sterile fish. Some of the aspects that are on our R&D plan are to study the early life stages of such fish to investigate the complete needs in these early phases. On board we have a feed supplier, University of Tromsø and Nofima.

We believe that the project of Grieg NL Seafarms Ltd. is a good production and look forward being an active partner and supplier of genetics as soon as the company has received their necessary licenses.

If you have any questions, do not hesitate to contact us.

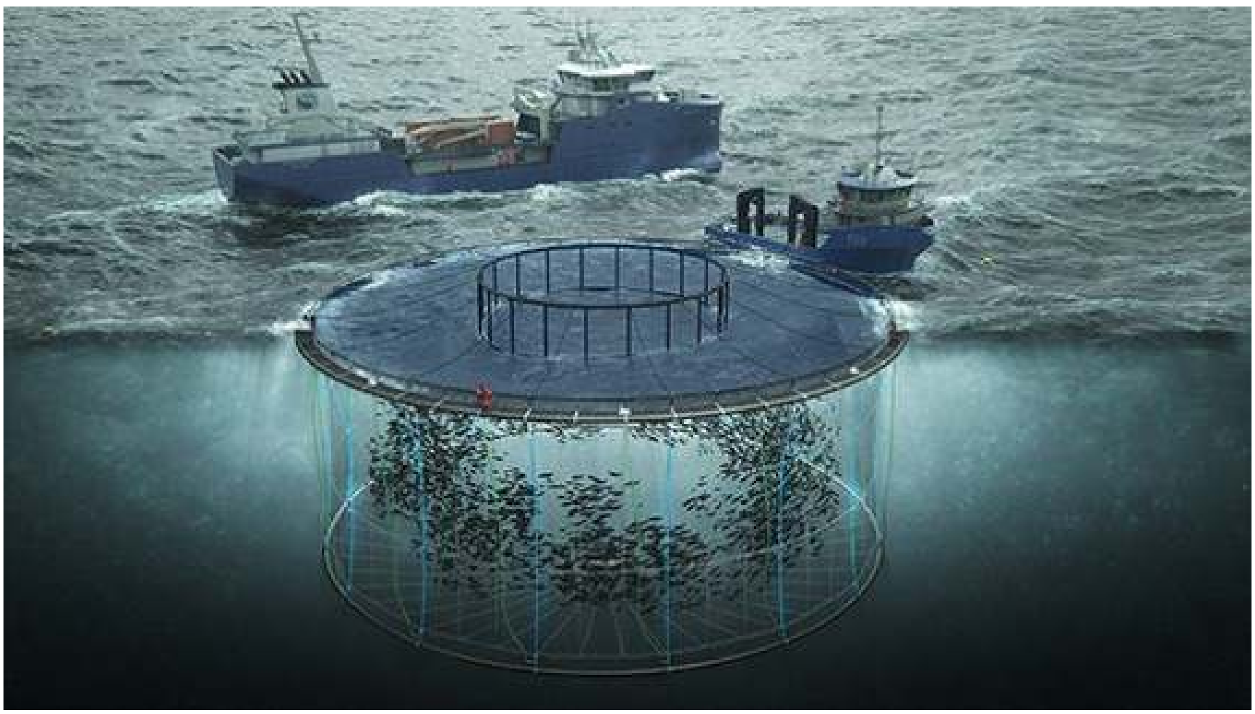
Best regards,

………………………………

Dr. Eduardo Rodriguez H.
Head of Functional Genomics
StofnFiskur

Rudi Ripman Seim
R&D and Technical Manager
SalmoBreed

PLACENTIA BAY MANAGEMENT PLAN



January 28th, 2016

Background

Grieg NL Seafarms Ltd. is owned Grieg Newfoundland Salmon Ltd. Grieg Newfoundland Salmon Ltd. is owned by the Norwegian company Grieg Newfoundland AS. Grieg NL Seafarms was formed to establish a fish farming operation on the south east coast of Newfoundland with a principle base in Marystown. Freshwater operations are under Grieg NL Nurseries Ltd. and are located in Marystown. Marine operations under Grieg NL Seafarms would span the Placentia Bay coastline with four Bay Management Areas (BMA's) from Long Harbour (Brine Island and Iona Islands) in the east and Merasheen (Valen Island, Chambers Island and Ship Island), and Red Island (Darby Harbour, Red Island, and Butler Island) in the central part of the Bay to Rushoon (Oderin Island, Gallows Harbour, and Long Island) in the west. This region of Placentia Bay encompasses nearly 250,000 hectares. Grieg operations entail licensing leases for up to 2,000 hectares. Cage area for production is 23 hectares and less than 0.01% of the region. The Production on a yearly basis will include stocking 1,800,000 smolt of Atlantic salmon (Salmo salar) 300 grams in May, 2,400,000 smolt of Atlantic salmon (Salmo salar) 450 grams in July, 1,800,000 at 600 grams in October for full cycle production and 1,000,000 smolt at 1,500 grams in April for a seasonal production. Output of live biomass once peak production is achieved is estimated at 33,000 Metric Tonnes live weight.

Fundamentals of the Production Plan and Driving Strategies

Grieg NL Seafarms, inclusive with various sister companies and subsidiaries, will integrate the entire operation: returning maximum value to the company from all stages of the production; and, managing risk with the best techniques known by the aquaculture industry from a global perspective. The Grieg companies in Newfoundland will use state of the art equipment at all phases of the production enhancing every aspect of sustainable production of salmon farming. These will include but are not limited to the following:

- Using triploid eggs – this provides access to world class commercial broodstock/egg supplier(s) and thus eliminating possibilities of shortness of egg supply. The sterile salmon provide other benefits as well including 100% reduction of risk to local wild stock should they escape;

- Using a state of the art AquaMaof RAS system – this provides for a number of enhancements to sustainability including:
    - Cost effective operations and smolt production by using gravity based internal flows. 100 % recirculation reducing water

chemistry management costs and pumping costs. Providing for a saline environment in the final stages to maintain the smoltification window and eliminate smolt regression;

  - Using a unique oxygen dissolving system (ODS) with a vacuum oxygen generator for provision of ultra-low cost oxygen;
  - Increased production flexibility of smolt size and times for entering the sea;
  - Reducing significantly growth time in the sea/cages and further reducing exposure to risk of diseases, sea lice and other parasites and escapes;

- Programmed production will enable the company to supply market year round with fresh product;

- Using of modern wellboats for transport of both smolt and live harvest salmon. This will provide for minimal handling of fish from the hatchery to the marine sites and live hauling of harvest fish to the plant. The live hauling of live fish to the plant ensures that there is no accidental blood spillage at sea. The live fish at the processing plant permits control of fish temperature and lactic acid management. Swimming to the processing line for humane slaughtering (concussion stunning) without struggle (temperature control). Processing immediately and before rigor sets in and full value added to all production where possible with an aim towards 100%;

- Using holding tanks on land at the processing facility for live salmon will give the processing plant flexibility for timing and temperature control of production as well as enabling to a 100% pre rigor production (increasing shelf life); hence, a significant improvement in quality and value for all concerned;

- The processing plant will provide for complete utilization of all fish products including offal, heads, bones, and trimmings. The processing of this raw material will be for established markets for fish oils, fish protein and calcium;

- All value from the salmon will be created and processed in Newfoundland. This provides a great economic benefit both to the company and as well as to the province of Newfoundland by keeping the employment available in the production in the Province.

Production philosophy:

Freshwater: (Grieg NL Nurseries Ltd.)

Technical production of Atlantic salmon smolt will include adaptation of an AquaMaof system that will feature 100% reuse and recirculation of water and complete digestion of all organic inputs at 98.5%. This is an adaptation of new technology for the expressed purpose of producing very large smolt at low energy costs and low environmental impacts. Large smolts are desired because Newfoundland has a limited number of degree units for growth at around 2500 whereas 5000 are required for 50 grams to 5000 grams (market size) of growth. Large smolt eliminate mesh swim through at entry over minimum size introductions. Transfer of smolt will eliminate as many steps and as much time as possible with a plan for direct transfer to the Wellboat from the hatchery and then directly to the site. Marystown has a suitable basalt type aquifer providing 1,200 litres per minute of pristine groundwater with suitable chemistry – day to day use of water will be a fraction of this at 150 to 300 litres per minute.

Marine: (Grieg NL Seafarms Ltd.)

Marine production will be based on the adaptation of the principle of the Norwegian "green" license philosophy to Canadian environs and also the application of the Newfoundland Code of Containment. This will include access to broodstock with consistent availability and consistent growth and conformation.

The salmon will be sterile triploid to alleviate all risk of genetic interaction with local salmon stocks in the event of escapement. All containment systems will be engineered specifically to manage escapement risk to provide a second layer of protection.

Sea lice will be managed using lumpfish (*Cyclopterus lumpus*) at 15 fish per 100 smolt. They require continuously clean nets to be effective. This will be a very significant transfer of Norwegian technology and pest management tools.

The intention is to use Aqualine's "escape proofed" systems including Midgard for nets, cages and moorings. This will involve using new materials such as Dyneema over nylon for nets and design to avoid contact with net anchors and hydraulic steady lifting. This in turn delivers a net that limits fouling and is more conducive to in situ cleaning which also reduces the opportunity for escape events proportionally. Nets will typically be 43 meters at the center – significantly deeper than typical nets in use in the region (15 meters). This will provide 70,000 M^3 of space per cage and providing a terminal stocking density of 11.8 kg/M^3.

The cages themselves will be Aqualine 160 meters circumference with working platforms on the pontoons. These nets and cages are entirely a new technology transfer from Norway that will provide for a much safer working environment for the workers on the cage and a more humane space for the fish to grow.

Mooring frames or grids will be Aqualine designed for off shore conditions. Compensation buoys on the frames will be 4000 liters at 400% the current industry standard. The plough anchors will be 5 MT with 100 MT of holding power each; there will be 1 at each side node and 2 at end nodes with combined holding power at a minimum of 200 MT.

Mortality removal will be done daily via a lift-up pumping system. This is a significant improvement over the current Standard Operating Practice (SOP) whereby mortalities are removed only on a weekly basis and only by diver. The current system provides for opportunities to increase bacterial load and risk and the divers provide for significant vectors of risk transfer. All mortalities will be ensilaged with 3% by weight of formic acid to reduce all infectious and spoilage agents on site.

The current depth requirement in the region is 30 meters and the farms in proposal here will be mostly in waters deeper than 60 meters with the majority of the sites in 100 meters and greater. This ensures that benthic impacts are minimized.

The current standard for site separation is 1000 meters and the planned production will increase this twofold in the majority of cases.

Economies of scale are created on the size and volume of cages, nets, and moorings by approximately 200% above the current SOP in use in the region.

Feed used will contain significant marine ingredients to maximize flesh levels of omega 3 fatty acids to the benefit of the health of the fish and the subsequent benefit of the consumers of the product. This will be accomplished with the use of algae and fish waste by-products of the traditional fishery to the extent that FIFO (Fish In - Fish Out) is reduced to 1:1 – a goal of sustainable production.

There will be 11 sites with approximately 200 hectares each. Each site will be licensed as separate entities under Grieg NL Seafarms Ltd.

Grieg NL Seafarms will manage the production areas under its farming control. There will be three full cycle management areas of Rushoon, Merasheen, and Red Island. All sites in the full cycle management areas will have the capacity for twelve 160 meter cages and nets with a depth of 43 meters. The fish capacity at each site will be stated at 2,000,000 smolt. Fish entry will be at a minimum of 300 grams average to ensure that there is no swim-through on a mesh of 35 mm (the smolt size as entered by average weight encompasses a bell curve of sizes from smaller to larger. By utilizing the much larger smolt the possibility of entering a fish so small on the bell curve of size that it can pass through the mesh is eliminated). The final capacity at each site may vary below this as the production experience progresses and each site's limits are defined. Entry of the fish to the site is targeted for May, July and October; this staggering is done to manage supplies to the market year round. The company will only gradually build to the expected capacity to ensure limits are not exceeded that would be detrimental to the welfare of the fish. In each full cycle management area there will be three sites as follows:

- Rushoon
    - Oderin Island Farms Ltd.
    - Gallows Island Farms Ltd.
    - Long Island Farms Ltd.
- Merasheen
    - Valen Island Farms Ltd.
    - Chambers Island Farms Ltd.
    - Ship Island Farms Ltd.
- Red Island
    - Red Island Farms Ltd.
    - Darby Harbour Farms Ltd.
    - Butler Island Farms Ltd.

There will be one seasonal management area by Long Harbour with two sites Iona Island Farms Ltd. and Brine Island Farms Ltd. These are 1,000,000 fish sites that will enter at 1,500 grams in the spring as soon as temperatures start to rebound from the winter; this is expected to be towards the end of April or early in May of each year. This production will be harvested in December and January.

The Rushoon management area will use Baine Harbour and Petit Forte as inflow mustering points for supplies and personnel. The Merasheen management area will use North Harbour and Arnold's Cove as its inflow mustering area. The Red Island and Long Harbour management areas will use Long Harbour. The following principles will guide operational procedures with the various management areas:

- All operational procedures will have Standard Operating Practices (SOPs) written for an Operational Manual for the company. These SOPs will be vetted through the Province's Aquatic Animal Health Division (AAHD). These SOPs will contain the minutiae of detail for each procedure and all aspects of biosecurity related to it;

- Vessels assigned to specific management areas will not cross or enter other management areas;

- No equipment, vessels or employees will travel from one management area to another without following proper biosecurity procedures and SOPs for cleaning and disinfection;

- The feed delivery vessel will not contact the feed barge but will transfer the feed via a coupling. The feed delivery vessel will not travel from one management area to another without having been first brought back to its docking station and pass through procedures of a biosecurity SOP of cleaning and disinfection;

- The well boat will be dedicated to either harvesting operations or other outflow activities. If the well boat is to be used to deliver smolt or to be used in bath treatments, it will be passed through a biosecurity SOP of cleaning and disinfection;

- All mortalities will be collected daily via an air lifting system and ground and placed into silage with a 3% of formic acid by weight. All mortalities will be ensilaged on site so that no infectious material is accidently transported to other sites or management areas;

- Nets will be on a rotation of continuous in situ cleaning for provision of optimal water quality and animal welfare to the fish. The always clean nets also encourage proper feeding attention in cleaner fish. The nets will **not** have copper based antifoulant;

- All smolt entering the site will be disease free and will be vaccinated against *Vibrio anguilarum, ordalii,* and *salmonicida* as well as *Furunculosis salmonicida* in an oil based adjuvant;

- Cleaner fish such as lumpfish will be used for sea lice control. Vaccines as they become available and are sanctioned by Health Canada for deterrence of sea lice will also be used. Functional feeds will also be used to help manage sea lice. Only as a last resort will therapeutants be used to control sea lice. Animal welfare will not be compromised;

- Outflow activities will include harvest operations, removal of silage, and removal of nets or any equipment from the site;

- Inflow activities will include smolt, day to day site personal, entry of new nets or newly recertified nets, feed and any equipment intended for use at the site;

- All personnel entering the site will be controlled, monitored and documented; and,

- All vessels entering the site will be controlled, monitored and documented.

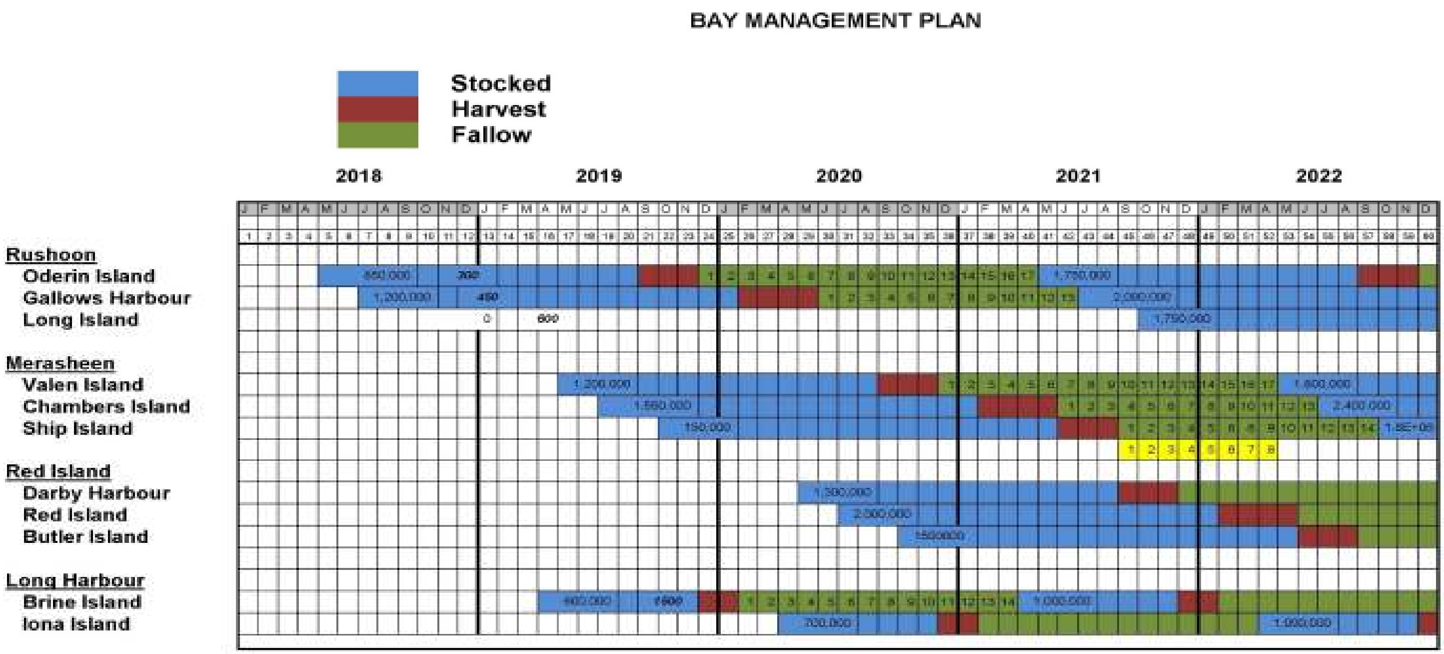
Processing:

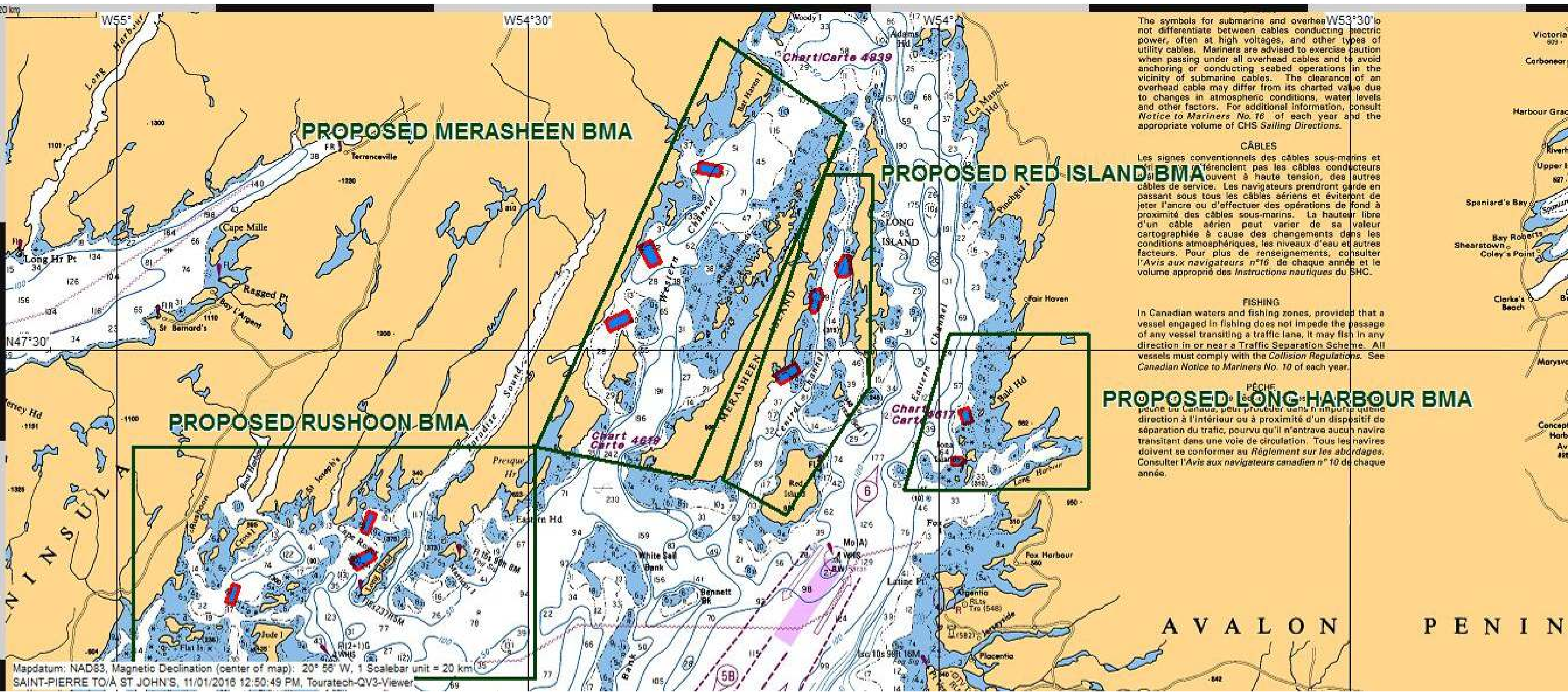
Harvest fish will be collected by the Wellboat and delivered live to the processing plants live holding system. From there the fish will swim into the humane stunning and bleeding system. The just in time arrival system permits a pre-rigour processing of all the salmon. Pre rigor has up to 4 days longer shelf life than traditional post rigor products which is crucial for the final buyer. In addition the products will only be handled once before hitting the market/buyers compared to past-rigor handling (2 - 4 days storing before processed, entering 2 or more geographical places for further processing before going to the market) which gives the production an unique quality and sales advantage compared to our completers. Loss of quality on the salmon starts immediately when the salmon comes out of rigor. Using pre rigor finalized products (fillets, loins and portions) also gives the production a significant saving on packing, ice and freight cost per unit of production as well as very positive environmental impacts due to less transport of non-human consumable products (heads, bones and skin). Processing will be done in partnership with an existing player in the Newfoundland processing industry.

Processing will take place well away from the salmon production areas at the north end of Placentia Bay and at St. Lawrence or some other similarly positioned community in the south of the productions BMAs. This is approximately 60 kilometers from the nearest site. Should there ever be an accidental failure with the blood water treatment system then the buffer of distance from the sites should be sufficient to reduce exposure to infectious agents or eliminate the risk entirely.

The company will implement a new way of handling deliveries of live salmon to the processing plant and introducing modern processing technology and pre rigor products. This gives a major increase in value for the company and offers the market a full week extra shelf life compared to what is available today.

The stocking, harvesting and fallowing plans are as follows:




PROPOSED MERASHEEN BMA
PROPOSED RED ISLAND BMA
PROPOSED LONG HARBOUR BMA
PROPOSED RUSHOON BMA
W55°
W54°30'
W54°
W53°30'
N47°30'
Chart/Carte 4839
Chart Carte 4619
Western Channel
MERASHEEN
LONG ISLAND
Eastern Channel
Red Island
Long Harbour
Bald Hd
Fair Haven
Fox Harbour
Placentia
Latine Pt
White Sail Bank
Bennett Bk
Eastern Hd
Presque Hr
Paradise Sound
Cape Mille
Ragged Pt
St Bernard's
Terrenceville
Long Hr Pt
AVALON PENIN
FISHING
In Canadian waters and fishing zones, provided that a vessel engaged in fishing does not impede the passage of any vessel transiting a traffic lane, it may fish in any direction in or near a Traffic Separation Scheme. All vessels must comply with the Collision Regulations. See Canadian Notice to Mariners No. 10 of each year.
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 56' W, 1 Scalebar unit = 20 km
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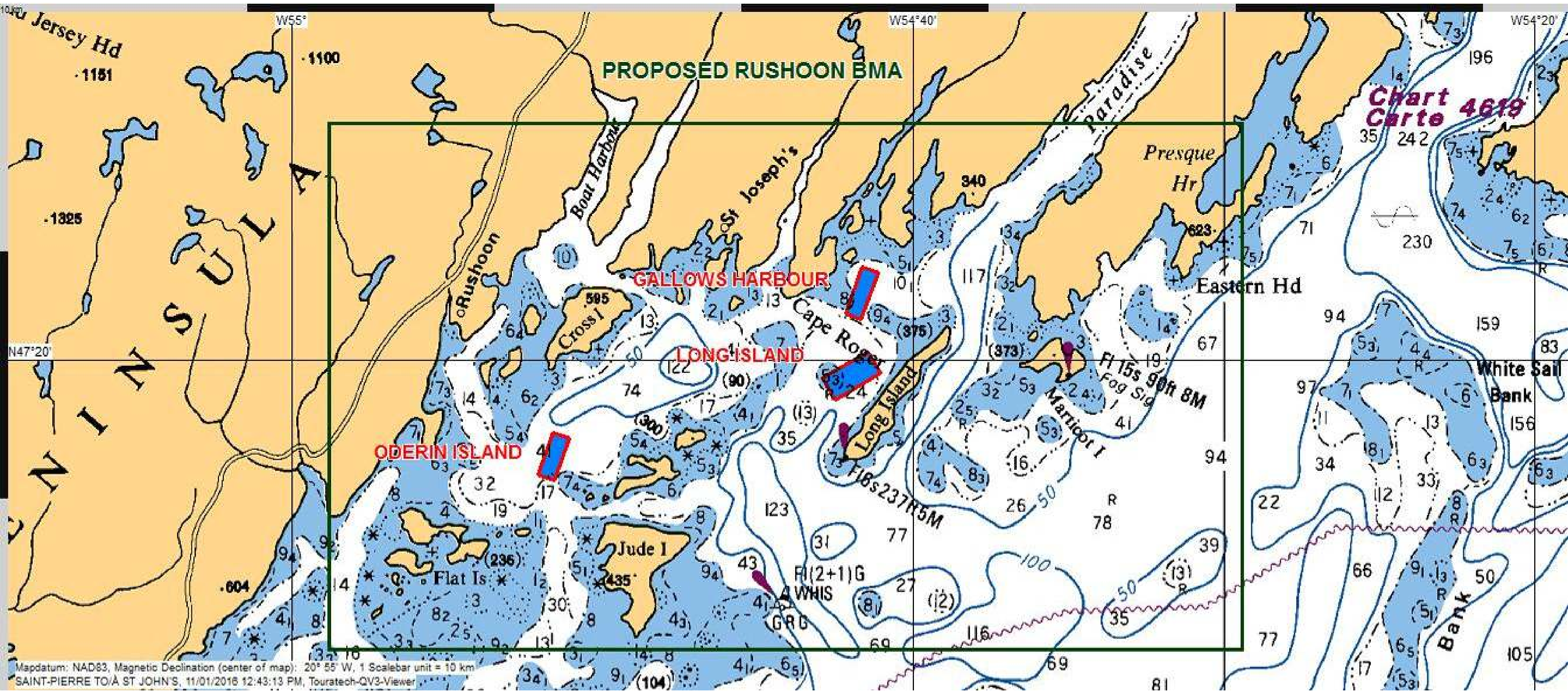
PROPOSED RUSHOON BMA
GALLOWS HARBOUR
LONG ISLAND
ODERIN ISLAND
Jersey Hd
PENINSULA
Rushoon
Boat Harbour
St Joseph's
Paradise
Presque Hr
Eastern Hd
Cross I
Cape Roger
Long Island
Marticot I
Flat Is
Jude I
White Sail Bank
Bank
Chart Carte 4619
Fl 15s 90ft 8M
Fog Sig
Fl 6s 237ft 5M
Fl(2+1)G
WHIS
GRG
W55°
W54°40'
W54°20'
N47°20'
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 55' W, 1 Scalebar unit = 10 km
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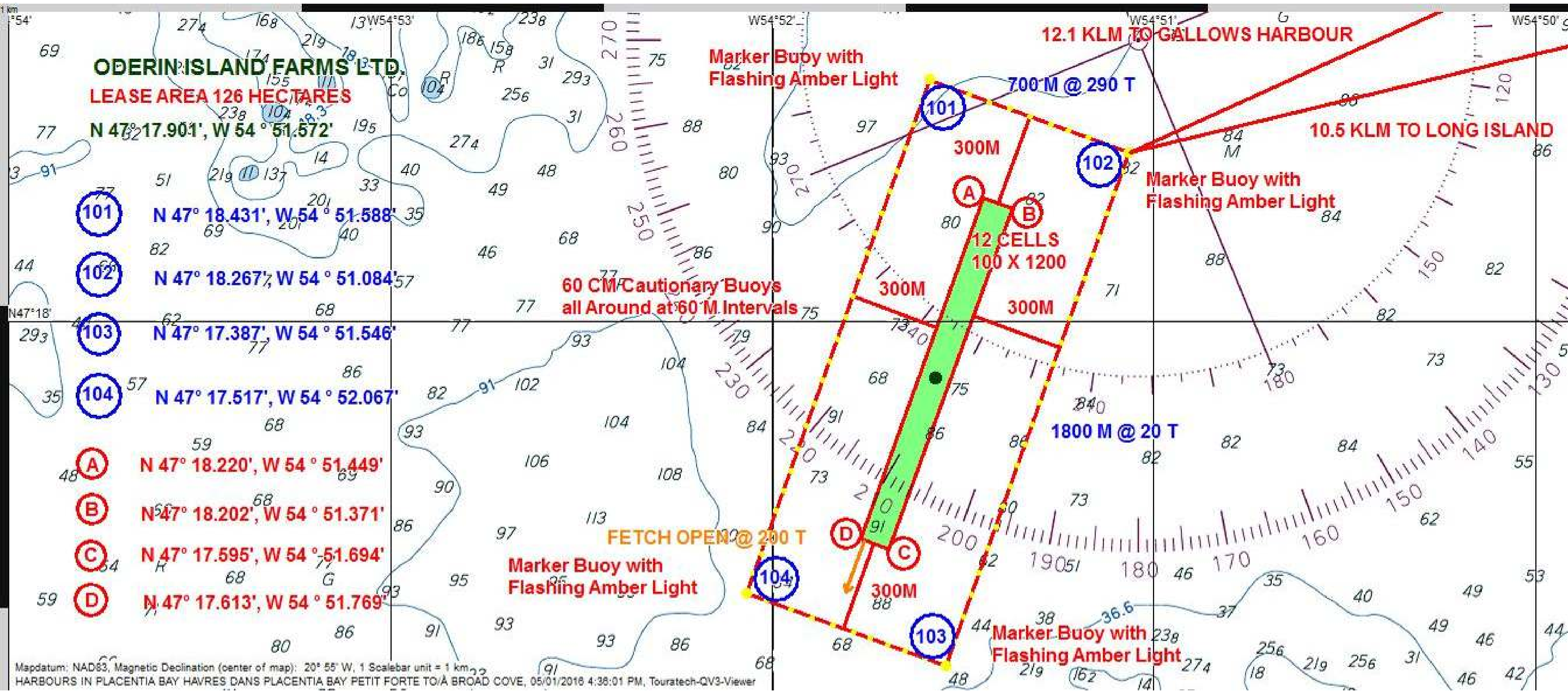
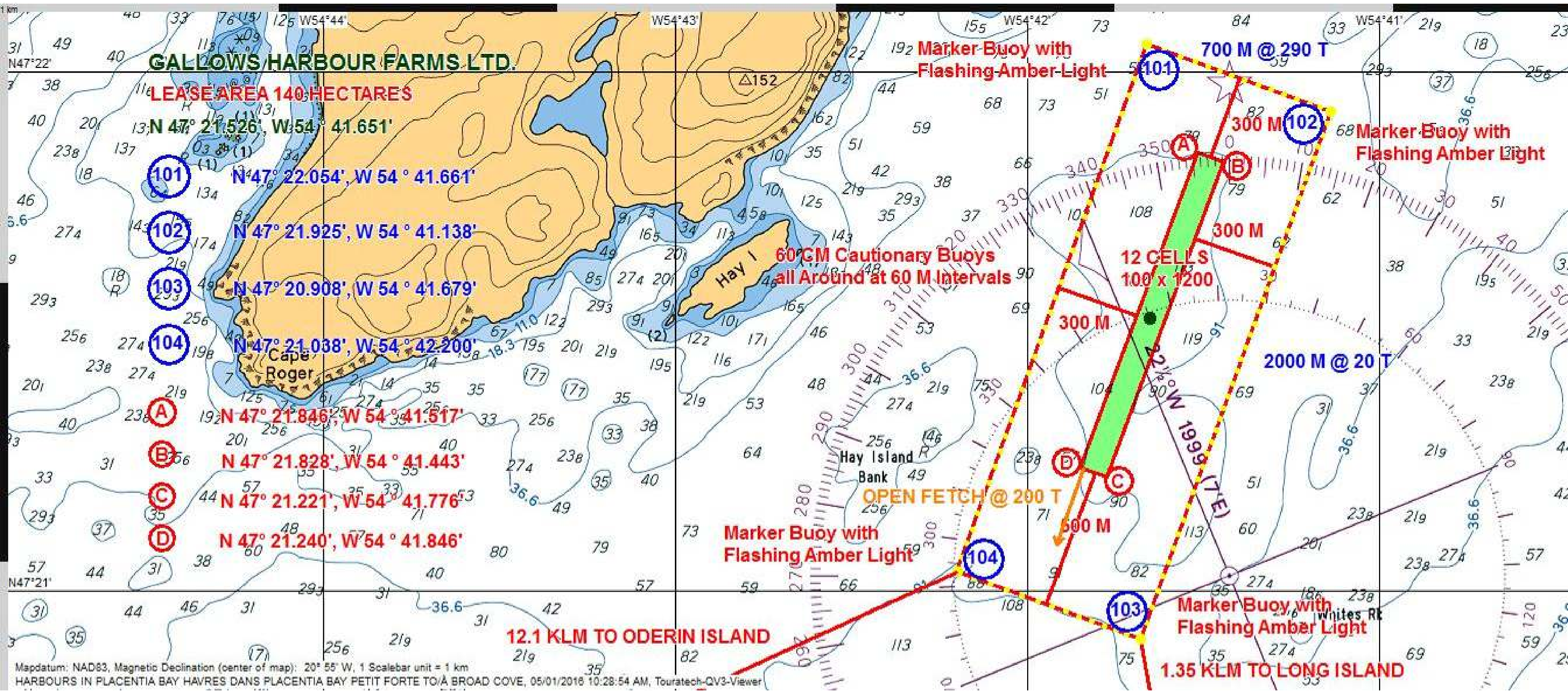
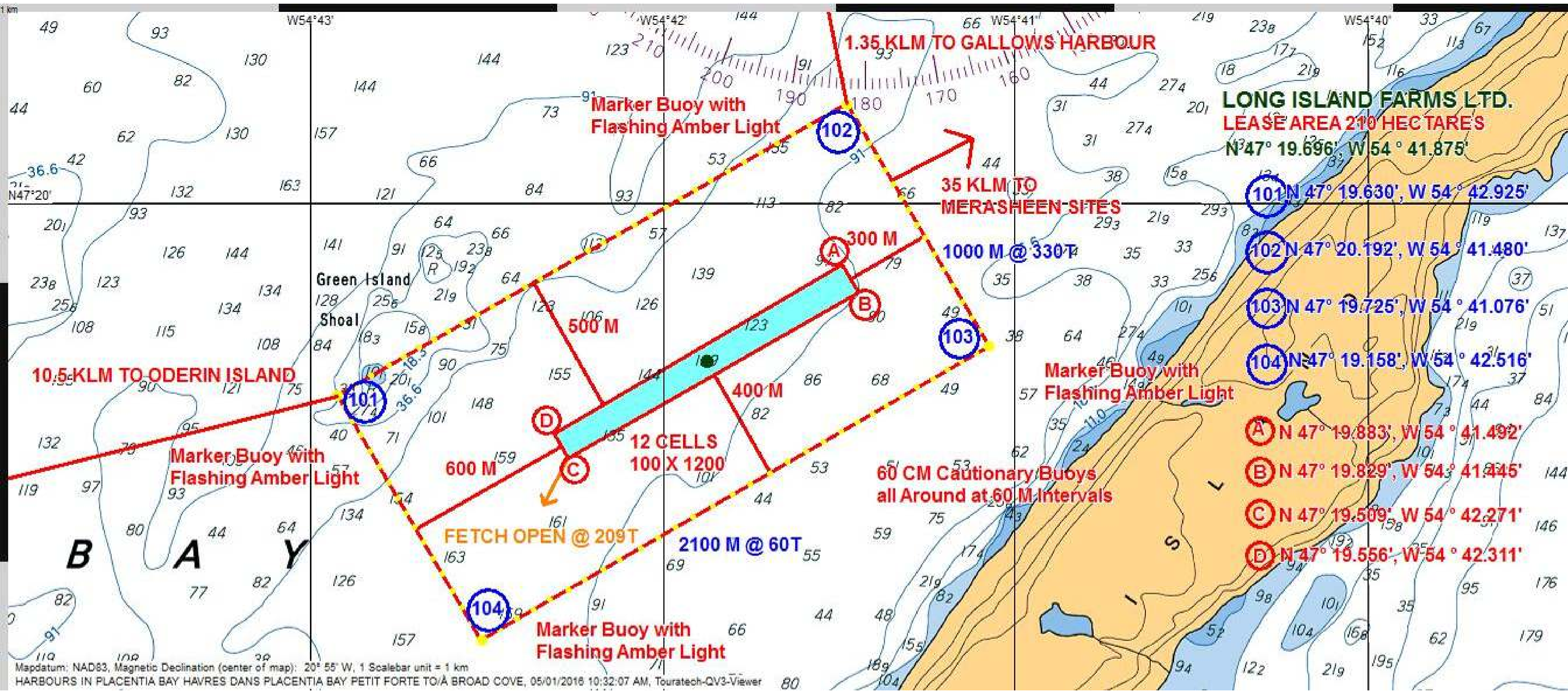
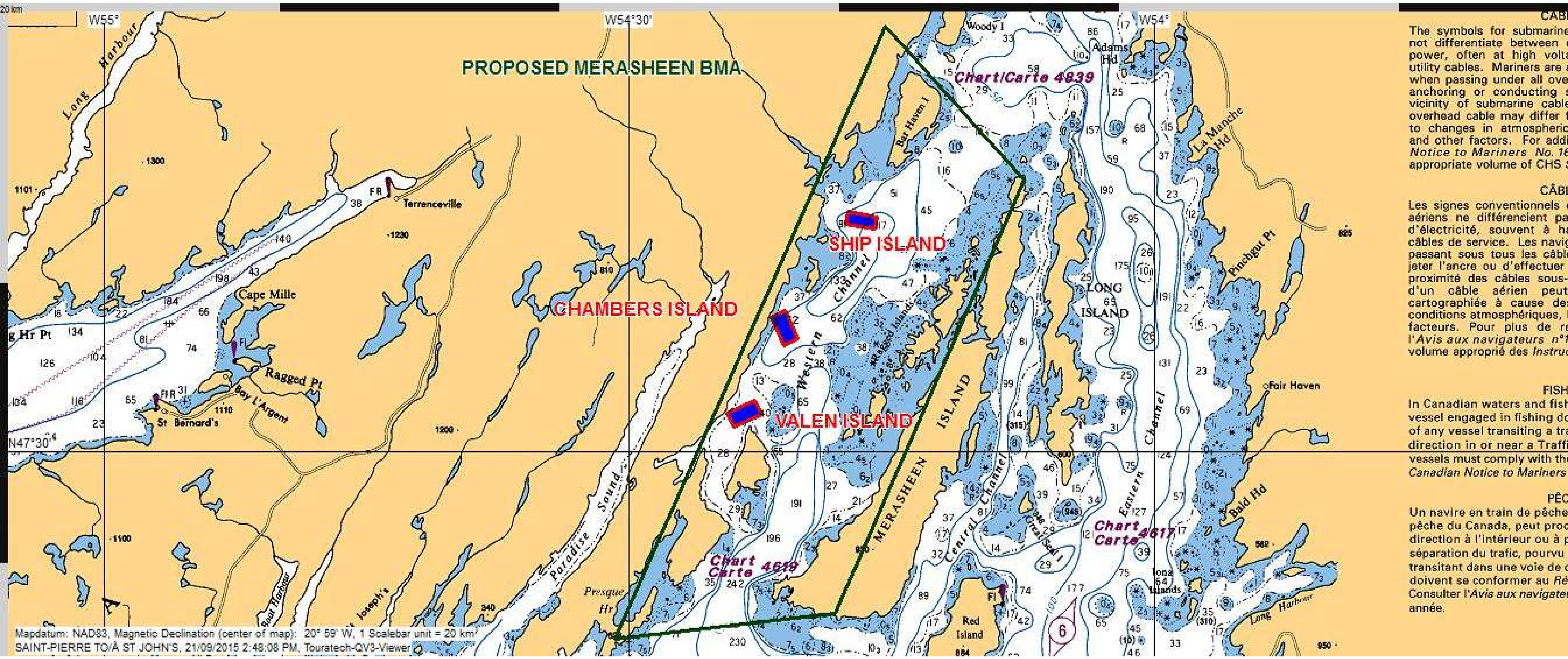

ODERIN ISLAND FARMS LTD.
LEASE AREA 126 HECTARES
N 47° 17.901', W 54 ° 51.572'
101 N 47° 18.431', W 54 ° 51.588'
102 N 47° 18.267', W 54 ° 51.084'
103 N 47° 17.387', W 54 ° 51.546'
104 N 47° 17.517', W 54 ° 52.067'
A N 47° 18.220', W 54 ° 51.449'
B N 47° 18.202', W 54 ° 51.371'
C N 47° 17.595', W 54 ° 51.694'
D N 47° 17.613', W 54 ° 51.769'
Marker Buoy with Flashing Amber Light
12.1 KLM TO GALLOWS HARBOUR
700 M @ 290 T
10.5 KLM TO LONG ISLAND
300M
12 CELLS 100 X 1200
60 CM Cautionary Buoys all Around at 60 M Intervals
1800 M @ 20 T
FETCH OPEN @ 200 T
W54°53'
W54°52'
W54°51'
W54°50'
N47°18'
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 55' W, 1 Scalebar unit = 1 km
HARBOURS IN PLACENTIA BAY HAVRES DANS PLACENTIA BAY PETIT FORTE TO/À BROAD COVE, 05/01/2016 4:36:01 PM, Touratech-QV3-Viewer


GALLOWS HARBOUR FARMS LTD.
LEASE AREA 140 HECTARES
N 47° 21.526', W 54 ° 41.651'
101 N 47° 22.054', W 54 ° 41.661'
102 N 47° 21.925', W 54 ° 41.138'
103 N 47° 20.908', W 54 ° 41.679'
104 N 47° 21.038', W 54 ° 42.200'
A N 47° 21.846', W 54 ° 41.517'
B N 47° 21.828', W 54 ° 41.443'
C N 47° 21.221', W 54 ° 41.776'
D N 47° 21.240', W 54 ° 41.846'
Marker Buoy with Flashing Amber Light
700 M @ 290 T
300 M
Marker Buoy with Flashing Amber Light
60 CM Cautionary Buoys all Around at 60 M Intervals
12 CELLS 100 x 1200
300 M
300 M
2000 M @ 20 T
OPEN FETCH @ 200 T
600 M
Marker Buoy with Flashing Amber Light
Marker Buoy with Flashing Amber Light
12.1 KLM TO ODERIN ISLAND
1.35 KLM TO LONG ISLAND
Cape Roger
Hay I
Hay Island Bank
Whites Rt
W54°44'
W54°43'
W54°42'
W54°41'
N47°22'
N47°21'
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 55' W, 1 Scalebar unit = 1 km
HARBOURS IN PLACENTIA BAY HAVRES DANS PLACENTIA BAY PETIT FORTE TO/À BROAD COVE, 05/01/2016 10:28:54 AM, Touratech-QV3-Viewer


LONG ISLAND FARMS LTD.
LEASE AREA 210 HECTARES
N 47° 19.696', W 54 ° 41.875'
101 N 47° 19.630', W 54 ° 42.925'
102 N 47° 20.192', W 54 ° 41.480'
103 N 47° 19.725', W 54 ° 41.076'
104 N 47° 19.158', W 54 ° 42.516'
A N 47° 19.883', W 54 ° 41.492'
B N 47° 19.829', W 54 ° 41.445'
C N 47° 19.509', W 54 ° 42.271'
D N 47° 19.556', W 54 ° 42.311'
1.35 KLM TO GALLOWS HARBOUR
35 KLM TO MERASHEEN SITES
10.5 KLM TO ODERIN ISLAND
Marker Buoy with Flashing Amber Light
1000 M @ 330T
2100 M @ 60T
300 M
500 M
400 M
600 M
12 CELLS
100 X 1200
FETCH OPEN @ 209T
60 CM Cautionary Buoys all Around at 60 M Intervals
Green Island Shoal
B A Y
W54°43'
W54°42'
W54°41'
W54°40'
N47°20'
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 55' W, 1 Scalebar unit = 1 km
HARBOURS IN PLACENTIA BAY HAVRES DANS PLACENTIA BAY PETIT FORTE TO/À BROAD COVE, 05/01/2016 10:32:07 AM, Touratech-QV3-Viewer



PROPOSED MERASHEEN BMA
SHIP ISLAND
CHAMBERS ISLAND
VALEN ISLAND
W55°
W54°30'
W54°
N47°30'
Chart/Carte 4839
Chart Carte 4619
Chart Carte 4617
Terrenceville
Cape Mille
Ragged Pt
Bay L'Argent
St Bernard's
Long Harbour
Paradise Sound
Presque Hr
Western Channel
Central Channel
Eastern Channel
MERASHEEN ISLAND
LONG ISLAND
Woody I
Adams Hd
La Manche Hd
Pinchgut Pt
Fair Haven
Bald Hd
Red Island
Iona Islands
Bar Haven I
Ragged Islands
Great Seal I
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 59' W, 1 Scalebar unit = 20 km
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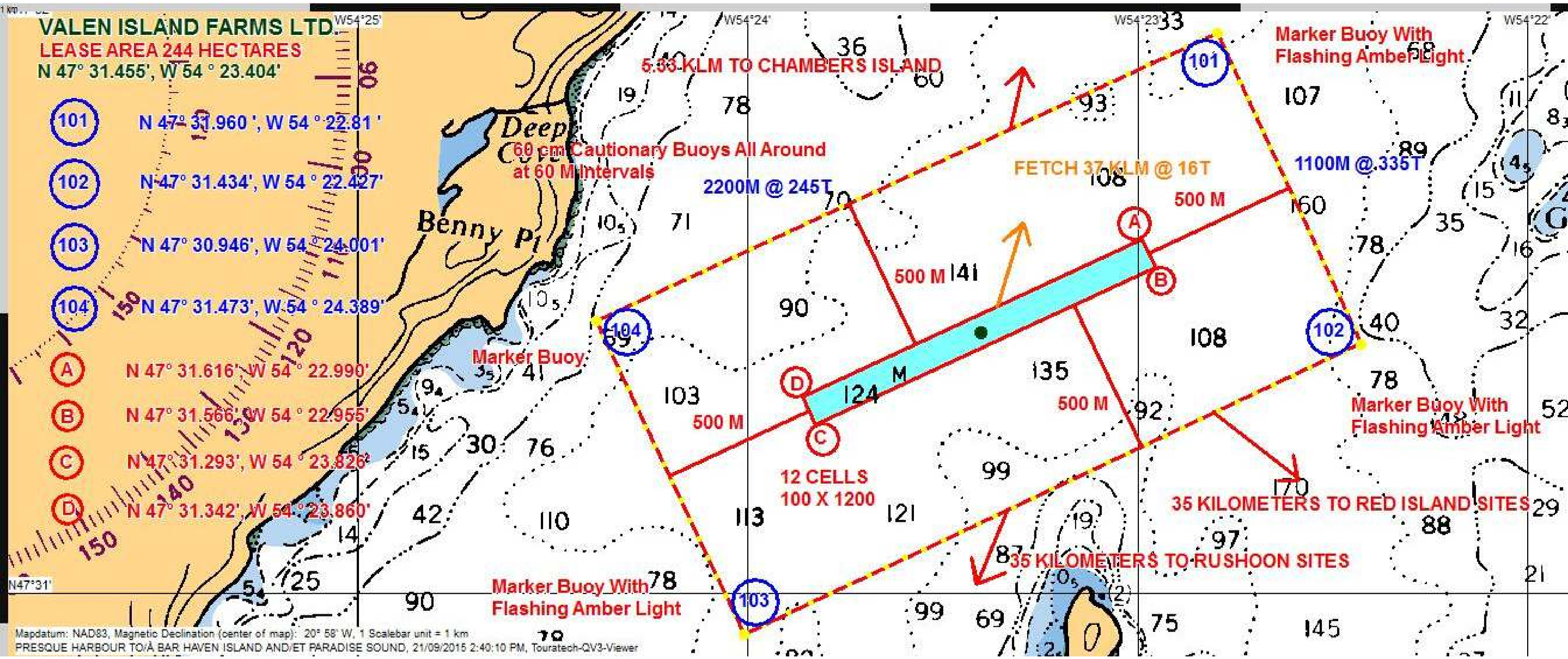
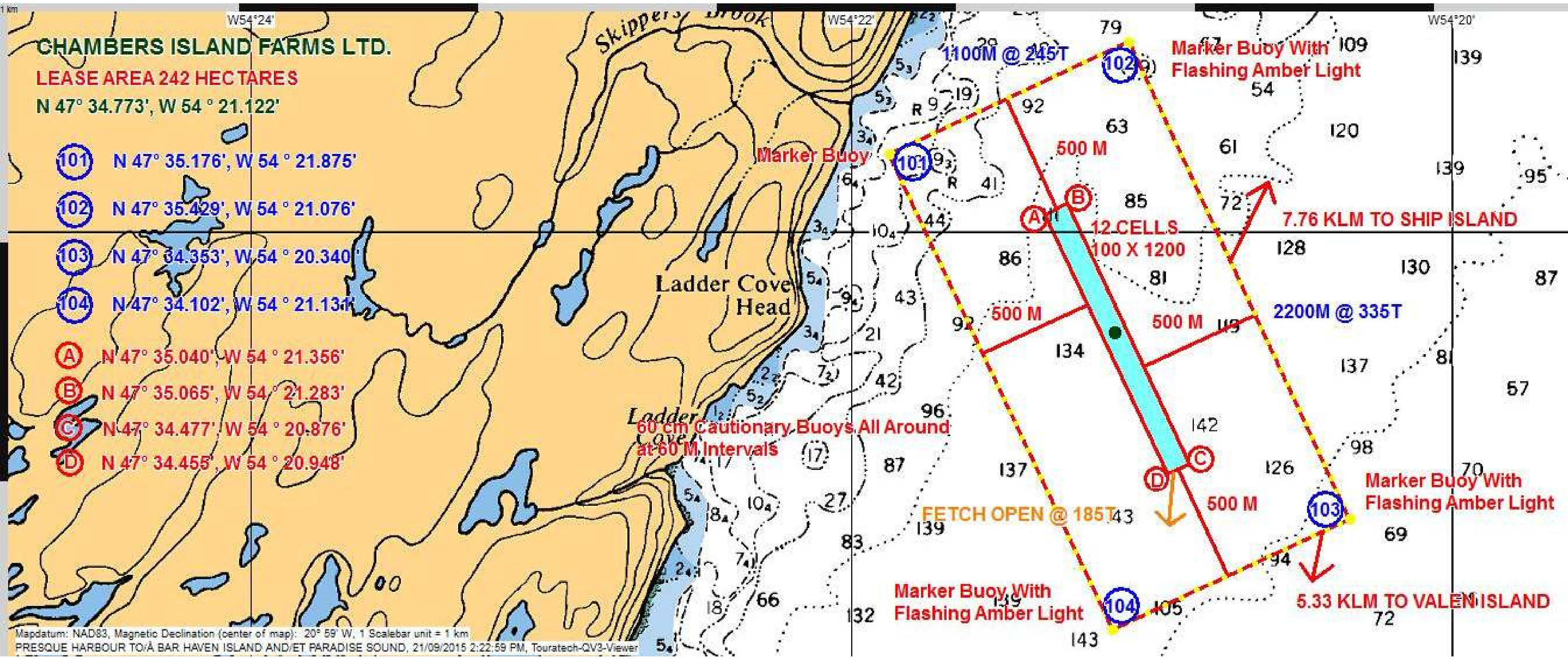
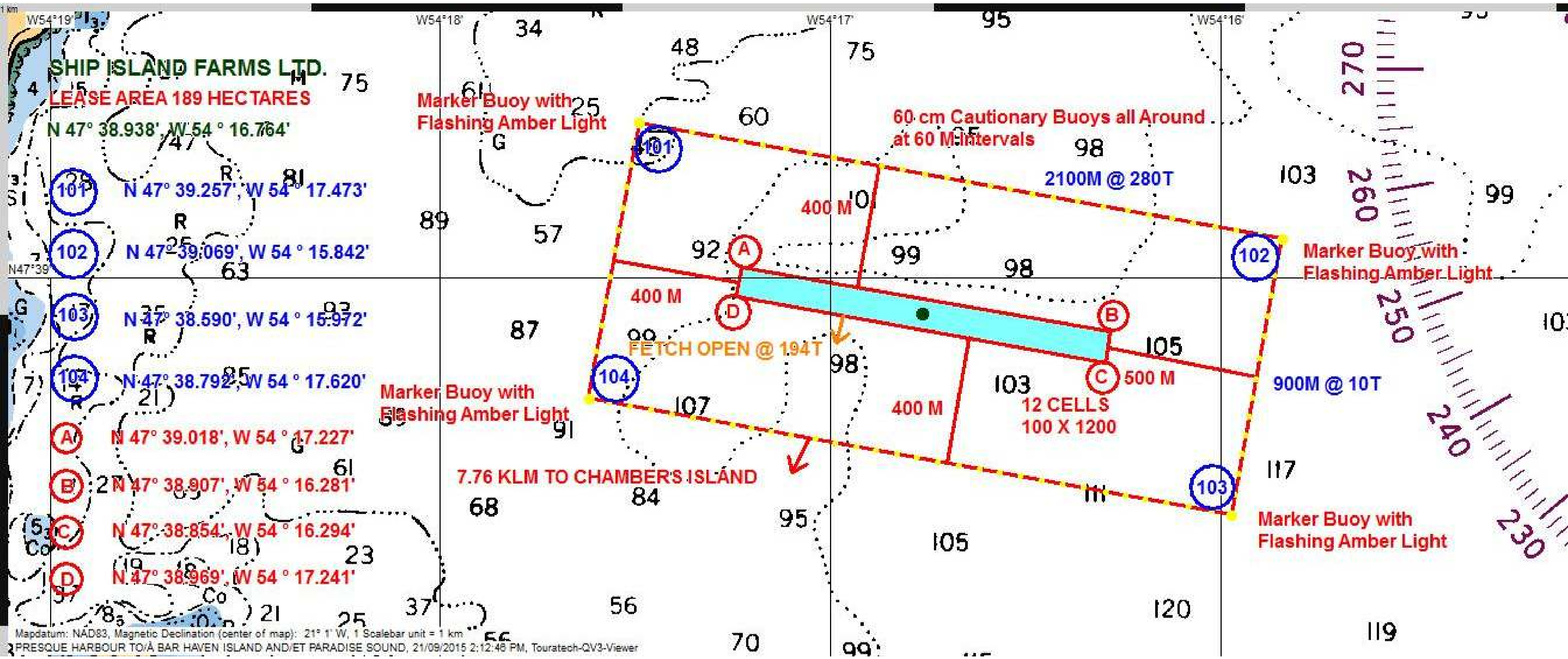
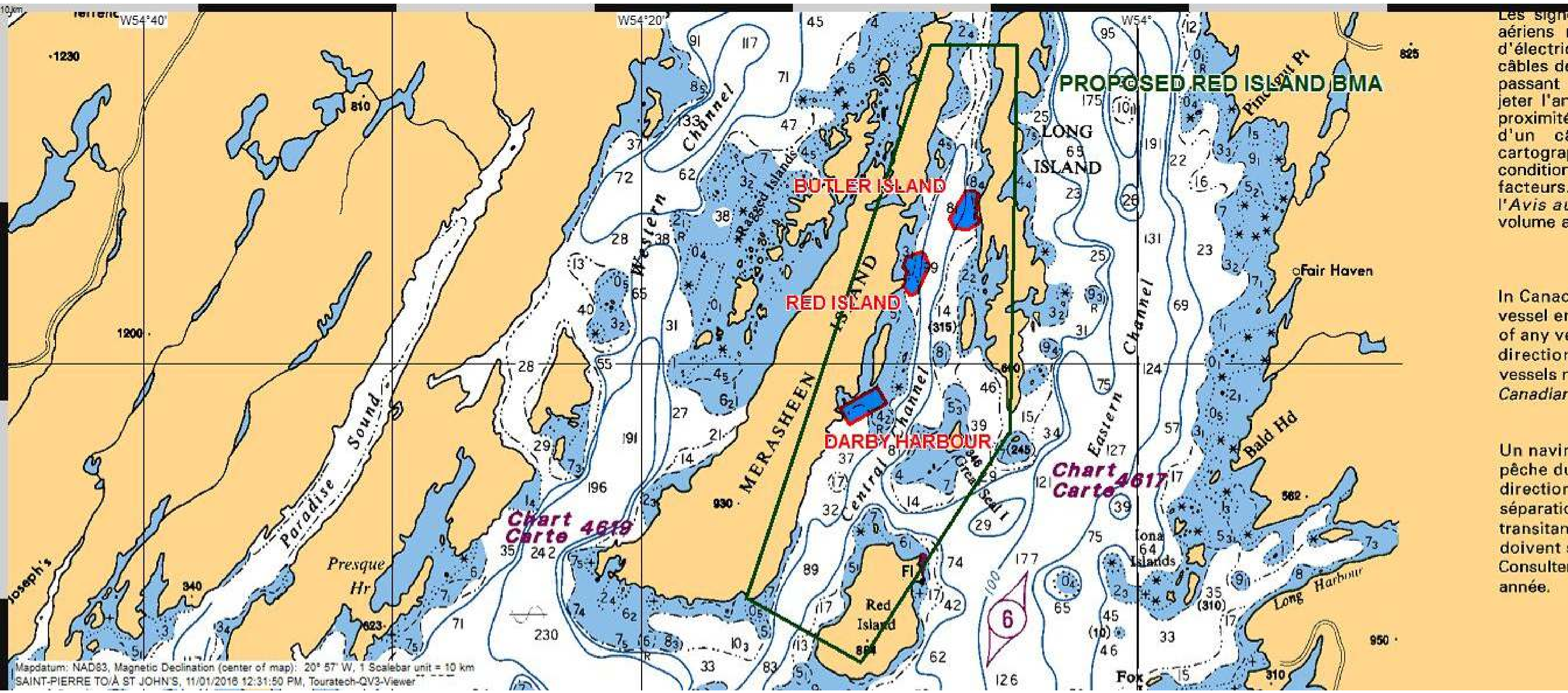
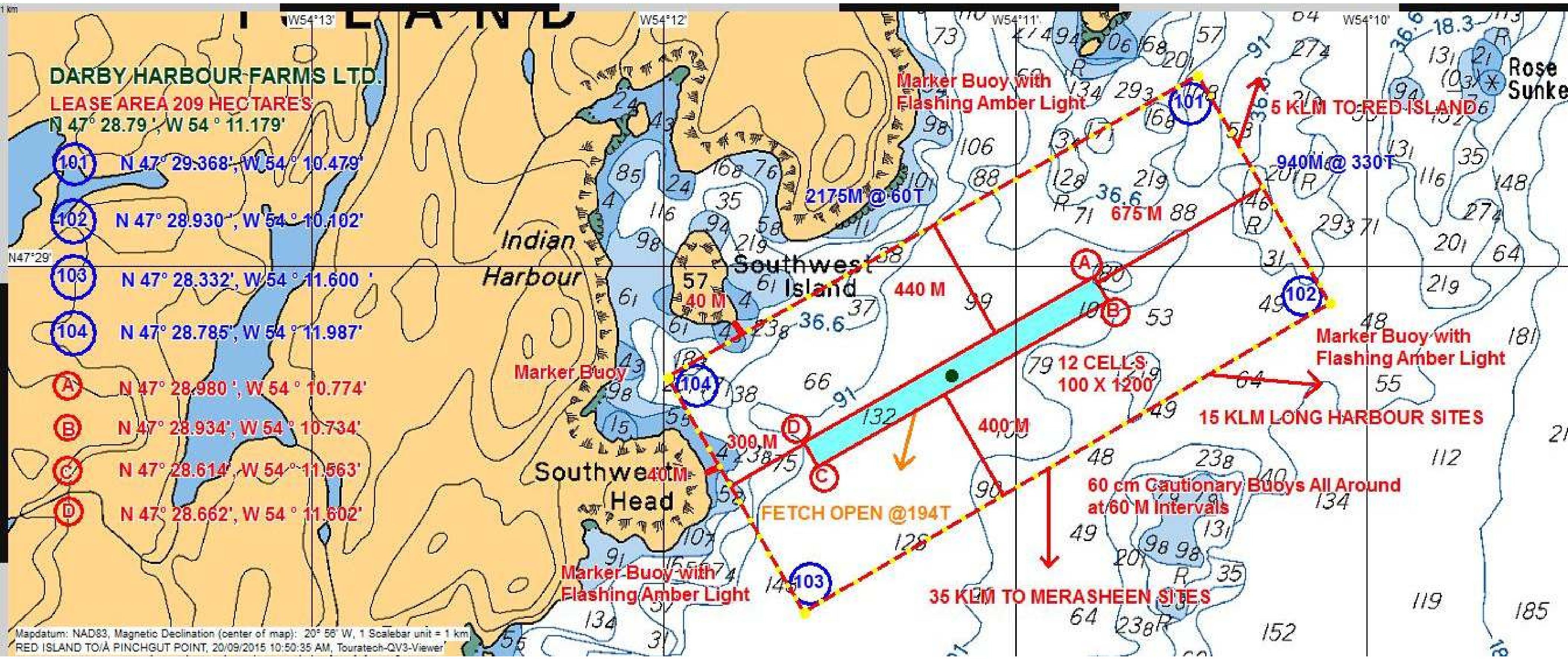
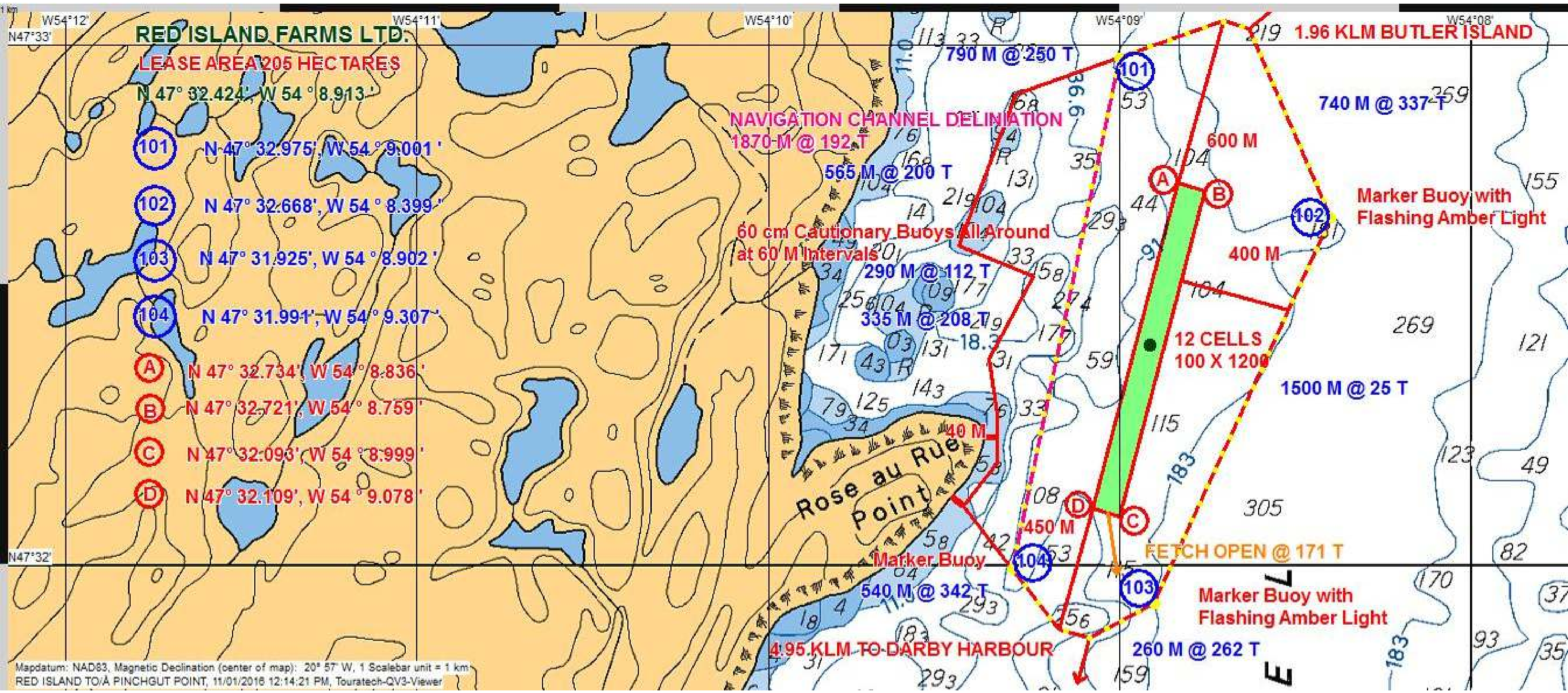

VALEN ISLAND FARMS LTD.
LEASE AREA 244 HECTARES
N 47° 31.455', W 54 ° 23.404'
101 N 47° 31.960 ', W 54 ° 22.81 '
102 N 47° 31.434', W 54 ° 22.427'
103 N 47° 30.946', W 54 ° 24.001'
104 N 47° 31.473', W 54 ° 24.389'
A N 47° 31.616', W 54 ° 22.990'
B N 47° 31.566', W 54 ° 22.955'
C N 47° 31.293', W 54 ° 23.826'
D N 47° 31.342', W 54 ° 23.860'
5.33 KLM TO CHAMBERS ISLAND
Marker Buoy With Flashing Amber Light
60 cm Cautionary Buoys All Around at 60 M Intervals
FETCH 37 KLM @ 16T
2200M @ 245T
1100M @ 335T
500 M
500 M
500 M
500 M
124 M
Marker Buoy
Marker Buoy With Flashing Amber Light
12 CELLS
100 X 1200
35 KILOMETERS TO RED ISLAND SITES
35 KILOMETERS TO RUSHOON SITES
Marker Buoy With Flashing Amber Light
Deep Cove
Benny Pt
W54°25'
W54°24'
W54°23'
W54°22'
N47°31'
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 58' W, 1 Scalebar unit = 1 km
PRESQUE HARBOUR TO/À BAR HAVEN ISLAND AND/ET PARADISE SOUND, 21/09/2015 2:40:10 PM, Touratech-QV3-Viewer

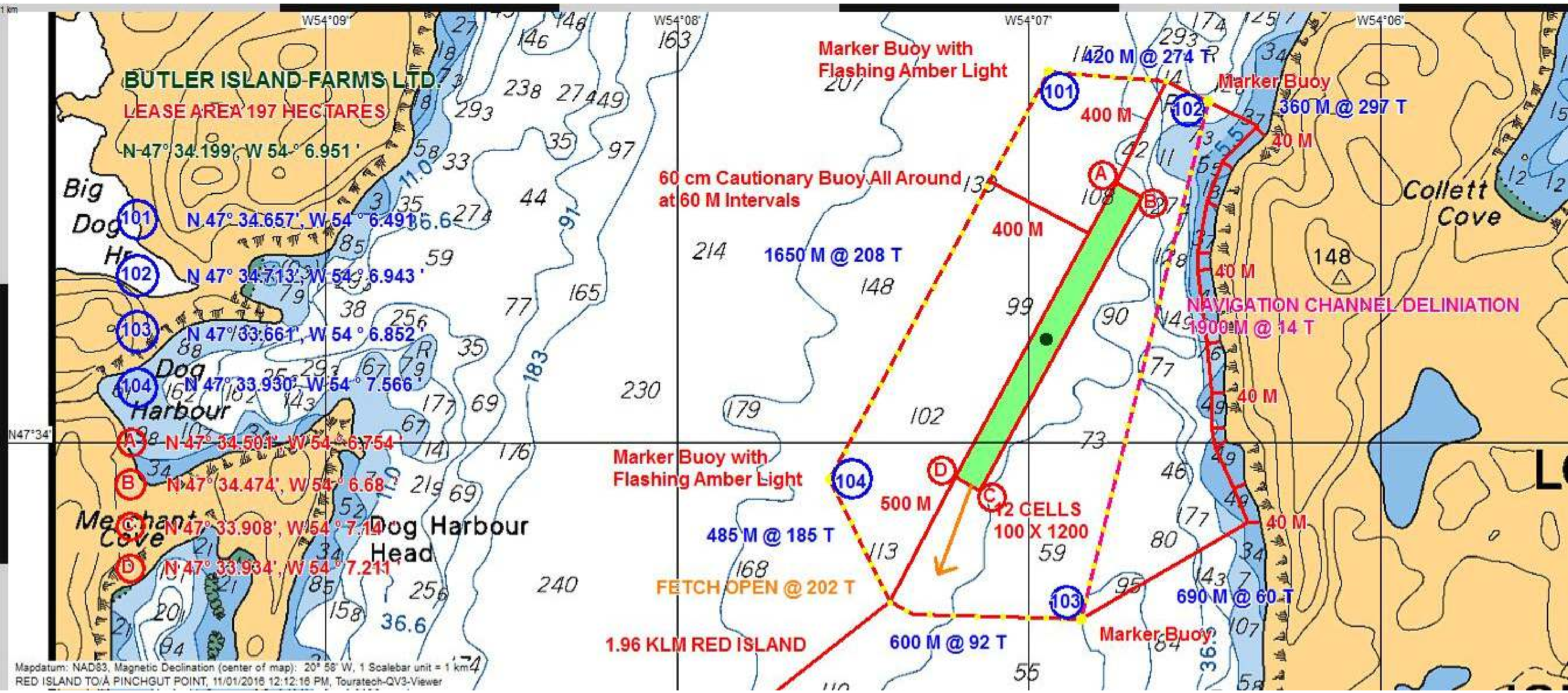

CHAMBERS ISLAND FARMS LTD.
LEASE AREA 242 HECTARES
N 47° 34.773', W 54 ° 21.122'
101 N 47° 35.176', W 54 ° 21.875'
102 N 47° 35.429', W 54 ° 21.076'
103 N 47° 34.353', W 54 ° 20.340'
104 N 47° 34.102', W 54 ° 21.131'
A N 47° 35.040', W 54 ° 21.356'
B N 47° 35.065', W 54 ° 21.283'
C N 47° 34.477', W 54 ° 20.876'
D N 47° 34.455', W 54 ° 20.948'
W54°24'
W54°22'
W54°20'
Skippers Brook
Ladder Cove Head
Ladder Cove
1100M @ 245T
Marker Buoy With Flashing Amber Light
Marker Buoy
500 M
12 CELLS 100 X 1200
7.76 KLM TO SHIP ISLAND
2200M @ 335T
60 cm Cautionary Buoys All Around at 60 M Intervals
FETCH OPEN @ 185T
Marker Buoy With Flashing Amber Light
Marker Buoy With Flashing Amber Light
5.33 KLM TO VALEN ISLAND
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 59' W, 1 Scalebar unit = 1 km
PRESQUE HARBOUR TO/À BAR HAVEN ISLAND AND/ET PARADISE SOUND, 21/09/2015 2:22:59 PM, Touratech-QV3-Viewer

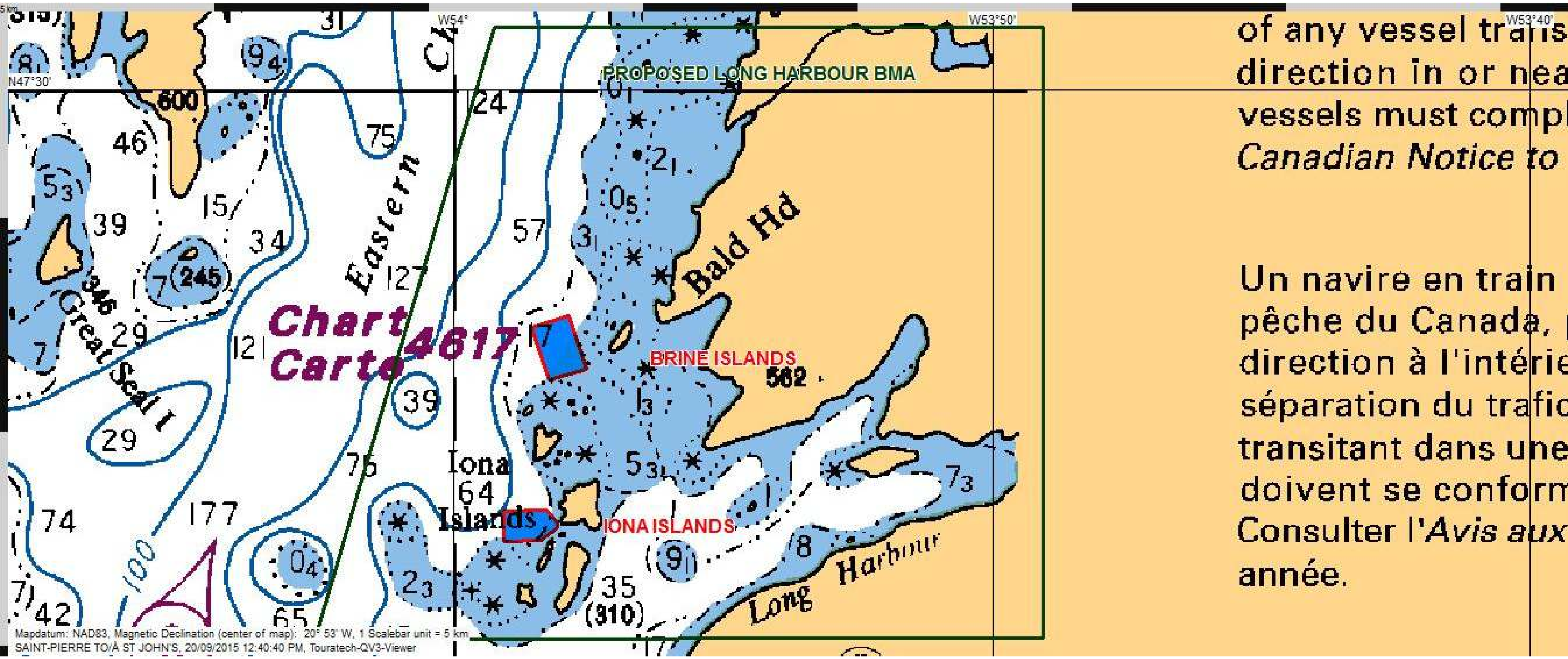

SHIP ISLAND FARMS LTD.
LEASE AREA 189 HECTARES
N 47° 38.938', W 54 ° 16.764'
101 N 47° 39.257', W 54 ° 17.473'
102 N 47° 39.069', W 54 ° 15.842'
103 N 47° 38.590', W 54 ° 15.972'
104 N 47° 38.792', W 54 ° 17.620'
A N 47° 39.018', W 54 ° 17.227'
B N 47° 38.907', W 54 ° 16.281'
C N 47° 38.854', W 54 ° 16.294'
D N 47° 38.969', W 54 ° 17.241'
Marker Buoy with Flashing Amber Light
60 cm Cautionary Buoys all Around at 60 M Intervals
2100M @ 280T
400 M
FETCH OPEN @ 194T
500 M
900M @ 10T
12 CELLS
100 X 1200
7.76 KLM TO CHAMBERS ISLAND
Mapdatum: NAD83, Magnetic Declination (center of map): 21° 1' W, 1 Scalebar unit = 1 km
PRESQUE HARBOUR TO/À BAR HAVEN ISLAND AND/ET PARADISE SOUND, 21/09/2015 2:12:46 PM, Touratech-QV3-Viewer

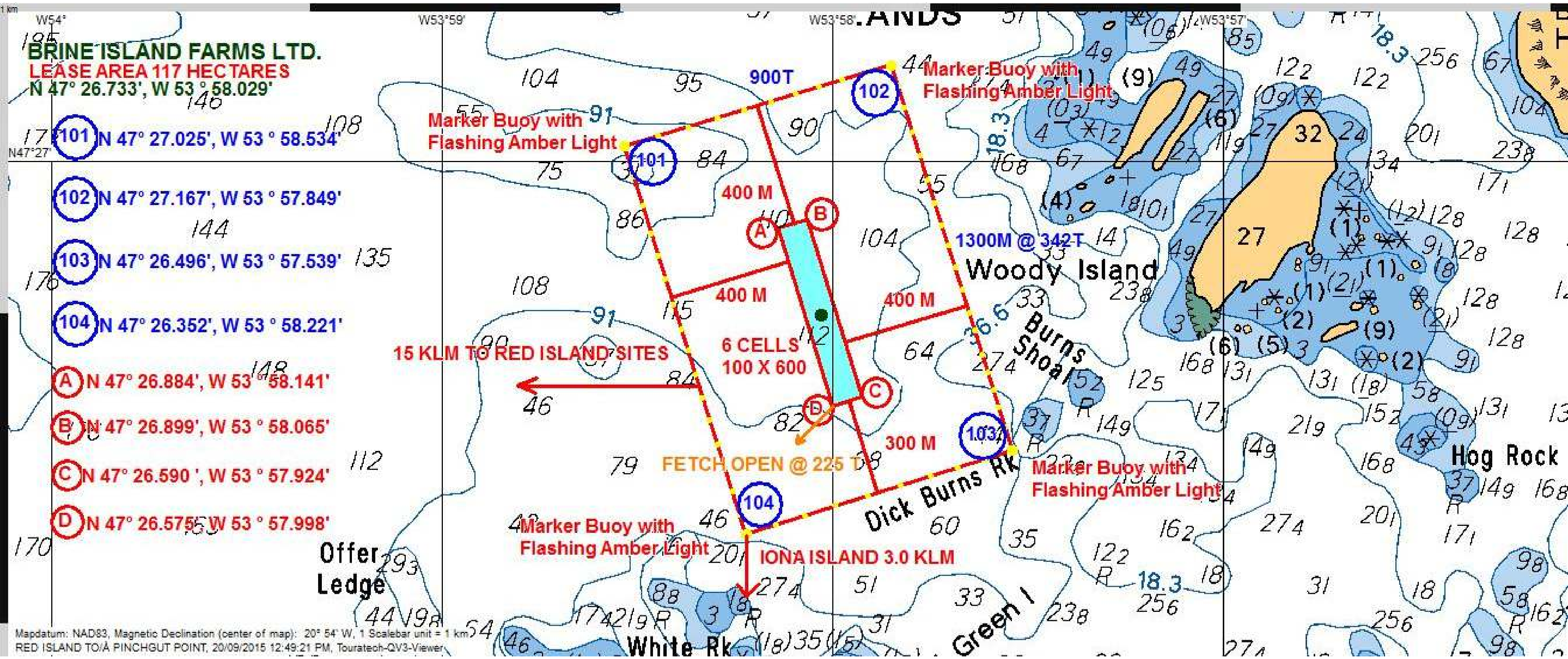

PROPOSED RED ISLAND BMA
BUTLER ISLAND
RED ISLAND
DARBY HARBOUR
W54°40'
W54°20'
W54°
MERASHEEN ISLAND
LONG ISLAND
Red Island
Western Channel
Central Channel
Eastern Channel
Ragged Islands
Paradise Sound
Presque Hr
Great Seal I
Fair Haven
Bald Hd
Pinchgut Pt
Iona Islands
Long Harbour
Chart Carte 4619
Chart Carte 4617
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 57' W, 1 Scalebar unit = 10 km
SAINT-PIERRE TO/À ST JOHN'S, 11/01/2016 12:31:50 PM, Touratech-QV3-Viewer


DARBY HARBOUR FARMS LTD.
LEASE AREA 209 HECTARES
N 47° 28.79 ', W 54 ° 11.179'
101 N 47° 29.368', W 54 ° 10.479'
102 N 47° 28.930 ', W 54 ° 10.102'
103 N 47° 28.332', W 54 ° 11.600 '
104 N 47° 28.785', W 54 ° 11.987'
A N 47° 28.980 ', W 54 ° 10.774'
B N 47° 28.934', W 54 ° 10.734'
C N 47° 28.614', W 54 ° 11.563'
D N 47° 28.662', W 54 ° 11.602'
Marker Buoy with Flashing Amber Light
5 KLM TO RED ISLAND
940M @ 330T
2175M @ 60T
675 M
440 M
40 M
Marker Buoy
12 CELLS 100 X 1200
Marker Buoy with Flashing Amber Light
15 KLM LONG HARBOUR SITES
300 M
400 M
40M
FETCH OPEN @194T
60 cm Cautionary Buoys All Around at 60 M Intervals
Marker Buoy with Flashing Amber Light
35 KLM TO MERASHEEN SITES
Indian Harbour
Southwest Island
Southwest Head
Rose
Sunke
W54°13'
W54°12'
W54°11'
W54°10'
N47°29'
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 56' W, 1 Scalebar unit = 1 km
RED ISLAND TO/Å PINCHGUT POINT, 20/09/2015 10:50:35 AM, Touratech-QV3-Viewer

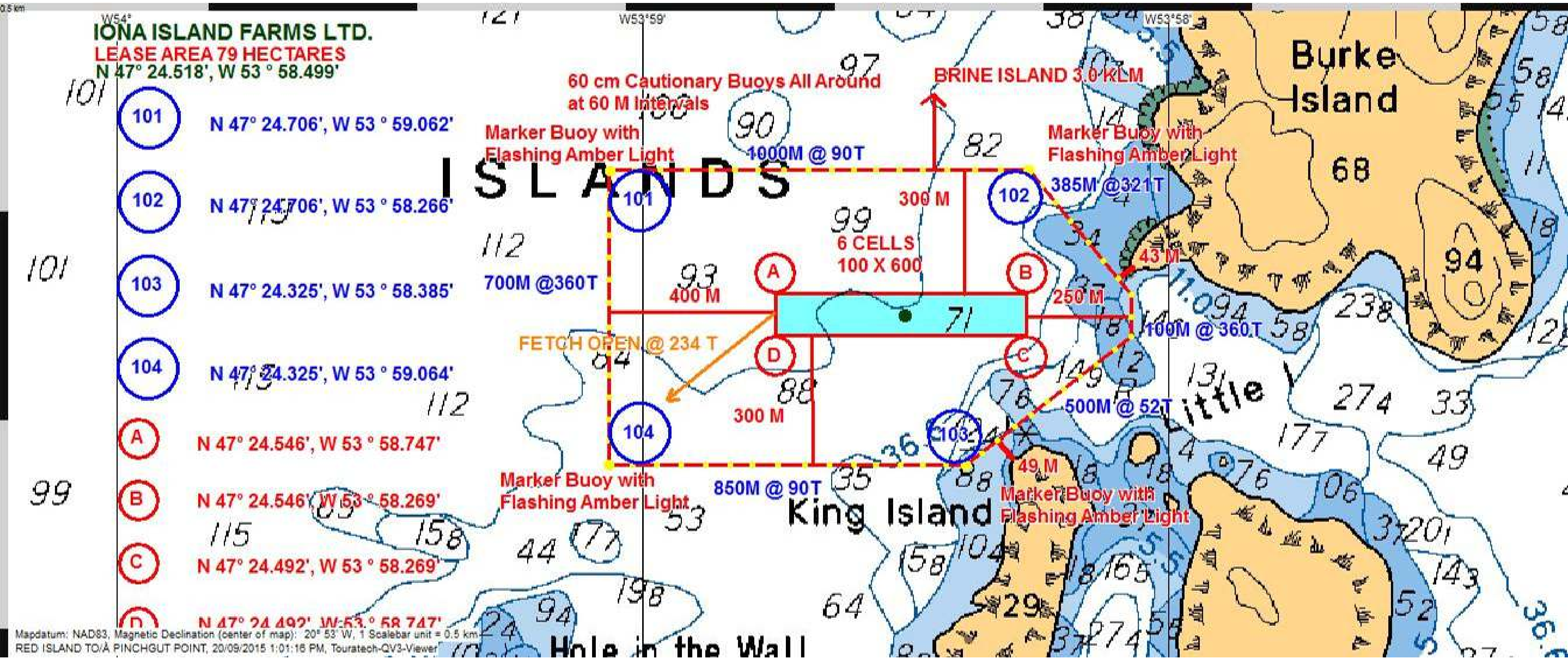

RED ISLAND FARMS LTD.
LEASE AREA 205 HECTARES
N 47° 32.424', W 54 ° 8.913 '
101 N 47° 32.975', W 54 ° 9.001 '
102 N 47° 32.668', W 54 ° 8.399 '
103 N 47° 31.925', W 54 ° 8.902 '
104 N 47° 31.991', W 54 ° 9.307 '
A N 47° 32.734', W 54 ° 8.836 '
B N 47° 32.721', W 54 ° 8.759 '
C N 47° 32.093', W 54 ° 8.999 '
D N 47° 32.109', W 54 ° 9.078 '
NAVIGATION CHANNEL DELINIATION
1870 M @ 192 T
790 M @ 250 T
565 M @ 200 T
60 cm Cautionary Buoys All Around
at 60 M Intervals
290 M @ 112 T
335 M @ 208 T
40 M
Rose au Rue Point
450 M
Marker Buoy
540 M @ 342 T
4.95 KLM TO DARBY HARBOUR
1.96 KLM BUTLER ISLAND
740 M @ 337 T
600 M
Marker Buoy with
Flashing Amber Light
400 M
12 CELLS
100 X 1200
1500 M @ 25 T
FETCH OPEN @ 171 T
Marker Buoy with
Flashing Amber Light
260 M @ 262 T
W54°12'
W54°11'
W54°10'
W54°09'
W54°08'
N47°33'
N47°32'
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 57' W, 1 Scalebar unit = 1 km
RED ISLAND TO/À PINCHGUT POINT, 11/01/2016 12:14:21 PM, Touratech-QV3-Viewer


BUTLER ISLAND FARMS LTD.
LEASE AREA 197 HECTARES
N 47° 34.199', W 54 ° 6.951 '
101 N 47° 34.657', W 54 ° 6.491 '
102 N 47° 34.713', W 54 ° 6.943 '
103 N 47° 33.661', W 54 ° 6.852 '
104 N 47° 33.930', W 54 ° 7.566 '
A N 47° 34.501', W 54 ° 6.754 '
B N 47° 34.474', W 54 ° 6.68 '
C N 47° 33.908', W 54 ° 7.14 '
D N 47° 33.934', W 54 ° 7.211 '
Big Dog Hr
Dog Harbour
Merchant Cove
Dog Harbour Head
Collett Cove
W54°09'
W54°08'
W54°07'
W54°06'
N47°34'
Marker Buoy with Flashing Amber Light
420 M @ 274 T
Marker Buoy
360 M @ 297 T
400 M
40 M
60 cm Cautionary Buoy All Around at 60 M Intervals
400 M
1650 M @ 208 T
NAVIGATION CHANNEL DELINIATION
1900 M @ 14 T
Marker Buoy with Flashing Amber Light
500 M
12 CELLS
100 X 1200
485 M @ 185 T
FETCH OPEN @ 202 T
690 M @ 60 T
1.96 KLM RED ISLAND
600 M @ 92 T
Marker Buoy
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 58' W, 1 Scalebar unit = 1 km
RED ISLAND TO/À PINCHGUT POINT, 11/01/2016 12:12:16 PM, Touratech-QV3-Viewer


W54°
W53°50'
W53°40'
N47°30'
PROPOSED LONG HARBOUR BMA
Eastern
Bald Hd
Great Seal I
Chart 4617
Carte
BRINE ISLANDS
Iona
Islands
IONA ISLANDS
Long Harbour
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 53' W, 1 Scalebar unit = 5 km
SAINT-PIERRE TO/À ST JOHN'S, 20/09/2015 12:40:40 PM, Touratech-QV3-Viewer
of any vessel trans
direction in or nea
vessels must compl
Canadian Notice to
Un navire en train
pêche du Canada, p
direction à l'intérie
séparation du trafic
transitant dans une
doivent se conform
Consulter l'Avis aux
année.



BRINE ISLAND FARMS LTD.
LEASE AREA 117 HECTARES
N 47° 26.733', W 53 ° 58.029'
101 N 47° 27.025', W 53 ° 58.534'
102 N 47° 27.167', W 53 ° 57.849'
103 N 47° 26.496', W 53 ° 57.539'
104 N 47° 26.352', W 53 ° 58.221'
A N 47° 26.884', W 53 ° 58.141'
B N 47° 26.899', W 53 ° 58.065'
C N 47° 26.590 ', W 53 ° 57.924'
D N 47° 26.575', W 53 ° 57.998'
900T
Marker Buoy with Flashing Amber Light
Marker Buoy with Flashing Amber Light
Marker Buoy with Flashing Amber Light
Marker Buoy with Flashing Amber Light
400 M
400 M
400 M
300 M
1300M @ 342T
6 CELLS 100 X 600
15 KLM TO RED ISLAND SITES
FETCH OPEN @ 225 T
IONA ISLAND 3.0 KLM
W54°
W53°59'
W53°58'
W53°57'
N47°27'
Woody Island
Burns Shoal
Dick Burns Rk
Hog Rock
Offer Ledge
White Rk
Green I
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 54' W, 1 Scalebar unit = 1 km
RED ISLAND TO/Å PINCHGUT POINT, 20/09/2015 12:49:21 PM, Touratech-QV3-Viewer


IONA ISLAND FARMS LTD.
LEASE AREA 79 HECTARES
N 47° 24.518', W 53 ° 58.499'
101 N 47° 24.706', W 53 ° 59.062'
102 N 47° 24.706', W 53 ° 58.266'
103 N 47° 24.325', W 53 ° 58.385'
104 N 47° 24.325', W 53 ° 59.064'
A N 47° 24.546', W 53 ° 58.747'
B N 47° 24.546', W 53 ° 58.269'
C N 47° 24.492', W 53 ° 58.269'
D N 47° 24.492', W 53 ° 58.747'
60 cm Cautionary Buoys All Around
at 60 M Intervals
BRINE ISLAND 3.0 KLM
Marker Buoy with
Flashing Amber Light
1000M @ 90T
385M @321T
300 M
6 CELLS
100 X 600
700M @360T
400 M
250 M
43 M
100M @ 360T
FETCH OPEN @ 234 T
300 M
500M @ 52T
49 M
850M @ 90T
ISLANDS
Burke
Island
King Island
Little
Hole in the Wall
W54°
W53°59'
W53°58'
Mapdatum: NAD83, Magnetic Declination (center of map): 20° 53' W, 1 Scalebar unit = 0.5 km
RED ISLAND TO/À PINCHGUT POINT, 20/09/2015 1:01:16 PM, Touratech-QV3-Viewer

Aquaculture Licensing Process for Sea Cage Sites

Prepared by
Department of Fisheries and Aquaculture
Aquaculture Development Division

December 15, 2015

Newfoundland Labrador

Department of Fisheries and Aquaculture

Aquaculture Licensing Process for Sea Cage Sites

The Sea Cage Site Aquaculture Licensing Process

All sea cage operations require an aquaculture licence from the Department of Fisheries and Aquaculture to operate. The licensing process requires referral to multiple federal and provincial agencies that must review the application and issue their own comments/permits/ approval before DFA will consider the site application for licensing. The aquaculture cage site application was developed by DFA with full consultations and considerations of other departments, federal and provincial, to ensure that the information requirements meet the various departments' needs, thus creating a "one stop shop" process.

Sea Cage site Aquaculture License Application preparation:

Before a site will be considered for an aquaculture licence, prospective operators must provide an application package that includes:

- A licence application completed in full and in accordance with Applicant Guidance Document – Environmental Information Reviews (in attached file; see section below on environmental information requirements and monitoring) and including a complete set of site drawings and a business plan. The application includes the following sections and can be found in Appendix 1, page 26:
    - Section A: Applicant Information
    - Section B: Species Information
    - Section C: Site Information
    - Section D: Environmental Concerns
    - Section E: Development/Production Plan
    - Section F: Water/Site Quality data
    - Section F(a): Site Suitability for Saltwater Cage Operations
    - Section F(b): Site Suitability for Fresh Water Cage Operations
    - Section F(c): Benthic environment and Current modelling information as per Aquaculture Activity Regulations (AAR). (see section "Key Environmental Information Requirements for Sea Cage Aquaculture Site Licence Applications" below, page 14-18); Benthic sampling on a 100 m grid across the site area (required by DFO for benthic characterization).
    - Section G: Consultations
    - Declaration, Consent and Disclosure
- Site diagrams including cross section and overview, plus maps indicating site location.
- A complete business plan with minimum:
    - Itemized projected statements of cash flows (for minimum of three years or until a positive cash flow exists)
    - Schedules of planned capital expenditures (for timeframes as above)
    - Identification of funding sources
    - Production/development plans for the farm

- Crown Lands application
- A waste management plan
- Considerations of Endangered Species in the Area

Application will not be accepted unless the full application package is submitted with all sections and materials as described above submitted.

Stakeholder Consultation:

Applicants that wish to license an aquaculture site must conduct consultations with stakeholders in the vicinity of the site prior to submission of the aquaculture application. This normally entails consultation with local fisher committees and the FFAW, towns, development groups and local interest groups Section G of the DFA Cage Culture Application states:

> "The proponent is required to make initial contact with other users of the water resource to identify and resolve any potential conflicts where possible. Such users include local fishers committees, tourism groups, economic development boards etc."

Applicants must provide date and times of consultations including details on issues that arose and whether or not they were resolved. DFA will not accept sea cage culture application without the completed section G. A complete description of the consultation process for sea cage aquaculture site applications is in Appendix 2, page 42.

The Sea Cage Site Aquaculture Licence Application Referral Process:

Once DFA has verified that the licence application package is complete it is assessed internally by the Aquaculture Development Division. The Aquaculture Development Division reviews the following information:

- Assess site specific data held in house and in application to ensure it is accurate (i.e. temperature, salinity, dissolved oxygen, water depth) for the region and capable of supporting salmonids in a farming setting.
- Ensure that the application is in compliance with existing departmental legislation, policy and management plans.
- Ensure type, size and amount of gear is appropriate for the proposed farming activity and that all gear fits within site footprint, with adequate mooring scope
- Ensure production plans are achievable given industry standard production parameters in Newfoundland.
- Ensure stocking densities are appropriate to ensure fish welfare and growing conditions
- Ensure the business plan is based on technically sound aquaculture practices and that all capital costs and biological assumptions are within industry norms.
- Ensure the waste management plan, environmental monitoring and protection information provided by applicants is in accordance with the Applicant Guidance Document – Environmental Information Reviews (see Appendix 5, page 64).
- Ensure that the production plan is in accordance with all existing management plans including the Code of Containment, the Newfoundland and Labrador Aquaculture Health Management Plan and the Bay Management Areas Agreement for the South Coast of NL
- Ensure the application and proposed farming project has been reviewed by AAHD for any issues that may impact health of the animals and that adequate resources have been allocated for fish health management.
- Ensure information in aquaculture application matches Crown Lands application

Once the Aquaculture Development Division has completed its review and has completed the Site Application Initial Assessment form, the Aquaculture Licensing Division refers out the application to external regulatory agencies for them to review against their own legislative mandate. A 30 day response time is requested. The specific agencies and their roles are listed below:

- Department of Fisheries and Aquaculture Regional Services Division - review based on any potential user conflicts with industry stakeholders and other marine resource users.
  - **Provides comments and recommendations**.
- Department of Environment and Conservation (ENVC) - Water Resources Division - reviewed against the requirements of the *Water Resources Act* and to determine whether other Divisions of the department require a review of the application. Water Resources administers provisions of the Water Resources Act and regulations pertaining to the use, conservation and efficiency, economics, allocation and granting of rights of all water resources
  - **Provides: Formal approval document issued: a Water Use Licence/Permit issued under authority of the *Water Resources Act*.**
  - **A standard Marine Aquaculture Water Use Licence/Permit contains 12 terms and conditions that identify the area licensed and its designated purpose, limitations, Minister's authority, as well as the licensee responsibilities to:**
    - **Not impact water quality**
    - **Secure and clearly mark the site with cautionary buoys**
    - **Notify the Minister of Environment of any problems**
    - **Remediate the site to it natural condition in the event the site is no longer to be used**
- Department of Municipal and Intergovernmental Affairs - Crown Lands Administration - An Application for Crown Lands forms part of the overall application package. Crown Lands process their application under their own application process.
  - **Provides: Formal approval document issued: a Crown Lands Lease**

- Department of Municipal and Intergovernmental Affairs - Municipal Engineering - review intended to identify any potential conflicts with municipal engineering infrastructure
  - **Provides: Comments and recommendations where appropriate**. Sea cage sites are not often located within municipal boundaries.
- Department of Business, Tourism, Culture and Rural Development - Provincial Archaeology Office - review against requirements of the Historic Resources Act to ensure any archaeological discoveries made during development are addressed appropriately.
  - **Provides: Comments and recommendations as appropriate.**
- Fisheries and Oceans Canada (DFO) - review against the requirement of the Fisheries Act and Regulations and the Aquaculture Activity Regulations (AAR). The AAR clarifies the conditions aquaculture operators may treat their fish, and deposit organic matter. The regulation also specifies minimum requirements for public reporting on environmental performance, as well as specific requirements for environmental monitoring and sampling. The Office of the Regional Aquaculture Coordinator will distribute and consolidate feedback from the following:
    - Science Branch
    - Resource Management
    - Conservation and Protection
    - Fisheries Protection Program
  - **Provides: Review of benthic information submitted and considers potential habitat impacts, potential wild fishery implications and consideration of impacts on wild fish habitat (including wild salmon). Provides comments and recommendations on whether or not to licence the site and includes advice on siting, fallow, depths for gear deployment, escape prevention in order to mitigate potential impacts.** (see section below "Key Environmental Information Requirements for Sea Cage Aquaculture Site Licence Applications, page 11-18):

- Transport Canada (TC) - review against the requirements of the Navigation Protection Act (NPA). The NPA review process includes a formal public notification process whereby the site application and diagrams must be posted in local municipality office and advertised in local papers in order to inform the public and illicit comments/concerns on navigational issues.
  - **Provides: Formal approval document issued: Navigation Protection Act Approval**

Once the application has been referred the proponent is required to advertise the aquaculture site license application (see Appendix 2, page 42, for complete consultation process). The applicant must advertise their intent for the proposed site and request comments from the public. The period for comments is two weeks after the ad last appears in the newspapers. DFA advises the applicant by email that:

> "As part of the aquaculture licensing process, applications must be advertised in local and regional newspapers to ensure other user groups have an opportunity to identify any concerns about the proposed aquaculture development.
>
> An applicant for a new licence, licence transfer or change of operator shall give notice of his or her intention to apply for the licence, by advertisement in the form prescribed, once a week for two consecutive weeks.
>
> Advertisements must appear in the Classified Section of:
>
> (1) A newspaper (Saturday edition) with province-wide circulation (e.g. Saturday Telegram) and
> (2) A newspaper circulating in the area in which the licence is requested (e.g. The Coaster).

The applicant must demonstrate that the advertisements have been placed in the appropriate manner by submitting a copy of the advertisements, the newspapers utilized and the dates of placement. This information should be submitted to the Aquaculture Licensing Administrator immediately after the advertisements have been published. Separate ads are required for each application."

The ads state:

"TAKE NOTICE that [*Company Name*] has applied under the provisions of the Aquaculture Act for the issuance of an Aquaculture Licence to operate a [*Type of Licence/Species*] aquaculture facility at [*Location, Coordinates*] in the Province of Newfoundland and Labrador.

Comments on this application should be directed to the Aquaculture Licensing Administrator, Department of Fisheries and Aquaculture. Comments must be received no later than [*specific date to be no less than two weeks after the date of the last advertisement*]"

Starting in November of 2015, all cage site applications will be posted on the DFA website. Anyone may comment or submit questions on any applications that are viewed on the DFA website by contacting either the company applying or DFA Licensing Division.

Key Environmental Information Requirements for Sea Cage Aquaculture Site Licence Applications:

There are two key environmental guidance documents that are offered to a proponent to help prepare an aquaculture licensing application, and used by DFA to review an application. The guidance documents are as follows:

- 'Applicant Guidance Document – Environmental Information Reviews', last revised April 4, 2012. Fisheries Act, Aquaculture Activity Regulations (2015) guidance document, administered by Fisheries and Ocean Canada

The 'Applicant Guidance Document – Environmental Information Reviews', is included in Appendix 5, page 64.

The AAR guidance document can be found at this link, http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/aar-raa-gd-eng.htm
The AAR aquaculture monitoring standard can be found at this link, http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/aar-raa-ann7-eng.htm

Applicant Guidance Document – Environmental Information Reviews

- First prepared in 2008 and periodically updated, it was prepared to address the need for more comprehensive environmental management planning, and help applicants prepare the required information in a more standardized fashion. It was prepared by DFA in consultation with Transport Canada, DFO, and ENVC.
- The goal is to improve the efficiency of "one-stop shop" application process on the basis that clear and complete information gathered early will reduce the need for multiple agencies to request additional information later in the review process. The information requested is reviewed on the basis that it is applying recognized operational standards, codes and regulation.

- The template is a reflection of the environment relevant sections of the aquaculture licence application for grow-out operations and the typical information is as follows:

Section C

- Site location and location of works
- Information on routine operational maintenance
- Description of fisheries in the vicinity of the undertaking.

Section D

- Activities or pollution sources in the area that may pose a threat to the site.
- Describe all waste materials expected to be generated by the operation released into the water or will require disposal on land, as well as the standard operation practices to mitigate impacts to the environment
- Impact of the environment on the project (e.g., weather and climate, tides, algal blooms, superchill), and measures to mitigate these changes.
- Potential risk due to malfunctions or accidents that may occur during installation, operation, and decommissioning phases of the project, and the operational plans to prevent such accidents and malfunctions and presentation of the contingency plans to deal with each of these potential situations (e.g., Retrieval methods for lost gear, plans/methods to limit escapees, Emergency Response Plan, refueling procedures, and spill response
- Measures to mitigate any harmful effects of the construction and operational phases of the project. Measures include, but are not limited to, ensuring that the construction site remains clean after work is completed and a biosecurity plan is in place.
- Identify species at risk (SAR) that may be present and outline appropriate management measures. In 2010 the information requirements for the '*Species at Risk Act* (SARA)' were expanded on the request of DFO. SARA prohibits: the killing, harming or harassing of a threatened, endangered or extirpated species; the damage or destruction of an individual species' residence; and the destruction of any part of a species' critical habitat.

1) The applicant must identify species at risk (SAR) that may be present and outline appropriate management measures. To do this, the applicant must review the SAR Public Registry for the most current information.
2) An aquaculture industry factsheet for SAR can be found at www.dfo-mpo.gc.ca/species-especes/act-loi/aquaculture-info-eng.htm. As well, SARA, Schedule 1 is updated periodically, and the applicant must access the public registry (http://www.sararegistry.gc.ca/default_e.cfm) in order to prepare its management measures. The applicant is also encouraged to be familiar with species being considered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) because they may be listed under SARA during the life of the site operation.
3) Where recovery strategies and action plans are available, they can be used to gather information on the species in question. Recovery strategies and action plans can be found at www.sararegistry.gc.ca/default_e.cfm.
4) DFO will review the applicant's management measures, how it will to respond to sightings and/or potential farm interaction with species of concern. Measures can include any one or more of the following: preventative measures; observation and recording; reporting; and handling and freeing of entangled or penned animals

- Respecting finfish sites, when managing nutrient loading/depositional waste (i.e., faeces, feed and biofouling), applicants need to consider the potential outcomes of mandatory "Environmental Effects Monitoring (EEM)", which DFO administers. There are multiple integrated management measures that can mitigate an operation's accumulation of organic matter, and examples of standard practices and mitigation measures applied in NL are listed in the guide.
- Description of proposed methods to minimize fish escapes from cages, and procedures for recapture of escapes.
- Should decommissioning be required, description of the process, including measures to restore the area to its natural setting. Provide details on how all associated infrastructure will be removed from the site if the site is no longer required. Explain how this material will be disposed of.

Section F

- This section focuses on benthic monitoring and going forward will make reference to the new AAR and its requirements, which replaces the previous management framework administered under the Fisheries Act that reviewed information on the basis of making a Harmful Alteration, Disruption or Destruction of Fish Habitat (HADD).

Aquaculture Activity Regulations (AAR) Information requirements (implemented in 2015): The AAR are new federal regulations implemented in 2015 and administered by DFO. The AAR:

- Clarify conditions under which aquaculture operators may treat their fish for disease and parasites, as well as deposit organic matter.
- They also impose public reporting on the environmental performance of the sector as well as specific environmental monitoring and sampling requirements.
- Designed to align with policies and regulatory regimes that already exist in provincial and other federal jurisdictions through codification of these measures, while providing further clarification with the addition of AAR-specific conditions.
- Reconciling and clarifying aquaculture-related regulations will improve coherence, simplicity and accountability.
- Increase operational certainty across Canada, improve environmental protection, and increase reporting with the intention of strengthening public confidence.
- AAR requires a proponent to collect site specific environmental data for baseline benthic conditions as well as ongoing benthic monitoring of each production cycle in order to measure and determine the effectiveness of a site to manage Biochemical Oxygen Demand (BOD).

In addition to the above, the DFO website (http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/aar-raa-eng.htm) regarding AAR states:

> "As in the past, the Regulations require that only products regulated by Health Canada under the *Pest Control Products Act* or the *Food and Drugs Act* may be used. The

Regulations also impose specific environmental monitoring and sampling requirements on the industry, as well as greater public reporting.

With these new Regulations, aquaculture operators now have to provide written reports of considered alternatives to pesticide and drug use. They also have to have mitigation measures in place to minimize serious harm to fish and fish habit when they do use any pesticide or drug, including immediately notifying Fisheries and Oceans Canada in the event of fish mortality or increased morbidity and take immediate actions as directed by the Department, such as stopping the deposit of pesticides. They must also report these activities on a yearly basis to the Department, which will make the overall data publicly available."

Baseline Data required for Assessment of Aquaculture Site Licence Applications

Prior to approving an undertaking, AAR requires all sea cage aquaculture site licence applicants to provide the following:

- Current measure and profiling, and predictive modelling of organic deposits (a specific model is not prescribed by the regulation, but an example would be DEPOMOD. The basis of models is to input current magnitude and direction, production scale and feeding scale, and bathymetry to make a prediction on the footprint carbon will deposit on an aquaculture lease)
- Bathymetry
- Substrate characterization
- Recording of pre-existing deposits and indicator species
- The assessment process is approximately 300 days

In addition to the AAR requirements, DFO also requires benthic sampling on a 100m grid over the entire site area in order to characterize the benthic area of the site. The characterization will allow DFO to make determination on sensitive or critical habitat (i.e. Species at Risk related habitat, fishing habitat).

1) <u>Bathymetry survey –</u>

The bathymetric survey must be conducted with a minimum resolution of 10 m contours to generate depth profiles within 1 g C/m^2/day depositional contours, calculated using a unspecified aquaculture waste deposition model and map of 1, 5 and 10g/m2/day depositional contours (i.e., DFO does not prescribe the model to be used, so the first year will be open to trialing models brought forward by the surveyers). Also, there is an option to use bathymetric maps from the Canadian Hydrographic Service instead of conducting a bathymetry survey for the purpose of displaying the 1 g C/m^2/day contours.

2) Substrate characterization –

The following information within the 1 g C/m2/day depositional contour must be collected:

- Geographical position
- Depth
- Date and time of sampling
- Sediment texture and colour
- Presence of gas bubbles
- Estimation of surface coverage of bacterial mats
- Presence of marine worms
- Presence of fish feces and feed
- Presence of flocculent (wool-like) organic material
- Video must be completed along two transects, perpendicular to each other, starting from each corner of the containment array and extending away from the array for 100 m
- Addition video transects must be recorded from the middle of each side of an array that will consists of more than nine cages in a row
- Free sulphide concentration
    - A minimum of two sample stations must be established, one at each edge of either side of the containment array in the direction of the dominant current.

- Redox and pH on all samples with free sulphide concentrations
- Total volatile solids (TVS)

3) <u>Reporting –</u>

The report of baseline survey findings must include:

- Observations recorded from underwater surveys including unedited images
- A map of the transect locations and habitat information generated during these transects at a resolution of 1:5,000 or finer
- Bathymetry of the seabed at a resolution of 10 m contours, and estimated footprint of BOD at 1, 5, and 10 g C/m^2/day contours
- Sediment sampling results

Compliance monitoring post licensing

There are several key components of ongoing effects and compliance monitoring as follows:

- Sample system based on multiple transects from cage end out to 100m
- Distance from cage and sample depth
- Substrate characterization
- Recording of deposits, chemistry and/or indicator species
- AAR prohibits an operator to begin a new production scale until it is demonstrated that measures of sulphide or *beggiatoa* (bacteria that favour sulphur rich environments) are within compliance thresholds (i.e., S is the indicator for soft bottom environments and *beggiatoe* for hard bottom environments)

Canadian Environmental Assessment Agency Screening

A Canadian Environmental Assessment Agency (CEAA) screening is no longer triggered by application to TC under the Navigation Protection Act (NPA) or to DFO for sea cage sites. A screening may still be required, but is no longer triggered by virtue of application. This process came into effect in December of 2012 when the CEAA screening was changed to focus only on projects that had potential to cause significant environmental effects. Since January of 2013, only 3 sea cage sites have been licensed. All other sea cage sites licensed prior to this would have been screened and released from any required for assessment under the CEAA.

DFO applies their environmental monitoring requirements and processes (as described above) and if necessary will feed into the Canadian Environmental Assessment Agency (CEAA) screening process. When TC was screening sea cage sites, they would refer to DFO for recommendations on whether assessment under CEAA was required – sea cage sites were always released without required for assessment.

When considering whether a project must be assessed under CEAA, the following information is provided on the CEAA website (https://www.ceaa-acee.gc.ca/default.asp?lang=en&n=1BBF802A-1) :

> ‘Considerations
>
> The Project List identifies types of major projects that have the greatest potential for significant adverse environmental effects in areas of federal jurisdiction. It is therefore expected that the majority of these designated projects will warrant an environmental assessment.
>
> The adverse environmental effects considered are referred to in section 5 of CEAA 2012 and include effects that are within the legislative authority of Parliament or that could result from a federal decision about the designated project.

In determining whether an environmental assessment is required, the Agency considers matters that include:

•the information provided in the proponent's project description

•the potential for adverse environmental effects taking into account the views of expert federal departments, Aboriginal groups and the public

•the potential nature and extent of the anticipated adverse environmental effects;

•the location and environmental setting of the project

•the potential for cumulative effects from the project and other existing and proposed activities in the same region

•potential impacts to Aboriginal peoples and to potential and established Aboriginal and Treaty rights

•the ability of regulatory or permitting processes to address potential adverse environmental effects

•the results of any relevant regional study conducted under CEAA2012

Considerations that could lead to a determination that an environmental assessment is not required include:

•the designated project is not likely to cause adverse environmental effects in areas of federal jurisdiction as set out in section 5 of CEAA 2012

•the adverse effects can be adequately managed through other existing legislative or regulatory mechanisms'

DFO has been managing environmental impacts through pre-site baseline assessment, fallow period monitoring and now the new AAR.

Further DFO's role under CEA is described on the CEAA website (https://www.ceaa-acee.gc.ca/default.asp?lang=en&n=E9928E55-1#ToC-18) as follows:

Fisheries and Oceans Canada

Fisheries and Oceans Canada is currently finalizing an internal operational guidance document that outlines an overarching risk-based approach for the assessment and reporting of environmental effects of projects proposed on federal lands that are subject to Section 67 of the Canadian Environmental Assessment Act, 2012 (CEAA 2012). The Department's guidance will be based on the Canadian Environmental Assessment Agency's Operational Policy Statement as well as an Inter-Departmental interim Section 67 Determination Guidance.

Presently, staff follows interim guidance that includes the requirement to complete a Project Effects Determination Report for projects subject to Section 67. The report is a means to record the predicted environmental effects and the proposed mitigation measures that are applied to minimize the potential negative environmental effects of projects on federal lands.

In addition, DFO's Fisheries Protection Program owns and manages a national database that is used for collecting information on various program activities. This system, called the Program Activity Tracking for Habitat - PATH, has been made available to all programs in the Department who have responsibilities under CEAA 2012 related to projects on federal lands. PATH can be used to obtain statistical reports on numbers of projects that the department has evaluated under section 67 of CEAA 2012.

Consolidation of Sea Cage Site Aquaculture Licence Application Referral Feedback:

Upon receipt of input/recommendations/ permits/approvals from each agency and from advertising, the application and input is reviewed by the DFA Aquaculture Licensing Committee. The committee makes a recommendation to the minister on whether the application should be approved, rejected or approved subject to any necessary provisions. An approval results in the issuance of an Aquaculture Licence. All referral agencies issue their approvals/permits to both the proponent, copying DFA (Water Resources sends their approval documents to DFA and DFA sends to proponent with the licence).

Approval Process for alternative strains of Atlantic Salmon (triploid and others):

The Newfoundland salmonid aquaculture industry currently has approved for use in Newfoundland the Saint John River strain of salmon and other salmon strains of Northwest Atlantic origins, assuming they meet fish health diagnostic requirements of both CFIA and DFA. The use of alternative strains of salmon, either triploid or diploid strains, must undergo several levels of approval prior to being permitted for use in the province. These approval processes can occur concurrently.

Requirements under the Aquaculture Act:

Section 8 (3) of the Aquaculture Act - Introduction, transfer and transport - states:

(3) The minister shall not approve the introduction into or transfer to a body of water or aquaculture facility in the province of a species or strain of aquatic plants or animals not present in that body of water or that aquaculture facility unless the impact of that introduction or transfer has been assessed in accordance with the Part X of the Environmental Protection Act, whether or not that introduction or transfer is an activity of the type otherwise requiring assessment under that Act.

The use of the triploid Norwegian or Iceland strain **must be register for Environmental Assessment.** The initial screening of the registration requires a 45 day review period, followed by a decision by the Minister. The Minister may choose to:

- Release the Project from further review. (this was done with the use of diploid trout in 1999)
- Require an Environmental Preview Report
- Require an Environmental Impact Statement
- Reject the Project.

Transfer Permitting Processes:

Applicants wishing to use alternative strains of salmon must apply for transfer permits from the Department of Fisheries and Oceans (DFO), the Canadian Food Inspection Agency (CFIA) and the Department of Fisheries and Aquaculture (DFA).

Fisheries and Oceans Canada (DFO):

Application to DFO to transfer alternative strains of salmon into the province must undergo a risk assessment under the federal National Code on Introductions and Transfers of Aquatic Organisms. The risk assessment considers both genetic and ecological consequences of the transfer of organisms and ranks them in a risk assessment matrix in low, medium and high categories. Risk must be mitigated to low risk prior to a transfer being permitted. Should this be achieved, DFO may issue a transfer license to allow the transfer to occur. The process is segmented into three main components to reflect the overall level of risk imposed by a proposed introduction or transfer:

1. General consequences of potential hazards from genetic and ecological factors associated with the proposed introduction or transfer,
2. The likelihood of occurrence of the hazard, and
3. A risk matrix that consolidates the consequences and likelihoods

The information requirements that an applicant must provide to apply for an introduction or transfer licence for new strains under the National Code on Introductions and Transfers of Aquatic Organisms is in Appendix 3. The risk assessment process from the National Code on Introductions and Transfers of Aquatic Organisms can be found in Appendix 4.

Canadian Food Inspection Agency (CFIA):

CFIA is the federal lead for the delivery of the National Aquatic Animal Health Program (NAAHP). Its goal is to prevent the introduction and spread of aquatic animal diseases.

Import permits are required from CFIA for susceptible species of finfish, molluscs, and crustaceans. These animals must meet the import requirements to enter Canada.

Under the NAAHP, CFIA utilizes a risk-based disease management approach reflecting defined lists of federally reportable diseases, immediately and annually notifiable diseases, and the species of finfish, molluscs, and crustaceans susceptible to these diseases. Import permits contain specific requirements based on the disease risks associated with the animal, the origin, and other relevant health information. Imported aquatic animals may require health certification from the country of origin, to ensure that the animals imported into Canada, meet Canada's aquatic animal health requirements.

More information about the NAAHP can be found at:
http://www.inspection.gc.ca/animals/aquatic-animals/eng/1299155892122/1320536294234

Newfoundland and Labrador Department of Fisheries and Aquaculture (DFA):
A transfer of all aquaculture stock into and around the province requires a permit from DFA. DFA assesses permits for compliance with existing policy, legislation, regulation and adherence to management plan. DFA's Aquatic Animal Health Division also requires diagnostics to be performed on all stock prior to transfers occurring in order to minimize the risk of disease transfer.

APPENDIX 1
Sea Cage Aquaculture Licence Application

Aquaculture Licence Application

Finfish Cage Culture

SECTION A: APPLICANT INFORMATION

Company/Individual Name:
____

Type of Business: Individual Partnership □ Company Date Incorporated
____

Principal Contact: _____________________________ Title:
____

Address: _________________________________ City/Town:
____

Province: _____________________ Country: ______________ Postal Code:
____

Phone #'s: Home ___________________ Business _________________ Cell
____

Fax __________________ E-mail Address
____

For Companies and Partnerships, include a separate list of owners showing names, addresses and percentage of ownership.

If the Environmental Assessment information was prepared by a consultant(s) or others on behalf of the proponent, please provide the same contact information for the responsible individual(s)

Company/Individual Name:
____

Principle Contact: ___________________________Title:__________________________

Address: ___________________________ City/Town: _______________________________

Province: _____________________ Country: ______________

Postal Code: __________________

Phone #'s: Home ____________________ Business __________________ Cell ___________________

Fax _______________E-mail Address ____

SECTION B: SPECIES INFORMATION

1. Species/Strain to be Cultured ____

2. Source of Animals:

   a) Company's own Broodstock Yes No

   b) If yes, location of hatchery: ____

   c) If no, who will be supplier of animals:

   Company ____

   Address____

   Phone # _________________ Contact Person ____________________________

3. Type of License: Developmental Commercial Research

4. Do you currently hold an aquaculture licence(s)? Yes No

If yes, give Licence Number(s) ____

SECTION C: SITE INFORMATION – ALL MEASUREMENTS IN METRIC UNITS

Include Separate Maps Showing Exact Location of Site and Details of Layout

1. Proposed Location: ____

Map Reference Coordinates (Measured at centre point of site in degrees and decimal minutes):

Examples: 56º 30'30" would be written as 56º 30.5'

56.725º would be written as 56 º43.5'

Latitude __________ º _________ ' Longitude __________ º ___________ '

2. Size of site in hectares: (1 hectare (ha) = 100 metres(m) x 100 metres(m))___________________

Dimension of Site: _________ metres **x** _________ metres.

3. Nearest Community:

____

4. Type of land tenure: Private Crown Land Other

____

5. Will onshore facilities be constructed? Yes No

If yes, type of facility:

____

When will construction begin?

____

Note: Applicant must obtain all necessary approvals from other Depts/Agencies.

* Indicate the location of these facilities on a map.

6. Provide information concerning any existing or planned construction activities that will take place in or near water, on wetlands, or on beaches. Include a schedule of proposed activities and their location in the following table.

Table 1.

Description	**Number**	**Dimension (in Meters)**	**Construction Date**

Example:

Wharf	**1**	**10m x 3m**	**May 2002**
Cabin	**1**	**10m x 6m**	**July 2002**
Floating Feed Shed	**1**	**8m x 8m**	**July 2002**

7. If heavy machinery, vehicles or vessels are required for installation and construction phases, list the specific types and explain when and how they are to be used. For example, an excavator may be used to dredge an area or install shore-based infrastructure.

____

____

____

____

8. Describe any routine facility maintenance procedures, including frequency.

____

____

____

____

____

9. Nearest aquaculture site

____

Distance ____________kilometers Species cultured _____________________

10. Describe any fishing activities (e.g., commercial , aboriginal or recreational fisheries), tourism operations, cabins, recreational activities (e.g., boating, diving, water skiing, swimming, etc) that are located **within a 2km radius of the site lease boundary**.Provide information on their time(s) of operation and proximity to the site.

____

____

____

____

____

11. Has an aquaculture assessment been carried out on the site? Yes No

If yes, give details

____

____

SECTION D: ENVIRONMENTAL CONCERNS

1. .Identify any known activities or pollution sources in the area that may pose a threat to the site. Describe the activity(ies) and explain how it/they could impact the site.

____

____

____

____

____

2 Describe all waste materials expected to be generated by the operation of this facility which shall be released into the water (i.e. fecal, food particles, etc.) or which will require disposal on land.

____

____

____

____

____

3. Identify any changes to the project that may be caused by the environment. Aspects of the environment, such as weather and climate, tides, algal blooms, superchill, etc. should be considered. Identify measures to mitigate these changes.

____

____

____

____

4. Identify potential risks due to **malfunctions or accidents** that may occur during the installation, operation, and decommissioning phases of the project (e.g., fuel spills, storm

destruction, etc.). Discuss operational plans to prevent such accidents and malfunctions and present contingency plans to deal with each of these potential situations.

____
____
____
____
____

5. List planned measures to mitigate any harmful effects of the **construction and operational phases** of the project. Measures include but are not limited to ensuring that the construction site remains clean after work is completed, a bio-security plan is in place, and application of the code of containment.

____
____
____
____
____

6. Describe proposed methods to minimize fish escapes from cages. Also describe procedures for recapture of escapees.

____
____
____
____
____

7. Should decommissioning be required, describe the process, including measures to restore the area to its natural setting. Provide details on how all associated infrastructure will be removed from the site if the site is no longer required. Explain how this material will be disposed of.

____
____
____
____
____

SECTION E: DEVELOPMENT/PRODUCTION PLAN

Please use Table 2 on page 5 to record the following information:

1 At full operation state:

a) estimated month and year stock will be purchased.

b) the expected number of smolts or fingerlings to be stocked;

c) the grow out period.

d) the average individual fish weight at the start and the end of grow out;

e) expected losses over grow out period.

f) The final production quantity (kg) at the end of growth period

Table 2.

Year/ Month	Stocking Number	Growth Period	Avg. Start Weight (kg)	Average Final Weight (kg)	Expected Losses (%)	Expected Production (kg)

Example

1999/05	50000	18	0.130 kg	3.5 kg	20%	140,000 kg

2. .Expected maximum stocking (rearing) density _____________ kg/m³

3. Broodstock will be reared: Yes No

If yes, state approximate number and weight:

____

4. If broodstock are stripped, where will egg incubation occur?

____

5. In what year do you anticipate to reach peak production?
____

6. At peak production, what is your anticipated harvest for this site? _____________ tonnes.

7. Indicate number and type of net cages proposed for each year in Table 3.

Table 3.

Year/Month	Type of Cage and Mesh Size	Number of Cages	Holding Capacity (cubic meters, m^3)

Example

1999/05	**Wooden (25m) Octagon**	**6**	**6 x 600 m^3 = 3960 m^3**

8. Identify predators that will likely threaten the site and describe any predator control plan.

____

____

____

SECTION F: WATER AND SITE QUALITY

1. A fallow period is required. Indicate licensed site location of fish (if not being harvested) during fallow period and describe the rotation plan for fallowing.

____

____

____

____

____

*Indicate on a map what area will be used for fallow.

2. Clearly specify type of feed used (ie. moist, dry, silage based, other):
____

3. Describe the method of feed administration (ie., by hand, auto feeders, etc.). Provide your feed schedule for the entire growth cycle. Include planned amounts to be used. Provide annual totals for production tonnage and feed consumption.

____

____

____

____

____

4. Describe, in detail, the methods that will be adopted to minimize excess feed such as the use of feed tables, calculations to optimize feed use., the use of one feed form over another, feed cameras or other electronic feedback systems (including frequency of monitoring), pellet size, etc.

____

____

____

____

______

Complete <u>either</u> Section F(a) on page 8 if applying for a salt water cage operation <u>or</u> Section F(b) on page 9 if applying for a fresh water cage operation.

<u>SECTION F(a) SITE SUITABILITY FOR SALTWATER NET CAGE OPERATION</u>

1. <u>TEMPERATURE SALINITY PROFILE</u>

record temperatures in degrees Celsius (ºC) and salinity as parts per thousand (ppt) at the indicated depths.

	Spring		Summer		Fall		Winter	
Depth (m)	**Temp**	**Salinity**	**Temp**	**Salinity**	**Temp**	**Salinity**	**Temp**	**Salinity**
0								
1								
2								

3								
4								
5								
10								
Bottom less 1 metre								

2. Minimum water depth **below the bottom of the net cages** at low tide ____________________m.

* Include this depth on cross-sectional drawing of site.

3. Exposure to Wind and waves:

a) Maximum fetch: _________ kilometers. Direction: _____________.

b) Prevailing wind direction:

Spring __________ Summer ___________ Fall ____________ Winter _________

c) Maximum wave height ______________ meters.

4. What is the prevailing **storm wind** direction?
____

* Label this wind on a map.

SECTION F(b): SITE SUITABILITY FOR FRESH WATER NET CAGE OPERATION

1. WATER QUALITY

- Determine the levels of the following parameters at your proposed site at a depth of one (1) meter.

Parameters Values	**Spring**	**Summer**	**Fall**	**Winter**
Dissolved Oxygen (mg/l)				
Total Alkalinity (mg/l)				
Hardness (as Calcium Carbonate) (mg/l)				
Ammonia (mg/l)				
pH				
Temperature (°C)				

2. DIMENSIONS OF LAKE

a) Overall area of lake: ___________ hectares.

b) Average depth of lake: __________ metres.

c) Maximum depth of lake: _________ metres.

3. Minimum water depth **below the bottom of the net cages** ____________m.

* Include this depth on cross-sectional drawing of site.

4. EXPOSURE TO WIND AND WAVES

a) Maximum fetch ________ kilometers. Direction ___________ .

b) Prevailing Winds:

Spring ________ Summer _________ Fall __________ Winter __________

c) Maximum wave height _________ m.

5. What is the prevailing **storm wind** direction?

____

* Label this wind on a map.

SECTION F(c): BOTTOM SAMPLES

Complete all Required Columns in the Table (See notes below):

Sample ID Number	Sample Site Coordinate	Water Depth at Low Tide	Sample Number	Sediment Color	Bottom Sediment(Sandy, Gravel, Rock, Mud)	Sediment Redox Potential Eh (mv)	Sediment Sulphide (uM)	Sample Photo Number, Short Description of Grab Composition and any Comments
			1					
			2	This section is currently being revised to reflect the baseline data required under the Aquaculture Activity Regulations. The AAR guidance document can be found at this link, http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/aar-raa-gd-eng.htm The AAR aquaculture monitoring standard can be found at this link, http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/aar-raa-ann7-eng.htm				
			3					
			1					
			2					
			3					
			1					
			2					
			3					
			1					
			2					
			3					

Notes of Completion of Table:

a) For aquaculture sites with five finfish cages or less, provide a sample from each cage location. For aquaculture sites with more than five cages, provide sediment samples and depths for the entire aquaculture lease area at a sample density or not more than 100 metres spacing. That is to say, minimum of four samples per hectare must be provided.

b) For each sample provide a description of the bottom ie. Is the bottom mud, sand, gravel, or rock? What colour is the sample? For example – Fine light brown sand, or grey sandy gravel, or black mud, etc.

c) For each sample site, and where possible, take an Ekman Grab or core sample of the bottom and measure the redox (Eh) potential and provide sulphide data from the sediment sample. If a sample cannot be taken, state why.

d) Provide at least one dated, colour photograph per station. Ensure each photograph is clearly referenced to the sample and station. Use a coin or other suitable object to indicate scale in each photograph.

SECTION G: CONSULTATION

The proponent is required to make initial contact with other users of the water resource to identify and resolve any potential conflicts where possible. Such users include local fishers committees, tourism groups, economic development boards etc. Please identify contacts made.

Organization	Contact Person	Phone	Concern	Date
			Yes No	
			Yes No	
			Yes No	
			Yes No	
			Yes No	

Details on any concerns noted:

____

____

____

____

DECLARATION, CONSENT, AND DISCLOSURE

I/We, the undersigned proponent(s) understand and acknowledge that in making this application for an aquaculture license, the following departments and/or agencies of government (provincial and federal) may be consulted and involved in the review of this application as follows:

1. Department of Environment and Conservation – Water Resources Management Division – under Sections 14 and 48 of the *Water Resources Act* SNL 2002 cW-4.01, **either,** Marine Aquaculture Water Use Licence/Permit for marine sites, **or**, Water Use License and Permit for freshwater sites. The need for environmental assessment or other related requirement(s) under the *Environmental Protection Act* SNL 2002 cE-14.2 will be determined as necessary.
2. Department of Environment and Conservation - Crown Lands Branch – approval under the *Lands Act.*
3. Transport Canada – approval under the *Navigable Waters Protection Act.*
4. Department of Fisheries and Aquaculture (Newfoundland and Labrador) – approval for aquaculture licence under the *Aquaculture Act.*
5. Fisheries and Oceans Canada
6. Other Departments/Agencies where applicable.

The information provided on this application do not release the applicant from obtaining the necessary approvals from any other Department, Agency or other entity having jurisdiction in relation to the site or activities occurring at that location.

I/We certify that the information contained in this application and the related documents is true and correct in all respects.

I/We hereby authorize the Department of Fisheries & Aquaculture to obtain information concerning my/our financial affairs in relation to this application from the parties noted.

____

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Date | Signature and Title of applicant
(Corporations must affix corporate seal)

APPENDIX 2

Consultation Process for Sea Cage Aquaculture Licence Applications

Consultation Process for Sea Cage Aquaculture Licence Applications

There are three methods whereby consultation with the public is sought.

1) **Pre-application submission consultation**:

Applicants that wish to licence an aquaculture site must conduct consultations with stakeholders in the vicinity of the site prior to submission of the aquaculture application. Section G of the DFA Cage Culture Application states:

> "The proponent is required to make initial contact with other users of the water resource to identify and resolve any potential conflicts where possible. Such users include local fishers committees, tourism groups, economic development boards etc."

Applicants must provide date and times of consultations including details on issues that arose and whether or not they were resolved. DFA will not accept sea cage culture application without the competed section G.

2) Advertising to the public:

Once the application is submitted, assessed internally by DFA staff and sent out to referral agencies, the applicant must advertise their intent for the proposed site and request comments from the public. The period for comments is for two weeks after the ad last appears in the newspapers. DFA advises the applicant by email that:

> "As part of the aquaculture licensing process, applications must be advertised in local and regional newspapers to ensure other user groups have an opportunity to identify any concerns about the proposed aquaculture development.
>
> An applicant for a new licence, licence transfer or change of operator shall give notice of his or her intention to apply for the licence, by advertisement in the form prescribed, once a week for two consecutive weeks.
>
> Advertisements must appear in the Classified Section of:
> (1) a newspaper (Saturday edition) with province-wide circulation (e.g. Saturday Telegram) and
> (2) a newspaper circulating in the area in which the licence is requested (e.g. The Coaster).
>
> The applicant must demonstrate that the advertisements have been placed in the appropriate manner by submitting a copy of the advertisements, the newspapers utilized and the dates of placement. This information should be submitted to the Aquaculture Licensing Administrator immediately after the advertisements have been published. Separate ads are required for each application."

The ads state:

> "TAKE NOTICE that [*Company Name*] has applied under the provisions of the Aquaculture Act for the issuance of an Aquaculture Licence to operate a [*Type of Licence/Species*] aquaculture facility at [*Location, Coordinates*] in the Province of Newfoundland and Labrador.
>
> Comments on this application should be directed to the Aquaculture Licensing Administrator, Department of Fisheries and Aquaculture. Comments must be received no later than [*specific date to be no less than two weeks after the date of the last advertisement*]"

Starting in November of 2015, all cage site applications will be posted on the DFA website. Anyone may comment or submit questions on any applications that are viewed on the DFA website by contacting either the company applying or DFA Licensing Division.

3) Transport Canada Advertising Requirements:

In addition to the advertising required by DFA as part of the application process, Transport Canada also requires advertising of all proposed works, including marine sea cage sites. Transport Canada assesses the site drawings for safe navigation and appropriate placement and then advises the applicant to advertise the proposed site diagrams for public comment. The specific requirements are below:

1. Deposit a copy of the enclosed reviewed stamped plans in the local Town Office The plans have to be posted for 30 days after the advertisement is local paper is printed (see step 2). Once the 30 days is reached the Town Clerk is to sign and date the plans and also complete a Certification of Plan Deposition "A" to attest that the plans were available for review during this period. Ensure to retrieve the documents from the Town Office, (see step 4);
2. Place an advertisement in the legal section of one local paper in or near the place where the work is to be constructed using the Model Advertisement. The public notice is required to appear in only one edition of the publication;
3. The owner is to complete the attached Letter of Confirmation as proof of public notice
4. Forward the Letter of Confirmation, Certification of Plan Deposition, Newspaper Advertisement and Reviewed Stamped Plans with the Town Clerk's signature and date back to Transport Canada.

Transport Canada withholds processing of the application until the public notification process is complete. The ad that is placed specifies:

> "Comments regarding the effect of this work on marine navigation may be directed to: Navigation Protection Program, Transport Canada However, comments will be considered only if they are in writing and are received not later than 30 days after the publication of the last notice. Although all comments conforming to the above will be considered, no individual response will be sent."

Where conflict does exist, the applicant is advised to work with the stakeholders that have identified concerns to see if a resolution can be found. All concerns expressed by stakeholders, resolved or not, are communicated to the Aquaculture Licensing Committee for consideration. The ALC will recommend to the Minister whether or not to license the site based on all feedback from referral agencies and consideration of stakeholder responses.

APPENDIX 3
Formal Risk Assessment Information Requirements

Formal Risk Assessment Information Requirements

(source: National Code on Introductions and Transfers of Aquatic Organisms 2013)

To be completed by applicant

Wherever possible, information must be supported by references from the scientific literature and notations to personal communications with scientific authorities and fisheries experts. Applications lacking detail will be returned to the proponent for additional material, delaying the proposal's assessment.

A. Executive Summary

Provide a brief summary of the document, including a description of the proposal, the potential impacts on native species and their habitats, and mitigation steps to minimize the potential impacts on native species.

B. Aquatic Organism

1. Provide the name (common and scientific [genus and species]) of the organism proposed for introduction or transfer.

2. Describe the organism′s characteristics, including distinguishing characteristics. Include a scientific drawing or photograph.

3. Describe the native range and range changes due to introductions.

4. Describe the factors that limit the species in its native range?

5. Describe the physiological tolerances (water quality, temperature, oxygen and salinity) at each life history stage of the organism (early life history stages, adults, reproductive stages).

6. Describe the habitat preferences and tolerances for each life history stage.

7. Describe the organism′s reproductive biology.

8. Describe the migratory behavior.

9. Describe the food preferences for each life history stage.

10. Describe the behavioural traits (social, territorial, aggressive).

11. Describe where the **introduced species** has been documented or theorized to hybridize with other species.

2013 National Code on Introductions and Transfers of Aquatic Organisms 25

12. Describe where the introduced species has been documented to compete on the spawning behaviour and spawning grounds of other species.

13. Describe the known parasites or fellow-travellers of the species or stock.

14. Describe the organism′s history in aquaculture, enhancement or other introductions (if appropriate).

- Record where the species was introduced previously and at what life-history stage, and describe the ecological effects on the environment of the receiving area (predator, prey, competitor, and/or structural/functional elements of the habitat).

C. Source

1. Provide the legal name of the owner and company, the aquaculture licence number, and the business licence (if applicable) and name of the competent authority with a contact name, telephone and fax numbers and email address.

2. Provide a map of the source location watershed with general topography and hydrology layers.

. List the species composition (major aquatic vertebrates, invertebrates and plants) of the source watershed/facility. Identify any of these species known or theorized to be able to survive in the destination watershed.

4. Describe the original source(s) and genetics of all stocks at the source facility (if known). Describe any selection criteria that may have been used on the source stocks.

5. Describe the water cycle process in the source facility.

6. Describe the chemical, biophysical and management precautions taken to prevent the accidental introduction of any fish, parasites and/or pathogens and their establishment in the source facility/water.

7. Describe contingency plans to be followed in the event of an unintentional, accidental or unauthorized breach of security at the source.

8. Describe precautions taken to ensure that no other species (**fellow-travellers)** accompany the shipment.

D. Destination

1. Provide the proponent′s legal name and respective organization, aquaculture licence number and business licence (if applicable), telephone and fax numbers, and email address.

2. Describe the objectives and rationale for the proposed introduction, including an explanation as to why such objectives cannot be met through the utilization of an indigenous species.

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3. Provide a map of the destination watershed with general topography and hydrology layers.

4. Provide physical information on the receiving environment and contiguous water bodies, such as seasonal water temperatures, salinity, turbidity, dissolved oxygen, pH, nutrients and metals. Identify those parameters that match the tolerances/preferences of the species to be introduced, including conditions needed for reproduction.

5. Provide information on habitat in the area of introduction, including contiguous waters, and identify critical habitat or overlap with any species of concern or threatened and endangered species as listed by the Committee on the Status of Endangered Wildlife in Canada. Identify which of those parameters match the tolerances/preferences or limitations of the species to be introduced.

6. List the species composition (major aquatic vertebrates, invertebrates and plants) of the destination watershed and facility. Identify any species in the local watershed known to occupy similar niches or to be susceptible to the diseases and parasites found in the source animal/area/region.

7. Describe any natural or man-made barriers that should prevent the movement of the introduced organisms to adjacent waters.

8. Describe the water cycle process in the destination facility.

9. Describe the chemical, biophysical and management precautions taken to prevent the accidental introduction of any fish, parasites and/or pathogens and their establishment in the destination facility and or surrounding waters. Give details of the water source, effluent destination, any effluent treatment, proximity to storm sewers, predator control, site security, and precautions to prevent escapes.

10. Describe contingency plans to be followed in the event of an accidental or unauthorized breach of security at the destination.

11. What is the potential for survival and establishment of the non-native species or lifehistory stage if it escapes? (This question applies to species intended for aquaculture or for live rearing in a contained facility.)

12. Will the introduced species survive and successfully reproduce in the proposed area of introduction, or will annual stocking be required? (This question applies to species not intended for aquaculture or life in a contained facility.)

13. Describe any plans for follow-up assessments of the proposed introduced species′ success and how negative impacts on native species and their habitats will be assessed. 2013 National Code on Introductions and Transfers of Aquatic Organisms 27

E. References

1. Provide a detailed bibliography of all references cited in the course of preparing the risk assessment.

2. Provide a list of names, including addresses and contacts, of scientific authorities and fisheries experts consulted

APPENDIX 4
Aquatic Organism Risk Assessment

Aquatic Organism Risk Assessment

(source: National Code on Introductions and Transfers of Aquatic Organisms 2013)

To be completed by Introductions and Transfers committees[1]

Introduction

To evaluate the risks associated with the introduction or transfer of aquatic organisms, it is necessary to assess both the probability that a species will become established and the consequences of that potential establishment. The assessment process addresses the major environmental components. It provides a standardised approach to evaluating the risk of genetic and ecological impacts as well as the potential for introducing a "fellow-traveller" or parasite that might impact the native species of the proposed receiving waters. The risk assessment process is to be conducted recognizing the existing industries and the historic transfers of the species that have been approved for use.

This risk assessment should consider other non-intentional vectors of live aquatic organisms where known establishments have occurred. It also provides a mechanism for assessment in cases where establishing a population in the wild is the intended outcome. This approach has been adapted from the final draft report to the Aquatic Nuisance Task Force, Generic Nonindigenous Aquatic Organisms Risk Analysis Review Process, 1996.[2]

At each of Steps 1, 2 and 3, the element rating and rationale for the rating should be recorded based on the following criteria:

A **HIGH** rating means the risk is likely or very likely to occur.

A **MEDIUM** rating means a negative impact is probable.

A **LOW** rating means the risk is considered insignificant.

The strength of the review process is not in the ratings but in the detailed biological and other relevant information statements that motivate them.

[1] Unless the authorising jurisdiction requires the risk assessment to be prepared by the proponent.

[2] Anon. 1996. Report to the Aquatic Nuisance Species Task Force. Generic nonindigenous aquatic organisms risk review process. Risk Assessment and Management Committee. US Aquatic Nuisance Species Task Force. Aquatic Nuisance Prevention and Control Act of 1990. Feb 9, 1996.

PART 1—ECOLOGICAL AND GENETIC RISK ASSESSMENT PROCESS

Part 1, Step 1: Determining the Probability of Establishment (beyond the intended area of introduction)

Complete the following table and provide a brief rationale with appropriate references to support the assigned rating.

Element	**Probability of Establishment (H, M, L)[1]**	**Level of Certainty (VC to VU)[2]**
Estimate the probability that the introduced species could successfully colonize and maintain a population in the intended area of introduction[3]		
Estimate the probability of its spreading beyond the intended area of introduction[4] **or**, Estimate the probability of its spreading beyond the intended are of introduction **if it escapes** (applies to cases in which the intended area of introduction is a confined environment)[5]		
Final Rating[5,6]		

Explanatory Notes

1. H High
   M Medium
   L Low

Element ratings should be supported with data and references, including a rationale.

2. VC Very certain
   RC Reasonably certain
   RU Reasonably uncertain
   VU Very uncertain

   The level of certainty is intended to give an estimate of whether the element that is being rated is based on scientific knowledge and/or experience, or whether it is extremely subjective and based on a "best guess." Such uncertainties need to be taken into account when making a decision.

3. Characteristics within this element include: the organism coming into contact with an adequate food resource; suitability of habitat; encountering appreciable biotic and abiotic environmental resistance; and the ability to reproduce in the new environment. If the organism is introduced into a confined facility (land-based, sea cages, etc.), the facility itself is identified as the intended area of introduction.

4. In cases in which the intended area of introduction is a natural habitat (i.e., the wild), the probability of spreading includes consideration of, but is not limited to, factors such as the ability to use human intervention/activity as a means of dispersal.

5. In cases in which the intended area of introduction is a confined environment, such as a land facility or cages, the probability of spreading beyond the area of introduction depends on whether or not the organism escapes from the area of introduction. For example, a **Low** probability of escape from a confined facility will necessarily result in a **Low** probability of spreading in the surrounding natural habitat. If the probability of escape is deemed **Medium**, then the probability of spreading beyond the area of introduction, if estimated as **High**, could still not be rated higher than Medium; whereas if the probability of escape is deemed **High**, the probability of spreading beyond the area of introduction will not be limited by its probability of escape and could be rated as estimated (i.e., High, Medium or Low).

6. The final rating for the **Probability of Establishment** is assigned the value of the element with the lowest rating (for example, **High** and **Low** ratings for the above elements would result in a final **Low** rating). Again, both events—the probability of the organism successfully colonizing and maintaining a population in the intended area of introduction (whether a confined environment, such as a facility, or a natural habitat) and the probability of spreading beyond the intended area of introduction (estimated as explained above)—need to occur in order to result in establishment beyond the intended area of introduction.

   The final rating for the **Level of Certainty** is assigned the value of the element with the **Lowest** level of certainty (e.g**., Very Certain** and **Reasonably Certain** ratings would result in a final **Reasonably Certain** rating).

Part 1, Step 2: Determining the Consequence of Establishment of an Aquatic Organism

The "**Consequence of Establishment**" is assigned a single rating based on environmental impacts.

Element Estimate of magnitude of environmental impacts, if established	**Consequences of Establishment (H, M, L)**[7]	**Level of Certainty (VC to VU)** [8]
Ecological impact on native ecosystems both locally and within the drainage basin[9]		
Genetic impacts on local self-sustaining stocks or populations[10]		
Final Rating[11,12]		

Explanatory Notes

7. See Note 1.

8. See Note 2.

9. Refers to ecological impacts that can affect the distribution or abundance of native species resulting from alterations in relationships, such as predation, prey availability and habitat availability. In assessing the ecological impacts of establishment, assessors should consider whether the non-indigenous stock i) enters or alters the habitat of indigenous species; ii) displaces indigenous species from optimal habitat; iii) affects the quantity, quality and availability of the food supply of indigenous species; or iv) preys on other species of concern.

10. Refers to genetic impacts that can affect native species' capacity to maintain and transfer to successive generations their current identity and diversity. In assessing genetic impacts, assessors should consider whether the non-indigenous stock i) encounters or interacts with species of concern; ii) affects the survival of local species; iii) affects the reproductive success of local species; iv) affects native stocks' or species' genetic characteristics; or v) when conducting a risk assessment it must be taken into consideration that historic transfers using non indigenous strains have occurred and in some regions no negative impacts have been identified.

11. The final rating for the **Consequences of Establishment** is assigned the value of the element (individual probability) with the **highest** rating (for example: a **High** probability of ecological impact and a **Medium** rating for the probability of genetic impact would result in an overall **High** probability of environmental impact), as both events are independent (i.e., additive probabilities).

12. See Note 6.

Part 1, Step 3: Estimating Aquatic Organism Risk Potential

The overall risk is assigned a single value based on the **Probability of Establishment** and the **Consequences of Establishment.**

Component	**Rating (H,M,L)**	**Level of Certainty (VC to VU)**
Probability of establishment estimate[13]		
Consequences of establishment estimate[14]		
FINAL RISK ESTIMATE [15, 16]		

<u>Explanatory Notes</u>

13. As estimated in Step 1: Use the "final rating level" and "final level of certainty," respectively.
14. As estimated in Step 2: Use the "final rating level" and "final level of certainty," respectively.
15. Under "element rating": Table 1 provides a guide for categorizing the final risk estimate. See also explanatory note 29 below Table 1.
16. Under "level of certainty": The final level of certainty for the **Final risk estimate** is assigned the value of the element with the **lowest** certainty level (e.g., a **Very Certain** and **Reasonably Uncertain** estimate for the probability of establishment and consequences of establishment, respectively, would result in an overall **Reasonably Uncertain** level of certainty).

Definition of **Overall Aquatic Organism Risk Potential**

HIGH = Organism(s) of major concern (major mitigation measures are required).

MEDIUM = Organism(s) of moderate concern.

LOW = Organism(s) of little concern.

Part 1, Step 4: Completion of Risk Assessment Documentation

Specific Management Questions (Mitigation Factors or Measures)

Additional Factors and Notes

1. Mitigation measures to reduce risks could include but are not limited to those listed in Appendix 5.

2. Are there any neighbouring jurisdictions to consult?
   - If Yes: Has this been done, and is the neighbouring jurisdiction concerned?

3. Historical transfers that have been conducted to support existing industries should be taken in consideration when conducting the risk assessment.

PART 2—PARASITE OR FELLOW-TRAVELLER RISK ASSESSMENT PROCESS

Part 2, Step 1: Determining the Probability of Establishment

Complete the following table and provide a brief rationale with appropriate references to support the rating given.
Steps 1 to 3 must be carried out for each **hazard** (i.e., parasite, fellow-traveller).

Element	**Probability of Establishment (H,M,L)** [17]	**Level of Certainty (VC to VU)**[18]
Estimate the probability that a parasite or fellow-traveller may be introduced along with the species proposed for introduction. Note that several pathways may exist through which accompanying species can enter fish habitat. Each must be evaluated.		
Estimate the probability that the parasite or fellow-traveller will encounter susceptible organisms or suitable habitat.		
Final Rating [19, 20]		

Explanatory Notes

17. See Note 1.

18. See Note 2.

19. The final rating for the **Probability of Establishment** is assigned the value of the element with the **lowest** risk rating (e.g., a **Medium** and **Low** estimate for the above elements would result in an overall **Low** rating). Note that the calculation of the final rating follows the multiplication rule of probabilities (i.e., the probability that a given event will occur corresponds to the product of the individual probabilities). Thus the final risk of establishment is assigned the value of the lowest individual probability estimate. Again, both events—the probability of the parasite or fellow-traveller successfully colonizing and maintaining a population in the intended area of introduction (whether in a confined environment, such as a facility, or in a natural habitat) and the probability of spreading beyond the intended area of introduction (see Note 4)—need to occur in order to result in establishment beyond the intended area of introduction.

20. The final rating for the **level of certainty** for the Probability of Establishment is assigned the value of the element with the **lowest** level of certainty (e.g., **Very Certain** and **Reasonably Uncertain** ratings for the above elements would result in a final **Reasonably Uncertain** rating).

Part 2, Step 2: Determining the Consequence of Establishment of a Parasite or Fellow-Traveller

Complete the following table and provide a brief rationale with appropriate references to support the rating given. The final rating of the Consequences of Establishment is assigned a single rating based on environmental impacts.

Element	**Consequences of Establishment (H, M, L)** [21]	**Level of Certainty (VC to VU)** [22]
Impacts of establishment of a parasite or fellow-traveller on native species and/or aquaculture in the watershed		
Ecological impacts on native ecosystems both locally and within the drainage basin, including reduction in reproductive capacity and habitat changes, etc.		
Genetic impacts on local self-sustaining stocks or populations (i.e., whether or not the parasite or fellow-traveler affects the genetic characteristics of native stocks or species)		
Final Rating[23, 24]		

<u>Explanatory Notes</u>

21. See Note 1.

22. See Note 2.

23. The final rating for the **Consequences of Establishment** is assigned the value of the element (individual probability) with highest risk rating (e.g., **High** and **Medium** ratings for the above elements would result in a final **High** rating), as both events are independent (i.e., additive probabilities).

24. See Note 20.

Part 2, Step 3: Estimating Parasite or Fellow-Traveller Risk Potential

The overall risk is assigned a single value based on the **Probability of Establishment** and the **Consequences of Establishment.**

Component	**Rating (H, M, L)**	**Level of Certainty (VC to VU)**
Probability of Establishment estimate[25]		
Consequence of Establishment estimate[26]		
FINAL RISK ESTIMATE [27, 28]		

Explanatory Notes

25. As estimated in Step 1: Use "final rating for probability of establishment" and "final rating for the level of certainty," respectively.

26. As estimated in Step 2: Use "final rating for consequences of establishment" and "final rating for the level of certainty," respectively.

27. Under "element rating," Table 1 below provides a guide for categorizing the final risk estimate.

28. See Note 20.

Definition of **"Parasite and Fellow-Traveller Organism Risk Potential"**

HIGH = Organism(s) of major concern (major mitigation measures are required).

MEDIUM = Organism(s) of moderate concern.

LOW = Acceptable risk - organism(s) of little concern.

Part 2, Step 4: Completion of Risk Assessment Documentation

Specific Management Questions (Mitigation Factors or Measures)

Additional Factors and Notes

Examples of mitigation measures to reduce risk are included in Appendix 5.

Table 1. How to Categorize the Final Risk Estimate[29]

Probability of Establishment	Consequences of Establishment	Final Risk Estimate
High	High	High
High	Medium	High
High	Low	Medium
Medium	High	High
Medium	Medium	Medium
Medium	Low	Medium
Low	High	Medium
Low	Medium	Medium
Low	Low	Low

Explanatory Note

29. If there is no probability increment between the two estimates (i.e., if the Probability of Establishment is **High** and the Consequence of Establishment is **Medium**), then the final risk estimate takes the value of the highest of the two probabilities to err on the side of safety (precautionary approach).

NATIONAL CODE ON INTRODUCTIONS AND TRANSFERS OF AQUATIC ORGANISMS

Organism Risk Assessment Summary Report Form

To be completed by Introductions and Transfers committees

Name of Proponent:

Summary Prepared By:

Date Submitted:

History, background and rationale for the request:

Description of aquatic organism or activity to be assessed:

Volume, quantity and frequency of importation:

Time schedule associated with introduction and transfer activity:

Hazard Identification

Organism Risk Assessment Summary Information

Summary of the Ecological and Genetic Risk Assessment

Summary of the Parasite/Fellow-Traveller Risk Assessment

Parasites:

Other “fellow-travellers”:

Comments:

Mitigation Measures:

Concluding Statement on Total Organism Potential Risk:

____

Approved by

__________________________________ _____________________

Signature Date

APPENDIX 5
Applicant Guidance Document – Environmental Information Reviews

APPLICANT GUIDANCE DOCUMENT –

ENVIRONMENTAL INFORMATION REVIEWS

LAST REVISED April 4, 2012

1. INTRODUCTION

New applications for aquaculture sites will undergo a preliminary environmental review by the Department of Fisheries and Aquaculture (DFA) – Aquaculture Branch as a component of the license assessment process.

This is not a change to the application process, or the application form. The review ensures applicants provide sufficient information at the beginning of the application process prior to referral. Its intended each agency will have all the necessary information it requires to complete a full assessment.

There is a requirement for comprehensive environmental management planning in our approach to developing the aquaculture industry. DFA is committed to sustainable development and providing an efficient "one-stop shop" application process, which this guide helps deliver. Complete information gathered early will reduce the need for multiple agencies to request additional information later in the review process.

The following will provide aquaculture applicants detailed guidance. The guide focuses on current areas of priority, which require comprehensive information (i.e., Section D of the application, Environmental Concerns). As a living document, users should note the guide's content can change with priorities and updates in protocol(s). This is the third update of the 'Applicant Guidance Document – Environmental Information Reviews'. The notable change relates to recent changes to the fish habitat baseline data requirements, and more comprehensive information on potential site decommissioning/contingency plans.

2. KEY ENVIRONMENTAL INFORMATION

2.1. GENERAL CONSIDERATIONS

Dated Information

In situations where an application has been previously submitted for a site, there are examples where the applicant relies on information gathered for the previous application. The applicant should not assume information gathered on a previous application is still valid and acceptable.

It will be considered whether the applicant demonstrated:

- It can manage the site and will apply up-to-date practices
- Familiarity in the activities and risks in the vicinity of the proposed undertaking, aquaculture or otherwise, where time lapsed between a previous application and the current application

An applicant should assume only up-to-date information is acceptable.

Competency

General statements referencing the applicant's level of experience will not substitute/address specific information requirements. Applicants should focus on describing the management, operational, and technical aspects of its business when addressing information requirements.

Sustainable Development Requires an Integrative Approach to Environmental Management

Although particular sections of the document (i.e., Section D) focus on the environment, the entire application is reviewed in the context of environmental management (e.g., site biomass information).

2.2. SECTION C: SITE INFORMATION

Supporting Documentation

Separate maps showing exact location of site and details of the layout should be included.

Respecting the site location, the corner coordinates of the site should be included on supporting maps. Coordinates should be expressed as degrees and decimal minutes.

The cage configuration is also important (Finfish). Respecting the details of the layout, the cage number and their layout should be provided as well as the cross-section in proportion to water depth. This is important because Fisheries and Oceans Canada (DFO) - Habitat Protection Division will request the coordinates of each cage are recorded for monitoring purposes.

Item 8: Describe any routine facility maintenance procedures, including frequency.

This should include on site net cleaning and changes (where, when and how) (Finfish).

Item 10: Describe any fishing activities (e.g., commercial, aboriginal or recreational fisheries), tourism operations, cabins, recreational activities (e.g., boating, diving, water skiing, swimming, etc) that are located within a 2 km radius of the site lease boundary. Provide information on their time(s) of operation and proximity to the site.

While DFO has in-house knowledge of fishing activities, local knowledge is helpful in providing context to the scale of activity and anticipating potential resource user issues prior to referral. (e.g., 2 lobster fishermen are known to fish in the area).

2.3. SECTION D: ENVIRONMENTAL CONCERNS

Item 1: Identify any known activities or pollution sources in the area that may pose a threat to the site. Describe the activity(ies) and explain how it/they could impact the site.

Key information requirements are:

- Number of cabins within the area
- Sewer outfalls/septic tanks emptying within the area
- Ocean disposal sites within the area
- Potential for vandalism in the area
- Amount of boating (recreational/inshore fishery/etc.) occurring within the area
- Industrial effluents

- Neighbouring aquaculture sites that do not meet the DFA aquaculture site separation policy criterion (i.e., a 1 km minimum between finfish sites and 400 m minimum between shellfish sites)

Item 2: Describe all waste materials expected to be generated by the operation of this facility, which shall be released into the water (i.e., fecal matter, food particles, etc.) or will require disposal on land.

The key objective is to identify and qualify/quantify (where possible) all possible waste streams. It is assumed operations will generate all of the material (waste) streams listed below. The applicant should describe each of these. If they are not generated, explain the practice(s) that eliminates its generation. Descriptions of the management and/or mitigation of these waste streams are required in Item 5, and the applicant should assume each item will require management measures.

Respecting finfish grow-out sites, over its production cycle a typical site will generate:

- Sanitary waste
- Fish carcasses
- Chemical wastes such as petroleum products, paints and cleaning products
- Operational debris and refuse (e.g., feed bags, pallets, rope, nets, buoys, cage materials, litter, etc)
- Possibly bloodwater from fish harvesting operations
- Biofouling material (i.e., organisms that accumulate on the nets)
- Nutrient loadings (e.g., fish feed and fish faeces)

Respecting shellfish sites, over its production cycle a typical site will generate:

- Sanitary waste
- Chemical wastes such as petroleum products, paints and cleaning products
- Operational debris and refuse (e.g., rope, buoys, litter, etc)
- Undersized product and shells
- Drop-off and harvesting wastage
- Pseudofeces
- Biofouling material (organisms that accumulate on barges, moorings, or vessels)

Item 3: Identify any changes to the project that may be caused by the environment. Aspects of the environment, such as weather and climate, tides, algal blooms, superchill, etc. should be considered. Identify measures to mitigate these changes.

Key information requirements include:

- Sites selected to avoid adverse climatic conditions
- Gear relocation/removal/addition for different seasons
- Removing gear prior to forecasted storm events
- Plans for coping with diseases introduced from native populations
- Aquatic invasive species avoidance and management

Item 4: Identify potential risk due to malfunctions or accidents that may occur during installation, operation, and decommissioning phases of the project (e.g. fuel spills, storm destruction, etc.). Discuss operational plans to prevent such accidents and malfunctions and present contingency plans to deal with each of these potential situations.

Key information requirements include:

- Retrieval methods for lost lines/cages/gear
- Plans/methods to limit escapees
- Emergency Response Plan
- Refueling procedures (when, where, and how)
- Spill Response Equipment present at refuelling station (if yes, what equipment present)

It is assumed that some fuel will be handled on the water; therefore, the applicant should address whether a spill kit with absorbents, absorbent pads, and/or boom will be maintained on vessels. Also, if there is potential to spill hydraulic fluid the same rationale applies.

Debris and refuse may be lost due to weather events, without a contingency plan to retrieve this material, refuse may become abandoned along shorelines. Applicants should provide a plan to address shoreline clean up and debris retrieval. Also, describe measures that prevent refuse and waste containers from tipping or blowing off site.

Item 5: List planned measures to mitigate any harmful effects of the construction and operational phases of the project. Measures include, but are not limited to, ensuring that the construction site remains clean after work is completed and a biosecurity plan is in place.

This item is one of the most extensive in the application; the applicant should expand upon the waste streams identified in Item (2), consider the potential effects of the project on the environment during construction and operation and vice versa; and describe the environmental management and/or mitigation practices that will be applied.

Potential environmental effects of the project include:

- Increased oxygen demand
- Organic waste deposition and accumulation (feed and feces/pseudofeces)
- Disruptions to nitrogen cycling
- Increased algal growth
- Changes in benthic community structure
- Smothering of benthic habitat/creation of anoxic or anaerobic benthic conditions
- Etc

Site-specific information is crucial because sites with large tidal fluctuations may replenish oxygen and remove organic waste regularly, thereby reducing such potential impacts.

The following items may be used to assess the site environment and how it may positively or negatively impact the aquaculture operation. Some of the following are also identified in the baseline data requirements identified in Section F.

- Filter capacities of shellfish
- Feed types and amount used for finfish
- Water depths at site
- Tidal fluctuations (i.e., differences between high and low tides)
- Substrate at site (i.e., sand, cobble, boulder, bedrock, etc.)
- Fetch
- Predominant current direction (if known)
- Aquatic flora and fauna species and locations
- Presence/absence of Species At Risk

Species at Risk Act **(SARA)** prohibits: the killing, harming or harassing of a threatened, endangered or extirpated species; the damage or destruction of an individual species' residence; and the destruction of any part of a species' critical habitat. The applicant must identify species at risk (SAR) that may be present and outline appropriate management measures. To do this, the applicant must review the SAR Public Registry for the most current information.

1. An aquaculture industry factsheet for SAR can be found at www.dfo-mpo.gc.ca/species-especes/act-loi/aquaculture-info-eng.htm.

2. The following is a list of SAR, at the time of writing, which may be sighted in the Newfoundland and Labrador (NL) and possibly observed around aquaculture sites. Schedule

1 of the *Species at Risk Act* is updated periodically, and the applicant must access the public registry (http://www.sararegistry.gc.ca/default_e.cfm) and be familiar with the up-to-date list.

3. State the management measures in place, to respond to sightings and/or potential farm interaction with species of concern. Measures can include any one or more of the following:

    - Preventative measures
    - Observation and recording
    - Reporting
    - Handling and freeing of entangled or penned animals

    Where recovery strategies and action plans are available, they can be used to gather information on the species in question. Recovery strategies and action plans can be found at www.sararegistry.gc.ca/default_e.cfm.

The applicant is also encouraged to be familiar with species being considered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) because they may be listed under SARA during the life of the site operation.

Using the information in Item (2) address the following (These questions are examples, for instance a farmer may prefer composting toilets over a chemical toilet):

Sanitary waste

- Will chemical toilets be used?

Dead fish carcasses

- How often are inspections, and how will they be performed?
- How will they be contained?
- How often will they be removed from the site?
- How will they be disposed and/or treated?

Chemical wastes (e.g., petroleum products, paints and cleaning products)

- How will they be disposed?
- Where will they be disposed?

Operational debris and refuse (e.g., feed bags, pallets, rope, nets, buoys, cage materials, litter, etc)

- Identify the location of the disposal facility.
- Identify if any of these materials are reused or recycled.

Bloodwater from fish harvesting operations

- Identify the management practices that prevent the discharge of untreated bloodwater.

Biofouling material (including organisms that accumulate on nets)

- Identify the management practices for on-site washing of biofoul (if performed), and the frequency.
- Is biofoul washed at a centralized facility, and if so, identify the location.

Fish feed

- Section F: Water/Site Quality; Item 4 also relates to this item.
- Summarize feed tables and feeding rates based on water temperature and stock size over the production cycle.

Respecting finfish sites, when managing nutrient loading/depositional waste (i.e., faeces, feed and biofouling), applicants should consider the potential outcomes of mandatory “Environmental Effects Monitoring (EEM)”, which DFO administers. DFO assesses proposed aquaculture finfish sites for risk of a harmful alteration, disruption or destruction (HADD) of fish habitat. It considers baseline information, site conditions, impact mitigation, site management, and a mandatory fallow period. The fallow period is an important mitigating measure to minimize or avoid a HADD; therefore, the effectiveness of operational efficiencies to reduce deposition is assessed by fallow period monitoring. This monitoring determines: accuracy of initial predictions; site sustainability; and effectiveness of mitigating and management measures. DFO finfish fallow period habitat monitoring program is comprised of two parts:

- Part I - Implemented at approximately the start of a fallow
- Part II - Completed prior to ending a fallow

Finfish Aquaculture – Farm Fallow Monitoring Report for Fish Habitat outlines the monitoring requirements. If site monitoring indicates negative impacts to fish habitat, the operator may require additional mitigation measures and/or changes to site management. If a HADD is determined likely, the applicant may require issuance of a *Fisheries Act* Authorization.

Applicants should consider preparing a contingency plan outlining proposed actions in the event operations accumulate organic deposition after a grow-out and fallow cycle. Table 1 lists examples of standard practices applied in NL, and Table 2 lists examples of possible considerations that can be included in a plan.

Table 1 – Examples of Standard Practices and Mitigation Measures Applied in NL that Minimize the Accumulation of Depositional Waste

Activity	Standard Practice/ Mitigation Measures	Benefits
Siting (i.e., Local)	• Cage setting in water depths greater 30 m • Baseline assessment using visual and chemical baseline data	Productive fish habitat avoidance (e.g., kelp and lobster habitat) and promote dispersion
Siting (i.e., Regional)	• Mandatory 1 km site separation • 1 km separation from scheduled salmon rivers	Promote dispersion and dilution of wastes
Fallowing	• Minimum 1 year fallow period following a production cycle • Seasonal fallow period for species using over-wintering sites (i.e., Steelhead trout)	Dedicates time for environmental assimilation of depositional organic material
Stock density	• Maximum 18 kg/m^3 stocking density during growing season	Dictates level of feeding and faecal material to be managed
Feeding	• Avoiding use of wet feed • Feed cameras monitor feed administration	Dry feed is easier to handle and disperse, and monitoring provides more control over feeding, thus minimizes overloading feed to the cages and subsequent accumulation on the sea bottom
Net cleaning	• Nets are removed from site to a centralized net washing facility	Biofoul is not disposed at the aquaculture site

Table 2 – Examples of Tools that can be included in a proposed Contingency/Mitigation Plan to Mitigate the Accumulation of Depositional Waste

Activity	Action	Benefit
Siting (i.e., Local)	• Conduct current and loading analysis to adjust site origination and/or location	Promote dispersion and environmental assimilation
Siting (i.e., Regional)	• Site separation variance to the mandatory 1 km; where it is demonstrated a higher degree of natural flushing and organic assimilation exists without compromising fish health and navigation	Promote dispersion, dilution and assimilation of nutrients loadings
Fallowing	• Apply ecosystem/performance-based approach to increase the duration of a fallow period beyond 1 year • Maintain fallow until monitoring demonstrates that the site returned to within 25% of baseline conditions, and use as a benchmark for future production cycles • Identify an alternate site in a contingency plan to avoid loss of production	Promote environmental assimilation of nutrient loadings
Stock density	• Prescribe a reduction in stock density for the next production cycle. • Identify an alternate site in a contingency plan to divert excess stock.	Direct reduction in feed requirements and production of faeces
Feeding	• Conduct a third party audit of feeding protocols • Check level of feeding in comparison to biomass and water temperatures • Monitoring - Direct staff monitoring in combination with submerged cameras • Daily records for feed type and amount (i.e., numbers, biomass, temp, growth rates) • Investigate and apply new technologies that capture and circulate feed • Investigate and apply more efficient feed monitoring technologies	Improve efficiencies in feeding. Can be part of a maintenance schedule and monitored more regularly using periodic internal audits
Net cleaning	• Investigate and apply more efficient technologies for onsite maintenance net cleaning, or adjust frequency of cleaning	Decrease the amount of colonization or prevent large bulk quantities of

	discharge

Item 6 (Finfish): Describe proposed methods to minimize fish escapes from cages. Also describe procedures for recapture of escapes.

Often the applicant will reference the Code of Containment (CoC), but this does not completely address the item. Annex 3 of the CoC provides a form for specifying the details of a proponent's recapture plan. Applicants must submit a description of its recapture plan procedures.

Item 6 (Shellfish) and 7 (Finfish): Should decommissioning be required, describe the process, including measures to restore the area to its natural setting. Provide details on how all associated infrastructure will be removed from the site if the site is no longer required. Explain how this material will be disposed of.

The potential risk of site abandonment due to environmental or financial factors requires applicants to submit a decommissioning/contingency plan that includes the following information:

- A cost estimation
- Capacity to execute
- Time of year when gear will be removed
- Types of gear to be removed
- Disposal of unwanted/damaged gear (i.e., how, where)
- List of gear to remain onsite (i.e. anchors, navigation aids, etc.)
- Identify what equipment is salvageable

2.4 SECTION F(c) BOTTOM SAMPLES (FINFISH)

Applicants must submit fish habitat baseline data as part of a site's initial environmental assessment. Regulators will also reference the baseline when assessing environmental effects monitoring, collected during operations. The following summarizes the collection requirements:

1. Number of samples:

- Sites with five cages or less - provide a video sample from each cage location
- Sites with more than five cages - provide video sample and depths for the entire aquaculture lease area at a sample density of not more than 100 meters spacing (i.e., a 20 hectare 400m x 500m site, would have 30 sample sites). A minimum of four samples per hectare must be provided.[1]

2. For each sample station provide:

   - Sample identification number
   - Coordinates
   - Water depth at low tide

3. Video sampling - Observations of each sample site must be provided along with a copy of the video. Provide a description of the bottom substrate type and colour:

   i.e., is the bottom mud, sand, gravel or rock?

   i.e., what colour is the sample? For example – Fine light brown sand, or grey sandy gravel, or black mud)

4. Bottom Type:

   - Hard Bottom – Video including the description
   - Soft Bottom - Where video indicates soft sediments (e.g., mud, sand, organic deposition):
     i. Obtain three (3) bottom grabs, if possible
     ii. For each grab sample provide:
        - Dated, colour photograph, indicating sample location
        - Observations (sediment color, consistency)
        - Redox potential, Eh (mV)
        - Sediment sulphide (μM)
        - If a sample cannot be taken, state why

[1] Samples in this context refer to sample station, which in turn requires three grab samples.

If the depth of a sample station is greater than 100 m then grab samples or video are generally not required.

Should you have any questions or comments regarding the above document please contact:

The Regional Aquaculture Development Officer
Grand Falls-Windsor (709) 292-4100

St. Alban's (709) 538-3705
Corner Brook (709) 637-2960
Or
Jonathan Kawaja
Aquaculture Environment Planner
Aquaculture Development Division
Tel: (709) 292-4100
Email: jonathankawaja@gov.nl.ca

Burin Peninsula Regional Service Board

Mr. Clyde Collier, Project Manager
Grieg NL Nurseries Ltd.
P.O. Box 457
Marystown, NL A0E 2M0

January 15, 2016

Dear Mr. Collier,

On behalf of the Burin Peninsula Regional Service Board, I would like to extend a welcome to your company as a potential addition to the business community of our region. We understand your company is well established as a leader in the farming of Atlantic salmon, and we look forward to working with you as your proposed operations commence in our region.

To offer some information about our organization, the Burin Peninsula Regional Service Board provides waste management services for residents and commercial operations on the Burin Peninsula, from Monkstown southward. We operate a regional waste management site outside Marystown, processing municipal solid waste, including source-separated organic and fibre materials, and source-separated metals. Our site is also the region's only permitted location for the disposal of septic sludge.

At present, we operate the province's only combined organic and fibre curbside collection program, with collection taking place weekly in the Town of Grand Bank. We process this material though windrow composting, and also accept source separated organic material at our site though public drop-off. Our current certificate allows for composting of up to 1000 tonnes per year of organic materials. In the event that regional waste generation shows the demand, we hope to obtain the required equipment to have this capacity increased.

If you have any information regarding the anticipated waste generation of your proposed operation, this would be helpful to our Board in conducting planning for future development. Similarly, if you have any questions regarding the existing waste management system in our region, please feel free to contact me.

Sincerely,

Joe Pittman
General Manager

Suite 228 · Father Berney Memorial Building · P.O. Box 510 · Burin Bay Arm · N.L.·A0E1G0
Tel. (709) 891-1717 · Fax. (709) 891-1727 · www.burinpenwaste.com · info@burinpenwaste.com

January 27, 2016

Burin Peninsula Regional Service Board
Suite 228, Father Berney Memorial Building
P.O. Box 510
Burin Bay Arm, NL
A0E 1G0

Attention: Joe Pittman (General Manager)

Dear Mr. Pittman;

Thank you for your warm welcome. Those of us at Grieg NL Seafarms greatly appreciate it and are looking forward to working with your organization. We are looking forward to sitting down with you in the near future to discuss our requirements in further detail. In the interim, it is very encouraging to us to see the operational capacity you have and how varied you waste management abilities are.

In response to your inquiry, we will have the sludge from the Hatchery which will comprise of 109 Metric tonnes in dry weight. This will contain 14 % N and 16 % P. We will have minor amounts of human septic waste from various vessels and barges. We will also have some industrial garbage from mooring setups comprising of rope ends which we are not anticipating to be of great volume.

Once again, we look forward to sitting down with you as well as seeing your facility.

Sincerely,

Clyde Collier
Project Manager

Placentia West Development Association
P.O. Box 76,
Boat Harbour, NL

June 26, 2015

Clyde Collier
Project Manager
Grieg Seafarms NL Ltd.

Dear Sir:
The Placentia West Development Association wishes to express its support for the acquaculture initiative your company is undertaking in Placentia Bay. In our role as an economic development agency in Placentia West, we see this project as having enormous employment potential.

We look forward to continuing to work with you. Please keep us informed of your progress.

Thank you.

Elizabeth Murphy

Elizabeth Murphy
Chairperson

From: Dennis Kelly [mailto:dkelly@townofmarystown.ca]
Sent: October-22-15 3:04 PM
To: 'Aquaculture Licensing,'; 'Brown, Ron'; 'Abdel-Razek, Dr. Abdel-Zaher'; 'Hanlon, Carol'; 'Davis, Corrie'; 'Mercer, Delphina'; 'Chris.Hendry@DFO-MPO.GC.CA'
Cc: 'mwalsh@townofmarystown.ca'; Barb Walsh (bwalsh@townofmarystown.ca); 'Jody Brushett'; 'Bungay, Trevor C'; Councillor Darlene LaFosse-Blagdon (dlblagdon@townofmarystown.ca); 'Councillor Leonard Pittman'; Councillor Lisa Slaney (lslaney@townofmarystown.ca); Councillor Mary Beth Farrell (mbfarrell@townofmarystown.ca); Councillor Ruby Hoskins (rhoskins@townofmarystown.ca); Deputy Mayor Al Spencer (aspencer@townofmarystown.ca); 'Mayor Sam Synard'; 'Mayor Sam Synard'
Subject: RE: NEW Aquaculture Licence Hatchery Application / Grieg Nurseries NL Ltd / Marystown / AQ15-HAT-APP-0011

Hi Claudette:

Further to our telephone conversation of this morning, please see below:

The Town Council of Marystown fully supports the application of Grieg Nurseries NL Ltd. to establish a commercial Atlantic Salmon Hatchery in Marystown. As a matter of fact, council just recently finalized the terms of an Agreement with Grieg Nurseries NL Ltd. to sell them Lot #'s 7, 9, 11, 13, and 15 in the Marystown Marine Industrial Park on which the Hatchery will be built. In this Agreement, council has also negotiated a Tax Agreement for the period 2019 to 2024, subject to further review after the five year period. We also want to note that the underground water well that is going to be used by Grieg Nurseries is also on town land and the use of that land and well for the Hatchery is also covered off in our Agreement.

The town has worked very closely with Grieg Nurseries since they became interested in Marystown for this development and has done everything in its power to assist them in their plans and subsequent applications for this project. The town is also committed to be a partner with other government agencies, both provincial and federal, to support construction of the waterline from the well site to the Hatchery, as well as other associated requirements such as laydown area and site development of other lots.

The construction of this Hatchery and the subsequent grow-out farms planned for Placentia Bay will have a very positive economic impact on Marystown and all communities in Placentia Bay. We understand from Grieg Nurseries Environmental Assessment that the Hatchery itself will employ 23 fulltime positions from facility management to technicians. There will be a potential need for 200 full-time and part-time jobs during the construction period. We also understand the grow-out farms will employ up to 600 and quite possibly more. In addition to primary jobs, this development will require numerous supplies and services, resulting in further development in our Marine Industrial Park and other areas of town, which will bring with it more primary jobs, as well as secondary jobs in the existing retail, food and service sector. All of this will also result in more residential development in Marystown as well.

Again, the Town of Marystown fully supports the application for a new aquaculture site for Grieg Nurseries NL Ltd. to establish a commercial Atlantic Salmon Hatchery in Marystown. We look forward to your approval of this application so construction can begin immediately.

Dennis Kelly

Chief Administrative Officer
Town of Marystown
P. O. Box 1118
Marystown, NL
A0E 2M0

Telephone: (709) 279-1661
Fax: (709) 279-2862
Email: dkelly@townofmarystown.ca

From: Aquaculture Licensing, [mailto:aquaculturelicensing@gov.nl.ca]
Sent: October-21-15 10:31 AM
To: 'dkelly@townofmarystown.ca'; Brown, Ron; Abdel-Razek, Dr. Abdel-Zaher; Hanlon, Carol; Davis, Corrie; Mercer, Delphina; Chris.Hendry@DFO-MPO.GC.CA
Subject: NEW Aquaculture Licence Hatchery Application / Grieg Nurseries NL Ltd / Marystown / AQ15-HAT-APP-0011

Attached for your review and response is documentation for the following application for a new aquaculture site for Grieg Nurseries NL Ltd. to establish a commercial Atlantic Salmon Hatchery in Marystown.

Please note: This application has been registered for an Environmental Assessment: (http://www.env.gov.nl.ca/env/env_assessment/projects/Y2015/1814/index.html)

This is a VERY HIGH priority for our Department and are hoping to have this application reviewed as soon as possible.

Applicant: Grieg Nurseries NL Ltd.

Knut Skeidsvoll

PO Box 98

St. Alban's, NL

A0H 2E0

Phone (709) 538-3659

Type of Aquaculture License requested: **COMMERCIAL**

Species: **Atlantic Salmon**

Location of Site: **Marystown**

All fees have been paid as per Receipt # 1119.

List of Referrals:

The Town of Marystown

Department of Fisheries and Aquaculture – Regional Services Division

Department of Environment and Conservation – Water Resources Division

Department of Municipal and Intergovernmental Affairs – Municipal Engineering Branch

Department of Business, Tourism, Culture and Recreation – Provincial Archaeology Office

Fisheries and Oceans Canada – Regional Aquaculture Coordinator

If you have any questions, please contact us.

Thank-you

Claudette Laing

Aquaculture Licensing Administrator
Department of Fisheries and Aquaculture
P.O. Box 679
58 Hardy Avenue
Grand Falls-Windsor, NL, A2A 2K2
t (709) 292-4103

LONG HARBOUR
DEVELOPMENT CORPORATION

P.O. Box 40, Long Harbour
Newfoundland & Labrador, CANADA A0B 2J0
T: (709) 228-2233 C: (709) 227-9084
F: (709) 228-3081 longharbour.net

Mr. Clyde Collier
Project Manager
Crieg Seafarms, NL Ltd.
5 Popular Place
P.O. 98
St. Alban's, NL
A0H 2E0

July 30th, 2015

Re: Grieg Seafarms NL. Ltd – Aquaculture Development

Dear Mr. Collier:

On behalf of the Long Harbour Development Corporation and the Town of Long Harbour Mt. Arlington Heights we are pleased to offer Crieg Seafarms NL Ltd. our full support and encouragement for your plans to develop a systems of sea pens dedicated to the production and harvesting of salmon in Placentia Bay.

The Corporation and the Town are encouraged by the vision and professionalism that have been demonstrated by Grieg Seafarms NL Ltd. in its efforts to keep our community and the surrounding area informed. We will continue to work cooperatively with your company and are pleased to offer any resources available to us to assist in the facilitation of public meetings or other matters that can assist Crieg Seafarms Ltd. getting this important project underway.

We wish you every success with this venture and be assured of our continued support.

Gary Keating, Mayor
Town Long Hr. – Mt. Arlington Heights

Joe Bennett, President & CEO
Long Hr. Development Corp.

Cc: J Gosse – Town Manager
LHDC – Board of Directors

LONG HARBOUR
DEVELOPMENT CORPORATION

P.O. Box 40, Long Harbour
Newfoundland & Labrador, CANADA A0B 2J0
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F: (709) 228-3081 longharbour.net

Knut Skeidsvoll
General Manager
Grieg Seafarms NL Ltd
P.O. Box 457
Marystown, NL
A0E 2M0

Re: Treatment of Sludge & Silage Grief Seafarms NL Ltd.

Dear Mr. Skeidsvoll:

Further to our recent conversations re the treatment of sludge and silage generated at Grieg Seafarms NL Ltd.'s proposed salmon hatchery facility at Marystown Newfoundland.

The Long Harbour Development Corp. (LHDC) and its business partners have expressed a desire to fully explore the opportunity of providing Grieg Seafarms NL Ltd. with a commercial-scale solution for sludge / silage dewatering and stabilization at the Marystown operation.

Our proposed proprietary processing equipment is a fully-automated system that can be scald to meet the specific needs of Grieg Seafarms NL Ltd. In addition we are confident that our proposed sludge dewatering and stabilization system will ensure that all of the environmental standards that are applicable to your operation in Marystown will be met or exceeded to the satisfaction of all regulatory agencies.

LHDC and its business partners would like to enter into formal discussions with Grieg Seafarms NL Ltd. to explore all aspects of this opportunity at your earliest convenience. We believe that we have a solution that is cost effective and will meet the highest operational standards. In addition we believe that our proposed solution is sensitive to the current environmental regulations impacting your operations.

We look forward to discussing this matter with you soon.

Sincerely

Joe Bennett

Joe Bennett
President & CEO
LHDC

CC: Gary Keating, Chairman, LHDC
Clyde Collier, Grieg Seafarms NL Ltd.