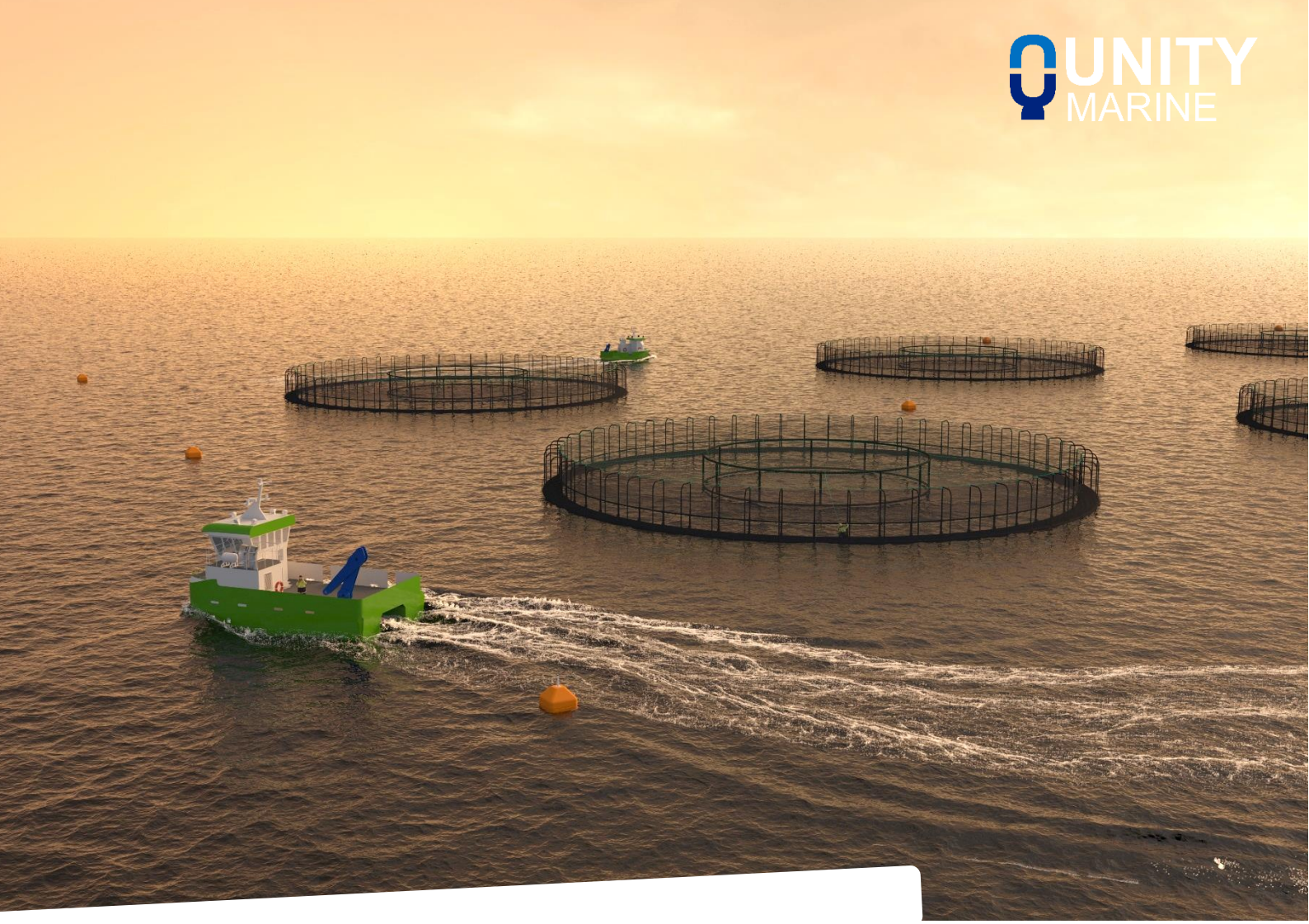


Unity Marine – Project Description v.2.1

PROJECT: 17.030 SALMON AQUACULTURE ON THE FALKLAND ISLANDS

UPDATED JAN 2026

1 Content

1 Content 1
2 Executive summary 6
2.1 Updated report 8
3 Document Scope 9
4 Glossary 10
5 Introduction 12
5.1 The Falkland Islands 12
5.2 Climate 13
5.3 Geography 14
5.4 Business community 14
5.4.1 Private sector services 15
5.4.2 Fishing sector 15
5.4.3 Logistics 15
5.4.4 Harbour facilities 16
5.4.5 Oil and gas 16
5.4.6 Falkland Island Development Company 17
5.5 Economy 17
5.5.1 FIG revenues and reserves 18
5.6 Salmon Aquaculture 19
5.6.1 Historical perspective 19
5.6.2 Aquaculture on the Falkland Islands 22
5.6.3 Current sector status 23
5.7 Laws and legislation 26
5.7.1 Planning Permission Ordinance 26
5.7.2 Fish Farming Ordinance 27
5.7.3 Fishery Products Ordinance 28
5.8 Falkland Island Development Plan 29
6 Project description 31
6.1 Scale of operations 32
6.2 Company ownership 32
6.3 Project Schedule 33
6.3.1 Phase I – Pre-study 33

6.3.2 Phase II - Design, Environmental Impact Assessment and Planning Permission 34
6.3.3 Phase III – Construction and Installation 36
6.3.4 Phase V – Operation 39
6.4 Land-based facilities 39
6.4.1 Placement of the facilities 40
6.4.2 Future outlook 44
6.4.3 Egg supply 45
6.4.4 Water 45
6.4.5 Influent water treatment 46
6.4.6 RAS Technology 46
6.4.7 Effluent water treatment 47
6.4.8 Power 48
6.4.9 Oxygen 48
6.4.10 Construction 49
6.4.11 Operations 52
6.5 Sea sites 57
6.5.1 Location 60
6.5.2 Wave and current modelling 65
6.5.3 Net pens 66
6.5.4 Feed barge 67
6.5.5 Auxiliary equipment 68
6.5.6 Construction 68
6.5.7 Operations 69
6.6 Well boat 75
6.6.1 Operation 76
6.7 Feed 77
6.7.1 Feed imported from Chile 77
6.8 Processing of fish 79
6.8.1 Processing on land 79
6.8.2 Processing ship 79
6.8.3 Conclusion 80
7 Labour 81
7.1.1 Local skilled labour 82

7.1.2 Corporate Social Responsibility 83
7.2 Land-based facilities 83
7.2.1 Operational needs 83
7.2.2 Construction phase 83
7.3 Sea site operation 84
7.3.1 Operational needs 84
7.3.2 Installation phase 85
7.4 Well boat service 85
7.4.1 Operational needs 85
7.5 Feed 85
7.6 Processing 86
7.6.1 Operational needs 86
7.6.2 Construction phase 86
7.7 Head office 86
7.7.1 Operational needs 86
7.7.2 Construction phase 86
7.8 Other needs 87
7.9 Secondary effects on labour market 87
7.9.1 Private sector 87
7.9.2 Public sector 87
7.10 Location of jobs 88
7.11 Long term labour market impact 89
8 Logistics 91
8.1 Transport of personnel 91
8.1.1 Domestic transport by Sea 91
8.1.2 Personnel transport by road 91
8.1.3 Personnel transport by air 91
8.1.4 International transport 92
8.2 Transport of goods 93
8.2.1 Export of product by sea 94
8.2.2 Export of product by air 94
8.2.3 Import of goods by sea 94
8.2.4 Import of goods by air 94

8.2.5 Domestic transport by road 95
8.2.6 Domestic transport by Sea 95
9 Infrastructure needs 96
9.1 Housing 96
9.1.1 Analysis of Requirements 96
9.1.2 Strategy 96
9.2 Roads and access 96
9.2.1 Analysis of Requirements 97
9.2.2 Strategy 97
9.3 Harbours and piers 97
9.3.1 Analysis of Requirements 97
9.3.2 Strategy 98
9.4 Power infrastructure 99
9.4.1 Analysis of Requirements 99
9.4.2 Strategy 100
9.5 Internet and cell coverage ## Jonas update med Starlink 100
9.5.1 Analysis of Requirements 100
9.5.2 Strategy 101
9.6 Temporary accommodation 101
9.7 Impact on FIG income and GDP 101
9.7.1 GDP growth and FIG revenues & reserves 102
10 Environmental impact considerations 104
10.1 Carrying capacity 104
10.2 CO_2-emissions 105
10.3 Discharge of nutrients 106
10.3.1 Organic matter 107
10.3.2 Nitrogen 107
10.3.3 Phosphorus 108
10.4 Vessel traffic 108
10.4.1 Wildlife strikes 108
10.5 Road traffic 109
10.6 Construction activities 109
10.7 Lights 110

10.8 Noise 110
10.9 Odour 111
10.10 Water use 111
10.11 Waste disposal 111
10.12 Escape of stock 112
10.13 Pathogens and parasites 114
10.14 Chemicals 114
10.15 Fuel spills 115
10.16 Invasive species 116
10.17 Impact on wildlife from physical structures 116
11 Table and figures 118
11.1 Figures 118
11.2 Tables 121
12 Appendixes 123

2 Executive summary

The following key points have been established related to development of the proposed aquaculture business on the Falkland Islands:

1. Unity Marine has detailed a plan for annual production of 50,000 tonnes of Atlantic Salmon in the Falkland Islands using modern technology and best available practices meeting the highest of international standards. The plan presented in this document has a considerably lower labour foot print on the Islands than the original plan as presented in April/ May 2018, as both the feed production and the processing now take place outside the Falkland Islands or on the sea. Furthermore, better understanding of the temperature regime and other production related improvements have allowed Unity Marine to reduce the required number of sea sites and thus labour footprint.

2. If the proposed schedule is followed the Company will initiate construction on the Islands in 2027, commence production in 2028 and harvest the first fish in 2031. The steady state production target of 50,000 tonnes of salmon can be achieved in 2032-2036 depending on the speed at which each phase of the project is implemented.

3. The business plan shows that the Company will be profitable from 2031 and on-wards, even with the considerably higher establishment costs on the Islands and increased logistical costs compared to other areas. The operations, being essentially animal husbandry, is planned with an indefinite time horizon. The activities will therefore be permanent, but practices may change as new technology and best-standards are introduced.

4. The company is planning to operate according to the Aquaculture Stewardship Council (ASC) standard and will also follow the highest of international standards in other areas (e.g. the Norwegian Standard NS:9415) to reduce potential environmental impacts from the suggested activities.

5. Unity Marine is still convinced that the project can be carried out with minimal impacts on the environment. This is supported by MacAlister Elliott & Partners report that was issued on the behalf of FIG in 2021, where it was concluded; “With good management and strong regulatory framework, it should be possible to reduce the impacts of the negative outfall (both real and perceived) from salmon farming in the Islands to low levels.”

6. During the investigations for this report the Company carried out extensive on-site investigations through a two-week sea site survey in collaboration with SAERI and land-based site investigations. The findings coupled with existing data indicates that Falkland Islands are ideally suited for Salmon farming. Several environmental studies through long term monitoring of temperature, wave patterns and current characteristics have been carried out from 2019 and 2022 on the planned locations and have underlined the suitability of the Falkland Islands for salmon farming.

7. Unity Marine have used a farm site capacity of 5,000 tonnes production per year as the basis of the production plan. The size of the individual sites and thereby number of sites will be subject to the specific carrying capacity evaluated throughout the EIA, and eventual regulatory requirements.

8. The company has screened 30 suitable marine sites for salmon farming surrounding East Falkland. The current plan is to utilize sixteen (16) of these sites. It is believed that there are many additional suitable sites surrounding the Falkland Islands around both East and West Falkland.

9. The number of sites can be reduced if the fish are kept in flow through systems on land for an additional three (3) to four (4) months.

10. Due to the need for proximity to the proposed sea sites, the Company will need to develop two (2) service hubs in Camp. Stanley Harbour is not considered to be positioned close enough to efficiently service the sites. Likewise, the hatcheries will preferably be placed close to the sea sites in Mare Harbour and New Haven, in order not to transport the live fish over long distances.

11. Unity Marine will harvest the fish directly at the sea sites and process at sea. This greatly reduces the labour footprint on the Islands from the project. It also reduces the need for developing new or upgrading existing freight route capacity.

12. The Company is planning to import the feed from Chile. This has resulted in a perceived reduction in the labour footprint from the project with approximately 30 FTE. It also reduces the need for developing new or upgrading existing freight route capacity.

13. The Company has described the potential areas of environmental concerns and corresponding mitigation strategies to minimize impact risk in Appendix A (Environmental Considerations Desktop Study), which has also been updated. This work is thought to be the first stepping stone towards a more detailed, robust and in-depth Environmental Impact Assessment. Main findings in the appendix are also reflected in this report.

14. Appendix B (Socio-Economic Impact Considerations) describes the overall economic and social footprint from the project on the Falkland Islands. The impact on the Falklands GDP and on FIG revenues will be substantial with an estimated annual GDP growth of £145m and FIG revenues of £26m, when full capacity is reached. Employment demand will peak and stabilise at approximately 100 additional on-shore workers, and 80 off-shore workers of which approximately half are Rotational shift workers not residing in the Islands. Further investigations might be needed in the future to substantiate the findings. Main findings are also reflected in this report.

15. The impact on the Falklands GDP and on FIG revenues & reserves will be substantial with an estimated annual GDP growth of £145m and FIG revenues of £26m when full capacity is reached. In comparison, the existing fishing industry accounted for 60% of the GDP in 2022, with FIG revenues of around £32m. Current FIG budgets for the next 5 years show a depletion of “net liquid assets” (reserves) from £254m to £113m and a reduction in the “ratio of uncommitted reserves to adjusted department expenditure” (the ratio) from 3.5 to 1.5 and a reduction in the ratio headroom from £166m to £21m. The FIG capital budget covers a period of 10 years and capital expenditure in

years 6 – 10 is expected to significantly exceed net operating income in year 5 indicating a further deterioration of reserves, the ratio and the headroom in years 6 – 10. The implementation of the suggested aquaculture business is expected to reduce and reverse this decline within 10 years.

2.1 Updated report

This report has been updated based on new findings related to the project, market developments and other general developments on the Falkland Islands.

The main change is linked to updated temperature assumptions based on measurements carried out by Unity Marine. Measurements that showed somewhat higher than expected temperatures in inner Falkland Islands waters. As Atlantic Salmon are a poikilothermic animal, the fish temperature reflects the surrounding water temperature. This in turn is reflected in the growth of the fish, that grows faster at higher temperatures.

Detailed monitoring of wave exposure and current at the proposed site in the intermediate years have also shown that preliminary findings of suitability of Falkland Islands inner waters for Salmon Farming were true.

The higher temperatures coupled with updated growth data from the egg supplier and genetics company Aquagen, Norway, has allowed Unity Marine to plan with faster growth of the fish, which in turn leads to shorter production time in the sea. As the number of required sea sites is coupled directly to the production time, Unity Marine has identified the potential to reduce the number of sea sites from 20 to 16, or a reduction of 20%. This is perceived to greatly reduce the footprint of the operation and will also have cascading impact on number of required employees and number of required vessels.

The report has also been updated with more information on potential socio-economic impacts, as well as potential environmental impacts and company mitigation strategies for said impacts. This has been done by implementing more of the findings in separate appendixes on these subjects. Numbers have also been updated to reflect current economic expectations, labour requirements and changes in nutrient discharges due to the reduced number of sites.

These updates are reflected in this report.

3 Document Scope

This document aims to describe the operations for the proposed Salmon farming project on the Falkland Islands in the South Atlantic Ocean and was handed over in its original form to FIG in March 2019. The project will be owned and operated by the Falkland Islands limited company Unity Marine Ltd. The document has now been updated with changes and additional findings, the current version is v.2.1.

A Letter Of Intent (LOI) was signed between F-Land Aps and the Falkland Islands Government (FIG) on the 26th of November 2018. The LOI describes a series of studies that needed to be conducted before the project progresses. This document seeks to create a baseline understanding of the activities and impacts on the Falkland Islands from the project in the fields set out in the LOI:

1. Environmental impact evaluation
2. Detailed project planning in terms of overall sizing and suggested placement of the Company's Land-based activities in the form of Smolt production, Feed mill, possible processing plant and other activities placed on the Falkland Islands
3. Needed labour force to undertake the project and the placement of the labour force in different areas of the Falkland Islands
4. Description of any specific investments or need for new infrastructure in direct connection with the production
5. Operational logistics analysis detailing transport of goods and personnel
6. Analysis of needed biosecurity measures
7. Analysis of the current aquaculture legislation and suggestions to new legislation framework needed to secure the interests of the Falkland Islands
8. Current Export and Import channels and an analysis of any additional needs generated by the Company's operations, if any.

The baseline understanding of the activities and expected impacts, are meant to support FIG in a qualitative assessment on how the salmon farming project falls within the Falkland Islands long term goals of diversifying the economy. It also forms the basis for further work including:

1. Full and robust Environmental Impact Assessment (EIA) work
2. Public consultation process
3. Further negotiations on project progress between FIG and Unity Marine.

Annexed to this report is a more in-depth Environmental Considerations Desktop Study (ECDS) and a Socio-Economic Impact Considerations study.

All documents have been updated to version 2.1 in 2026, based on updated local inputs and market change.

4 Glossary

All-female: All female stock. Delivered as all-female eggs from egg supplier.

Broodstock: Parent fish

EIA: Environmental Impact Assessment

EIS: Environmental Impact Statement

Eyed egg: A fish egg containing an embryo that has developed enough so that the black spot of the eyes is visible through the egg membrane. Indicates that the egg is less sensitive to movement and can be handled safely.

Feed Conversion Rate (FCR): The amount of dry feed fed to the fish to grow one (1) kg of fish. The FCR differs between species and the size of the fish but also with factors like temperature and general water quality. It is also dependent on feed quality.

Hatchery: Facility used to hatch the eggs and rear the juveniles. Usually, the term is used to describe a facility that takes the fish all the way through the smoltification process.

Net pen: Square or circular sea-based aquaculture construction consisting of a floating collar and a net that contains the fish. Disambiguation: Net cage, sea cage, open net pen

Nutrient: A nutrient is a substance used by an organism to survive, grow, and reproduce. In this document it is primarily used to describe the nutrients nitrogen and phosphorous discharged from the company's facilities.

Post-smolt: Smolt retained on land in sea- or brackish water to a size of 200-1,000g before being transferred to the sea sites.

Recirculated Aquaculture System (RAS): A system where the water is cleaned and reused several times before discharge.

Salmon: In this document salmon primarily refers to Atlantic Salmon (*Salmo salar*). If it relates to another species, the specific species will be mentioned.

Salmonid: Sub-family (Salmonidae) of Salmonidae which is a family of ray-finned fishes. Contains all trout, salmon and char species. The only Falkland species in the group is the introduced Brown Trout (*Salmo trutta*). The native Zebra Trout is not a real trout and is not closely related to salmonids.

Smolt: Term that describes a salmonid at the point where it has gone through the smoltification process and is ready to migrate from a freshwater body to sea. Usual size is from 80-150 g, but wild smolt can be considerably smaller.

Smoltification: A light and/ or temperature induced process where the young freshwater form of a salmonid goes through morphological change enabling it to live in sea water.

Triploid: Animal or plant with three (3) chromosomes in every pair. Triploids are usually sterile. Atlantic Salmon triploids are sterile.

Well boat: Specialised vessel used to transport live fish.

Work boat: Specialised vessel equipped with a crane or cranes, used to install and perform maintenance on the net pens and moorings.

Yolk sac larvae: Newly hatched fish larvae that still carries the yolk sac. The larvae will typically not feed before the yolk sac has been fully consumed.

5 Introduction

The aim of the project is to establish a 50,000 tonnes Atlantic Salmon (*Salmo salar*) production industry on the Falkland Islands using modern technology and best available practices meeting the highest of international standards.

Due to the current infrastructure level and the isolated geographical position of the Islands, as well as the new nature of the aquaculture business in the area; it will be necessary to establish extensive new infrastructure to support the business goals.

Due to the need for proximity of service facilities and hatcheries to the potential sea sites, most of the development will take place in Camp on East Falkland.



Figure 1: The envisioned hatchery at New Haven seen from the North.

5.1 The Falkland Islands

The Falkland Islands are an archipelago in the South Atlantic Ocean on the Patagonian Shelf. The principal islands are about 300 miles (483 kilometres) east of South America's southern Patagonian coast, at a latitude of about 52°S. The archipelago, with an area of 12,000 square kilometres, is comprised of East Falkland, West Falkland and a large number of smaller islands. As a British overseas territory, the Falklands have internal self-governance, while the United Kingdom takes responsibility for the defence and foreign affairs of the Islands. The Islands' capital is Stanley on East Falkland.

The population of the Islands is currently 3,622[1] residents of which 334 resides at Mount Pleasant Military base and 2,974 live in Stanley. Approximately a third of the population were born on the Islands. The population is comprised mainly of people of British and British Overseas Territories descent. In between the

[1] 2021 Census, FIG

2012 and 2016 censuses the population grew with 360 persons equivalent to a yearly increase of 3.2%. From 2016 to 2021 the population grew with 586 persons.

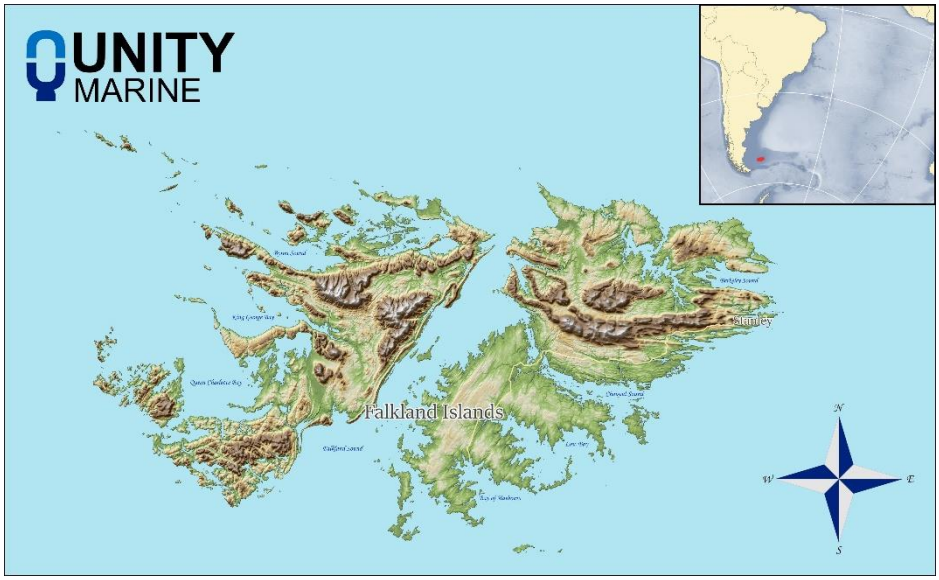


Figure 2: The Falkland Islands.

5.2 Climate

The climate of the Falkland Islands is cold, windy and humid maritime. The temperature has historically stayed between 21.1 and −11.1 °C in Stanley, with mean monthly temperatures varying from 9 °C early in the year to −1 °C in July. Strong westerly winds and cloudy skies are common. Numerous storms are recorded each year but are interceded by calmer wind periods. Rainfall is common over half of the year, averaging 610 millimetres in Stanley, and sporadic light snowfall occurs nearly all year. The Islands are ice-berg free and the inner waters are normally also ice-free year-round.

Sea water temperatures are relatively stable and offers very good conditions for Salmon rearing. The average monthly temperatures alternate between 4.5°C in July and 11.3°C in February. Lowest measured temperatures are 3.1°C and the highest observed temperature is 13.3°C both in Falkland Sound. The maximum and minimum temperatures from Stanley and three other sites from Salmon producing areas can be seen in the figure below.

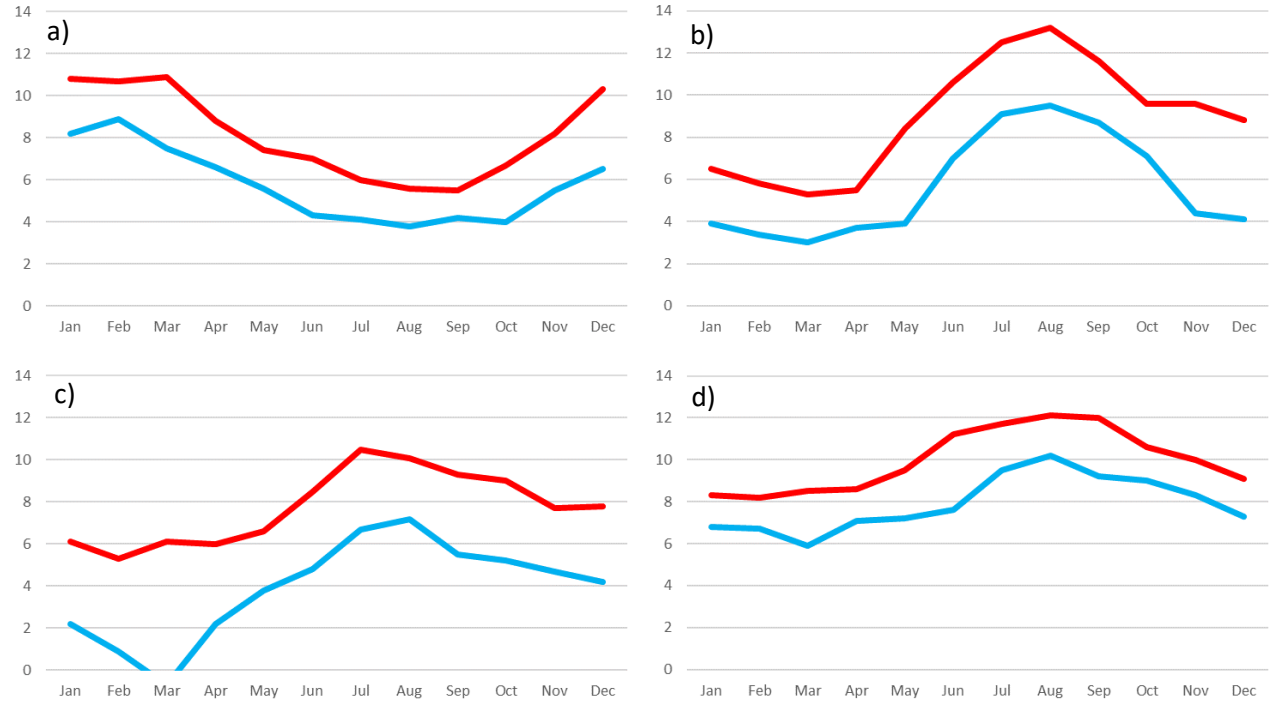


Figure 3: Maximum and minimum sea water temperatures in a) Stanley, Falkland Islands, b) Tromsø, Norway, c) Isafjordur, Iceland and d) Torshavn, Faroe Islands

The average yearly temperature is similar to Tromsø in Norway, lower than Faroe Islands but significantly higher than in the regions used for salmon farming in Iceland. Of specific note is also the relatively high winter temperatures which makes the area ideal for salmon farming.

5.3 Geography

The Falkland Islands have a land area of 12,000 km^2 and a considerable length of coastline. The two (2) main islands, West Falkland and East Falkland, and about 776 smaller islands constitute the archipelago. The Islands are predominantly mountainous and hilly, with the major exception the depressed plains of Lafonia, a peninsula forming the southern part of East Falkland.

The Falklands are situated approximately at latitude 51°40′ – 53°00′ S and longitude 57°40′ – 62°00′ W. The archipelago's two main islands are separated by the Falkland Sound, and it's coastal indentations form natural harbours. The sounds and indents also create sheltered locations that can be used for net pen aquaculture operations.

5.4 Business community

The economy on the Islands is dominated by the fishing industry contributing between 50 and 60% of the GDP. Other major sectors are agriculture and tourism, with 10% of the workforce employed on a total of 84 sheep and cattle farms on the Islands. The tourism sector was growing up and until the onset of the global COVID pandemic with around 60,000 tourists visiting the Islands each year. The cruise ship industry was specifically harshly hit during the pandemic but is forecasted to regain momentum in the coming years. The local government employs a little over a quarter of the workforce making it the largest employer on the Islands.

There is virtually no unemployment on the Islands. Many jobs are therefore covered by British and foreign workers that are usually employed on six (6) month to two (2) year contracts. Persons that have been ordinarily residents in the Falkland Islands for a period of at least seven (7) years can apply for full Falkland Islands status.

5.4.1 Private sector services

The private sector is dominated by a few larger companies like Falkland Island Company (FIC) and Stanley Services that operates and delivers a broad range of services including retail, accommodation rental, hotels, building services, fuel supply, shipping, restaurants as well as car purchase and hiring.

There are some construction services available on the Islands, but for larger construction projects manpower is usually brought in from overseas. The construction companies are usually backed up by a UK general contracting company that will allow them to draw in extra manpower for such projects. With the current shortage in available accommodation and the potential for a future oil exploitation in Falkland Islands waters, there will potentially be a strain on capacity of the construction companies on the Islands.

Currently there is no dry dock or shipyard facilities on the Falkland Islands. Of specific interest for the project there is decompression chamber on the Islands.

5.4.2 Fishing sector

There is several fishering companies located on the Falkland Islands. They usually operate in joint venture with international companies.

Currently there are more than 130 fishing vessels operation in Falkland waters. Ilex-squid jiggers account for approximately 100 vessels which operate under partner/agent agreements between local and primarily Asian companies. There are approximately thirty (30) trawl vessels that fish for finfish and/or Loligo-squid under UK, Falklands, or Spanish flags. These are part owned or operated by local businesses and quota holders. There is also one longline vessel that fishes for Patagonian toothfish, which is also the Falkland's only MSC certified fishery currently. The bridge and factory crews on fishing vessels are almost entirely foreign nationals who live elsewhere and spend little time in the Falklands.

Point of landing of catches varies with each fishery, where Ilex-squid can be landed in Asian or European countries, while the majority of finfish and Loligo-squid is landed in Spain. Some catch is transhipped in Stanley, but the majority is transhipped at sea to reefer vessels for export to the point of landing. There is a single land-based fish processing plant that produces value-added product for local and international markets.

5.4.3 Logistics

The current only commercial flight route connects the Islands to Punta Arenas, Chile every Saturday. A second route from Sao Paulo, Brazil was started in 2019 but was discontinued at the onset of the COVID pandemic. The Falkland Islands government is still in discussions with Latam on whether to resume the flights. The MOD also operates a biweekly service from Brize Norton, UK to Mount Pleasant. 30 seats on each departure are allocated for civilian passengers. Domestic flight routes are operated from Stanley and can be chartered to take passengers to several smaller airstrips around the Islands.

In terms of bulk freight, South American Atlantic Service Ltd. (SAAS) operates a containerized shipping link to Montevideo, Uruguay on a monthly or bimonthly basis. SAAS have recently invested in a new and larger freight vessel, which will secure more capacity. SAAS has a substantial experience with transporting chilled produce in the form of fish or processed lamb in reefer containers through this link. The service is operated out of Stanley using FIPASS. There are also some container services that links to Chile every year.

The military operates a direct shipping route to Marchwood, UK. The military allows some civilian cargo on the route, but military equipment has priority. The UK link utilizes the military port at Mare Harbour as the point of entry into the Falklands. The UK link can be chartered to take odd size cargo. Due to the fact that military cargo has priority the link should not be used to transport time sensitive goods.

5.4.4 Harbour facilities

There are only three (3) developed harbour facilities on the Islands. Unity Marine will need harbour or port facilities in relative proximity to the sea sites in order to operate efficiently.

In Stanley Harbour the FIPASS provides the main civilian harbour facility. FIPASS was a temporary port solution brought in just after the conflict with Argentina. There are plans to develop a new port facility in Stanley, as the FIPASS is nearing the end of its lifetime and there is need for a larger facility for civilian purposes. Albeit a UK company was chosen to develop the project, the plans have been postponed due to increase in budget beyond the initial allocated funds for the project. Therefore, FIPASS is currently undergoing additional maintenance to prolong lifetime.

The Temporary Dock Facility is a newer wharf in Stanley Harbour that was developed by the oil industry. The Temporary Dock Facility is however partly decommissioned at the moment but is currently being refurbished for use by the oil companies.

The military is operating the only other major port facility at Mare Harbour. While there are restrictions for civilian use, the military might be interested in cooperation as there is currently free capacity at the harbour.

New Haven is the only port facility on the west coast of East Falkland. It has been constructed for and is used as a ferry terminal. There is not currently any capacity for additional activities. Therefore, new harbour facilities would need to be constructed in the area if it was to function as a service hub.

New Haven and Mare Harbour will be the preferred sites for the company service hubs and hatcheries due to their proximity to the proposed sea sites. The usage will be subject to FIG approval and in case of Mare Harbour both the Military and FIG would need to approve the use. Development at New Haven would also be done in a way ensuring no disruption to the ferry services.

5.4.5 Oil and gas

There has been substantial exploration for oil and gas reserves in Falkland Island waters during the last 15-20 years. The exploration has resulted in considerable findings of both oil and gas reserves. Due to insufficient funds for initiating the exploitation of the resources have not yet been commenced. Final investment decision by current license holder Navitas Petroleum, Israel and Rockhopper Exploration, Falkland Islands was made in December 2025.

The oil and gas industry have, along with FIG, conducted thorough studies of the potential Socio-Economic impacts on the Falkland Islands as a result of future hydrocarbon exploitation[2]. The studies detail the potential pressure on the labour market on the Islands as well as other bottleneck effects in the housing and service sectors.

5.4.6 Falkland Island Development Company

Development of the economy is promoted by the Falkland Islands Development Corporation (FIDC) a quasi-autonomous, government-established, largely self-funding body. It was set up in 1984 and is mainly funded from its own reserves and income streams. Initiatives it has fostered include air transport, connection to the global containerised shipping network, supporting agricultural diversification, establishing a meat export industry and promoting tourism. It also offers advice, loans and grants to further local business development. They have also funded investigations into aquaculture possibilities in the past.



Figure 4: The pier in Stanley used to accept cruise ship passengers (left). Sheep rearing (right), one of the major business sectors on the Falkland Island.

5.5 Economy

Since 1982, the economy has grown dramatically, with GDP rising from £3m to £150m. Agriculture, including fisheries, continues to be a major contributor with 95% of the GDP. Farmland accounts for a little over 80% of the Falklands land area, but agriculture is less than 2% of the economy. Fishing is the largest part of the economy, and most of the fish harvested in the Falkland Islands waters are either squid or finfish.

The fishing and aquaculture industry accounted for between 35% and 48% of the GDP between 2007 to 2015. The catches vary over the years from as little as 111,495 tonnes in 2016 to 462,487 tonnes in 2015. Resulting FIG revenues are between £10m and £30m. Other major sectors are agriculture and tourism, with 10% of the workforce employed on a total of 84 sheep farms on the islands.

The emergent tourism sector has seen rapid growth in the last 15 years, with 60,000 tourists visiting the Islands by cruise ship each year, and a further 1,600 tourists arriving by air annually to enjoy the Islands unique wildlife and unspoiled environment. With the onset of the global COVID pandemic, tourism was hit hard by travel bans, requirements for quarantining and reduction in available transport routes. The cruise

[2] Socio-Economic Study of Oil and Gas Development in the Falklands, Regeneris Consulting Ltd. on behalf of FIG, May 2013

ship segment was hit particularly hard and experienced multiple major COVID breakouts on cruise ships that were covered widely in mass media. As the Falkland Islands had a stringent quarantine practice, and the tourism sector is mainly reliant on cruise ship passengers the tourism sector suffered. FIG incentives to promote local tourism were introduced to support the industry, as people were to a large extent prevented from travelling abroad, and the incentives had some effect.

The tourism sector is the second largest contributor to the Islands economy.

5.5.1 FIG revenues and reserves

Based on the Falkland Islands Government's own Draft Budget and Financial Plans for 2024/25 and beyond, they will reach the limit of their own fiscal rule of maintaining an uncommitted reserves ratio of 1.5x adjusted departmental expenditure in FY 2027/28. This fiscal rule was only introduced in 2025, reducing from the previously maintained 2.5x ratio and against a backdrop of unstable income.

Maintaining this ratio would mean that either new sources of revenue would be required, or FIG will need to make dramatic cuts to budgets and services. It also leaves no headroom for future capital expenditure or other investments that may be required.

The table below extrapolates the Falkland Islands Government's own budget out to 10yrs, demonstrating what is projected to happen in the absence of a new source of income:

	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34
Opening Net Liquid Assets Balance	**254**	**203**	**158**	**141**	**114**	**113**	**105**	**86**	**62**	**44**
Total Operating Revenue	129	127	124	123	121	121	121	120	118	117
Operating Expenditure Departmental	(93)	(94)	(91)	(91)	(91)	(91)	(91)	(91)	(91)	(91)
Operating Expenditure Other	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)
Net Capital Expenditure	(76)	(117)	(88)	(49)	(20)	(28)	(37)	(42)	(34)	(32)
External borrowing drawdown	-	50	50	-	-	-	-	-	-	-
Closing Net Liquid Assets	**203**	**158**	**141**	**114**	**113**	**105**	**86**	**62**	**44**	**28**
In year movement in net liquid assets	**(51)**	**(45)**	**(16)**	**(28)**	**(1)**	**(8)**	**(19)**	**(24)**	**(18)**	**(17)**
Operating Expenditure Departmental	(93)	(94)	(91)	(91)	(91)	(91)	(91)	(91)	(91)	(91)
Addback recharges	18	17	17	17	17	17	17	17	17	17
Revised departmental expenditure	**(75)**	**(76)**	**(74)**	**(74)**	**(75)**	**(75)**	**(75)**	**(75)**	**(75)**	**(75)**
FIG liquidity ratios										
Ratio	2.7	2.1	1.9	1.5	1.5	1.4	1.2	0.8	0.6	0.4
Headroom	90	43	30	2	1	(8)	(26)	(50)	(68)	(84)
Headroom with insurance	110	63	50	22	21	12	(6)	(30)	(48)	(64)

Table 1: Extrapolation of FIG budgeted reserves with current trajectory. Notes: red = projections assume unchanged levels of operating revenue (except investment income which is linked to reserve levels), departmental expenditure, other expenditure and recharges in years 6 – 10, blue = capital expenditure based on the 10 year capital budget plus expected port loan repayments of £11m per annum.

The potential impact on the Falklands GDP and on FIG revenues & reserves will be substantial with an estimated annual GDP growth of £200m and FIG revenues of £26m when full capacity is reached. In comparison, the existing fishing industry accounted for 60% of the GDP between in 2022, with FIG revenues of around £32m. Current FIG budgets for the next 5 years show a depletion of "net liquid assets" (reserves) from £254m to £113m and a reduction in the "ratio of uncommitted reserves to adjusted department expenditure" (the ratio) 1.5% and a reduction in the ratio headroom from £166m to £21m. Projections indicate that expenditure in years 6 – 10 is expected to significantly exceed net operating revenue with a further deterioration of reserves (reducing to £28m), liquidity ratio (reducing to 0.4%) and headroom (a deficit of -£64m). The impact of the proposed aquaculture business is expected to reduce and reverse this

decline within 10 years. This impact is explored more fully in Appendix B, Socio-economic Impact Considerations.

5.6 Salmon Aquaculture

Salmon aquaculture started less than 50 years ago with small scale production in Norway. Since then, the industry has grown to be a global industry with production on all continents.

Atlantic Salmon has developed into a global commodity and is now commonly available in most countries around the globe.

Atlantic salmon is an anadromous species, that is, it spawns in freshwater streams, the adults return to sea. After hatching the juveniles remain in freshwater for two (2) or three (3) years. When the fish are about 15 cm in length, the young salmon (smolt) will undergo a biochemical metamorphosis called smoltification, whereby the acquire the ability to osmoregulate in sea water. Once the metamorphosis has been completed, they will migrate to the sea where they will live for one (1) to four (4) years before returning to freshwater to spawn.

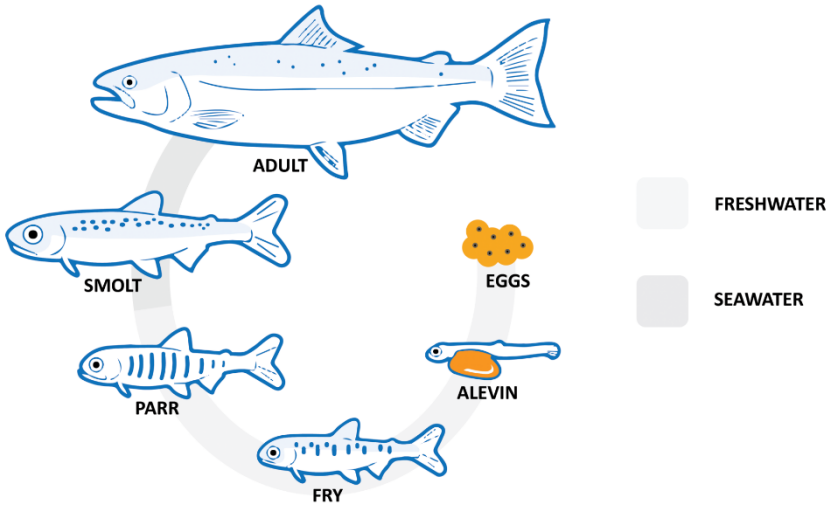


Figure 5: Life cycle of Atlantic Salmon entails a juvenile freshwater phase. After a morphological change called smoltification the fish becomes a saltwater fish, and it is then ready to migrate to the sea.

Likewise, in salmon aquaculture the fish are kept in freshwater in the juvenile stages, before the fish are smoltified and transferred to sea sites for on-growing in full salinity saltwater. Sometimes the fish are however retained for a prolonged period of time on land in seawater, before they are transferred to the sea. Fish in the size range of 200-1,000 g produced in this way are usually referred to as post-smolt.

5.6.1 Historical perspective

In 1853 the first attempts were carried out to increase the wild salmon- and trout stocks in Norway by artificial hatching and rearing of salmon and trout fry and releasing them into Norwegian rivers. After a period of 20 years, these activities slowly decreased towards 1873, as it was difficult to register any positive effect from the restocking programme.

From 1869 and onwards people started to establish saltwater parks, in estuaries where sea water flowed in and out with the tide. These saltwater parks were fenced off with nets and then stocked with small wild salmon and trout. These fish would grow bigger, by preying naturally occurring food in the enclosure. There was no commercial feeding of the fish. The saltwater parks normally did not survive more than few years, and this concept never became a commercial success.

Modern salmon farming has its roots in the Danish trout farming industry. The first Danish trout farm was established in 1890, and by 1914 more than 300 fish farms with more than 3,000 ponds were established in Denmark.

From 1919 and the next 20 years several Norwegian entrepreneurs attempted to replicate the Danish concept producing rainbow trout, but they were not successful. There were massive losses of fish during the production period, because of river flooding in periods of heavy rains. The growth and Feed Conversion rates (FCR) were also quite poor. However, the main reason for the failure, was the distance to the markets. Shipping rainbow trout from Norway to the European market was at the time technically demanding and associated with high cost, rendering the fish farming projects unfeasible.

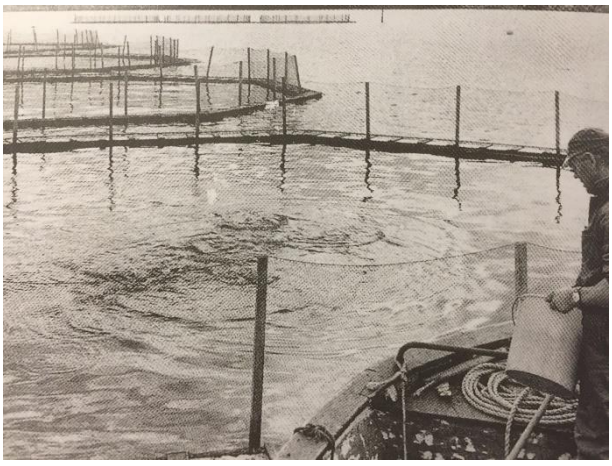


Figure 6: Octagonal Grøntvedt cages in Frøya Edelfisk AS facility around 1970.

The first successful salmon- and trout farming in Norway happened in the 1960's. Ponds and concrete tanks were established close to the fiords, and seawater was pumped into the tanks. This gradual shift from freshwater farming to increasing use of saltwater, had a significant influence on the fish that grew faster and were healthier compared to fish grown strictly in freshwater. In this period the production of rainbow trout was much bigger than the salmon production in Norway.

The great breakthrough came around 1970, when the aquaculture industry moved from land and into the sea. The production was still a combination of rainbow trout and salmon. In the beginning of the 70's the total Norwegian production was below 1,000 tonnes/ year.

The first number of years most of the net pens were the "Grøntvedt Brothers design". These net pens were octagonal, with walkways made of wood placed on top of polystyrene floats. The most common size was pens with a diameter of ten (10) meters. While several companies sold net pens with this design, many fish farmers preferred to build the net pens themselves. Not surprisingly the number of escaped salmon was significant compared to the total production in early sea-based farming, due to the flimsy design.

In the following years the salmon production increased substantially and in 1977 the salmon production was for the first time bigger than the rainbow trout production.

In the late 70's and the 80's individual steel cage constructions, as well as integrated steel cage systems consisting of several steel cages tied together with steel walkways was developed. Round net pens consisting of one or several PE pipes, known as the Polar Circle Design was introduced in the industry at the same time.

The demand for sea farming equipment was booming, because the salmon production increased from around 8,000 tonnes in 1980 to more than 150,000 tonnes in 1990. Chile began producing Atlantic Salmon in the early 80's. It was in the same period salmon farming was trialled in Fox Bay on West Falkland (1985-1990).



Figure 7: Steel cage system from the 1980s.

Development of new fish feed types made this expansion possible. In the 1970's the fish feed was produced on the fish farm. The feed was mostly wet mash made of ground up fish and fish discards. It normally took five (5) to six (6) kilo of wet mash feed to produce one (1) kilo of salmon. In the Fox Bay trials, it was considered to use ensilaged mutton to feed the fish. Unsurprisingly it was however concluded that it was not the optimal feed for salmon.

Around 1980 dry pellets were introduced in the industry. This fish feed was developed by professional feed companies. The first types of pellets took two (2) to three (3) kilo dry pellets to produce one (1) kilo of salmon. In the late 80's and the start of the 90's extruded fish feed was also introduced. Extruded feed pellets are easier for the salmon to digest than traditional pellets. The feed Conversion rate was subsequently reduced to around 1.5.



Figure 8: Hand feeding was very common in the 80's. (Picture from 1986, Bent Højgaard feeding fish).

In the 80's most farmers would still feed the salmon by hand. This was ideal, since the net pens were quite small, ranging from ten (10) meter to fifteen (15) meters in diameter and a depth of six (6) to twelve (12) meters. The feeding had to be quite precise to avoid feed floating out of the net pens.

In the 90's it became more and more common to install central feeding systems. The diameter and depth of the net pens was now much larger. The biomass in each net pen was so large, that hand feeding became a very labour-intensive process. Feeding by hand, however, remains widely used for feeding of other species, e.g. tilapia and shrimp in developing countries.

After the industry crisis that began in 1989 ended in 1991, the production in 1993 had decreased to 147,800 tons. This again coincided with the Fox Bay trials, and might have played a determining factor in the project not garnering financial support to continue. Only a few years later the salmon production dramatically increased again, and in 2002 the production reached 546,000 tons.



Figure 9: Central feeding system in the 1990's.

The next breakthrough in the salmon farming business came when Lerøy was listed on the stock exchange in Oslo in 2002. Later other large companies like Marine Harvest (now Mowi), Salmar, Norway Royal Salmon (NRS) and Bakkafrost became listed on the stock exchange. The listing made it possible for these companies to get access to the capital it required to expand. The result was a vigorous consolidation of the industry and soaring production numbers.

Norway produced more than one (1) million tons/ year of Atlantic Salmon in 2012, and the production is now 1.3-1.4 million tons per year.

5.6.2 Aquaculture on the Falkland Islands

There have historically been a few ventures into aquaculture on the Falkland Islands. Aquaculture has repeatedly been mentioned in Island Plans as a mean of diversifying the economy and generating economic activity in Camp.

From 1985 to 1990 a Salmon production was tested out in Fox Bay under directions from FIDC with help from a Norwegian fish farmer. The fish were imported from Sterling University, UK and kept in a small freshwater hatchery. Upon reaching approximately 35g the fish were transferred to a number of smaller pens in the ocean. The growth of the fish was good, even though the setup was found to be lacking in some respects and the import of feed was associated with certain challenges.

It was concluded that the water temperature of the Islands where ideal for Salmon farming. Development of the business however stalled on lack of capital to increase tonnage and develop the sites.

From 2010 – 2013 FIDC ran an aquaculture research project trying to determine, which species would be feasible to rear on the Islands. The project ended in 2013 but was continued through the local fishery company Fortuna ltd. that set up a small Brown Trout (*Salmo trutta*) facility comprised of a hatchery in Stanley and a couple of net pens situated outside Fitzroy. The peak production is thought to be below 20 tonnes per year and has since discontinued. The brown trout is an introduced species and not native to the area but has a well-established breeding population in the waterways on the Islands.

Consolidated Fisheries Ltd. is currently also running a breeding program for Patagonian Toothfish in Stanley, but this has not led to any commercial production yet.

5.6.3 Current sector status

Today salmon aquaculture is carried out in many countries around the world. The main producing countries are Norway, Chile, Canada, United Kingdom, the Faroe Islands (Danish overseas self-governing territory) and Australia. While the production differs somewhat in between regions there are general trends in the industry. The current world production is approximately 2.8 million tonnes/ year (2022).

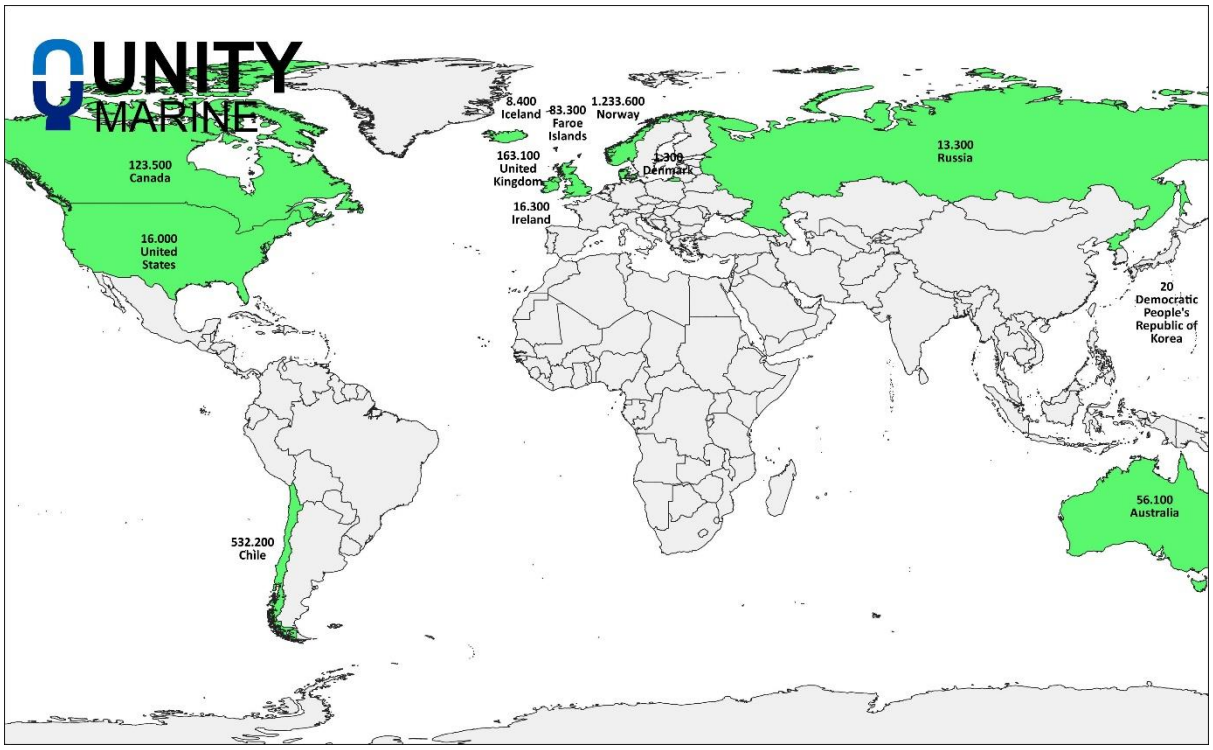


Figure 10: Atlantic salmon producing countries of the World, and the individual salmon production figures for each country respectively in 2016.

Production of salmon starts in a Hatchery, where salmon eggs are hatched and weaned to feed on dry pellets. When the juvenile reaches its smolt stage the fish are transferred to net pens in the ocean. Today hatcheries can be divided into two categories: flow-through systems and Recirculated Aquaculture Systems (RAS). Originally all hatcheries and smolt facilities were of the flow-through type.

A flow through system is a facility where the incoming water flows through the production tanks one time, and then the water is discharged. There are still many flow-through systems in use, but almost all new facilities are now constructed as Recirculated Aquaculture Systems (RAS).

In RAS facilities the intake water is re-used up to 99.6 %, which reduces the environmental impact and allows the farmer to keep a stable temperature all year round. It also dramatically reduces the need for new freshwater allowing facilities to be operated independently of large freshwater resources. The RAS technology has evolved substantially in recent years and there is a tendency towards building larger systems and producing both more and larger fish than a traditionally flow-through system. Many smaller flow-through systems have subsequently been closed down.

A RAS facility contains a water treatment unit where solids, carbon dioxide and ammonia are removed from the water before being led back to the fish tanks where the fish are kept. Oxygen is also added to the water in a separate process.



Figure 11: Fish tanks in a salmon smolt production facility.

Whether the salmon smolt production facility is a flow through type or RAS type, the general trend is that the systems of today are equipped with substantial number of sensors that measure and data log different parameters. The sensors are linked to a PLC-systems that control pumps and other equipment. Newer systems typically have a higher degree of automation and monitoring than e.g. waste water treatment plants.

Modern salmon smolt systems also have solutions in place that makes grading, vaccination, feeding and collection of mortalities from the fish tanks as optimal as possible and thus reduces the needed amount of labour to operate the facilities.

Chile was first movers on broad implementation and use of RAS systems starting in 2001, while Norway began to build RAS systems in larger numbers from 2008. The Faroe Islands are currently the only country where all smolts are hatched and reared in RAS due to limited freshwater resources on the Islands.

Approximately 80% of the worlds salmon smolt RAS systems have been designed and constructed by Danish companies, as Denmark had developed the technology in the early 1980's for the country's eel industry. Many of these companies have however been acquired by international companies within the last decade.

When the salmon juveniles have smoltified they are transported from the land-based hatchery to the sea site by a well boat. Well boats are specialized vessels, optimized for transport of live fish. The well boats are utilized to transport the fish from land-based hatcheries to the sea sites, from the sea sites to the processing facilities and for grading and transferring fish internally on the site.



Figure 12: Medium size well boat with a 1,000 m^3 hold.

During the last ten years the number and size of the well boats have grown considerably. What was considered a large well boat ten (10) years ago is now considered medium sized or small. Recently the world's biggest well boat was delivered to a customer on Tasmania. It is equipped with a hold of no less than 7,450 m^3 of water and can carry up to 800 tonnes of live salmon.

A modern well boat is also equipped with advanced water disinfection systems like UV-disinfection and ozone systems. All water is thus disinfected prior to discharge to reduce biosecurity risks, when the vessels are passing other farms.

Within the last couple of years, a new type of vessel has made its entry on the market. Processing ships are large vessels used to harvest the fish at the sea site and transport the gutted salmon to land-based processing plant for further processing.

The biggest vessel, the Norwegian Gannet, is capable of harvesting 1,000 tonnes in ten (10) hours and transport it straight to the market. This vessel alone is estimated to reduce the yearly number of truck hauls on Norwegian roads by 7,000- 10,000.

Modern sea farms consist of big net pens (160-240 m circumference or 50-76 m diameter) with large water volumes depending on depth. The feed is distributed from feed barges by pressurized air or water in dedicated pipes to each net pen. The feed barge also acts as living quarters for the staff on the sea site. The staff will stay for longer intervals on the feed barges. Depending on the country of operation the period can be anything from a week to a couple of months.



Figure 13: Modern sea farm including, net pens and a Feed barge with a central feeding system.

The feed barges are usually fuelled by marine grade diesel used in the generators, but recent developments have seen new hybrids with a combination of generators and batteries. Norway is also currently electrifying some of the barges by coupling them to the land-based grid.

The aquaculture companies are also upgrading their sea sites with new equipment and technology. There is focus on technology that optimizes the daily operations and make them safer and less time consuming. The new systems include mortality collectors, semi- automatic net cleaners, cameras and advanced PLC systems. Trials of semi-closed cages placed in the sea is also currently being carried out in especially Norway. These systems have however not to this date proven to provide adequate benefits to be commercially viable.

New developments have seen the industry trying out a new type of production, where the fish are kept in RAS systems on land for the entire lifespan. This allows for production in new areas close to the end customer. A 10,000 tonnes system has been built in Florida by Atlantic Sapphire but has failed to reach intended production numbers. Other players in Switzerland, Denmark, Norway and Poland have experienced similar problems and have struggled to turn a profit. New facilities is being built but at a slower pace than originally planned. Developments therefore is watched closely by industry investors.

Some land based growout facilities utilizing flow-through technology has been constructed in Norway and Iceland within the last five (5) years. These facilities rely heavily on ambient sea water temperature and are therefore geographically constricted.

Due to the capital needs and the subsequent need to be close to the market, a fully land-based operation would not be profitable on the Falkland Islands. So far, the land-based systems have struggled with slow growth, early maturation and off flavour in the product. It has therefore yet to be seen, if this business segment will be a part of the salmon aquaculture future.

5.7 Laws and legislation

In general laws and regulations in place on the Falkland Islands are similar or close to British legislation. There are currently only three ordinances that specifically mentions aquaculture; the Fish Farming Ordinance, the Fishery Products Ordinance which both were enacted in 2006 and the Planning Permission Ordinance from 1991.

FIG have received a more throughout walk through of legislative regimes in different countries, as well as considerations on how potential future legislation on the Falkland Islands could look like in the MacAllister and Elliot report: “Salmon Farming in the Falklands – Legislative Review” from August 2021.

5.7.1 Planning Permission Ordinance

Before any construction and installation can be initiated on the Falkland Islands planning permission must be sought.

The Planning Permission Ordinance provides the rules for that process. Unlike in many other countries the Ordinance does not distinguish between land-based and marine installations. That means that the installation of net pen sites would be required to seek planning permission under the same Ordinance as the land-based facilities.

This is detailed specifically for fish farming in section 26 under Meaning of development and requirement for planning permission:

> *“(5) For the purposes of this section, and without prejudice to any other situation in which any of the same constitute development, development of land for the purposes of breeding or rearing fish, shellfish or molluscs and development of land for the purposes of breeding or rearing animals or birds (not being cats or dogs), which in their wild state are predators, is not development for the purposes of agriculture.*
>
> *(6) Where the placing or assembly of any tank, cage, frame, rope, spatting line, float, buoy or other apparatus or structure of any kind whatsoever in any part of the sea or in any part of the inland waters for the purpose of fish farming there would not, apart from this subsection, involve development of the land below, this Ordinance shall have effect as if the tank, cage, frame, rope, spatting line, float, buoy or other apparatus or structure resulted from carrying out engineering operations over that land; and in this subsection-*
>
> - *"fish farming" means the breeding, rearing, or keeping of fish or shellfish (which includes any kind of crustacean or mollusc);*
> - *"inland waters" means waters which do not form part of the sea or of any creek, bay or estuary of any river as far as the tide flows;*
> - *"sea" means the territorial sea, any creek, bay or estuary of any river as far as the tide flows and any other part of the sea lying to landward of the baselines from which the territorial sea is measured.”*

In section 39 of the Planning permission ordinance it is further detailed that:

> *"(1) Subject to the following subsections, an application for planning permission for exploration for or winning and working of minerals or an application for planning permission for fish farming must be determined by the Governor."*

As such this determines that fish farming needs equivalent permission as Mineral extraction on the Islands.

The planning permission also specifies that an Environmental Impact Assessment (EIA) can be a requirement for any Planning Permission process. In section 33 Environmental Impact Assessment it is stated that:

(2) Without prejudice to the generality of subsection (1), regulations made under this section may-

- *(a) impose the requirement for the conduct of an environmental impact assessment in relation to any type of development specified in section 26 of this Ordinance while, expressly or by implication, excluding other types of development from the requirement;*
- *(b) prescribe more or less extensive environmental impact assessments for different classes of development, or in relation to specific applications or specific proposed developments, as the case may be;*
  …….
- *(e) categorise developments based on their proposed scale or extent, and stipulate, depending on the specified category into which a particular development is classified, that the commencement of certain developments-*
  - *i. must be preceded by planning permission that resulted from an application process that at some stage included an environmental impact assessment carried out on such scale or to such extent as may be specified in the regulations;*

Given the scale of extent and the novelty of the aquaculture industry on the Islands, it is concluded that an EIA for the project must be prepared at some stage in the Planning Permission process. The scope and extents of that EIA is however not detailed.

Any Planning Permission may be given with certain pre-requisites for obtaining the permission, among these there can be specific requirement regarding environmental issues as here in Section 40:

> *(d) requiring that steps be taken for the protection of the environment;*

And that these requirements might change in the future.

5.7.2 Fish Farming Ordinance

In 2006 the Legislative Assembly passed the Fish Farming Ordinance (Ordinance No. 20 of 2006) setting out rules and regulations in connection with aquaculture production in the Falkland Islands. There are several prerequisites that needs to be fulfilled before a company is qualified to apply for a fish farming licence:

1. At least 25.1% of ordinary share capital is vested in persons or companies enjoying Falkland Islands status
2. Planning permission for the proposed activities is in force

As part of the licencing application the company shall provide information of the following information:

1. A map showing the waters where the operation is sought
2. Description of the activities directly associated with the operation at site
3. Description of the activities directly associated with the operation in surrounding waters or land areas
4. Detailed descriptions of the installations and equipment that will be employed on the site
5. Timeline for proposed installations and commencement of aquaculture activities
6. Details on the financial source of the project
7. The applicant's business plan, including:
    a. An overview of the aquaculture business to be carried out by the applicant
    b. The marketing and sales strategy by the applicant
    c. The proposed management and staffing by the business
    d. A financial forecast for the first 5 years after the licence comes into force
8. Information of beneficial owners of the applicant
9. Details on the approved planning permission regarding the activities, installations and operation at the site and in surrounding areas in the form of the sea or land areas

The Ordinance refers to royalties in section 18, but the royalties associated with holding a licence has not been specified. Therefore, it is considered likely that the licence holder will be subject to payment of a royalty in the future. How the royalty is calculated and what parameters will be used in that calculation will need to be developed.

The ordinance does not refer to any environmental impact assessment process, but it does require an assessment of effects on the marine environment (section 5). However, there is an expectation by stakeholders that the EIA process and standard will inherit some of the aspects that has been developed for the hydrocarbon industry.

Based on discussions with FIG, it is considered likely that the Fish Farming Ordinance will be updated in the future, to better cover the aspects of the proposed project, if it moves forward[3].

5.7.3 Fishery Products Ordinance

In 2006 the Legislative assembly passed the Fishery Products Ordinance (Ordinance No. 21 of 2006) setting out rules and regulations in connection with water used for aquaculture production, animal welfare and the quality of fishery as well as aquaculture products. The ordinance concerns products from the fishing fleet as well as aquaculture. The ordinance also seeks to protect marine areas of specific vulnerability or areas of importance as breeding grounds for fish, molluscs and other marine animals.

The ordinance specifies the means for the Governor to designate specific areas as controlled waters as set out below:

> *"If it appears to the Governor that any marine waters need protection or improvement in order that they or any part of them may support fish, shellfish or crustaceans, or fish, shellfish or crustaceans of a particular description, he may by order designate-*
>
> *(a) those waters, and*

[3] Diane Simsovic, Director of Policy and Economic Development, November 2018

(b) *any inland waters (whether natural or artificial, or above or below ground) which discharge either directly or indirectly into those waters, as controlled waters for the purpose of this Part."*

Any activity in controlled waters may never lead to a water quality classification down grade of those waters. Discharge of effluents or pollutants is also not permitted. However, a specific discharge consent can be given if an application for the purpose is submitted. The consent will be subject to certain pre-requisites. While not referring specifically to an EIA there some of the pre-requisites that would naturally be part of a future EIA process:

"A consent under this section may include in particular conditions-

(a) as to the places at which discharges to which the consent relates may be made and as to the design and construction of any outlets for the discharges;
(b) as to the nature, origin, composition, temperature, volume and rate of the discharges and as to the periods during which they may be made;
(c) as to the steps to be taken, in relation to the discharges or by way of subjecting any substance likely to affect the description of matter discharged to treatment or any other process, for minimising the polluting effects of the discharges on any controlled waters;"

The ordinance also has brief descriptions of rules for movement of aquaculture animals, controls of diseases and import of eggs that all will need to be followed. There is also a brief description of the export of aquaculture animals for human consumption, if the product is exported to the EU it must comply with EU standards in the field.

The company will seek clarification for specifics given in the ordinance in phase II of the project. For the purpose of this document the company has adopted best available practices (e.g. ASC certification) in all fields and it is therefore thought that the Company will be in compliance with the Fishery Products Ordinance.

5.8 Falkland Island Development Plan

In 2015 the Falkland Islands Government adopted a nationwide Development Plan that sets outs certain general principles for the development on the Falkland Islands in the period from 2015 to 2030. The plan also contains a specific town plan for the Stanley area.

In general FIG is supportive of new business' or business areas in the Falklands as it is described in point 2 of the summary:

> *"Our overarching principle will always be when considering development proposals to take a positive approach that reflects a broad presumption in favour of sustainable development. We will work proactively with applicants to find solutions which mean that proposals can be approved wherever possible, and to secure development that adds to the economic, social and environmental fabric of the Islands."*

Any new business or activity will however be weighed against potential impacts on the environment, economy and the society.

In section "Policy SP8: Rivers, Coastal Areas and Territorial Sea" the plan details the requirements for any future aquaculture related activities taking place on the islands. In referral with point B under SP8 it states:

> *"B. Both marine and freshwater aquaculture proposals, together with any associated proposals on land, will:*
>
> 1. *be considered against the impact on marine ecology, bio-diversity and heritage resources, water quality and catchment and visual amenity and landscape/coastal quality; and*
> 2. *only be supported where they demonstrate no significant adverse impact on the environment and how any structures are to be removed and the land reinstated if/when no longer in use."*

The statements are further explained in section 5.25:

> *"Marine Farming or Aquaculture is identified by Government as a possible growth area to help diversify the economy of the Falkland Islands. It brings with it a range of environmental concerns about the effects on the marine environment and these will differ for different forms of aquaculture, be it shellfish, finfish or other opportunities. At this early stage, environmental concerns relate mainly to ecological impact on the marine environment and less to the physical appearance of marine structures than may be the case in other more populated areas of the world. The industry will also require onshore seafood processing facilities, and these are likely to be manufacturing in nature and therefore will be directed to industrial sites in Stanley or to appropriate sites in Camp. The primary objective therefore is to ensure that the development of marine farming can be undertaken sustainably with no undue impact on native species."*

Any government support of a plan to introduce a substantial production of finfish on the Islands will thus be heavily weighed against the potential environmental impact.

Later Islands Plans have contained continued commitment to strengthening economic development and diversification as well as rural economic activity.

6 Project description

The overall business plan contemplates the development of a fully integrated aquaculture company registered and operated from the Falkland Islands. In accordance with the current Fish Farming Ordinance[4] it is envisioned that at least 25.1% of the relevant proportion of the issued ordinary share capital is owned by persons enjoying Falkland Island status. There are also provisions in place that ensures that Falkland Island ownership is increased over time, as the Falkland Island company owners has first right of refusal to procure any shares being sold by international owners.

It is the aim of the company to establish a fully integrated production of 50,000 tonnes of Atlantic Salmon. Due to the current level of aquaculture infrastructure, it is necessary to provide a viable plan for either producing the feed on the Islands or bring it in from overseas. Means to process and export the product as well as movement of the fish between sites and veterinary services also needs to be planned.

In other salmon producing countries these functions are usually performed by independent companies, that services more than one of the salmon producers[5]. Unity Marine wishes to engage with local businesses to ensure that as large a share of services and supply is procured from Falkland Islands partners.

The company is therefore planning to build, procure, lease and/ or operate the following facilities and services:

1. Two (2) land-based hatcheries
2. Sixteen (16) Sea sites
    a. Ten (10) net pens at each site
    b. One (1) feed barge at each site
3. Vessels[6]
    a. Eight (8) smaller work boat
    b. Ten (8) medium sized catamaran work boats
    c. Three (3) larger work boats
    d. One (1) Supply vessel
4. Well boat
5. Warehouse facilities
6. Processing ship
7. Veterinary services
8. Main office

To support these operations infrastructure in the form of power supply, harbour or pier facilities, internet coverage and possibly roads would need to be constructed or improved. To support the activities the company will also need to employ labours. The labour force is planned to be a combination of locals, permanent expats, and foreign rotational shift workers.

[4] Fish Farming Ordinance 2006, Ordinance No. 20 of 2006, Falkland Island Government, 2006
[5] The Norwegian aquaculture analysis 2017, Ernest & Young, 2018
[6] Please see Appendix I for vessel data sheets

6.1 Scale of operations

Due to the requirements for specialized labour, new infrastructure and buildings as well as imports of feed and export of the product it has been estimated that 50,000 tonnes of production are the minimum initial scale for making the project viable. This has been concluded as for the following reasons:

1. Smaller smolt facilities would require the same number of employees.
    a. Same requirements for specialized labour
    b. 24h personnel coverage
2. The import of feed needs a certain minimum scale.
    a. Same delivery frequency needed for a smaller operation.
3. Scale of processing
    a. The envisioned vessel has a price tag of roughly 90 million GBP. The company operating and owning that vessel will need scale to make the operation profitable.
    b. If the volume becomes too small for a processing ship operating out of another country, then processing on land would be the alternative. That would both increase labour footprint locally from the activities considerably and raise the question of how to get the product exported through existing channels.
4. Two (2) large service vessels and a well boat is required independent of the scale of production.
    a. Each service vessel comes with a price tag of approximately 4.5 million GBP.
    b. Well boat has fixed cost independent of scale of production.
5. The veterinary service, administrative processes and other specialized positions would not scale 1:1 with reduction in the production.
    a. It is thus relatively more expensive to operate a company with a smaller production.
6. It is believed that the workload on FIG will be roughly the same from a smaller production (new ordinances and laws, law enforcement).

6.2 Company ownership

Due to the magnitude of the project and the subsequent consequences for the local community, both in terms of economic influence and due to the influx of new residents to the Islands, it is of paramount importance to embed the project with the local populace. Therefore, local investments into the venture have been sought among the Island's private sector.

A local limited Falkland Island company has been established in joint venture with local businesses and investors under the name Unity Marine. The aim of the company is to build up all the elements necessary to operate a successful salmon farming business in the Falkland Islands.

The company ownership have been divided into two share classes. "A" and "B" shares.

It will be ensured that Unity Marine will always have a local ownership of minimum of 25.1%. This will be ensured by issuing of "A" shares that can only be held by persons or companies that enjoy Falkland Island status. Certain benefits will be attached to the "A" shares. Unity Marine will seek to create a broader shareholder base locally through future sales of "B" shares.

"B" shares are the principal share successive to further offerings during establishment of the company's operations. The "B" shares will be attached with various rules and clauses in order to control the ultimate ownership. Ownership of the "B" shares are in principle not limited to any specific nationality, but all

transfers of shares is successive to approval before any sale can be executed. The task of approval is the responsibility of the board of directors of Unity Marine under guidelines specifying what foreign interests are approved. “A” share holders have first right of refusal to any “B” share sales, which is meant to increase local ownership in the future.

In order to fully finance the project offering of new shares will take place before phase III of the project. “A” shares will have a pre-set pricing in order to ensure that investments from local partners can be reduced to an accessible level. The total funding of the project is 356 million GBP of which 178 million GBP is planned to come from loan financing.

6.3 Project Schedule

The project has been split into five (5) phases to address the level of development through the project life cycle. There will be some overlap between some of the phases, e.g. phase IV will overlap with phase V as the first facilities will already be in production, while the second set of activities is under development.

1. Phase I – Pre-study (this report and data collection already completed)
2. Phase II – Design, Environmental Impact Assessment and Planning Permission
3. Phase III – Construction and installation
    a. IIIa Construction and Installation on East coast of East Falkland 5.000 ton
    b. IIIb Construction and Installation on East coast of East Falkland 10.000 ton
    c. IIIc Construction and Installation on East coast of East Falkland 10.000 ton
4. Phase IV - Construction and Installation on West coast of East Falkland
5. Phase V – Operation

Each of the phases has been split into several sub-phases and tasks to accommodate for more detailed planning and execution.

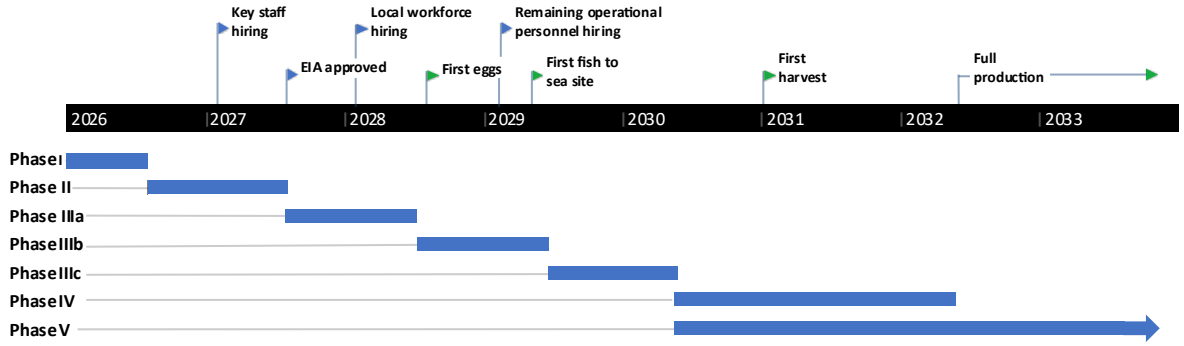


Figure 14: Proposed overall project schedule. The schedule details that the first eggs will be imported in August 2028 and the first harvest in start of 2030. The company will reach full production in 2032-2035. A pre-requisite is that the construction of the first land-based hatchery is commenced in August 2027..

6.3.1 Phase I – Pre-study

Phase I of the project covers the current phase and will end with the handing in of this document to the Falkland Island Government and completion of a potential public consultation process, as set out in the

Letter of Intent (LOI) that was agreed between the parties on the 26th of November 2018. 530,000 GBP has been allocated by the legal owners of Unity Marine to complete this Phase of the project.

In the Pre-study phase all preliminary investigations in terms of data collection, stakeholder consultations, analysis of constraints and challenges as well as business plan development are carried out.

The data collection and the subsequent analyses will lead to the generation of the Project description, initial environmental impact and Socio-economic impact work that will describe the proposed activities and potential impacts for the Falkland Islands.

The output of the Pre-study phase will be:

1. A detailed project description
    a. Description of project background, aims and scope
    b. Description of the proposed activities
    c. Analysis on the local footprint in terms of workforce employment, logistical implications, government revenues and use of infrastructure
    d. Legal review of current legislation on the area and suggestions for additional legislation
2. Environmental Considerations Desktop Study
    a. Environmental Impact Identification (ENVID) identifying the potential impacts on the Environment
    b. Environmental baseline description
    c. Description of identified impacts
    d. Gap analysis – identifying need for additional data to create a robust EIA process
3. Socio-Economic Impact Considerations
    a. Workforce requirements and emigration
    b. Tax and license revenues for the Falkland Island Government
    c. Accommodation requirements
    d. Other socio-economic impacts

The output is thought to lead to further negotiations with the Falkland Island Government on details and plans for executing the project on the Falkland Islands. As agreed, a public consultation process at this point in time that could also be included.

6.3.2 Phase II - Design, Environmental Impact Assessment and Planning Permission

Phase II of the project will be initiated, when the public consultation process has been completed and an agreement with FIG on the framework of the project has been completed. Phase II is thought to take a maximum of twelve (12) months. The budget for this phase is six (6) million GBP. Funding will be provided solely by the legal owners of Unity Marine.

In the design, planning permission and Environmental phase of the project, the company will design and seek final approval for the activities in subsequent phases. During this phase Unity Marine will start hiring key staff and build the platform of the company that will allow for successful execution of the construction and operational phases.

As a part of this phase, detailed site investigations will be carried out using either a company owned or a chartered vessel. The vessel will be equipped with a multibeam sonar and equipment to install measuring buoys and perform benthic samples. All collected data will be provided to FIG.

It is envisioned that the planning permission process also entails a detailed EIA investigation with a subsequent public consultation process.

The following tasks of the project will be executed during phase II:

a. Hiring key staff
    a. General manager (CEO)
    b. Chief Financial Officer (CFO)
    c. Fresh water production manager
    d. Sea water production manager
    e. Five (5) to ten (10) Engineers and specialists needed to support the business goals
    f. One (1) veterinarian
    g. One (1) or two (2) non-technical staff
b. Potentially acquisition of the first vessel to be used in the detailed sea site investigations
c. Detailed design of Land-based hatcheries
    a. Power generation
    b. Influent water development
    c. Effluent water development
    d. Rearing units
    e. Staff quarters
d. Detailed design of sea sites
    a. Mooring systems
    b. Net pen design
    c. Feed barge design
e. Design of wharf/ harbour facilities
    a. Fish delivery pipe Mare Harbour
    b. New Wharf and potentially a breakwater at New Haven
    c. Fish delivery pipe at New Haven
f. Plan for Head office
    a. Buy, lease or new build
g. Planning permission process
    a. Detailed project description
    b. Robust EIA work
    c. Planning Permission
h. Fish Farming Licenses applications
i. Detailed plans for operation of the company's activities

The output of this phase is thought be concrete permissions to carry out the all of Unity Marine's activities in the subsequent phases.

Upon the completion of this phase funding in the form of equity and loan financing will be sought to construct and operate the construction and operations in phase III and IV.

6.3.3 Phase III – Construction and Installation

In phase III the company will construct and install all the described facilities and equipment. The phase has been further broken down into phase IIIa and IIIb in order to minimize the footprint on the workforce on the Islands. IIIa specifically deals with the construction and installation on the East coast of East Falkland and IIIb contains the activities on the West side of East Falkland.

Phase III cannot be initiated before all the necessary permits and permissions has been obtained. It is thus envisioned that phase III will be initiated earliest ultimo 2027. Phase III is planned to be finalized with the installation of the last sea site in Falkland Sound or Ruggles Bay.

During phase III the company will also initiate a substantial training and education program for future employees in order to secure people with the right skills are available to support the business. The program will be focused on Falkland Islanders that want to work in the business. Details can be found in Chapter 7 of this report or in Appendix B. Phase III has been divided into three (3) subphases, IIIa, IIIb and IIIc which primarily relates to sea site production implementation. IIIa is the first step with a planned production of 5,000 tonnes, phase IIIb and IIIc increases the production capacity with 10,000 each. The reasoning for this division of phases is that important experience and knowledge is gained during phase IIIa, can be implemented in phase IIIb and further refined in phase IIIc.

The total budget for phase III will be approximately 302 million GBP.

The following parts of the project will be executed during phase IIIa:

a. Hiring of staff
    I. Chief Operating Officer (CFO)
    II. Fleet manager
    III. Two (2) operational staff for land-based facility
    IV. Five (5) operational staff for the sea sites
    V. Eight (8) crew for larger service vessel
    VI. Five (5) crew for supply vessel
    VII. Eight (8) office staff
b. Construction of Land-based hatchery at Mare Harbour
a. Establishment of eight (8) net pen sites each with a capacity of 5,000 tonnes production per harvest (19-month cycle) or a total of 25,000 tons per year.
c.
    I. Four (3) sites in Choiseul Sound Region
    II. Five (5) sites in Adventure Sound Region
d. Investment in vessels
    I. Four (4) smaller vessels for personal transport
    II. Four (4) medium sized service vessels
    III. Two (2) larger service vessels
    IV. One (1) Service/ transport vessel (Feed, Fuel, Supplies, Water)
e. Construction of head office facilities in Stanley

Once the construction of the hatchery has been completed phase IV will be initiated. It is expected that the hatchery at Mare Harbour will be completed and commissioned in 2031.

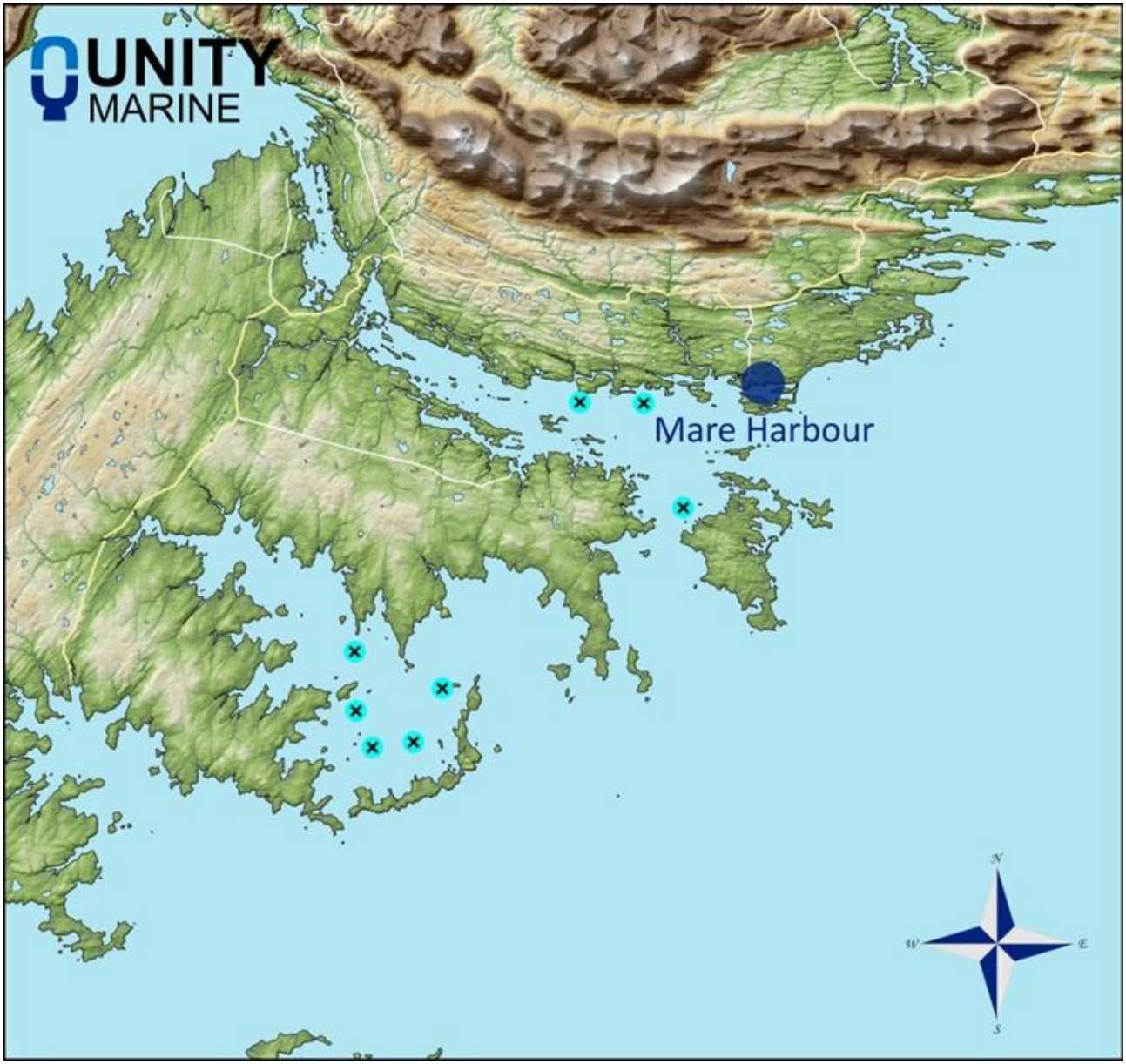


Figure 15: The placement of the proposed activities in phase IIIa. A total of eight (8) sea sites on the east coast of East Falkland will be installed as well as the land-based hatchery at Mare Harbour.

The following parts of the project will be executed during phase IV:

b. Hiring of staff
    I. Two (2) operational staff for land-based facility
    II. Five (5) operational staff for the sea sites
    III. Four (4) crew for larger service vessel
    IV. One (1) veterinarian
c. Construction of Land-based hatchery at New Haven
d. Construction of new wharf and harbour facilities in New Haven
e. Establishment of eight (8) net pen sites each with a capacity of 5,000 tonnes production per harvest (19-month cycle) or a total of 25,000 tons per year.

I. Three (3) sites in Grantham Sound Region
II. Four (4) sites in Main Passage Region
III. One (1) site in Ruggles Bay Region

f. Investment in vessels
I. Four (4) smaller vessels for personal transport
II. Four (4) medium sized service vessels
III. One (1) larger service vessels

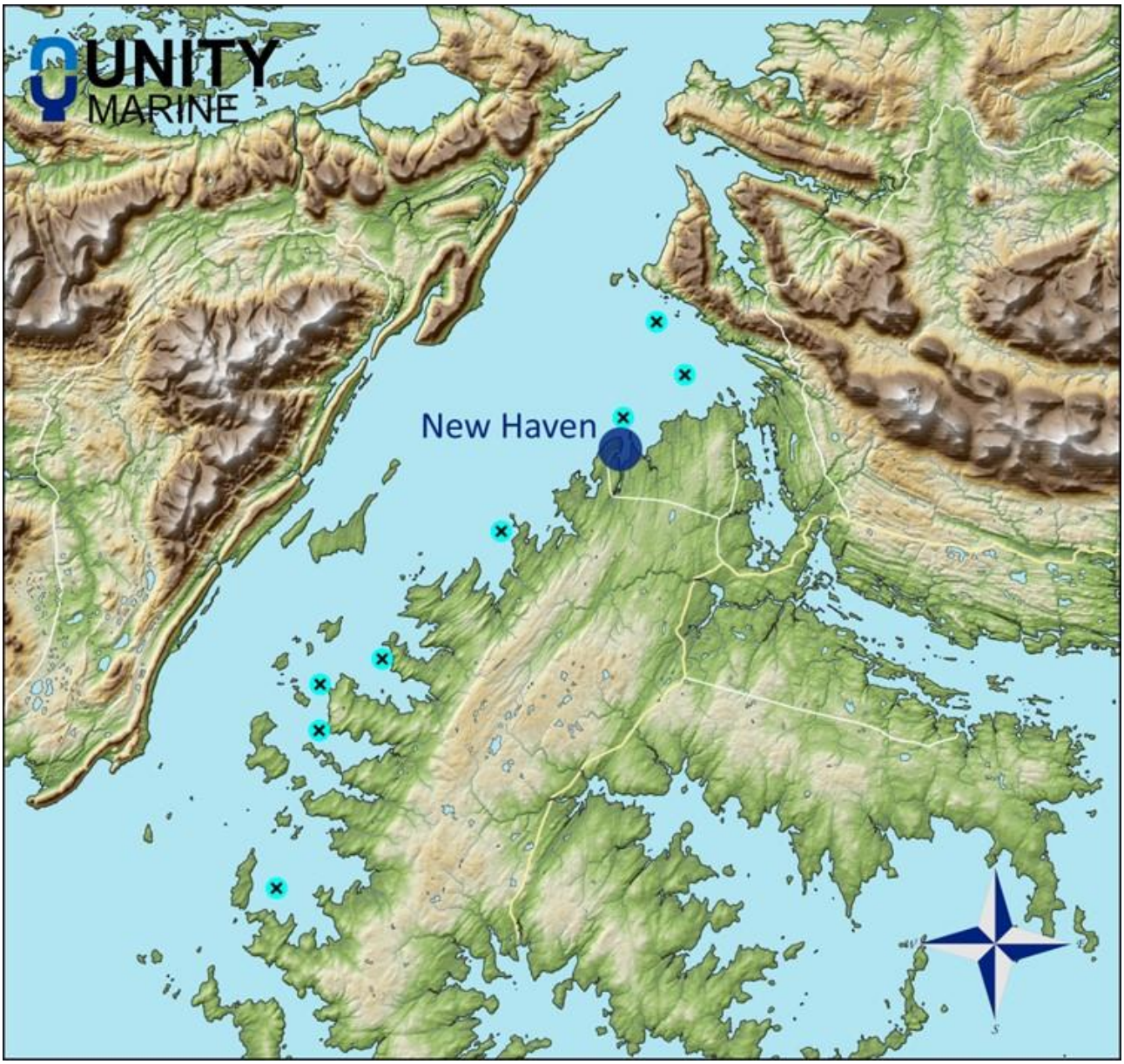


Figure 16: The placement of the proposed activities in phase IIIb. A total of eight (8) sea sites along the west coast of East Falkland will be installed as well as the land-based hatchery at New Haven.

6.3.4 Phase V – Operation

Phase IV commences when the first Land-based hatchery has been completed and the first eggs are introduced from certified biosecure facilities. During the initial stages of phase V, there will still be considerable installation and construction work associated with phase IV.

During this phase the company will hire all the remaining operational personnel to staff the production units as they are commissioned and ready to receive fish or eggs.

a. Hiring of staff
    I. Fifteen (20) operational staff for land-based facility
    II. Seventy (70) operational staff sea sites
    III. Nine (9) workshop and warehouse staff

Phase IV is the final and operational stage of the project. The first eggs will be received in 2029 and the first fish will be transferred to the sea sites later that year. The first harvest is expected to take place in 2031 and the company will reach full harvest capacity of 50,000 tonnes/ year in 2033 at the earliest.

6.4 Land-based facilities

The land-based facilities each consists of ten (10) Recirculated Aquaculture Systems (RAS) placed in an insulated industrial type building. RAS technology allows the operator to reduce the amount of new water used as the water is usually re-used up to 100 times. Using RAS technology secures full control of water quality within the systems as well as full temperature control. Furthermore, the water entering and leaving the facility, can be treated to ensure a high level of biosecurity.

Each facility will contain the following systems:

- Two (2) hatcheries
    - Hatching of eggs
- Two (2) start feeding facilities
    - Start feeding and rearing of fish from 0.18g – 2.0 g
- Two (2) Parr facilities
    - Rearing of fish from 2g – 14 g
- Two (2) pre-smolt facilities
    - Rearing of fish from 14g – 60 g
- Two (2) smolt facilities
    - Rearing of fish from 60g – 125 g
- Intake water treatment system
- Effluent water treatment system
- Generator and/ or wind mill and emergency generator with fuel storage
- Staff quarters and offices
- Feed storage
- Veterinary facilities
- Accommodation facilities
- Storage area and mechanical workshop
- Oxygen generators with back up storage capacity

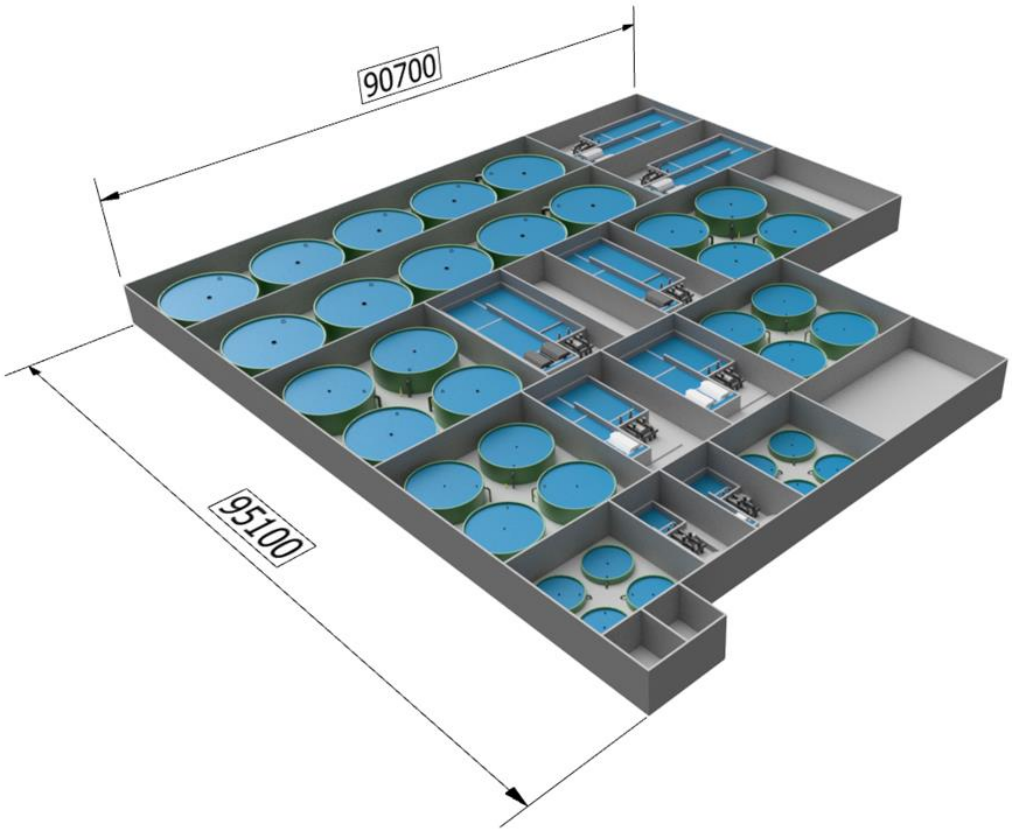


Figure 17: Schematic drawing of one of the facilities for smolt rearing. Based on site investigations the facilities will be built on two separate plots at Mare Harbour and New Haven. All measurements are given in millimetres.

The land-based production facility will contain the fish from egg to approximately 125 g. When reaching 100-150 g, the fish are smoltified and moved to the sea sites in a well boat. The smoltification process sees the fish naturally develop from the freshwater juvenile stage to the sea water form. The process is induced in the fish with the use of light and temperature signals. Once the fish have been smoltified it will need to go to sea within a relatively short period of time or it will transform back into the freshwater form.

The process from hatching of the eggs to the fish are transported to the sea sites is approximately 8-9 months. During this period the fish will undergo several gradings. At approximately 40 g the fish will be injection vaccinated according to the Company veterinarian's proscriptions. Depending on the threat level in the area the fish might be dip vaccinated at a size of 1-10 g as well. The vaccination will either be carried out by a manual vaccination team brought in for the task or by using an automated vaccination machine.

The two (2) post-smolt facilities would most likely be placed in Mare Harbour and New Haven.

6.4.1 Placement of the facilities

From the 8th to the 11th of November 2018 a site investigation field survey was carried out. Potential sites were surveyed, and nearby potential water sources were tested. The main characteristics that were sought consisted of the following:

1. Placement in proximity to the sea sites

    a. In order to transport the fish as shortly as possible a site on the East side and on the West side of East Falkland was sought.
    b. It is possible to transport the fish from one side of the island to the other, but due to fish welfare considerations it would be better with shorter transport
2. Fresh water availability
    a. The site needs access to at least 35 l/s of fresh water
    b. The fresh water resource is preferably not to be contaminated with heavy metals
    c. As the water will be treated prior to use bacterial contamination or organic particles is acceptable
3. Access to the sea
    a. The fish will be moved out of the facility by well boat. The well boat has a draft of at least 5 meters. The facility thus needs to be placed adjacent to relatively deep water
    b. The fish can be transported in a floating pipe to the well boat. The distance from the smolt facility to the loading point should preferably not be greater than 500m
4. Road infrastructure
    a. The facility will rely on road infrastructure for transport of building materials, personnel to and from the site, consumables and input (stocking) of eggs.
    b. Access to the facility is needed all year round.
5. Pier or harbour facilities
    a. The facility is ideally placed next to harbour, wharf or pier facilities
6. Other infrastructure or considerations
    a. Any other infrastructure in the terms of power, portable water etc. is considered a benefit
    b. Proximity to Stanley or a larger settlement is considered a benefit
    c. Communication such as access to cell phone coverage and internet availability

The following areas were investigated on the site survey trip:

1. Mare Harbour
2. Walker Creek
3. Goose Green
4. Darwin and surrounding area
5. Saladero
6. New Haven
7. Port Sussex
8. Head of the Bay and San Carlos
9. Port San Carlos

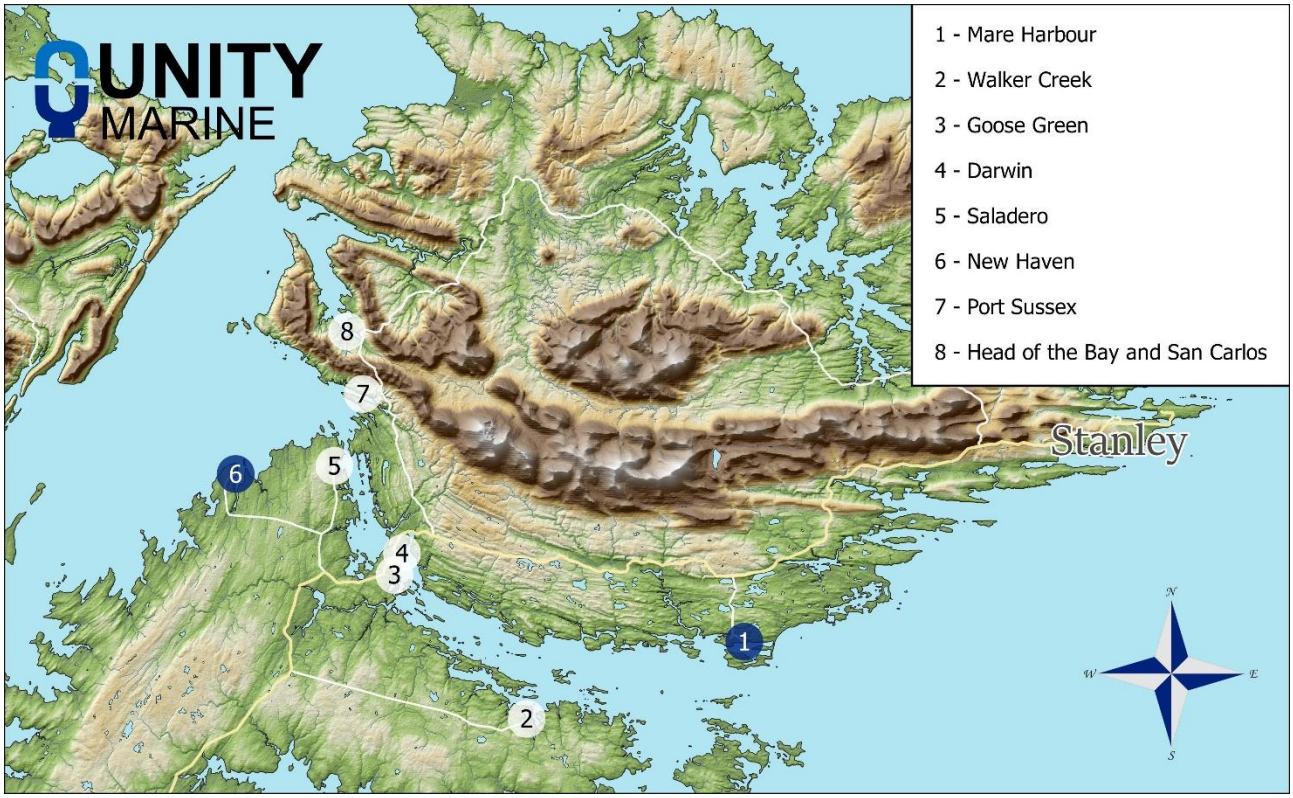


Figure 18: Location of the land- based site investigations conducted in November 2018. Based on the site investigations Mare harbour and New Haven was chosen. These sites have been marked in dark blue.

An analysis of the suitability of the different sites can be found in appendix C. The results of the water quality testing can be found in appendix D.

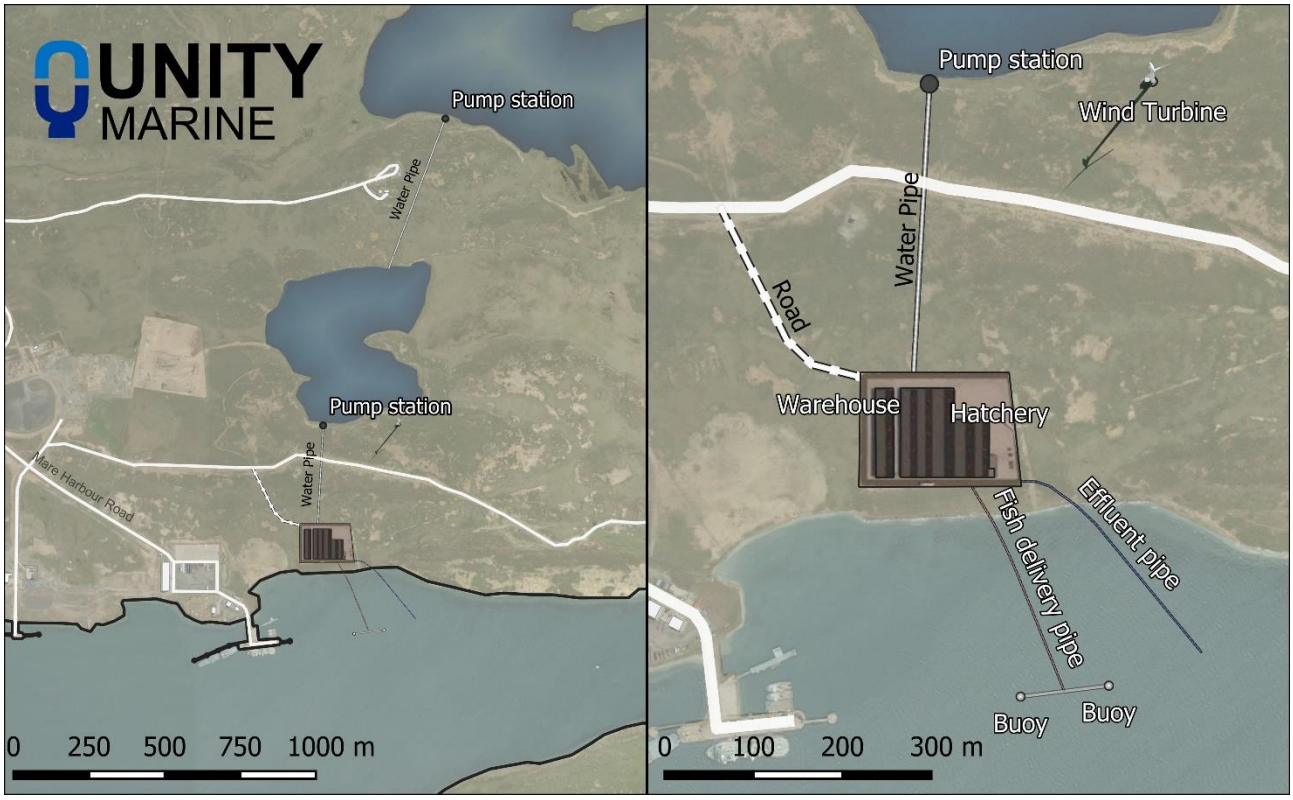


Figure 19: Planned land-based site East of Mare Harbour. The water is planned to be drawn from the pond close to the site and back up water can be sources from East Cove Pond.

Based on the findings Mare Harbour and New Haven was identified as the most suitable sites. Further water testing at Mare Harbour will however be needed in the future due to relatively high aluminium content of the water.



Figure 20: Planned land-based site at New Haven. The water is planned to be drawn from the three streams at Dos Lomas. Pipe is planned to be put down next road. There is also an identified need for an additional wharf at New Haven.

6.4.2 Future outlook

If it is decided to keep the fish on land for a prolonged time in flow-through seawater facilities, it is likely beneficial that the two (2) hatcheries are merged into one (1) larger hatchery. Such a facility will require the same sections as described above, but each section will need to be doubled in size.

This also negates the requirement for placement close to the sea, as the smolt will be required to be transferred to the post-smolt facilities prior to transfer. This transfer would be carried out by trucks. Therefore, new potential placements could be considered, where better water sourcing is available. It would still be required to place the facility close to an A-class road.

The two (2) flow-through facilities would likely be placed in Mare Harbour and New Haven to be able to transfer the fish easily to a well boat and further on to the sea sites.

6.4.3 Egg supply

As there is currently no supply of eggs on the Islands, these will have to be imported. Due to biosecurity considerations, it is planned to import eyed eggs from a bio-secure closed containment facility like Stofnfiskur's on Iceland or AquaGen's facility Profunda in Norway. The eggs could come from a different supplier that can guarantee pathogen free deliveries from closed facilities, if such a supplier is available. The eggs and the broodstock will also be screened with PCR technology for known diseases as an additional precaution prior to shipment.

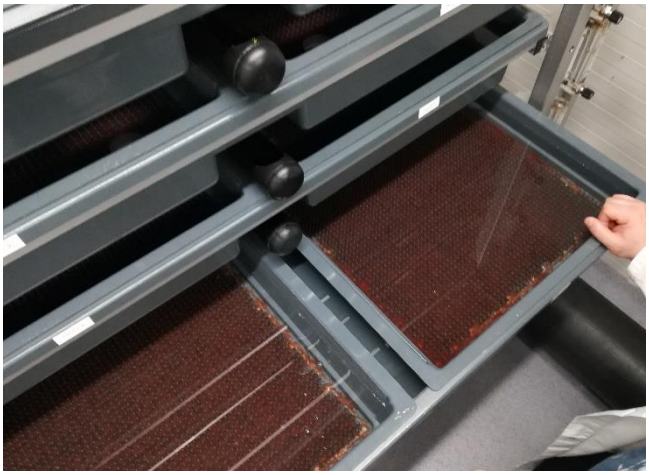


Figure 21: CompHatch hatching system installed at smolt facility in Norway.

For additional biosecurity the eggs will be disinfected prior to transfer to the facility and transport containers will be destructed or incinerated.

The eggs will be inserted into specialized rearing units for salmon egg hatching. The eggs need to be kept at relatively low and stable temperatures (4-10°C) to secure optimal hatching and egg development. The eggs will hatch after approximately 440 day-degrees, but the larvae will at least be kept in the system until they have consumed their yolk sac. Once the yolk sac is gone the larvae will swim up in the water column and be ready to start feed.

6.4.4 Water

Each facility will need a fresh water source. The water can be taken from wells or a surface water source in the form of a river or lake. In case the water is drawn from a surface source then the influent water treatment system will be scaled to tackle any seasonal variations in water quality, like peat or organic wash out during periods of heavy rain.

Due to the use of RAS the amount of water used will be much smaller than for a more traditional facility using flow through technology. It is estimated that the water use on average will be approximately 20 l/s, while peak usage will be in the range of 35-50 l/s. Environmental impact on the chosen streams and ponds will need to be assessed in phase II of the project.

The drawing of water is planned to have minimal impact on the streams and ponds supplying the water. This is done by not pumping directly from the water source, but through gravitational in seeping through the ground to the pump sump.

It has also been planned to use solar or wind with battery backup to drive the pumps in to avoid potential spill of diesel from generators into nearby water bodies.

The disinfection system will be dimensioned to mitigate the risk of pathogen introduction.

6.4.5 Influent water treatment

Reusing the water allows for especially fine treatment of the influent water as the flow rate compared to a traditional flow-through system drops almost 100-fold.

Based on the influent water source the water can be cleaned for peat and other organic materials, silt, iron, bacteria, virus or other unwanted organic and inorganic substances.

The influent water treatment will as a minimum consist of a filtration unit followed by a UV system for inactivation of bacteria and virus. Based on the condition of the water source, ozone treatment might be used as well. Based on the pH of the water and the buffer capacity, the alkalinity might also be adjusted with the use of lye (NaOH), Calcium Carbonate ($CaCO_3$) or another base approved for food production.

6.4.6 RAS Technology

The hatcheries will be operated using a Recirculated Aquaculture System (RAS) for the following reasons:

- Lower water usage
- Constant water temperature
- Control of water chemistry – not affected by external events
- Increased biosecurity
- Timing of transfer to the sea sites
- Delivery of smolts year round

The facilities will be designed and built by a company specialized in RAS technology, e.g. Billund Aquaculture (Denmark)[7], Nofitech (Norway)[8] or AKVA group Land-based (Denmark)[9]. A commercial offer from Billund Aquaculture for the system can be found in Appendix K.

Based on the supplier the final technical solution will differ somewhat in terms of the technical specifications, but the facility will be constructed around some core features that is briefly outlined below.

The fish will be kept in round tanks constructed from concrete, fiberglass, polyethylene (PE) lined steel or another material suitable for the purpose. The tanks will be fitted with specialized inlets and outlets, designed to keep a certain current within the tanks maintaining self-cleaning ability and optimum swimming speed, while removing faeces and uneaten feed pellets. The water exchange in the tanks will take place 1 to 2.5 times per hour, depending on the size of the fish and the stocking density. The tanks will also be fitted with a primary and secondary (emergency) oxygen system to secure enough oxygen for the fish at all times. There will



Figure 22: Tank room in newly built salmon RAS farm in Norway. The facility was designed by Pisco ApS, Denmark.

[7] https://www.billundaquaculture.com/
[8] https://nofitech.com/en/front-page/
[9] http://www.akvagroup.com/land-based-aquaculture

also be a specialized system for the removal of possible fish mortalities and fixed pipes for transfer of fish from tank to tank or to the grading area.

Water from the tanks will be led through a pipe system to primary treatment in drum filters fitted with 30-60 µm screens. The retained solids will be fed to a storage tank on the premises.

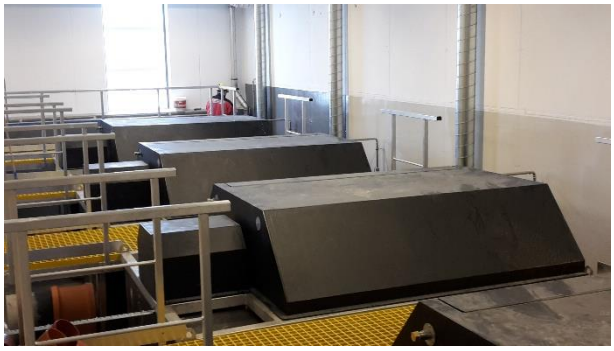


Figure 23: Drumfilters installed in a RAS facility in Norway.

After the drum filter the water will flow by gravity to the biofilters, where ammonia (NH_3) and ammonium (NH_4^+) will be converted intermediately by nitrifying bacteria to Nitrite (NO_2^-) and subsequently Nitrate (NO_3^-). Nitrate is diluted from the system using new make-up water. The dilution of Nitrate is the driving parameter that determines the water exchange of the facility.

Before being pumped back into the tanks the water will be degassed in order to remove carbon dioxide (CO_2) from the water and increase the oxygen content. The degassers will either consist of ventilated cascade columns or diffuser based under water aerators. The removed CO_2 will be vented from the building.

Prior to being led back into the tanks the water will be oxygenated in e.g. oxygen cones to keep the oxygen saturation within optimal levels for salmon rearing. The addition of oxygen will be controlled by the control system via continuous monitoring of the oxygen levels in each fish tank. An emergency oxygen system will also be fitted to each tank.

The system will be fitted with a control system. All motors end equipment will thus be controlled by a PLC system that can be accessed locally or remotely. In case of critical failures, the employees on-duty will receive an alarm, so proper actions can be taken immediately.



Figure 24: Degassing unit in Norwegian Salmon RAS farm. This degasser is constructed with diffusors spaced out in a sump at relatively low depth (0.8m).

In case of power outs, the facility will have emergency generators installed. The emergency generators will be sized to cover the essential needs of the facility without compromising fish health and maintaining normal operations.

6.4.7 Effluent water treatment

The effluent water will be treated in order to retain solids and prevent potential fish escape. The treatment will involve fine screen filtration using a drum filter or similar treatment equipment. A fixed rigid coarse grid will be installed to prevent fish from escaping as a secondary measure.

Fish sludge contains macro and micronutrients, especially in the form of Nitrogen and Phosphorous that can be utilized for plant growth. It can also be used to increase organic content in depleted soils. The

retained solids from the production will be collected and can be used for fertilizer on local farm lands.[10] The sludge from the drum filters, within the system can likewise be used as fertilizer on farm lands. FLH has also shown interest in using the nitrogen rich effluent water on farmlands. The feasibility of using the effluent water will however need to be investigated in detail[11].

After treatment the water will be led to the sea through a pipe. The pipe exit will be placed a minimum of 50 m from the shore and in a position where discharged nutrients will be dissipated over larger area to avoid local build-up of organic materials. The exact length of the pipe will be designed during phase II of the project. The sludge will be collected and stored on the site.

6.4.8 Power

Each facility will draw around 0.8-1.2 MW year-round depending on which sub-units are in operation at any given time. The power will be used to operate pumps and process equipment, ventilation, oxygen generation, heating of the production water and general utilities office equipment as well as overhead lighting.

Based on a report carried out by Sweco, Denmark on behalf of F-Land ApS it was suggested that a combination of renewable energy in the form of a windmill in combination with diesel generators was the best standalone option for both facilities. Emergency diesel generators will also be installed to ensure the wellbeing of the fish. In case of a power outage it is estimated that the fish will start dying after approximately five (5) – ten (10) minutes. Sufficient backup capacity is therefore vital for the operation.

Due to the infrastructure in Camp the entire electricity infrastructure will need to be built from scratch. Please see chapter 9.4 on power infrastructure for details and appendix E for full analysis of potential standalone setup of power supply.

6.4.9 Oxygen

Oxygen for aquaculture purposes can either be sourced as liquid oxygen and stored in a cryogenic tank on the facility or be generated using oxygen generators on site.

As there is no liquid oxygen available on the Falkland Islands, oxygen will need to be produced on site using oxygen generators. The use of oxygen generators is a well-established method for oxygen supply within the aquaculture business. There are several brands on the market that could be used e.g. Oxymat, Denmark[12] or AirSep, USA[13].

The oxygen supply is a vital part of the facility. In case of failure on the equipment there is an immediate (within minutes) risk to the stock. Therefore, sufficient back up capacity for oxygen generation will be installed on each of the two sites.

[10] Utilization of sludge from recirculation aquaculture systems, Nofima, March 2010
[11] Interview with Andrew Pollard, November 2018
[12] https://www.oxymat.com
[13] https://www.caireinc.com/commercial/products/oxygen-products/

The oxygen generators will be coupled with backup pressurized oxygen containers, capable of supplying oxygen in emergency situations, in case of a power outage. The pressurized oxygen containers will be automatically filled by the oxygen generators, when they are not required to operate at full capacity.

The facility's oxygen generator will be able to supply back-up oxygen to King Edward VII memorial Hospital in Stanley in the case of breakdown in the hospitals own supply. The oxygen would in this case be filled on pressurized cylinders and transported to the hospital by car or truck.

6.4.10 Construction

The facilities will be constructed in two phases, so the first facility will be built in year one and the second facility will be built in year two of the project. There will generally not be overlap between the two construction periods in order not to strain the already taxed workforce requirements on the Islands. There might however be some site preparation and concrete work on site II before the first facility is completely commissioned.

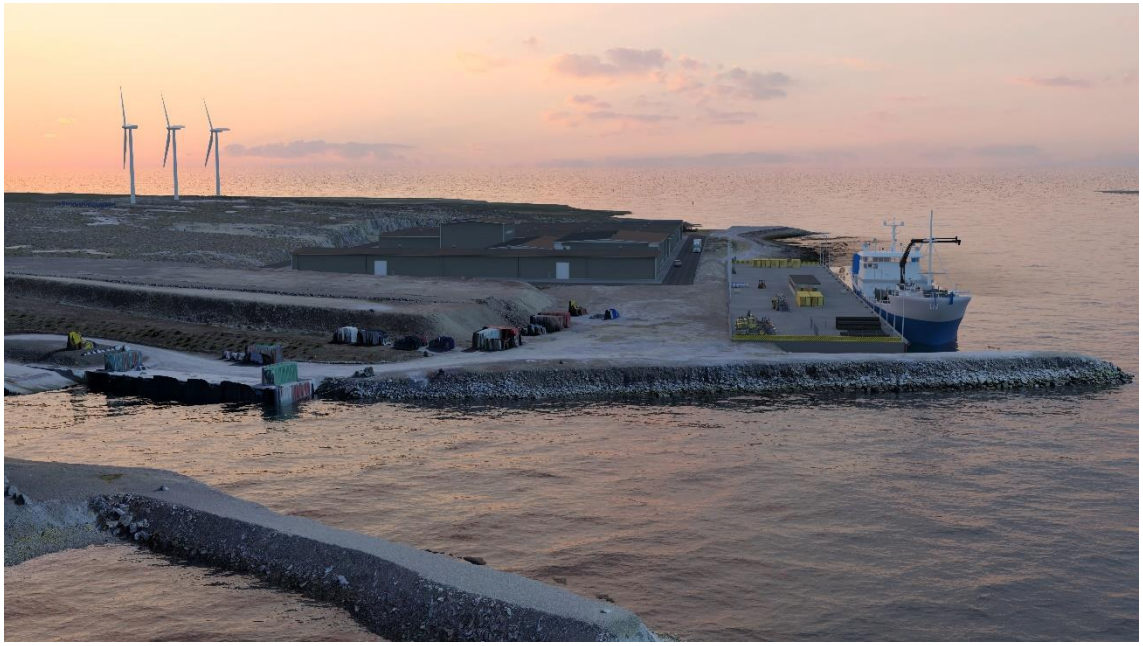


Figure 25: Render of the planned facility at New Haven.

The construction period for each of the two sites can be split into the following phases:

1. Design and Planning permission
2. Site clearing and preparation
    a. Levelling
    b. Grubbing
    c. Compacting
3. Concrete construction (Water treatment units)
    a. Compacting and backfilling
    b. Reinforcement assembly
    c. Formwork
    d. Concrete pouring

4. Building foundations and erection
    a. Concrete curtain walls
    b. Erection of supporting pillars
    c. Cladding
5. Underground piping and trenching
    a. Trenching
    b. Pipe installation
    c. Backfilling and compacting
6. Tank, equipment and above ground piping installation
    a. Compacting and backfilling around tanks
    b. Tank installation
    c. Mechanical installation
    d. Pipe and valve installation including wall fixings
7. Concrete flooring
    a. Compacting and backfilling
    b. Reinforcement
    c. Concrete pouring
8. Electrical installation
    a. Electrical cabinet installation
    b. Wiring of machinery and sensor
    c. Testing
9. Commissioning and start-up
    a. Seeding of biofilters
    b. Testing
10. Production (phase IV)

Each of the phases will to some extent overlap as the hatchery and first feeding units will receive fish before the units used to rear the larger fish. E.g. the hatchery will need to be completed, tested and commissioned approximately six (6) months before the smolt unit. An example of a phased building process can be seen in Figure 26.

Site preparation is required prior to the commencement of facility construction. Both sites will need to be cleared, and the land will need to be levelled and grubbed. An access road to the site at Mare Harbour will also need to be constructed prior to construction.

The construction will begin once planning permission is received and the project is approved following any EIA process. Construction of the first facility is estimated to be twelve (12) months after construction begins. The second facility will follow the same timeline from the finalization of the construction of the first facility.

Prefab building materials will be used to construct the building for the land-based facilities. The supplier of the materials has yet to be determined and will rely on which company is chosen as the general contractor. The general contractor will usually have a preferred supplier of the prefab building materials. The materials

will need to be procured internationally and shipped to the Islands either through established lanes to the UK (to Mare Harbour) or Uruguay (to FIPASS). It is estimated that the total shipping volume is in the order of 250 – 350 forty (40) foot containers for each of the facilities. The final number will be calculated during the detailed design phase.

Concrete and backfill will be sourced locally from the quarry. Volumes and potential limits in supply will be gauged in detail during phase II of the project.

Equipment utilized during the construction phase would be typical of most building type construction projects of this size. Equipment would generally be diesel fuelled (resulting in typical diesel emissions) and would consist of the following:



Figure 26: The Atlantic Sapphire facility in Dade County, Florida, USA as of September 2023. The first phase has been completed and is in production (right), while the construction of the next phase facilities is still in various phases of construction (left).

- Loaders
- Excavators
- Crane/Boom
- Trucks Tele-Handlers
- Diesel/electric pipe fusing machines
- Pit trucks
- Dozers Grader
- Tandem dump trucks
- Semi dump trucks
- Diesel Generators

Development of infrastructure for fresh water supply, effluent disposal and power generation surrounding the facility will take place alongside the main construction and installation. These processes are thus to be considered outside the phasing as given above and will run on separate project schedules.

The separate infrastructure projects are given below:

1. Development of fresh water supply
    a. Piping
    b. Trenching
    c. Pump station
    d. Potential drilling
2. Development of power infrastructure
    a. Windmill installation including concrete foundations
    b. Diesel generator
    c. Wiring and electrical

   d. Trenching
3. Fuel infrastructure and/ or bunkering (to be discussed with Stanley Services)
   a. Concrete base
   b. Tank erection
   c. Pump installation
4. Access road improvements or construction
5. Effluent infrastructure
   a. Underwater piping
   b. Concrete sump construction
   c. Excavation

Any additional access roads around the land-based facility at Mare Harbour, will not cross any bodies of water. Therefore, no rearrangement or redirecting of surface waters in culverts are expected.

6.4.11 Operations

The operations and management of a land-based RAS Smolt facility consist mainly of:

- Stocking (receiving eggs)
- Feeding
- Monitoring fish welfare and veterinary control
- Surveying water quality
- Collection of mortalities
- Grading and moving
- Vaccination
- Maintenance of mechanical, electric equipment and production areas
- Quality sampling and quality assurance
- Housekeeping and cleaning
- Reporting
- Follow self-monitoring, Quality Assurance systems and HSE.
- Delivery of smolts

The different operations are described in the following chapters. Detailed plans for operations, HSE and fish welfare plans will be developed prior to applications for Fish Farming Licenses under the Fish Farming Ordinance.

The following non-exhaustible list of plans and journals will be developed and maintained for the operation before the first eggs enter the facility:

1. Maintenance plan
2. Fish Welfare Plan
3. Production protocol
4. Production journal

A full list of all planned protocols, procedures and plans can be found in Appendix L.

6.4.11.1 Stocking

The eggs are packed in Styrofoam boxes which is divided into compartments and layers. The boxes are brought into the hatchery through a dedicated sluice. Before the eggs are transferred to the hatching trays, they are disinfected, and the boxes are destroyed. The eggs will be spread among the trays to secure good spacing and waterflow to the individual egg.

The eggs are transported refrigerated and must be handled with care. Increase in temperature can cause early hatching, deformities in the larvae or mortalities. The hatchery will usually be kept at 4°C initially. After a stabilization period of a few days, the temperature will be increased to approximately 7°C until hatching. Pre-hatching, the eggs have to be kept in complete darkness. The operators will use red headlight or very dimmed light when handling the eggs. To reduce the risk of fungal infections the salinity will be adjusted slightly to 0.5-1.0 ppt using disinfected sea water.

Once the eggs hatch, they will remain in the hatching trays until they have used the yolk sack and the fry starts to swim to the surface, thereafter they will be moved gently to the start feeding tanks.

Data on number of eggs and egg supplier certificates will be logged in the company's Production Journal.

6.4.11.2 Feeding

Once the larvae have been moved to the start feeding tanks, they will be introduced to dry feed, at this point in time the average weight of the fish will be approximately 0.18 grams. The first feed will be crumbles of a size of 0.5 mm. The used pellet size will increase incrementally with fish size, resulting in a maximum pellet size of 3 or 4.5mm for a 125g smolt.

The feed is hot extruded to be bio-secure and maintain high technical quality. This ensures higher utilization and lower feed consumption, while maintaining good water quality due to low breakage and subsequent dust formation. The ingredients are carefully selected to the different stages of the larvae, fry, parr, pre-smolt and smolt. The diets are well documented within the industry over 50 years to ensure the right nutritional demands of the fish is fulfilled. The protein content of the feed is considerably higher for the early life stages of the fish than later in the life cycle of the fish. The land-based facility will thus also use feed with a higher protein content than the subsequent production at sea.

The feeding behaviour will be monitored closely, so the feeding regime can be adjusted to the support the wellbeing of the fish. Feeding will be done using automatic or semi-automatic feeders. Hoppers on the feeders will be topped up daily by use of forklift or a pipe conveyer belt distribution system.

Data on amount, size and make of feed will be logged in the company's Production Journal.

6.4.11.3 Grading and moving

Throughout the production cycle the fish needs to be moved and graded at regular intervals.

Movement of fish is done with specialized fish pumps through a permanently installed pipe system and to some extent in flexible hoses. The fish will only be transferred in "one direction" through the systems, so the batches are never mixed.

Fish, even from the same batch, grow at different rates, resulting in spread of sizing in the population, therefore they will be graded at regular intervals. Grading will be done using a specialised salmon grader,

e.g. Apollo Grading machine, Apollo Maskinfabrik, Denmark[14]. The fish are pumped with the fish pump into the grader, before being graded they will pass a dewatering unit. The water will be pumped back into the originating system. The fish will then enter the grading machine, where they will be graded based on size. After grading the fish will run by gravity to the destination tank through fixed pipes or flexible hoses.

When the fish are moved and/or grading the fish will be counted with automated counters, e.g. Aquascan CSE -series counter, Aquascan, Norway[15].

When the fish have smoltified and are ready to be transferred to the sea site. The fish will be pumped out of the tanks, counted and sent thru a delivery pipe to the well boat. The well boat will subsequently transport the fish to the designated sea site. The smoltification will be verified with biochemical tests.

All grading or moving events will follow the guidelines that will be set out in the company's Fish Welfare Plan. All fish movement, grading or delivery will be recorded the company's Production Journal to ensure full traceability of the production.

6.4.11.4 Collection of mortalities

Mortalities are estimated to be between 20-25% while being reared in the facility. The major part of the mortality is expected in the egg phase (10%) and during start-feeding (5%).

Mortalities will either be collected with automated mort collectors installed in the tanks or manually with dip nets. Mortalities will be collected daily and will be transferred to the ensilage tank. All mortalities will be categorised and recorded in the Production Journal.

Dead fish will be ground and mixed with formic acid to keep its quality for further processing or to be used as a fertilizer. Formic acid will be used in the ensilage process. The company is planning to use food grade formic acid (85% dilution) which will be transported to the facility by truck in 1,000 L containers. The formic acid will be dosed directly from the containers. The containers will be placed in the facility chemical room that will be equipped with a spill tank that can contain the entire volume of one container in case leaks or a container break.

Prior to entering the actual ensilage tank, the mortalities are ground into a slurry and formic acid is dosed to lower the pH to 3.0. The ensilage is then transferred to ensilage tanks located outside the facility. The silage can be further processed, used in animal feed (e.g. pig feed) or used as fertilizer on farmland.

6.4.11.5 Water quality and health monitoring

Fish depend on good water quality to thrive, grow and feed. In order not to stress the fish, it is also vital to keep physical parameters like temperature and current in the tanks (and thus the swimming speed) constant. A stressed fish will grow slower and be more susceptible to catching pathogens.

Fish characteristics like fins, gills, loss of scales, deformities and colour changes as well as behaviour will be subject to regular monitoring and registration. In case of indications of stress or damage of the fish the company's veterinarian will be consulted and the case noted in the Production Journal. Any infection with a pathogen will immediately be reported to the government veterinary department and proper actions in

[14] http://www.apollo.dk/en/component/content/article?id=5
[15] http://www.aquascan.com/event/dolink/famid/131221

accordance with the company's veterinarian's prescriptions and the Fish Health Management Plan will be carried out.

Veterinary visits and controls will be performed at least once per month by the Company's veterinarian. Additional veterinary inspections will usually be carried out at times when the fish are moved, graded or have just been vaccinated.

In addition to basic registration, behaviour is monitored visually by the staff. Behavioural abnormalities usually give an early indication of potential problems. Observations and changes in production must be evaluated regularly with the company's veterinarian.

Monitoring of these parameters is thus key to ensure optimal welfare and performance of the fish. In this sense, the following parameters will be constantly monitored, as they are the most important for fish health and for system performance.

- pH – Probes constantly measuring pH will be placed in the water treatment unit and in the Influent Treatment System.
- Temperature – Temperature sensors will be placed in each tank and in the Influent Treatment System.
- Oxygen – Probes monitoring oxygen levels will be placed in the fish tanks and in the influent treatment system.
- CO_2 – Sensors for carbon dioxide will be placed in the water treatment units.

The data will be stored on the company's data system for at least five (5) years from the day of measurement and can be provided as per request.

Routine monitoring protocols for the following parameters will also be established:

- TAN – Total Ammonia Nitrogen will be checked daily in the tanks via spectrophotometer. Once a week it will also be analysed in the influent treatment system.
- Nitrite – Daily samples will be collected and analysed via spectrophotometer. Monthly samples will be taken in the influent treatment system.
- Nitrate – Daily samples will be collected and analysed via spectrophotometer. Monthly samples will be taken in the influent treatment system
- Alkalinity – Weekly samples will be collected and analysed via spectrophotometer.
- H_2S – Weekly samples will be collected and analysed via spectrophotometer.
- N_2 – Hand-held TGP probes will be used in the tanks for monitoring of N_2 gas saturation. Weekly measurements will be taken.
- Metals – Screening for heavy metals will take place every six (6) month in the Influent Treatment Systems. A water sample will be taken and sent out to an authorized laboratory for analysis.

All information will be logged in the company's Production Journal.

6.4.11.6 Vaccination and pathogens

Depending on the current pathogen threat level in the area, the company veterinarians will set a vaccination program that all company fish must follow.

Vaccination will either be performed by hand by a specialised team brought in from abroad or by use of a vaccination robot that will be permanently installed on the facility, e.g. Maskon Vaccination Machine, Skala Maskon, Norway[16]. The vaccination consists of an injected emulsion of approximately 0.05 ml. All fish will be stick vaccinated individually. Fish must be over 35 grams to ensure the vaccine is correctly deposited. After the vaccination the fish will need to be kept in the land-based facility for at least thirty (30) days to develop the immune response. The effect of the vaccine is at its highest at the time of delivery to the sea sites, so the fish enters the sea with maximum protection.

Based on the current situation on the Falkland Islands the company's veterinarian will determine the need for vaccinations and procurement of salmon strains with increased resistance for specific viral infections like PD, ISA, HSMI and IPN.

As a base level of protection, the vaccine package will as a minimum provide protection for traditional and well-known diseases such as furunculosis and vibriosis.

Fungal infections usually only occur in the freshwater phase of the production cycle and is almost always caused by *Saprolegnia* spp. Treatments consists of increasing salinity in the production water, hydrogen peroxide addition and historically use of formalin. Use of formalin is now restricted and will not be used on the Falkland Islands.

All treatments will be applied only on veterinary prescription. Any treatment will also follow the rules set out in the company's Fish Health Management Plan and will be noted in the Production Journal.

6.4.11.7 Maintenance and cleaning

Modern hatchery facilities contain different technical equipment, such as motors, pumps, blowers, gears, valves and other moving parts. Due to the remote location of the Falkland Islands and the subsequent challenges with procurement of replacement parts locally a good technical maintenance plan is key.

The company will generate a Maintenance Plan, that according to the equipment suppliers recommended service program, will schedule periodic maintenance and replacement of parts. The Maintenance Plan will also detail which spare parts that must be kept at stock on the Islands at all times. If a spare part is used a replacement will immediately be ordered and added to the inventory.

Routines for high level of cleaning and housekeeping is very important in continuous livestock rearing. Improper cleaning procedures can lead to accumulation of waste and subsequent pest infections, or it will create good breeding conditions for pathogens. The production protocols will detail regular cleaning intervals of equipment, floors, tanks, pipes and walls. During cleaning some standard detergents will be utilized alongside pressure cleaning or hosing with clean fresh water.

6.4.11.8 Chemical usage

In a normal production cycle, the fish will not be treated with any chemicals or therapeutics beyond the vaccination process described earlier.

Detergents will always be used with proper care for the fish. Tanks will as an example be cleaned with a detergent, when it has been emptied of fish. All equipment is rinsed thoroughly after the cleaning

[16] https://maskon.no/en/produkt/vaccination/

procedure has been completed, this is done to be sure there is no leftovers or residues. Heat exchangers are also CIP cleaned to maintain efficient energy transfer.

The biological filters of the water treatment units convert ammonia/ ammonium to nitrate in an acidifying process, causing the pH of the production water to drop. In order to maintain an optimal stable pH of the production water a base in the form of lye (NaOH) or calcium carbonate ($CaCO_3$) is continuously dosed to the system. The base will be automatically dosed in the water treatment unit based on sensor readings.

All chemicals will be stored in the facility's chemical room that will be equipped with a spill tank that can contain the entire volume of one container in case leaks or a container break. The handling and storing will follow the company's Spill Management Plan.

Any chemical use will be duly noted in the company's Production Journal.

Chemical	Identification number	Use
Formic Acid	CAS nr.: 64-18-6	Used for ensilage of mortalities. Dosed directly into the ensilage tank based on pH measurement (pH 3.0). The company will use a slightly diluted product to avoid potential explosion risks. The silage can be used directly as fertilizer.
Iodofor™ or similar	CAS nr.: 39392-86-4	Used for disinfection of equipment and footbaths. Disinfection of eggs upon arrival.
Sodium Hydroxide (NaOH)	CAS nr.: 1310-73-2	Dosed into the water to buffer acidifying nitrification in the biofilters.
Calcium Carbonate ($CaCO_3$)	CAS nr.: 471-34-1	Used to buffer the production water and increase alkalinity. Calcium is also used by the fish to osmoregulate.
Waterglass ($Na_2Si_3O_7$)	CAS nr.: 1344-09-8	Used to buffer the production water, especially in connection with high metal content in the influent water. No usage anticipated
Benzoak vet. or similar	E.g. ATCvet nr. QN01A X92	Used to anesthetize the fish during grading. Will be discharged with effluent. No known environmental effects.
Marine grade Diesel	-	Used in the generators and emergency generators for power generation
Food Grade Lubricants and oil	-	Used to lubricate and maintain the motors and equipment
House hold detergents	-	Common household cleaning detergents, soap and other cleaning substances.

Table 2: The chemicals planned to be used in the land-based operation.

6.5 Sea sites

The coastline of the Falkland Islands is made up of coves, sounds and islands that provide good shelter for net pen sites.

Each site will be chosen based on the depth of the site, wave exposure, temperature profiles, local tide profiles, bottom and surface water current as well as the overall accessibility of the site. Other spatial use of the area or special environmental consideration will also be taken into account.

Each site will be equipped with one (1) feed barge and ten (10) net pens. The net pens and the feed barge will be moored with the use of anchors, ropes and chains. From the feed barge there will be a dedicated floating polyethylene (PE) pipe going to each feed point in the net pens.

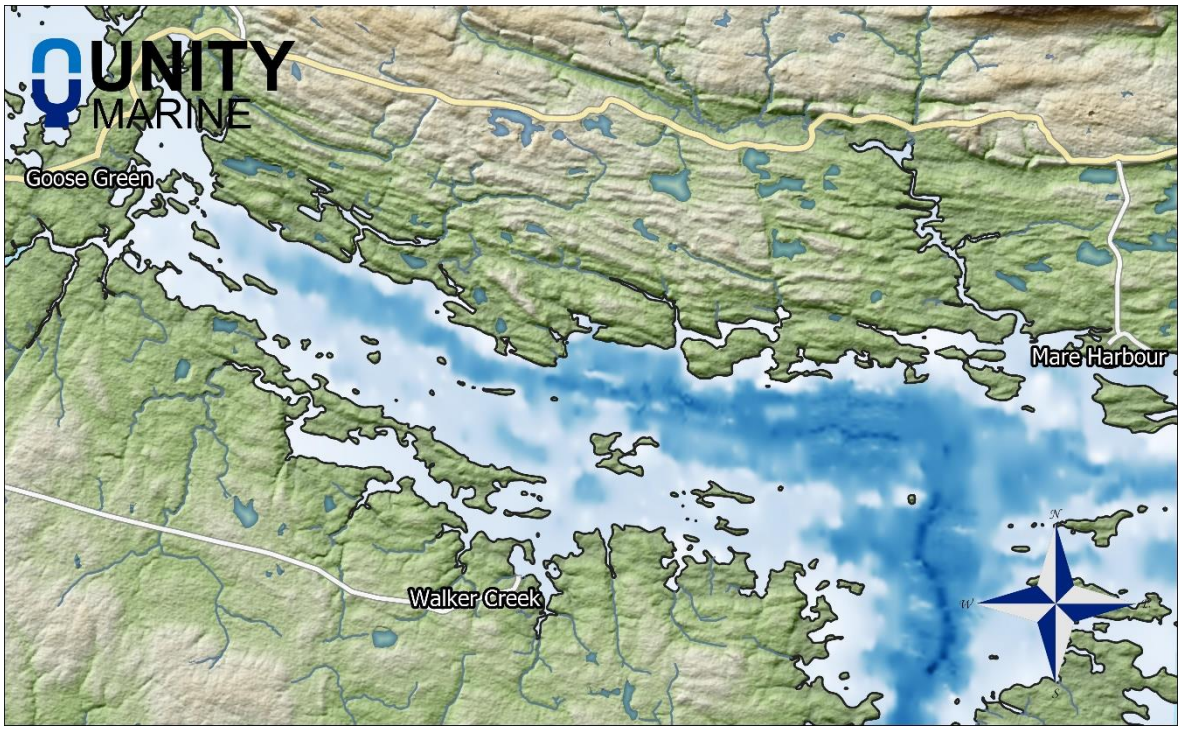


Figure 27: Choiseul Sound a sheltered 20 km long water body south of Stanley on East Falkland. The Sound is thought to be able to contain at least 4 sites for salmon production. Depths indicated are in meters. Choiseul Sound was also mentioned as a possible site for Salmon aquaculture after the trial is Fox Bays in the 80's. It was suggested that the sound could easily contain 12-15 sites, albeit of smaller size.

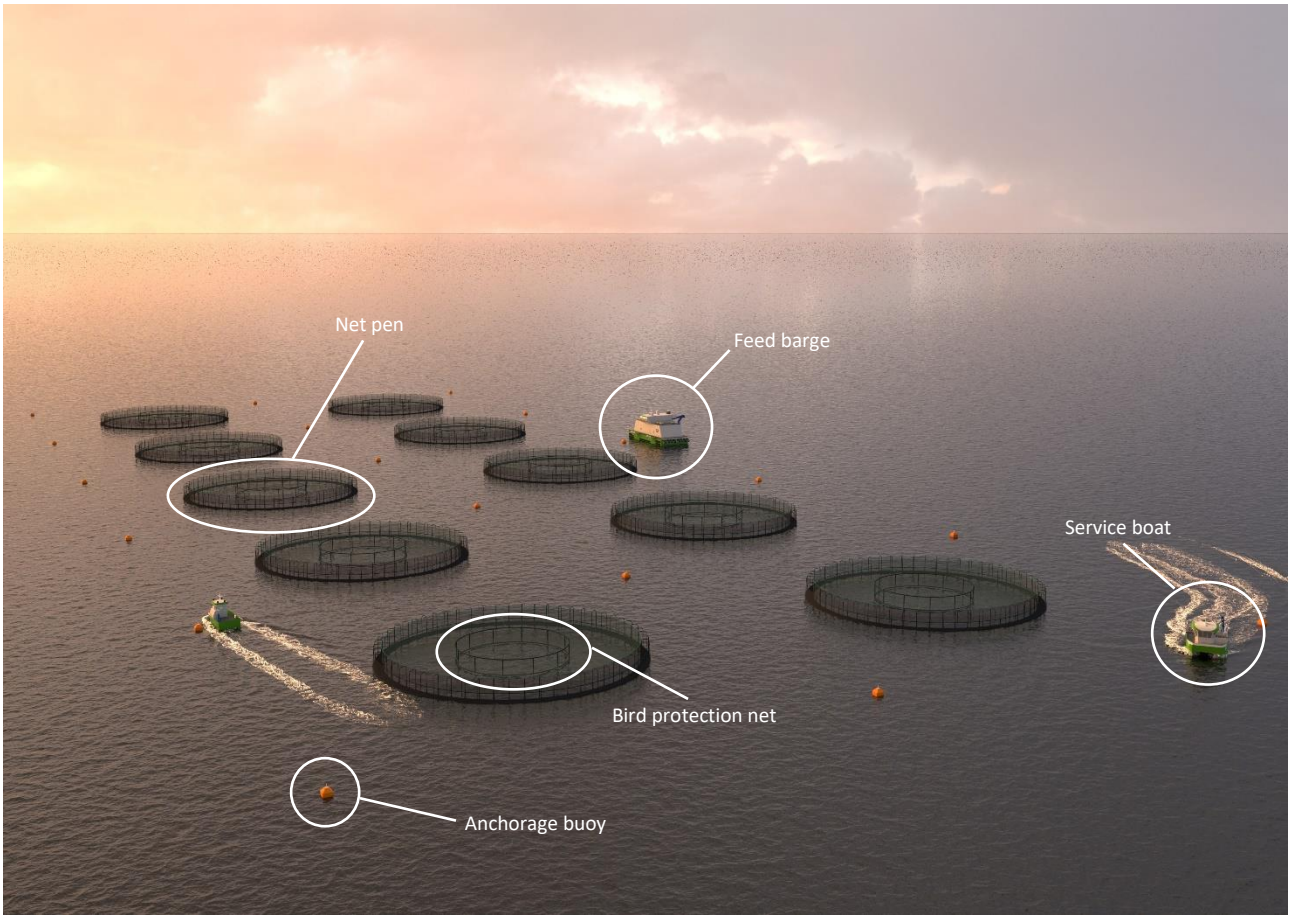


Figure 28: Sea site with ten (10) net pens, feed barge and service boats.

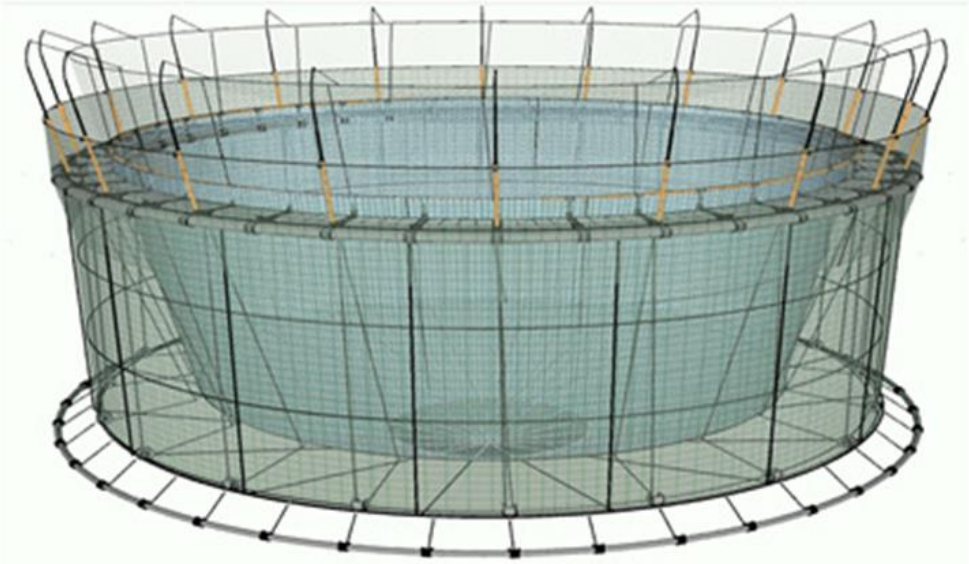


Figure 29: The net pen setup that is to be employed by Unity Marine. The inner net will contain the fish and the outer net will provide predator protection. The predator net is raised three (3) meters above the outer rim of the pen to provide protection for the employees from sea mammals. Bird netting will be fitted from flexible posts from the outer rim of the pen.

All pens, barges, moorings, anchoring, nets and other structural components will be designed and operated in accordance with the Norwegian Standard "NS9415:2021"[17]. This standard has been the main driver in avoiding escapes of fish and reducing the environmental impact in Norwegian aquaculture by regulating the design and maintenance requirements as well as the needs for robust site investigations prior to the structural and design phase.

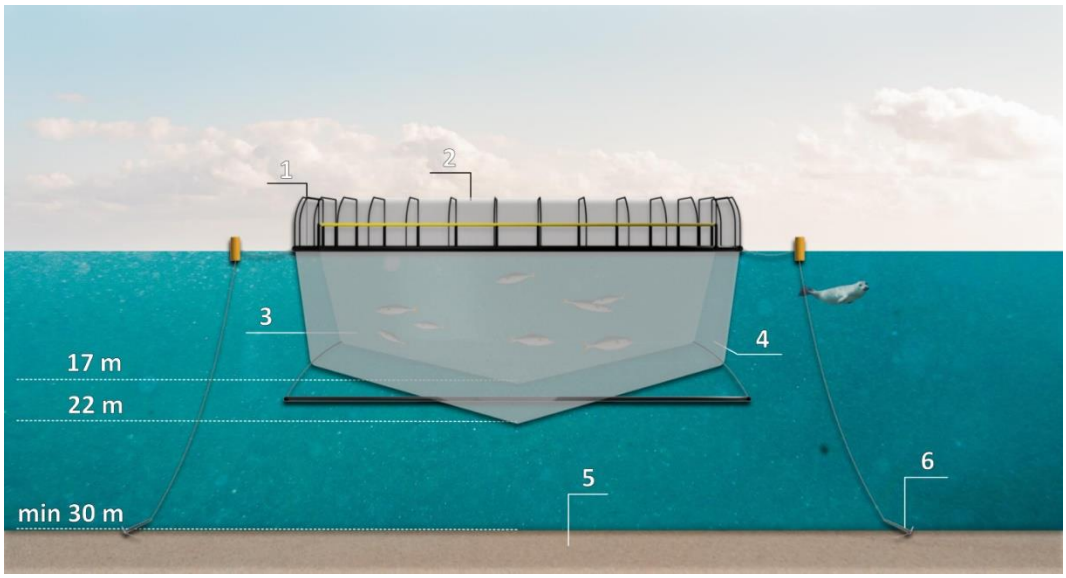


Figure 30: Cross section schematic of the net pens. The inner net containing the fish (3) will extend to 17 m below the water line, while the predator net (4) will extend to a depth of 22m. This ensures that the inner net will never be in contact with the predator net even in rough sea conditions. The predator net is extended above the water line on the outside of the pen, ensuring that marine mammals cannot get into the net while creating a safe working platform surrounding the nets (1). A bird net (2) will be suspended over the net pen from flexible poles attached to the outer rim. All sites are placed with a minimum water depth of 30m above the bottom (5) giving a freeboard of at least 8 m below the predator net. The moorings (6) will keep the net pens in place. The mooring system will be designed with focus on wave and current exposure at the specific site.

6.5.1 Location

During September 2018 a site investigation was carried out in the waters surrounding East Falkland. More specifically Choiseul Sound, Adventure Sound, Bay of Harbours, Eagle Passage and Falkland Sound were visited, and specific chosen areas were investigated more closely. Due to weather restraints the team was only able to visit 26 out of the pre-identified 35 sites.

The site investigation was performed in cooperation with South Atlantic Environmental Research Institute (SAERI) on a Sullivan Shipping chartered vessel. Visual inspections were carried out as well as bottom scans with Side Scan Sonar (Starfish 452F, Tritech International Limited, UK) and the vessels single Beam Sonar. Additionally, benthic investigations were carried out using an underwater camera. The full Survey report can be found in Appendix G[18].

[17] NS 9415:2021 Forskrift om krav til teknisk standard for flytende akvakulturanlegg (NYTEK-forskriften), Norway
[18] Has not been resubmitted.

Subsequently wave and current modelling was undertaken by DHI UK. This along with the site investigations has allowed the company to pre-screen the suitability of the sites.

In 2019 Unity Marine procured a wave and current measuring equipment, Acoustic Doppler Current Profiler (ADCP), that was later deployed at four different sites in Falkland Sound, Choiseul Sound and Adventure Sound. Waves and current were measured over three (3) months on three (3) of the sites and over a full year on one (1) additional site. Waves and current were found to be highly suitable for aquaculture purposes. Especially bottom current was surprisingly steady with relatively short periods of time with little or no current, which is considered extremely positive as it will reduce impact of sedimentation on the benthos.

Most of the pre-defined areas were found to be suitable for the proposed activities, based on the obtained data from the ADCP and the modelling work. Further site investigations and modelling work is however needed to fully deem the sites suitable. In order to live up to the NS 9415:2021 an ADCP should be deployed on all sites for at least three (3) months and a throughout bathymetric mapping should be undertaken. Based on this data, more accurate 30 and 50 year event predicitions can be modelled.

Some sites were discarded due to being either placed in a military zone (three (3) sites) or being too exposed (two (2) sites). The remaining 30 sites are in principle suitable. The company has chosen 16 of the 30 suitable sites in later description in this document and its annexes. If one of the chosen sites is later deemed unsuitable one of the other suitable sites could be developed. The other suitable sites could also potentially be used for future expansions. From the site surveys and from studying nautical charts of the Islands it is the company's opinion that there are many other potential sites in the inner Falkland waters.

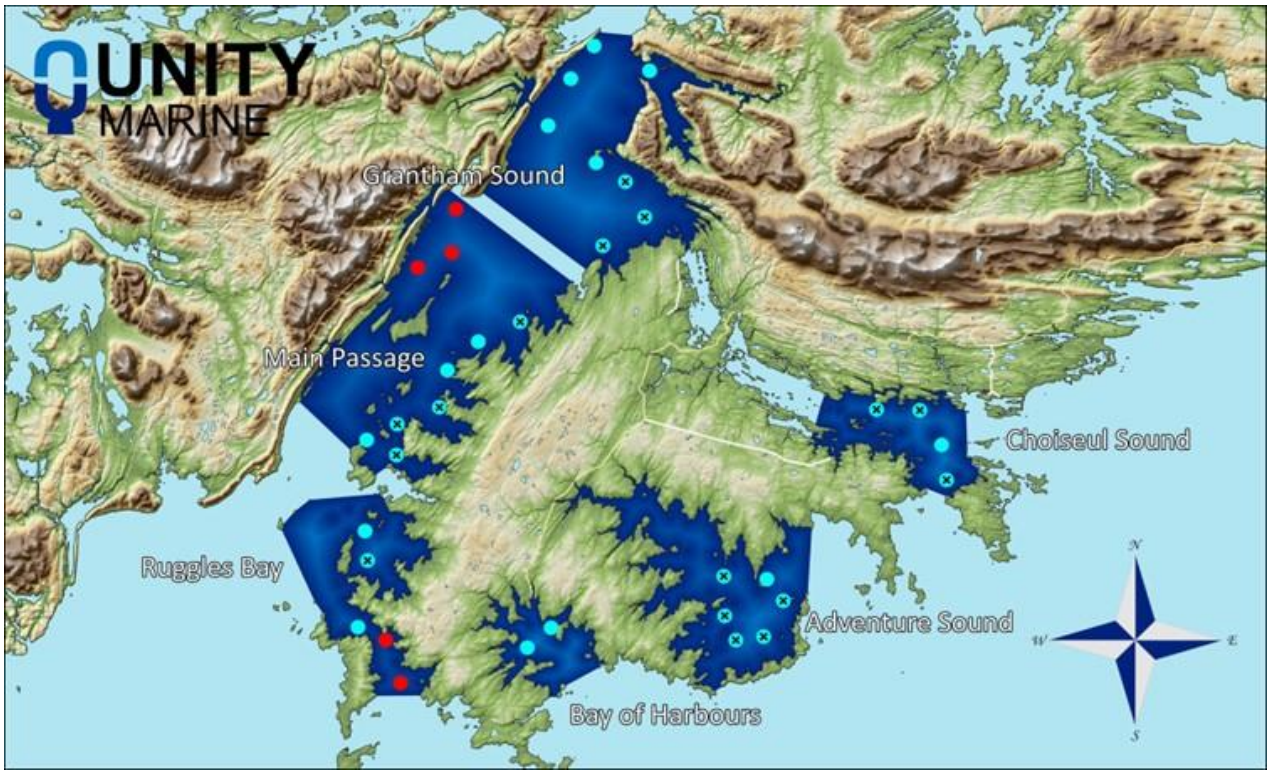


Figure 31: The 35 pre-identified sites around East Falkland. Five (5) sites were found to be too exposed or were placed inside a military zone (red). The remaining 30 sites have been found to be potentially suitable (blue). The sixteen (16) sites that are currently planned to be utilized are marked with a cross.

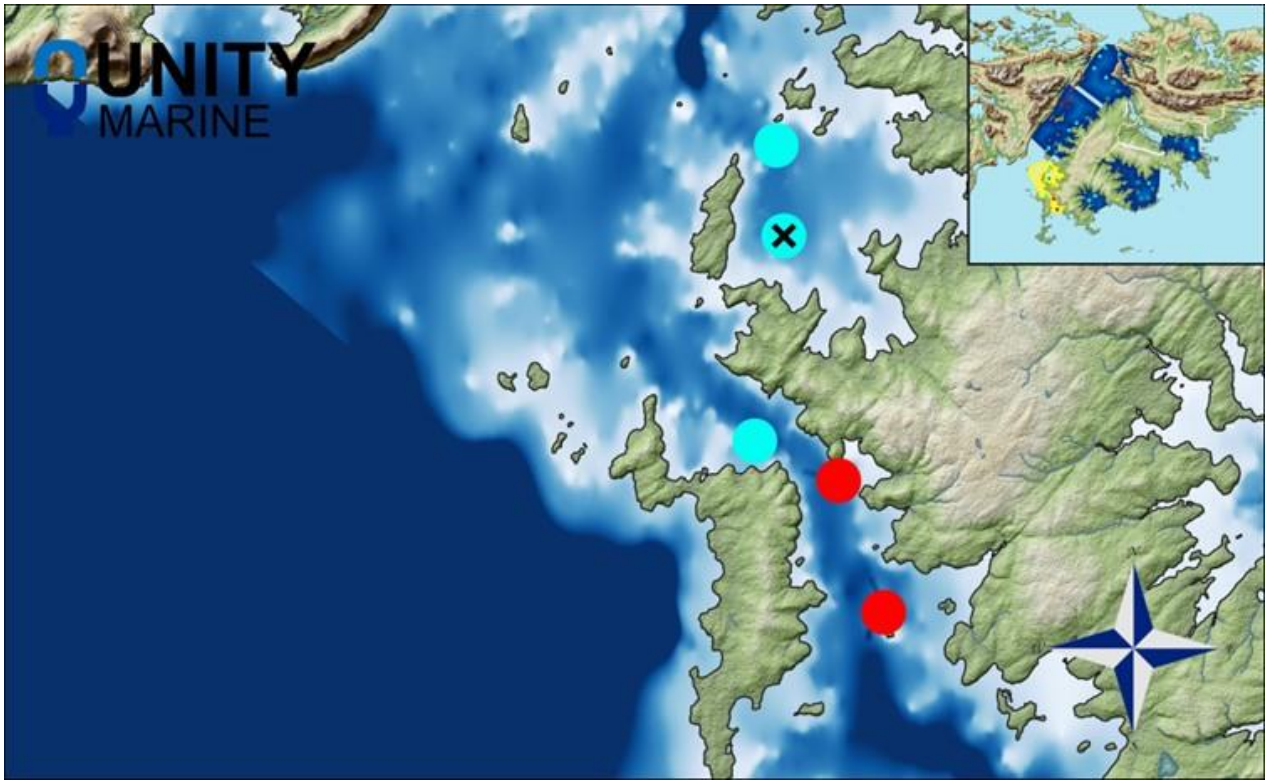


Figure 32: The identified sites in southern part of Falkland Sound and Eagle Passage (Ruggles Bay region). Two sites were found to be too exposed and has therefore been marked with red. The sites would be serviced out of New Haven.

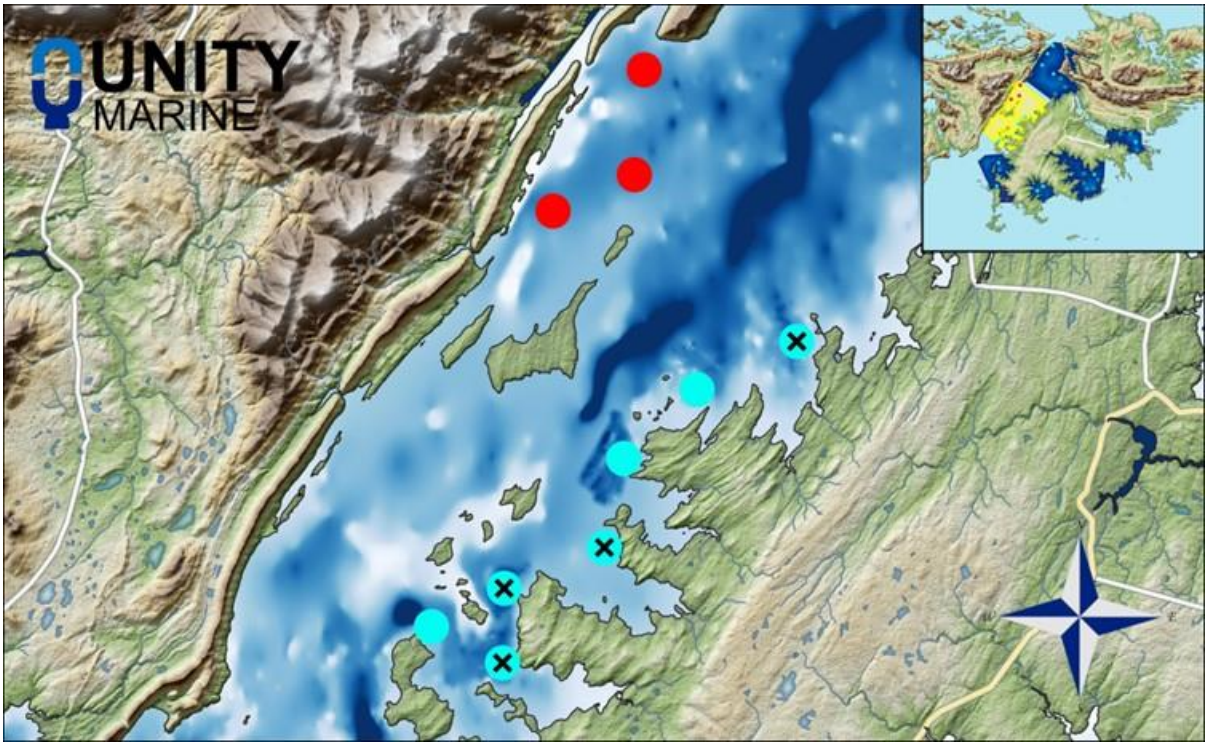


Figure 33: The identified sites in the middle of Falkland Sound (Main passage region). All identified sites in the region have currently been found suitable, however three (3) sites were placed in a military area and therefore been marked with red. The sites would be serviced out of New Haven.

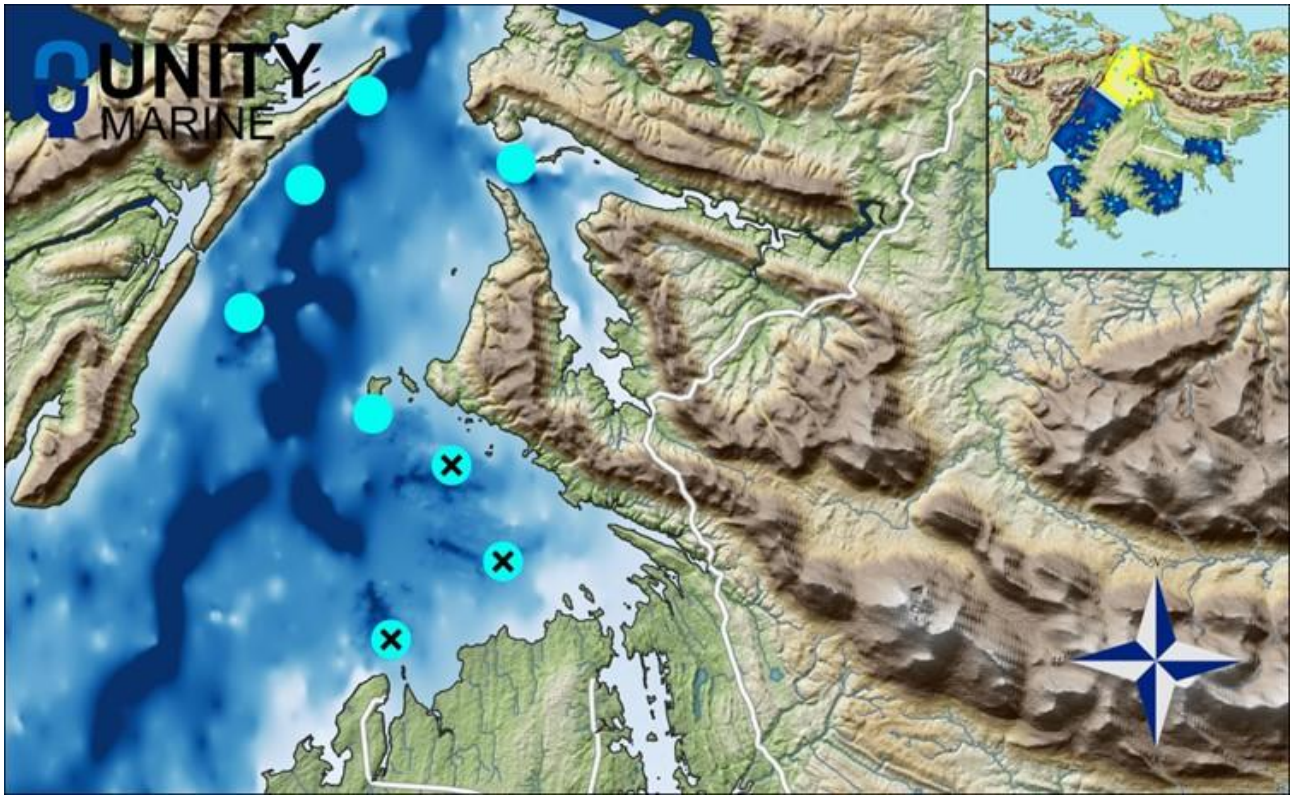


Figure 34: The identified sites in the Northern part of Falkland Sound (Grantham sound region). All identified sites in the region have currently been found suitable. The sites would be serviced out of New Haven.

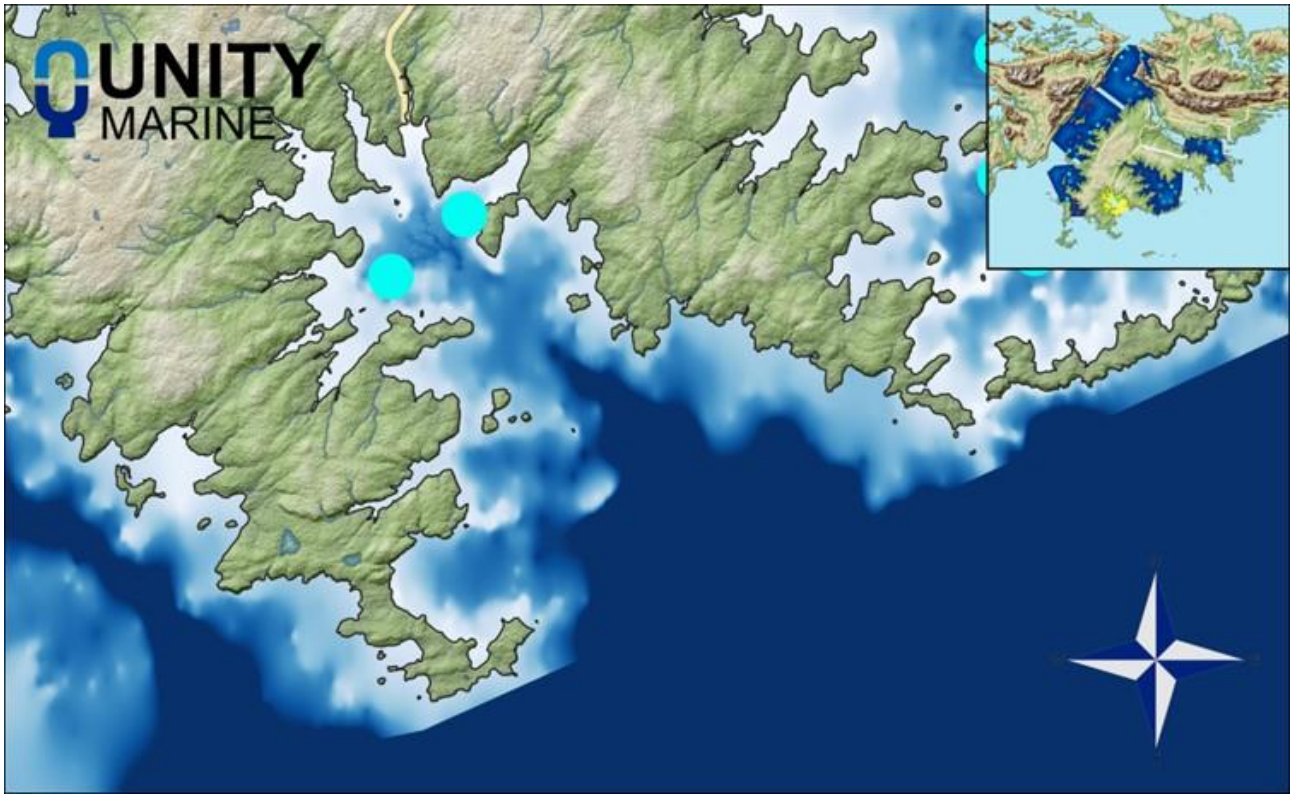


Figure 35: The identified sites in Bay of Harbours (Bay of Harbours region). All identified sites in the region have currently been found suitable. The sites would be serviced out of Mare Harbour, but it is not currently being planned to use the sites.

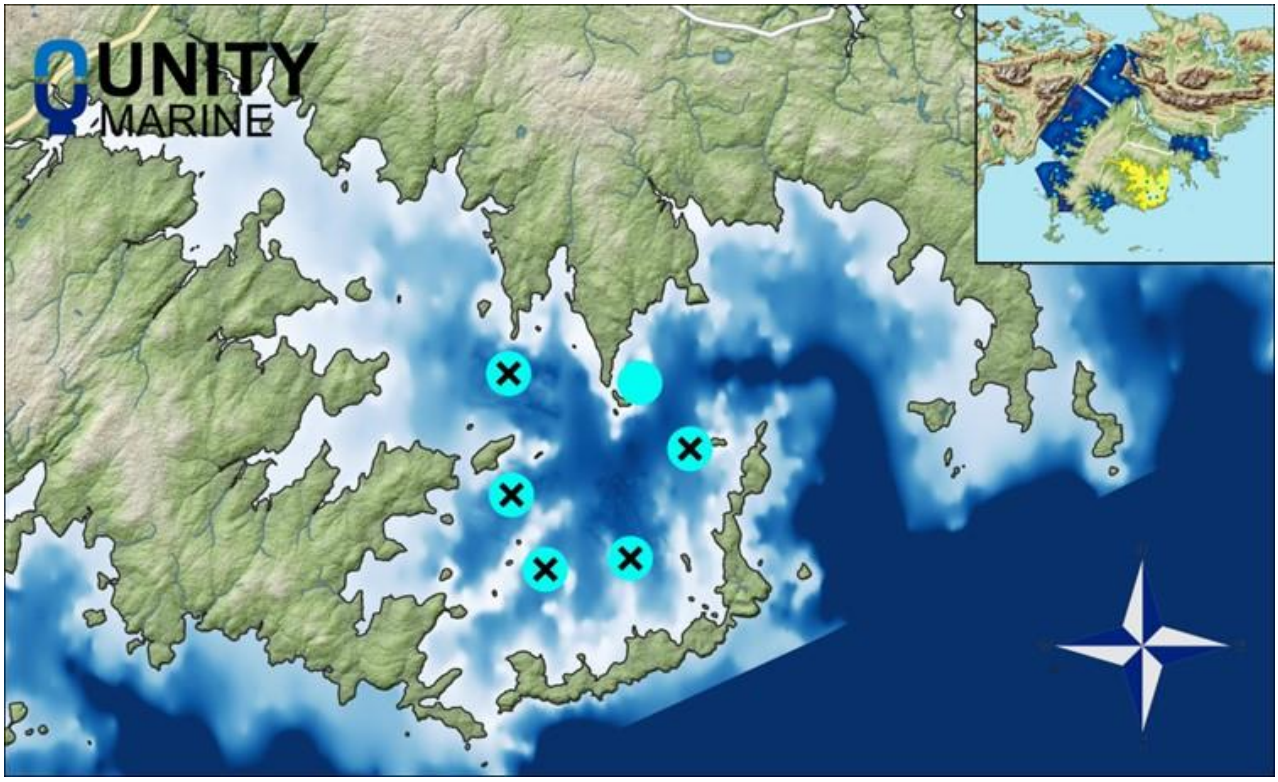


Figure 36: The identified sites in Adventure Sound (Adventure Sound region). All identified sites in the region have currently been found suitable. The sites would be serviced out of Mare Harbour.

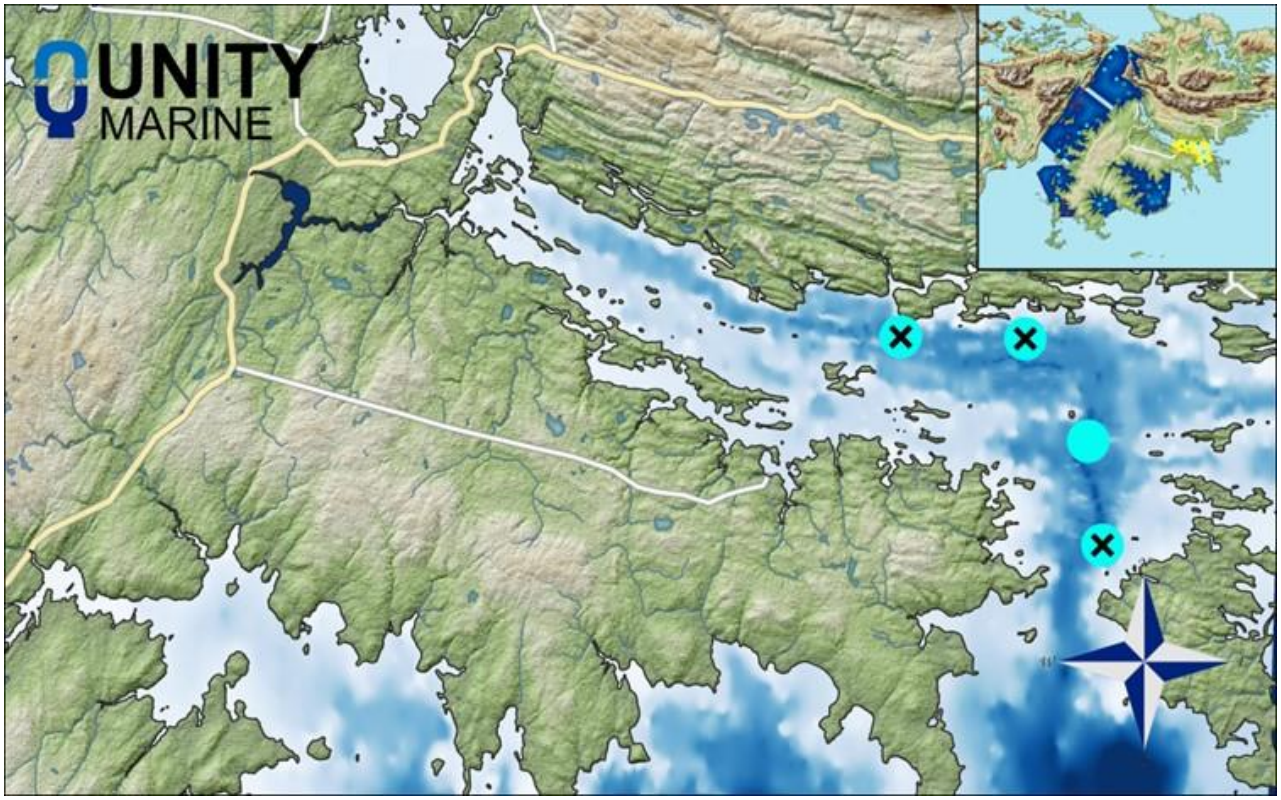


Figure 37: The identified sites in Choiseul Sound (Choiseul Sound region). All identified sites in the region have currently been found suitable. The sites would be serviced out of Mare Harbour.

It is emphasized that the site investigations and modelling carried out under the pre-studies is not adequate to obtain planning permissions or subsequent Fish Farming Licenses. The indicated sites as such therefore only functions as a guideline for possible site locations.



Figure 38: Visual representation of a sea site seen from five (5) km on a clear day with an air humidity of 0% (no visual impediment).

All the sea sites are placed at some distance from the shore in areas with little human activity. Subsequently visual impairment is perceived to be minimal. A visual representation of a site seen from five (5) km distance on a clear day can be seen on the figure above.

6.5.2 Wave and current modelling

The sea sites were further investigated through modelling of current, wave height and wave frequency. The model used a 1-year and 50-year storm event from the northwest and south. The outputs of the modelling included:

- Analysis of surge levels and typical surge profiles
- Outputs of "Significant Wave Height" (H_{m0}) and "Max Wave Height" (H_{max}) for the storm events and other relevant parameters "peak wave period" (T_P) and "Mean Wave Direction" (MWD)
- Outputs of peak and mean current speeds within each zone for tidal and storm conditions and summary for single points in domain along with spatial plots of variability in current conditions in each zone
- Tabular comparison of key wave and current of sites

Based on the findings in the report and through site investigation work (Appendix G[19]) and subsequent analysis (Appendix F[20]). It was found that only two (2) of the total 35 initially identified sites were unsuitable in regard to the energy of currents and waves.

[19] Has not been resubmitted.
[20] Has not been resubmitted.

It was however also recognized that further development of the model is needed for better accuracy and that these models must be supported by in-situ measurements. This work is planned to be done during Phase II of the project and is needed for safe design of moorings and net pens in accordance with NS:9415.

From 2020 to 2022 Unity Marine also deployed an ADCP on four (4) sites and have thus obtained a substantial amount of wave and current modelling from some of the sites. This data will be used to increase the accuracy of the modelling. The data is available for other development purposes, by FIG, scientific institutions and other businesses, on the Falkland Islands and access can be requested through SAERI.

6.5.3 Net pens

Net pens will be of the polyethylene round Polarcirkel[21] type delivered by AKVA group, Norway or Morenot, Denmark or a similar design from another supplier. Emphasis will be put on sturdiness but also predator protection systems e.g. bird nets and special predator safe netting.

The stock protection system uses a lighter-weight inner net to contain the fish, set within a heavier outer net to keep predators away from the fish. A light-weight bird net set on flexible poles attaches to the inner fish net, keeping birds away from the fish feed and the fish.

The inner net that holds the fish will be approximately 200m in circumference at the waterline. It will extend to a depth of 17m when fully weighed and will have a volume of approximately 37,000m^3. The outer predator net will extend to a depth of 22m when fully weighted. There will be a minimum of 2m separation between the two nets to deter marine mammals from attacking the fish or gnawing through the nets to get to the fish. The outer predator net is also designed to be taught to avoid entanglement of marine mammals.

All nets will be constructed using an Ultra-High-Density polymer (Dynema) thread. The inner net will comprise a 35mm mesh with a 330kg break load. This net will be tensioned off the outer predator net. The outer predator net (designed to keep seals, pinguins and sea lions out) will be comprised of a 125mm double-knotted mesh with a break load of 1,200kg. This net will be tensioned with a sinker tube and weighed in the base. During stocking with smolt a smaller mesh netting might be used for containing the fish until they reach a size suitable for the growout net.

The bird net will consist of a 60mm mesh net with a break load of 70kg and will be set on flexible poles to allow the net to distort, as the pen changes shape in adverse weather. The mesh size has been chosen to prevent cormorants and other birds from being able to enter the pen (a potential problem when pens are stocked with smolt). The bird net is also specifically chosen to avoid entanglement by local bird life.

The net pens will be equipped will automatic net pen cleaners from Aqua Robotics[22] or similar type of net cleaner, which will greatly reduce the amount of manual labour in and around the net pens. The automatic net cleaner will continuously remove the fouling of the nets (three (3) visits a day) without human interference. This will ensure reduced fouling and subsequent better fish welfare, due to increased flow of oxygen rich fresh water through the net pens. This will also allow the company not to employ anti-biofouling paint.

[21] http://www.akvagroup.com/cage-farming-aquaculture/cages-nets/plastic-cages-
[22] https://aquarobotics.no/#start

A mortality collector will be installed in the bottom of each net pen. The mortality collector is operated using an airlift mammoth pump that creates a current that removes potential dead fish from the centre of the net pens and deposits them in a box on the side of the pens. Mortality removal is a part of the crew's daily operation. All dead fish will be collected, registered and moved to the feed barge's ensilage tank. The ensilage will be collected and brought to land for further treatment at regular intervals.

6.5.4 Feed barge

Each site will have a dedicated feed barge providing the local foundation for the farming operation. The feed barges will be prepared to hold at least fourteen (14) days of feed at peak feeding at any given site. The feed barge will be equipped with sleeping and dining facilities for the crew and will always be manned, when there is fish at the site.

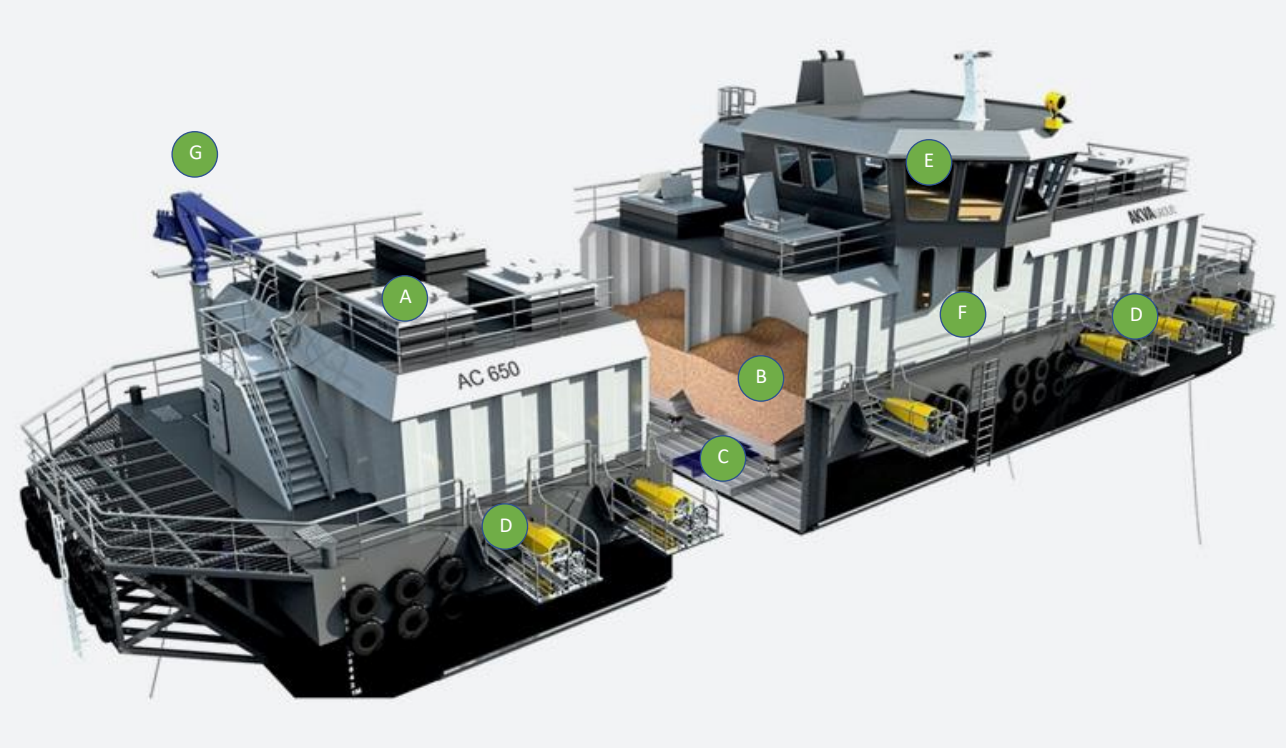


Figure 39: AKVA group ASA feed barge with 650 tonnes feed storage capacity. A) Feed silo hatch for filling of silo. B) Feed silo. C) Feed doser. D) Automatic feed system distributor valve. E) Brigde with overview over the site and access to the central control system. F) Crew quarters. G) Crane for minor service and maintenance duties

The feed barge will be moored permanently on the site and will also remain at the site during fallowing of the site.

The feed barge will have a permanently accessible room that can be used in case of emergency for sailors in distress. The emergency room will have blankets, food supply, first aid equipment and provisions for sending emergency signals.

The feed barge will be equipped with diesel, fresh water, sewage and ensilage tanks. In the unlikely event of a leak of one of the tanks the barge will be designed, so the contents of an entire tank will be collected in the hull. If a spill occurs the spill will be pumped onto one of the company's work boats or supply vessels and brought to shore for processing. Since the original project description was submitted, hybrid feed

barges have been introduced broadly in the industry. A hybrid barge is equipped with a battery back that will be recharged by the generators. This allows for more efficient use of the generators, which in turn results in diesel use being cut by approximately 65%. Unity Marine will likely use this new barge type to reduce CO_2 emissions by reducing diesel usage.

Each barge will be equipped with a central feeding system. The feeding system will distribute the feed to the net pens through floating PE piping using pressurized air. The blowers and the feeding system will be powered by the generators on the barge.

6.5.5 Auxiliary equipment

Camera systems will be installed in all the net pens and will feedback into the central control system. The company will employ a specialized camera system developed for aquaculture like the Orbit underwater camera from ScaleAQ[23] or a similar product from another supplier. The camera system will always allow the operator to visually inspect the fish and observe the feeding and general behaviour. The feeding will be adjusted based on the fish appetite to minimize potential feed waste and reduce the feed conversion ratio. A low feed conversion ratio also ensures that a smaller amount of nutrients is discharged and reduce impact on the benthos.

6.5.6 Construction

Materials for the net pens will be purchased from a supplier in Norway, Denmark, Chile or the UK. Construction and installation of all net pen systems and associated moorings will be completed by the supplier and a third-party installer, with oversight by Unity Marine staff. The primary vessels for handling the installation and anchoring operation will be the company's service vessels. It is foreseen that two (2) to three (3) vessels will be involved in the installation. Specification on the vessels can be found in Appendix I[24].

The mooring system will be specifically designed for each of the sixteen (16) sea sites by the supplier. The collected and modelled oceanographic data (wind, bathymetry, currents, waves) will be used in the design. The mooring system will be designed to withstand site specific exposure to waves, wind and current on at least a 50-year event scale. The mooring system connects the net pens in a grid and securely fixes them in place via a series of anchors embedded into the seabed.

One (1) feed barge will also be moored at each site. The mooring system for the feed barge will likewise be designed with considerations to the collected and modelled oceanographic data.

Two (2) of the company's vessels will be required to install the moorings. Moorings will be installed prior to net pen installation. Once moorings are installed, they are not relocated but can be removed if the site is decommissioned.

Prior to installing the net pens, all anchors and moorings will be inspected according to the standards set out in NS:9415.

The floating collar is assembled through a series of customized brackets. All parts required for assembly of the floating collars will arrive well in advance of the planned operation to ensure sufficient time for

[23] https://scaleaq.com/product-category/feeding-and-monitoring/camera-systems/
[24] Has not been resubmitted.

assembly. It is anticipated that the net pens will be assembled on pasture lands East of Mare Harbour and North of the proposed site at New Haven. The final decision on net pen assembly areas is dependent on permissions from local land holders and other local stakeholders hereunder FIG. The pens will then be towed to the net pen sites by the company's work boats or a chartered tugboat.

The assembled collars will be towed (without the pens net attached) by a service vessel at a speed less than three (3) knots (5.6 km/h) to the sea sites and will be installed at least one (1) month before being stocked with fish. These operations will require the use of two (2) to three (3) service vessels which will each have a 60 -100 tonnes crane capacity.

A tow route will be established in consultation with MPA and FIG. The tow speed will be below three (3) knots. Towing activities will be clearly communicated to stakeholders in the area and through Notice in the Penguin News, on the Falkland Island Community Board Facebook page and on the company web page.

The materials for the sea sites in terms of net pens, nets, mooring systems, ropes, chains and other equipment will need to be procured internationally and shipped to the Islands either through established lanes to the UK (to Mare Harbour) or Uruguay (to FIPASS). It is estimated that the total shipping volume is in the order of twenty-five (25) 40-foot containers for each of the sites. This results in a total of approximately 400 containers over a 3-4 year period. The final number will be calculated during the detailed design phase.

6.5.7 Operations

The daily operations of the net pen sites are described in this chapter. In general, it can be said that the company will develop detailed management plans for all the operations.

6.5.7.1 Feeding

The feed will be distributed to the net pens using a dedicated feed system on the barge. The feeding system consists of a set of hoppers containing the feed, a dosing valve on each silo, selector valves selecting the destination of the feed and blowers that blows the feed to the net pens. Dedicated floating pipes for feed distribution to each net pen will be installed from the barge to the distribution points. Each net pen will have one or two distribution points for the feed, each distribution point is equipped with a rotor spreader.



Figure 40: Rotor spreader installed in a net pen.

The feeding will be monitored visually from the feed barge deck and below the water using underwater cameras installed in each net pen. The behaviour and appetite will be monitored, to adjust the amount of feeding accordingly. In case of feed not being eaten the amount of feed distributed will be reduced, to avoid loss of feed and to avoid sedimentation of uneaten feed below the net pens. The feeding will take place continuously during the light hours meaning feeding regimes will vary seasonally.

The hoppers will be filled from either the company's supply vessel or a dedicated feed delivery vessel. The feed will be blown from the storage facility on the vessel and into the hoppers.

6.5.7.2 Maintenance

Unity Marine will, as described, use robots for routine net cleaning and maintenance. Fouling of the nets will vary depending on a number of factors including water temperature and seasonal biological activity (e.g. mussel spawning or algae settling season). If additional seasonal net cleaning is needed and for cleaning of predator nets, the Company will use high pressurized cleaners operated from the service vessels. Unity Marine does not intend to use anti-fouling material on nets resulting in no copper or other toxins being released into the water column.

Pens and nets will also be cleaned after harvesting is completed and prior to new fish are being transferred to the site. An AKVA smart cage cleaner or similar product will be used to clean the pen collar. This type of cleaner is typically mounted on the stern of one of the service vessels. The system consists of a lifting unit and a hydraulically driven system that rotates the pen while it is being washed. The pen is rotated around its own axis, while a windscreen washer mounted on rotating arms cleans the collar using pressurized water. No chemicals are used in the process.

Routine checks of equipment utilizing underwater cameras, ROV's and inspections by divers (as needed) will be used to confirm the cleaning schedule and structural integrity of the net pens. In case of tears or rips in the net underwater repairs can be done in-situ using a ROV with a specialized sewing machine or the operation can be performed using divers.

In general, any maintenance work will strictly follow the standards set out in the Norwegian standard NS 9415:2021.

6.5.7.3 Fish health

Unity Marine will develop and implement a Fish Health Management Plan and all personnel will be trained in the proper procedures. The Fish Health Management Plan is an action plan aimed at improving the health and welfare of the animals, which are drawn up between the farmer and the veterinary. The Fish Health Management Plan will be a flexible, farm-specific document that will be reviewed, updated and developed with advice from the veterinarian, to ensure that the fish health and welfare remains as good as possible at all times. It will be updated on an ad-hoc basis. In summary, mitigation measures and regular monitoring will be in place to maintain fish health including biosecurity measures, routine husbandry practices, health checks and procedures, use of specialized feed and feeding procedures, sea lice control procedures, water quality monitoring, vaccinations, and removal and treatment of mortalities.

Fish will routinely be monitored by staff both manually and by using the installed underwater cameras for physical damage such as fin erosion, lesions, pigmentation problems, parasites and deformities. Fish behaviour changes will also be monitored. The staff will be trained in the importance of noticing and reporting any noticeable changes to the veterinarian.

Most fish pathogens are considered to be opportunistic and can create serious health challenges, especially if the fish are exposed to stressful events or prolonged sub-optimal conditions. Therefore, care will be taken, to ensure the effects of necessary stressful events are kept to a minimum. Routine parasite screening will be carried out as well as routine diagnostic testing. Any irregularities will be reported to the Department of Agriculture.

6.5.7.4 Harvest of fish

Unity Marine will harvest the fish using a processing ship (operated by a third-party supplier). The processing ship will move directly adjacent to the net pens and using a flexible hose, fish will be pumped into the vessel. The processing ship will be equipped with a redundant line system for stunning, bleeding and gutting of the fish. The salmon will be weighed and counted on the vessel. Size distribution and numbers of fish harvested will be reported directly to the authorities.

During harvest of fish the operating crew of the site as well as the processing ship crew will always be present to monitor the operation and mitigate unwanted events or unnecessary stress of the fish.

6.5.7.5 Environmental data

The company will continuously be collecting environmental data both for securing the wellbeing of the stock and to monitor potential environmental impact at all the sites. Data loggers will be installed on the barge at each sea site and will measure temperature, oxygen levels, current speed and direction as well as pH, salinity and chlorophyll concentration.

Before, during and after a production cycle bottom sampling will be carried out, to determine potential environmental impact from sedimentation on the benthic community. Plankton samples will also be performed at regular intervals, analysed and levels recorded.

All data will be logged and will be made available on the company web page with public access, as it will be set out in the Company's Environmental Monitoring Plan.

6.5.7.6 Mortalities

Mortalities are estimated to be between 2-10% during the 14 months that fish will be at sea with an average of about 5%. The major part of the mortality is expected within the first month in the sea just after transfer.

Mortalities typically accumulates at the bottom of the net pens and to some extent at the surface. The dead fish will be pumped using air lift (mammoth pump) through a pipe, which connects into collection box on the side of the pen. Mortalities will be collected daily and will be transferred to the ensilage tank on the feed barge. The number of mortalities will be recorded and reported.

Formic acid will be used in the ensilage process. The company is planning to use food grade formic acid (85% dilution) which will be transported to the barge by the supply vessel in 1,000 L containers. The containers will be lifted onto the barge using the barge crane. The barge is equipped with a designated storage tank for the formic acid.

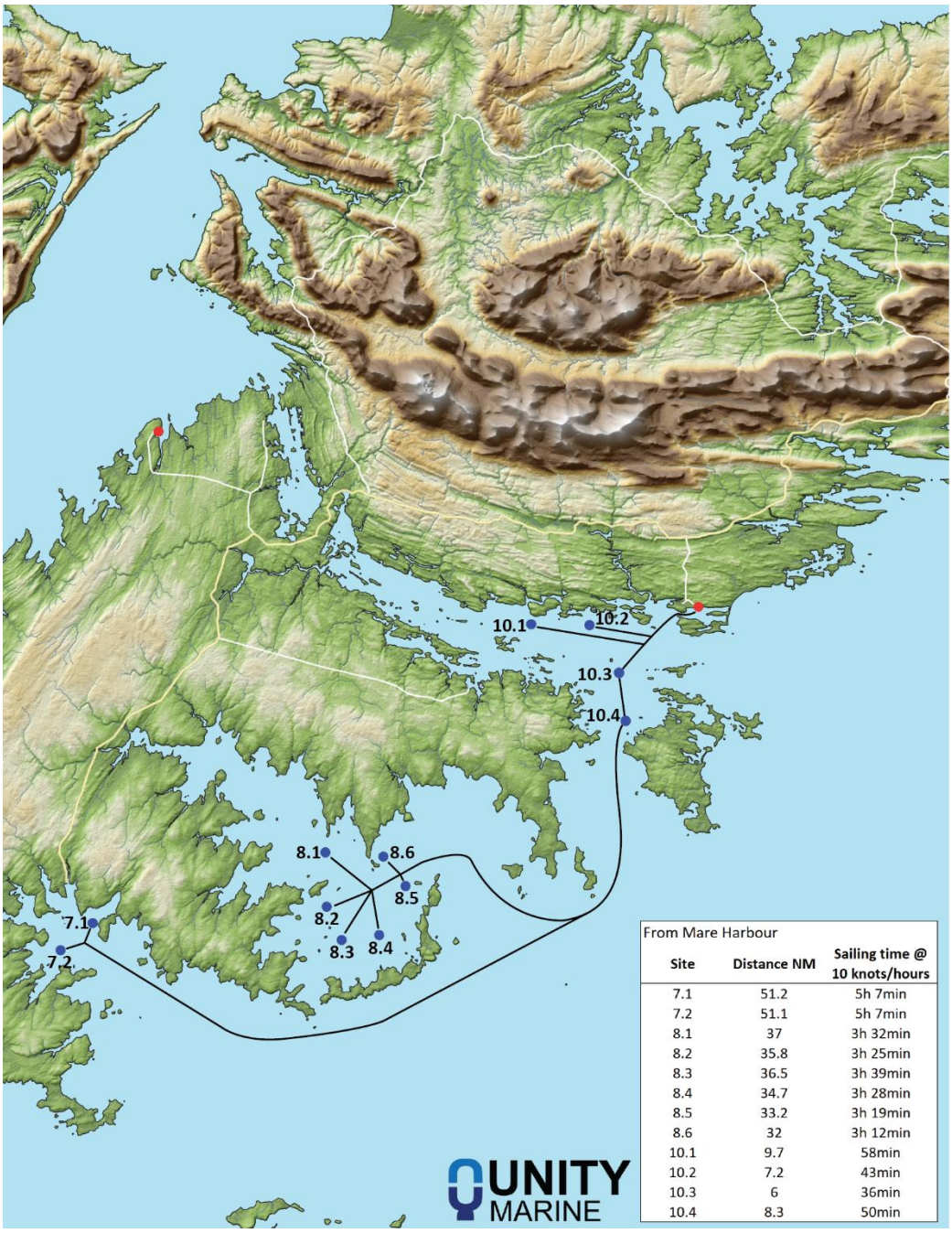
Prior to entering the actual ensilage tank, the mortalities are ground into a slurry and formic acid is dosed to lower the pH to 3.0. The ensilage is then transferred to the integrated ensilage tanks located on the barge. The ensilage is stored in the tanks until it is removed through the ensilage discharge onto the supply ship that brings it to shore for further processing, use in animal feed (e.g. Pig feed) or used as fertilizer on farmland.

6.5.7.7 Personnel transfer

The sea sites personnel will be transported using the dedicated crew vessels and the medium sized workboats. Unity Marine anticipates two (2) month shifts with change over every month of one of the

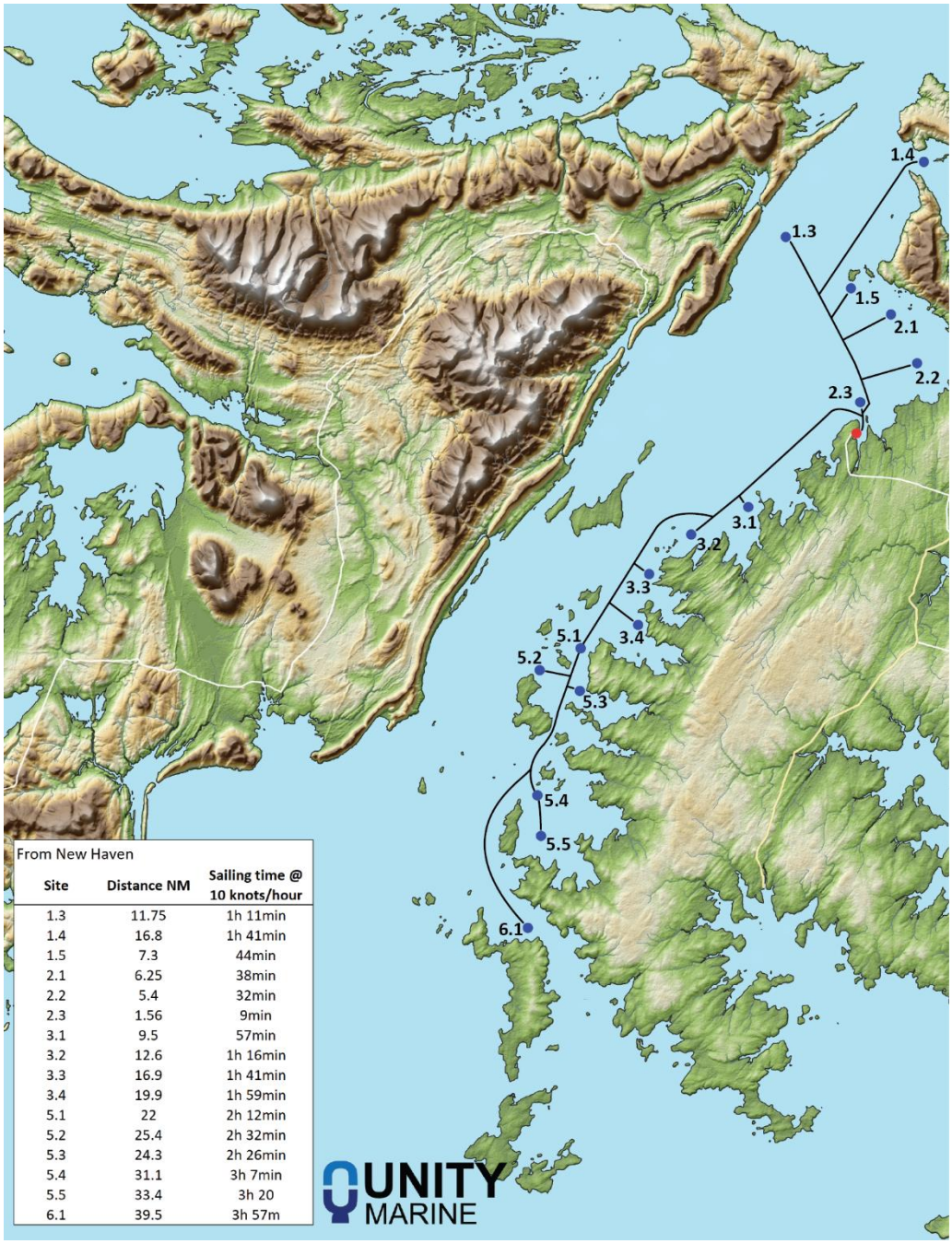
crew. During the shift the personnel will live aboard the feed barge. The crew will however have some days or weekends off during the two-month shifts, so additional personnel transport is anticipated. There will always be at least two (2) persons on each site.

Crew changes and transport will take place between the net pen sites and the service hubs in Mare Harbour and New Haven. Crew change runs will also be used to re-supply the feed barges with provisions for the crew. Primary shipping routes can be seen from the figure below.



Site	Distance NM	Sailing time @ 10 knots/hours
7.1	51.2	5h 7min
7.2	51.1	5h 7min
8.1	37	3h 32min
8.2	35.8	3h 25min
8.3	36.5	3h 39min
8.4	34.7	3h 28min
8.5	33.2	3h 19min
8.6	32	3h 12min
10.1	9.7	58min
10.2	7.2	43min
10.3	6	36min
10.4	8.3	50min

Figure 41: Proposed routes for personnel transfer on the East coast of East Falklands, distance to the potential sites in nautical miles and estimated travel time at ten (10) knots.



From New Haven

Site	Distance NM	Sailing time @ 10 knots/hour
1.3	11.75	1h 11min
1.4	16.8	1h 41min
1.5	7.3	44min
2.1	6.25	38min
2.2	5.4	32min
2.3	1.56	9min
3.1	9.5	57min
3.2	12.6	1h 16min
3.3	16.9	1h 41min
3.4	19.9	1h 59min
5.1	22	2h 12min
5.2	25.4	2h 32min
5.3	24.3	2h 26min
5.4	31.1	3h 7min
5.5	33.4	3h 20
6.1	39.5	3h 57m

Figure 42: Proposed routes for personnel transfer on the West coast of East Falklands, distance to the potential sites in nautical miles and estimated travel time at ten (10) knots.

6.5.7.8 Re-supply

Unity Marine will use the two service hubs in Mare Harbour and New Haven to re-supply the sea sites. The primary sailing routes will follow the described personnel transfer routes. Nets, equipment, mooring ropes, chains and other spare parts will be kept in warehouses at the two (2) service hubs. Nets and other equipment will be brought into the service hubs for repair work or back out to the sea sites by the Company's work boats.

The fish feed will be distributed to the feed barges either by the company supply ship or a dedicated feed transport vessel from the feed supplier. The supply ship will also provide the feed barges with fresh water, supplies, and other consumables.

Diesel will most likely be transported directly to the feed barges from Stanley in a dedicated vessel operated by a third-party local vendor or the Company's supply ship. Smaller vessels will be able to refuel from the feed barges or at the service hubs.

6.5.7.9 Chemical use

Little or no chemical usage is expected on the sea sites in direct contact with the water. Only in the case of an unlikely bacterial or tapeworm infection the proper treatment will be administered through the feed.

On any indication on an infection of the stock the company's fish veterinarian will be called in. Treatment will only take place in case if the veterinarian proscribes a treatment. Only medicine, that has been approved for fish farming in the UK will be used. No treatments are expected, but if the situation dictates it, even considering the Company's biosecurity protocols and vaccination programme.

The following treatments could be used; Oxolinic acid, consisting of Sulfadiazin (CAS no. 68-35-9), Trimethoprim (CAS no. 738-70-5) as well as Florfenicol. The treatment will be given through feeding of specialized feed e.g. Aquavet (Biomar, Brande, DK). The feeding will be monitored closely during treatments to ensure that the feed is eaten by the fish to reduce potential discharge of the medicaments to the environment.

As the North European salmon lice (*Lepeophtheirus salmonis*) are not present on the Islands, the company is not planning treatments to control this potential pest. In the unlikely event of a salmon lice infestation or infestation by another parasitic copepod species, the company will use non-chemical treatments of the fish like e.g. Thermolicer[25], Stingray[26] or local species of cleaner fish to control the situation.

The company's mitigation strategy consists of a prophylactic vaccination program and good husbandry practices reducing stress on the fish and thus likelihood of disease breakouts.

On a yearly average the company does not foresee a antibiotics usage above 26 kgs of active substance. Based on whether there is a presence of tapeworms in Falkland waters it might be necessary to administer Praziquantel as well. In that case the use will be around 16 kgs of active substance per year.

Antibacterial substances	Norway 2017	Falkland Island – 50,000 tonnes
Florfenicol	285	11.5
Oxolinic acid	346	14.0
Oxytetracycline	10	0.4
Total antibiotics	641	26.0
Anti-Tapeworm		
Praziquantel	380	15.4

Table 3: Treatments used in Norwegian aquaculture and extrapolated use in the project – assuming the same health standards are maintained on the Falkland Islands.

In terms of other chemicals used on the sea sites please see the table below.

[25] https://scaleaq.com/product/thermolicer/
[26] https://www.stingray.no/?lang=en

Chemical	Identification number	Use
Formic Acid	CAS nr.: 64-18-6	Used for ensilage of mortalities. Dosed directly into the ensilage tank based on pH measurement (pH 3.0). The company will use a slightly diluted product to avoid potential explosion risks. The silage can be used directly as fertilizer.
Iodofor™	CAS nr.: 39392-86-4	Used for disinfection of equipment and footbaths. Use on the sea sites will be minimal.
Marine grade Diesel	-	Used in the barge generators and the company's vessels for propulsion.
Lubricants and oil	-	Used to lubricate and maintain the motors and equipment on the company's vessels and the feed barge.
Household detergents	-	Common household cleaning detergents, soap, shampoo and other cleaning substances. Will be collected in the barge sewage tank.

Table 4: Planned use of chemicals on the sea sites.

FIG will be made aware of any additional substances identified in the future. Approval for the use will be sought with the relevant government office before use. The disposal of chemicals will be handled in accordance with appropriate regulations and procedures in place on the Falkland Islands.

6.6 Well boat

A well boat will be utilized to transport fish from the hatchery to the sea sites and potentially also from the sea sites to the processing plant. The well boat will also be used to grade and potentially treat the fish.

A well boat is a specialized vessel used specifically for transport of live fish. The well boat contains two (2) or three (3) cargo holds that is used to hold the fish during transport. The cargo holds are equipped with sliding bulkheads and under pressure loading system used to gently load and unload the fish. During transport the water needs to be continuously renewed to keep the fish alive. Modern well boats disinfect the water after it has passed through the cargo holds. The disinfection is usually achieved by a combination of ozone addition and UV treatment. Water quality will be closely monitored during transport of the fish.

The well boat will also be used in operations where fish needs to be graded. The well boat will therefore be equipped with specialized equipment for grading, counting and size estimation of the fish.

In the unlikely event de-lousing is needed, then the company would use a non-chemical treatment to remove the lice from the fish. One potential solution is to use a Thermolicer, ScaleAQ, Norway[27]. The Thermolicer would be installed on the well boat deck, and the fish would be pumped through lukewarm freshwater to remove the lice. The lice will be collected from the rinsing water using specialized drumfilters[28].

The company will lease the well boat and the services from a third party well boat operator most likely from Chile. In the future the company could potentially opt to procure and crew its own well boat. The

[27] https://scaleaq.com/product/thermolicer/
[28] https://cmaqua.dk/product/hex-model-ship/

crew will most likely be Chilean and will work on rotational shifts. The well boat will only operate in Falkland Islands waters, due to potential biosecurity risks of using the boat in other areas.

The production plan dictates that the company will need a well boat with approximately 1,000m^3 cargo hold. An example of sizing of a similar sized vessel has been provided in the table below.

Dimension	Value
Length	54.07 m (177.4 feet)
Breadth	12 m (39.4 feet)
Depth	5.1 m (16.7 feet)
Speed	11 knots
Crew	6 members
Cargo hold	2 x 470m^3
Capacities	
Cargo system	Sliding bulkhead and under pressure loading system
Fuel oil tanks	147.24 m^3
Fresh water	48.70 m^3
Ballast water	155.11 m^3
Bow and Stern thrusters	300 Bhp
Refrigerated Seawater System	680,000 Kcal/h.
Circulation Pump	18,000 m^3/h.
Vacuum pump	2 x 5,000 L.
Grading equipment	3 sizes with fish counter
Main engine	3,350 BHP

Table 5: Main dimensions and characteristics for the well boat "Ronja Commander" owned and operated by Søvltrans AS, Norway.

6.6.1 Operation

The well boat will dock at either a wharf or a dedicated mooring point when it will pick up the smolts from the land-based hatcheries. In case a mooring point is used, a fixed pipe will be used to transport the fish to the well boat. During the transfer the fish will be counted. Only fish that have been deemed fully smoltified will be allowed to be transferred to the well boat.



Figure 43: The well boat Ronja Commander, which is similar in size to the one suggested to be used in the project.

After loading the well boat will sail directly to the sea site that will receive the fish. During the transport the water in the cargo holds will continuously be exchanged and the water quality in terms of oxygen content, salinity and temperature will be monitored. All outgoing water will be disinfected for biosecurity purposes. During the transfer the fish will be monitored (via video camera).

Once the well boat reaches the sea site, the fish is transferred to the net pen via a flexible pipe. The fish will be pumped out of the hold. The fish will be monitored and counted during transfer into the net pens.

The well boat will need berthing to resupply diesel, fresh water and supplies as well as crew exchanges. The well boat will alternate between the East Coast and the West Coast of East Falkland and will thus be able to re-supply at both Mare Harbour and New Haven. It could potentially also re-supply in Stanley. There are no specific planned sailing routes for the well boat as it will service all the fourteen (14) sea sites and the two (2) land-based hatcheries.

6.7 Feed

It is vital for the operation to gain access to high quality feed. The company will thus need a stable supply of high-quality ASC certified feed to support the business.

Due to the geographical isolation of the Islands, it is sub-optimal to transport feed in large quantities from external suppliers through the existing logistical channels. Therefore, different alternative solutions have been explored. The three (3) scenarios that has been identified are:

1. Construct and operate a feed mill on the Islands
2. Import the feed in Bulk from the UK
3. Import the feed using specialized vessels from Chile

In the start of the operation feed will have to be imported to sustain the smolt production, no matter what scenario is chosen. Due to the logistical constraints of either bringing feed ingredients or feed from the UK in and the additional strain on local labour market from construction a feed mill on the Islands. The company have decided to work with Scenario III.

Scenario I remain the long-term goal of Unity Marine. More detailed plans and logistical analysis will however need to be carried out. Construction and operation of the feed mill is also likely to further strain the labour market on the Islands. It has therefore been decided to postpone the development of the feed mill.

6.7.1 Feed imported from Chile

Chile is the second largest producer of Salmon worldwide and also has substantial feed production and have a number of established feed mills in and around Puerto Montt. If sourced from one of these facilities

the feed would need be transported from the feed mill to a storage facility in Southern Chile, most likely Punta Arenas.

Unity Marine has however, been in talks with one of the major feed producers, that would be interested in setting up a new feed mill in the Punta Arenas area. Not just to serve a potential future Falkland Islands operation, but also local salmon farms in Chile's Region XII. If the project proceeds this will be investigated further.

The feed would subsequently be distributed directly to the sites on the Falkland Islands by specialised vessels for feed pellet transport. A smaller warehouse capacity for storing feed for the hatcheries and for emergency feed for the sea sites (approximately 1,000-2,000 tonnes) will need to be constructed and maintained on the Islands. These storage facilities are planned to be established in connection with the hatcheries at one of the two service hubs in Mare Harbour and New Haven.

It has been estimated that one (1) or two (2) Fish Pellet Carriers could be needed to transport the feed from the feed storage facility in Southern Chile to the sea sites in a shuttle service. The vessels would be operated by a third-party contractor contracted by Unity Marine or by the fish feed producer. The vessels would be operated out of Chile and would thus not entail any labour footprint on the Islands.



Figure 44: The fish pellet carrier MS Høydal operated by Biomar in Norway. The vessel is powered by liquid natural gas (LNG) reducing CO_2 emissions by 25% compared to a similar diesel driven vessel. The loading capacity is 2,200 tons.

The feed pellet carriers would only dock at the company's service hubs in New Haven and Mare Harbour to unload fish feed for the hatcheries. The vessels will be required to carry advanced positioning systems for safe unloading at the sea sites even in rough weather conditions. Each vessel could potentially make a round trip every ten (10) to fifteen (15) days. Each vessel would be required to be able to carry a load of approximately 1,500 tonnes. Any excess feed will be unloaded at the service hubs and used to maintain the emergency store of feed. The emergency feed will be distributed by the company service vessels in case of extreme weather events preventing sailing from Chile.

The vessels can potentially also be used to transport personnel to the sea sites from Punta Arenas, if the flight on Saturday is fully booked. This would in turn reduce the company need of flight seats. The vessel could potentially also transport some goods directly from Chile to the Falkland Islands opening up a new logistical trade route.

The following pros for procuring feed from Chile have been identified:

1. Established production apparatus in place for high quality feed in Chile
2. Would reduce labour footprint on the Islands
3. The feed would be relatively fresh (2-6 weeks at feeding)
4. Could potentially be used to bring rotational shift workers to and from the Islands – reducing impact on number of flight seats

The following cons for scenario III have been identified:

1. Operating a shuttle service with two specialized vessels will increase costs
2. Potential biosecurity issues (ballast water) – mitigation strategy required

6.8 Processing of fish

In order to reduce transportation costs, it will be necessary to establish processing capacity on the Islands. That can be done either by building a land-based processing plant or employ a processing ship to harvest and gut the fish by the net pens. The minimum requirement would be to gut the fish and export as "Heads On Gutted" (HOG) but could also entail filleting and further processing in like smoking or portioning.

6.8.1 Processing on land

The product can be exported frozen by sea or fresh by air. If transported frozen by sea the existing link to Uruguay and the military freight line directly to the UK could be used. The product would in that case be frozen on the Islands most likely HOG and packed in reefer containers. The SAAS link to Uruguay is already being used for exporting meat from the Abattoir as well as fish in reefer containers and have experience handling similar cargoes[29].

Transporting fresh fish by air freight will probably not be feasible in large quantities due to the number of flight connections. A market for high quality salmon sold fresh in the greater London area is very interesting, if a possible delivery airport close to London can be identified. This would however demand a dedicated flight connection for the export of the product, which is not considered feasible at the time being.

A small proportion of the production will however likely be processed locally and made available for local purchase, exported directly and to passing cruise ships. Unity Marine is currently investigating establishing such a facility in Port Howard to secure further economic growth in Camp and specifically on West Falkland.

6.8.2 Processing ship

Given the logistical constraints and low labour supply on the Falkland Islands it is planned in the initial phases to export the product as HOG fresh fish to Chile for further processing. Therefore, this assessment works with the employment of a processing ship staffed by Chilean or other foreign workers.

A processing ship would be able to harvest the fish directly from the net pens and transport it fresh chilled to a processing plant in Punta Arenas in Chiles Magallanes Region, where further processing and export can be undertaken. This however will demand that the ship will be allowed to sail through Argentinian waters. Alternatively, the fish will be sailed to another South American country like Uruguay or Brazil that has better logistical infrastructure than Punta Arenas.

Live fish are pumped into the vessel using a specialized fish pump. The water is separated from the fish by a dewatering unit, with the sea water returning to the sea. After the water is removed the fish are led into an orientation-unit where a stunner touches the head of the salmon and delivers an electrical shock killing the

[29] Communication Eugene Hurley, General Manager, South American Atlantic Services Ltd., May 2018

fish. Electrical stunning of fish prior to processing is an industry best practice, as it reduces stress for the fish, which in turn results in a high-quality product.



Figure 45: The Norwegian Gannet, a Danish/ Norwegian vessel used for stunning, bleeding and gutting Norwegian produced salmon. Norwegian Gannet has a capacity of 1,000 tonnes per trip. The vessel will harvest around the Norwegian island of Hitra and export directly to a dedicated processing facility in Hirtshals, Denmark. The sailing distance from Hitra to Hirtshals is similar to the distance from Stanley to Punta Arenas.

Immediately after stunning, the fish is bled by cutting the gill, this results in the fish bleeding out of and secures a high-quality product. Process-water (blood-water and cleaning water) is held in a tank onboard the vessel that can be removed and treated/disinfected on shore at the processing plant or treated onboard.

After the fish have bled out the guts are removed, and the fish are led into a chilled tank for transport to the land-based processing facility outside the Falklands. The guts and intestines will be ensiled on the processing ship and brought to shore at the processing facility, where it can be further processed.

The dead hold vessel will undergo a disinfection procedure after each transfer of fish and before returning to Falkland waters. The vessel will also abide by the International Maritime Organization's "International Convention for the Control and Management of Ships' Ballast Water and Sediments" (BWM)[30] to reduce the risk of introducing invasive species.

6.8.3 Conclusion

Due to the logistical constraints of exporting the finished product and the potential large labour footprint of establishing the processing facility on the Falkland Islands, Unity Marine will work on the scenario including a processing ship operating out of Chile or another South American country.

The crew of the vessel will reside and live outside of the Falkland Islands, thus there will be no labour footprint on the Islands residing from the processing.

A small proportion of the production will however still be processed in the Falkland Islands to serve the local market.

[30] International Maritime Organization, http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships'-Ballast-Water-and-Sediments-(BWM).aspx

7 Labour

Skilled and experienced labour is key to any successful business. This is not least true for aquaculture, where multidisciplinary experience and skills are required to secure the welfare of the fish. As there is no or very limited aquaculture experience on the islands, it will be necessary to bring in experienced resources from abroad to ensure successful implementation and operation of the business.

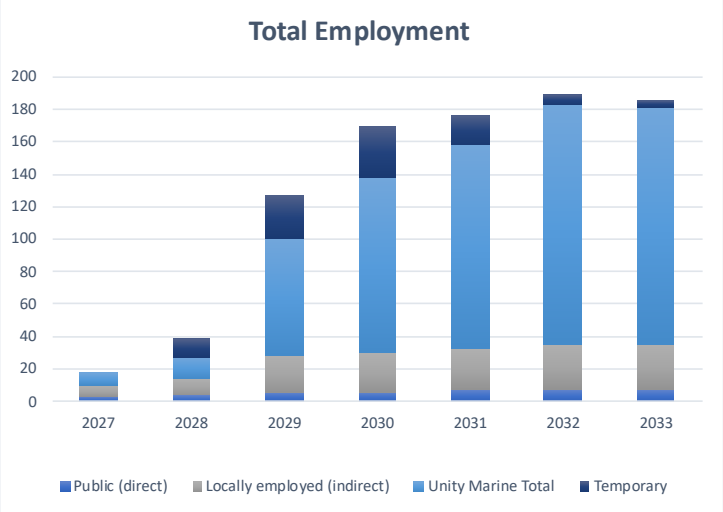


Figure 46: Number of FTEs stemming directly from the company activities.

It is planned to employ a mix of senior resources from the UK and Scandinavia as well as skilled labour from Chile. The labour will be a mix of expats and temporary workers.

The specific character of the business requires employment of key people managing the business, from an executive, operational or technical point of view, with specialized experience and competences. These resources will mainly be expats moving to the Falkland Islands for a longer period of time.

The Chilean labour is expected to be temporarily on the islands working in shifts, with two (2) months on the islands, followed by one (1) month at home. Further, they will have an extended vacation, when the sea sites are fallowing. It is expected that the Chilean workers will work 183 days or more on the islands and thus be applicable for labour tax on the Falklands.

Chile has the second largest salmon production in the world and thus have a large workforce with relevant experience. The workforce is also very mobile and skilled staff can be attracted with good wage packages.



Figure 47: Expected employment in Unity Marine's different business segments.

Recruitment will be made gradually supporting the establishment and ramp up of operations on the land and sea sites.

7.1.1 Local skilled labour

Currently there is very little or no local labour available with aquaculture skills. The few people with experience are currently employed by Fortuna Ltd subsidiary Falkland Fresh Ltd. on the hatchery in Stanley and the net pen site outside of Fitzroy.

The company will require employees within many different backgrounds and skill sets. There will be many positions with potential for locals to fill even though they do not have prior experience within the world of aquaculture. Some potential positions that could be interesting for locals can be seen below:

- Electricians
- Mechanics
- HR manager and assistants
- Secretaries
- Logistical and procurement managers
- Vessel crews
- Farm hands or service technicians on land-based and sea-based facilities
- Divers
- Veterinarians (would most likely need to upgrade skills)

To embed the business locally an active effort to recruit islanders will be pursued. The company would be interested in funding programs for the local youth to gain the skills necessary to fill the needs of the company. This could be in the form of scholarships or funded training programs, carried out in the Falkland Islands, UK or Scandinavia.

7.1.2 Corporate Social Responsibility

Development of the local community will be a key for retaining staff and their families. It is essential that partners to the employees can create a life for themselves and for their children on the Falkland Islands. Therefore, a part of the investment in the company will be dedicated to developing kindergartens, schools, sport facilities and other public service institutions.

Investing in the local community will also strengthen the bonds to the local population and allow for a positive atmosphere around the project locally.

7.2 Land-based facilities

The land-based facilities consist of two the nurseries, where the fish are reared from egg to a size of approximately 125g. The facilities will be placed on plots adjacent to Mare Harbour and New Haven on East Falkland.

7.2.1 Operational needs

Smolt rearing is a complex operation that includes knowledge on fish welfare and behaviour as well as technical insight and maintenance tasks. There are however also many daily operational and maintenance routines that does not necessarily require a high level of skill. Therefore, the staff will need to consist of a mixture of trained aquaculturists and unskilled labours.

Position	Key skills	Number of employees
Fresh Water Manager	Management, extensive experience with smolt farming	1
Plant Managers	Management, experience with smolt farming (one at each site)	2
Staff (locally employed)	Locally employed team with specific veterinarian, diving, electrical, black smith, and IT experience	10
Staff (rotational workers)	Hatchery manager, Fry manager, Parr manager, Smolt manager, and additional staff	14

Table 6: Need of labour for both hatchery facilities. Each facility will have a yearly production of approximately 6 million smolt.

To reach the full production capacity two smolt facilities will be needed. Thus, the total operational needs will be 27 full time employees.

Due to the placement of the facilities in rural areas it is envisioned that some of the employees and their families will want to settle down in camp. Managers and group leaders would probably have to be recruited abroad. Staff can be recruited locally or in Chile. In time it is likely the manager and group leader positions will be taken up by Falkland Islanders, as the aquaculture skill level is adequate. Some of the staff can work on rotational shifts and would thus not need to settle permanently on the Falkland Islands.

7.2.2 Construction phase

Each facility consists of an industrial type building covering approximately 7,000 m^2. The building will contain fish tanks, water treatment units and technical installations as well as staff quarters in form of offices, mess hall and rest rooms. An additional 3,000 m^2 of warehouses and net repair workshop will also be constructed adjacent to the hatchery.

The construction period is envisioned to be about twelve (12) months for each of the facilities. Due to the size of the installation it is likely that large parts of the construction will be contracted to foreign companies

or will be contracted to local companies that can draw on additional workforce from existing collaboration with UK general contractors.

The technical installation including the installation of pipes, machinery, electrical components and tanks will be contracted to a design build company that specializes in Recirculated aquaculture facilities. This company will have an average of eight (8) people at site during the construction period with a peak of twenty (20) people.

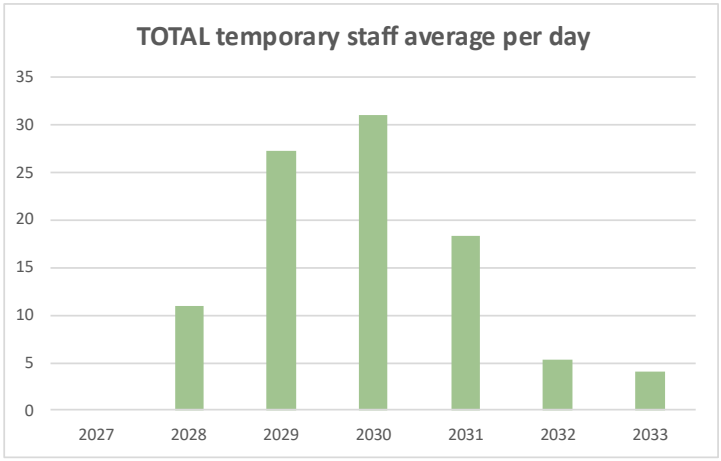


Figure 48: Average number of temporary workers on the islands every day. This number equals the need for temporary accommodation (Hotels, self-catering or rented short term accommodation).

The technical installation and the installation of concrete structures and erection of the building will overlap somewhat. Therefore, there will be a need for temporary housing of up to 30 persons during the construction period.

7.3 Sea site operation

Each net pen site will be continuously manned by at least two people. The team at each site will consist of a regional manager (one for every five sites) who is permanently residing on the Falklands and one (1) site manager as well as three (3) crew members that will be working on rotational shifts. The site manager and the crew members will most likely be hired in Chile and will not be residing permanently on the Islands.

7.3.1 Operational needs

Unity Marine anticipates rotational workers to work in two-month on one month off shift. During the shift the personnel will live aboard the feed barge. The crew will have some days or weekends off during the two-month shifts, so additional personnel transport is anticipated. There will always be at least two (2) persons on site, and three (3) on average except during fallowing.

Position	Key skills	Number of employees
Sea Site manager	Management, extensive experience with net pen salmon farming	1
Regional Managers	Management, experience with net pen salmon farming	4
Operating Managers	Experience with net pen salmon farming	20
Staff	Experience from net pen operation, mechanical maintenance or fisheries	48

Table 7: Number of expected employees on the sea sites.

If possible, the company would like to hire locals as crew members. If a situation arises in the future, where there is an increase in unemployment on the Falkland Islands the rotational shift workers can be substituted with local workforce.

7.3.2 Installation phase

The installation of the net pens will need specialized labour and machinery in the form of divers and workboats/ tugboats. The large workboats that will form a part of the permanent company presence on the Islands will be able to conduct much of or all the work. It is likely that the necessary labour and machinery will be for the most part be contracted from Chile. It is estimated that the installation time for each net pen site will be approximately one (1) month.

Some of the diving services will be procured on the Falkland Islands. As part of this work it will be necessary to install and operate a decompression chamber on the Islands.

It is believed that the installation of each site will demand a workforce of ten (10) of which four (4) are employed by the company and will later fill other roles in the daily operation.

7.4 Well boat service

As the fish will be processed on a specialized vessel, the well boat will primarily be tasked with transport of smolts to the sea sites and with grading and transfer of fish internally on the individual sites. This also reduces the need to just one well boat. In case the well boat is in for repairs or maintenance another well boat will be leased for the duration of the offlay.

The company would be looking to lease the well boat from a Chilean well boat operator. All the crew will be working on rotational shifts, will be employed by the well boat operator and will thus not add directly to the local labour footprint on the Islands.

7.4.1 Operational needs

The well boat is thought to work on two operational shifts. With a crew of six (6) that entails twelve (12) full time positions on the vessel. All the employees will live on board the well boat and will thus not need accommodation on the Islands. In periods with little transfer activity or during time off the crew might however opt to visit Stanley or other places on the Islands. All crew will be rotational shift workers.

The crew will need the proper education to operate the vessel and will require to fulfil any maritime ordinance or law in place at any given time to operate a vessel of this size in Falkland Islands waters.

7.5 Feed

If a feed mill is constructed in the future it will in itself be the company's single most labour demanding business unit with approximately 25-30 full time positions. As the company is currently planning to import the feed from Chile, no labour footprint is envisioned from feed production at this time in the project.

The company would be looking to lease the feed pellet carrier from a Chilean operator or directly from the feed company. All the crew will be employed by the operator and will be working out of Chile and will thus not add to local labour footprint on the Islands.

7.6 Processing

As the processing will be conducted at sea on a vessel operating out of Punta Arenas or another South American port there will not be any local workforce needs in respect to the processing.

If a small processing plant is constructed on West Falkland there will be a labour requirement. The extent is not known at present and relies on the size of the facility.

7.6.1 Operational needs

No local needs identified initially.

A small-scale production of high value-added products might be considered on West Falkland this will require an additional workforce that would live on West Falkland. There might be need for minor additional import of workforce during the cruise season, if the company wishes to supply fish directly to the cruise ships.

7.6.2 Construction phase

The processing vessel(s) will be designed, built, tested and commissioned outside of the Falkland Islands. Therefore, no present need for additional labour has been identified at this time.

7.7 Head office

Unity Marine is a Falkland Islands limited company and will as thus need a local head quarter with offices, meeting rooms and other services normally associated with office facilities. The headquarters could potentially be placed either in town, in the office area around FIDC or in the industrial area east of town.

7.7.1 Operational needs

The Unity Marine main office will be located in Stanley and will be the heart of executive and operational management activities, as well as all administrative and supporting functions. The CEO will head the management team consisting of CEO, COO, CFO and the Program/Project Manager during construction. HR will report directly to the CEO and support all managers in the comprehensive process of recruitment and on boarding of required staff.

Veterinarians, divers, procurement, accounting, travel and booking, as well as all round secretarial staff supporting all operational units will be based at the main office.

Sales are expected to be handled as one contract, and traditional sales activities are expected to be limited. The sales activities will thus have a more coordination and logistics character and is expected to be handled by the regional managers, supported by the executive management and the administrative staff at the main office.

7.7.2 Construction phase

Based on the availability of suitable office space in Stanley the company will either buy, lease or build the needed facilities.

If the company opts to build new office facilities in Stanley, the building phase is thought to take around 6-8 months and will employ an average of 6-8 people over the entire construction phase. The company will contract a local company to build the office facilities.

7.8 Other needs

There is potentially a need for additional workers in connection with the construction of the wharf/ harbour facilities at New Haven. The detailed plans for the sizing of the harbour facilities and the design will be carried out in phase II of the project. This will also include an analysis of needed labour to undertake the construction.

Establishment of bunkering facilities might also need to be constructed at New Haven. Detailed plans for this will be elaborated with Stanley Services in phase II of the project.

7.9 Secondary effects on labour market

There are several other private businesses that will see increased activity as a result of the project. It is also expected that public service needs will increase with the population growth and FIG will need additional personnel to manage a new industry on the Falkland Islands.

7.9.1 Private sector

Stanley services will need to supply fuel to the company vessels, feed barges and generators at the land-based facilities. The company is expecting to purchase fuel for at approximately four (4) to five (5) million GBP per year when fully operational.

During the construction phase there will be a significant need for temporary accommodation in the form of hotel rooms or use of rural self-catering facilities. It is expected that the peak need is a yearly average of 30 rooms per day in 2028 and the long-term need settles around five (5) rooms a day year-round.

Other private sectors will also see an increased activity from normal servicing of the employees of the company. It is expected that supermarkets, pubs, restaurants and retail stores will receive additional business. Company employees are also expected to purchase personal vehicles, which would in turn need to be serviced.

The company will also look to enter into a contract with one of the local supermarkets for supplying food and consumables for the sixteen (16) sea-sites that will be permanently manned. Likewise, Unity Marine will also need to work closely with Sure to establish and operate the necessary telecommunication infrastructure.

Internal freight of goods, feed and waste generated at the company facilities will also be contracted locally.

7.9.2 Public sector

Establishment of a new aquaculture industry on the Falkland Islands is likely lead to an increased employment in private and public services with a total of 27 FTE at full production:

- Public services directly related to the new aquaculture industry (7 FTE)

- Public and private services related to increased population and activities (20 FTE)

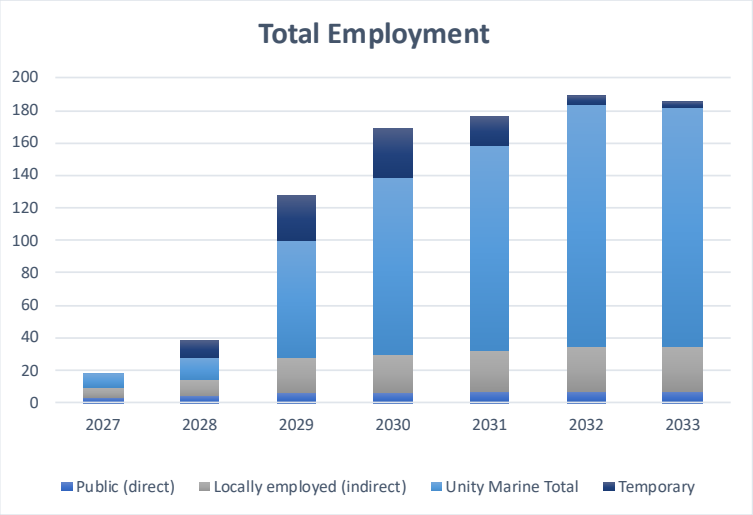


Figure 49: Number of FTEs stemming directly from the company activities.

FIG will need additional competencies and resources to handle the specific aquaculture activities directly related to establishment and operation of the new aquaculture business. The following is foreseen:

- 2027: environmental officer, planning officer, administrational staff
- 2029 (production start): veterinarian and biosecurity staff
- Earliest 2031 (full production): additional administrational staff

Veterinarian, biosecurity and environmental positions are expected to be staffed with experienced expats but could potentially be locals if employees with the right skill sets are identified. Employment strategy obviously fully rests with FIG, costs will be covered by increase in tax revenues and/or any license fees if implemented by FIG in the future.

7.10 Location of jobs

The operational activities will generate a distributed employment distributed widely over East Falkland. The primary workplaces for the 181 expected employees (both direct and indirect effect) are as given below:

- Stanley area (Main office, direct and indirect public/private)
  - 9 Expats
  - 28 locally employed
- Mare Harbour (Land based facility, workshop, warehouse)
  - 5 Expats
  - 14 Locally Employed
  - 7 On shore rotational workers
- New Haven (Land based facility, workshop, warehouse, fleet base and management)
  - 9 Expats
  - 22 Locally employed
  - 7 On shore rotational workers
- Offshore (sea sites, feeding barges)

- 80 rotational workers

The rotational shift workers will not reside permanently on the Islands. The distribution including secondary effects can also be seen in the figure below.

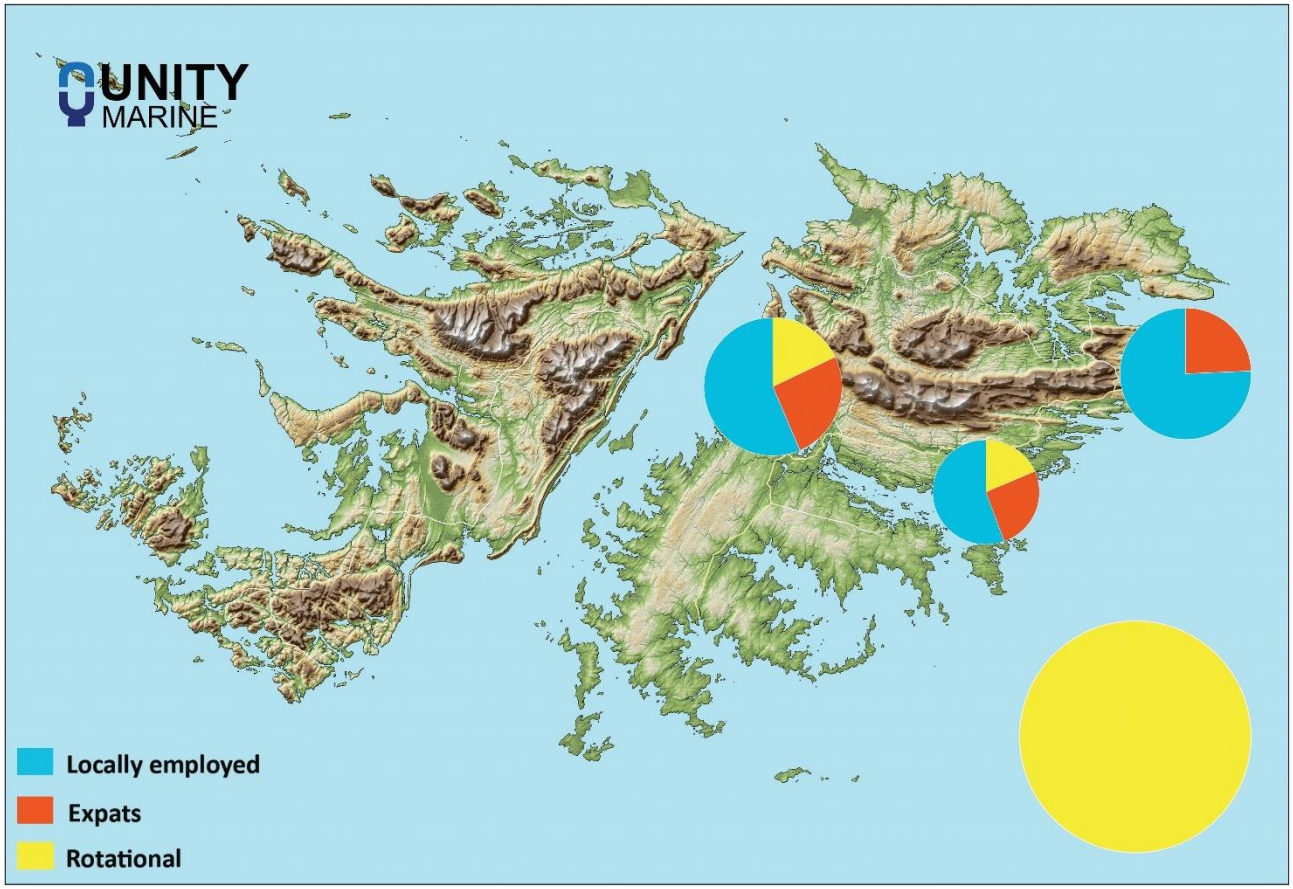


Figure 50: Expected spatial distribution of new jobs and the expected category they fall under. Approximately half of all positions will be offshore rotational workers.

7.11 Long term labour market impact

The continuous effect of the aquaculture business and supporting activities will generate around 181 FTE jobs or around a 10% increase on current level of employment (1,909) in the Falkland Islands. Of these 80 are expected to be offshore rotational workers. It is possible in the future to convert these positions to locally employed employees, in a pace fitting with the strategic population development of the Falkland Islands society.

In the future, an expansion of the aquaculture business could utilize the West Falkland Islands and could be seen as an engine to boost the development of this part of the Islands. It would naturally have many of the same requirements and effects as described in this document for the East Falkland Island. It would, however, also potentially add additional requirements as West Falkland, does not have the same level of infrastructure as Stanley offers.

Employment and recruitment should be seen and developed, as a vehicle for the future population increase. The new aquaculture business will enable the Falkland Islands to attract young, ambitious and

well-educated expats, who will bring spouses and families that will be the future foundation and development of the Falkland Islands.

The increased FIG revenues will be a significant contribution to the Falkland Islands economy, improving FIG's ability to develop, upgrade or extend public buildings, institutions and services in alignment with FIG strategic plan for long term development.

As the Falkland Islands is a relatively small society, the development and increase in population must be implemented gradually, to safeguard the Falkland Island culture. Staffing positions in the aquaculture business with a relatively large share of rotational workers will ensure the right planning and pace of the population development.

8 Logistics

The current only commercial flight connections to the islands are from Punta Arenas, Chile on Saturdays with return the same day. Pre-COVID an additional second weekly return flight from Sao Paulo in Brazil had just been started, whilst it is the plan to restart this route, no immediate plans exists at the moment.

There are regular sea freight routes to and from the Islands every 2 – 5 weeks depending on the season and the amount of freight.

8.1 Transport of personnel

Domestic transport of personnel is thought to be accomplished primarily by road or by sea.

The two service hubs, that also accommodates the land-based hatchery facilities will also be point of operations and will see the major share of increased activity. Both are placed close to class-a roads, that will allow heavy traffic all year round.

8.1.1 Domestic transport by Sea

Domestic transport of personnel is thought to be accomplished primarily by road or by sea.

The two service hubs, that also accommodates the land-based hatchery facilities will also be point of operations for the exchange of the rotational shift workers employed on the sea sites.

It is estimated that each service hub will have 2-5 daily berthing's with different sized vessels.

8.1.2 Personnel transport by road

There will be daily transport of personnel to and from the two service hubs in Mare Harbour and New Haven.

It is estimated that 10-25 personal vehicles to each site daily. The busiest days will most likely be on Saturdays when rotational shift workers arrive and leave on the Punta Arenas flight.

The office in Stanley will most likely have 10-30 daily visits by personal vehicles. This covers both workers and visitors.

8.1.3 Personnel transport by air

A limited use of the internal air services is foreseen. As the company's operations are primarily lies within comfortable driving distance from MPA and Stanley.

There will however from time to time be a need to transport personnel quickly to more remote areas on the East Island or potentially to some of the airstrips on the smaller islands in proximity of the company's sea sites. A total of less than 50 annual flights is expected.

8.1.4 International transport

The workforce used in the project will need to be transported to and from the Islands at regular intervals. Permanently based personnel will need to go abroad for holidays, participation in fairs or conferences as well as training sessions.

As described above a large part of the staff working on rotational shifts can be recruited in Chile. Therefore, they will primarily use the commercial flight from Punta Arenas, Chile in order to reach the Falklands. The permanent staff will contain a mixture of locals, Chileans and internationally recruited staff of which the bulk will be of Scandinavian or British heritage. Therefore, it is foreseen that the permanent staff will use both the commercial flight from Chile and the MOD flight from Brize Norton.

Beyond the direct needs for international flights from the staff, additional needs for transport is anticipated from short term contractors and the families of the permanent staff. Furthermore, flights for vacation are included in the following table to illustrate the total load on the flight connections to and from the Falkland Islands.

It is assumed that each Chilean citizen on rotational shift work for two (2) months and have one (1) month off, resulting in four (4) yearly return trips. Likewise, Falkland citizens or permanent residents have been calculated to have two (2) yearly holiday return trips.

	2027	2028	2029	2030	2031	2032	2033
Flight seats Increase	**50**	**233**	**595**	**767**	**837**	**823**	**791**
Per week	1	4	11	15	16	16	15
Employee Flights	25	35	189	301	366	463	463
Vacational Flights	25	40	95	95	100	115	115
Temporary personnel flights	0	158	311	371	371	245	213
Head quater/Main Office							
Service technicians, various	0	0	120	120	120	120	120
Vaccination team	0	0	0	60	60	60	60
Specialists	0	0	24	24	24	24	24
Board meetings, quarterly, one expected off site	0	9	9	9	9	9	9
Smolt facilities							
Equipment suppliers on site, Design	0	8	0	0	0	0	0
Equipment suppliers on site, Construction on site	0	36	36	36	36	0	0
Additional construction on site staff	0	90	90	90	90	0	0
Sea sites							
Suppliers on site, Design	0	15	0	0	0	0	0
Suppliers on site, Construction on shore	0	0	32	32	32	32	0

Table 8: Total expected number of flight seats occupied by the project activities.

The total need for round flights per year has been split out evenly over the weeks. This results in a need for additional 16 weekly round flights seats from 2031 and onwards, as illustrated below. The majority being work related flights by Unity Marine employees.

The current and planned future routes (to Sao Paulo, Brazil) are overall expected to be able to accommodate the increased need. However, particularly during the summer tourist peak, demand is expected to exceed the available number of seats. Due to the high travel activity by Unity Marine's

employees, a travel and booking coordinator will be responsible for coordination and booking of all employee transportation.

During the summertime, Unity Marine will ensure that Unity Marine employees are not blocking for other passengers, e.g. by transporting rotational workers to and from the Falkland Islands on the feed pellet carrier. The transport by boat could potentially be employed all year round if needed.

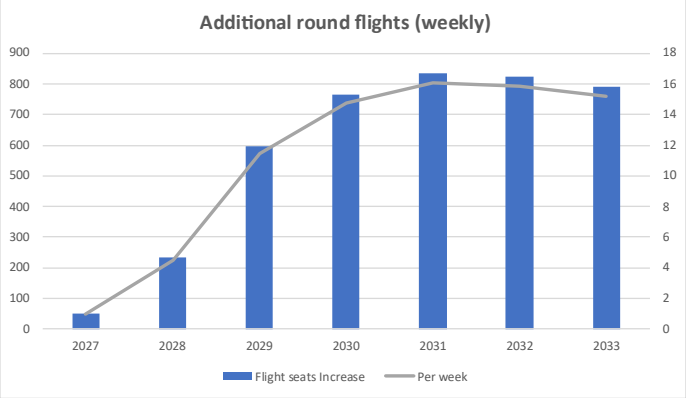


Figure 51: Additional return flights expected on a weekly basis from project activities.

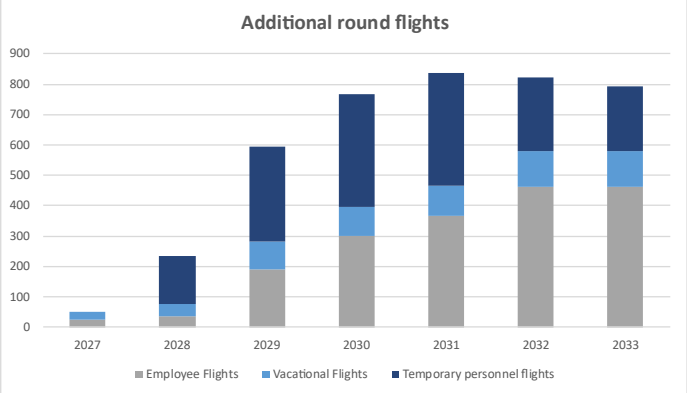


Figure 52: Additional return flights expected every year from project activities.

Additional foreign labour, either as expats or rotational workers, will increase the need for round flights. As mentioned earlier, the specific need will depend on the recruited profiles and will be evaluated in future phases, as part of the recruitment strategy.

8.2 Transport of goods

Export, import and domestic transport of fuel, goods, equipment and generated waste requires planning and the necessary infrastructure. Due to the logistical remoteness of the Falkland Islands, Unity Marine has tried to minimize the overall amount of transport through existing channels.

8.2.1 Export of product by sea

The business plan details that the product will be stunned, bled and gutted on board one (1) or two (2) specialized vessel(s). The vessels will operate out of Punta Arenas, Chile or another port in South America. There are thus not any specific needs for harbour facilities or infrastructure on the Islands at this point.

8.2.2 Export of product by air

Due to the current air transport infrastructure and the plans for processing at sea/ in Chile, there is no plans to export any of the product by air freight.

8.2.3 Import of goods by sea

The feed will be transported to the Islands by specialized vessels going directly from one of the Skretting, EWOS (Cargill) or Biomar facilities in Chile. The feed will be transported directly to the feed barges on site. There are thus not any specific needs for harbour facilities or infrastructure on the Islands regarding the feed for the on-growing phases of the production at this point in time. It is estimated that the total volume of feed shipped in will be from 55- 65,000 tonnes per year. The transport will generate approximately 24 yearly trips in between the feed mill and the Falkland Islands.

The feed for the juveniles in the hatcheries will either be transported on the feed vessels and unloaded at one of the land-based facilities or be transported in reefers using the SAAS sea link to Montevideo. In case the latter option is used, spare capacity of reefer containers normally shipped empty to the Islands could be used.

Equipment and building materials will be imported using the current logistical channels from Marchwood in the UK and through the SAAS link to Montevideo. Most of the materials will be containerized prior to transport. The existing sea links will also be used to transport spares, replacement parts and consumables to the Islands.

8.2.4 Import of goods by air

Some items and goods will need to be brought in by air transport. There are planned shipments of items with short shelf life like eggs or vaccines, but it could also be vital spare parts for the company's facilities.

All eggs will be transported by refrigerated air transport. The eggs will be sourced from biosecure broodstock in Iceland or Norway and will be brought down on one of the two commercial lines. Chile already has approved the import of eggs from specific facilities, as they are thought not to present any risk in connection with the spread of pathogens. A polystyrene transport box can contain approximately 72,000 eggs. With a yearly use of 15,000,000 eggs this implies 210 boxes imported every year. Each box weighs approximately 20 kilos.

Vaccines are normally transported chilled and will also need to be brought in by plane. All the major companies supplying salmon vaccines has local presence in Chile. It is therefore most likely that any vaccine will be imported through the airlink to Punta Arenas. 5-10 yearly shipments of vaccines are planned.

Even though the company is planning to maintain a warehouse with an extensive spare part inventory, there might be situations where a specific replacement component will be needed to be sourced quickly. In that instance the spare part could be sent by airfreight from Punta Arenas or Sao Paolo.

8.2.5 Domestic transport by road

The company is planning to use the existing road network to transport goods to and from the company facilities. It is expected that there will be 3– 5 trucks to and from each of the hubs every week.

The trucks will be transporting:

- Equipment
- Building materials
- Supplies
- Chemicals
- Potentially feed
- Eggs (from Mount Pleasant)
- Waste to the dumps in Stanley

The transport of feed to each facility from Stanley by road is estimated to 2-5 truckloads per month if the feed for the juveniles is shipped in through Montevideo.

Waste generated at the facilities will be transported to Stanley for further processing or delivery to the public landfills. Some fractions will be transported off the Islands for recycling e.g. netting and polycarbonate piping used on the sea sites. The waste will be in the form non-toxic industrial waste like organics, plastic and building material as well as metals. There will also be a need for emptying the facilities septic tanks at regular intervals for solids.

During the construction period a substantial transport of goods and personnel in and out of the site is expected. As it expected that a large proportion of the goods for the construction of the facilities will be shipped to Mare Harbour the road transport to this construction site will be considerably lower than that to New Haven.

Dependent on the diesel storage facilities and whether Stanley Services will deliver fuel by truck or boat, there will also potentially be land transport of fuel.

8.2.6 Domestic transport by Sea

The company plans to transport equipment, fuel and supplies to the sea sites and sewage and silage from the feed barges to the service hubs using the company vessels.

Dependent on the diesel storage facilities and whether Stanley Services will deliver fuel by truck or boat, there will also potentially be transport of fuel to the service hubs from Stanley.

9 Infrastructure needs

New infrastructure will be needed in the form of accommodation for workers, harbour facilities and telecommunication networks internally on the Falkland Islands.

9.1 Housing

Due to the size of the local community appropriate housing will need to be constructed for some of the permanently positioned employees working on longer tenures. Please also see the Socio-economic appendix B for more detail.

9.1.1 Analysis of Requirements

Based on the number of new immigrants it is estimated that a total of 23 housing units will be needed. In addition to this the company will need four (4) company houses that can each accommodate five (5) rotational onshore workers. The need might prove to be larger if the personnel thought to be sourced locally is exchanged with expats or the businesses where the locals are currently employed fills gaps with expats.

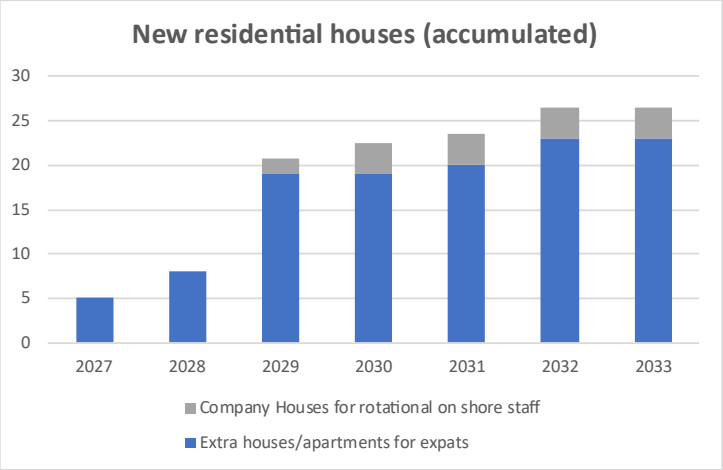


Figure 53: Estimated needs for new homes on the Falkland Islands.

As there is currently a housing shortage in the Falklands, the majority of the new homes are expected to be new houses.

9.1.2 Strategy

In terms of construction, there are local companies capable of building housing. Finding suitable land with the right location (proximity to operational sites, as well as to schools and other social facilities) and getting the houses built in time to accommodate the new employees, need to be planned in detail together with FIG and local construction companies.

9.2 Roads and access

All the company's facilities will require roading infrastructure to ease the transport of goods and personnel. In the analysis below only, facilities requiring special needs in terms of heavy trucking have been

considered. All office or other facilities requiring only transport of personnel have been intentionally omitted.

9.2.1 Analysis of Requirements

Both smolt facilities requires year-round access for trucks and personnel. One of the major considerations regarding the placement was thus the proximity to existing good quality road (class A-road, 38t allowance year-round).

The smolt facilities will need to be surrounded by a fortified area that is suitable for daily operations and movement of equipment with trucks, forklifts and cars. The facilities will also need adequate parking for employees and potential visitors.

No other specific requirements have been identified at this point in time.

9.2.2 Strategy

Due to the planned placement of the land-based facilities at New Haven and Mare Harbour the need for new roading infrastructure will be minimal.

There will be some needs for roading material associated with constructing approximately 400- 500 m at Mare Harbour. Backfilling and compacting of the areas around the smolt facilities would also require material.

It is believed the material for these purposes can be acquired in the existing quarries on the East Falkland Island, but will have to be investigated further. The possibilities will need to be explored in detail in Phase II of the project.

9.3 Harbours and piers

The company will require harbour facilities for at the two service hubs in Mare Harbour and New Haven. While the existing harbour facilities at Mare Harbour have been found to be adequate, New Haven would need to be upgraded with a wharf and potentially a breakwater. The upgrade should be carried out without impacting the ferry services.

9.3.1 Analysis of Requirements

The well boat transporting the fish from the land-based facilities to the sea sites requires a loading point adjacent or close to the land-based facility. The loading point can either be positioned directly on a pier, wharf or jetty with a minimum depth of 5 – 5.5 m or a permanent pipe for fish transport can be installed on a floating jetty or to a buoy. In the latter instance the well boat would anchor at the end of the floating jetty or the loading point buoy. The fish cannot be transported more than 2,000m and preferably no more than 500 m from the land-based facility.

There is an identified need for two service ports to accommodate the company's vessels. One should be placed on the East side of East Falkland and the other on the West side of the island.

The following vessels will need berthing and possibility to resupply and re-fuel on each of the supply centres:

- Six (4) smaller vessels for personnel transport (30-45” vessels)
- Five (4) medium sized service vessels (49” vessels)
- Two (2) large service vessel (One vessel to alternate between East and West) (49” and 79” vessels)
- One (1) Supply ship (approximately 50-60” vessel)
- One (1) well boat (alternate between East and West) – can be moored at buoy when not in use. (160-180” vessels)

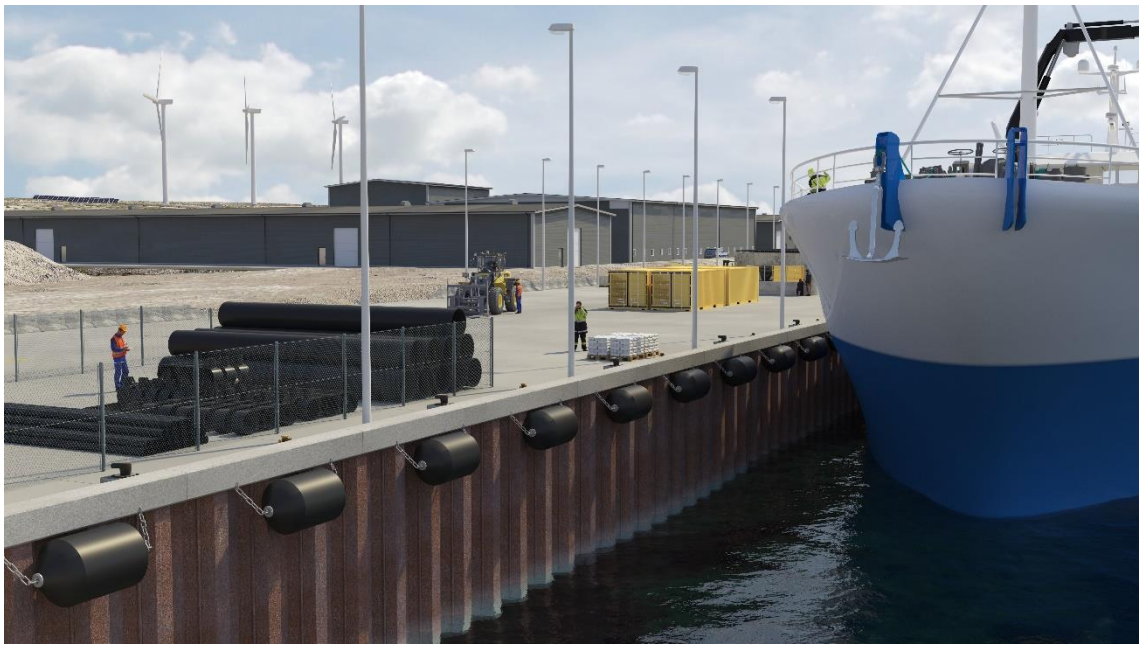


Figure 54: Render of the new planned wharf at New Haven with docking well boat.

9.3.2 Strategy

During site investigations Mare Harbour on the East side of East Falkland and New Haven on the West side of the Island was identified as the most suitable sites for support of the company’s vessels.

Mare Harbour

- Sufficient capacity to accommodate the suggested vessels.
  - Smaller vessels can be accommodated on the floating dock.
  - Larger service boats can be accommodated on the inside of the dock.
  - Well boat can be refuelled at the dock but will need independent fish loading point, which would need to be established.
- Warehouse
  - The company will need to establish warehouse facilities for storing of nets, feed and consumables.
  - The warehouse is planned to be built in connection with the planned land-based hatchery
- Roads and access
  - Current roading infrastructure is adequate.
- Planning and permissions
  - The operations will be dependent on military approvals.

- MPA has indicated they are cautiously positive to the plans.[31]
- Warehouse and fish loading pipe installed on FLC land next to harbour.
- Normal planning permission procedure would need to be completed for new structures on civilian land.

New Haven:

- In-sufficient capacity to accommodate the suggested vessels
  - A new wharf will be constructed on the north side of the harbour.
  - Hydrological modelling will need to be completed to investigate the need for a pier to protect the wharf.
  - Well boat can be refuelled at the dock but might need independent fish loading point, which would need to be established.
- New Haven currently does not have provisions for re-fuelling the vessels and therefore bunkering facilities would need to be established.
- Warehouse
  - The company will need to establish warehouse facilities for storing of nets, feed and consumables.
  - The warehouse is thought built in connection with the planned land-based hatchery.
- Roads and access
  - Current roading infrastructure is adequate.
- Planning and permissions
  - Warehouse and fish loading pipe installed on FLC land next to harbour.
  - New wharf planned on North side of existing harbour facilities.
  - Normal planning permission procedure would need to be completed for new structures.

Stanley Harbour:

- The new deep-water port will impact any future plans for the use of Stanley Harbour.
- Currently there are no plans for any new activities in Stanley Harbour.

9.4 Power infrastructure

The company will need to power to operate the two service hubs and the land-based facilities at Mare Harbour and New Haven.

9.4.1 Analysis of Requirements

A total power requirement of approximately 0.8-1.2 MW will be needed at both facilities.

It might be possible for the company to have power supplied by the Military at Mare Harbour. This will however have to be negotiated with the military in Phase II of the project.

[31] Meeting with the Command Secretary, Claire Pilkington on the 8th of November 2018

In the further analysis of requirements, it has been assumed that both facilities will need a completely new power infrastructure.

Both facilities will need a primary power infrastructure as well as a backup emergency power infrastructure. In case of a power outage, it is estimated that there is a risk that the fish will start dying within a couple of minutes.

9.4.2 Strategy

The company have employed Sweco, Denmark to analyse the best potential standalone energy supply for the two sites at Mare Harbour and New Haven. The report can be seen in appendix E.

Based on the findings it was concluded that the best option is to have a wind turbine backed up by diesel generator on each site. The suggested windmill would be an 800-900 kW Enercon, Germany turbine. This is currently the smallest commercial size land-based windmill on the market. It is considered likely that the use of an Enercon turbine would create synergies in terms of maintenance and service as it is the same brand utilized in the Sand Bay Wind Farm.

Since the issue of the report the market for wind turbines have developed further and the smallest available commercial size turbines are likely considerably bigger now than in 2019. The final decision on brand and size will, therefore, rely on the outcome of further research and a later tender stage.

Based on the findings in the report an 800-900 kW mill would cost approximately 1.1 million GBP. The calculated savings in diesel would provide a pay-back time of approximately 18 months. With the ongoing development of batteries for energy storage and costs of solar panels, these technologies are likely to be included in the final setup and is likely to reduce the use of diesel further.

The facilities would still be equipped with a diesel generator that can provide the full power need at any given time. Bothe facilities will also have back-up generators installed in case of failures in the primary system.

The company will also work with the military in order to determine whether the Mare Harbour facility can be joined to the MPA grid. This could potentially mutually benefit both parties.

The company will be interested in working with FIG and local stakeholders to provide electricity to other local needs. If a need for power infrastructure around the ferry terminal or any other nearby Camp activities arises in the future, it would be natural to join this to the Unity Marine grid.

9.5 Internet and cell coverage ## Jonas update med Starlink

All land-based facilities and sea sites needs access to the internet, cell coverage and or call via internet.

9.5.1 Analysis of Requirements

The land-based facilities will need to provide adequate bandwidth for streaming data from sensors on feed barges and net pens as well as video streams and general communication services from users. This service must be facilitated seamlessly within the Islands, but not necessarily overseas.

All sites will preferably be able to access a reliable high-speed. A main server hub could potentially be situated in New Haven, Mare Harbour or Stanley.

9.5.2 Strategy

The emergence of Starlink have efficiently removed the previous challenges in the implementation of a reliable network to more remote areas on the islands.

All facilities both seabased and landbased will be equipped with a starlink connection.

The company will use IP telephones for the cellcoverage, and thereby all vessels will be equipped with a separate starlink connection.

9.6 Temporary accommodation

The company will need to accommodate temporary staff both during the installation phase, but also as a part of the normal operation, where specialists and service engineers will be brought in on a regular basis.

As it can be seen from the figure it is estimated that the need for temporary accommodation will peak in 2029 with a need for approximately yearly average of 32 beds. This is thought to put a considerable strain on the need for hotel rooms and other temporary accommodation. Therefore, the company will develop mitigation strategies during phase II of the project. One such strategy could be to install a construction camp at the sites.



Figure 55: Estimated needs for accommodation on the Falkland Islands given in average daily accommodation needs.

9.7 Impact on FIG income and GDP

The Gross Domestic Product (GDP) is the monetary value of all finished goods and services produced within a country's borders in a specific time period, typically on an annual basis. A county's GDP includes all private and public consumption and investments, inventories, construction costs and the foreign balance of trade (exports are added, imports are subtracted). In the following, the GDP impact resulting from the new aquaculture industry will be evaluated.

9.7.1 GDP growth and FIG revenues & reserves

Based on planned capacity ramp up and the assumed price of 95 NOK/kg, the GDP is expected to grow with approximately £140m from 2032 and the FIG revenues will grow with approximately £26m from 2033.

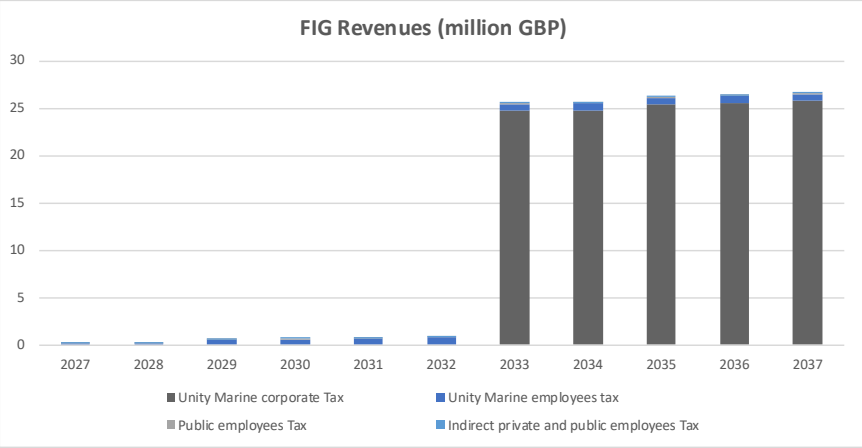


Figure 56: Expected revenues FIG tax revenues from company activities.

The GDP includes the gross profit generated in Unity Marine, as well as direct and indirect wages. Capital investments in infrastructure have been included in the year of establishment. Financial costs have been excluded.

The total increased GDP does not translate directly to increased FIG revenues but is a sum of the value creation of the project that will be experienced broadly by the residents and other businesses in the Falklands.

The part of GDP that will be retained on the Falkland Islands as FIG revenues are tax paid directly to FIG either by Unity Marine or by the additional employees or through taxes from employees in supporting businesses and their corporate taxes.

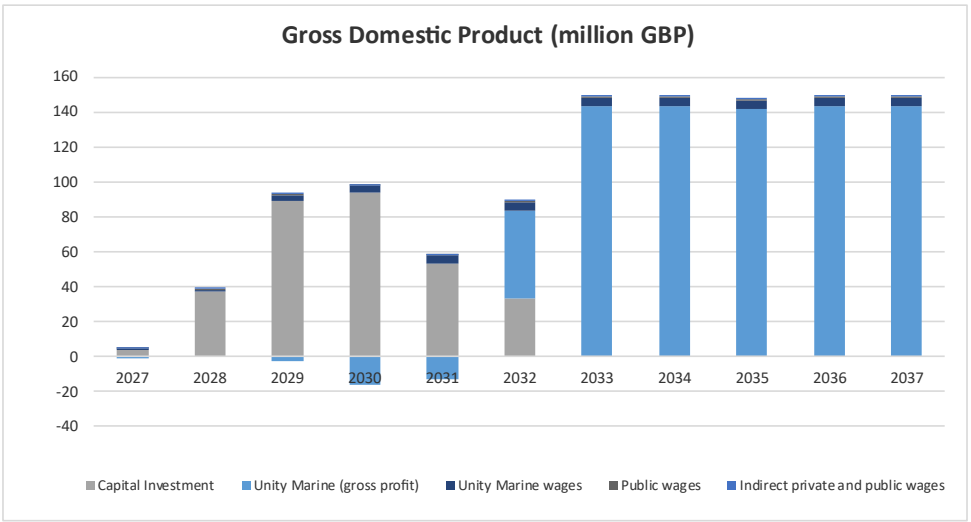


Figure 57: Expected project contribution to the gross domestic product on the Falkland Islands.

As set out in Figure 6 above, the implementation of the suggested aquaculture business is expected to generate additional FIG revenues of around £26m in 2033. These would act to reduce and reverse the budgeted and extrapolated decline in reserves, the ratio and the headroom within 10 years although projections still remain significantly under the ratio and the headroom targets.

	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34
Opening Net Liquid Assets Balance	**254**	**203**	**158**	**141**	**114**	**113**	**105**	**88**	**69**	**72**
Total Operating Revenue	129	127	124	123	121	121	123	126	145	145
Operating Expenditure Departmental	(93)	(94)	(91)	(91)	(91)	(91)	(92)	(92)	(97)	(97)
Operating Expenditure Other	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)
Net Capital Expenditure	(76)	(117)	(88)	(49)	(20)	(28)	(37)	(42)	(34)	(32)
External borrowing drawdown	-	50	50	-	-	-	-	-	-	-
Closing Net Liquid Assets	**203**	**158**	**141**	**114**	**113**	**105**	**88**	**69**	**72**	**78**
In year movement in net liquid assets	**(51)**	**(45)**	**(16)**	**(28)**	**(1)**	**(8)**	**(17)**	**(19)**	**3**	**6**
Operating Expenditure Departmental	(93)	(94)	(91)	(91)	(91)	(91)	(92)	(92)	(97)	(97)
Addback recharges	18	17	17	17	17	17	17	17	17	17
Revised departmental expenditure	**(75)**	**(76)**	**(74)**	**(74)**	**(75)**	**(75)**	**(75)**	**(76)**	**(80)**	**(80)**
FIG liquidity ratios										
Ratio	2.7	2.1	1.9	1.5	1.5	1.4	1.2	0.9	0.9	1.0
Headroom	90	43	30	2	1	(8)	(25)	(45)	(48)	(42)
Headroom with insurance	110	63	50	22	21	12	(5)	(25)	(28)	(22)

Table 9: Extrapolation of FIG budgeted reserves with a salmon project as suggested by Unity Marine. Notes: red = projections assume unchanged levels of operating revenue (except investment income which is linked to reserve levels), departmental expenditure, other expenditure and recharges in years 6 – 10, blue = capital expenditure based on the 10 year capital budget plus expected port loan repayments of £11m per annum, green = FIG salmon revenues are as projected elsewhere in the report with an estimated 25% cost of collecting the revenues.

From the table above it can be observed that in 2033/34 the comparison to the position without salmon income as shown in section 6.5 is as follows:

2033/34 comparison	No Salmon income	Salmon income	Difference
Closing net liquid assets	£28m	£78m	+£50m
In year movement in net liquid assets	(£17m)	£6m	+£23m
The ratio	0.4	1.0	+0.6
Headroom without insurance	(£84m)	(£42m)	+£42m
Headroom with insurance	(£64m)	(£22m)	+£42m

Table 10: Comparison of future FIG economic position with and without a salmon farming industry in 2033/34.

10 Environmental impact considerations

Since the start of the project multiple environmental concerns have been raised in community, both from Members og the Legislative assembly, other industries, environmental groups and the broader public.

Among the topics raised are the following:

- Escaped salmon will establish themselves on the Falkland Islands
- Escaped salmon will impact fisheries
- Discharge of nutrients and organic matter
- Visual impact of the sea sites
- Impact of sea lice on the fish
- Disturbing local wildlife

Many of the concerns were already addressed by inclusion of mitigation strategies in the original project proposal. In the following chapters potential vectors of environmental impact is briefly described, as well as Unity Marine's intended mitigation strategies to minimize said impact.

After the project proposal was handed over to FIG in 2019, Unity Marine continued to work on the environmental aspects of the project. SAERI carried out the first step of a later anticipated EIA process by hosting an ENVIID workshop.

An ENVIID is a process of systematic identification of potential interactions between project activities/events and known receptors. An ENVIID workshop allows for detailed discussions between a multidisciplinary group of key project leaders, project engineers, and the assessment team on proposed operations, identification of receptors, identification of impacts of planned, unplanned and accidental events, and possible mitigations. Consideration is given to those areas that need further research or alternatively, can be screened out from further consideration in the EIA.

The ENVIID informs later process of identifying the requirements for a Current Environmental Baseline and subsequent identification of gaps (Gap Analysis) in the current knowledge and understanding of the environment.

10.1 Carrying capacity

The ecological carrying capacity of the inner Falkland Islands waters where the planned activities will take place will need to be determined. The ecological carrying capacity is defined as the magnitude of aquaculture production that can be supported without leading to unacceptable changes in species, populations, communities or the broader environment.

The main determination of the carrying capacity is usually associated with the effluent from the farm sites in the form of nitrogen, phosphorous and organic matter, whereas impacts on birds, mammals and other wildlife are usually manageable. In waters with adequate dispersal currents the organic matter only affects a smaller area of up to 500 m from the net pens, therefore the bottom below the pens will be affected. This impact can usually be reversed by implementing a strategy for proper fallowing.

It is difficult to determine the exact carrying capacity on paper without running extensive deposition, current and wave models. The models must be based on a combination of in-situ measurements, weather data and topographic maps of the area in question. It is also necessary not only to model dispersion from

one farming site but to include data from multiple sites if more than one site is in operation. This ensures that potential overlapping effects will be caught in the models. Detailed modelling work is planned to be carried out in a later EIA stage, as it is also the custom in other jurisdictions.

Production in some different regions or countries has been compared with the suggested production in the Falkland Islands. It should be emphasized that this is a very crude way of establishing a potential carrying capacity but does provide some guidelines for limits of production. As can be seen, the suggested production is lower per km^2 of territorial water than for similar areas in the North Atlantic. It is important to state that Unity Marine does not consider the 50,000 tons to be the carrying capacity of the inner Falkland waters, the 50,000 tons is set as the minimum viable project size on the Falkland Islands. The carrying capacity is perceived to be considerably larger.

Area/ Country	Country area	Territorial water area	Production	Production per km^2	Production per territorial water area
Faroe Islands	1,200 km^2	11,552 km^2	90,000 tons	75.00 tons/ km^2	7.79 tons/ km^2
Shetland Islands	1,467 km^2	12,214 km^2	39,358 tons*	26.48 tons/ km^2	3.22 tons/ km^2
Orkney Islands	523 km^2	7,198 km^2	18,786 tons*	35.92 tons/ km^2	2.61 tons/ km^2
Norway	385,207 km^2	143,707 km^2	1,479,000 tons	3.84 tons/ km^2	10.29 tons/ km^2
Falkland Islands	12,000 km^2	36,624 km2	50,000 tons**	4.16 tons/ km^2	1.37 tons/ km^2

*Table 11: Comparison between different farming regions land area, territorial waters and production. *2022 figure from Appendix 3 - Scottish Fish Farm Production Survey 2022 - gov.scot ** suggested by Unity Marine*

As part of the current work commissioned by FIG on socio-economic impacts from the establishment of a potential salmon industry on the Falkland Islands, MEP and Hatch have included modelling of nutrient discharges in the work. These models will give a better understanding of the actual carrying capacity of the water bodies surrounding East Falkland. Unity Marine have provided collected data of currents and waves at five (5) sites to increase the precision and accuracy of the modelling work.

10.2 CO_2-emissions

The company's activities will entail use of fossil fuels with subsequent CO_2-emissions through hatchery, vessel, and road-based activities. Unity Marine will use modern vessels and equipment as well as renewable energy sources to reduce the carbon footprint of the activities. Phase II of the project will include a detailed calculation of diesel use for the different proposed activities.

In a 2009 report issued by the Norwegian "The Fisheries and Aquaculture Industry Research Fund" (FHF), it was found that one (1) kg of farmed salmon fillet that is eaten in Paris gives a CO_2-equivalent of around 2.5. The carbon footprint for salmon farming is thus far lower than for cattle production, which emits approximately 30 CO_2-equivalents per kilogram. Pork production has a CO_2-equivalent of around 5.9. It was also found that 95% of the CO_2-emissions associated to salmon farming were found to be related to the

production of fish feed[32]. The substitute of fish meal with plant-based feed ingredients and general improvements and focus on low emission equipment and motors have lowered the carbon footprint of the production since the report was issued.

Statistics on CO_2 and other Green House Gas emissions will be submitted to FIG; predicted emissions will be determined within the EIA.

The company will use the following mitigation strategies to lower the emission from fossil fuel use:

1. Design of a system with low energy usage
2. Re-use of heat from plant operations (e.g. oxygen generators) to heat the production water
3. Use of equipment using IE3 or IE4 standard (increased efficiency)
4. Use of IE3 or EI4 generator (reduced fuel usage)
5. Use of renewable energy sources to cover some of the power use
6. Facility will be well insulated.
7. Use hybrid feed barges with battery back-up.

10.3 Discharge of nutrients

Discharge of nutrients in the form of nitrogenous compounds, phosphorous and organic matter can influence trophic characteristics of the marine environment and lead to eutrophication of water bodies. Discharge of nutrients can increase the algal production, influence the bottom fauna composition and distribution and subsequently disturb the secondary trophic levels in the ecosystem.

The actual impact will be determined by examining local factors such as current, natural nutrient availability, seasonality, etc.

In Norway and Scotland eutrophication of coastal waters where there is frequent water exchange is considered to pose negligible impact on the environment, while discharge in narrow, shallow low depth fiords can potentially be of concern. In Denmark that is surrounded by shallow marine areas with a large

There are a number of planned mitigations strategies that will be used to reduce the potential impacts from the discharge of organic matter and nutrients:

1. Placement of sites in areas with optimal current and thus dissipation nutrients.
2. Frequent fallowing.
3. Use of high-quality feed.
4. Feeding behaviour monitoring.
5. Monitoring of seabed nutrient loading.
6. Monitoring of seabed fauna development.
7. Explore the opportunities for using the entire discharge as fertilizer on nearby pastureland (from landbased production).

[32] Carbon footprint and energy use of Norwegian seafood products, SINTEF fisheries and aquaculture, December 2009

nutrient influx from all the countries surrounding the Baltic Sea, discharge of nitrogen is considered to have a potential significant impact on sea water, while phosphorous in general is not considered to have an effect.

Actual effect of nutrient discharges will therefore have to be established during the EIA process and needs to take local conditions into account. Potential effects will be a result of local conditions hereunder current nutrient compositions, current patterns and planned seasonal production.

10.3.1 Organic matter

Organic matter will be produced in the hatcheries and sea-based facilities either as mortalities, fish faeces, or uneaten feed. Breakdown of organic matter consumes oxygen, therefore managing such organic waste is a critical aspect to maintaining fish health.

Hatchery derived organic waste will be collected and could be made available to the farming community as fertilizer and/ or for soil improvement. The Falklands Landholdings Corporation have expressed interest in using the organic waste as fertilizer due to its N and P content[33].

At the sea sites the organic matter will dissipate in the water column dependent on the current at the site. Close to or below the site some organic matter will accumulate. The accumulation of organic matter can influence the benthic fauna by altering the food web for detritus and/or filter feeders and through the use of oxygen by microorganisms in sediments.

10.3.2 Nitrogen

In fish farming nitrogen is a metabolic product from feed digestion. The fish will either store the Nitrogen incorporated as building blocks into the fish or is excreted over the gills as Ammonia (NH_3), which will quickly transform Ammonium (NH_4^+). The equilibrium between ammonia and ammonium is heavily pH dependant at natural pH ammonium is the predominant form.

In the hatchery the ammonium and ammonia will be transformed to Nitrate (NO_3^-) in the facility's biofilters. Nitrate will thus be the main discharge constituent.

In the net pens at sea the nitrogenous discharge will primarily be in the form of Ammonium. Nitrifying bacteria will transform the ammonium to nitrate in time. The transformation rate will depend on natural conditions, especially temperature.

Nitrogen in the form of Nitrate and to a lesser extent ammonia/ ammonium can be taken up by microalgae or macroalgae.

Nitrogen is usually the limiting factor for algae growth in near shore marine ecosystems. Nutrients availability in inner Falkland waters will have to be mapped to gain understanding og local nutrient dynamics and potential impact from discharge of nitrogens.

[33] Personal communication, Andrew Pollard, General Manager, Falkland Landholdings Corporation, 2019

10.3.3 Phosphorus

In fish farming Phosphorous is fed to the fish primarily through the feed lipid content. They will incorporate phosphorous in lipids used in cell walls, lipids, skeletal formation and is used in the cell energy transfer. Usually 70-85% of dietary P, is excreted as phosphate (PO_4^{3-}), much of the excreted phosphate will be primarily particle bound.

Phosphorous is usually the limiting factor for algae growth in freshwater systems. As Unity Marine is not planning operations in or discharge to freshwater bodies the effect of phosphorus discharge is likely limited.

10.4 Vessel traffic

The company is planning to operate a number of vessels used to transport personnel, fish and supplies as well as performing maintenance work, repairs and installation of the sea-based structures. The company activities will also see the use of a specialized processing ship that will be used to harvest and process the fish at the net pens.

Vessel traffic can potentially lead to a number of impacts on the environment. The following planned impacts have been identified:

1. CO_2-emissions
2. Noise
3. Lights

The following accidental impacts have been identified:

1. Erosion of coastal areas from stern waves
2. Wildlife strikes
3. Chemical spills
4. Fuel spills
5. Vessel strikes of other boats
6. Vessel sinking

Albeit the potential impacts are well understood in the Falkland Islands, that already has some near shore vessel activity, they will still have to be quantified and qualified in the EIA process.

10.4.1 Wildlife strikes

Marine mammal responses to vessels can be variable and range from avoidance at long distances to little or no response on approach, or indeed vessels can attract some marine mammals. Risk of vessels striking marine mammals will depend on location, season, and vessel behaviour. Strikes can cause minor injuries to marine mammals, sub-lethal injuries, or death.

The company's main mitigation strategy is to lower sailing speed to allow wildlife to react to approaching vessels.

Any vessel sailing in waters that has known populations of marine mammals will need to follow the following rules to reduce risk of wildlife strikes:

1. Reduce sailing speed of vessels when in areas with frequent marine mammal activity.
2. Reduce sailing speed if congregations of whales, dolphins or other mammals are observed, and include seasonality in the Vessel Management Plan.
3. Employ a Vessel Management Plan, developed by the Fleet Manager.

In order to reduce the likelihood of bird strikes the following mitigation strategies:

1. Minimize sailing during night-time.

10.5 Road traffic

Increased road traffic will in itself present a potential impact on the environment through fossil fuel burning and increased noise and lights from night activities. The traffic can consist of both moving personnel in light vehicles as well as trucking of supplies or building materials.

The following impacts have been identified through planned activities:

1. CO_2-emissions
2. Noise
3. Lights

The following potential accidental impacts have been identified:

1. Bird or wildlife strikes
2. Sheep or cattle strikes

As the traffic will take place on already existing roads, the potential impacts are thought to be quantifiable and qualifiable, but will still need to be screened in the EIA process.

10.6 Construction activities

Construction and installation of the company's facilities on land and at sea can potentially impact the environment through many of the same paths as the operational activities. The construction period will see the employment of heavy machinery to prepare the site, move backfill, erect the building and through movement of goods from the port of arrival or quarries to the sites.

The following planned impacts have been identified:

1. CO_2-emissions
2. Noise
3. Lights
4. Waste generation backfill and soil
5. Waste generation building materials

The following accidental impacts have been identified:

1. Fuel spills
2. Chemical spills
3. Loss of building materials due to extreme weather conditions

10.7 Lights

Lights can disturb the wildlife by either attracting, repelling or disturbing animals and thus change the patterns of the of the animals.

All light sources can be said to fall in the planned impact category and can come from the following sources:

1. Cars or trucks
2. Vessels
3. Heavy construction machinery (in construction phase)
4. Construction light (in construction phase)
5. Outdoor work lights on the land-based hatchery, warehouses and harbour facilities
6. Work lights on feed barges
7. Buoy markings
8. Underwater lights (No plan to use in the project)

To mitigate potential impacts from light the company will:

1. Install light proof curtains in connection with windows installed in the administration-, office- and staff facilities, if light shows to be affecting the wildlife.
2. Only turn on outdoor light, when human activity outside the production facilities is required.
3. Use directional lighting.
4. Generally, only perform service operations during daylight hours.
5. Avoid the use of underwater lights in net pens.

10.8 Noise

Noise can disturb the wildlife by either attracting, dispelling or disturbing animals. Noise can either be in the form of a sudden loud or constant noise.

Ship noise, through masking, can reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time. In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking. Noise could also be a potential source of stress for marine mammals.

All noise sources can be said to fall in the planned impact category, the following potential sources have been identified:

1. Cars or trucks
2. Vessels traffic
3. Heavy construction machinery (in construction phase)
4. Equipment at land-based facilities (ventilators, generators, pumps, etc.)
5. Machinery on feed barges
6. Vessel machinery used during operational procedures

To mitigate potential impacts from noise the company will:

1. Use insulated buildings in general, which gives a very good noise protection.
2. Compressors will be established in special noise protected rooms or in individual noise cabinets.
3. Carefully select the establishment sites of the facilities, in order to avoid conflicts with breeding grounds or nesting areas.
4. Sailing routes planned to avoid sensitive areas.
5. No use of marine mammal acoustic deterrent devices.
6. Placement of noisy equipment inside feed barge or vessel.

10.9 Odour

The activities can result in odour escaping the facilities. The generation of odour will primarily stem from the ensiling process of the mortalities and potentially from the manure generated at the land-based facilities.

10.10 Water use

The land-based facilities will rely on the ability to draw new fresh water all year round.

The company wishes to use RAS technology on the land-based hatcheries, which results in a water usage approximately 30-fold below traditional flow through facilities. Each of the hatcheries is thus only planned to use a maximum of 35 l/s.

The drawing of water will be planned to have minimal impact on the streams and ponds supplying the water. This is done by not pumping directly from the water source, but through gravitational in seeping through the ground to the pump sump.

Digging of trenches for drainpipes around the streams and the ponds will need to be planned to avoid disturbing plants and bird nesting sites. This will be assessed in the EIA.

It has also been planned to use solar or wind with battery backup to drive the pumps in to avoid potential spill of diesel from generators into the water bodies.

10.11 Waste disposal

Like any other commercial activity, the company will generate waste in the form of plastic, paper, cardboard, metals and other non-toxic materials. During the construction phase there will be waste generation of excess building materials, pipe cut offs, wood, plastic and other materials normally associated with the erection of an industrial type building.

The operations will also see waste generated in connection with the collection and silage of fish mortalities. The silage can either be further processed to fertilizer locally used directly as animal feed or fertilizer.

The facilities on land and the feed barges will also generate human sewage. The sewage from the land-based facilities will collected in septic tanks and the effluent will be led to a septic drain field. The septic tanks will be emptied for solids, when required. The sewage generated on the feed barges will be collected and stored on the barge until collected by a service vessel and brought to shore for processing in the land-based systems septic tank. The final setup of sewage disposal will be discussed with FIG.

The volumes of all waste produced will be assessed and compared to the current capacity of dealing with waste in the Falklands.

To mitigate potential impacts from waste disposal the company will:

1. Collect and separate the waste disposal according to the local guidelines.
2. The employees will be trained in proper waste handling and sorting procedures.
3. Secure that waste disposal is stored securely, in order to avoid that wildlife can get contact to the waste disposal, and to avoid the disposal to be spread by wind or wildlife.

10.12 Escape of stock

Aquaculture will like any animal husbandry practice have a risk of escape of stock. Using the best available equipment and practices will however reduce the amount of escaped fish. Escaped fish can potentially affect the environment by competing with local species for food or breeding grounds, predate on other species or be eaten by local wildlife. Escaped fish can potentially also function as a pathogen carrier to areas that is not close to the rearing facilities.

The company will aim to eliminate the possibility of salmon escaping from the hatchery, during transfer of salmon to sea sites, and at sea sites. A wide array of mitigation strategies will be employed. One of the main mitigation strategies is to use either All-female or triploid stock or a combination of the two, this is specifically done to avoid establishment of a local breeding population.

All-female stock will in the lack of indigenous males be prevented from establishing a breeding population in the wild. Albeit some cross breeding with brown trout can occur, the offspring is usually sterile. Egg suppliers provide 100% conformity certificates on All-female eggs, therefore using all females will effectively mitigate the risk of establishing a local breeding population of Atlantic Salmon.

The use of sterile triploids is a relatively new practice in Atlantic Salmon aquaculture but have been used extensively in e.g. Rainbow trout aquaculture for the last 30 years. By using triploid salmon, the chance of any establishment of a breeding population is severely reduced. It will also be relatively easy to identify whether fish caught in the wild are from escaped stock, as the company's fish will have an extra set of chromosomes. Triploid fish are generated by applying pressure to newly fertilized eggs and does not employ the use of any chemicals, hormones or genetical treatment.

The facilities will be fitted with primary and secondary fish retaining systems to prevent escapes of the stock. Therefore, no escapes of stock are expected from daily operations of the land-based facilities.

It is important to note that the fish reared in the land-based systems will not be adapted to live in sea water before they have smoltified. Any fish escaping the system prior to the smoltification would thus die of in the sea in less than a couple of hours. The facilities are placed well away from any freshwater bodies, so escape of stock to rivers and lakes will be impossible.

In connection with transport of fish to the net pens, the fish will be pumped to the well boat. Smaller escape incidents can potentially occur from human errors or malfunction of equipment, like the unfastening or breakdown of a pipe. As the transfer of fish is constantly monitored by the personnel, any errors will be quickly observed, and proper actions will be taken to prevent larger escapes. It is therefore not anticipated that any escape incident would result in more than a few hundred escapees and only one or two incidents is expected yearly, when at full production. All flexible couplings or joints will also be encapsulated in nets to prevent escapes.

As the production is relying on sterile or all female fish, any escapees will not be able to create a breeding population in the wild.

To mitigate potential impacts from escapees the company will:

1. Facility will be designed to the standards set in NS 9416
2. Only use sterile or all female fish at all times, that cannot establish a wild population.
3. Periodic test of the eggs upon arrival for triploid compliancy
4. Hatchery fish will be isolated from entering freshwater systems. In the unlikely event that young hatchery fish are released into the marine environment, these fish will die from osmotic stress within minutes.
5. Use high quality- and well proven equipment in connection with transportation.
6. Carry out careful education of the staff in handling and transport of fish.
7. Design and build the system with primary and secondary fish retaining systems.
8. All fish tanks and pipes used to contain, or transport fish will be certified for such use.
9. The company will keep maintenance schedule and logs to secure equipment standards.

Furthermore, the company's mitigation strategies for avoiding damage on the nets consists of the following measures:

1. All net pen installations will be designed to meet the standards set in NS 9415
2. Installation of predator nets surrounding the net pens.
3. Extension of the predator nets above the water line.
4. Removal of potential mortalities part of daily routine.
5. Storing mortalities in the silage tanks on the barge.
6. Design to keep nets tight (increased weights) reducing potential seal/ sea lion ability to get to the stock and reducing risk of entanglement.
7. Regular cleaning of inner and outer nets for biofouling and reducing attractiveness to invertebrates and fish species.

10.13 Pathogens and parasites

Pathogens are always a threat in any form of animal husbandry operation. The threat is seen both in the direct association with production loss due to infected stock and a risk for lateral transfer to wild stock. The lateral transfer is primarily taking place between the produced species and wild stock of the same or closely related species. Pathogens found in the wild stock can likewise transfer to the farmed fish and result in outbreaks of disease in the net pens.

For example, Falklands mullet are known to have *Lepeophtheirus sp*., *Pseudoterranova sp*., *Contracaecum* and *Anisakis* sp. These are potential parasites of salmon with generally low host specificity. As the salmon are fed with extruded, and thus parasite free, feed external parasites are considered to have the highest risk of lateral transfer. Other local fish species are likely to be infected with parasites as well.

The following possible impacts have been identified. The impacts are all considered accidental.

1. Introductions of pathogen from outside the Falklands.
2. Spread of pathogens to wild fish populations
3. Company stock functioning as a pool for already present pathogens in the wild stock and thus increase the spread of already present pathogens or parasites
4. Discharge of medicines in connection with treatment of pathogens or parasites
5. Discharge of chemicals in connection with treatment of parasites

To mitigate potential impacts from spread of pathogens the company will:

1. Only import fish eggs and never hatched fish.
2. The supply of fish eggs, will only come from approved and certified closed containment breeding facilities.
3. The eggs will be disinfected upon arrival in the Falklands.
4. The land-based production facility is a closed indoor facility, established with bio-sluices at the entrances from outside and between the individual production units internally.
5. All fish will be vaccinated prior to movement to the sea.
6. The broodstock and ovarian fluid will be screened for all known diseases prior to shipment.

10.14 Chemicals

The company plans to use a number of different chemicals during the production at the land-based and sea-based production. Furthermore, the company will generate waste in the form of silage consisting of ensiled mortalities from the operation. Silage will in case of spills be degraded in nature due to the organic composition and is thus not likely to pose potential long-term impacts in case of spills.

The company is planning to use a number of chemicals in the production for buffering production water (NaOH, $CaCO_3$), ensiling mortalities (Formic Acid), anesthetize the fish (Benzoak vet.), disinfecting equipment (Iodofor™) and general cleaning procedures (detergents). All chemicals used on the land-based facilities in direct contact to the production water will be food grade and are considered safe to use for aquaculture purposes in Scandinavia and the UK.

To mitigate potential impacts from chemical spills from the activities the company will:

1. Any tank containing chemicals will be placed or installed so the full volume of the tank can be retained on site and the spill subsequently removed.
2. Due to the placement of the land based facilities ponds, lakes and streams cannot be contaminated from chemical spills, unless it involves spills from a traffic accident.
3. Only containers or tanks approved to hold any specific chemical will be used.
4. Any transfer of chemicals will be monitored closely be company personnel.
5. Train and educate the staff in how to handle the different chemical substances correctly as described in the company chemical management plan.
6. Develop safety procedures for the transfer of chemicals to the barge or removal of silage from the barge.
7. In case of breakdown of a tank the spill will be pumped from the spill tank into the supply vessel and brought to shore for safe disposal.
8. The company will use food grade oil wherever possible to reduce impacts from potential spills.

10.15 Fuel spills

Fuel for vehicles, generators and vessels will be stored on land. Spill of marine grade diesel in connection with transferring fuel from one vessel to another or during bunkering in one of the company's service hubs can potentially lead to impacts on the environment. Breakdown of a fuel tank or sinking of a vessel can also potentially lead to a discharge of fuel.

To reduce the risk of fuel spills the company will employ the following mitigation strategies:

1. Any fuel tank will be placed or installed so the full volume of the tank can be retained on site and the spill subsequently removed.
2. Due to the placement of the facilities ponds, lakes and streams cannot be contaminated from fuel spills, unless it involves spills from a traffic accident.
3. Only containers or tanks approved to hold the fuel will be used.
4. Any transfer of fuel will be monitored closely be company personnel.
5. Train and educate the staff in how to handle the different fuel spill correctly.

10.16 Invasive species

Invasive aquatic species present a threat to the marine ecosystems, and shipping has been identified as a significant pathway for introducing species to new environments.

The Falkland Islands already have challenges with earlier introduced invasive species. Rats, earwigs and mice are examples of terrestrial invasive species on the Falkland Islands. In the marine environment, the North Atlantic ascidian Sea Vase (*Ciona intestinalis)* is another example of an introduced species. During the sea site investigations, the species was observed in several new areas around the Islands.

The Brown trout (*Salmo trutta*) is an invasive species that was purposely introduced on the Islands. While it is competing with the native Zebra Trout in some areas, it is at the same time highly prized by local anglers and protected under local legislation. Coho salmon (*Oncorhynchus kisutch*) have recently started to migrate to the islands from the South American mainland. It is however at present unknown whether there is a breeding Coho salmon population on the islands, albeit it is likely with the uptick in catches.

The company activities will see regular transports of goods, feed and product to and from the islands. Any vessel coming from an overseas destination can potentially transfer new species to the Falkland Islands. Unity Marine will strictly follow The International Ballast Water Convention to minimize the risk of introducing new species. Any ship that has been used for fish transport in other countries will also be disinfected prior to departure to the islands.

The company will bring in fertilized Atlantic Salmon (*Salmo salar*) eggs, that will be hatched and reared on the Islands. The introduction of the eggs could potentially introduce new fish pathogens to the islands, this risk is however mitigated by sourcing the eggs from closed bio secure facilities.

To mitigate the potential risk of bringing in invasive species the company will employ the following general strategies:

1. Any company vessel will be required to abide to the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM)[1]
2. Any third-party vessel contracted by the company will be required to abide to the BWM

10.17 Impact on wildlife from physical structures

The company's structures and installations can potentially displace or prevent wildlife from entering areas. Both the land-based facilities are planned to be constructed on rural farmland and will thus take up space where protected plant and animal wildlife currently occur.

The net pens will prevent animals from entering certain areas of the sea. Therefore, the sea sites will be planned to be positioned away from known major migratory routes of sea mammals or penguins, if any. The moorings will also take up some or the sea bottom potentially displacing wildlife from these small areas.

Entanglement of wildlife in the bird nets above the water and the nets, predator nets and moorings can also potentially present an impact fauna.

In order not to impair the movement of wildlife through the area the company is planning the following mitigation strategy:

1. Prior to placement of facilities, a survey of flora and fauna will be done such that important bird or plant areas are not impacted.
2. Placement of the net pen sites away from any known migratory route.
3. Placement of the net pen sites away from any known major feeding area.
4. Reduce footprint of anchors used for mooring the net pens and feed barge.

11 Table and figures

11.1 Figures

Figure 1: The envisioned hatchery at New Haven seen from the North. 12

Figure 2: The Falkland Islands. 13

Figure 3: Maximum and minimum sea water temperatures in a) Stanley, Falkland Islands, b) Tromsø, Norway, c) Isafjordur, Iceland and d) Torshavn, Faroe Islands 14

Figure 4: The pier in Stanley used to accept cruise ship passengers (left). Sheep rearing (right), one of the major business sectors on the Falkland Island. 17

Figure 5: Life cycle of Atlantic Salmon entails a juvenile freshwater phase. After a morphological change called smoltification the fish becomes a saltwater fish, and it is then ready to migrate to the sea. 19

Figure 6: Octagonal Grøntvedt cages in Frøya Edelfisk AS facility around 1970. 20

Figure 7: Steel cage system from the 1980s. 21

Figure 8: Hand feeding was very common in the 80's. (Picture from 1986, Bent Højgaard feeding fish). 21

Figure 9: Central feeding system in the 1990's. 22

Figure 10: Atlantic salmon producing countries of the World, and the individual salmon production figures for each country respectively in 2016. 23

Figure 11: Fish tanks in a salmon smolt production facility. 24

Figure 12: Medium size well boat with a 1,000 m^3 hold. 24

Figure 13: Modern sea farm including, net pens and a Feed barge with a central feeding system. 25

Figure 14: Proposed overall project schedule. The schedule details that the first eggs will be imported in August 2027 and the first harvest in end 2029. The company will reach full production in 2030. A pre-requisite is that the construction of the first land-based hatchery is commenced in August 2026. 33

Figure 15: The placement of the proposed activities in phase IIIa. A total of eight (8) sea sites on the east coast of East Falkland will be installed as well as the land-based hatchery at Mare Harbour. 37

Figure 16: The placement of the proposed activities in phase IIIb. A total of eight (8) sea sites along the west coast of East Falkland will be installed as well as the land-based hatchery at New Haven. 38

Figure 17: Schematic drawing of one of the facilities for smolt rearing. Based on site investigations the facilities will be built on two separate plots at Mare Harbour and New Haven. All measurements are given in millimetres. 40

Figure 18: Location of the land- based site investigations conducted in November 2018. Based on the site investigations Mare harbour and New Haven was chosen. These sites have been marked in dark blue. 42

Figure 19: Planned land-based site East of Mare Harbour. The water is planned to be drawn from the pond close to the site and back up water can be sources from East Cove Pond. 43

Figure 20: Planned land-based site at New Haven. The water is planned to be drawn from the three streams at Dos Lomas. Pipe is planned to be put down next road. There is also an identified need for an additional wharf at New Haven. 44

Figure 21: CompHatch hatching system installed at smolt facility in Norway. 45

Figure 22: Tank room in newly built salmon RAS farm in Norway. The facility was designed by Pisco ApS, Denmark. 46

Figure 23: Drumfilters installed in a RAS facility in Norway. 47

Figure 24: Degassing unit in Norwegian Salmon RAS farm. This degasser is constructed with diffusors spaced out in a sump at relatively low depth (0.8m). 47

Figure 25: Render of the planned facility at New Haven. 49

Figure 26: The Atlantic Sapphire facility in Dade County, Florida, USA as of September 2023. The first phase has been completed and is in production (right), while the construction of the next phase facilities is still in various phases of construction (left). 51

Figure 27: Choiseul Sound a sheltered 20 km long water body south of Stanley on East Falkland. The Sound is thought to be able to contain at least 4 sites for salmon production. Depths indicated are in meters. Choiseul Sound was also mentioned as a possible site for Salmon aquaculture after the trial is Fox Bays in the 80's. It was suggested that the sound could easily contain 12-15 sites, albeit of smaller size. 58

Figure 28: Sea site with ten (10) net pens, feed barge and service boats. 59

Figure 29: The net pen setup that is to be employed by Unity Marine. The inner net will contain the fish and the outer net will provide predator protection. The predator net is raised three (3) meters above the outer rim of the pen to provide protection for the employees from sea mammals. Bird netting will be fitted from flexible posts from the outer rim of the pen. 59

Figure 30: Cross section schematic of the net pens. The inner net containing the fish (3) will extend to 17 m below the water line, while the predator net (4) will extend to a depth of 22m. This ensures that the inner net will never be in contact with the predator net even in rough sea conditions. The predator net is extended above the water line on the outside of the pen, ensuring that marine mammals cannot get into the net while creating a safe working platform surrounding the nets (1). A bird net (2) will be suspended over the net pen from flexible poles attached to the outer rim. All sites are placed with a minimum water depth of 30m above the bottom (5) giving a freeboard of at least 8 m below the predator net. The moorings (6) will keep the net pens in place. The mooring system will be designed with focus on wave and current exposure at the specific site. 60

Figure 31: The 35 pre-identified sites around East Falkland. Five (5) sites were found to be too exposed or were placed inside a military zone (red). The remaining 30 sites have been found to be potentially suitable (blue). The sixteen (16) sites that are currently planned to be utilized are marked with a cross. 61

Figure 32: The identified sites in southern part of Falkland Sound and Eagle Passage (Ruggles Bay region). Two sites were found to be too exposed and has therefore been marked with red. The sites would be serviced out of New Haven. 62

Figure 33: The identified sites in the middle of Falkland Sound (Main passage region). All identified sites in the region have currently been found suitable, however three (3) sites were placed in a military area and therefore been marked with red. The sites would be serviced out of New Haven. 62

Figure 34: The identified sites in the Northern part of Falkland Sound (Grantham sound region). All identified sites in the region have currently been found suitable. The sites would be serviced out of New Haven. 63

Figure 35: The identified sites in Bay of Harbours (Bay of Harbours region). All identified sites in the region have currently been found suitable. The sites would be serviced out of Mare Harbour, but it is not currently being planned to use the sites. 63

Figure 36: The identified sites in Adventure Sound (Adventure Sound region). All identified sites in the region have currently been found suitable. The sites would be serviced out of Mare Harbour. 64

Figure 37: The identified sites in Choiseul Sound (Choiseul Sound region). All identified sites in the region have currently been found suitable. The sites would be serviced out of Mare Harbour. 64

Figure 38: Visual representation of a sea site seen from five (5) km on a clear day with an air humidity of 0% (no visual impediment). 65

Figure 39: AKVA group ASA feed barge with 650 tonnes feed storage capacity. A) Feed silo hatch for filling of silo. B) Feed silo. C) Feed doser. D) Automatic feed system distributor valve. E) Brigde with overview over the site and access to the central control system. F) Crew quarters. G) Crane for minor service and maintenance duties 67

Figure 40: Rotor spreader installed in a net pen. 69

Figure 41: Proposed routes for personnel transfer on the East coast of East Falklands, distance to the potential sites in nautical miles and estimated travel time at ten (10) knots. 72

Figure 42: Proposed routes for personnel transfer on the West coast of East Falklands, distance to the potential sites in nautical miles and estimated travel time at ten (10) knots. 73

Figure 43: The well boat Ronja Commander, which is similar in size to the one suggested to be used in the project. 77

Figure 44: The fish pellet carrier MS Høydal operated by Biomar in Norway. The vessel is powered by liquid natural gas (LNG) reducing CO_2 emissions by 25% compared to a similar diesel driven vessel. The loading capacity is 2,200 tons. 78

Figure 45: The Norwegian Gannet, a Danish/ Norwegian vessel used for stunning, bleeding and gutting Norwegian produced salmon. Norwegian Gannet has a capacity of 1,000 tonnes per trip. The vessel will harvest around the Norwegian island of Hitra and export directly to a dedicated processing facility in Hirtshals, Denmark. The sailing distance from Hitra to Hirtshals is similar to the distance from Stanley to Punta Arenas. 80

Figure 46: Number of FTEs stemming directly from the company activities. 81

Figure 47: Expected employment in Unity Marine's different business segments. 82

Figure 48: Average number of temporary workers on the islands every day. This number equals the need for temporary accommodation (Hotels, self-catering or rented short term accommodation). 84

Figure 49: Number of FTEs stemming directly from the company activities. 88

Figure 50: Expected spatial distribution of new jobs and the expected category they fall under. Approximately half of all positions will be offshore rotational workers. 89

Figure 51: Additional return flights expected on a weekly basis from project activities. 93

Figure 52: Additional return flights expected every year from project activities. 93

Figure 53: Estimated needs for new homes on the Falkland Islands. 96

Figure 54: Render of the new planned wharf at New Haven with docking well boat. 98

Figure 55: Estimated needs for accommodation on the Falkland Islands given in average daily accommodation needs. 101

Figure 56: Expected revenues FIG tax revenues from company activities. 102

Figure 57: Expected project contribution to the gross domestic product on the Falkland Islands. 102

11.2 Tables

Table 1: Extrapolation of FIG budgeted reserves with current trajectory. Notes: red = projections assume unchanged levels of operating revenue (except investment income which is linked to reserve levels), departmental expenditure, other expenditure and recharges in years 6 – 10, blue = capital expenditure based on the 10 year capital budget plus expected port loan repayments of £11m per annum. 18

Table 2: The chemicals planned to be used in the land-based operation. 57

Table 3: Treatments used in Norwegian aquaculture and extrapolated use in the project – assuming the same health standards are maintained on the Falkland Islands. 74

Table 4: Planned use of chemicals on the sea sites. 75

Table 5: Main dimensions and characteristics for the well boat “Ronja Commander” owned and operated by Søvltrans AS, Norway. 76

Table 6: Need of labour for both hatchery facilities. Each facility will have a yearly production of approximately 6 million smolt. 83

Table 7: Number of expected employees on the sea sites. 84

Table 8: Total expected number of flight seats occupied by the project activities. 92

Table 9: Extrapolation of FIG budgeted reserves with a salmon project as suggested by Unity Marine. Notes: red = projections assume unchanged levels of operating revenue (except investment income which is linked to reserve levels), departmental expenditure, other expenditure and recharges in years 6 – 10, blue = capital expenditure based on the 10 year capital budget plus expected port loan repayments of £11m per annum, green = FIG salmon revenues are as projected elsewhere in the report with an estimated 25% cost of collecting the revenues. 103

Table 10: Comparison of future FIG economic position with and without a salmon farming industry in 2033/34. 103

Table 11: Comparison between different farming regions land area, territorial waters and production. *2022 figure from Appendix 3 - Scottish Fish Farm Production Survey 2022 - gov.scot ** suggested by Unity Marine 105

12 Appendixes

The following is a list of all appendixes to this report:

- **Appendix A:** Environmental Considerations Desktop Study
- **Appendix B:** Socio-Economic Impact Considerations
- **Appendix C:** Land-based site investigations
- **Appendix D:** Fresh water sampling results
- **Appendix E:** Falkland Power Facility, Sweco
- **Appendix F:** Site suitability report
- **Appendix G:** SAERI cruise Report
- **Appendix H**: Aquaculture Wave and Current Feasibility Study
- **Appendix I:** Service vessels
- **Appendix J:** Sea site equipment
- **Appendix L:** List of procedures
- **Appendix N:** Business plan
- **Appendix O:** Policy Considerations



Unity Marine – Environmental Considerations Desktop Study

APPENDIX A

UPDATED JANUARY 2026, V.2.1

1 Content

1 Content 1
2 Executive summary 5
2.1 Updated Appendix 6
3 Document Scope 7
4 Glossary 8
5 Salmon biology 9
5.1 Salmon biology in the wild 9
5.2 Distribution in the wild 9
5.3 Historical introduction *of Salmo salar* on the Falkland Islands 10
6 Environmental considerations for proposed Salmon farming in the Falklands. 11
6.1 CO_2-emissions 11
6.2 Discharge of nutrients 12
6.2.1 Organic matter 12
6.2.2 Nitrogen 12
6.2.3 Phosphorus 13
6.3 Vessel traffic 13
6.3.1 Wildlife strikes 13
6.4 Road traffic 13
6.5 Construction activities 14
6.6 Lights 14
6.7 Noise 15
6.8 Odour 15
6.9 Water use 15
6.10 Waste disposal 15
6.11 Escape of stock 16
6.12 Pathogens and parasites 16
6.13 Chemicals 16
6.14 Fuel spills 17
6.15 Invasive species 17
6.16 Impact on wildlife from physical structures 17
7 Certifications and Management Plans 19
7.1 Aquaculture Stewardship Council 19

7.2 Freedom food standard 19
7.3 NS 9515:2021 20
7.4 BWM 21
7.5 Management Plans 21
8 Environmental impact Hatchery 22
8.1 CO_2-emission 23
8.2 Discharge of nutrients 24
8.2.1 Nutrients produced 25
8.2.2 Nitrogen discharge 26
8.2.3 Phosphorous discharge 26
8.2.4 Organic material 27
8.2.5 Mitigation strategies 28
8.3 Road traffic 28
8.4 Noise 28
8.5 Light 29
8.6 Odour 29
8.7 Water use 29
8.7.1 Mare Harbour 30
8.7.2 New Haven 31
8.8 Waste disposal 32
8.9 Escape of the stock 32
8.10 Pathogens 33
8.11 Chemical spill 34
8.11.1 Planned use of chemicals 34
8.11.2 Chemical spills 35
8.11.3 Treatments 35
8.12 Fuel spill 36
8.13 Impact on wildlife from physical structures 36
8.14 Invasive Species 37
9 Environmental impact Sea Sites 38
9.1 CO_2-emission 39
9.2 Discharge of nutrients 39
9.2.1 Nutrients produced 41

9.2.2 Nitrogen discharge 42
9.2.3 Phosphorous discharge 43
9.2.4 Organic material 44
9.2.5 Mitigation strategies 45
9.3 Noise 46
9.4 Light 47
9.5 Vessel traffic 47
9.5.1 Coast erosion 51
9.5.2 Wildlife strikes 51
9.5.3 Chemical spills 52
9.5.4 Fuel spills 52
9.5.5 Vessel strikes of other boats 52
9.6 Waste disposal 52
9.7 Escape of stock 53
9.7.1 Predator attacks 54
9.7.2 Extreme weather 55
9.7.3 Mechanical malfunction 55
9.7.4 Vessel strikes 56
9.7.5 Human errors 57
9.8 Pathogens 57
9.8.1 Spread of pathogens 57
9.8.2 Bacterial infections 58
9.8.3 Fungal infections 59
9.8.4 Viral infections 59
9.8.5 Parasites 59
9.8.6 Treatments 60
9.8.7 Mitigation strategies 62
9.8.8 Medicine 63
9.9 Chemical spills 63
9.10 Fuel spills 65
9.11 Impact on wildlife from physical structures 65
10 Processing ship and feed pellet carrier 67
10.1 Feed Carrier 67

10.2 Processing vessel 67
10.3 Risks and mitigation 67
11 Harbour/ wharf activity 69
12 Appendix A: Table and figures 71
12.1 Figures 71
12.2 Tables 72

2 Executive summary

The environmental impacts related to development of the proposed aquaculture business on the Falkland Islands have been analysed, and the following key points have been established:

1. This document contains an overview over identified potential environmental impacts and general Company strategies to mitigate these impacts. Further mitigation strategies will be developed if additional potential impacts are identified in the future.

2. The identified impacts and mitigation effects on these impacts will be qualified in later EIA work any estimation of perceived concrete impacts is thus not included in this document.

3. The Company will operate according to the best standards in the industry and will develop an extensive list of procedures and management plans to be followed by the employees. Unity Marine will also focus on transparency and will present collected environmental data to the public.

4. Unity Marine will work to be certified to the Aquaculture Stewardship Council (ASC) standard, that is currently considered the most far-reaching Environmental Standard within Salmon Aquaculture. The ASC standard has extensive provisions for the protection of the marine environment.

5. The company will employ the Norwegian Standard NS:9415 for the sea-based sites greatly reducing the risk of potential escape of the stock from the facilities operated by Unity Marine.

6. Any vessels operating in between the Falkland Islands and another country will abide to international standards to mitigate risks of introducing invasive species with ballast water or through other potential links.

7. Unity Marine will only use sterile fish in the production, mitigating the risk of establishing a breeding population of Atlantic Salmon on the Falkland Islands. All egg batches will be screened for known fish pathogens prior to shipment and will be disinfected upon arrival, mitigating the risk of introducing fish pathogens in the Islands.

8. Specific plans to mitigate risk of wildlife strikes or disturbance from lights and noise from vessel traffic has been developed but will need to be defined in Phase II of the project. The proposed net pen design has a proven track record in connection with avoiding bird or marine mammal entanglement from Tasmania but will have to be assessed in a local perspective.

9. Identified potential impacts like nutrient discharge will have to be modelled in the future and be evaluated against local base line data like limiting nutrient factor, before any potential impact can be determined.

10. It is suggested to handle the proposed upgrade of the harbour facilities at New Haven as a standalone EIA. The EIA would need robust modelling of hydrodynamic impacts from the activities and perceived impact on the environment.

11. Unity Marine is still convinced that the project can be carried out with minimal impacts on the environment. This is supported by MacAlister Elliott & Partners report that was issued on the behalf of FIG in 2021, where it was concluded; “With good management and strong regulatory framework, it should be possible to reduce the impacts of the negative outfall (both real and perceived) from salmon farming in the Islands to low levels.”

2.1 Updated Appendix

This appendix has been updated based on new findings related to the project, market developments and other general developments on the Falkland Islands.

The main change is linked to updated temperature assumptions based on measurements carried out by Unity Marine. Measurements that showed somewhat higher than expected temperatures in inner Falkland Islands waters. As Atlantic Salmon are a poikilothermic animal, the fish temperature reflects the surrounding water temperature. This in turn is reflected in the growth of the fish, that grows faster at higher temperatures.

Detailed monitoring of wave exposure and current at the proposed site in the intermediate years have also shown that preliminary findings of suitability of Falkland Islands inner waters for Salmon Farming were true.

The higher temperatures coupled with updated growth data from the egg supplier and genetics company Aquagen, Norway, has allowed Unity Marine to plan with faster growth of the fish, which in turn leads to shorter production time in the sea. As the number of required sea sites is coupled directly to the production time, Unity Marine has identified the potential to reduce the number of sea sites from 20 to 16, or a reduction of 20%. This is perceived to greatly reduce the footprint of the operation and will also have cascading impact on number of required employees and number of required vessels.

These updates are reflected in this report.

3 Document Scope

This document aims to broadly describe the possible environmental impacts from the introduction of a Salmon farming business on the Falkland Islands as described in the Project Description. The document also describes some of the planned mitigation strategies the Unity Marine will employ to reduce potential impacts on the environment. The document is not an Environmental Impact Assessment (EIA) and must not be seen as such. Future EIA work will detail comprehensive mitigation strategies and assess over-all environmental risk. An Environmental Impact Identification (ENVIID) workshop will identify any additional impacts not identified in this report prior to the EIA work, if any.

This document is not an exhaustive review, but rather seeks to create a baseline understanding of the potential impacts, which can form the basis for further work including:

1. Environmental Impact Identification workshop (ENVIID)
2. Detailed Environmental Baseline description
3. Data Gap Analysis
4. Environmental Impact Assessment (EIA) scoping
5. Environmental Impact Assessment
6. Public consultations

The appendix only describes the potential impacts of activities that presents a possible impact on the environment or that is not already covered by already existing businesses on the Islands.

The following activities has therefore intentionally been omitted from this Annex:

- The establishment of office facilities in Stanley
- Construction of housing and accommodations

The document functions as Annex A to the main Project description report

For this Annex, the South Atlantic Environmental Research Institute (SAERI) has been engaged to provide local context to potential impacts. Development of the future full EIA is planned to be carried out by SAERI. SAERI has however not been engaged to update the document.

4 Glossary

Broodstock: Parent fish

EIA: Environmental Impact Assessment

EIS: Environmental Impact Statement

Eyed egg: A fish egg containing an embryo that has developed enough so that the black spot of the eyes are visible through the egg membrane. Indicates that the egg is less sensitive to movement and can be handled safely.

Feed Conversion Rate (FCR): The amount of dry feed per kilo production ratio. The FCR differs between species and the size of the fish but also with abiotic factors like temperature and general water quality. It is also dependent on feed quality.

Hatchery: Facility used to hatch the eggs and rear the juveniles. Usually the term is used to describe a facility that takes the fish all the way through the smoltification process.

Net pen: Square or circular sea-based aquaculture construction consisting of a floating collar and a net that contains the fish. Disambiguation: Net cage, sea cage, open net pen

Nutrient: A nutrient is a substance used by an organism to survive, grow, and reproduce. In this document it is primarily used to describe the nutrients nitrogen and phosphorous discharged from the company's facilities.

Recirculated Aquaculture System (RAS): A system where the water is cleaned and reused several times before discharge.

Salmon: In this document salmon primarily refers to Atlantic Salmon (*Salmo salar*). If it relates to another species, the specific species will be mentioned.

Salmonid: Sub-family (Salmoninae) of Salmonidae which is a family of ray-finned fishes. Contains all trout, salmon and char species. Only Falkland species in the group is the Brown Trout (*Salmo trutta*). The Zebra Trout is not a real trout and is not closely related to salmonids.

Smolt: Term that describes a salmonid at the point where it has gone through the smoltification process and is ready to migrate from a fresh water body to sea.

Smoltification: A light and/ or temperature induced process where the young freshwater form of a salmonid goes through morphological change enabling it to live in sea water.

Triploid: Animal or plant with three (3) chromosomes in every pair. Triploids are usually sterile. Atlantic Salmon triploids are sterile.

Well boat: Specialised vessel used to transport live fish.

Yolk sac larvae: Newly hatched fish larvae that still carries the yolk sac. The larvae will typically not feed before the yolk sac has been fully consumed.

5 Salmon biology

5.1 Salmon biology in the wild

The Atlantic salmon is an anadromous species, that is, it spawns in freshwater streams, the adults return to sea and the young remain in fresh water for two (2) or three (3) years. When the fish are about 15 cm in length, the young salmon (smolt) will undergo a biochemical metamorphosis (smoltification) whereby the acquire the ability to osmoregulate in sea water. Once the metamorphosis has been completed, they will migrate to the sea where they will live for one (1) to four (4) years before returning to fresh water to spawn.

Juveniles that have not gone through the smoltification process will die of osmotic stress if they enter the sea. The smoltification process is induced by a combination of temperature and light stimuluses.

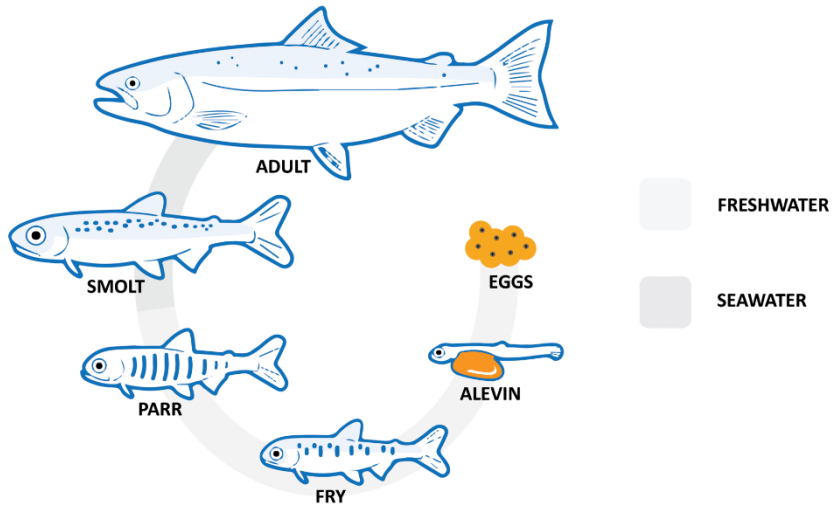


Figure 1: Life cycle of Atlantic Salmon entails a juvenile fresh water phase. After a morphological change called smoltification the fish becomes a salt water fish and migrates to the sea.

In Canada and Norway, Atlantic salmon spawn in October and December. The actual date depends on the region. Marine salmon move into estuaries and, thence, to fresh water in spring, summer, or early autumn, the approximate time being characteristic for each river. Normally the salmon return to the river where it was hatched, and in larger river systems to the specific part of the river where it was hatched. This is called homing. The mechanism behind this homing it is still not fully understood.

As the adults prepare for spawning, the head of the male undergoes transformation. The head elongates, and the lower jaw becomes enlarged and hooked at the tip. The actual nesting site is chosen by the female, usually a gravel-bottom riffle area above or below a pool. While the male drives off other males and intruders, the female, on her side, uses her caudal fin like a paddle and excavates a nesting depression. Adult female salmon can deposit from 1,100 – 1,500 eggs per kg of body weight. The eggs are usually a pale orange in colour and measure 5 – 7 mm in diameter.

5.2 Distribution in the wild

The Atlantic salmon occurs on both sides of the North Atlantic Ocean. In the eastern Atlantic it is found along the European coast from the White Sea, the coasts of Norway, Sweden, Denmark, and into the Baltic Sea, including Finland and Russia, southward around the British Isles and the coast of western Europe to the border region of Spain and Portugal (Mino River). It also occurs in Iceland. On the western side it ranges

from the Ungava Bay, Hudson and Davis straits, and southern Greenland southward in most rivers along the Labrador coast, Newfoundland, Quebec, and the Maritime Provinces to the Connecticut River.

The Atlantic salmon has established a range in Europe of between 40°and 70°latitude and in North America of 40° to 60° latitude.

The Atlantic salmon is adversely affected by increased acidity of spawning areas caused by acid precipitation. Reduction and/or loss of river stocks has been recorded for some Nova Scotia rivers and for many rivers in southern Norway and Sweden. Reduced breeding populations have also been seen from dam construction blocking migrating routes and from physical destruction of the spawning beds from straightening of rivers for drainage purposes or other human development activities.

5.3 Historical introduction *of Salmo salar* on the Falkland Islands

Atlantic Salmon was introduced on the Falkland Islands from the United Kingdom in 1960 (and possibly earlier as well) in an effort to establish a population for angling purposes. It did however not establish a breeding population on the Islands[1].

The species was again reintroduced for aquaculture purposes in 1986[2]. The farm was setup in Fox Bay and had a freshwater smolt production unit as well as small net pens in the sea. The fish were sourced from Stirling University in the United Kingdom. The trials were closed down in 1990 after having established that Atlantic Salmon grows very well in Falkland Islands waters, but the project was not financially viable[3]. It is not known whether any salmon escaped during the trials. There have however not been any reports on an established wild population in the area. From time to time Atlantic salmon is however caught by anglers on the Islands. These fish are thought to be migrating fish from either escaped reared salmon from Chile or "wild" salmon from one of the established populations in South America[4]. Some of these fish have however been identified as Coho salmon (*Oncorhynchus kisutch*) by genetic analysis, it is very likely that all the caught Salmon are this species as they are difficult to distinguish visually. Coho Salmon is a North American species of salmon that is well established in the wild in Patagonia.

Little is known on the previous attempt to establish a breeding population of Atlantic salmon on the Islands. It can therefore not be concluded that it will not be possible for a breeding Atlantic Salmon population to establish it-self in Falklands streams and rivers. Atlantic Salmon has however established itself in some rivers in Argentinian Patagonia from releases around the same time as the attempts on the Falkland Islands[5].

[1] International introductions of inland aquatic species, Welcomme RL, FAO, 1988.
[2] Falkland Island Newspaper, Nr 28, August 1986
[3] Verbal communication FIDC
[4] Personal communication Paul Brewin, SAERI
[5] International introductions of inland aquatic species, Welcomme RL, FAO, 1988.

6 Environmental considerations for proposed Salmon farming in the Falklands.

Potential environmental Impacts from the project can come in many forms. Escape of farmed fish, lateral transfer of pathogens, discharge of nutrients, light, noise and general increased human activity can all affect our surroundings and the environment.

Due to the variety of activities of the proposed activities in the project the single possible impacts for the different activities will be addressed under the following key considerations:

6.1 - CO_2 and other emissions
6.2 - Discharge of nutrients – from the production
6.3 - Vessel traffic
6.4 - Road trafficRoad traffic
6.5 - Construction activities
6.6 - Lights
6.7 - Noise
6.8 - Odour
6.9 - Water use
6.10 - Waste disposal
6.11 - Escape of stock
6.12 - Spread of pathogens
6.13 - Chemical spill
6.14 - Fuel spills
6.15 - Invasive species
6.16 - Impact on wildlife from physical structures

In this chapter the broad definitions of potential impacts from the different constituents are described. These are described in more detail in subsequent chapters.

6.1 CO_2-emissions

The company's activities will entail burning of fossil fuels with subsequent CO_2-emissions through hatchery, vessel, and road-based activities. Unity Marine will use modern vessels and equipment as well as renewable energy sources to reduce the carbon footprint of the activities. Phase II of the project will include a detailed calculation of diesel use for the different proposed activities.

In a 2009 report issued by the Norwegian "The Fisheries and Aquaculture Industry Research Fund" (FHF), it was found that one (1) kg of farmed salmon fillet that is eaten in Paris gives a CO_2-equivalent of around 2.5. The carbon footprint for salmon farming is thus far lower than for cattle production, which emits approximately 30 CO_2-equivalents per kilogram. Pork production has a CO_2-equivalent of around 5.9. It was also found that 95% of the CO_2-emissions associated to salmon farming were found to be related to the production of fish feed[6]. The substitute of fish meal with plant-based feed ingredients and general improvements and focus on low emission equipment and motors have lowered the carbon footprint of the production since the report was issued.

[6] Carbon footprint and energy use of Norwegian seafood products, SINTEF fisheries and aquaculture, December 2009

Statistics on CO_2 and other Green House Gas emissions will be submitted to FIG; predicted emissions will be determined within the EIA.

6.2 Discharge of nutrients

Discharge of nutrients in the form of nitrogenous compounds, phosphorous and organic matter can influence trophic characteristics of the marine environment and lead to eutrophication of some water bodies. Discharge of nutrients can increase the algal production, influence the bottom fauna composition and distribution and subsequently disturb the secondary trophic levels in the ecosystem.

The actual impact will be determined by examining local factors such as current, natural nutrient availability, seasonality, etc.

In Norway and Scotland eutrophication of coastal waters where there is frequent water exchange is considered to pose negligible impact on the environment, while discharge in narrow, shallow low depth fiords can potentially be of concern. In Denmark that is surrounded by shallow marine areas with a large nutrient influx from all the countries surrounding the Baltic Sea, discharge of nitrogen is considered to have a potential significant impact on sea water, while phosphorous in general is not considered to have an effect.

6.2.1 Organic matter

Organic matter will be produced in the hatcheries and sea-based facilities either as mortalities, fish faeces, or uneaten feed. Breakdown of organic matter consumes oxygen, therefore managing such organic waste is a critical aspect to maintaining fish health.

Hatchery derived organic waste will be collected and could be made available to the farming community as fertilizer and/ or for soil improvement. The Falklands Landholdings Corporation have expressed interest in using the organic waste sludge as fertilizer[7].

At the sea sites the organic matter will dissipate in the water column dependent on the current at the site. Close to or below the site some organic matter will accumulate. The accumulation of organic matter can influence the benthic fauna by altering the food web for detritus and/or filter feeders and through the use of oxygen by microorganisms in sediments.

6.2.2 Nitrogen

In fish farming nitrogen is a metabolic product from feed digestion. The fish will either store the Nitrogen incorporated as building blocks into the fish or is excreted over the gills as Ammonia (NH_3), which will quickly transform Ammonium (NH_4^+). The equilibrium between ammonia and ammonium is heavily pH dependant at natural pH ammonium is the predominant form.

In the hatchery the ammonium and ammonia will be transformed to Nitrate (NO_3^-) in the facility's biofilters. Nitrate will thus be the main discharge constituent.

[7] Personal communication, Andrew Pollard, General Manager, Falkland Landholdings Corporation

In the net pens at sea the nitrogenous discharge will primarily be in the form of Ammonium. Nitrifying bacteria will transform the ammonium to nitrate in time. The transformation rate will depend on natural conditions especially temperature.

Nitrogen in the form of Nitrate and to a lesser extent ammonia/ ammonium can be taken up by algae or marine plants and used to generate growth.

6.2.3 Phosphorus

In fish farming Phosphorous is fed to the fish primarily through the feed lipid content. They will incorporate phosphorous in lipids used in cell walls, lipids, skeletal formation and is used in the cell energy transfer. Usually 70-85% of dietary P, is excreted as phosphate (PO_4^{3-}), much of the excreted phosphate will be bound in particles.

6.3 Vessel traffic

The company is planning to operate a number of vessels used to transport personnel, fish and supplies as well as performing maintenance work, repairs and installation of the sea-based structures. The company activities will also see the use of a specialized processing ship that will be used to harvest and process the fish at the net pens.

Vessel traffic can potentially lead to a number of impacts on the environment. The following planned impacts have been identified:

1. CO_2-emissions
2. Noise
3. Lights

The following accidental impacts have been identified:

1. Erosion of coastal areas from stern waves
2. Wildlife strikes
3. Chemical spills
4. Fuel spills
5. Vessel strikes of other boats
6. Vessel sinking

6.3.1 Wildlife strikes

Marine mammal responses to vessels can be variable and range from avoidance at long distances to little or no response on approach, or indeed vessels can attract some marine mammals. Risk of vessels striking marine mammals will depend on location, season, and vessel behaviour. Strikes can cause minor injuries to marine mammals, sub-lethal injuries, or death.

6.4 Road traffic

Increased road traffic will in itself present a potential impact on the environment through fossil fuel burning and increased noise and lights from night activities. The traffic can consist of both moving personnel in light vehicles as well as trucking of supplies or building materials.

The following impacts have been identified through planned activities:

1. CO_2-emissions
2. Noise
3. Lights

The following potential accidental impacts have been identified:

1. Bird or wildlife strikes
2. Sheep or cattle strikes

6.5 Construction activities

Construction and installation of the company's facilities on land and at sea can potentially impact the environment through many of the same paths as the operational activities. The construction period will see the employment of heavy machinery to prepare the site, move backfill, erect the building and through movement of goods from the port of arrival or quarries to the sites.

The following planned impacts have been identified:

1. CO_2-emissions
2. Noise
3. Lights
4. Waste generation backfill and soil
5. Waste generation building materials

The following accidental impacts have been identified:

1. Fuel spills
2. Chemical spills
3. Loss of building materials due to extreme weather conditions

6.6 Lights

Lights can disturb the wildlife by either attracting, repelling or disturbing animals and thus change the patterns of the of the animals.

All light sources can be said to fall in the planned impact category and can come from the following sources:

1. Cars or trucks
2. Vessels
3. Heavy construction machinery (in construction phase)
4. Construction light (in construction phase)
5. Outdoor work lights on the land-based hatchery, warehouses and harbour facilities
6. Work lights on feed barges
7. Buoy markings
8. Underwater lights (No plan to use in the project)

6.7 Noise

Noise can disturb the wildlife by either attracting, dispelling or disturbing animals. Noise can either be in the form of a sudden loud or constant noise.

Ship noise, through masking, can reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time. In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking. Noise could also be a potential source of stress for marine mammals.

All noise sources can be said to fall in the planned impact category, the following potential sources have been identified:

1. Cars or trucks
2. Vessels traffic
3. Heavy construction machinery (in construction phase)
4. Equipment at land-based facilities (ventilators, generators, pumps, etc.)
5. Machinery on feed barges
6. Vessel machinery used during operational procedures

6.8 Odour

The activities can result in odour escaping the facilities. The generation of odour will primarily stem from the ensiling process of the mortalities and potentially from the manure generated at the land-based facilities.

6.9 Water use

The land-based facilities will rely on the ability to draw new fresh water all year round.

The company wishes to use RAS technology on the land-based hatcheries, which results in a water usage approximately 30-fold below traditional flow through facilities. Each of the hatcheries is thus only planned to use a maximum of 35 l/s.

The drawing of water will be planned to have minimal impact on the streams and ponds supplying the water. This is done by not pumping directly from the water source, but through gravitational in seeping through the ground to the pump sump.

Digging of trenches for drain pipes around the streams and the ponds will need to be planned to avoid disturbing plants and bird nesting sites. This will be assessed in the EIA.

It has also been planned to use solar or wind with battery backup to drive the pumps in to avoid potential spill of diesel from generators into the water bodies.

6.10 Waste disposal

Like any other commercial activity, the company will generate waste in the form of plastic, paper, cardboard, metals and other non-toxic materials. During the construction phase there will be waste

generation of excess building materials, pipe cut offs, wood, plastic and other materials normally associated with the erection of an industrial type building.

The operations will also see waste generated in connection with the collection and silage of fish mortalities. The silage can either be further processed to fertilizer locally used directly as animal feed or fertilizer.

The facilities on land and the feed barges will also generate human sewage. The sewage from the land-based facilities will collected in septic tanks and the effluent will be led to a septic drain field. The septic tanks will be emptied for solids, when required. The sewage generated on the feed barges will be collected and stored on the barge until collected by a service vessel and brought to shore for processing in the land-based systems septic tank. The final setup of sewage disposal will be discussed with FIG.

The volumes of all waste produced will be assessed and compared to the current capacity of dealing with waste in the Falklands.

6.11 Escape of stock

Aquaculture will like any animal husbandry practice have a risk of escape of stock. Using the best available equipment and practices will however reduce the amount of escaped fish. Escaped fish can potentially affect the environment by competing with local species for food or breeding grounds, predate on other species or be eaten by local wildlife. Escaped fish can potentially also function as a pathogen carrier to areas that is not close to the rearing facilities.

6.12 Pathogens and parasites

Pathogens are always a threat in any form of animal husbandry operation. The threat is seen both in the direct association with production loss due to infected stock and a risk for lateral transfer to wild stock. The lateral transfer is primarily taking place between the produced species and wild stock of the same or closely related species. Pathogens found in the wild stock can likewise transfer to the farmed fish and result in outbreaks of disease in the net pens.

For example, Falklands mullet are known to have *Lepeophtheirus sp.*, *Pseudoterranova sp.*, *Contracaecum* and *Anisakis* sp. These are potential parasites of salmon with generally low host specificity. As the salmon are fed with extruded, and thus parasite free, feed external parasites are considered to have the highest risk of lateral transfer. Other local fish species are likely to be infected with parasites as well.

The following possible impacts have been identified. The impacts are all considered accidental.

1. Introductions of pathogen from outside the Falklands.
2. Spread of pathogens to wild fish populations
3. Company stock functioning as a pool for already present pathogens in the wild stock and thus increase the spread of already present pathogens or parasites
4. Discharge of medicines in connection with treatment of pathogens or parasites
5. Discharge of chemicals in connection with treatment of parasites

6.13 Chemicals

The company plans to use a number of different chemicals during the production at the land-based and sea-based production. Furthermore, the company will generate waste in the form of silage consisting of

ensiled mortalities from the operation. Silage will in case of spills be degraded in nature due to the organic composition and is thus not likely to pose potential long-term impacts in case of spills.

The company is planning to use a number of chemicals in the production for buffering production water, ensiling mortalities, disinfecting equipment and general cleaning procedures. All chemicals used on the land-based facilities in direct contact to the production water will be food grade and is generally considered safe to use for aquaculture purposes in Scandinavia and the UK.

6.14 Fuel spills

Fuel for vehicles, generators and vessels will be stored on land. Spill of marine grade diesel in connection with transferring fuel from one vessel to another or during bunkering in one of the company's service hubs can potentially lead to impacts on the environment. Breakdown of a fuel tank or sinking of a vessel can also potentially lead to a discharge of fuel.

6.15 Invasive species

Invasive aquatic species present a major threat to the marine ecosystems, and shipping has been identified as a major pathway for introducing species to new environments.

The Falkland Islands already suffers from introduction of several invasive species. Introduction of rats and mice are examples of invasive species on the Falkland Islands. In the marine environment the North Atlantic ascidian Sea Vase (*Ciona intestinalis)* is another example of an introduced invasive species on the Falkland Islands. During the sea site investigations, the species was observed in several new areas around the Islands.

The Brown trout (*Salmo trutta*) is another invasive species that was purposely introduced on the Islands. While it has outcompeted the native Zebra Trout in some areas it is at the same time highly prized by local anglers and protected under legislation. As mentioned elsewhere Coho salmon (*Oncorhynchus kisutch*) have also recently started to migrate to the islands from the mainland. It is however at present unknown whether there is a breeding Coho salmon population on the islands, albeit it is likely with the uptick in catches.

The company activities will see regular transports of goods, fish and feed to and from the islands. Any vessel coming from an overseas destination can potentially transfer new species to the Falkland Islands. The company will also bring in fertilized Atlantic Salmon (*Salmo salar*) eggs, that will be hatched and reared on the Islands. The introduction of the eggs could potentially introduce new fish pathogens to the islands, but is very unlikely as the eggs will be sourced from bio secure facilities.

6.16 Impact on wildlife from physical structures

The company's structures and installations can potentially displace or prevent wildlife from entering areas. Both the land-based facilities are planned to be constructed on rural farmland and will thus take up space where protected plant and animal wildlife currently occur.

The net pens will prevent animals from entering certain areas of the sea. Therefore, the sea sites will be planned to be positioned away from known major migratory routes of sea mammals or penguins, if any. The moorings will also take up some or the sea bottom potentially displacing wildlife from these small areas.

Entanglement of wildlife in the bird nets above the water and the nets, predator nets and moorings can also potentially present an impact fauna.

7 Certifications and Management Plans

7.1 Aquaculture Stewardship Council

Unity Marine will actively seek to be certified to the Aquaculture Stewardship Council (ASC) for salmon farms[8]. To obtain certification the company will need to live up to a set of rules that reduces potential impacts on the environment, protects local wildlife, reduces the use of medicine and secures the certain benefits for workers.

ASC set standards for the salmon farms in order to minimise impacts on the local ecosystem in a number of ways, such as the development and implementation of an impact assessment to protect birds, marine mammals and sensitive habitats, protection of the ecological quality of the seabed, ensuring farms are not sited in High Conservation Value Areas (HCVA) and minimising fish escapes to an absolute minimum. All lethal incidents with wildlife must be made publicly available.

ASC certification requires salmon farms to adhere to strict limits to minimise the use of wild fish as an ingredient for feed. In addition, the standard requires farms to ensure full traceability back to a responsibly managed source, preferably certified, both for wild fish and soy.

ASC certified salmon farms are required to measure various water parameters (phosphorus, oxygen levels, etc.) at regular intervals and remain within set limits. Responsible farming can only take place in water bodies that are classified as 'good' or 'very good' (e.g. by the EU Water Framework Directive). Copper release into the water must also be minimised and monitored.

ASC certified salmon farms are required to adhere to rigorous requirements to minimise disease outbreaks. In doing so, they must also cooperate with other farmers operating in the same area. A Fish Health Management Plan detailing steps for biosecurity management must be developed under supervision of a veterinarian and implemented on the farm. In addition, the farms need to adhere to low levels of parasites (especially sea lice) and can only use certain medicines under very strict conditions. The use of medicine before a disease is diagnosed (prophylactic use), is prohibited. Producers need to manage farms in such a way that salmon survival rate is high. Instances of unexplained increased mortality, as well as sea lice counts are required to be publicly available.

ASC certification imposes strict requirements based on the core principles of the International Labour Organisation (ILO), these include prohibiting the use of child labour or any form of forced labour. All ASC certified farms are safe and equitable working environments where employees earn a decent wage and have regulated working hours.

7.2 Freedom food standard

RSPCA runs the Freedom Food program that has a group of standards for animal husbandry among these one specifically developed for salmon[9]. The company will implement certain parts of the standard that are more far reaching than the rules setup in ASC especially in connection with the stocking density in the tanks and net pens.

[8] https://www.asc-aqua.org/wp-content/uploads/2022/09/ASC-Salmon-Standard-v1.4-Final.pdf
[9] https://view.pagetiger.com/Salmonstandards2018/Salmonstandards2018

The reason for this is that Unity Marine wishes to follow good husbandry practices and animal welfare practices. Reducing stocking density will reduce stress for the fish and subsequently fish welfare and increase resistance to pathogens.

The company will follow the guidelines set by the Freedom Food Standard with a maximum stocking density in the different phases as seen below:

- < 1 g: maximum density 10 kg/m^3
- 1 – 5 g: maximum density 20 kg/m^3
- 5-30 g: maximum density 30 kg/m^3
- 30-50 g: maximum density 50 kg/m^3
- >50 g on land: maximum density 60 kg/m^3
- Net pens maximum stocking density 17 kg/m^3

The company will also follow the standards rules for densities during transport of live fish.

7.3 NS 9515:2021

The Norwegian technical standard NS 9415:2004 was implemented through Norwegian legislation on the 1st of April, 2004. The standard introduced technical standards for marine fish farms in Norway. NS 9415 specifies requirements for the design of equipment at sea sites more specifically; feed barges, net pens, floating collars and mooring systems to ensure the equipment can withstand environmental forces as well as the handling and use of the equipment through daily operations. All equipment must be independently certified against the standard. To ensure all existing fish farms met the requirements of NS 9415, independently accredited companies conducted technical analysis of equipment being used. Farms would, if the were found to be proven capable, receive a certificate of operation for three (3) years. The certificate could be reissued repeatedly until 2012.

After 2012 all main components of a marine fish farm site had to be certified. NS 9415 went through a revision in 2009 which resulted in significant changes and improvements. The standard is hereafter referred to as NS 9415:2009 it was further updated to NS 9415:2021 in 2021.

Norway was used a case study by Jensen et al. (2010)[10] to describe the development and implementation of measures to reduce Atlantic Salmon escape. Correlative evidence suggests that NS 9415 led to a decline in yearly salmon escapes from more than 600,000 fish per year in 2001-2006 to less than 200,000 fish per year in 2007-2009. This reduction was reached despite an increase in production of 44% during the study period. The number of escapes has been consistently low since the study period with a maximum of approximately 370,000 in 2011 and a minimum of 10,000 in 2017[11].

NS 9415:2021 is currently considered the most robust standard regarding the design and operation of marine sea sites in the world.

[10] Escapes of fishes from Norwegian sea-cage aquaculture: causes, consequences and prevention, Jensen et al. 2010
[11] Årsrapport 2017, Fiskerdirektoratet, Norway 2018

7.4 BWM

Ballast water taken onboard by ships can contain aquatic or marine microbes, plants and animals, which can be transferred with vessel traffic to other areas or regions. Untreated ballast water released at the ship's destination could potentially introduce a new invasive marine species.

The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) was adopted in 2004 to introduce global regulations to control the transfer of potentially invasive species.

Under the Convention, all ships in international traffic are required to manage their ballast water and sediments to a certain standard, according to a ship-specific ballast water management plan. All ships have to carry a ballast water record book and an international ballast water management certificate.
The BWM Convention requires that ballast water management systems used, to comply with the Convention, must be approved according to the guidelines for approval of ballast water management systems.

Unity Marine will ensure that all vessels that are directly operated, leased by the Company or delivers feed and harvest fish, follows the BWM Convention to mitigate the risk of introducing invasive species.

7.5 Management Plans

The company will develop the following management plans to ensure environmental protection and mitigation methods remain effective as well as maintaining a high level of safety and smooth operation of land and marine facilities:

1. Environmental Monitoring Plan
2. Biosecurity Protocol
3. General Maintenance Plan
4. Training and Education Plans
5. Production Plans
6. Monitoring-, control- and work plans
7. Chemical Management Plan
8. Fuel Management Plan
9. Spill Management Plan (Chemicals and Fuel)
10. Waste management plan
11. Fish Health Management Plan
12. Escapee Management Plan
13. Ballast Water Management Plan (ship specific)
14. Vessel Traffic Protocol
15. Harvest plan
16. Reports to authorities
17. Production Journal

This list is not exhaustive and will be further refined as the project develops.

8 Environmental impact Hatchery

The land-based facilities in the form of the smolt rearing units can possibly affect the environment from discharge of nutrients, escape of fish or through noise, lights and increased human activity.



Figure 2: Map showing proposed locations of land-based facilities at Mare Harbour and New Haven.

The following planned sources that potentially can have environmental impacts have been identified for the land-based facilities:

8.1 CO_2-emission
8.2 Discharge of nutrients
8.3 Road traffic
8.4 Noise
8.5 Light
8.6 Odour
8.7 Water use
8.8 Waste disposal

The following accidental sources can potentially lead to environmental impacts have been identified:

8.9 Escape of the stock
8.10 Spread of pathogens
8.11 Chemical spill
8.12 Fuel spill
8.13 Impact on wildlife from physical structures

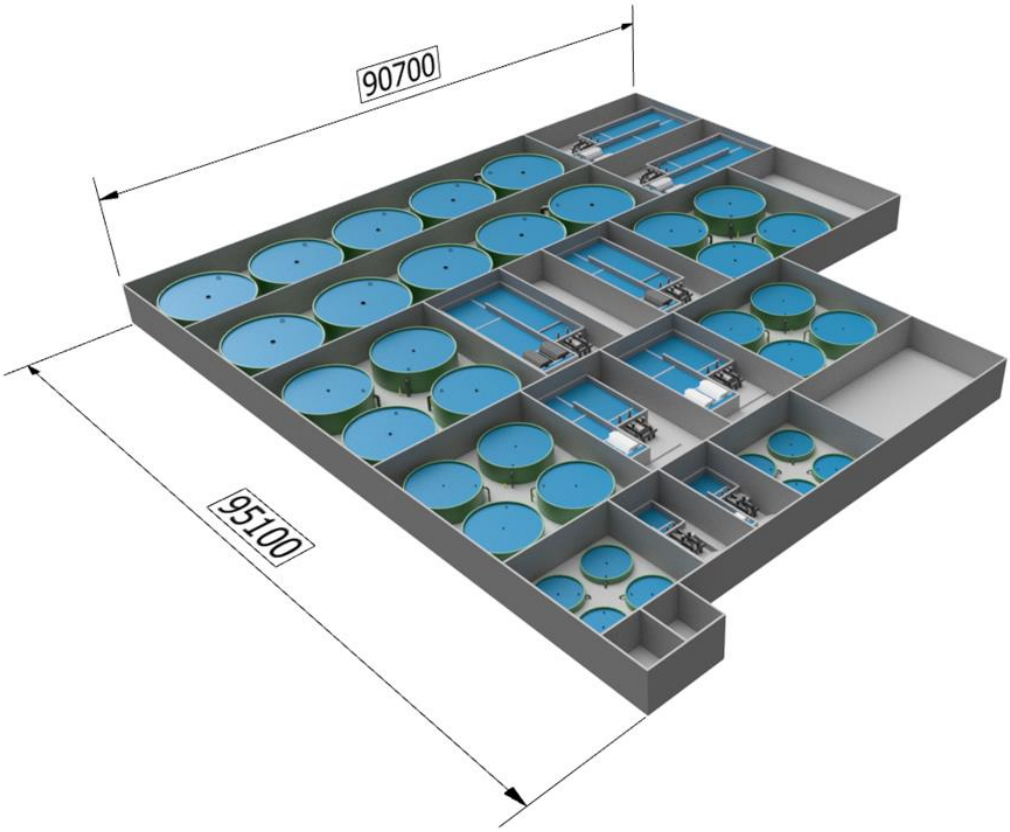


Figure 3: Schematic drawing of one of the facilities for smolt rearing. Based on site investigations the facilities will be built on two separate plots at Mare Harbour and New Haven. Measurements in millimeters.

8.1 CO_2-emission

The hatchery will rely electrical driven pumps, motors and other equipment. Due to rural placement of the facilities power infrastructure will need to be constructed. There is however a possibility that the Mare Harbour facility can be powered by the existing MPA infrastructure.

The company's mitigation strategy consists of the construction of a wind turbine to cover some of the power generation and thus reduce the diesel use and subsequently the CO_2 emission. The company will

The company will use the following mitigation strategies to lower the emission from fossil fuel use:

1. Design of a system with low energy usage
2. Re-use of heat from plant operations (e.g. oxygen generators) to heat the production water
3. Use of equipment using IE3 or IE4 standard (increased efficiency)
4. Use of IE3 or EI4 generator (reduced fuel usage)
5. Use of renewable energy sources to cover some of the power use
6. Facility will be well insulated.

also focus on using the highest standards of equipment in regard to efficiency to lower the overall power use of the facility.

The facility will be designed to accommodate for low energy usage by e.g. reducing the lifting height of the water, re-use heat generated by the equipment to warm the water and other similar solutions that lowers the overall power use of the facility.

The company will also follow the developments on the energy market and would be interested in increasing the use of renewable energy, when a feasible energy storage solution is available (e.g. battery or thermal).

Available comparable emissions data will be gathered and compared to the proposed emission levels for this project. Emissions offsetting options may also be considered.

8.2 Discharge of nutrients

An increased discharge of nutrients into any water body can potentially lead to eutrophication and alteration of the food web. The actual impact will be determined by local factors like current nutrient availability and subsequent limiting factor.

Predictions of feed usage and associated volumes of discharged nutrients can be modelled based on proposed number of fish to be reared, water temperature, and other factors. Modelling was carried out for the Mare harbour hatchery to provide some initial figures; **Error! Reference source not found.** shows the feeding from the Mare Harbour Hatchery in a staggered production cycle of approximately six (6) million salmon smolts of 125 g. The fish will be transferred approximately eight (8) months after initiation of the start feeding. Table 1 gives additional production parameters.

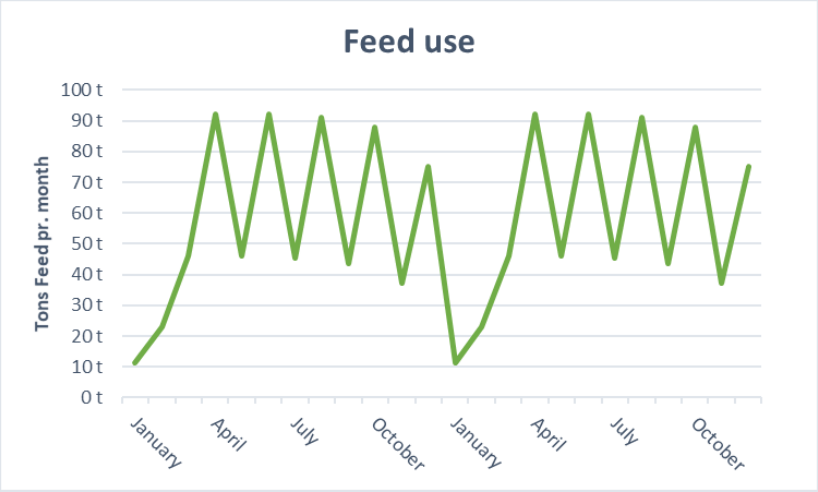


Figure 4: Simulated feeding pr. month at the Mare Harbour hatchery. The feed administered is a function of the size of the fish and the total biomass.

Production parameters	
Realised feed conversion ratio (FCR)	0.90
Feed waste (% of applied feed)	1.5%
Fish feed (tons/ year)	691 t
Fish produced (tons/ year)	767 t

Table 1: Production parameters for one of the smolt facilities. Production in metric tons (t).

- FCR: Is the amount of fish feed (dry weight) that you need to feed to gain 1 kg of fish
- Feed waste: The amount of feed that is uneaten
- Feed fed: Total amount of feed used in the production
- Fish produced: Total amount of fish produced. This is a result of the amount of feed fed at a given FCR

The following parameters describes the composition of the feed used. These data are used to calculate the resulting quantities of the various components in the discharge water and sludge. The feed composition is derived from Biomar AS, Brande, Denmark[12].

Biomar Intro FO[13]	
Raw protein	48%
Fat	22%
Carbohydrates (NFE)	14%
Fibres	1.9%
Ash	10%
Total phosphorous	1.6%

Table 2: Feed composition for the smolt just prior to transfer to the sea.

Smaller fish needs relatively more feed than larger fish but consumes less feed per kg of added biomass. Salmon being a poikilotherm (cold blooded) animal will grow faster at higher temperatures, therefore high growth is anticipated year-round in the land-based facility as the water temperature will be kept at 13-14°C at all times, with ambient factory temperature kept at a slightly higher temperature to reduce condensation.

8.2.1 Nutrients produced

The distribution of the nutrients and organic matter discharged from the land-based facilities will be influenced by the amount and composition of the feed utilized in the production period. A part of the nitrogen and phosphorous will be retained in the fish, however a large part of the nitrogen and phosphorous will be released to the effluent water by secretion from respiratory processes of the fish and as uneaten fish feed. The hatchery will also retain collect solids. The solids can be used as fertilizer on nearby farmland.

The company will visually monitor feeding operations. The visual monitoring will allow for the personnel to observe the feeding behaviour of the fish and ensure that the correct amount of feed is used. This will lead

[12] http://www.biomar.com/da/danmark/produkter--arter/laks/yngel--smolt/
[13] https://www.biomar.com/da-dk/p/intro-atlantic-salmon

to better feed utilization (lower FCR) and a reduced feed waste with a subsequent reduction of discharge to the surroundings.

Discharge of nutrients to the marine environment will be minimised, where hatchery water will be recycled and stripped of suspended and dissolved nutrients where possible. Dispersion of nutrients in discharged water will depend on current, tides, wind, waves, and seasonal effects. Uptake of nutrients into trophic pathways will depend on numerous factors including sea surface temperature, season, sunlight, etc. These will be more fully investigated in later project stages.

8.2.2 Nitrogen discharge

The nitrogen potentially poses the greatest source of impact on the surrounding waters. Nitrogen is the single most important nutrient for plant or algae growth. Nitrogen is usually the limiting factor for algae growth in the world's oceans. The nitrogen will thus likely lead to an increased primary production, that in

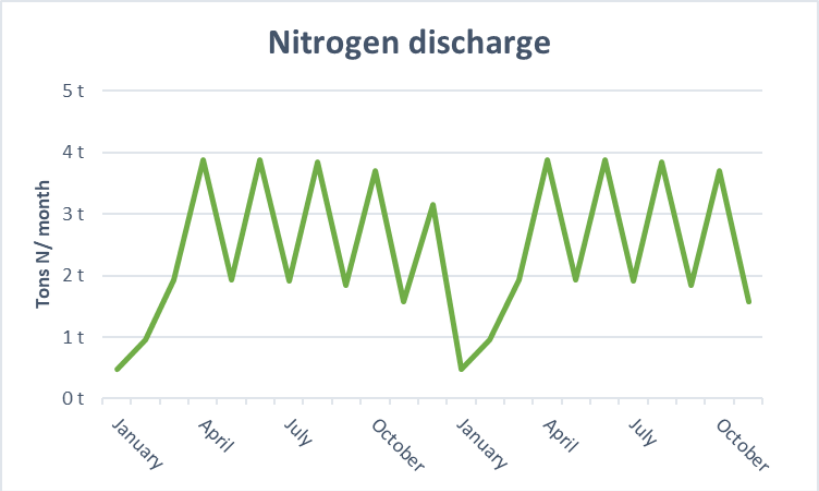


Figure 5: Simulated nitrogen discharge pr. month at the Mare Harbour hatchery. The feed administered is a function of the size of the fish and the total biomass.

turn can impact other trophic levels and dependent food webs. The spatial distribution of the increased primary production is thought to be small (0.3-0.5 km from the discharge point).

The potential impacts from increase in nitrogen availability is thought to be small if the company activities are distributed over a large geographical area[14]. It will however need to be modelled and thoroughly analysed in the site-specific Environmental Impact Assessments during the planning permission.

8.2.3 Phosphorous discharge

Phosphorous is abundant in the world's oceans and is thus less likely to impact primary production significantly. If placed in shallow sounds with little water exchange it can potentially lead to an increased primary production that in turn can impact other trophic levels and dependent food webs. The spatial distribution of the increased primary production is thought to be small (0.3-0.5 km from the discharge point).

[14] Salmon Farming in the Falkland Islands: A review of environmental and social challenges and opportunities, Seagreen Research on behalf of Falklands Conservation, September, 2018

Most of the phosphorous is retained in the sludge that will be collected in the facility's drumfilters.

The potential impacts from increase in phosphorus availability will be investigated. Again, the dispersion will need to be modelled and thoroughly analysed as guided by the site-specific Environmental Impact Assessments.

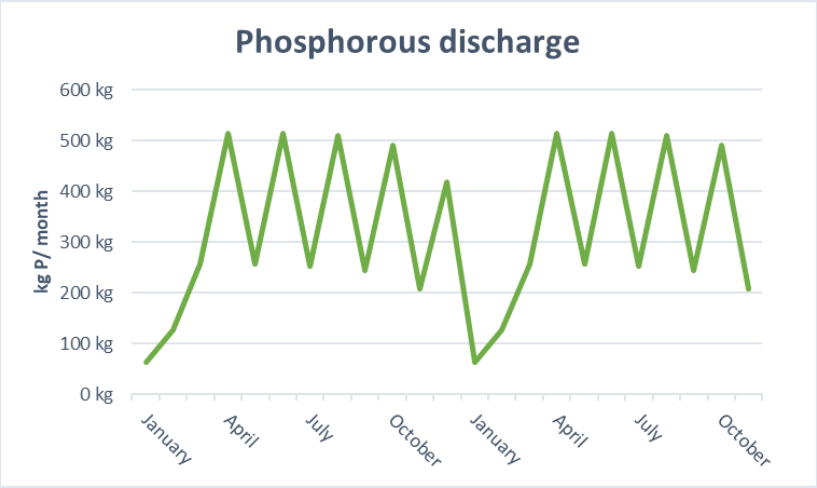


Figure 6: Simulated phosphorous discharge pr. month at the Mare Harbour hatchery. The feed administered is a function of the size of the fish and the total biomass.

8.2.4 Organic material

The land-based facility will collect and store the sludge from the production. The sludge can be used for soil improvement and is thought used as fertilizer on nearby pastureland. Although most suspended organic material will be collected, some solids may be discharged in the form of dissolved organics or particles smaller than 40 µm that may settle on the seabed around the effluent pipe. The result is a local organic loading in sediments surrounding the discharge point. This can potentially have an impact on organisms close proximity to the point of discharge.

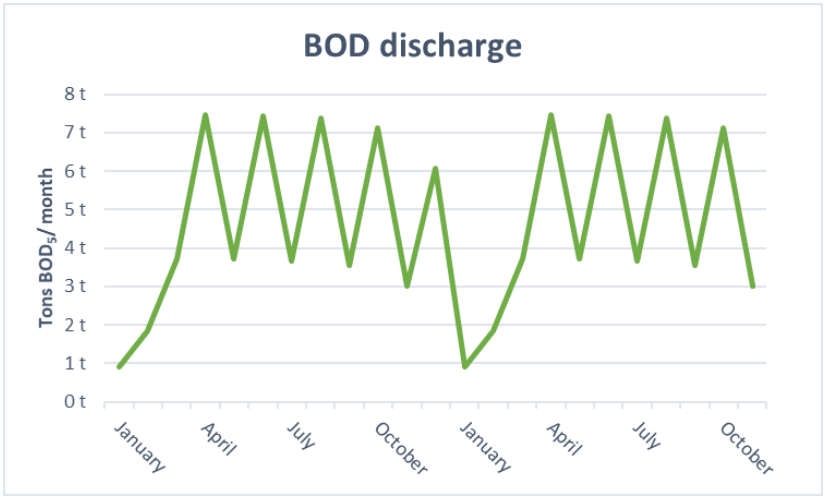


Figure 7: Simulated BOD_5 discharge pr. month at the Mare Harbour hatchery. The feed administered is a function of the size of the fish and the total biomass.

8.2.5 Mitigation strategies

There are a number of planned mitigations strategies that will be used to reduce the potential impacts of the nutrient and organic matter discharge.

> The company will use the following mitigation strategies to minimize impacts from nutrient discharge:
>
> 1. Use of high-quality feed.
> 2. Feeding behaviour monitoring.
> 3. Monitoring of seabed nutrient loading.
> 4. Monitoring of seabed fauna development.
> 5. Explore the opportunities for using the entire discharge as fertilizer on nearby pastureland.

The company is planning to use high quality feed in the production. The feed will thus have a high digestive content increasing retention of nutrients in the fish and reducing the subsequent discharge to the surroundings. The company will also monitor the feeding closely in order to reduce the amount of uneaten feed and subsequent discharge or organics and nutrients to a minimum.

As part of the company's monitoring program the area surrounding the effluent point will be inspected as frequently as required for effective monitoring. The nutrient loading and benthic community composition will be monitored. In the unlikely case severe local effects are identified the company will lay a second effluent pipe to another location. The effluent discharge will then be alternated between the two pipes to allow for fallowing of the single discharge points.

Due to the placement of the discharge pipe below the sea and the potential need for periodical cleaning, the pipe is planned with a single outlet point. In case FLH wishes to use the effluent on nearby farmland the effluent water will be spread over a larger area with diffusers.

Special mitigation strategies for the effluent water and sludge disposal can be seen in the following sub-chapters.

8.3 Road traffic

Please see chapter 6.4 for details on road traffic.

8.4 Noise

The facility will be housed in an industrial type, insulated building. Therefore, very little or no noise is expected to affect the surroundings from standard daily operations.

The building will be equipped with standard ventilation fans. Frequency and decibel level of these will be measured and assessed for impact.

Movement of goods or stock either by truck, supply ship, well boat or internally on the premises by forklift will take place and will result in temporary noise from the operation.

The location of important bird areas will be assessed before final placement of facilities will be made.

To mitigate potential impacts from noise the company will:

1. Use insulated buildings in general, which gives a very good noise protection.
2. Compressors will be established in special noise protected rooms or in individual noise cabinets.
3. Carefully select the establishment sites of the facilities, in order to avoid conflicts with breeding grounds or nesting areas.

8.5 Light

Neither normal windows nor roof windows are planned to be established in the production facilities. There will be windows in connection to administration-, office- and staff facilities. Outdoor working light will be established where needed.

The facility's light emission field will be modelled for assessment during the EIA.

To mitigate potential impacts from light the company will:

1. Install light proof curtains in connection with windows installed in the administration-, office- and staff facilities, if light shows to be affecting the wildlife.
2. Only turn on outdoor light, when human activity outside the production facilities is required.
3. Use directional lighting.

8.6 Odour

Odour from the mortality silage can potentially escape the facility. Therefore, the silage container will be equipped with an odour destruction unit if this problem is identified.

The placement of the facilities well away from any dwellings will also reduce the potential impacts on humans.

The attractiveness of facility odours to birds and other fauna will be assessed.

8.7 Water use

The water for the two facilities will be drawn from nearby fresh water sources. This could potentially drain the water bodies partly or completely and leading to degraded natural habitat.

The pump stations will be placed at a certain distance from the hatcheries and will thus need independent standalone power sources.

> In order to mitigate potential effects on the water sources, the company is planning the following mitigation strategies:
>
> 1. No pumping will take place directly from surface water source.
> 2. Pump stations will be powered by standalone renewable energy source with battery back-up.
> 3. Water levels/ and or flows will be monitored.
> 4. Flora and fauna of the pond or stream will be assessed and monitored.

8.7.1 Mare Harbour

The water from the Mare Harbour facility will be drawn from "small pond next to East Cove Pond" that is placed close to the facility. The Pond is relatively shallow, and the water column is relatively turbid from clay particles in suspension. In order to filter out the clay particles it is planned to dig a drainage trench by the pond shore, where water will infiltrate into a drainage pipe from the Pond. A schematic of this type of system is shown in Figure 9.

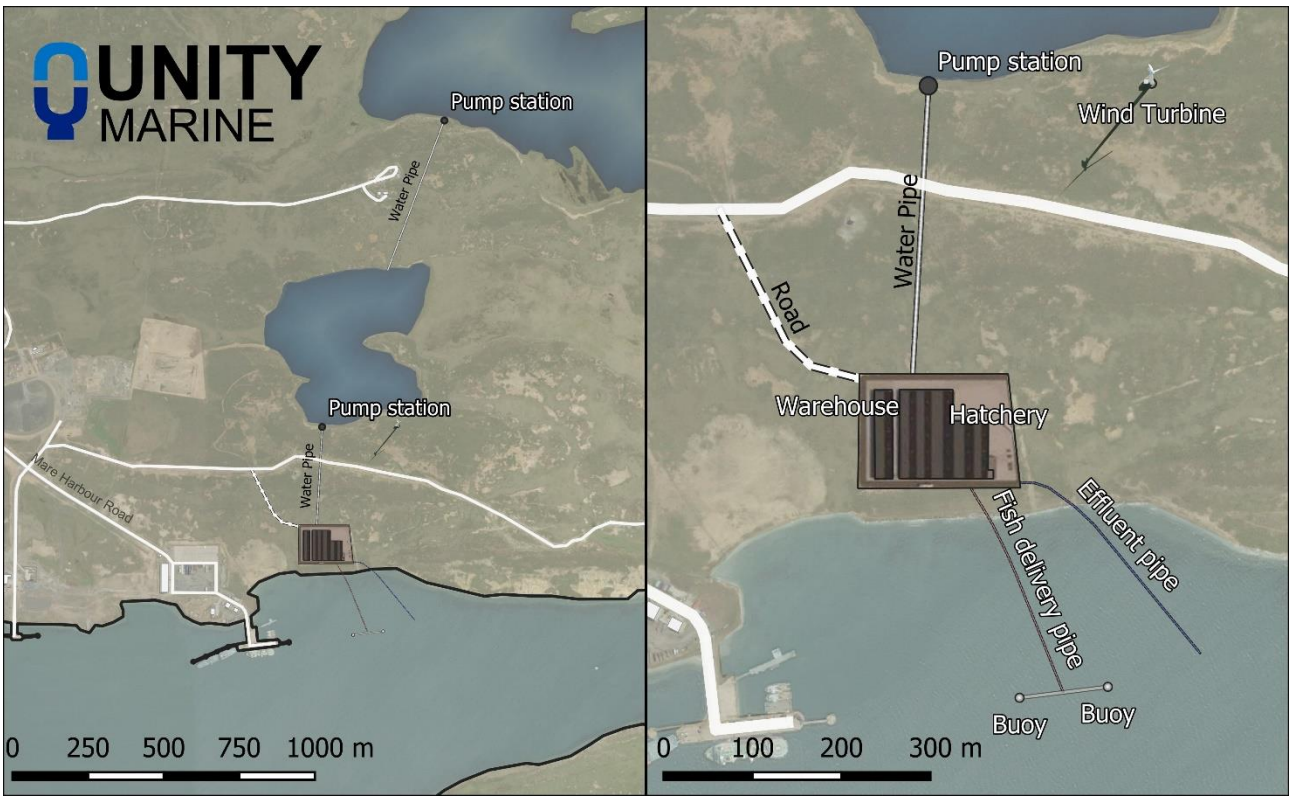


Figure 8: Site layout for Mare Harbour. Water will be drawn through a pump station placed at the lake shore.

The pumping station is planned to be constructed with a pumping well that will be filled by gravity driven infiltration recharge. This means that the water will enter the pump sump seeping through the ground from the pond. Clay particles will be filtered out through the ground.

The following additional mitigation strategies will be used at Mare Harbour:

1. If effluent water is allowed to be spread on Pond upland, no net water will be drawn.
2. In case of low water level, a reserve pump station will pump water from East Cove Pond
3. Assessment of surround flora and fauna will be made prior to placement of pumping station and groundwork.

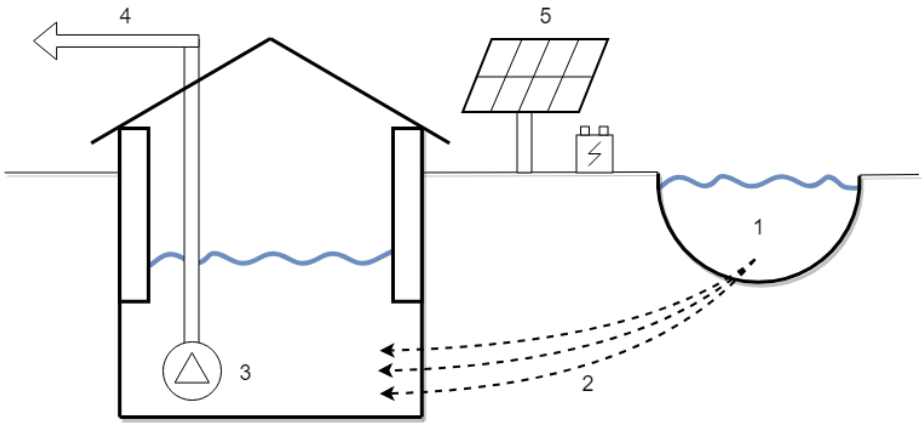


Figure 9: Principal of influent water pump station planned to be used at both at Mare Harbour and New Haven. 1) Fresh water resource (pond or stream), 2) gravitational in-seeping through the ground to the pump sump, 3) Pump sump with submerged pump, 4) influent water pipe to the facility, 5) renewable energy source and battery backup.

8.7.2 New Haven

The fresh water from the facility is planned to be drawn from the three (3) permanently running streams entering the sea at the bottom of the peninsula by Dos Lomas.

The pumping stations are planned to be constructed with a pumping well that will be filled by gravity driven infiltration recharge. This means that the water will enter the pump sump seeping through the ground.

The pumps will be powered with renewable energy with battery backup. The water will be led through a pipe thought to be installed alongside the road to the site (in the ground).

Flora and fauna will be assessed prior to any groundwork.



Figure 10: Site layout for New Haven. Water will be drawn through three pump stations placed at the streams by Dos Lomas and pumped to the facility.

8.8 Waste disposal

Waste includes domestic waste such as sewage, rubbish, packaging etc. This will be collected and separated according to the facility's Waste Management Plan, and the guidelines of how to treat the waste disposal on the Falkland Islands.

To mitigate potential impacts from waste disposal the company will:

1. Collect and separate the waste disposal according to the local guidelines.
2. The employees will be trained in proper waste handling and sorting procedures.
3. Secure that waste disposal is stored securely, in order to avoid that wildlife can get contact to the waste disposal, and to avoid the disposal to be spread by wind or wildlife.

8.9 Escape of the stock

The company will aim to eliminate the possibility of salmon escaping from the hatchery, during transfer of salmon to sea sites, and at sea sites. A wide array of mitigation strategies will be employed.

The use of sterile triploids is a relatively new practice in Atlantic Salmon aquaculture but have been used extensively in e.g. Rainbow trout aquaculture for the last 30 years. By using triploid salmon, the chance of any establishment of a breeding population is severely reduced. It will also be relatively easy to identify whether fish caught in the wild are from escaped stock, as the company's fish will have an extra set of chromosomes. Triploid fish are generated by applying pressure to newly fertilized eggs and does not employ the use of any chemicals, hormones or genetical treatment.

The facilities will be fitted with primary and secondary fish retaining systems to prevent escapes of the stock. Therefore, no escapes of stock are expected from daily operations of the land-based facilities.

It is important to note that the fish reared in the land-based systems will not be adapted to live in sea water before they have smoltified. Any fish escaping the system prior to the smoltification would thus die of in the sea in less than a couple of hours. The facilities are placed well away from any freshwater bodies, so escape of stock to rivers and lakes will be impossible.

In connection with transport of fish to the net pens, the fish will be pumped to the well boat. Smaller escape incidents can potentially occur from human errors or malfunction of equipment, like the unfastening or breakdown of a pipe. As the transfer of fish is constantly monitored by the personnel, any errors will be quickly observed, and proper actions will be taken to prevent larger escapes. It is therefore not anticipated that any escape incident would result in more than a few hundred escapees and only one or two incidents is expected yearly, when at full production. All flexible couplings or joints will also be encapsulated in nets to prevent escapes.

As the production is relying on sterile or all female fish, any escapees will not be able to create a breeding population in the wild.

To mitigate potential impacts from escapees the company will:

1. Facility will be designed to the standards set in NS 9416
2. Only use sterile or all female fish at all times, that cannot establish a wild population.
3. Periodic test of the eggs upon arrival for triploid compliancy
4. Hatchery fish will be isolated from entering freshwater systems. In the unlikely event that young hatchery fish are released into the marine environment, these fish will die from osmotic stress within minutes.
5. Use high quality- and well proven equipment in connection with transportation.
6. Carry out careful education of the staff in handling and transport of fish.
7. Design and build the system with primary and secondary fish retaining systems.
8. All fish tanks and pipes used to contain, or transport fish will be certified for such use.
9. The company will keep maintenance schedule and logs to secure equipment standards.

8.10 Pathogens

The majority of today's egg production is based on marine farmed brood stock. This presents a challenge in relation to hygiene status regarding important infectious agents found in the marine environment. The company is however planning to use broodstock from closed contained broodstock, minimizing this risk and

thus also the risk of introducing new pathogens to the Falkland Islands. The eggs will also be disinfected upon arrival.

As the hatchery will use close containment RAS technology it is highly unlikely that any potential infections will spread from the hatchery. Effluent water will be treated with UV to secure that any potential pathogens brought in with the eggs will not be dissipated to the environment.

In case of an outbreak of disease the company's veterinarian will determine the correct action, whether that is treatment of the fish or culling and subsequent sterilisation of one of the sections or the entire facility. The authorities' veterinarian will also be informed immediately.

Fungal infections usually only occur in the freshwater phase of the production cycle and is almost always caused by *Saprolegnia* spp. species. Infections are most common in connection with hatcheries but is also observed in broodstock in the freshwater phase. Treatments consists of increasing salinity in the production water or potentially hydrogen peroxide (H_2O_2) treatment.

The company is not planning to use any chemical treatments of the stock, beyond the initial disinfection of the eyed eggs on arrival at the hatchery. An iodophore product will be used for the disinfection protocol.

All fish will be vaccinated prior to transport to the net pens. The exact vaccination program will be determined by the company's veterinarian and will be based on the current determined pathogen threat level in the area. The fish will be anesthetized prior to vaccination.

To mitigate potential impacts from spread of pathogens the company will:

1. Only import fish eggs and never hatched fish.
2. The supply of fish eggs, will only come from approved and certified closed containment breeding facilities.
3. The eggs will be disinfected upon arrival in the Falklands.
4. The land-based production facility is a closed indoor facility, established with bio-sluices at the entrances from outside and between the individual production units internally.
5. All fish will be vaccinated prior to movement to the sea.
6. The broodstock and ovarian fluid will be screened for all known diseases prior to shipment.

8.11 Chemical spill

Unity Marine will develop a Spill Management Plan setting out all mitigation, inspection schedules and responses in the event of spill or loss to the environment.

8.11.1 Planned use of chemicals

A list of planned use on the land-based facilities can be seen below.

Chemical	Identification number	Use
Formic Acid	CAS nr.: 64-18-6	Used for ensilage of mortalities. Dosed directly into the ensilage tank based on pH measurement (pH 3.0). The company will use a slightly diluted product to avoid

		potential explosion risks. The silage can be used directly as fertilizer.
Iodofor™ or similar	CAS nr.: 39392-86-4	Used for disinfection of equipment and footbaths. Use on the sea sites will be small.
Sodium Hydroxide (NaOH)	CAS nr.: 1310-73-2	Dosed into the water to buffer acidifying nitrification in the biofilters.
Calcium Carbonate ($CaCO_3$)	CAS nr.: 471-34-1	Used to buffer the production water and increase alkalinity. Calcium is also used by the fish to osmoregulate.
Waterglass ($Na_2Si_3O_7$)	CAS nr.: 1344-09-8	Used to buffer the production water, especially in connection with high metal content in the influent water. No usage anticipated
Benzoak vet. or similar	E.g. ATCvet nr. QN01A X92	Used to anesthetize the fish during grading. Will be discharged with effluent. No known environmental effects.
Food Grade Lubricants and oil	-	Used to lubricate and maintain the motors and equipment
House hold detergents	-	Common household cleaning detergents, soap and other cleaning substances.

Table 3: List of chemicals planned to be used in the land-based facilities.

Any chemical use will be duly noted in the company's Production Journal.

8.11.2 Chemical spills

Accidental spill of chemicals in connection with transferring from one vessel or truck to another or during transfer to and from a vessel to one of the company harbour facilities can potentially lead to spills and subsequent impacts on the environment. Breakdown of any chemical tank, traffic accident or sinking of a vessel can also potentially lead to a discharge of chemicals.

Most of the chemicals the company plans to use are relatively non-toxic but could potentially lead to local impacts on plant and wildlife. The acids and bases used for the silage and pH buffering of the land-based facilities can potentially alter the pH of smaller water bodies if a spill were to occur in e.g. a stream, pond or lake.

8.11.3 Treatments

All chemicals will be stored in the facility's chemical room that will be equipped with a spill tank that can contain the entire volume of the containment containers in case leaks or a container break.

Most of the chemicals the company plans to use are relatively non-toxic but could potentially lead to local impacts on plant and wildlife. The acids and bases used for the silage and pH buffering of the land-based facilities can potentially alter the pH of smaller water bodies if a spill were to occur in e.g. a stream, pond or lake.

Chemicals will be handled according to the guideline for handling chemicals on the Falkland Islands.

To mitigate potential impacts from chemical spills from the land-based facility the company will:

1. Any tank containing chemicals will be placed or installed so the full volume of the tank can be retained on site and the spill subsequently removed.
2. Due to the placement of the facilities ponds, lakes and streams cannot be contaminated from chemical spills, unless it involves spills from a traffic accident.
3. Only containers or tanks approved to hold any specific chemical will be used.
4. Any transfer of chemicals will be monitored closely be company personnel.
5. Train and educate the staff in how to handle the different chemical substances correctly as described in the company chemical management plan.

Any chemical spills will be reported immediately to the Environmental Planning Department.

8.12 Fuel spill

During transfer of fuel to or from the fuel tanks or in case of a breakdown of one of the fuel tanks there is a potential risk that fuel could contaminate the terrestrial ecosystem surrounding the building.

All fuel will be stored in the facility's fuel tank that will be equipped with a spill tank that can contain the entire volume of the fuel tank in case leaks or a tank breakdown.

Any process where fuel is pumped from a tanker to the facility fuel tank will be monitored by the company personnel. Any spill due to a slipping pipe or mechanical breakdown of a pipe is therefore not likely to be larger than 30-100l per spill.

To reduce the risk of fuel spills the company will employ the following mitigation strategies:

1. Any fuel tank will be placed or installed so the full volume of the tank can be retained on site and the spill subsequently removed.
2. Due to the placement of the facilities ponds, lakes and streams cannot be contaminated from fuel spills, unless it involves spills from a traffic accident.
3. Only containers or tanks approved to hold the fuel will be used.
4. Any transfer of fuel will be monitored closely be company personnel.
5. Train and educate the staff in how to handle the different fuel spill correctly.

8.13 Impact on wildlife from physical structures

The land-based facility can potentially displace or prevent wildlife from entering and/ or passing through the area.

Both the land-based facilities are planned to be constructed on rural farmland and will thus take up space that could otherwise house wildlife.

> In order not to impair the movement of wildlife through the area the company is planning the following mitigation strategy:
>
> 1. Prior to placement of facilities, a survey of flora and fauna will be done such that important bird or plant areas are not impacted.

8.14 Invasive Species

The Falkland Islands already suffers from introduction of several invasive species. Introduction of Rats and mice are examples of invasive species on the Falkland Islands. In the marine environment the North Atlantic ascidian species Sea Vase (*Ciona intestinalis)* is another example of an introduced invasive species on the Falkland Islands. During the sea site investigations, the species was observed in several new areas around the Islands.

The Brown trout (*Salmo trutta*) is another invasive species that was purposely introduced on the Islands. While it has outcompeted the native Zebra Trout in some areas it is at the same time highly prized by local anglers.

The company activities will see regular transports of goods, fish and feed to and from the islands. Any vessel coming from an overseas destination can potentially transfer new species to the Falkland Islands. The company will also bring in fertilized Atlantic Salmon (*Salmo salar*) eggs, that will be hatched and reared on the Islands. The introduction of the eggs could potentially introduce new fish pathogens to the islands.

> To mitigate the potential risk of bringing in invasive species the company will employ the following general strategies:
>
> 1. Any company vessel will be required to abide to the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM)[1]
> 2. Any third-party vessel contracted by the company will be required to abide to the BWM

9 Environmental impact Sea Sites

The net pens operation at the sea sites can possibly affect the environment from discharge of nutrients, escape of fish, transfer of pathogens, light disturbance or through noise and human activity.

The following planned sources that can have potentially environmental impacts have been identified for the sea sites:

9.1 CO_2-emissions
9.2 Discharge of nutrients
9.3 Noise
9.4 Light
9.5 Vessel traffic
9.6 Waste disposal

The following accidental sources that can potentially lead to environmental impacts have been identified:

9.7 Escape of the stock
9.8 Spread of pathogens
9.9 Chemical spills
9.10 Fuel spill
9.11 Impact on wildlife from physical structures

Please note that vessel traffic contains planned as well as accidental potential impacts.



Figure 11: Placement of the sea sites around East Falkland.

9.1 CO_2-emission

The sea sites will rely on electrical blowers, motors and other equipment. Due to remote placement at the sea power infrastructure will be installed on the barges in the form of diesel generators.

> The company will use the following mitigation strategies to lower the emission from fossil fuel use:
>
> 1. Use of equipment using IE3 or IE4 standard (increased efficiency)
> 2. Use of IE3 or EI4 generator (reduced fuel usage)
> 3. Use hybrid barges with battery back-up.

The barges will be designed to accommodate for low energy usage by e.g. using the highest standard of generators and other similar solutions that lowers the overall power use of the barge. Unity Marine will also use hybrid feed barges with battery back-up. This type of feed barge have been shown to reduce the diesel use by 2/3.

The company will also follow the developments on the energy market and would be interested in increasing the cover by renewable energy in the form of solar panels that can lower overall emissions.

9.2 Discharge of nutrients

An increased discharge of nutrients into any water body can potentially lead to eutrophication and alteration of the food web. The actual impact will be determined by local factors like current nutrient availability and subsequent limiting factor.

Discharge of nutrients will lead to an increased activity in the primary trophic level. The use of feed will vary over the production period as a function of the biomass, the size of the fish and the temperature.

Smaller fish needs more feed than larger fish but consumes less feed per kg of added biomass. Salmon being a poikilotherm animal will grow faster at higher temperatures, therefore the use of feed will also be peaking in the summer months, where sea water temperatures are at the highest.

In the Northern hemisphere there is usually a relatively large fish population below the net pens. The fish feeds off scavengers like krill, shrimps and other animals that feed of the organic matter discharged from the net pens. It is uncertain whether fish will aggregate around the net pens on the Falkland Islands.

While the impact area can be predicted using mathematical models, it is important to note that the net pens will potentially impact sensitive species to be determined. Potential sites will thus need to be screened for any potential endangered species before a license is approved.

In the figure below the feeding in one of the sites have been modelled for an al-in all-out production cycle in the Falklands of approximately 5,000 tonnes of salmon put out as 125g smolts in October. The fish will be harvested in January fourteen (14) months after transfer at an average weight of 5.07 kg. Following the harvest of fish, the company will maintain a 4-month fallowing period to allow for regeneration of the sea bed and maintenance work. New fish would then be transferred to the site in October, precisely two years after the first transfer.

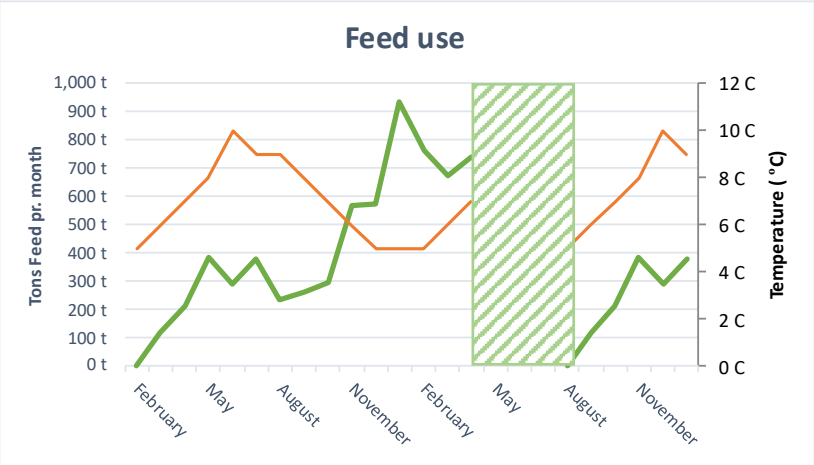


Figure 12: Simulated feeding program for the Falklands. Month at a sea site with all-in all-out production scenario. The feed administered is a function of the size of the fish, the total biomass and the sea water temperature. The crossed area represents the fallowing period.

The following describes the production parameters for one of the sea sites.

Production parameters	
Realised feed conversion ratio (FCR) average	1.10
Uneaten feed (% of applied feed)	1.5%
Fish feed (tons/ year)	Maximum 6,200 t/ year
Fish produced (tons/ year)	4,974 t/ year

Table 4: Production parameters for one of the sea sites with all-in all-out batch transferred in October.

- FCR: Is the amount of fish feed (dry weight) that you need to feed to gain 1 kg of fish.
- Uneaten feed: The amount of feed that is uneaten.
- Feed fed: Total amount of feed used in the production.
- Fish produced: Total amount of fish produced. This is a result of the amount of feed fed at a given FCR.

The table below describes the composition of the feed used. These data are used to calculate the resulting quantities of the various components that is discharged to the water column. The feed composition is derived from on-growing salmon feed line from Biomar AS, Brande, Denmark[15].

[15] https://www.biomar.com/

Biomar EFICIO Enviro 940[16]			
Raw protein			38-47%
Fat			33-36%
Carbohydrates (NFE)			14%
Fibres			1.9%
Ash			10%
Total phosphorous			1.6%

Table 5: Feed composition for the grow-out phase at sea. Feed composition varies somewhat with the size of the fish. Therefore, there is a range applied to the different constituents. All discharge data has been calculated with the right formula for the right size of fish.

9.2.1 Nutrients produced

The distribution of the nutrients and organic matter discharged from the net pens will be influenced by the amount and composition of the feed utilized in the production period. A part of the nitrogen and phosphorous will be retained in the fish, however a large part of the nitrogen and phosphorous will be released to the surrounding ocean by secretion from reparatory processes of the fish and as uneaten fish feed.

The company will monitor feeding operations with the use of underwater camera systems placed in each pen. The visual monitoring will allow for the personnel to observe the feeding behaviour of the fish and ensure that the correct amount of feed is used. This will lead to better feed utilization (lower FCR) and a reduced feed waste with a subsequent reduction of discharge to the surroundings.

The current and waves will distribute the discharged material over a larger area. The spread will be determined by the weather in a given year, the temperature (and thus the amount of feeding) and whether the site is in the first or second year of the production cycle. The effect will dissipate exponentially with distance from the site. The exact spread and dissipation will be determined by the use of environmental modelling in the EIA phase of the project.

In 2017 DHI (Danish Hydraulic Institute) carried out environmental impact assessments for the Danish government on eight (8) different sites in inner Danish waters. The aim of the investigation was to determine the potential environmental impacts from the placement and operation of new sites with a total of 20,000-24,000 tons production per year in the Kattegat area[17]. As part of the investigations the distribution of inorganic nitrogen and phosphorous in the surface water layer and changes in the organic carbon on the ocean floor was modelled. The models for dissipation of N, P and inorganic carbon is used to visualize how an area surrounding the net pen site could potential be affected by the discharge. The report concluded that the effects of nutrient discharge were thought to be small and would not adversely affect the environment in the area.

[16] http://www.biomar.com/globalassets/.global/pdf-files-_en/datasheets-_en/-denmark/salmon/dk-efico-enviro-940-3-8-mm-salmon-084---13.pdf

[17] Modellering af lokaliteter til havbrug, Screening af Kattegat for egnede områder, DHI for NaturErhverstyrelsen 2017.

Likewise modelling of nutrient distribution could be carried out for the proposed sites on the Falkland Islands in the EIA if deemed necessary. The modelling program would in that case re-parameterised for Falklands conditions.

9.2.2 Nitrogen discharge

The nitrogen potentially poses the greatest source of impact on the surrounding waters. Nitrogen is the single most important nutrient for plant or algae growth. Nitrogen is usually the limiting factor for algae growth in the world's oceans. The nitrogen will thus likely lead to an increased primary production, that in turn can impact other trophic levels and dependent food webs. The spatial distribution of the increased primary production is thought to be small (0.5-1 km from the sites).

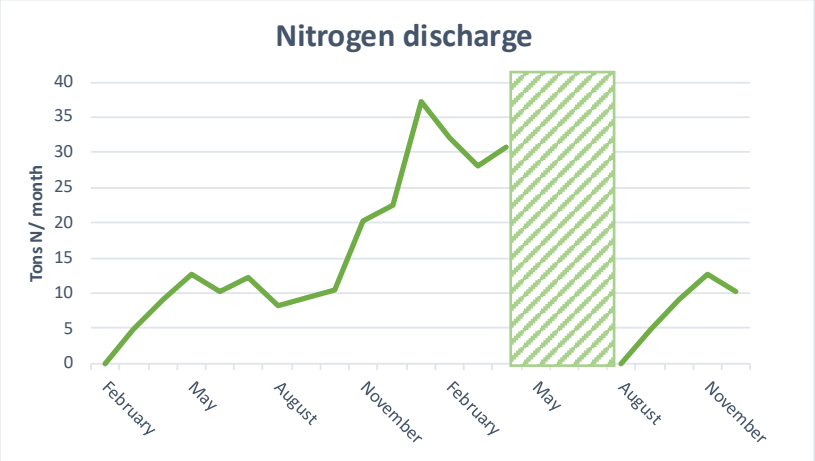


Figure 13: Simulated nitrogen discharge pr. Month at a sea site with all-in all-out production scenario. The feed administered is a function of the size of the fish, the total biomass and the sea water temperature. The crossed area represents the fallowing period.

The potential impacts from increase in nitrogen availability is thought to be small if the net pen sites are distributed over a larger geographical area[18]. It will however need to be modelled and thoroughly analysed in the site-specific Environmental Impact Assessments during the planning permission.

[18] Salmon Farming in the Falkland Islands: A review of environmental and social challenges and opportunities, Seagreen Research on behalf of Falklands Conservation, September, 2018

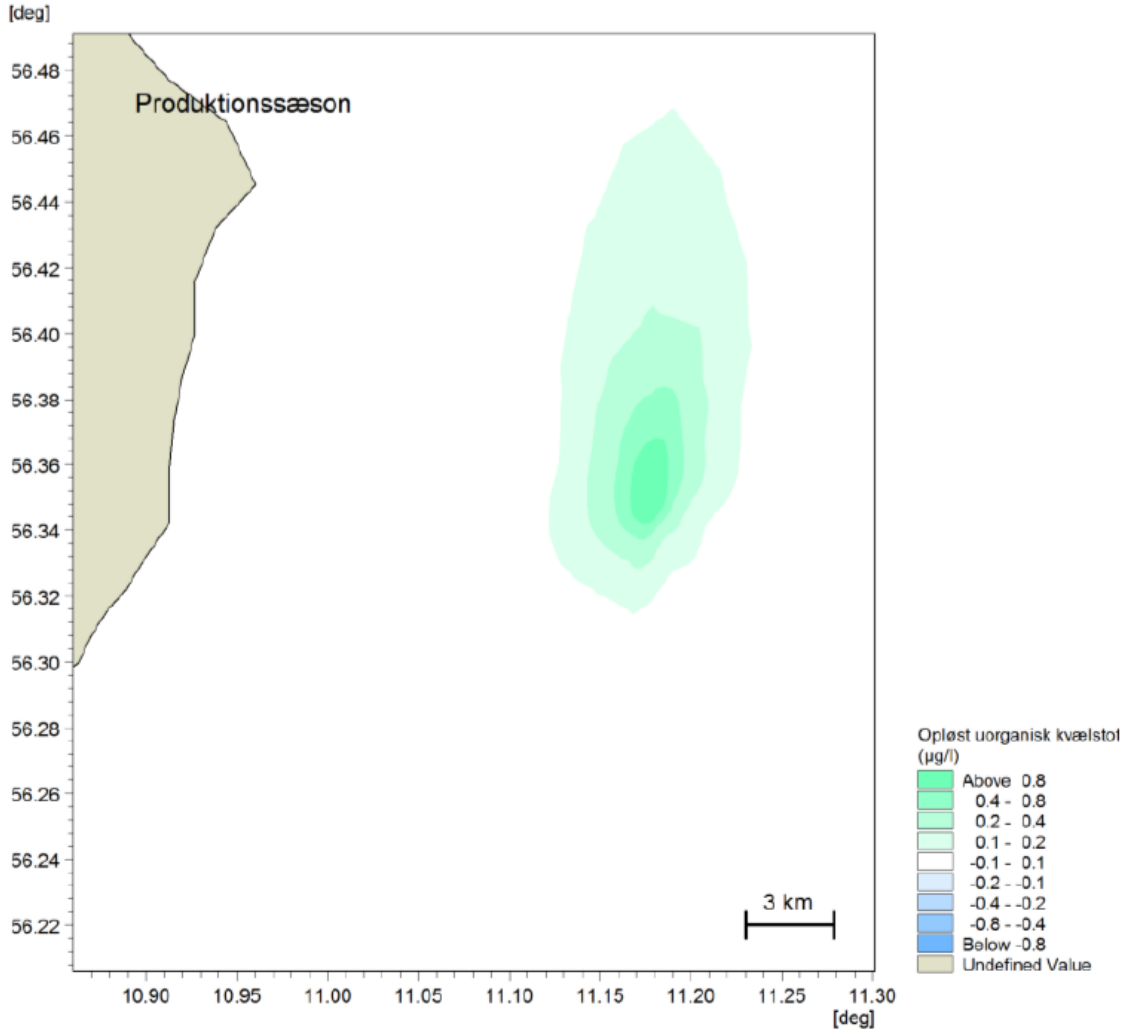


Figure 14: Figure showing the style of model output that will be conducted in the Falklands. Diagram shows the modelled changes in average dissolved inorganic nitrogen during the production period in the surface water from a net pen site in Denmark. The site has been modelled with a total Nitrogen discharge contribution of 100 tonnes/ year[19]. The discharged amount nitrogen is similar to the size of discharge anticipated from a site on Falkland Islands.

9.2.3 Phosphorous discharge

Phosphorous is abundant in the world oceans and is thus less likely to impact primary production significantly. If placed in shallow sounds with little water exchange it can potentially lead to an increased primary production that in turn can impact other trophic levels and dependent food webs. The spatial distribution of the increased primary production is thought to be small (0.5-1 km from the sites).

[19] Modellering af lokaliteter til havbrug, Vurdering af miljøeffekter, Standard Havbrug D i Havbrugszone D, DHI for NaturErhverstyrelsen 2017.

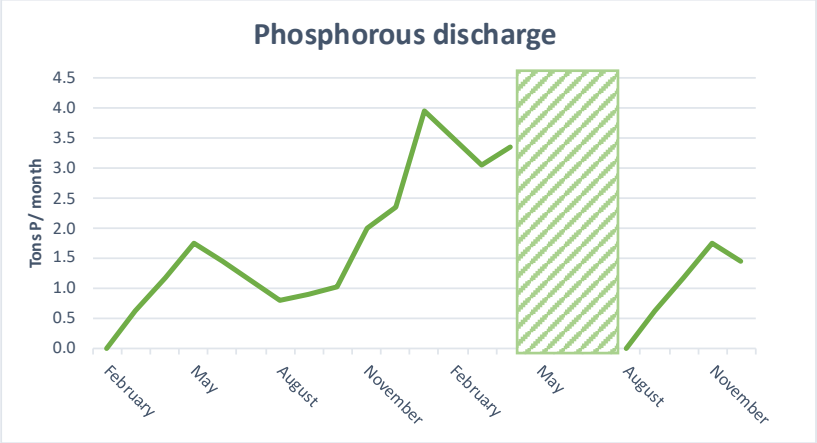


Figure 15: Simulated phosphorous discharge pr. Month at a sea site with all-in all-out production scenario. The feed administered is a function of the size of the fish, the total biomass and the sea water temperature. The crossed area represents the following period.

The potential impacts from increase in phosphorus availability is thought to be negligible if the net pen sites are distributed over a larger geographical area[20]. Again, the effect will need to be modelled and thoroughly analysed in the site-specific Environmental Impact Assessments during the planning permission.

As it can be seen the change in N and P concentrations in the surface water (Figure 14 and Figure 15) is relatively small as soon as you move away from the site. It is important to stress that these models are not directly transferrable to the Falkland Island waters, due to abiotic factors like waves, wind, current and bottom substrate.

9.2.4 Organic material

BOD in the form of faeces and uneaten feed settle on the seabed in an area controlled by the water depth and the current speed. The result is a local organic loading in sediments below and surrounding the net pens. This can potentially have a profound impact on organisms directly under the net pens. The effect however decreases exponentially with increasing distance from the site, such that impacts are typically not observable at 500 m from the farm.

[20] Salmon Farming in the Falkland Islands: A review of environmental and social challenges and opportunities, Seagreen Research on behalf of Falklands Conservation, September 2018

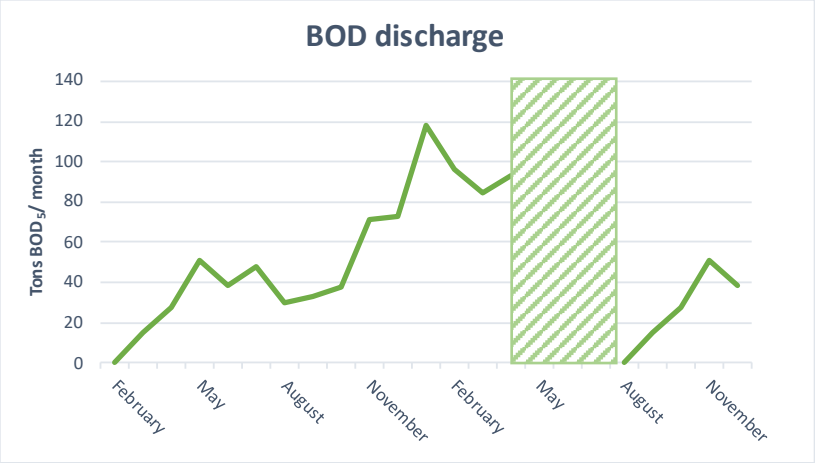


Figure 16: Simulated BOD_5 discharge pr. Month at a sea site with all-in all-out production scenario. The feed administered is a function of the size of the fish, the total biomass and the sea water temperature. The crossed area represents the fallowing period.

9.2.5 Mitigation strategies

As the company is aiming to be certified in accordance with the ASC standards it will also follow criterion 2.1 in that standard. Criterion 2.1 has specific requirements for impacts on benthic biodiversity and benthic effects stemming from the aquaculture operation. The company will thus document redox potential in the sediment and fauna indexes that provide evidence of impacts being within pre-defined levels.

The sea sites will be placed based on a throughout measuring and modelling analysis, which will secure that the current on the site will dissipate and spread the discharged nutrients and organic material over a wider area.

There are a number of planned mitigations strategies that will be used to reduce the potential impacts from the discharge of organic matter and nutrients:

1. Placement of sites in areas with optimal current and thus dissipation nutrients.
2. Use of high-quality feed.
3. Feeding behaviour monitoring.
4. Frequent fallowing.
5. Monitoring of seabed nutrient loading.
6. Monitoring of seabed fauna development.

The company plans to install underwater cameras in all the net pens. This will enable the staff to visually inspect the fish and adjust the feeding manually. This secures that the fish are fed according to their appetite with subsequent little loss of feed pellets to the surroundings. The feed used will be of the highest quality with a high digestible content, increasing nutrient retention, lowering the feed conversion ratio and subsequently lowering the nutrient discharge and the amount of feed fed.

The company will continuously be collecting environmental data both for securing the wellbeing of the stock and to monitor potential environmental impact at all the sites. Data loggers will be installed on the

barge at each sea site and will measure temperature, oxygen levels, current speed and direction as well as pH, salinity and chlorophyll concentration.

Before, during and after a production cycle bottom sampling with a Van Veen grab will be carried out, to determine potential environmental impact from sedimentation on the benthic community. Plankton samples will also be performed at regular intervals, analysed and levels recorded.

After every finished production period the site will be fully fallowed for four (4) months. This will allow benthic assemblage to recover before new fish are transferred to the sites.

Secondary mitigation strategies, if the company's monitoring program identifies unwanted build-up of organic content in the sediment surrounding the site or other derived effects, will be as follows:

1. Immediate reduction in feeding, reducing output to the sea.
2. Moving of some or all the stock to another site.
3. Prolonged fallowing period after finished production cycle.
4. In case of repetitive events on the same site the equipment will be moved to a new site (subject to independent EIA) or the site will be re-classified with lower maximum biomass and feed allowance.

All data will be logged and will be made available on the company web page with public access.

9.3 Noise

Underwater noise associated with regular, ongoing farm activities (including vessels) may either exclude, disturb or attract marine mammals, sea birds and penguins. Furthermore, the mechanical systems on the feed barges will create a more permanent background noise.

The personnel operating the farm will sail from the barge to each of the net pens to perform daily duties and collect possible mortalities from the mort collectors. Temporary noise from these operations can be expected.

Mitigation strategies for reducing the effects of noise generation consists of the following:

1. Placement of facilities well away from known bird breeding colonies.
2. Sailing routes planned to avoid sensitive areas.
3. No use of marine mammal acoustic deterrent devices.
4. Placement of noisy equipment inside feed barge or vessel.

The company suggest that all net pen installations are placed a minimum distance to any known bird breeding colony or area, in order not to disturb the birds during the breeding season. Any ship or vessel will also need to sail in planned routes to avoid disturbing sensitive areas.

It is common in some aquaculture areas, like Scotland and Chile, to use acoustic deterrent devices to keep marine mammals away from the net pens. The company will not use such devices, as they have both; proven to be ineffective and they are prohibited in use in the ASC certification.

The potentially noisy equipment in the forms of blowers and the generators are placed inside the barge in a closed compartment. Therefore, very little or no noise is expected to affect the surroundings from standard daily operations. All operations including use of noisy equipment not contained on the barge or inside a vessel will to be carefully planned and reduced to a minimum.

9.4 Light

Work light on vessels and barges, positioning lights on buoys and the potential use of underwater lights can all disturb, attract or dispel local wild life.

> In order to minimize potential impacts, the following mitigation strategies will be implemented:
>
> 1. Restrict the use of outdoor work lights on vessels and barges.
> 2. If lights are needed, directional lighting will be used.
> 3. Generally, only perform service operations during daylight hours.
> 4. Avoid the use of underwater lights.

The company might opt to use artificial underwater lights to prevent the fish from maturing and increase the daylength and thus period of feeding.

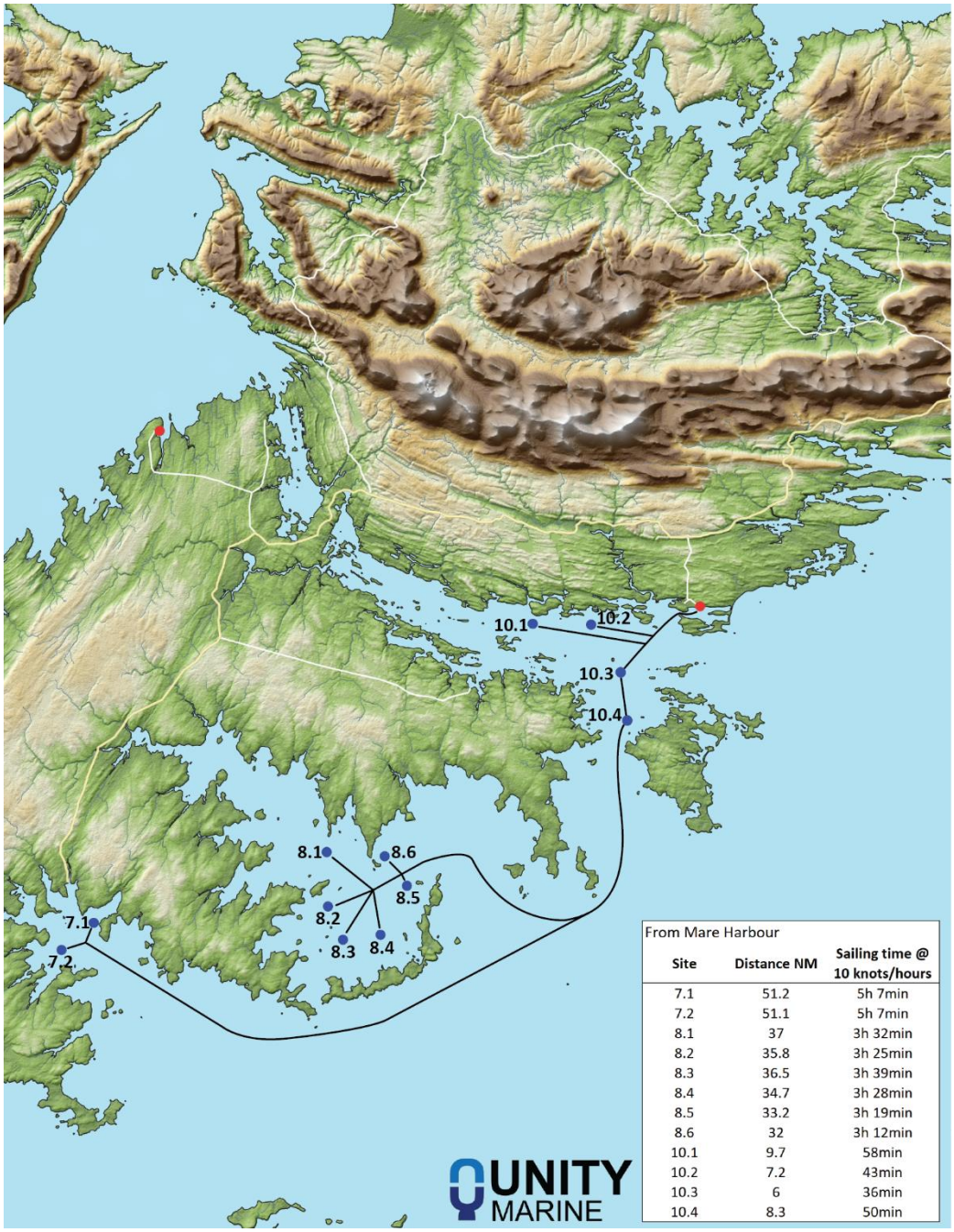
Artificial underwater lights have been showed to attract both invertebrates and small fish to sea sites[21]. The use of underwater lights can thus inadvertently attract marine mammals to the aggregation of wild fish or lead to increased predation activity on caged fish.

There are currently no known studies on the effects on food webs from the use of underwater lights. It is however likely that the use of the lights will increase predation on small invertebrates and fish by larger predators like pinnipeds or penguins around the pens.

9.5 Vessel traffic

Transport of goods and personnel will take place on a daily basis around the sites. The activities can potentially disturb breeding colonies of birds or mammals close to the sites. The company's fleet manager will be coordinating and planning the frequency and routes for vessel traffic to ensure safety.

[21] Effect of artificial light on marine invertebrate and fish abundance in an area of salmon farming, A. McConnell *et al*., Mar Ecol Prog Ser, 2010

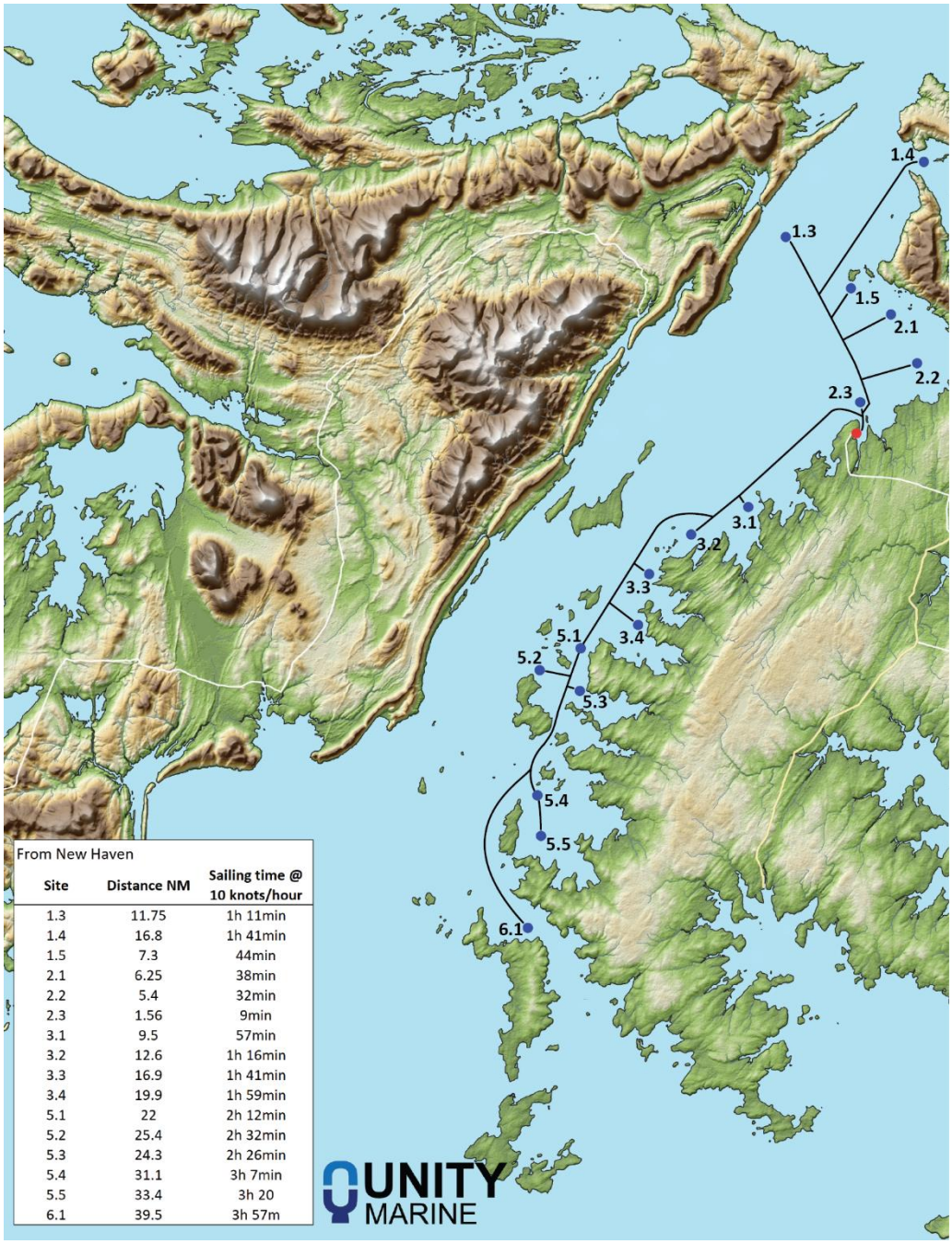


From Mare Harbour

Site	Distance NM	Sailing time @ 10 knots/hours
7.1	51.2	5h 7min
7.2	51.1	5h 7min
8.1	37	3h 32min
8.2	35.8	3h 25min
8.3	36.5	3h 39min
8.4	34.7	3h 28min
8.5	33.2	3h 19min
8.6	32	3h 12min
10.1	9.7	58min
10.2	7.2	43min
10.3	6	36min
10.4	8.3	50min

Figure 17: Proposed routes for personnel transfer on the East coast of East Falklands, distance to the sites in nautical miles and estimated travel time at ten (10) knots.

Workboats performing maintenance on the net pens or personnel carrying ships will go to and from each site every 3-5 days.



From New Haven

Site	Distance NM	Sailing time @ 10 knots/hour
1.3	11.75	1h 11min
1.4	16.8	1h 41min
1.5	7.3	44min
2.1	6.25	38min
2.2	5.4	32min
2.3	1.56	9min
3.1	9.5	57min
3.2	12.6	1h 16min
3.3	16.9	1h 41min
3.4	19.9	1h 59min
5.1	22	2h 12min
5.2	25.4	2h 32min
5.3	24.3	2h 26min
5.4	31.1	3h 7min
5.5	33.4	3h 20
6.1	39.5	3h 57m

Figure 18: Proposed routes for personnel transfer on the West coast of East Falklands, distance to the sites in nautical miles and estimated travel time at ten (10) knots.

Fish feed, fresh water and diesel for the aggregates will be transported to each site approximately every second week by boat. Transport of smolts from the land-based facilities and harvests will take place approximately three (3) to eight (8) times every year at each site.

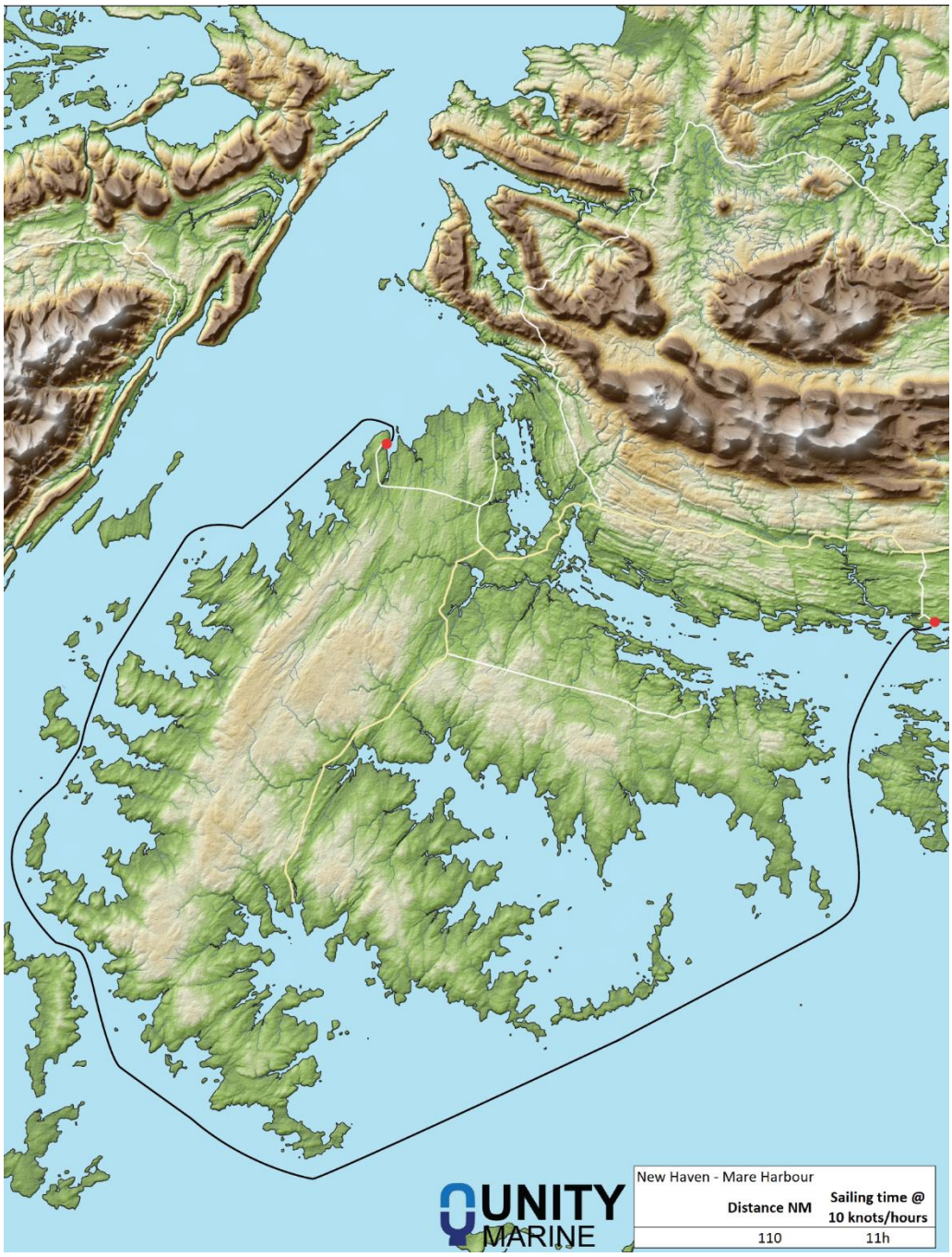


Figure 19: Proposed sailing routes when the large service vessels, the supply vessel and the well boat are travelling from East to West of East Falklands or vice versa.

The company's general mitigation strategies consist of the following:

1. Placement of the company activities well away from known bird breeding colonies
2. Planning of standard sailing routes away from specifically sensitive areas or areas with known congregations of sea mammals.

The company would like to place their sea-based activities at least 0.5 NM from any known important bird nesting area or sea mammal breeding ground in order not to disturb the wild life. The company will also avoid placing any activities within a 2 NM distance to any Ramsar area.

Potential accidental impacts are described in following sub-chapters.

9.5.1 Coast erosion

Vessel traffic stern wakes can potentially cause coastal erosion.

In order to mitigate the potential risk of coast erosion the following mitigation strategies will be employed:

1. Reduce sailing speed of vessels when sailing within 300 m from the coast
2. Avoid sailing near to specifically sensitive stretches, if any
3. Yearly inspections of coast stretches with frequent vessel traffic
4. In case of identification of damage to a coast stretch sailing routes and/ or allowed sailing speed will be adjusted

9.5.2 Wildlife strikes

There is potential for company vessels to strike marine mammal resulting in injury or death. Birds are most likely to strike vessels during nighttime, when the vessel has lights turned on.

Strikes may be more likely in areas where large numbers of whales congregate to feed as well as evidence that vessel sound signatures are louder from the side and stern of the vessel than from the bow, making detection of an approaching vessel more difficult for a whale in front of the vessel. Most lethal and severe injuries to large whales resulting from documented ship strikes have occurred when vessels were travelling at ≥ 14 knots.

Specific mitigation strategies for minimizing the effects of the potential impacts can be found in subsequent chapters.

Any vessel sailing in waters that has known populations of marine mammals will need to follow the following rules to reduce risk of wildlife strikes:

1. Reduce sailing speed of vessels when in areas with frequent marine mammal activity.
2. Reduce sailing speed if congregations of whales, dolphins or other mammals are observed, and include seasonality in the Vessel Management Plan.
3. Employ a Vessel Management Plan, developed by the Fleet Manager.

In order to reduce the likelihood of bird strikes the following mitigation strategies:

1. Minimize sailing during night-time.

9.5.3 Chemical spills

No chemical spills (silage, formic acid) are expected from vessel traffic. Transfer to and from the feed barge of any such substance is further detailed in section 9.9.

9.5.4 Fuel spills

No fuel spills are expected from vessel traffic. Transfer to and from the feed barge of fuel is further detailed in section 9.10.

9.5.5 Vessel strikes of other boats

The company vessels can potentially hit other company vessels, private or third-party vessels. In worst case scenarios one or both of the involved boats can sink. This can lead to fuel or chemical leaking to the surroundings and subsequent harm of local marine environment.

In order to reduce the potential risk of vessel strikes the following mitigation strategies will be employed:

1. All vessels will be equipped with Automatic Identification System (AIS).
2. Reduce sailing speed of vessels when sailing in areas with other traffic.
3. Secure that all personnel operating boats have been trained in handling the specific vessel.
4. A Fleet Manager will be employed to manage all vessel activity and coordinate activities with FIG and Mare Harbour.
5. All fuel tanks will be fitted with one-way valves.

In case of any vessel sinking in Falkland Islands waters, the larger of the company work boats will be capable of raising (80 t crane) and towing this vessel to shore or assisting the authorities in maritime emergencies.

9.6 Waste disposal

Waste will be collected, separated and disposed of according to the guidelines on the Falkland Islands. The waste can consist of used netting, mooring chains, ropes and other equipment as well as sewage and silage from the feed barge.

To mitigate potential impacts from waste disposal the company will:

1. Collect and separate the waste disposal according to local guidelines.
2. Secure that waste disposal is stored securely, in order to avoid that wildlife can get contact to the waste disposal, and to avoid the disposal to be spread by wind or wildlife.
3. Sewage from the feed barge will be collected and brought to shore for further processing.
4. Silage will be brought to shore, used for fertilizer of animal feed or exported.

9.7 Escape of stock

Generally Atlantic Salmon has been shown to be poor at colonizing new areas outside the species' original range. Atlantic salmon has been one of the most intensively introduced species around the world. Despite many attempts to establish sport fisheries, Atlantic salmon have shown poor colonizing ability when introduced sporadically and have generally failed to establish self-sustaining populations beyond the native range[22].

Even without establishing a breeding population on the Falkland Islands there is still a potential ecological effect of escaped salmon. One such impact can be through predation on other fish species and invertebrates. Escaped Atlantic Salmon is thought to occupy the same niche as the Brown Trout living off crustaceans, cephalopods and small fish. Some escaped fish might also migrate into the rivers and disturb spawning beds of the Brown Trout.

Salmon have a maximum reported lifespan of 13 years. Escaped salmon could thus live up to ten (10) years in the wild. Gut analyses have however found that of marine-captured Atlantic salmon in the Northeast Pacific Ocean found that only 6-21% of the escaped fish contained food items[23]. This would indicate that the domesticated fish have trouble adapting to a life in the wild. This would in turn also indicate a somewhat shorter life expectancy of escaped fish.

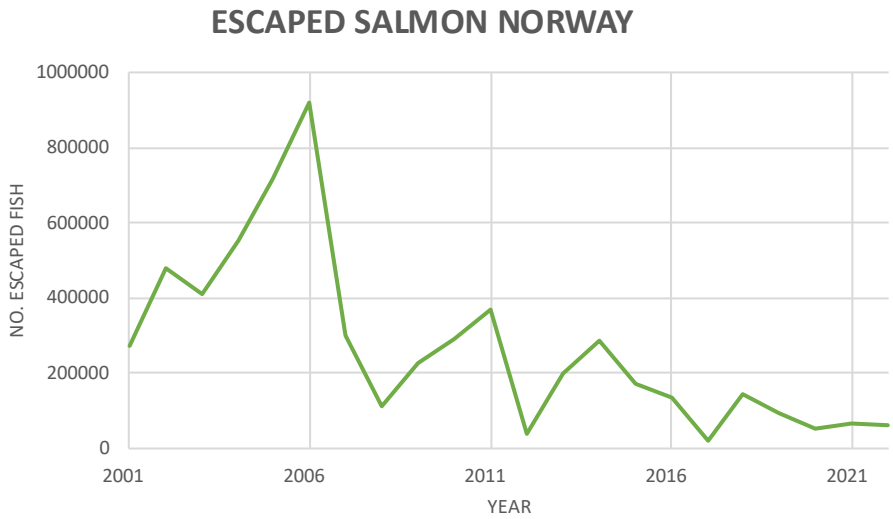


Figure 20: Number of escaped salmons in Norway from 2001-2022. A dramatic drop can be seen from 2006-2007 when the NS 9415 standard was fully implemented. The production increased threefold in the period[1].

The Norwegian salmon production has been approximately 1,300,000 tonnes on average from 2013-2022. If the number of escaped salmons from Norwegian aquaculture is scaled to the suggested production of 50,000 tonnes on the Falkland Islands, then an average of yearly escape of 4,670 fish would be expected.

[22] Incidence and impacts of escaped farmed Atlantic salmon Salmo salar in nature, Thorstad et. al, NINA Special Report 36., World Wildlife Fund, 2008
[23] Incidence and impacts of escaped farmed Atlantic salmon Salmo salar in nature, Thorstad et. al, NINA Special Report 36., World Wildlife Fund, 2008

Escapes from the net pens can potentially happen from a number of factors:

- Net damage caused by predator attacks
- Mechanical damage caused by extreme weather conditions
- Mechanical damage caused by equipment malfunctioning
- Mechanical damage caused by vessels
- Human errors in connection with net change or movement of fish

As the production is relying on sterile fish, any escapees be unlikely to generate reproducing populations in the wild. Potential impacts of escaped salmon on prey species will be investigated for the EIA.

9.7.1 Predator attacks

The South American Fur Seal (*Arctocephalus australis*), Southern Sea Lion (*Otaria flavescens*), the Southern Elephant Seal (*Mirounga leonine)* or Leopard seal (*Hydrurga leptonyx*) can all potentially attack the net pens to feed on the fish inside the pen.

Especially seal and Sea lion attacks are often encountered in all the areas where net pen salmon aquaculture is taking place.

There have not been any reports of actual whale attacks on pens. Orcas and other dolphins have been known to swim close by the pens, without interfering with the net pens. Some Canadian Humphback whales has developed a strategy for feeding on newly released salmon smolts for restocking. In this case the whales swim close by the pens but never actually interferes with the net pens[24]. Some reports on equipment entanglement by especially Humpback Whales has been reported. Entanglement can lead to mechanical damage to the nets (and mammal injury) and subsequent escape of stock, please see section 9.11 for details.

The net pen design with a weighted sinker tube allows for even and “bar-tight” tensioning around the whole of the predator and stock nets. Attachment of both nets to the same sinker tube ensures that a significant gap is maintained between the nets, preventing seals from pushing the other net right in to the stock net to attack the fish.

The outer predator net is designed to come up to a height of 2.5 m above the water line supported by the extended stanchions holding the bird net. This will not just prevent Sea mammals to scale the net and get in through the top, it will also create a safe working platform for the company’s employees. The pens and nets are further designed so that tension can be regulated from the surface on the drop ropes down to the sinker tube.

[24] Humpback whales feed on hatchery-released juvenile salmon, E. M. Chenoweth et al., Royal Society Open Science, 2017

The company will also focus on removing potential mortalities from the net pens quickly and never dispose any potential feed source in the form of guts, blood water or feed pellets to the surroundings. Removing the potential feed source from the sites will make the net pens less interesting for the marine mammals in the area.

The company's mitigation strategies for avoiding damage on the nets consists of the following measures:

1. Installation of predator nets surrounding the net pens.
2. Extension of the predator nets above the water line.
3. Removal of potential mortalities part of daily routine.
4. Storing mortalities in the silage tanks on the barge.
5. Design to keep nets tight (increased weights) reducing potential seal/ sea lion ability to get to the stock and reducing risk of entanglement.
6. Regular cleaning of inner and outer nets for biofouling and reducing attractiveness to invertebrates and fish species.

The company is, as earlier mentioned, also planning on using sterile or all female fish in the production further reducing the impact of possible escapees to the surroundings.

9.7.2 Extreme weather

Extreme weather in the form of exposure to waves, wind, ice formation or current needs to be considered and mitigation efforts needs to be taken to avoid mechanical failure due to possible events.

The following mitigation strategies will be employed to reduce the risk of damage or breakdown of the equipment due to extreme weather events:

1. Incorporation of NS 9415 standard for maintenance, design and operation of the sea sites
2. Detailed measurement and modelling of current, winds and waves prior to design

The company plans to use the Norwegian standard NS 9415:2021 for the dimensioning and operation of the sites. NS 9415:20021 has specific requirements for site surveys, risk analyses, design, dimensioning, production, installation and operation of net pen sites in marine waters[25]. In general, it can be said that all constructions need to be planned to withstand 50-year events in terms of wind, wave and current exposure.

9.7.3 Mechanical malfunction

Mechanical malfunction can happen because of wear and tear of the equipment, insufficient maintenance or improper use or installation of equipment. A mechanical malfunction can lead to escape of some or all the fish in a net pen.

[25] Marine fish farms, Standard Norway, NS 9415.E:2021, ICS 65.150;67.260

Industry standard mitigation strategies varies greatly between regions. Norway is frontrunner within this field having adopted the standard NS 9415[26], that has dramatically reduced the number of escapees from Norwegian aquaculture.

> The following mitigation strategies will be employed to reduce the risk of mechanical malfunction or breakdown and subsequent escape of stock:
>
> 1. Incorporation of NS 9415 standard for maintenance, design and operation of the sea sites

The company plans to use the Norwegian standard NS 9415:2021 for the dimensioning and operation of the sites. NS 9415:2021 has specific requirements for site surveys, risk analyses, design, dimensioning, production, installation and operation of net pen sites in marine waters.

The standard sets out standards for proper maintenance procedures and requirements for used equipment. All equipment used will thus be certified according to the standard.

9.7.4 Vessel strikes

Vessels strikes can cause damage to the net pens with subsequent risk of escape of the stock. Vessel strikes can be caused by both the company's own vessels or other vessels in the area. Vessel strikes is considered to cause accidental impacts on the environment.

The net pens and mooring systems will be marked with buoys according to the current legislation on the Falkland Islands. Furthermore, the sites will always be manned. In case of imminent danger of collision, the company's personnel will hail the intruding ship via radio and secondarily by visual means e.g. flares or strobe lights. Due to the remoteness of the sites and the low frequency of vessel activity in the area, the risk of vessel strikes by non/company vessels is reduced compared to waters in other regions.

The company's vessels, whether it is a well boat, processing ship or a maintenance vessel, will regularly sail close to the pens and mooring systems. That increases the risk of strikes at low speed or entanglement in mooring lines or nets. The company will train the personnel in safely operating the vessels in close proximity to the net pens. It is also worth to note that vessel strikes, or damage caused by the company's own vessel usually tends to have a lower impact, as the company's personnel is present at the time of the damage and will thus be able to take immediate precautions to reduce the impact of the damage.

Mitigation strategies will consist of throughout procedures and checklists in connection with docking or sailing close to the sea sites. The procedures will be described in the company's Production Protocol and will be in accordance with any specifications found in NS 9415. All personnel participating in the operations will also need to go through the company's training program.

[26] Marine fish farms, Standard Norway, NS 9415.E:2021, ICS 65.150;67.260

The following mitigation strategies will be employed to reduce the risk of vessel strikes and propeller entanglement of nets or moorings:

1. Buoy marking of all installations, potentially including lights, radar reflectors or electronic beacons.
2. Personnel presence at the site.
3. Training of the company staff.
4. Minimize sailing during night-time.
5. All vessels will be equipped with Automatic Identification System (AIS).

9.7.5 Human errors

Although accidents will occur due to human error, the company will produce detailed protocols and managed plans for minimising the opportunity of human error where possible. Such protocols and management plans will necessarily include inspection logs and similar tools for full, auditable tracing of any accidents of gaps in the management plans.

The most likely events for potential fish loss are during grading or transfer of fish and during net changing procedures.

The following mitigation strategies will be employed to reduce the risk of human errors:

1. Development of safe standard procedures.
2. Incorporation of NS 9415 standard for maintenance.
3. Training of the company staff.

During grading or transfer events a pipe can slip if not properly fastened. This type of incident is usually quickly discovered, as personnel will be present during the operation and usually only results in the escape of a few hundred fish.

Mitigation strategies will consist of throughout procedures and checklists in connection with net changing and movement of fish. The procedures will be described in the company's Production Protocol and will be in accordance with any specifications found in NS 9415. All personnel participating in the operations will also need to go through the company's training program.

9.8 Pathogens

9.8.1 Spread of pathogens

The Zebra trout (*Aplochiton zebra)* inhabits fresh waters of the Falkland Islands and could present a link for pathogen transfer even though it is not closely related to the Atlantic salmon. Along with the Falkland Minnow the other endemic fresh water fish it also believed to spend some of the juvenile stages in the sea. The risk of lateral transfer between species not closely related is however considered to be minimal.

As the water from the land-based fresh water facilities will be discharged to sea, no direct line of infection is anticipated. The Brown Trout can however function as an intermediate host for pathogens in lateral transfer from the farmed salmon to the Zebra trout or wise versa. The unlikely transfer of diseases between these not closely related species is however likely to have taken place already, if possible, during the time since the Brown Trout was introduced in the 50'ies.

The Brown Trout will be migrating to and from the spawning rivers and is likely to pass in close proximity to the net pens. Horizontal transfer is thus a real risk that needs to be taken into account. Naturally occurring parasites in the wild stock of Brown Trout will need to be investigated in order to generate a better understanding of pathogens and parasites that could be encountered on the Islands. This will be a part of the company veterinarian's assessment of the pathogen threat level on the Islands. Like the Brown Trout the recently immigrated Coho Salmon can have cause lateral transfer of diseases. This could also affect the Brown Trout and should be monitored closely.

9.8.2 Bacterial infections

Bacterial infections can be treated with either antibiotics and through prophylactic use of vaccines.

The most noticeable bacterial infections in Salmon farming are Furunculosis, Coldwater Vibriosis (*Vibrio salmonicidae*) and Winter Ulcer (several bacterial strains, most prevalent *Moritella viscosa*) as well as Piscirickettsiosis in Chile. They have all historically presented serious threats to the industry.

Coldwater Vibriosis was detected in the net pens in Fox Bay during the trials run by FIDC in 1989 and should thus be considered to be present in Falkland Island waters already[27]. Effective vaccines have reduced the bacterial infection within the industry dramatically over the last couple of decades. Piscirickettsiosis remains a threat to Chilean aquaculture even though it has been almost eradicated in Norway[28].

Yersiniosis (*Yersinia ruckeri*) or endemic Redmouth Disease is still a problem in some fresh water production sites in Norway. Early dip vaccination of the stock can prevent outbreaks and is used systematically in some facilities that seems to have developed house strains.

The types of bacterial infections reported from Norwegian aquaculture in 2017, can be seen below.

Viral infection	Treatment	Status
Furunculosis	Vaccination	Almost eradicated in Norway through vaccination programme. Likely to be present in local population of Brown Trout.
Coldwater vibriosis	Vaccination	No observations in Norway in 2016
Winter Ulcer	Vaccination in case of *M. viscosa* infection, Florfenicol or Oxolinic acid treatment in case of other strain	Some observations from Northern Norway, especially during winter at low temperatures.
Yersiniosis	Vaccination (dip vac.), Florfenicol or Oxolinic acid if outbreak	Relatively common in Norway, where some facilities have developed house strains.
Piscirickettsiosis	Vaccination, Florfenicol or Oxolinic acid if outbreak	Almost absent in Norway, most prevalent bacterial infection agent in Chile

[27] Salmon Pilot Project, report by Eilif Dagsvold, Fox Bay 15th June 1990

[28] Informe Sanitario de Salmonicultura en Centros Marinos 1° semestre 2017, Servicio Nacional de Pesca y Acuicultura, 2017

Table 6: Possible bacterial infections.

9.8.3 Fungal infections

Fungal infections usually only occur in the fresh water phase of the production cycle and is almost always caused by *Saprolegnia* spp. species. Infections are most common in connection with hatcheries but is also observed in broodstock in the fresh water phase. Outbreaks in the sea water phase of the production is highly unlikely.

9.8.4 Viral infections

Viral infections along with salmon lice attacks (see **Error! Reference source not found.**) usually presents the largest risk to the production and subsequently horizontal transfer to wild stock.

In the table below the most commonly encountered viral infection can be seen. There are dedicated breeding programs on Salmon broodstock, that increases the resistance of the stock against Pancrease Disease (PD) and Infectious Pancreatic Necrosis (IPN) as well as Heart and Skeletal Muscle Inflammation (HSMI). Vaccinations have been developed for PD (partial coverage), IPN and Infectious Salmon Anemia (ISA). A vaccine for HSMI is under development and should be on the market within a few years.

Viral infection	Number of infections Norway 2017	Prophylactic treatment	Action in case of outbreak
Pancrease Disease (PD)	176	Vaccination, Breeding, avoiding stress	Establishment of certain biosecurity measures, including zoning and limitations on fish movement
Infectious Salmon Anemia (IPA)	14	Vaccination	Culling, fallowing of site
Infectious Pancreatic Necrosis (IPN)	23	Vaccination, Breeding	Removal of infected fish, Biosecurity measures
Cardiomyopathy Syndrome (CMS)	96	Breeding, avoiding stress	Removal of infected fish Biosecurity measures
Heart and Skeletal Muscle Inflammation (HSMI)	93	Breeding, Vaccine (under development), avoiding stress	Removal of infected fish, Biosecurity measures, avoiding stress
Viral Haemorrhagic Septicaemia (VHS)	None	No treatments	Removal of infected fish, Biosecurity measures

Table 7: Main viral types of infection, treatments and number of cases from the Norwegian aquaculture sector in 2016.

Most viral pathogens will be strictly associated with Salmon and to some extent closely related species like the Brown Tout. Some species can however function as reservoirs for pathogens without showing signs of infection e.g. PD in Lump suckers.

On the Falkland Islands the Company's veterinarian will determine the need for vaccinations and procurement of salmon strains with increased resistance for specific viral infections like PD, ISA, HSMI and IPN.

9.8.5 Parasites

The most commonly encountered parasite in aquaculture is the Salmon Louse (*Lepeophtheirus salmonis).* The salmon louse is not currently present in Falkland Island waters and is thus not likely to present a

problem for the production or lateral transfer to wild stock of Brown trout. *L. salmonis* is a strictly marine species and is often treated with fresh water baths, so in the case of infections it can be dealt with without the use of chemicals.

Another fish louse *Caligus rogercresseyi* known to attack salmon is more likely to be present in Falkland Islands' waters. *C. rogercresseyi* infections are widespread in the Chiles region X and XI but not so in the colder region XII. *C. rogercresseyi* predates on many different species and is thought to have transferred to salmon from a local rock cod species in Chile. The species is temperature dependent and will not develop at a temperature below 4.2°C[29]. Furthermore, it has been shown that only half of the nauplii will survive at a temperature of 6°C[30]. Given the local sea water temperatures, it is considered unlikely that epidemic infections will take place in the Falklands. Rising sea water temperatures, due to global warming, can however make infections more likely in the future.

Amoebic gill disease (AGD) is caused by a parasitic amoeba *Paramoeba perurans*. It was first encountered and have caused considerable numbers of outbreaks in the Salmon industry on Tasmania, Australia. In the last decades it has been observed in other salmon farming countries (Scotland, Ireland, Norway and Canada). The AGD parasite is believed to have a global distribution range.

AGD is treated with fresh water or hydrogen peroxide baths – where the fresh water treatment is thought to be the most effective. Unlike most other salmon parasites, it can infect laterally to non salmonoid species (e.g. Lumpsucker and Ballan Wrasse). It is usually associated with high water temperatures (>11°C) and high salinities. With the summer temperatures reaching a maximum of around 12°C in the Falkland Islands, it is considered unlikely that *Paramoeba perurans* poses a threat to a Salmon farming operation in Falkland Island waters.

There are a number of less commonly occurring parasites including tapeworms (*Eubothrium spp.*), *Desmozoon lepeophtherii*, two species of *Ichthyobodo spp.* and *Parvicapsula pseudobranchicola*. These infections are less severe. In the case of *Parvicapsula pseudobranchicola* it has a limited distribution due to a complicated life cycle, where a local polychaete in Northern Norway functions as the main host and the fish as an intermediate host. It is therefore not considered to be a threat on the Falkland Islands.

9.8.6 Treatments

The number of treatments used in aquaculture depends on the veterinarian and management precaution taken by the producer, the general pathogenic threat in the farming area and the Company's prophylactic use of vaccines. In the table below the total number of antibiotic treatments in Norwegian aquaculture can be seen.

	2012	2013	2014	2015	2016	2017
Salmon – fresh water stage	57	35	39	24	21	28
Salmon – sea water	21	15	11	8	11	6
Total treatments	78	50	50	32	32	34

Table 8: Total number of antibiotics treatments in Norwegian aquaculture. There were 976 active sea sites and 187 smolt production facilities in operation in 2016 indicating 2.75% of all sites experienced a situation where a

[29] Life cycle of Caligus rogercresseyi, (Copepod: Caligidae) parasite of Chilean reared salmonids, L González and J. Carvajal, Aquaculture 220 (2003) 101-117

[30] Early development of the ectoparasite Caligus rogercresseyi under combined salinity and temperature gradients, J. A. Montory et al., Aquaculture 486 (2018) 68–74

antibiotics treatment was necessary. If extrapolated to the suggested setup on the Falkland Islands 0.6 treatments/ year should be expected.

In total only six (6) net pen sites used proscribed antibiotics in 2017. The amount used in each treatment is higher for the net pen sites than for fish in the freshwater stage, as the biomass in the net pens are far larger than the biomass on land.

There is a risk of potential use of antibiotics can lead to an accumulation of antibiotic residues in the sediment surrounding the sea sites. The residues can potentially subsequently be distributed in the food web. Considering the small anticipated use of antibiotics, the impact is currently thought to be low, but will however need to be investigated in detail in the EIA.

In the table below the use of pharmaceutical products used in Norwegian Aquaculture on a yearly basis can be seen. It should be noted that almost half the 2017 use of antibiotics could be ascribed to one treatment at sea. As it can be seen

Antibacterial substances	2017	2018	2019	2020	2021	2022
Florfenicol	285	858	156	113	546	397
Oxolinic acid	343	54	66	107	57	28
Oxytetracycline	0	20	0	0	0	0
Total antibiotics	612	931	222	220	593	425
Anti-Tapeworm						
Praziquantel	380	171	50	123	38	59

Table 9: Total use of pharmaceutical products (active substance in kgs) in Norwegian aquaculture from 2017 – 2022. Anti-salmon lice treatments intentionally omitted. The table includes the total use of products, some of the antibiotics has been used on other species than salmon e.g. lump suckers.

If the numbers from the production of 1,234,000 tons of salmon in Norway was extrapolated to the 50,000 tons of planned production on the Falkland Islands, then the expected pharmaceutical use on the Islands can be calculated. This number is however dependent on the operation maintaining high veterinary standards, as in Norway.

Antibacterial substances	Norway 2023	Falkland Island – 50,000 tonnes
Florfenicol	490	19.9
Oxolinic acid	33	1.3
Oxytetracycline	0	0
Total antibiotics	523	22.2
Anti-Tapeworm		
Praziquantel	117	4.7

Table 10: Treatments used in Norwegian aquaculture and extrapolated use in the project (active substance in kgs) – assuming the same health standards are maintained on the Falkland Islands.

The use of antibiotics was thus approximately 0.4 mg/ kg of produced fish in Norway in 2023. In the production of pork in Denmark 57 mg/ kg of meat is used in 2017. A large part of this production is exported to the UK.

The average UK human consumption was 135 mg/ kg (of human) in 2013[31]. If it is assumed that this figure is valid for the Falkland Islands and the average weight of a human being on the Islands is estimated to be 75

[31] UK One Health Report Joint report on human and animal antibiotic use, sales and resistance, HM government, 2013

kg, that gives a total human biomass of 225,000 kgs on the islands. Then that entails a yearly human antibiotics usage of 30.38 kgs.

Put in perspective Unity Marine anticipates a yearly use of 26 kilos for a production of 50,000,000 kgs of fish.

In Salmon aquaculture in the northern hemisphere the use of treatments for sea lice includes various compounds like Slice® and hydrogen peroxide (H_2O_2). Chemical treatments are currently being phased out of Norwegian aquaculture and substituted with mechanical treatments (scrubbing, warm fresh water, in-situ removal by laser) or use of cleaner fish (Lump sucker, Ballan Wrasse). In case of a lice infestation Unity Marine is planning to rely solely on mechanical treatments with no use of chemicals.

9.8.7 Mitigation strategies

All fish will be vaccinated prior to transport to the net pens. It will be the company's strategy in general to use prophylactic vaccines instead of treatments, to reduce the use of medicaments in the production. The exact vaccination program will be determined by the company's veterinarian and will be based on the current determined pathogen threat level in the area.

The fish will be monitored continuously using underwater cameras and the feeding behaviour. Any potential mortalities will be collected daily and duly recorded in the production log. In case of any suspicious symptoms the company's veterinarian will be contacted and action taken based on the veterinarian's prescriptions.

There are currently no salmon lice (*Lepeophtheirus salmonis)* population in Falkland Island waters. There might be local Caligulus species that can transfer to salmon. Therefore, no treatments with salmon lice medicaments are expected. If any lice problems are encountered the company will use either local cleaner fish, mechanical de-lousing methods or another procedure not including chemical treatments.

The following mitigation strategies will be employed to reduce the risk of pathogen infections and potential spread to wild stock:

1. Using bio-secure stock from closed containment facilities.
2. The company will vaccinate the fish against salmon pathogens identified locally.
3. Regular visits from the company's veterinarian.
4. Continuous monitoring of the stock by use of underwater cameras.
5. Daily removal and registering of potential mortalities from the net pens.
6. Following the routines in the company's Fish Health Plan.
7. Following guidelines set in the Company's Fish Health Plan for removal and culling of infected stock as well as disinfecting and fallowing of the site.

Please see general chapter on pathogens (6.12) for more throughout Impact assessment.

9.8.8 Medicine

On any indication on an infection of the stock the company's fish veterinarian be called in. Treatment will only take place in case if the veterinarian proscribes a treatment. Only medicine, that has been approved for fish farming in the UK will be used, where the UK standards are considered industry best practice. No treatments are expected, but if the situation dictates it, even considering the company's biosecurity protocols and vaccination programme, then up to three (3) treatment can take place a year on a single site.

The company's mitigation strategy consists of a prophylactic vaccination program and good husbandry practices reducing stress on the fish and thus likelihood of disease breakouts.

> The following mitigation strategies for reducing discharge of medicines or chemicals to the marine environment will be followed:
>
> 1. Continuous monitoring of feeding during treatment to reduce loss of non-eaten feed.
> 2. Prophylactic vaccination program.
> 3. Use of non-chemical treatments to remove sea lice, if encountered.
> 4. Employ the highest standards in animal welfare including managing stocking. densities and other factors that will reduce fish stress.

The following treatments could be used; Oxolinic acid and Tribissen, consisting of Sulfadiazin (CAS no. 68-35-9), Trimethoprim (CAS no. 738-70-5) as well as Florfenicol. The treatment will be given through feeding of specialized feed e.g. Aquavet (Biomar, Brande, DK). The feeding will be monitored closely during treatments to ensure that the feed is eaten by the fish to reduce potential discharge of the medicaments to the environment.

As salmon lice are not present on the islands the company is not planning treatments to control this potential pest. In the unlikely event of a salmon lice infestation or infestation by another Caligus, the company will use non-chemical treatments of the fish like e.g. Thermolicer[32], Stingray[33] or local species of cleaner fish to control the situation.

On a yearly average the company does not foresee a antibiotics usage above 26 kgs of active substance. Based on whether there is a presence of tapeworms in Falkland waters it might be necessary to administer Praziquantel as well. In that case the use will be around 16 kgs of active substance per year.

9.9 Chemical spills

The company's feed barges will contain dedicated tanks for the containment of mortalities collected from the net pens and for the chemicals that has been planned to be used in the production.

In terms of chemicals used on the sea sites please see the table below. It is worth to note that no chemicals are planned to be in direct contact with the production water. Any chemical use will be duly noted in the company's Production Journal.

[32] https://www.steinsvik.no/en/products/e/seaculture/fish-health/thermolicer
[33] http://en.stingray.no/page/6026/Optical_Delousing

Chemical	Identification number	Use
Formic Acid	CAS nr.: 64-18-6	Used for ensilage of mortalities. Dosed directly into the ensilage tank based on pH measurement (pH 3.0). The company will use a slightly diluted product to avoid potential explosion risks. The silage can be used directly as fertilizer.
Iodofor™ or similar	CAS nr.: 39392-86-4	Used for disinfection of equipment and footbaths. Use on the sea sites will be small.
Lubricants and oil	-	Used to lubricate and maintain the motors and equipment on the company's vessels and the feed barge. Food grade oils to be used wherever possible.
House hold detergents	-	Common household cleaning detergents, soap, shampoo and other cleaning substances. Will be collected in the barge sewage tank.

Table 11: Anticipated use of chemicals at the sea sites.

During transfer of formic acid for the ensilage process from personnel and fish ensilage of mortalities to or from the barges or in case of a breakdown of one of the barge fuel tanks there is a potential that the substances could end up in the ocean resulting in damage to the marine environment.

The feed barge will be fitted with spill tanks able to contain chemical, oil or ensilage spills in case of breakdown of any of the containing tanks. No spills from these substances due to breakdown of containment tank into the surrounding environment is therefore likely.

Any process where silage is pumped from the barge to the supply ship will be monitored by the company personnel. Any spill due to a slipping pipe or mechanical breakdown of a pipe is therefore not likely to be larger than 30-100l per spill.

To reduce impact on the environment on any potential chemical spill the company will employ the following mitigation strategies:

1. The feed barges will be constructed with spill tanks that can collect the entire volume of any tank.
2. Develop safety procedures for the transfer of chemicals to the barge or removal of silage from the barge.
3. Personnel will always be present during any transfer of fluids.
4. In case of breakdown of a tank the spill will be pumped from the spill tank into the supply vessel and brought to shore for safe disposal.
5. The company will use food grade oil wherever possible to reduce impacts from potential spills.

Any spill will be immediately reported to the authorities. All the substances are organic and will eventually be broken down by microorganisms in case of a spill.

9.10 Fuel spills

A Fuel Management Plan will be used to outline protocols and procedures for storing fuel and containing spills. During transfer of fuel to or from the barges or in case of a breakdown of one of the barge fuel tanks there is a potential that the fuel could end up in the ocean resulting in damage to the marine environment.

The feed barge will be fitted with spill tanks able to contain all the fuel in case of breakdown of any of the fuel tanks. No spills from these substances into the surrounding environment is therefore likely to take place.

Any process where fuel is pumped from the barge to the supply ship will be monitored by the company personnel. Any spill due to a slipping pipe or mechanical breakdown of a pipe is therefore not likely to be larger than 30-100l per spill.

To reduce the risk of fuel spills the company will employ the following mitigation strategies:

1. The feed barges will be constructed with spill tanks that can collect the entire volume of any tank containing fuel.
2. Develop safety procedures for the transfer of fuel to the barge or pumping of fuel from the barge to any of the company vessels.
3. Personnel will always be present during any transfer of fluids.
4. In case of breakdown of a tank the spilled fuel will be pumped from the spill tank into the supply vessel and brought to shore for safe disposal.

Any spill will be immediately reported to the authorities.

9.11 Impact on wildlife from physical structures

The installations and moorings can potentially displace or prevent wildlife from entering the used sea areas.

The net pens will prevent animals from entering the production areas – and thus exclude wildlife from these areas. Therefore, the sea sites will be planned to be positioned away from known major migratory routes or feeding areas of sea mammals or penguins, if any. The moorings will also take up some or the sea bottom potentially displacing wildlife from these small areas.

The following mitigation strategies will be employed to reduce exclusion of wildlife:

1. Placement of the net pen sites away from any known migratory route.
2. Placement of the net pen sites away from any known major feeding area.
3. Reduce footprint of anchors used for mooring the net pens and feed barge.



Figure 21: Sea birds around a Huon Aquaculture net pen. Despite many seals and sea birds in the farming area Huon only reported nine (9) bird mortalities and one (1) seal mortality in the last 12 months from ten (10) net pen sites. Similar technology will be employed by Unity Marine on the Falkland Islands. Details can be found on Huon Aquaculture website: https://dashboard.huonaqua.com.au/

The nets and moorings below the water and the bird protection net above the water can potentially also entangle wildlife in the form of whales, seal, sea lions or birds. Unity Marine will use net pens designed to keep the below water nets taught. This has been proven to reduce the number of mammal entanglements. The bird net has its own 6m carbon fiber supports that themselves exert an outward tension from the center of the pen to keep the bird net taught and well above any feeder bin or feeder spreader in the pen. A taught net is less likely to cause entanglements.

A similar design is employed by Huon Aquaculture in Tasmania (https://dashboard.huonaqua.com.au).

All wildlife will be reported immediately to the authorities and will also be reported on the company web page.

The following mitigation strategies will be employed to reduce mortalities from entanglements:

1. Net pens will be designed with two meters of free water between the fish containing net and the predator net to reduce seal and sea lion interest in fish inside the net.
2. Bird net will be equipped with bird escape hatch for birds accidently trapped inside the bird net.
3. All nets and ropes will be kept taught to reduce likelihood of entanglement.
4. Personnel will be trained in gently handling of potentially entrapped wildlife.

10 Processing ship and feed pellet carrier

The Company has opted to import fish feed pellets, rather than the alternative of producing feed on the island. Similarly, fish processing will likely occur in Chile where gutted, chilled fish will be shipped directly from the farm on the processing vessels. These activities will increase marine traffic in areas where there is currently little activity.

Managing environmental impacts of this increased marine traffic will fall to both Unity Marine as well as FIG authorities depending on chartering arrangements or services required by Unity Marine. However, the company will ensure that processes are in place for minimising environmental impacts of related traffic in the Falklands as well as operations carried out by those vessels on site.

10.1 Feed Carrier

The amount of feed required is predicted to be 60,000 tonnes/ year. This equates to 2,250- 2,500 containers of feed delivered through standard freight routes to Mare Harbour or Stanley (FIPASS) if the feed is delivered as containerized freight.

The feed pellet carrier will only unload approximately 10% of the total delivered feed on the hatchery wharfs at Mare Harbour and/or New Haven. It is anticipated that most of the feed will be delivered directly to the feed barges at the sea sites. This aspect will naturally limit the size of feed delivery ships to those that can effectively manoeuvre the waterways surrounding the sea farm sites and link with the feed barges.

Frequency of feed delivery is predicted to be twice per month. This would require at least two vessels in constant rotation delivering feed and returning to Chile for new supplies.

Feed transfer at the wharf would likely occur at any time day or night. Feed transfer at sea site feed barges would be restricted to daylight hours only for operational safety purposes, as well as reducing light levels attracting seabirds.

10.2 Processing vessel

This vessel or vessels will make multiple return trips between farm sites and Chile or another South American country, where fish will be processed. This may involve a single ship or multiple ships working in rotation. Depending of the size and number of the vessels, the frequency can be once or twice every week year-round. Similar to feed carriers, processing vessels will be restricted to those that are able to safely operate within waterways surrounding farm sites.

Transfer of salmon from sea pens to processing vessels will be done during daylight hours only. Transfer operations will be conducted according to strict and auditable protocols for minimising potential escape of salmon to the sea. A full harvest of 1,000 tonnes takes approximately ten (10) hours.

10.3 Risks and mitigation

Many of the mitigation strategies for potential environmental impacts, for example in relation to CO_2 – emissions, noise generation, light disturbances, chemical spills and fuel spills, will be similar to the Company's mitigation strategies for vessel activities.

Plans for vessel activities are pending other financial and logistic factors and are thus currently not fully determined. However, the following risks can be assumed;

1. CO_2 and other emissions
2. Noise
3. Light

The following accidental sources that can potentially lead to environmental impacts have been identified:

4. Vessel traffic
5. Chemical spill
6. Fuel spill
7. Escape of stock
8. Invasive species
9. Impact on wildlife from physical structures

General mitigation strategies to minimize impacts from vessel activity in connection with processing and feed delivery:

1. Modern vessels with low CO_2 footprint.
2. Dynamic positioning systems on board all vessels.
3. Clear protocols, logs and training of crew.
4. Vessel will be required to sail under a flag with proper safety and insurance policies.
5. FIG biosecurity and Fisheries/ Customs compliance and monitoring.
6. All discards in the form of processing waste will be brought to shore at the processing ship harbour of operations.

11 Harbour/ wharf activity

Wharves and related facilities will need to be constructed at New Haven and Mare Harbour sites. Wharf activities at New Haven and Mare Harbour will function as a service hub for sea sites in Falklands Sound and south east coast of East Falkland, respectively. While the current harbour facilities at Mare Harbour are thought to be adequate, facilities in New Haven will need to be upgraded with a new wharf independent of the ferry terminal. In order to ensure continuous and safe operations and New Haven, a breakwater pier may also need to be constructed.

Plans for these developments are pending other financial and logistic factors are currently not fully determined. However, the following planned sources that potentially can have environmental impacts have been identified for the harbour/ wharf facilities:

1. Road traffic
2. Noise
3. Light
4. Waste disposal
5. Construction activities

The following accidental sources can potentially lead to environmental impacts have been identified:

6. Vessel traffic
7. Chemical spill
8. Fuel spill
9. Invasive species
10. Impact on wildlife from physical structures

The harbour/ wharf activities are suggested to be described and assessed independently of the main EIA process.

Many of the mitigation strategies for potential environmental impacts, for example in relation to road traffic, noise generation, light disturbances, waste disposal, chemical spills and fuel spills, will be similar to the Company's mitigation strategies in other fields. Management will also be further described in the company management plans.

The construction of the new wharf and potential breakwater pier at New Haven, will be subject to a detailed planning, design and investigative phase. Disturbance of sediments and wildlife in connection with the construction of the facilities will be of specific concern and will thus be assessed in detail.

General mitigation strategies to minimize impacts from harbour/ wharf activities:

1. Comprehensive EIAs for each wharf sites completed prior to wharf construction approval.
2. Detailed modelling of potential disturbances and changes in current and subsequent sedimentation in connection with wharf/ breakwater at New Haven.
3. All operations will follow the detailed operational and management plans.
4. FIG biosecurity and Fisheries/Customs compliance and monitoring.
5. All waste will be controlled under the Waste Management Plan.

12 Appendix A: Table and figures

12.1 Figures

Figure 1: Life cycle of Atlantic Salmon entails a juvenile fresh water phase. After a morphological change called smoltification the fish becomes a salt water fish and migrates to the sea. 9

Figure 2: Map showing proposed locations of land-based facilities at Mare Harbour and New Haven. 22

Figure 3: Schematic drawing of one of the facilities for smolt rearing. Based on site investigations the facilities will be built on two separate plots at Mare Harbour and New Haven. Measurements in millimeters. 23

Figure 4: Simulated feeding pr. month at the Mare Harbour hatchery. The feed administered is a function of the size of the fish and the total biomass. 24

Figure 5: Simulated nitrogen discharge pr. month at the Mare Harbour hatchery. The feed administered is a function of the size of the fish and the total biomass. 26

Figure 6: Simulated phosphorous discharge pr. month at the Mare Harbour hatchery. The feed administered is a function of the size of the fish and the total biomass. 27

Figure 7: Simulated BOD_5 discharge pr. month at the Mare Harbour hatchery. The feed administered is a function of the size of the fish and the total biomass. 27

Figure 8: Site layout for Mare Harbour. Water will be drawn through a pump station placed at the lake shore. 30

Figure 9: Principal of influent water pump station planned to be used at both at Mare Harbour and New Haven. 1) Fresh water resource (pond or stream), 2) gravitational in-seeping through the ground to the pump sump, 3) Pump sump with submerged pump, 4) influent water pipe to the facility, 5) renewable energy source and battery backup. 31

Figure 10: Site layout for New Haven. Water will be drawn through three pump stations placed at the streams by Dos Lomas and pumped to the facility. 32

Figure 11: Placement of the sea sites around East Falkland. 38

Figure 12: Simulated feeding program for the Falklands. Month at a sea site with all-in all-out production scenario. The feed administered is a function of the size of the fish, the total biomass and the sea water temperature. The crossed area represents the fallowing period. 40

Figure 13: Simulated nitrogen discharge pr. Month at a sea site with all-in all-out production scenario. The feed administered is a function of the size of the fish, the total biomass and the sea water temperature. The crossed area represents the fallowing period. 42

Figure 14: Figure showing the style of model output that will be conducted in the Falklands. Diagram shows the modelled changes in average dissolved inorganic nitrogen during the production period in the surface water from a net pen site in Denmark. The site has been modelled with a total Nitrogen discharge contribution of 100 tonnes/ year. The discharged amount nitrogen is similar to the size of discharge anticipated from a site on Falkland Islands. 43

Figure 15: Simulated phosphorous discharge pr. Month at a sea site with all-in all-out production scenario. The feed administered is a function of the size of the fish, the total biomass and the sea water temperature. The crossed area represents the fallowing period. 44

Figure 16: Simulated BOD_5 discharge pr. Month at a sea site with all-in all-out production scenario. The feed administered is a function of the size of the fish, the total biomass and the sea water temperature. The crossed area represents the fallowing period. 45

Figure 17: Proposed routes for personnel transfer on the East coast of East Falklands, distance to the sites in nautical miles and estimated travel time at ten (10) knots. 48

Figure 18: Proposed routes for personnel transfer on the West coast of East Falklands, distance to the sites in nautical miles and estimated travel time at ten (10) knots. 49

Figure 19: Proposed sailing routes when the large service vessels, the supply vessel and the well boat are travelling from East to West of East Falklands or vice versa. 50

Figure 20: Number of escaped salmons in Norway from 2001-2022. A dramatic drop can be seen from 2006-2007 when the NS 9415 standard was fully implemented. The production increased threefold in the period. 53

Figure 21: Sea birds around a Huon Aquaculture net pen. Despite many seals and sea birds in the farming area Huon only reported nine (9) bird mortalities and one (1) seal mortality in the last 12 months from ten (10) net pen sites. Similar technology will be employed by Unity Marine on the Falkland Islands. Details can be found on Huon Aquaculture website: https://dashboard.huonaqua.com.au/ 66

12.2 Tables

Table 1: Production parameters for one of the smolt facilities. Production in metric tons (t). 25

Table 2: Feed composition for the smolt just prior to transfer to the sea. 25

Table 3: List of chemicals planned to be used in the land-based facilities. 35

Table 4: Production parameters for one of the sea sites with all-in all-out batch transferred in October. 40

Table 5: Feed composition for the grow-out phase at sea. Feed composition varies somewhat with the size of the fish. Therefore, there is a range applied to the different constituents. All discharge data has been calculated with the right formula for the right size of fish. 41

Table 6: Possible bacterial infections. 59

Table 7: Main viral types of infection, treatments and number of cases from the Norwegian aquaculture sector in 2016. 59

Table 8: Total number of antibiotics treatments in Norwegian aquaculture. There were 976 active sea sites and 187 smolt production facilities in operation in 2016 indicating 2.75% of all sites experienced a situation where a antibiotics treatment was necessary. If extrapolated to the suggested setup on the Falkland Islands 0.6 treatments/ year should be expected. 60

Table 9: Total use of pharmaceutical products (active substance in kgs) in Norwegian aquaculture from 2017 – 2022. Anti-salmon lice treatments intentionally omitted. The table includes the total use of products, some of the antibiotics has been used on other species than salmon e.g. lump suckers. 61

Table 10: Treatments used in Norwegian aquaculture and extrapolated use in the project (active substance in kgs) – assuming the same health standards are maintained on the Falkland Islands. 61

Table 11: Anticipated use of chemicals at the sea sites. 64



Unity Marine - Socio-Economic Impact Considerations

APPENDIX B

UPDATED JANUARY 2026, V.2.0

1 Content

1 Content 1
2 Document Scope 4
3 Executive summary 5
4 Introduction 7
4.1 Socio Economic impact of establishing an aquaculture enterprise 7
4.2 Updated report 7
5 Unity Marine Project Description 9
5.1 Project Objective 9
5.2 Project Schedule 10
6 Current Economy and Society on the Falkland Islands 11
6.1 Falkland Islands 11
6.2 Population 11
6.3 Employment 12
6.4 Housing and Accommodation 12
6.5 GDP and FIG revenues & reserves 12
6.6 Businesses 14
6.7 Logistics 14
6.8 Oil and gas 14
6.9 Fishery sector 15
6.10 Aquaculture on the Falkland Islands 15
6.11 Laws and legislation 16
6.11.1 Aquaculture ordinance 16
6.11.2 Falkland Island development plan 16
7 Socio-Economic Impact 18
7.1 Direct Impact 18
7.2 Indirect Impact 18
8 Impact on GDP and FIG revenues & reserves 19
8.1 Expected GDP growth from direct activities 19
8.1.1 Production capacity 19
8.1.2 Salmon Prices 19
8.1.3 GDP growth and FIG revenues & reserves 20
9 Impact on Employment 23

9.1 Employment Strategy 23
9.2 Unity Marine employment 24
9.2.1 Stanley office 26
9.2.2 Operational management team 26
9.2.3 Land based operations 26
9.2.4 Sea Sites 27
9.2.5 Warehouse and Workshop 27
9.2.6 Supply ship 28
9.2.7 Well boat 28
9.3 Employment in public and private sector 28
9.3.1 Public Services directly related to new aquaculture industry 28
9.3.2 Indirect public and private services 29
9.4 Local Employment 29
9.5 Temporary Employment 29
9.6 Long term labour market impact 31
10 Impact on Population 32
10.1 Overall Employment and Population Impact Correlation 32
10.2 Population Impact 32
10.3 Local Employment 33
10.4 Joint recruitment activities 34
10.5 Immigration Policy and Work Permits 34
11 Impact on Housing and Accommodation 35
11.1 Increased population and rotational workers on shore 35
11.2 Establishment of new homes and accommodation 35
11.3 Expat homes 36
11.4 Rotational workers and people temporarily onshore 36
11.5 Demand for temporary accommodation 36
12 Impact on Infrastructure and Construction Needs 38
12.1 Airport and flights 38
12.1 Harbours and piers 39
12.2 Electricity 39
12.3 Roads 40
12.4 Hospitals 40

12.5 Schools and Education 40
12.6 Construction capabilities 40
12.7 Corporate Social Responsibility 40
13 Business Sector Effects 41
13.1 Current interaction with local businesses 41
13.2 Future interaction with local businesses 41
13.2.1 Collaboration with the tourism sector 41
13.2.2 Joint recruitment initiatives 42
13.2.3 Local house rental business 42
14 Spatial and Societal Effects 43
14.1 Geographical distribution of activities, employment and population 43
14.2 Effects and future potential in Stanley 44
14.3 Effects and potential in Camp 44
14.4 Future potential on West Falkland 45
15 Appendix A: Table and figures 46
15.1 Figures 46
15.2 Tables 47

2 Document Scope

This document describes the potential Socio-Economic impacts from the introduction of a Salmon farming business in the Falkland Islands. It describes the methods used to inform the analysis and sets out conclusions regarding impacts directly related to the establishment and operation of an indicative project, as well as the indirect impacts with respect to:

1. GDP growth
2. FIG revenues & reserves
3. Employment and labour market effects
4. Public services and private business community
5. Population growth
6. Housing and accommodation demand
7. Infrastructure needs

3 Executive summary

The key socio-economic impacts are set out below:

1. A company head office would be established in Stanley, in addition to two (2) on shore hatchery facilities in Mare Harbour and New Haven for farming of juvenile salmon, as well as sixteen (16) off shore sites with net pens for on growing of the salmon. The finished product will be processed on an off-shore processing ship, and feed will be transported directly to the production sites from Chile.

2. Establishment of the aquaculture business will create a demand for labour, immigration and new additional housing and accommodation. Employment demand will peak and stabilise at approximately 100 additional onshore workers, and 100 off-shore workers. The majority (82%) are hired directly by Unity Marine, whereas the rest will be additional private and public sector jobs. The spatial distribution of the new on shore jobs would see 37 FTEs in Stanley, 26 FTEs in Mare Harbour and 38 FTEs in New Haven.

3. Due to high employment rate and required aquaculture experience, most of the additional labour demand will be filled by foreign expats and rotational workers. Expats with specific aquaculture experienced are required for 23 positions, whereas the rest can be hired locally, as rotational workers or as expats, with the opportunity for jobs for locals aligned to a skills development programme.

4. The total labour demand of 181 employees (including planned offshore rotational workers), is lower than the general population growth of 7.8% that the Falkland Islands have experienced over the last five (5) years (2016-2021).

5. The employment of foreign labour will generate a need for new housing and accommodation that will be provided by the business operating the salmon farming operation The expats with families will need 23 new family homes. Unity Marine will be looking to establish four (4) company houses for rotational on shore workers living on the Islands, typically in two-month shifts. Each company house will have capacity for five (5) rotational or temporary workers.

6. Temporary labour demand during the construction and installation phase will peak in 2029 and 2030 with an average of 31 temporary contracted foreign workers on shore. Existing temporary accommodation is expected to be sufficient, and temporary accommodation facilities can be established during peaks if needed.

7. The aquaculture business offers an opportunity for the Falkland Islands to further diversify the economy and generate new and substantial additional revenues for the Falkland Islands Government. A small fraction of this income will be required to meet the additional pressure on public services. The remainder will be available to the Government for investment in the development of essential infrastructure and improved public services and quality of life for residents.

8. Policies for work permits and immigration may require review to facilitate a smooth process for recruitment of foreign workers critical for the successful establishment of the aquaculture business.

This will be important to how additional workers integrate within the wider Falkland Islands community, particularly within and alongside camp settlements.

9. The potential impact on the Falklands GDP and on FIG revenues & reserves will be substantial with an estimated annual GDP growth of £200m and FIG revenues of £26m when full capacity is reached. In comparison, the existing fishing industry accounted for 60% of the GDP between in 2022, with FIG revenues of around £32m. Current FIG budgets for the next 5 years show a depletion of "net liquid assets" (reserves) from £254m to £113m and a reduction in the "ratio of uncommitted reserves to adjusted department expenditure" (the ratio) 1.5% and a reduction in the ratio headroom from £166m to £21m. Projections indicate that expenditure in years 6 – 10 is expected to significantly exceed net operating revenue with a further deterioration of reserves (reducing to £28m), liquidity ratio (reducing to 0.4%) and headroom (a deficit of -£64m). The impact of the proposed aquaculture business is expected to reduce and reverse this decline within 10 years.

4 Introduction

The plans for the proposed aquaculture business on the Falkland Islands is detailed in the main project description. The plan describes the need for several large-scale facilities to be constructed or installed on the Falkland Islands to support the business goals. As there is no current aquaculture business on the Islands, infrastructure will need be constructed from scratch and furthermore will need to be of a scale that makes it economically viable and to deliver the wider and economic forecast benefits to the Falkland Islands.

4.1 Socio Economic impact of establishing an aquaculture enterprise

Development of an aquaculture business on the Falkland Islands will have a significant socio-economic impact, particularly considering the small resident population of around 3,662 individuals. The aim of this study is to describe the effect on:

1. The potential direct and indirect economic impacts (GDP and revenues & reserves).
2. The need for labour and resulting population changes.
3. The increased needs for accommodation, housing and logistics.
4. Changes in private and public sector service and infrastructure needs.
5. Spatial and society effects.

This socio-economic impact assessment has been carried out by Pisco ApS of Denmark on the behalf of F-land ApS and have somewhat been based on the assumptions from the Socio-Economic Study of Oil and Gas Development in the Falklands, performed by Regeneris Consulting Ltd, UK and S2V Consulting, Australia for the Falkland Island Government (FIG) in 2012-2013[1].

In this study the focus is on the socio-economic effects of establishing an aquaculture business. Any cumulative effects regarding establishment of an oil and gas sector, or any other major commercial undertaking on the Falkland Islands has not been included in this study. For obvious reasons cumulative stress on the labour market, housing and accommodation, infrastructure and on public sector services will be seen if a concurrent development of the oil and gas industry takes place at the same time as development of the aquaculture business.

During this study the team has carried out the following tasks to complete this report:

1. Interviews with key government and commercial stakeholders
2. Carried out multiple visits to the Falkland Islands
3. Reviewed of existing social and economic data on the Falkland Islands
4. Reviewed of experience from introducing aquaculture in other remote locations around the world

4.2 Updated report

This latest analysis has been updated based on a revised project proposal, market developments and other general developments on the Falkland Islands.

The main change is linked to updated temperature assumptions based on measurements carried out by Unity Marine. Measurements that showed somewhat higher than expected temperatures in inner Falkland

[1] Socio-Economic Study of Oil and Gas Development in the Falklands, Regeneris Consulting Ltd, May 2013

Islands waters. As Atlantic Salmon are a poikilothermic animal, the fish temperature reflects the surrounding water temperature. This in turn is reflected in the growth of the fish, that grows faster at higher temperatures.

The higher temperatures coupled with updated growth data from the egg supplier and genetics company Aquagen, Norway, has allowed Unity Marine to plan with faster growth of the fish, which in turn leads to shorter production time in the sea. As the number of required sea sites is coupled directly to the production time, Unity Marine has identified the potential to reduce the number of sea sites from 20 to 16, or a reduction of 20%. This is perceived to greatly reduce the footprint of the operation and will also have cascading impact on number of required employees and number of required vessels.

The change in number of employees as well as updated market data has been used to update the estimated Socio-economic impacts.

5 Unity Marine Project Description

In this section the suggested aquaculture business and the implementation project is briefly outlined. For a detailed description of establishment and operations, please refer to the project description.

5.1 Project Objective

The overall business plan describes the development of a fully integrated aquaculture company registered and operated from the Falkland Islands. In accordance with the current Fish Farming Ordinance[2] it is determined that at least 25.1% of the relevant proportion of the issued ordinary share capital is owned by persons enjoying Falkland Island status. This share can, due to the charter of the company never be less than the 25.1% but can be increased through local ownership of internationally traded shares. Unity Marine

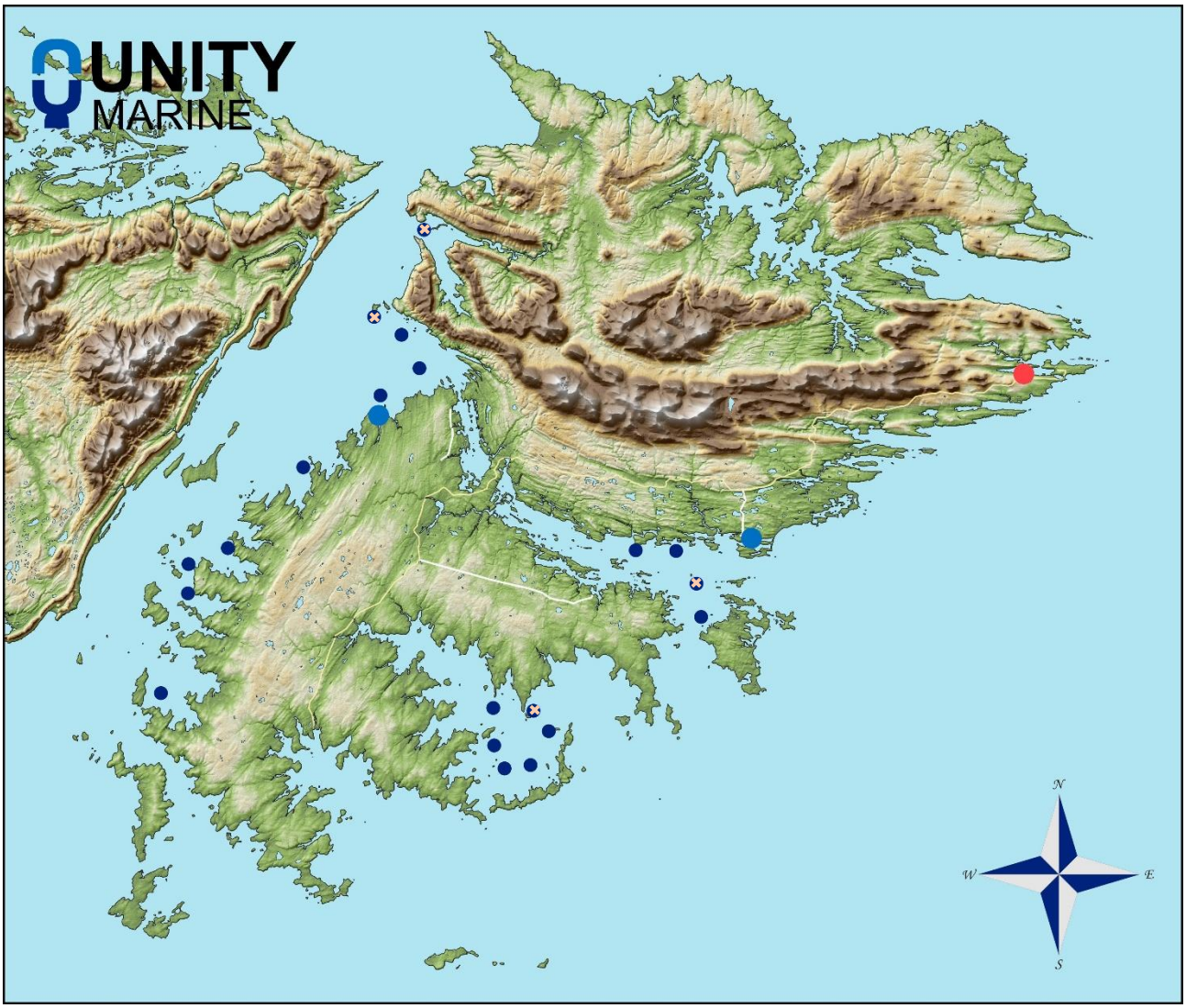


Figure 1: The proposed company activities on the Falkland Islands. The sea sites that is no longer planned to be used are marked with an x.

[2] Fish Farming Ordinance 2006, Ordinance No. 20 of 2006, Falkland Island Government, 2006

has a stated goal of maximizing local ownership, therefore local shareholders will always have first right of refusal for procurement of internationally tradeable shares put out for sale.

The aim is to establish a fully integrated production of annually 50,000 metric tons of Atlantic Salmon using best available standards. In addition to the operational units, it will be necessary to import feed and process the fish as well as move the fish and provide veterinary services.

The company is planning to build, procure, lease and operate the following facilities and services:

1. Two land-based operations, workshops and warehouse facilities in Mare Harbour and New Haven.
2. Sixteen (16) offshore sea sites with net pens.
3. Supply ship, service vessels and well boat.
4. Processing ship (offshore).
5. Veterinary services.
6. Main office.

5.2 Project Schedule

The project has been split into four (4) phases to address the level of development through the project life cycle. There will be some overlap between some of the phases, e.g. phase IIIb will overlap with phase IV as operation of the first land-based facilities will be initiated, while the second phase is under development.

1. Phase I – Pre-study
2. Phase II – Design, Planning Permission and Environmental Impact
3. Phase IIIa (Mare Harbour) and IIIb (New Haven) – Construction and installation
4. Phase IV – Operation

Each of the phases has been split into several sub-phases and tasks to accommodate for more detailed planning and execution. For more details please refer to Project Description.

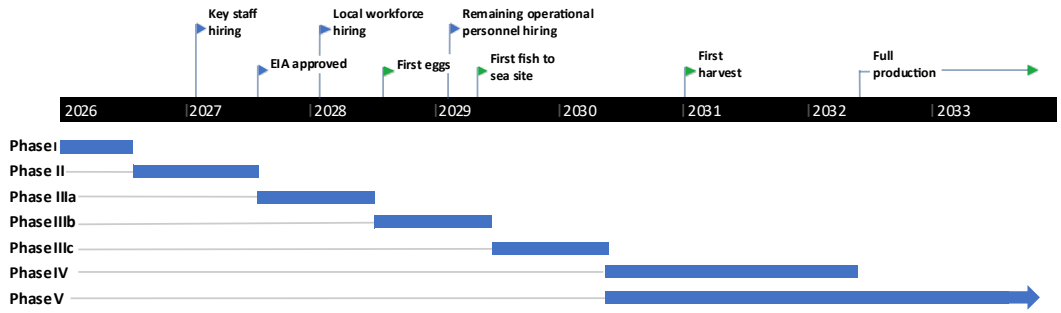


Figure 2: Proposed overall project schedule. The schedule details that the first eggs will be imported in August 2028 and the first harvest in start of 2030. The company will reach full production in 2032-2035. A pre-requisite is that the construction of the first land-based hatchery is commenced in August 2027

6 Current Economy and Society on the Falkland Islands

In this section, the current economy and society on the Falkland Islands is briefly described, with main focus on areas that will be impacted by the establishment of the suggested aquaculture business. The later section will analyse the impact on these areas with respect to status quo.

6.1 Falkland Islands

The Falkland Islands are an archipelago in the South Atlantic Ocean on the Patagonian Shelf. As a British overseas territory, the Falklands have internal self-governance, and the United Kingdom takes responsibility for their defence and foreign affairs. The Islands' capital is Stanley on East Falkland.

6.2 Population

Based on the latest Census 2021, the total number of people on the Falkland Islands is 3,662[3]. The population increased by 586 people equivalent to 8% during the five (5) years between the latest census and the former Census issued in 2016. Population change was distributed across all locations:

- Stanley +360 persons
- Camp -44 persons

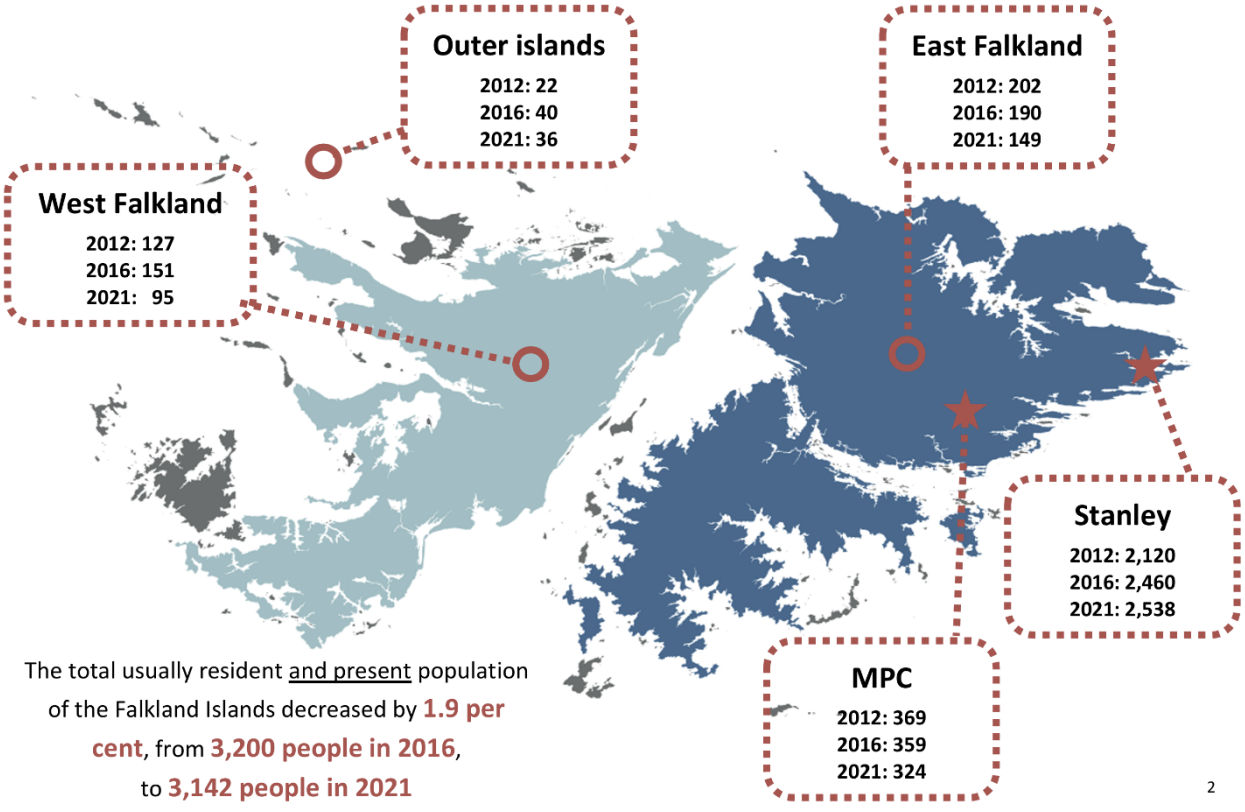


Figure 3: Results from the 2012, 2016 and 2021 census. As it can be seen all areas have experienced a population growth over the nine (9) years between the first and last census, except for East Falkland including MPC that experienced a significantly reduction in number of residents.

[3] https://www.falklands.gov.fk/policy/2021-census/census

The majority of the population (2,974 people) live in the capital, Stanley. The town is the centre of virtually all economic activity in the Falklands beyond agriculture and tourism sites. The economic pull of Stanley has led to depopulation in Camp settlements in recent decades. Although this trend has reduced over the last ten years, Camp depopulation remains a significant local concern and maintaining economic and social life in the Camp is a highly valued aim for Falkland Islanders.

The Ministry of Defence base at Mount Pleasant Airport (MPA) towards the centre of East Falkland is a largely self-contained community but provides the main airport base for international flights, according to the census 334 people were permanently residing at Mount Pleasant.

6.3 Employment

There is essentially full employment in the Islands with an unemployment rate below 1%, and the mean income in 2021 was £26,400. From 2016 to 2021, employment increased with 198 employees or 11%, from 1,829 to 2,027 FTE's. The exceptional high employment rate means that there is virtually no spare labour capacity on the market, and practically all additional labour demand must be filled by foreign workers.

The Falklands economy thus relies heavily on immigrant workers, with 23% of its workforce on temporary work permits. These workers are concentrated in jobs where specific competencies or experience is needed and jobs where additional resources are needed, and local people don't wish to apply. 15% of the Work Permit Holders have been resident for more than 10 years.

The local government employs a little over a quarter of the workforce making it the single largest employer on the islands.

6.4 Housing and Accommodation

There are currently 1,142 occupied houses on the Islands, with 1,002 in Stanley and 77 in East, 47 in West, and 16 on the Outer Islands.

More than fifteen percent (15%) of the private and public properties on the islands were established within the past ten (10) years, demonstrating significant construction investments and capacity. There are still available building plots, e.g. in Sappers Hill. There is privately owned land in or in the environs of Stanley suitable for development of housing, and a private company recently acquired 15 acres of land for development. As all land in the Falklands is either privately owned or owned by the Government, finding suitable land and building plots for new houses requires significant planning and negotiation with private and public owners.

There are many temporary accommodation possibilities on the islands, the majority in Stanley. The main hotel accommodation in Stanley includes the Malvina House Hotel (currently 35 rooms), Shorty's Motel (6 rooms) and the Waterfront Hotel (8 rooms).

6.5 GDP and FIG revenues & reserves

Since 1982, the economy has grown dramatically, with GDP rising from £3m to £150m. Agriculture, including fisheries, continues to be a major contributor with 95% of the GDP. Farmland accounts for a little over 80% of the Falklands land area, but agriculture is less than 2% of the economy. Fishing is the largest

part of the economy, and most of the fish harvested in the Falkland Islands waters are either squid or finfish.

The fishing and aquaculture industry accounted for between 35% and 48% of the GDP between 2007 to 2015. The catches vary over the years from as little as 111,495 tonnes in 2016 to 462,487 tonnes in 2015. Resulting FIG revenues are between £10m and £30m. Other major sectors are agriculture and tourism, with 10% of the workforce employed on a total of 84 sheep farms on the islands.

The emergent tourism sector has seen rapid growth in the last 15 years, with 60,000 tourists visiting the Islands by cruise ship each year, and a further 1,600 tourists arriving by air annually to enjoy the Islands unique wildlife and unspoilt environment. With the onset of the global COVID pandemic, tourism was hit hard by travel bans, requirements for quarantining and reduction in available transport routes. The cruise ship segment was hit particularly hard and experienced multiple major COVID breakouts on cruise ships that were covered widely in mass media. As the Falkland Islands had a stringent quarantine practice, and the tourism sector is mainly reliant on cruise ship passengers the tourism sector suffered. FIG incentives to promote local tourism were introduced to support the industry, as people were to a large extent prevented from travelling abroad, and the incentives had some effect.

The tourism sector is the second largest contributor to the Islands economy.

Current FIG budgets for the next 5 years show a depletion of "net liquid assets" (reserves) from £254m to £113m and a reduction in the "ratio of uncommitted reserves to adjusted department expenditure" (the ratio) 1.5% and a reduction in the ratio headroom from £166m to £21m. Projections indicate that expenditure in years 6 – 10 is expected to significantly exceed net operating revenue with a further deterioration of reserves (reducing to £28m), liquidity ratio (reducing to 0.4%) and headroom (a deficit of -£64m). The table below extrapolates the Falkland Islands Government's own budget out to 10yrs, demonstrating what is projected to happen in the absence of a new source of income:

	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34
Opening Net Liquid Assets Balance	**254**	**203**	**158**	**141**	**114**	**113**	**105**	**86**	**62**	**44**
Total Operating Revenue	129	127	124	123	121	121	121	120	118	117
Operating Expenditure Departmental	(93)	(94)	(91)	(91)	(91)	(91)	(91)	(91)	(91)	(91)
Operating Expenditure Other	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)
Net Capital Expenditure	(76)	(117)	(88)	(49)	(20)	(28)	(37)	(42)	(34)	(32)
External borrowing drawdown	-	50	50	-	-	-	-	-	-	-
Closing Net Liquid Assets	**203**	**158**	**141**	**114**	**113**	**105**	**86**	**62**	**44**	**28**
In year movement in net liquid assets	**(51)**	**(45)**	**(16)**	**(28)**	**(1)**	**(8)**	**(19)**	**(24)**	**(18)**	**(17)**
Operating Expenditure Departmental	(93)	(94)	(91)	(91)	(91)	(91)	(91)	(91)	(91)	(91)
Addback recharges	18	17	17	17	17	17	17	17	17	17
Revised departmental expenditure	**(75)**	**(76)**	**(74)**	**(74)**	**(75)**	**(75)**	**(75)**	**(75)**	**(75)**	**(75)**
FIG liquidity ratios										
Ratio	2.7	2.1	1.9	1.5	1.5	1.4	1.2	0.8	0.6	0.4
Headroom	90	43	30	2	1	(8)	(26)	(50)	(68)	(84)
Headroom with insurance	110	63	50	22	21	12	(6)	(30)	(48)	(64)

Table 1: Extrapolation of FIG budgeted reserves with current trajectory. Notes: red = projections assume unchanged levels of operating revenue (except investment income which is linked to reserve levels), departmental expenditure, other expenditure and recharges in years 6 – 10, blue = capital expenditure based on the 10 year capital budget plus expected port loan repayments of £11m per annum.

6.6 Businesses

There are around 290 registered businesses on the Falkland Islands, of which it is estimated that around 130 are active. Analysis by GDP and employment highlights that public services, fisheries, agriculture, tourism and construction are all key sectors of the local economy. These five (5) sectors account for around 85% of GDP and around two thirds of all jobs.

The private sector is dominated by a few larger companies like Falkland Island Company (FIC) and Stanley Services Ltd that operate and deliver a broad range of services including retail, accommodation rental, hotels, building services, restaurants as well as car purchase and hiring.

There are some construction services available on the Islands, but for larger construction projects additional manpower is usually brought in from overseas. The construction companies are usually backed up by a UK general contracting company that will allow them to draw in extra manpower for such projects. With the current restrictions on available accommodation and the potential for a future oil exploitation in Falkland Islands waters, there will potentially be a lack in capacity of the construction companies on the islands.

Currently there is no dry dock facilities on the Falkland Islands.

6.7 Logistics

The currently only commercial flight route connects the islands to Punta Arenas, Chile every Saturday. A second route from Sao Paulo, Brazil was started up, but was discontinued with the onset of the global pandemic. It remains to be seen whether it is restarted. Domestic flight routes are operated from Stanley and can be chartered to take you to several smaller airstrips around the islands.

In terms of bulk freight, South American Atlantic Service Ltd. (SAAS) operates a containerized shipping link to Montevideo, Uruguay on a monthly or bimonthly basis. SAAS has a substantial experience with transporting chilled produce in the form of fish or processed lamb in reefer containers through this link. The service is operated out of Stanley using FIPASS. The wish to construct new harbour facilities in Stanley replacing the ailing FIPASS, has been in process over at least a decade. Recently the project was brought to a standstill due to higher-than-expected costs and subsequent lack of government funding. It was instead decided to refurbish FIPASS for use in an unknown number of intermediate years until funding for the new harbour could be secured.

FIC also operates a direct route shipping route to Marchwood, UK in cooperation with a UK carrier. The UK link utilizes the military port at Mare Harbour as the point of entry into the Falklands. The UK link can be chartered to take odd size cargo.

6.8 Oil and gas

The Sea Lion field is a significant oil discovery located approximately 220km to the north of the Falkland Islands. Navitas Petroleum Development and Production Ltd, a UK based fully owned indirect subsidiary of international oil and gas organisation Navitas Petroleum, and Rockhopper Exploration plc have now reached Final Investment Decision on the Sea Lion Northern Development. This means that all the necessary approvals and funding for full-scale project execution have been secured.

Sea Lion's activities will be run from Navitas offices in London, Aberdeen and Stanley and production is expected to last for over 30 years, creating jobs across the FI & UK supply chain over that period.

Navitas is taking a staged approach to Sea Lion. Having secured the required regulatory approvals and finance for Phase 1&2, it will commence drilling 11 subsea wells, tied back to a redeployed floating production, storage and offloading (FPSO) vessel. Phase 2 will commence approximately three years after first oil, with 12 further subsea wells to be drilled and tied back.

Navitas, which owns 65% of Sea Lion with partner Rockhopper Exploration plc (35%), plans to produce first oil in early 2028.

The oil and gas industry have along with FIG conducted thorough studies of the potential Socio-Economic impacts on the Falkland Islands as a result of future hydrocarbons exploitation. The studies detail the potential pressure on the labour market on the Islands as well as other bottleneck effects in the housing and service sectors. An updated was issued by Navitas Petroleum in June 2025.

6.9 Fishery sector

There are a number of fishery companies located on the Falkland Islands. They usually operate in joint venture with international companies. The workforce on the fishing vessels are foreign contractual workers from e.g. Peru or Indonesia that only spend a short time on land on the Islands.

The major part of the catch is transported directly to Vigo in Spain on a Reefer vessel. High value species like the Patagonian toothfish is to some extent processed on the Islands and exported as containerized freight in Reefer containers through the sea link to Montevideo.

6.10 Aquaculture on the Falkland Islands

There have historically been a few ventures into aquaculture on the Falkland Islands. Aquaculture has repeatedly been mentioned in Island Plans as a mean of diversifying the economy and generating economic activity in Camp.

From 1985 to 1990 a Salmon production was tested out in Fox Bay under directions from FIDC with help from a Norwegian fish farmer. The fish were imported from Sterling University, UK and kept in a small freshwater hatchery. Upon reaching approximately 35g the fish were transferred to a number of smaller pens in the ocean. The growth of the fish was good, even though the setup was found to be lacking in some respects, and the import of feed was associated with certain challenges.

It was concluded that the water temperature of the Islands was ideal for Salmon farming. Development of the business however stalled on lack of capital to increase tonnage and develop the sites.

From 2010 – 2013 FIDC ran an aquaculture research project trying to determine, which species would be feasible to rear on the Islands. The project ended in 2013 but was continued through the local fishery company Fortuna ltd. that set up a small Brown Trout (*Salmo trutta*) facility comprised of a hatchery in Stanley and a couple of net pens situated outside Fitzroy. The peak production is thought to be below 20 tonnes per year and has since discontinued. The brown trout is an introduced species and not native to the area but has a well-established breeding population in the waterways on the Islands. The trout farm has since been discontinued.

Consolidated Fisheries Ltd. is currently also running a breeding program for Patagonian Toothfish in Stanley, but this has not led to any commercial production yet.

6.11 Laws and legislation

In general laws and regulations in place on the Falkland Islands are similar or close to British legislation, albeit with several amendments to either simplify implementation or fit them to local conditions.

6.11.1 Aquaculture ordinance

In 2006 the Legislative assembly passed the Fish Farming Ordinance (Ordinance No. 20 of 2006) setting out rules and regulations in connection with aquaculture production in the Falkland Islands. There are several prerequisites that needs to be fulfilled before a company is qualified to apply for a fish farming licence:

1. At least 25.1% of ordinary share capital is vested in persons or companies enjoying Falkland Islands status.
2. Planning permission for the proposed.

As part of the licencing application the company shall provide additional information describing the location, operation activities, required construction and installations, timeline for installations and commencement of aquaculture activities, financials, business plan, information of beneficial owners.

The ordinance refers to royalties in section 18, but the royalties associated with holding a licence has not been specified. Therefore, it is considered likely that the licence holder will be subject to payment of a royalty in the future. How the royalty is calculated and what parameters will be used in that calculation will need to be developed.

6.11.2 Falkland Island development plan

In 2015 the Falkland Islands Government adopted a nationwide development plan that sets outs certain general principles for the development on the Falkland Islands in the period from 2015 to 2030. The plan also contains a specific town plan for the Stanley area.

In general FIG is supportive of new business' or business areas in the Falklands as it is described in point 2 of the summary:

> *"Our overarching principle will always be when considering development proposals to take a positive approach that reflects a broad presumption in favour of sustainable development. We will work proactively with applicants to find solutions which mean that proposals can be approved wherever possible, and to secure development that adds to the economic, social and environmental fabric of the Islands."*

Any new business or activity will however be scrutinized in respect to potential socio-economic and environmental impacts.

In section "Policy SP8: Rivers, Coastal Areas and Territorial Sea" the plan details the requirements for any future aquaculture related activities taking place on the islands. In referral with point B under SP8 it dictates:

> *"B. Both marine and freshwater aquaculture proposals, together with any associated proposals on land, will:*
>
> 1. *be considered against the impact on marine ecology, bio-diversity and heritage resources, water quality and catchment and visual amenity and landscape/coastal quality; and*
> 2. *only be supported where they demonstrate no significant adverse impact on the environment and how any structures are to be removed and the land reinstated if/when no longer in use."*

The statements are further explained in section 5.25:

> *"Marine Farming or Aquaculture is identified by Government as a possible growth area to help diversify the economy of the Falkland Islands. It brings with it a range of environmental concerns about the effects on the marine environment and these will differ for different forms of aquaculture, be it shellfish, finfish or other opportunities. At this early stage, environmental concerns relate mainly to ecological impact on the marine environment and less to the physical appearance of marine structures than may be the case in other more populated areas of the world. The industry will also require onshore seafood processing facilities and these are likely to be manufacturing in nature and therefore will be directed to industrial sites in Stanley or to appropriate sites in Camp. The primary objective therefore is to ensure that the development of marine farming can be undertaken sustainably with no undue impact on native species."*

Any government support of plans to introduce a substantial production of finfish on the islands will thus be heavily weighed against the potential environmental impact.

7 Socio-Economic Impact

The potential social and economic impact of development of Aquaculture on the Falkland Islands will be significant, not least in proportional terms, as the economy with an estimated GDP of just £255m in 2018 and total employment of around 2,027 is relatively small.

7.1 Direct Impact

The development of an aquaculture salmon business producing annually 50,000 MT on the Falkland Islands will have several interrelated socio-economic impacts, directly related to the Company and its direct suppliers and partners working with the aquaculture business. The new industry will have an impact on:

- GDP
- FIG revenues & reserves
- Employment; employees directly hired by Unity Marine as well as additional public and private employees required to support the new aquaculture activities and population
- Infrastructure Investments

In the following chapters, each topic will be analysed in detail.

7.2 Indirect Impact

The direct effects are enhanced by several indirect economic effects, related to increased population and activity:

- **Increased workforce and population**
  Due to the limited available labour supply in the Falklands, extra employment will require an increase in the workforce and population on the Falklands.
- **Increased need for private and public services**
  The increase in population will increase the need for private and public services which lead to additional effects (extra housing, public servants, nurses, teachers etc.) and their extra spend in the Falklands.
- **Increased activity during construction**
  The investment in infrastructure and housing directly result in increased economic activity and population growth, producing further economic effects as a result of the construction activity.
- **Additional FIG revenues (not incl. in assessment)**
  The new additional tax revenues for FIG are likely to lead to extra spending in the economy (e.g. capital investments or extra public services or reduced income tax). This increased net spending may also generate future economic impacts.

8 Impact on GDP and FIG revenues & reserves

The Gross Domestic Product (GDP) is the monetary value of all finished goods and services produced within a country's borders in a specific time period, typically on an annual basis. A county's GDP includes all private and public consumption and investments, inventories, construction costs and the foreign balance of trade (exports are added, imports are subtracted). In the following, the GDP impact resulting from the new aquaculture industry will be evaluated.

8.1 Expected GDP growth from direct activities

The largest contribution to the Falklands GDP will come from the sale of Salmon and will thus depend on production capacity and the future salmon prices.

8.1.1 Production capacity

The forecast shows a gradual ramp up of production, with harvest reaching full capacity in year 2033, with 50,000 MT/year or 43,000 MT/ year Heads On Gutted (HOG), at which level the production stabilises. The impact on Falkland Island GDP and FIG revenues will follow the same pattern.

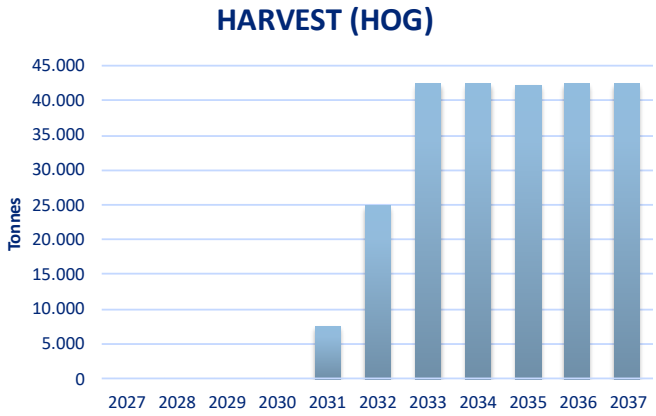


Figure 4: Expected yearly harvest in MT HOG/ year in the first 10 years of operation.

8.1.2 Salmon Prices

The variation of the future salmon prices will have significant impact on the contribution to GDP and FIG revenues. Based on the past salmon world price development[4] and the forecasted future salmon prices[5] a salmon price of 58 NOK/kg HOG was originally used as basis for the economical assessment. Norwegian kroners (NOK) are the normal currency used to price salmon. Recent market developments and a weak NOK have resulted in the current projections utilizing a 95 NOK/ kg estimate. The current forward pricing for 2024 is 100 NOK/ kg HOG. Cost of feed, wages, construction materials, equipment and other services have however also increased significantly since earlier estimates, this is also reflected in calculations of profits and subsequent corporate taxes.

[4] http://fishpool.eu/price-information/spot-prices/weekly-details/
[5] http://fishpool.eu/price-information/forward-prices-3

The NOK is a free-floating currency and future numbers can thus be influenced by currency fluctuations. The assumptions are relatively conservative, and the impact on the Falkland Island GDP and revenues will be substantial, even with some variation in prices.

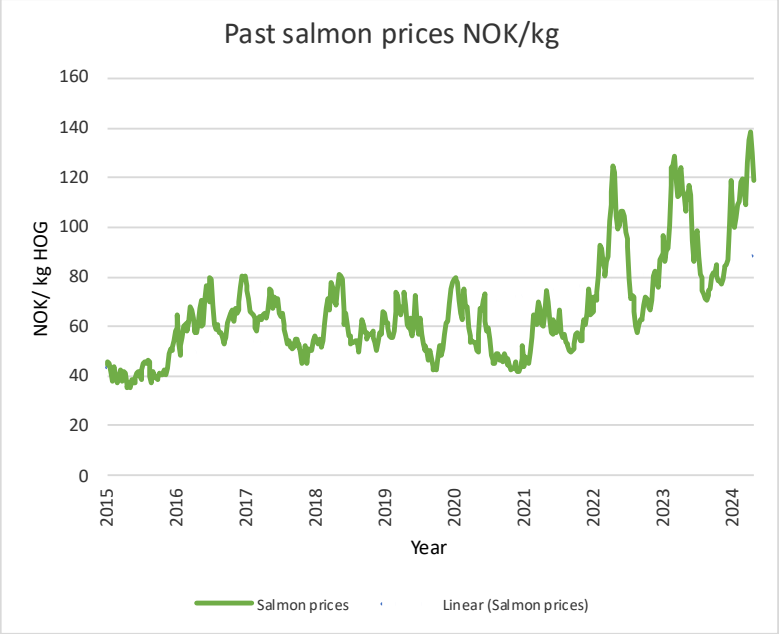


Figure 5: Historical Salmon prices on the Nasdaq Salmon exchange in Oslo.

8.1.3 GDP growth and FIG revenues & reserves

Based on planned capacity ramp up and the assumed price of 95 NOK/kg, the GDP is expected to grow with approximately £140m from 2032 and the FIG revenues will grow with approximately £26m from 2033.

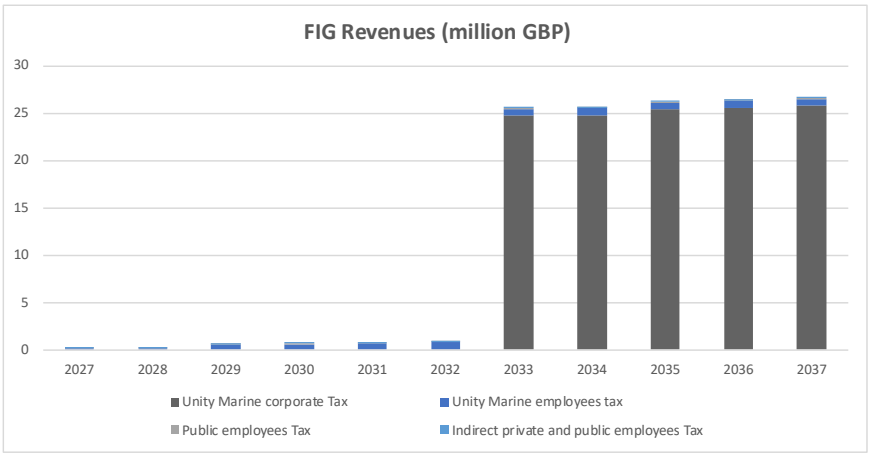


Figure 6: Expected revenues FIG tax revenues from company activities.

The GDP includes the gross profit generated in Unity Marine, as well as direct and indirect wages. Capital investments in infrastructure has been included in the year of establishment. Financial costs have been excluded.

The total increased GDP does not translate directly to increased FIG revenues but is a sum of the value creation of the project that will be experienced broadly by the residents and other businesses in the Falklands.

The part of GDP that will be retained on the Falkland Islands as FIG revenues are tax paid directly to FIG either by Unity Marine or by the additional employees or through taxes from employees in supporting businesses and their corporate taxes.

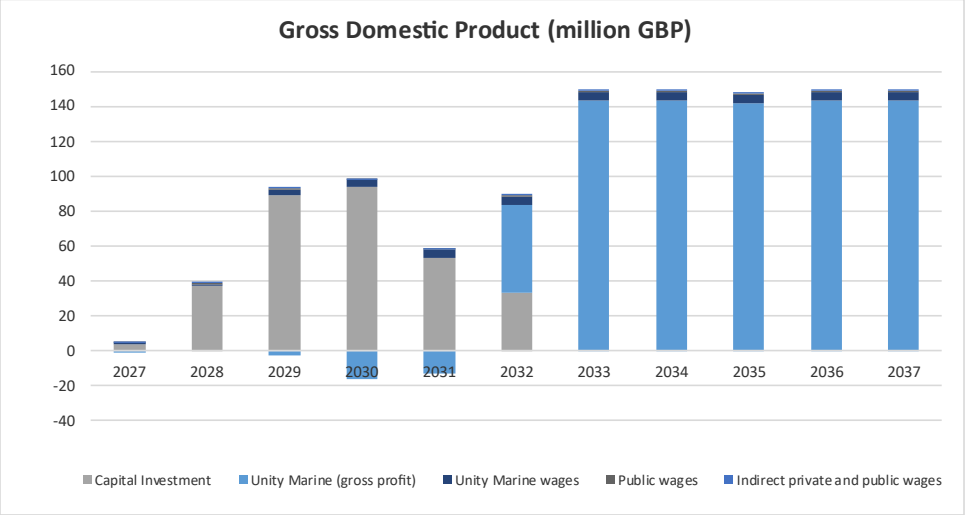


Figure 7: Expected project contribution to the gross domestic product on the Falkland Islands.

As illustrated in Figures 6 and 7 above, the potential impact on the Falklands GDP and on FIG revenues & reserves will be substantial with an estimated annual GDP growth of £200m and FIG revenues of £26m when full capacity is reached. In comparison, the existing fishing industry accounted for 60% of the GDP between in 2022, with FIG revenues of around £32m. Current FIG budgets for the next 5 years show a depletion of "net liquid assets" (reserves) from £254m to £113m and a reduction in the "ratio of uncommitted reserves to adjusted department expenditure" (the ratio) 1.5% and a reduction in the ratio headroom from £166m to £21m. Projections indicate that expenditure in years 6 – 10 is expected to significantly exceed net operating revenue with a further deterioration of reserves (reducing to £28m), liquidity ratio (reducing to 0.4%) and headroom (a deficit of -£64m). The impact of the proposed aquaculture business is expected to reduce and reverse this decline within 10 years, although projections still remain significantly under the liquidity ration and headroom targets. Table 2 below shows the impact of commercial salmon farming on FIG's financial position.

	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34
Opening Net Liquid Assets Balance	**254**	**203**	**158**	**141**	**114**	**113**	**105**	**88**	**69**	**72**
Total Operating Revenue	129	127	124	123	121	121	123	126	145	145
Operating Expenditure Departmental	(93)	(94)	(91)	(91)	(91)	(91)	(92)	(92)	(97)	(97)
Operating Expenditure Other	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)	(11)
Net Capital Expenditure	(76)	(117)	(88)	(49)	(20)	(28)	(37)	(42)	(34)	(32)
External borrowing drawdown	-	50	50	-	-	-	-	-	-	-
Closing Net Liquid Assets	**203**	**158**	**141**	**114**	**113**	**105**	**88**	**69**	**72**	**78**
In year movement in net liquid assets	**(51)**	**(45)**	**(16)**	**(28)**	**(1)**	**(8)**	**(17)**	**(19)**	**3**	**6**
Operating Expenditure Departmental	(93)	(94)	(91)	(91)	(91)	(91)	(92)	(92)	(97)	(97)
Addback recharges	18	17	17	17	17	17	17	17	17	17
Revised departmental expenditure	**(75)**	**(76)**	**(74)**	**(74)**	**(75)**	**(75)**	**(75)**	**(76)**	**(80)**	**(80)**
FIG liquidity ratios										
Ratio	2.7	2.1	1.9	1.5	1.5	1.4	1.2	0.9	0.9	1.0
Headroom	90	43	30	2	1	(8)	(25)	(45)	(48)	(42)
Headroom with insurance	110	63	50	22	21	12	(5)	(25)	(28)	(22)

Table 2: Extrapolation of FIG budgeted reserves with a salmon project as suggested by Unity Marine. Notes: red = projections assume unchanged levels of operating revenue (except investment income which is linked to reserve levels), departmental expenditure, other expenditure and recharges in years 6 – 10, blue = capital expenditure based on the 10 year capital budget plus expected port loan repayments of £11m per annum, green = FIG salmon revenues are as projected elsewhere in the report with an estimated 25% cost of collecting the revenues.

From the table above it can be observed that in 2033/34 the comparison to the position without salmon income as shown in section 6.5 is as follows:

2033/34 comparison	No Salmon income	Salmon income	Difference
Closing net liquid assets	£28m	£78m	+£50m
In year movement in net liquid assets	(£17m)	£6m	+£23m
The ratio	0.4	1.0	+0.6
Headroom without insurance	(£84m)	(£42m)	+£42m
Headroom with insurance	(£64m)	(£22m)	+£42m

Table 3: Comparison of future FIG economic position with and without a salmon farming industry in 2033/34.

9 Impact on Employment

Establishment and operation of the new aquaculture business will naturally require labour, resources and competences, resulting in labour market effects. The following section includes an analysis of the required labour for establishment and operation of the new aquaculture business, including identified peak needs for temporary labour during the establishment and construction phase.

In general, Unity Marine expects a close collaboration with FIG to ensure compliance with all policies regarding terms of employment, priority to local candidates and local advertisement, as well as long term strategic population planning.

9.1 Employment Strategy

The overall objective is to identify the number of required employees, as well as their required competencies and experience, in order to establish an overview of:

- Total number of employees resulting from the establishment of an aquaculture business.
- Recruitment strategy for specific positions.

The analysis initially focusses on establishment of a complete future organisation, capable of successful implementation and operation of the proposed activities. A staffing plan specifying all permanent and temporary roles, required competencies and specific start up time has been completed and forms the basis on the expected employment predictions.

Roles where specific aquaculture experience and competencies are critical for the future success of the business has been identified. Due to lack of specific aquaculture experience on the Falkland Islands, foreign resources are expected and needed for these positions. It is foreseen to staff the aquaculture experienced positions with:

- Expats (mainly from northern Europe including the UK)
- Rotational on/ offshore workers (mainly from Chile)

This results in significant demand for locally employed resources.

The diagrams below show the total employment as a result of establishment and operation of the new aquaculture business on the Falkland Islands. When full production capacity is reached, a total of 181 additional FTEs is expected, hereof 96 Offshore rotational workers, and 101 new on shore employees on the islands.

The 101 new on shore jobs are expected to be staffed with:

- 23 expats
- 64 local labours (incl. expat spouses)
- 14 Onshore rotational workers

The majority of the new jobs will be employees directly hired by Unity Marine, whereas the rest are public and private employees working in positions directly related to the aquaculture, or indirectly as a result of increased population and activity:

- 147 Unity Marine employees

- 7 new public jobs related to aquaculture
- 27 indirect public and private jobs related to increased population and activities

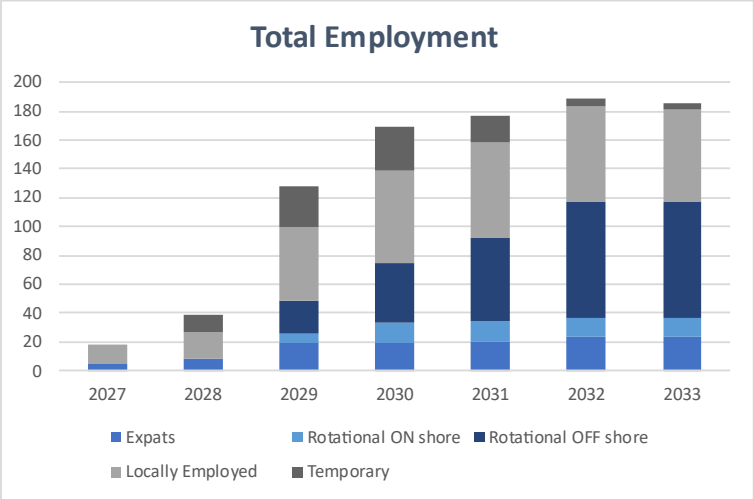


Figure 8: Number of positions expected to be covered by expats, rotational shift workers, temporary workers and locally employed staff. Both direct Unity Marine hires and secondary effects included.

The diagrams include temporary workers on site during the construction and operation.

9.2 Unity Marine employment

Skilled and experienced labour is key to any successful business. This is not least true for aquaculture, where multidisciplinary experience and skills are required to secure the welfare of the fish. As there is no or very limited aquaculture experience on the islands, it will be necessary to bring in experienced resources from abroad to ensure successful implementation and operation of the business.

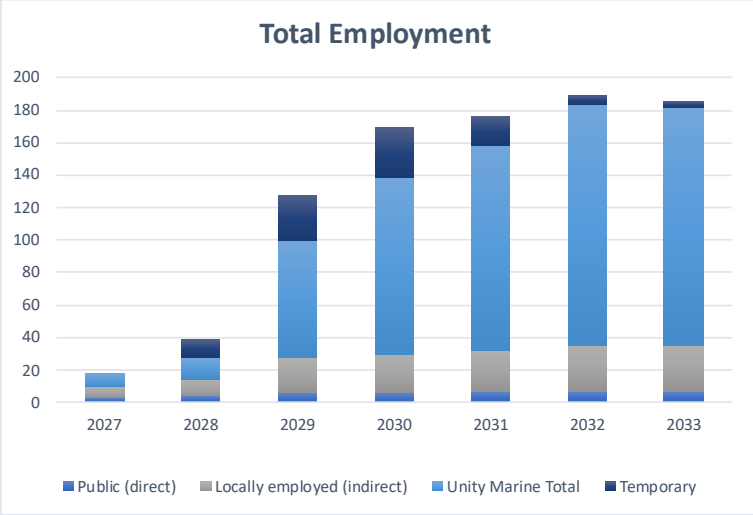


Figure 9: Number of FTEs stemming directly from the company activities.

It is planned to employ a mix of senior resources from the UK and Scandinavia as well as skilled labour from Chile. The labour will be a mix of expats and temporary workers.

The specific character of the business requires employment of key people managing the business, from an executive, operational or technical point of view, with specialised experience and competences. These resources will mainly be expats moving to the Falkland Islands for a longer period of time.

The Chilean labour is expected to be temporarily on the islands working in shifts, with two (2) months on the islands, followed by one (1) month at home. Further, they will have an extended vacation, when the sea sites are fallowing. It is expected that the Chilean workers will work 183 days or more on the islands and thus be applicable for labour tax on the Falklands.

Chile has the second largest salmon production in the world and thus have a large workforce with relevant experience. The workforce is also very mobile and skilled staff can be attracted with good wage packages.

The overall organisation of Unity Marine is expected to be structured as below.

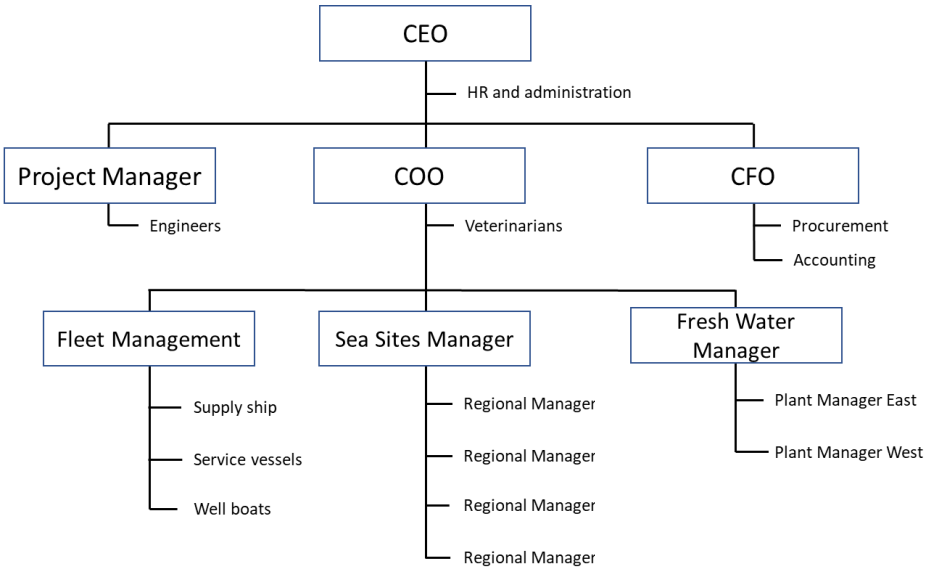


Figure 10: Overall organization diagram for unity marine. The top management will be placed in Stanley.



Figure 11: Expected employment in Unity Marine's different business segments.

Recruitment will be done gradually supporting the establishment and ramp up of operations on the land and sea sites.

9.2.1 Stanley office

The Unity Marine main office will be located in the Stanley area and will be the heart of executive management activities, as well as administrative and supporting functions. The CEO will head the management team consisting of CEO, COO, CFO and the Program/Project Manager during construction. HR will report directly to the CEO and support all managers in the comprehensive process of recruitment and on-boarding of required staff.

Veterinarians, divers, procurement managers, accountants, travel- and booking staff, as well as all round secretarial staff supporting all operational units, will initially be based at the main office. Gradually, when operations are ramping up, many will spend more time at the two operational facilities in Mare Harbour and New Haven.

Sales is expected to be handled as sales to one client under one contract, and traditional sales activities are thus expected to be limited. The sales activities will have a more coordination and logistics character and is expected to be handled by the regional managers, supported by the executive management and the administrative staff.

9.2.2 Operational management team

The operational management team will consist of the COO, the Fresh Water Manager responsible for all land-based activities, and the Sea Sites Manager responsible for all sea sites. A Fleet Manager will be responsible for coordination of the company's own vessels, as well as chartered boats.

9.2.3 Land based operations

The Fresh Water Manager will have one aquaculture experienced Plant Manager at each of the land-based production facilities. The Plant Manager will be responsible for the daily management of the facility. The

operational team at each site consists of a local team with electrical, blacksmith and IT experience, combined with a team of rotational onshore workers. A total of 26 FTEs is expected to operate the two land-based production sites.

Smolt rearing is a complex operation, that includes knowledge on fish welfare and behaviour as well as technical insight and maintenance tasks. There are however also many daily operational and maintenance routines that does not necessarily require a high level of skill. Staff will be a mixture of locally employed labour, experienced with local regulations and rotational workers from Chile, experienced with aquaculture.

Position	Key skills	Number of employees
Fresh Water Manager	Management, extensive experience with smolt farming	1
Plant Managers	Management, experience with smolt farming (one at each site)	2
Staff (locally employed)	Team of fish farming staff with specific veterinarian, diving, electrical, black smith, and IT experience	10
Staff (rotational workers)	Hatchery manager, Fry manager, Parr manager, Smolt manager, and additional staff	14

Table 4: Number of expected employees associated directly with the land-based facilities in New Haven and Mare Harbour.

9.2.4 Sea Sites

The Sea Water Manager will have four (4) regional managers, each responsible for four (4) sites. At each of the sixteen (16) sea sites a Sea Site Manager will head a team of rotational workers. The regional managers will be aquaculture experienced expats, whereas the sea site manager as well as additional staff is expected to be rotational workers from Chile.

Unity Marine anticipates rotational workers to work in two-month on one month off shift. During the shift the personnel will live aboard the feed barge. The crew will have some days or weekends off during the two-month shifts, so additional personnel transport is anticipated. There will always be at least two (2) persons on site, and three (3) on average except during fallowing.

Position	Key skills	Number of employees
Sea Site manager	Management, extensive experience with net pen salmon farming	1
Regional Managers	Management, experience with net pen salmon farming	4
Operating Managers	Experience with net pen salmon farming	20
Staff	Experience from net pen operation, mechanical maintenance or fisheries	48

Table 5: Number of expected employees on the sea sites.

9.2.5 Warehouse and Workshop

Next to each of the land based operational facilities, a warehouse and workshop will be established, supporting both land and sea-based activities. A team of practical all-round mechanical engineers and divers will be headed by a warehouse and procurement manager. A total of nine (9) employees are foreseen, whereof two (2) of the three (3) divers are expected to be expats.

9.2.6 Supply ship

On the supply ship the captain and one officer are expected to be experienced expats, whereas one (1) additional officer and three (3) additional crew is expected to be hired locally (or as rotational workers, depending on labour availability). A total of six (6) employees are expected.

9.2.6.1 Service boats

Three (3) large service boats will support the sea site activities. On each service boat the captain is expected to be an experienced expat, whereas additional crew is expected to be a combination of staff hired locally, or as rotational workers, depending on labour availability. A total of twelve (12) employees, four (4) on each boat, are expected on the service boats.

9.2.7 Well boat

The well boat will be leased, and all twelve (12) staff, incl. captain is thus expected to be rotational off shore workers.

9.3 Employment in public and private sector

Establishment of a new aquaculture industry on the Falkland Islands will lead to an increased employment in private and public services with a total of 27 FTE at full production:

- Public services directly related to the new aquaculture industry (7 FTE)
- Public and private services related to increased population and activities (20 FTE)

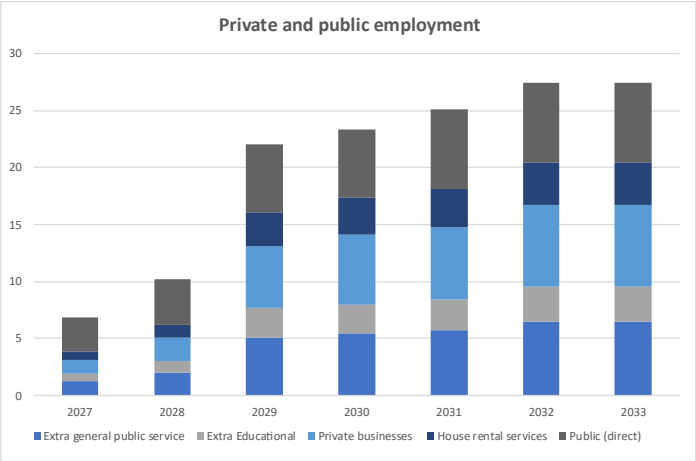


Figure 12: Expected private and public employment not directly associated with Unity Marine.

9.3.1 Public Services directly related to new aquaculture industry

The authorities will need additional competencies and resources to handle the specific aquaculture activities directly related to establishment and operation of the new aquaculture business. The following is foreseen

- 2027: environmental officer, planning officer, administrational staff
- 2029: (production start): veterinarian and biosecurity staff

- Earliest 2031 (full production): additional administrational staff

Veterinarian, biosecurity and environmental positions are expected to be staffed with experienced expats but could potentially be locals if employees with the right skill sets are identified.

9.3.2 Indirect public and private services

A number of new positions will be required as a result of the increased population and general increased activity on the islands. From 2026 and onwards, the anticipated 23 expats, some with spouses and families, are expected to increase the population with:

- Sixty new residents (40 adults and 17 children)
- Fourteen (14) onshore rotational workers

The additional people on the islands will require additional general public services, such as medical services, police and fire fighting. General public services are estimated to be ten (10) FTE per 100 extra citizens, and five (5) FTE per extra 100 Rotational onshore staff, resulting in a total of additional seven (7) from 2023 and onwards.

The additional seventeen (17) expat children will attend the local schools. The need for educational staff is estimated to be eighteen (18) FTE per 100 extra school children, resulting in additional three (3) employees.

9.4 Local Employment

The current plan indicates recruitment of 64 local employees from 2028 to 2034. As the spare labour capacity on the Falkland Islands is limited, identification of relevant candidates for these positions will be a challenge. However, if the population growth from 2012 to 2016 continues, these positions can be staffed with local employees. Recruitment activities and immigration policies must be focused on ensuring that the population grows with the right profiles.

The following solutions must be considered to mitigate the lack of local available labour, and will be part of the detailed recruitment plans in the following phases:

1. Expat spouses (with the current number of expats, 17 spouses are expected)
2. Recruitment packages for expat couples; package of two jobs for couples interested work on the Falkland Islands (this will increase the population, and all the consequential effects)
3. Rotational workers from Chile, UK or similar, to ensure qualified staff

There is a relatively high interest from foreigners in working on the Falkland Islands, which indicates that identifying foreign labour will be possible, if process and policies supports immigration and work permits approvals.

9.5 Temporary Employment

In the design phase, from mid 2027 to mid 2028 a number of highly skilled specialists will stay on the Islands for shorter periods for on-site investigations and data collection required to design the facilities and make a full operational plan.

In the construction and installation phase a combination of on-site supervisors and foreign construction workers will work on site in shifts, ensuring constant support and additional resources for the local construction companies.

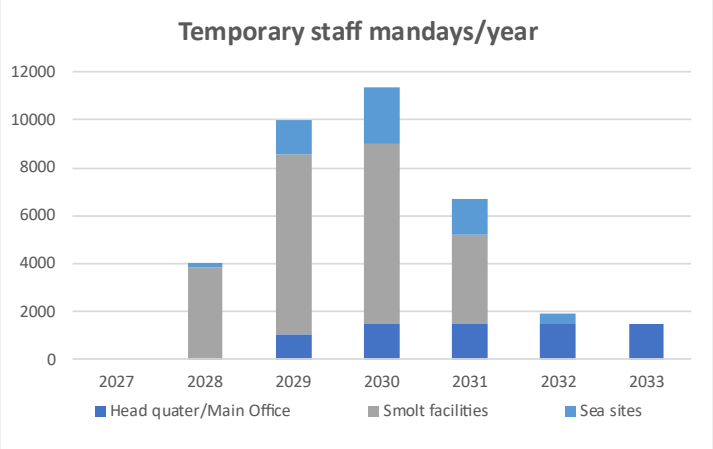


Figure 13: Temporary construction and installation staff as well as temporary work performed by specialists and contractors. Shown in working days per year.

The total amount of man days has been calculated for specific tasks in accordance with the overall time schedule, resulting in a total man days per year. The total man days per year has then been converted to an average per day. Note that this average per day must be used with caution and requires detailed planning in future phases.

During 2029 and 2030 the construction work is peaking, and the presence of temporary workers maxes out with a total of 31.

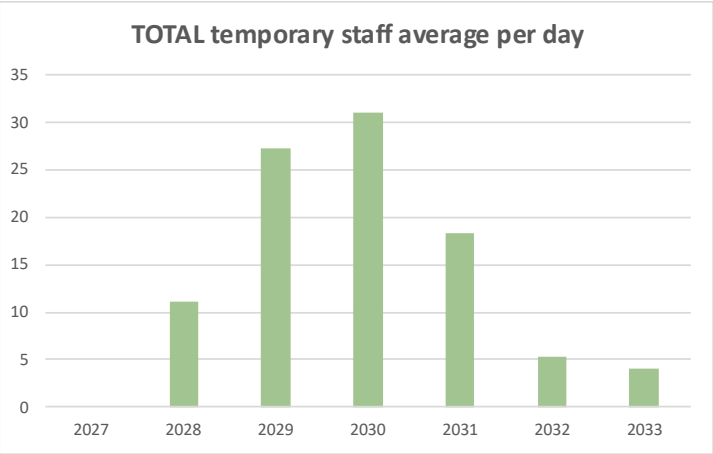


Figure 14: Average number of temporary workers on the islands every day. This number equals the need for temporary accommodation (Hotels, self-catering or rented short term accommodation).

There will be significant differences in locations and specific timing of activities requiring temporary workers on shore. The activities on different sites will be planned also with respect to accommodation for temporary workers and described in the detailed project execution plan developed in the next phase.

9.6 Long term labour market impact

The continuous effect of the aquaculture business and supporting activities will generate around 181 FTE jobs or around a 10% increase on current level of employment (1,909) in the Falkland Islands. Of these 80 are expected to be offshore rotational workers. It is possible in the future to convert these positions to locally employed employees, in a pace fitting with the strategic population development of the Falkland Islands society.

In the future, an expansion of the aquaculture business could utilize the West Falkland Islands, and could be seen as an engine to boost the development of this part of the Islands. It would naturally have many of the same requirements and effects as described in this document for the East Falkland Island. It would however also potentially add additional requirements as West Falkland, does not have the same level of infrastructure as Stanley offers.

The employment and recruitment should be seen and developed, as a vehicle for the future population increase. The new aquaculture business will enable the Falkland Islands to attract young, ambitious and well-educated expats, who will bring spouses and families that will be the future foundation and development of the Falkland Islands.

The increased FIG revenues will be a significant contribution to the Falkland Islands economy, improving FIG's ability to develop, upgrade or extend public buildings, institutions and services in alignment with FIG strategic plan for long term development.

As the Falkland Islands is a relatively small society, the development and increase in population must be implemented gradually, to safeguard the Falkland Island culture. Staffing of positions in the aquaculture business with a relatively large share of rotational workers will ensure the right planning and pace of the population development.

10 Impact on Population

As there is close to full employment on the Falkland Islands, the new demand for labour will to a high degree be filled by foreign workers. Based on the current recruitment plans, this section seeks to describe the impact on the population.

10.1 Overall Employment and Population Impact Correlation

Recruitment will as mentioned be balanced, to ensure required industry specific as well as local competences and experience. This analysis results in a significant demand for labour that can be hired locally, if labour is available. Several of these positions may be staffed with local labour, which will create a need for labour, where these employees were employed before joining the new aquaculture business. Which again, due to the limited available labour, need to be filled by foreign resources.

From an overall population point of view, most of the new permanent jobs will result in an increase in population, with people working either in aquaculture or in other industries.

Acknowledging that the society on the Falkland Islands is relatively small, and that an increase in population must be implemented gradually, rotational workers from Chile has been suggested for many positions. Thereby, the positions will be staffed with industry experienced staff, with limited impact on the society. These positions can gradually be converted to local employment, if/when it supports the overall strategic development of the society and infrastructure on the Falkland Islands.

10.2 Population Impact

The population impact analysis, based on required industry specific competences and experience, is illustrated in below diagram. The diagram shows the required expats, their expected spouses and children, as well as on shore rotational workers. The rotational workers will as the name indicates be rotational, meaning that it will be shifting people. A total of 14 on shore rotational workers are expected continuously on the islands.

Approximately half of the new 181 employees will be rotational offshore workers, living and working on the feed barges at the sea sites and the well boat, with limited presence and impact on the society on the Falkland Islands.

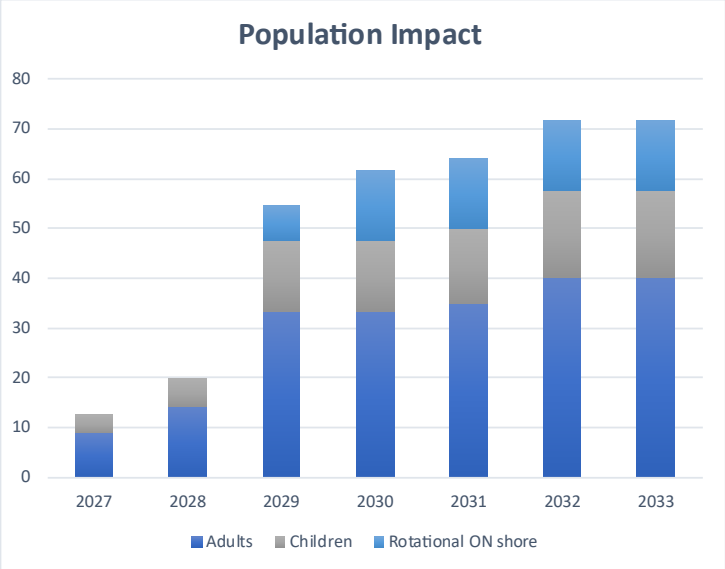


Figure 15: Expected increase in the population stemming from the project.

In addition to the offshore rotational workers, additionally 101 people are expected for positions onshore, including direct and indirect private and public employment:

- 23 expats
- 64 locally employed
- 14 on shore rotational workers

Based on an overall evaluation of the profiles that will be relevant for the expat positions, it has been estimated that 75% of the expats will bring a spouse, resulting in a total of 40 adults, whereof 17 are spouses. Due to the shortage of labour on the islands, expat spouses will be potential new employees, either in one of the 64 “local employment” positions related to the aquaculture industry, or in other industries.

It has further been estimated that 50% of the expat couples will bring on average 2 children, resulting in 17 additional children.

Recruitment will be done with focus on long term contribution to the strategic development of the Falkland Islands. Candidates with relevant experience, who are also expected to become permanent residents will be preferred. Proficient English skills will naturally also be a focus in recruitment efforts. It is expected that some of the expats will become long term permanent residents.

10.3 Local Employment

A total of 64 positions is suggested as “locally hired employees”. These are positions where no specific aquaculture experience is needed, that can be staffed with both local and foreign labour.

As mentioned, there are not currently that many resources available today. From a population impact point of view, it is irrelevant if resources are hired in the new aquaculture industry or in other jobs on the islands. Based on available local resources, Unity Marine could have planned staffing of more positions with rotational workers, reducing the impact on the local labour market. This has not been done to ensure that

local people will have the opportunity of joining the new aquaculture business and to allow FIG to manage the population increase strategically.

The analysis of future need for foreign competences and resources depends on the interest in the specific existing and new local jobs, either with Unity Marine or in with other entities. Unskilled jobs can easily be staffed with rotational workers, or young unskilled workers, who are not likely to bring families, whereas senior positions typically will be staffed with more experienced profiles bringing families.

It can be concluded that 64 positions currently planned as "locally employed" will not be staffed with resources already present on the islands, without leaving a similar lack of labour elsewhere on the Falkland Islands. It is expected that a large proportion of the 17 spouses will be interested in local employment.

Previous experience shows that migrants are typically either single, not bringing partners and families, or bring working spouses. If all spouses are expected to work, this still indicates an additional increase in population (in addition to the adults, children, and rotational workers described above), to staff the remaining 47 positions. If all these positions are staffed with rotational workers, the population increase will be insignificant. If all are staffed with expats with families, the impact will be more significant.

The final number of additional adults and children will be analysed in further detail in the following phases, based on more in-depth discussions and alignment with FIG's long-term goals.

10.4 Joint recruitment activities

Acknowledging that Unity Marine activities will put additional tension on the already stressed local labour market, that some local businesses may face difficulties in staffing or maintaining labour, and finally that Unity Marine will establish a HR function with extensive experience in recruitment and onboarding of foreign labour. Unity Marine expects close collaboration with FIG and local companies regarding recruitment. E.g. being able to offer potential applicants with spouses/ families a package of two relevant job positions, will be of great importance in attracting the right new residents and employees.

10.5 Immigration Policy and Work Permits

The policies for immigration and work permits must support the overall long-term strategic development of the Falkland Islands. Recruitment of foreign labour will be a critical factor for both Unity Marine and other local public and private functions, and new residents will be a significant contribution to the future development of the Falkland Islands society. The policies must thus be reviewed with special focus on:

1. Clear definition and classification of immigration nature, particularly regarding short/long term immigration
2. Balance across nationalities ensuring continuation of the Falklands' culture
3. Attractiveness and ease for long term immigrants, particularly those with families
4. Streamlined and quick process for work permit application and approval
5. Easy process for spouses' work permit applications
6. Attractive educational offerings to immigrants bringing children
7. Ensure an easy transfer process from work permits to permanent resident status and encourage more of those on work permits to aspire to becoming permanent residents

11 Impact on Housing and Accommodation

The expected future population increase as well as temporary workers on the islands results in an increased demand for housing and accommodation. This section seeks to analyse and determine the required need for houses and accommodation.

11.1 Increased population and rotational workers on shore

The total employment on or around the islands and the population increase on shore are described in detail in the Population chapter. At full production in 2025, employment totals:

- 23 Expats, 75% bringing a spouse or family
- 14 onshore rotational workers
- 80 Offshore rotational workers
- 64 Locally employed (whereas 43 may be changed to expats, some with families, or rotational workers)

As mentioned in the Population chapter, the number of expats and on shore rotational workers is conservative and expected to increase due to limited available local labour. The housing and accommodation strategies are significantly different for expats and rotational workers. The analysis and the numbers below will thus be impacted by additional expats and rotational workers.

11.2 Establishment of new homes and accommodation

As there is currently a housing shortage in the Falklands, the majority of the new homes is expected to be new houses.

In terms of construction, there are local companies capable of building the houses. Finding suitable land with the right location (proximity to operational sites, as well as to schools and other social facilities) and getting the houses built in time needs to be planned in detail together with FIG and local construction companies.

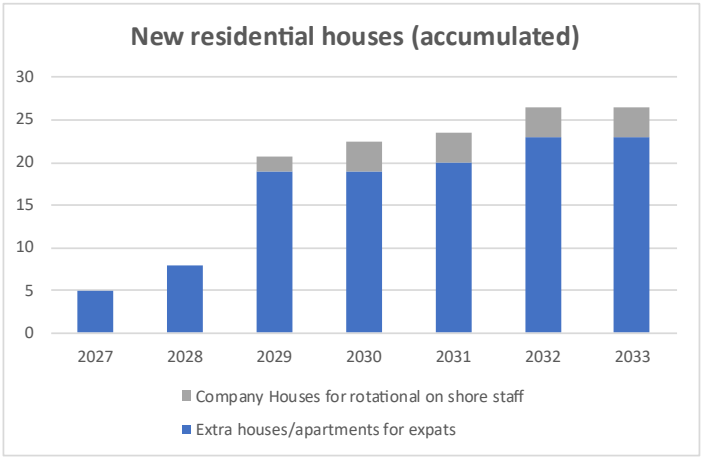


Figure 16: Estimated needs for new homes on the Falkland Islands.

11.3 Expat homes

All expats are expected to be staying on the Falkland Islands for a longer period and will thus need to establish themselves in a permanent home. The required homes are expected to be one family houses.

The need for houses follows the gradual implementation and subsequent recruitment. Starting with five (5) new houses in 2027, three (3) more in 2028, and additionally eleven (11) in 2029. After 2029 it will only be a few additional houses per year.

11.4 Rotational workers and people temporarily onshore

Staffing of the land-based operations includes fourteen (14) onshore rotational workers from Chile, who will be on the islands typically two (2) months at a time, followed by one (1) month off work, back in Chile.

The rotational workers are only temporarily on the islands, with work as their sole purpose. They will not bring spouses or children and will thus not need a permanent home. They will need decent accommodation making it easy for them to socialise with their “work family” (the other rotational workers), while still having their privacy. They are not expected to leave a significant footprint on the general social life on the islands, but will of course make use of the local convenience stores etc.

Unity Marine expects to build or lease four (4) company houses, two relatively close to each of the land-based facilities. The Company houses will have the following facilities:

- Five (5) rooms, with own bathroom (extra capacity for people temporarily on the islands)
- Kitchen
- Large living room
- Fitness room
- Scullery with washing machines etc.

The Company houses will have spare capacity for people temporarily on the islands; offshore rotational workers spending a night on shore, vaccination team, service and maintenance personnel and similar.

The company houses need to be ready no later than start-up of the land-based operations, meaning the first house in Q3 2028 and the second one year later in Q3 2029. However, due to need for temporary accommodation for temporary workers during construction, the houses can be built earlier to accommodate that need.

11.5 Demand for temporary accommodation

An increased demand for temporary accommodation is expected during the construction phase. The amount of required on site man days has been estimated for specific tasks in accordance with the overall time schedule, resulting in a total man days per year. The total man days per year has then been converted to an average per day. Note that the number must be used with caution and requires detailed planning in future phases. During 2029 and 2030 the construction work is at its highest, and the presence of temporary workers onshore peaks with a total of 31. This translates directly to the need for temporary accommodation.



Figure 17: Estimated needs for accommodation on the Falkland Islands given in average daily accommodation needs.

From an overall point of view, it is not unrealistic that the total demand of 31 rooms can be accommodated with existing hotel and lodges and self-catering houses. However, there will be significant differences in location and specific timing of activities requiring temporary workers. The timing of activities on different sites, and the accommodation for temporary workers will be planned with respect to the general need for accommodation specifically during the summer, to ensure that the tourism industry will not be impacted.

To mitigate the effect of potential bottlenecks in the temporary accommodation market, the company would investigate the possibility of building the company houses earlier than expected (with respect to operational start up), as well as establishing temporary facilities for accommodation purposes at location. Many suppliers prefer to bring their own temporary accommodation facilities that will be established on site. The final plan and need for temporary accommodation will thus also depend on choice of suppliers.

12 Impact on Infrastructure and Construction Needs

In this section the impact on the current infrastructure is evaluated.

12.1 Airport and flights

For every employee needed in relation to the new aquaculture industry, the specific yearly round flights have been estimated. For all rotational workers, four (4) yearly round flights are expected. For expats with families two (2) yearly vacations are expected.

Lastly, a draft plan for temporary workers on site has been prepared and the need for round flights have been estimated.

	2027	2028	2029	2030	2031	2032	2033
Flight seats Increase	**50**	**233**	**595**	**767**	**837**	**823**	**791**
Per week	1	4	11	15	16	16	15
Employee Flights	25	35	189	301	366	463	463
Vacational Flights	25	40	95	95	100	115	115
Temporary personnel flights	0	158	311	371	371	245	213
Head quater/Main Office							
Service technicians, various	0	0	120	120	120	120	120
Vaccination team	0	0	0	60	60	60	60
Specialists	0	0	24	24	24	24	24
Board meetings, quarterly, one expected off site	0	9	9	9	9	9	9
Smolt facilities							
Equipment suppliers on site, Design	0	8	0	0	0	0	0
Equipment suppliers on site, Construction on site	0	36	36	36	36	0	0
Additional construction on site staff	0	90	90	90	90	0	0
Sea sites							
Suppliers on site, Design	0	15	0	0	0	0	0
Suppliers on site, Construction on shore	0	0	32	32	32	32	0

Table 6: Total expected number of flight seats occupied by the project activities.

The total need for round flights per year has been split out evenly on weeks. This results in a need for additionally 16 weekly round flights seats from 2031 and onwards, as illustrated below. The majority being work related flights by Unity Marine employees.

The current and planned future routes (to Sao Paulo, Brazil) are overall expected to be able to accommodate the increased need. However, particularly during the summer tourist peak, demand is expected to exceed the available number of seats. Due to the high travel activity by Unity Marine's employees, a travel and booking coordinator will be responsible for coordination and booking of all employee transportation.

During the summertime, Unity Marine will ensure that Unity Marine employees are not blocking for other passengers, e.g. by transporting rotational workers to and from the Falkland Islands on the feed pellet carrier. The transport by boat could potentially be employed all year round if needed.

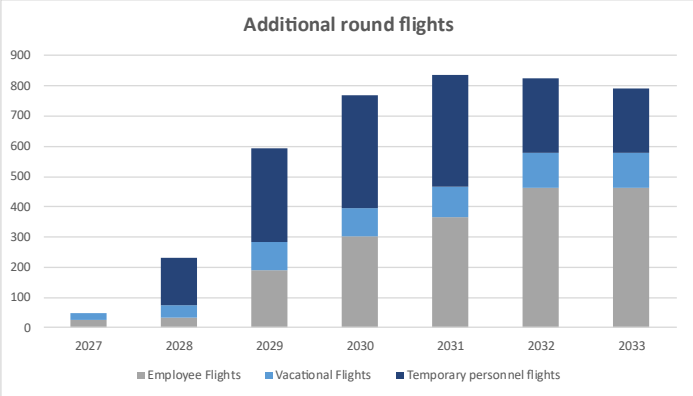


Figure 19: Additional return flights expected every year from project activities.

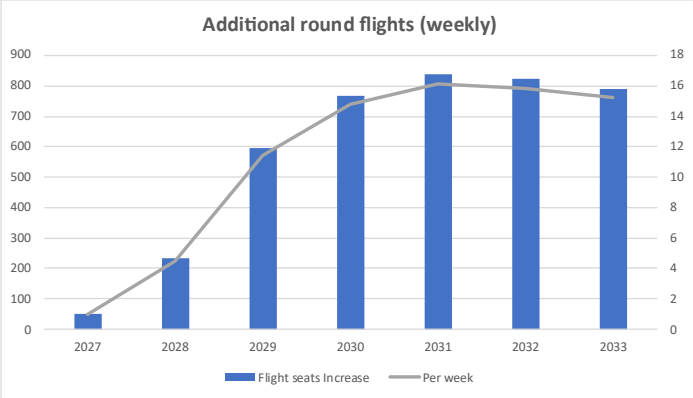


Figure 18: Additional return flights expected on a weekly basis from project activities.

Additional foreign labour, either as expats or rotational workers, will increase the need for round flights. As mentioned earlier, the specific need will depend on the recruited profiles and will be evaluated in future phases, as part of the recruitment strategy.

12.1 Harbours and piers

The capacity at New Haven is evaluated to be insufficient to accommodate the suggested vessels, and a new wharf is planned to be constructed on the north side of the harbour. Further, Unity Marine will establish warehouse facilities for storing of nets and consumables, and a workshop to support both the land based and sea-based operations.

The harbour capacity at Mare Harbour is evaluated to be sufficient. Warehouse and workshop facilities will be built in connection with the land-based facilities.

Currently there are no plans for activities in Stanley Harbour beyond utilization of the existing freight link operated by SAAS.

12.2 Electricity

Each of the land-based facilities will draw around 0.6-1.0 MW. Due to the infrastructure in Camp the entire electricity infrastructure will need to be built from scratch. The company is planning to use a combination

of renewable energy in the form of windmills and diesel generators. See Project description for details. The new residential houses as well as office facilities will not generate an extraordinary need for power.

12.3 Roads

The need for new roading infrastructure will be minimal. There will be some needs for roading material associated with constructing approximately 400- 500 m at Mare Harbour. Backfilling and compacting of the areas around the smolt facilities would also require material. It is believed the material for these purposes can be acquired in the existing quarries on the East Falkland Island. Roads might require additional maintenance due to increased traffic loads, that might lead to additional needs for staffing in the PWD.

12.4 Hospitals

With new residents comes increased demand for medical services and hospital capacity. Additional medical staff has been added in the Employment analysis. Any need for extension of the hospital capacity should be evaluated and considered by Falkland Islands general strategic infrastructure development plans. Unity Marine will ensure that all non-residential rotational workers have health and medical insurances to cover for emergency medical services.

12.5 Schools and Education

The capacity at the junior school is limited, with current usage of temporary classrooms. Additional educational staff has been estimated in the Employment section, whereas the need for additional facilities should be evaluated by FIG and the employees at the schools, ensuring optimal utilization of existing and possible new facilities.

12.6 Construction capabilities

A number of buildings will need to be established; houses for accommodation, office buildings, warehouses and the industrial buildings for the land-based operations. There are several local contractors capable of supplying construction services for all these traditional building projects. The aquaculture process suppliers will supply and supervise the construction and installation of aquaculture equipment and are expected to work alongside local contractors for building unusual or specialist buildings.

Specific timing, not least considering other projects on the islands, need to be analysed and planned together with FIG in further detail in the following phase. In case of labour shortage, it is planned to bring in foreign construction workers in peak periods.

12.7 Corporate Social Responsibility

Development of the local community will be a key for retaining staff and their families. It is essential that partners to the employees can create a life for themselves and for their children on the Falkland Islands. Therefore, a part of the investment in the company will be dedicated to developing kindergartens, schools, sport facilities and other public service institutions.

Investing in the local community will also strengthen the bonds to the local population and allow for a positive atmosphere around the project locally.

13 Business Sector Effects

In this section effects on the general business sector is analysed.

13.1 Current interaction with local businesses

During the pre-study Unity Marine has interacted with a number of local businesses. A non-exhaustive list can be seen below:

- Stanley services – fuel supply, provision of accommodation (Malvina House Hotel and Darwin Lodge)
- South Atlantic Environmental Research Institute (SAERI) – Environmental Impact Assessment and on-site investigations
- Sullivan Shipping – Launch hire and operation
- Fortuna Ltd – setting up of local joint venture company

To this point the activity has only contributed minimally to the local economy. If the project moves ahead the next step, with detailed design, planning applications and environmental survey work will entail considerably higher spending locally. It is also the company's plan to setup a permanent presence in the form of a main office in Stanley.

13.2 Future interaction with local businesses

The interaction with local businesses will be seen as direct interaction between the company and the local business or through indirect means through increased spending of the company employees.

Below a non-exhaustible list of potential direct interactions can be seen:

- South American Atlantic Shipping Ltd (SAAS) – shipping and logistics
- Stanley Services Ltd – fuel supply, accommodation, logistics
- SAERI – Environmental monitoring
- Local construction companies
- Private sector rentals
- Local vessel hire
- Fortuna Ltd, Consolidated Fisheries, others – partners in the company

The indirect effects from increased consumer spending will be distributed on almost all the businesses on the islands. The increased experienced and well-educated workforce related to the aquaculture business will result in potential employees for other existing or new businesses.

13.2.1 Collaboration with the tourism sector

Advanced aquaculture operations utilizing new technology often experience interest from tourists who wish to visit the aquaculture operations. In some cases, people travel just to visit a particularly relevant aquaculture facility. Given a similar interest, Unity Marine will make arrangements with local tour operators to make scheduled visits on the land-based and sea-based operations possible.

13.2.2 Joint recruitment initiatives

As there is limited available resources on the islands, Unity Marine foresees a close collaboration with FIG and the local businesses to proactively recruit qualified candidates, supporting the long-term development of the Falkland Island permanent population.

13.2.3 Local house rental business

Unity Marine will have a significant need for houses and temporary accommodation for their permanent and temporary employees. Unity Marine's core business will be fish farming and will thus be looking to identify a local company interested in establishing the houses and making long term rental agreements with Unity Marine. Based on the current numbers (minimum, as local employment will be transferred to foreign labour either as expats or rotational workers) a total of 23 new family houses and four (4) company houses would be the basis of the long-term house rental business.

Expressions of interest will be invited for provision of land/housing development from the Falklands private sector as appropriate.

14 Spatial and Societal Effects

In this section the employment and population increase is analysed from a geographical perspective, in order to determine the spatial effects and future potential development.

14.1 Geographical distribution of activities, employment and population

The operational activities will generate a distributed employment, and thus distributed population increase (including public and private sector activities):

- Stanley area (Main office, direct and indirect public/private)
  - 9 Expats
  - 28 locally employed
- Mare Harbour (Land based facility, workshop, warehouse)
  - 5 Expats
  - 14 Locally Employed
  - 7 On shore rotational workers
- New Haven (Land based facility, workshop, warehouse, fleet base and management)
  - 9 Expats
  - 22 Locally employed
  - 7 On shore rotational workers
- Offshore (sea sites, feeding barges, well boat)
  - 80 rotational workers

The staff identified as locally employed will most likely be converted to expats or rotational workers, depending on the future recruitment activities together with FIG and local businesses.

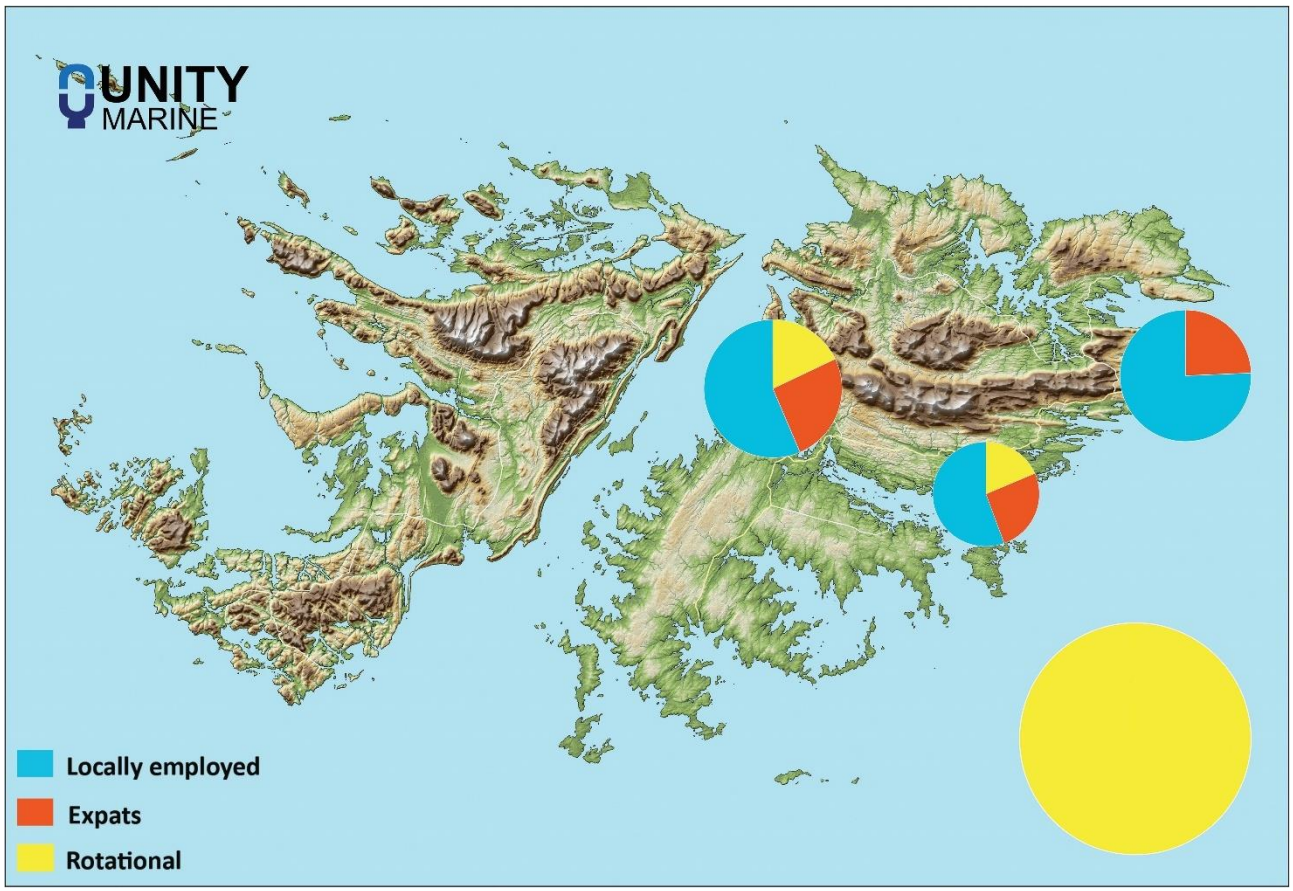


Figure 20: Expected spatial distribution of new jobs and the expected category they fall under. Approximately half of all positions will be offshore rotational workers.

14.2 Effects and future potential in Stanley

The main office is expected to be located in the Stanley area, for the executive management team to be close to governmental institutions, public and private decisions makers and stakeholders. Close collaboration with FIG and local businesses regarding recruitment of foreign employees are expected in the establishment phase.

A joint approach, process and supplementary offerings to potential candidates will make it easier to attract the right candidates and thus meet the increased need for labour on the Falkland Islands. These activities will be especially critical during establishment and ramp up of production. On a long-term basis, it will be equally important for the management team to stay closely involved in the operational activities in Mare Harbour and New Haven.

14.3 Effects and potential in Camp

All of Unity Marine's operational activities will be in Camp, and proximity to the operational sites will be considered with regard to placement of the future new houses for employees. The new operational activities and additional employees are expected to generate a need for more services and supplies that can be meet by increased local offerings close to the operational sites in New Haven and Mare Harbour.

14.4 Future potential on West Falkland

The current plans are focused on development of aquaculture on East Falkland. Possible future expansion could include utilization of West Falkland Islands. This would require establishment of infrastructure supporting operational requirements as well as increased residential activities on West Falkland.

15 Appendix A: Table and figures

15.1 Figures

Figure 1: The proposed company activities on the Falkland Islands. The sea sites that is no longer planned to be used are marked with an x. 9

Figure 2: Proposed overall project schedule. The schedule details that the first eggs will be imported in August 2028 and the first harvest in start of 2030. The company will reach full production in 2032-2035. A pre-requisite is that the construction of the first land-based hatchery is commenced in August 2027 10

Figure 3: Results from the 2012, 2016 and 2021 census. As it can be seen all areas have experienced a population growth over the nine (9) years between the first and last census, except for East Falkland including MPC that experienced a significantly reduction in number of residents. 11

Figure 4: Expected yearly harvest in MT HOG/ year in the first 10 years of operation. 19

Figure 5: Historical Salmon prices on the Nasdaq Salmon exchange in Oslo. 20

Figure 6: Expected revenues FIG tax revenues from company activities. 20

Figure 7: Expected project contribution to the gross domestic product on the Falkland Islands. 21

Figure 8: Number of positions expected to be covered by expats, rotational shift workers, temporary workers and locally employed staff. Both direct Unity Marine hires and secondary effects included. 24

Figure 9: Number of FTEs stemming directly from the company activities. 24

Figure 10: Overall organization diagram for unity marine. The top management will be placed in Stanley. 25

Figure 11: Expected employment in Unity Marine's different business segments. 26

Figure 12: Expected private and public employment not directly associated with Unity Marine. 28

Figure 13: Temporary construction and installation staff as well as temporary work performed by specialists and contractors. Shown in working days per year. 30

Figure 14: Average number of temporary workers on the islands every day. This number equals the need for temporary accommodation (Hotels, self-catering or rented short term accommodation). 30

Figure 15: Expected increase in the population stemming from the project. 33

Figure 16: Estimated needs for new homes on the Falkland Islands. 35

Figure 17: Estimated needs for accommodation on the Falkland Islands given in average daily accommodation needs. 37

Figure 18: Additional return flights expected on a weekly basis from project activities. 39

Figure 19: Additional return flights expected every year from project activities. 39

Figure 20: Expected spatial distribution of new jobs and the expected category they fall under. Approximately half of all positions will be offshore rotational workers. 44

15.2 Tables

Table 1: Extrapolation of FIG budgeted reserves with current trajectory. Notes: red = projections assume unchanged levels of operating revenue (except investment income which is linked to reserve levels), departmental expenditure, other expenditure and recharges in years 6 – 10, blue = capital expenditure based on the 10 year capital budget plus expected port loan repayments of £11m per annum. 13

Table 2: Extrapolation of FIG budgeted reserves with a salmon project as suggested by Unity Marine. Notes: red = projections assume unchanged levels of operating revenue (except investment income which is linked to reserve levels), departmental expenditure, other expenditure and recharges in years 6 – 10, blue = capital expenditure based on the 10 year capital budget plus expected port loan repayments of £11m per annum, green = FIG salmon revenues are as projected elsewhere in the report with an estimated 25% cost of collecting the revenues. 22

Table 3: Comparison of future FIG economic position with and without a salmon farming industry in 2033/34. 22

Table 4: Number of expected employees associated directly with the land-based facilities in New Haven and Mare Harbour. 27

Table 5: Number of expected employees on the sea sites. 27

Table 6: Total expected number of flight seats occupied by the project activities. 38



Unity Marine – Land-based site investigations

APPENDIX C

1 Land Based site investigations

This annex contains a suitability matrix and water sampling data for the visited land-based sites (from the 8th – 11th of November 2018).

1.1 Water test results

During the land-based site investigations relevant streams and ponds were sampled to determine whether they were suitable for use in the land-based hatcheries. The water sources were tested for pH, temperature and oxygen content. Water samples for lab testing of metals were also taken for analysis and sent to Eurofins, Denmark[1]. Eurofins is an accredited water testing company.

The following sites and test results were found:

Site	Sample	Latitude	Longitude	pH	Temperature (°C)	Oxygen saturation (%)	Approximate flow (l/s)
Mare Harbour	PSC1	S51° 53.944	W058°26.154	NA	NA	NA	NA
Saladero	PSC2	S51° 46.801	W059° 04.259	NA	NA	NA	40-60 l/s
New Haven I	PSC3	S51°45.935	W059°13.514	6.46	6.6 °C	98%	10 l/s
New Haven II	PSC4	S51°45.975	W059°13.358	7.3	8.9 °C	98%	15-25 l/s
New Haven III	PSC5	S51°44.070	W059°13.239	5.91	6.8 °C	94%	Small
New Haven V	PSC6	S51°46.026	W059°12.803	6.84	8.1°C	112%	30-40 l/s
Port Sussex I-Trout court	PSC7	S51°40.349	W058°58.537	6.84	8.3 °C	106%	80 l/s
Head of the Bay I	PSC8	S51°36.251	W059°02.602	6.48	14.2 °C	102%	30-40 l/s
Head of the Bay II	PSC9	S51°36.131	W059°02.290	NA	NA	NA	NA
Head of the bay brook	PSC10	S51°36.355	W059°00.852	5.48	12.3°C	102%	130-170 l/s

Table 1: Water sources tested during the land-based site investigations conducted from the 8th-11th of November 2018.

Site	Al (µg/ l)	Ca (mg/ l)	Fe (mg/ l)	K (mg/ l)	Cu (µg/ l)	Mg (mg/ l)	Mn (mg/ l)	Na (mg/ l)	Zn (µg/ l)
Mare Harbour*	8,900	48	14	19	8	82	0.40	580	42
Saladero	110	7.6	0.4	2.0	1.2	6.3	0.013	41	4.0
New Haven I	120	12	0.15	1.4	< 0.03	7.5	0.015	45	1.5
New Haven II	60	9.4	0.070	1.3	< 0.03	6.6	0.006	39	15
New Haven III	490	9.4	0.71	1.8	0.14	9.2	0.086	64	13
New Haven V	80	7.6	0.32	1.3	< 0.03	6.2	0.006	41	5.6
Port Sussex I-Trout court	130	4.0	0.22	1.1	4.2	3.8	0.013	24	5.6
Head of the Bay I	300	3.0	0.91	1.6	0.87	4.8	0.036	40	7.9
Head of the Bay II	-	-	-	-	-	-	-	-	-
Head of the bay brook	330	1.8	0.88	0.95	< 0.03	3.0	0.028	25	2.2

*Table 2: Identified metals during water sampling. *The water sample in Mare Harbour was very turbid with many clay particles in the water. Clay is known to bind metal ions. Further testing will be carried out.*

[1] https://www.eurofins.dk/

Constituent	Limit	Comments
Aluminium (Al)	<200 mg/ l	
Calcium (Ca)	<200 mg/ l	Limit is not specifically set in law but associated with alkalinity or hardness
Iron (Fe)	< 200 µg/ l	
Potassium (K)	<10 mg/ l	
Copper (Cu)	< 2 mg/ l	
Magnesium (Mg)	< 50 mg/ l	
Manganese (Mn)	< 50 µg/ l	
Sodium (Na)	< 175 mg/ l	
Zink (Zn)	< 3 mg/ l	

Table 3: Danish drinking water standards for the tested metals and minerals.

As it can be seen from the results of the water testing all water sources except for Mare Harbour are below drinking water threshold values for Calcium, Potassium, Copper, Magnesium, Sodium and Zink.

The planned water sources for New Haven (I, II and V) lived up to drinking water standards on all parameters except for a slightly elevated Iron content in New Haven V. This is however thought to be within acceptable limits for salmon farming. Iron can relatively easily be removed in an oxidation tower.

The Mare Harbour sample was relatively high in many of the sampled metals and minerals. This is thought to be caused by high turbidity at the time of sampling. The turbidity was caused by clay particles in the water column. Clay colloids are known to bind metal ions like Iron and aluminium. The company is therefore planning to do additional samples from this water source in March 2019. More specifically a small pit will be dug on the side of the lake and the water sample will be collected from the water seeping into this pit. East Cove Pond will also be sampled.

The Head of the Bay and New Haven III samples contained more aluminium than allowed in drinking water. New Haven III also had higher Manganese and Iron contents than allowed for drinking water. New Haven III is however not planned to be utilized.

Please see the accredited test results in appendix D.

1.2 Suitability matrix

Green colouring indicates that the site has been found to have adequate facilities or characteristics in the given category. Yellow indicates that the site only partially lives up to the criteria, while red indicates major challenges using the given site in this category.

Site	1. Access to Sea Sites	2. Fresh Water	3. Access to Sea
Mare Harbour	East coast, access to Choiseul Sound	East Cove Pond and smaller pond nearer to harbour	Good deep-water anchorage (+7m) right next to site
Walker Creek	East coast, access to Choiseul Sound	Fresh water can be found approximately 5-6 km	The jetty has access to water with some depth (3-4m).

		east of and 3 km west of the jetty.	
Goose Green	East coast, access to Choiseul Sound	No suitable water sources identified	The jetty has access to water with some depth (3-4m).
Darwin and surrounding area	East coast, access to Choiseul Sound	No suitable water sources identified.	The jetty has access to water with some depth (3-4m).
Saladero	West Coast, access to Brenton Loch and leading to Falkland Sound	Sampled stream south of Saladero. Estimated flow of 40-60 l/s.	Reefs, shoals and low water depth in Brenton Loch inaccessible to larger vessels.
New Haven	West coast, access to Falkland Sound	One spring identified on the east side of the peninsula 3-8 l/s, three streams at bottom of the Peninsula near Dos Lomas sampled (5-10 l/s, 15-25 l/s and 30-40 l/s). Will need to be pumped approximately 5 km to the site in pipeline along the road to the site.	Good water depth (+5m) outside the Ferry Harbour.
Port Sussex	West Coast, access to Port Sussex and leading to Falkland Sound	Two streams identified in the bottom of Port Sussex (one of them Shepperd's Brook). One stream was sampled. The steams are placed 6-7 km from a suitable plot. Pipeline would cross rugged terrain.	Good water depth in Port Sussex.
Head of the Bay and San Carlos	West Coast, access to San Carlos Water and leading to Falkland Sound	Two streams identified one emptying out in the southern part of San Carlos Water in a small tidal pool. The other Head of the Bay Brook. Both were sampled. Both were placed long di-stance from deep water.	Good water depth in adjacent waters around White Rincon and Little Rincon.
Port San Carlos	West Coast, access to Port San Carlos and leading to Falkland Sound	No suitable water sources identified. Mare River is was considered but found to be to distant.	Good water depth in adjacent waters

Site	4. Road Infrastructure	5. Pier or Harbour facilities	6. Other infrastructure considerations
Mare Harbour	Class A road to the harbour. New road needs to be put in from Bertha Beach road to site (approximately 250m)	Well-established deep-water port. Has smaller floating jetty that could be used for berthing and re-supply of smaller vessels.	Potential for linking to the MPA electrical, sewage and portable water grid. Approval for link up would need to be agreed with the military. Personnel can be based in Stanley or in Fitzroy.
Walker Creek	Class B Road	Jetty is in disrepair and cannot be used in present state.	No additional infrastructure identified.
Goose Green	Proximity to Class A road. Smaller road upgrade would need to be installed	Jetty is in relatively good state but would need to be expanded considerably.	Electrical network could be combined with existing settlement network. Personnel can be based in the settlement.
Darwin and surrounding area	Proximity to Class A road. Smaller road upgrade would need to be installed	Jetty is in disrepair and cannot be used in present state.	No additional infrastructure identified. Personnel can be based in the settlement or in Goose Green.
Saladero	Relatively close to class A road. Upgrades to some of the Saladero road would be needed.	None	No additional infrastructure identified. Personnel can be based in Goose Green.
New Haven	Class A road to New Haven Ferry terminal. No need for construction of extra roading.	Ferry terminal could be used or enlarged to accommodate the Company's vessels. Potential to build wharf next to smolt site.	No additional infrastructure identified. Personnel can be based in Goose Green.
Port Sussex	Class B Road	None	No additional infrastructure identified.
Head of the Bay and San Carlos	Class B Road	Jetty is in disrepair and cannot be used in present state.	Personnel could potentially be based in the settlement. Would need agreement with local landowners.
Port San Carlos	Class B Road	Jetty is in relatively good state but would need to be expanded considerably.	Personnel could potentially be based in the settlement. Would need agreement with local landowners.

Based on the above matrix Mare Harbour and New Haven was chosen as the preferred sites for the facilities.

1.3 Further perspectives

Given the results of the water sampling it is likely that many of the streams on East Falkland could be turned into drinking water resources. The water would need to be disinfected and, in some instances, Iron would need to be precipitated in an oxidation tower. This could provide settlements like Darwin and Goose Green with new drinking water resources if surface water was piped in and treated.

It might be of interest to sample the livestock (sheep and cattle) around some of the ponds surrounding MPA. The high aluminium and other metal content could potentially be harmful for the animals if the frequently drink from the ponds.



Unity Marine – Fresh Water Sampling Results

APPENDIX D

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Batchnr.: EUDKVE-00747056
Kundenr.: CA0020641
Modt. dato: 10.12.2018

Analyserapport

Prøvetype: Andet rent vand - Andet
Prøveudtagning:
Prøvetager: Rekvirenten
Analyseperiode: 10.12.2018 - 20.12.2018

Prøvemærke: Mare harbour #1

Lab prøvenr:	80640018	Enhed	Kravværdier Min.	Kravværdier Max.	DL.	Metode	Urel (%)
Metaller							
Aluminium (Al)	8900	µg/l			0.2	DS/EN ISO 17294m:2016 ICP-MS	20
Calcium (Ca)	48	mg/l			0.5	DS/EN ISO 17294m:2016 ICP-MS	15
Jern (Fe)	14	mg/l			0.01	DS/EN ISO 17294m:2016 ICP-MS	20
Kalium (K)	19	mg/l			0.05	DS/EN ISO 17294m:2016 ICP-MS	15
Kobber (Cu)	8.0	µg/l			0.03	DS/EN ISO 17294m:2016 ICP-MS	20
Magnesium (Mg)	82	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Mangan (Mn)	0.40	mg/l			0.002	DS/EN ISO 17294m:2016 ICP-MS	20
Natrium (Na)	580	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Zink (Zn)	42	µg/l			0.3	DS/EN ISO 17294m:2016 ICP-MS	20
Oplysninger fra rekvirent							
Akkrediteret prøvetagning	Nej					*	

Prøvekommentar:
Prøven til metal-analyser er dekanteret inden analyse grundet bundfald i prøven. Totalindholdet for metaller omfatter ikke partikelbundne metaller.

20.12.2018

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i.p.: ikke påvist
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Urel (%): Ekspanderede relative måleusikkerhed, med dækningsfaktor 2. For resultater på detektionsgrænseniveau kan usikkerheden være større end oplyst på rapporten.
σ): Usikkerheder på mikrobiologiske parametre angives som logaritmeret standardafvigelse

Prøvningsresultaterne gælder udelukkende for de(n) undersøgte prøve(r).
Rapporten må ikke gengives, undtagen i sin helhed, uden prøvningslaboratoriets skriftlige godkendelse.

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Analyserapport

Prøvetype: Andet rent vand - Andet
Prøveudtagning:
Prøvetager: Rekvirenten
Analyseperiode: 10.12.2018 - 14.12.2018

Prøvemærke: Saladero #1

Lab prøvenr:	80640014	Enhed	Kravværdier Min.	Kravværdier Max.	DL.	Metode	Urel (%)
Metaller							
Aluminium (Al)	110	µg/l			0.2	DS/EN ISO 17294m:2016 ICP-MS	20
Calcium (Ca)	7.6	mg/l			0.5	DS/EN ISO 17294m:2016 ICP-MS	15
Jern (Fe)	0.40	mg/l			0.01	DS/EN ISO 17294m:2016 ICP-MS	20
Kalium (K)	2.0	mg/l			0.05	DS/EN ISO 17294m:2016 ICP-MS	15
Kobber (Cu)	1.2	µg/l			0.03	DS/EN ISO 17294m:2016 ICP-MS	20
Magnesium (Mg)	6.3	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Mangan (Mn)	0.013	mg/l			0.002	DS/EN ISO 17294m:2016 ICP-MS	20
Natrium (Na)	41	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Zink (Zn)	4.0	µg/l			0.3	DS/EN ISO 17294m:2016 ICP-MS	20
Oplysninger fra rekvirent							
Akkrediteret prøvetagning	Nej					*	

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Modt. dato:	10.12.2018

Analyserapport

Prøvetype:	Andet rent vand - Andet
Prøveudtagning:	
Prøvetager:	Rekvirenten
Analyseperiode:	10.12.2018 - 14.12.2018

Prøvemærke: New haven 1 #1

Lab prøvenr:	80640019	Enhed	Kravværdier Min.	Kravværdier Max.	DL.	Metode	Urel (%)
Metaller							
Aluminium (Al)	120	µg/l			0.2	DS/EN ISO 17294m:2016 ICP-MS	20
Calcium (Ca)	12	mg/l			0.5	DS/EN ISO 17294m:2016 ICP-MS	15
Jern (Fe)	0.15	mg/l			0.01	DS/EN ISO 17294m:2016 ICP-MS	20
Kalium (K)	1.4	mg/l			0.05	DS/EN ISO 17294m:2016 ICP-MS	15
Kobber (Cu)	< 0.03	µg/l			0.03	DS/EN ISO 17294m:2016 ICP-MS	20
Magnesium (Mg)	7.5	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Mangan (Mn)	0.015	mg/l			0.002	DS/EN ISO 17294m:2016 ICP-MS	20
Natrium (Na)	45	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Zink (Zn)	1.5	µg/l			0.3	DS/EN ISO 17294m:2016 ICP-MS	20
Oplysninger fra rekvirent							
Akkrediteret prøvetagning	Nej				*		

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Prøvetype: Andet rent vand - Andet
Prøveudtagning:
Prøvetager: Rekvirenten
Analyseperiode: 10.12.2018 - 14.12.2018

Prøvemærke: New haven 2 #1

Lab prøvenr:	80640020	Enhed	Kravværdier Min.	Kravværdier Max.	DL.	Metode	Urel (%)
Metaller							
Aluminium (Al)	60	µg/l			0.2	DS/EN ISO 17294m:2016 ICP-MS	20
Calcium (Ca)	9.4	mg/l			0.5	DS/EN ISO 17294m:2016 ICP-MS	15
Jern (Fe)	0.070	mg/l			0.01	DS/EN ISO 17294m:2016 ICP-MS	20
Kalium (K)	1.3	mg/l			0.05	DS/EN ISO 17294m:2016 ICP-MS	15
Kobber (Cu)	< 0.03	µg/l			0.03	DS/EN ISO 17294m:2016 ICP-MS	20
Magnesium (Mg)	6.6	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Mangan (Mn)	0.006	mg/l			0.002	DS/EN ISO 17294m:2016 ICP-MS	20
Natrium (Na)	39	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Zink (Zn)	15	µg/l			0.3	DS/EN ISO 17294m:2016 ICP-MS	20
Oplysninger fra rekvirent							
Akkrediteret prøvetagning	Nej					*	

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Rapportnr.: AR-18-CA-00747059-01
Batchnr.: EUDKVE-00747059
Kundenr.: CA0020641
Modt. dato: 10.12.2018

Analyserapport

Prøvetype: Andet rent vand - Andet
Prøveudtagning:
Prøvetager: Rekvirenten
Analyseperiode: 10.12.2018 - 14.12.2018

Prøvemærke: New haven 3 #1

Lab prøvenr:	80640021	Enhed	Kravværdier Min.	Kravværdier Max.	DL.	Metode	Urel (%)
Metaller							
Aluminium (Al)	490	µg/l			0.2	DS/EN ISO 17294m:2016 ICP-MS	20
Calcium (Ca)	9.4	mg/l			0.5	DS/EN ISO 17294m:2016 ICP-MS	15
Jern (Fe)	0.71	mg/l			0.01	DS/EN ISO 17294m:2016 ICP-MS	20
Kalium (K)	1.8	mg/l			0.05	DS/EN ISO 17294m:2016 ICP-MS	15
Kobber (Cu)	0.14	µg/l			0.03	DS/EN ISO 17294m:2016 ICP-MS	20
Magnesium (Mg)	9.2	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Mangan (Mn)	0.086	mg/l			0.002	DS/EN ISO 17294m:2016 ICP-MS	20
Natrium (Na)	64	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Zink (Zn)	13	µg/l			0.3	DS/EN ISO 17294m:2016 ICP-MS	20
Oplysninger fra rekvirent							
Akkrediteret prøvetagning	Nej					*	

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Batchnr.:	EUDKVE-00747060
Kundenr.:	CA0020641
Modt. dato:	10.12.2018

Analyserapport

Prøvetype:	Andet rent vand - Andet
Prøveudtagning:	
Prøvetager:	Rekvirenten
Analyseperiode:	10.12.2018 - 14.12.2018

Prøvemærke: New Haven 5 #1

Lab prøvenr:	80640022	Enhed	Kravværdier Min.	Kravværdier Max.	DL.	Metode	Urel (%)
Metaller							
Aluminium (Al)	80	µg/l			0.2	DS/EN ISO 17294m:2016 ICP-MS	20
Calcium (Ca)	7.6	mg/l			0.5	DS/EN ISO 17294m:2016 ICP-MS	15
Jern (Fe)	0.32	mg/l			0.01	DS/EN ISO 17294m:2016 ICP-MS	20
Kalium (K)	1.3	mg/l			0.05	DS/EN ISO 17294m:2016 ICP-MS	15
Kobber (Cu)	< 0.03	µg/l			0.03	DS/EN ISO 17294m:2016 ICP-MS	20
Magnesium (Mg)	6.2	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Mangan (Mn)	0.006	mg/l			0.002	DS/EN ISO 17294m:2016 ICP-MS	20
Natrium (Na)	41	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Zink (Zn)	5.6	µg/l			0.3	DS/EN ISO 17294m:2016 ICP-MS	20
Oplysninger fra rekvirent							
Akkrediteret prøvetagning	Nej					*	

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Analyserapport

Prøvetype: Andet rent vand - Andet
Prøveudtagning:
Prøvetager: Rekvirenten
Analyseperiode: 10.12.2018 - 14.12.2018

Prøvemærke: Port Sussex trout court #1

Lab prøvenr:	80640015	Enhed	Kravværdier Min.	Kravværdier Max.	DL.	Metode	Urel (%)
Metaller							
Aluminium (Al)	130	µg/l			0.2	DS/EN ISO 17294m:2016 ICP-MS	20
Calcium (Ca)	4.0	mg/l			0.5	DS/EN ISO 17294m:2016 ICP-MS	15
Jern (Fe)	0.22	mg/l			0.01	DS/EN ISO 17294m:2016 ICP-MS	20
Kalium (K)	1.1	mg/l			0.05	DS/EN ISO 17294m:2016 ICP-MS	15
Kobber (Cu)	4.2	µg/l			0.03	DS/EN ISO 17294m:2016 ICP-MS	20
Magnesium (Mg)	3.8	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Mangan (Mn)	0.013	mg/l			0.002	DS/EN ISO 17294m:2016 ICP-MS	20
Natrium (Na)	24	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Zink (Zn)	5.6	µg/l			0.3	DS/EN ISO 17294m:2016 ICP-MS	20
Oplysninger fra rekvirent							
Akkrediteret prøvetagning	Nej					*	

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Batchnr.:	EUDKVE-00747054
Kundenr.:	CA0020641
Modt. dato:	10.12.2018

Analyserapport

Prøvetype:	Andet rent vand - Andet
Prøveudtagning:	
Prøvetager:	Rekvirenten
Analyseperiode:	10.12.2018 - 14.12.2018

Prøvemærke: Head of the bay #1

Lab prøvenr:	80640016	Enhed	Kravværdier Min.	Kravværdier Max.	DL.	Metode	Urel (%)
Metaller							
Aluminium (Al)	300	µg/l			0.2	DS/EN ISO 17294m:2016 ICP-MS	20
Calcium (Ca)	3.0	mg/l			0.5	DS/EN ISO 17294m:2016 ICP-MS	15
Jern (Fe)	0.91	mg/l			0.01	DS/EN ISO 17294m:2016 ICP-MS	20
Kalium (K)	1.6	mg/l			0.05	DS/EN ISO 17294m:2016 ICP-MS	15
Kobber (Cu)	0.87	µg/l			0.03	DS/EN ISO 17294m:2016 ICP-MS	20
Magnesium (Mg)	4.8	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Mangan (Mn)	0.036	mg/l			0.002	DS/EN ISO 17294m:2016 ICP-MS	20
Natrium (Na)	40	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Zink (Zn)	7.9	µg/l			0.3	DS/EN ISO 17294m:2016 ICP-MS	20
Oplysninger fra rekvirent							
Akkrediteret prøvetagning	Nej					*	

Prøvekommentar:
Prøven til metal-analyser er dekanteret inden analyse grundet bundfald i prøven. Totalindholdet for metaller omfatter ikke partikelbundne metaller.

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Batchnr.: EUDKVE-00747055
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Modt. dato: 10.12.2018

Analyserapport

Prøvetype: Andet rent vand - Andet
Prøveudtagning:
Prøvetager: Rekvirenten
Analyseperiode: 10.12.2018 - 14.12.2018

Prøvemærke: Head of the bay brook #1

Lab prøvenr:	80640017	Enhed	Kravværdier Min.	Kravværdier Max.	DL.	Metode	Urel (%)
Metaller							
Aluminium (Al)	330	µg/l			0.2	DS/EN ISO 17294m:2016 ICP-MS	20
Calcium (Ca)	1.8	mg/l			0.5	DS/EN ISO 17294m:2016 ICP-MS	15
Jern (Fe)	0.88	mg/l			0.01	DS/EN ISO 17294m:2016 ICP-MS	20
Kalium (K)	0.95	mg/l			0.05	DS/EN ISO 17294m:2016 ICP-MS	15
Kobber (Cu)	< 0.03	µg/l			0.03	DS/EN ISO 17294m:2016 ICP-MS	20
Magnesium (Mg)	3.0	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Mangan (Mn)	0.028	mg/l			0.002	DS/EN ISO 17294m:2016 ICP-MS	20
Natrium (Na)	25	mg/l			0.1	DS/EN ISO 17294m:2016 ICP-MS	15
Zink (Zn)	2.2	µg/l			0.3	DS/EN ISO 17294m:2016 ICP-MS	20
Oplysninger fra rekvirent							
Akkrediteret prøvetagning	Nej				*		

Prøvekommentar:
Prøven til metal-analyser er dekanteret inden analyse grundet bundfald i prøven. Totalindholdet for metaller omfatter ikke partikelbundne metaller.

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Unity Marine – Falkland Power Facility

APPENDIX E

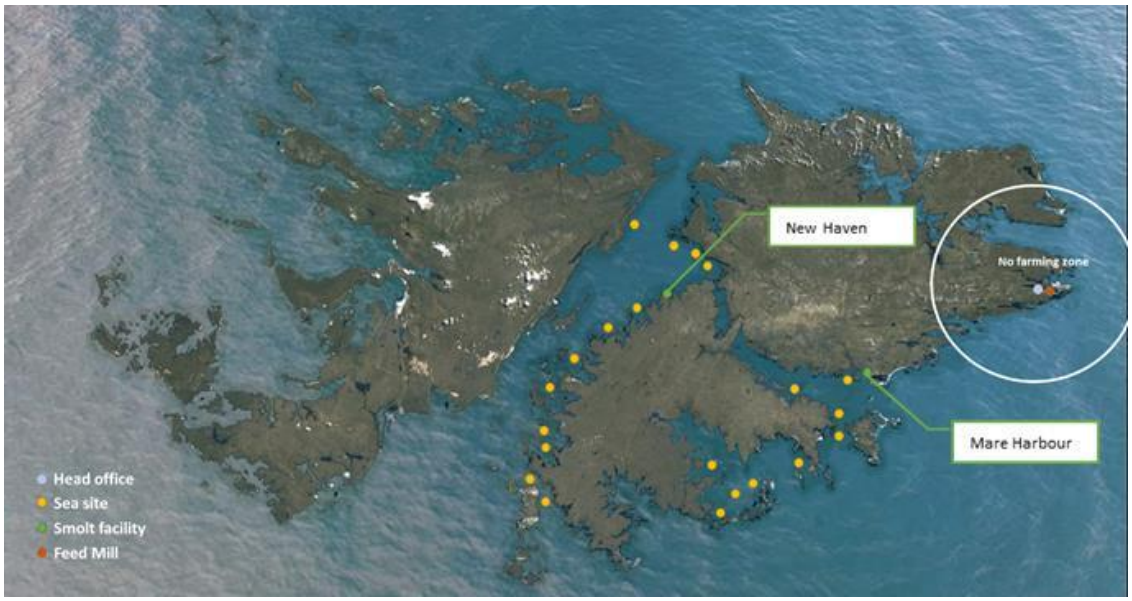
REPORT

F-LAND APS

Falkland Power Facility

PROJECT NUMBER 30.9280.01

STAND-ALONE POWER FACILITY FOR SMOLT SITES



DRAFT REPORT

JANUARY 2019, REV2

Sweco

ENERGY SECTION

JOHNNY IVERSEN, SIGURD LAURITSEN

Summary

A stand-alone power solution for smolt sites is analysed for two specific areas in the Falkland Islands.

The technical and economic best solution is found to be a combination of a wind turbine and a diesel engine. The production share from the wind turbine will be in the area of 60-65 % resulting in a favourable Levelized Cost of Electricity (LCOE).

The market for land-based wind turbines in the range of 0.5-1.0 MW is, however, very limited as turbine capacity sizes have increased rapidly over the last approx. 10 years due to the technical development.

Other power production possibilities such as solar PV and hydro power are found to be too expensive and technically unfeasible.

The next development step related to this issue is to carry out a more detailed feasibility study including contacting potential wind turbine manufacturers and EPC contractors. Subsequently, a tendering phase providing the proper documentation for an investment decision should follow.

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Table of contents

1	**Introduction**	**1**
2	**Technical solution**	**2**
2.1	Prerequisites and other types of background material/information	2
2.2	Wind power	3
2.3	Diesel power	3
2.4	Other technologies	3
3	**Business case**	**4**
3.1	General assumptions	4
3.2	Investments and operating expenses	4
3.2.1	Wind turbine	4
3.2.2	Diesel engine	4
3.3	Mare Harbour	5
3.4	New Haven	9
4	**Recommendations**	**12**
5	**Next steps**	**12**

Attachments

Attachment 1: Data and production data from Stanley wind farm project

Attachment 2: Enercon E-44, E-48 and E-53 wind turbines

Attachment 3: Data sheet on investment and other assumptions

Attachment 4: Production data – Mare Harbour smolt site

Attachment 5: Production data – New Haven smolt site

1 Introduction

In cooperation with partners, F-land is developing a fish farming project in the Falkland Islands. The electricity production of the islands consists of a wind-diesel power plant close to Stanley providing Stanley with electricity through a local grid.

Other settlements of the islands have wind turbines and diesel gen-set providing electricity sometimes with provisions for battery backup. Finally, farms and small settlements have small hybrid solutions, primarily small household stand-alone wind turbines and diesel back-up. The islands have no electricity grid infrastructure outside the capital city of Stanley and MPC. Wind turbines have been used on the islands since 2007.

The wind conditions in the Falkland Islands are quite favourable for wind energy production with an annual average wind speed just above 8 m/s during the summer months and approx. 14 m/s during winter months, and wind speeds of up to 17 m/s for approx. 10 % of the time.

Two smolt sites have been pointed out at Mare Harbour and New Haven respectively. The sites are shown in the figure below. The area around Stanley is shown with the no farming zone.



Figure 1 Location of the two smolt sites, Mare Harbour and New Haven.

Each of the smolt sites needs a power supply of approx. 0.8 MW in average all year round with an annual electricity demand of approx. 7,000 MWh.

F-land is therefore seeking the best solution from a technical and economical perspective for a stand-alone power facility.

The equipment package for a smolt site always includes a diesel backup facility of 1 MW electricity which means that the business case for the stand-alone solution does not have to include further backup facilities.

The project is at an early development stage and detailed planning, specifications for tendering etc. are foreseen for a later stage 2.

2 Technical solution

The immediate solution for a stand-alone power facility, taking into consideration the site and the environment, would be a wind power facility in combination with diesel power to cover the fluctuations in the wind production. Other renewable electricity production technologies than land-based wind power would not be competitive from a business case perspective. In the Falkland Islands, solar PV and hydro power demonstration projects have been assessed. The hydro power project has faced problems with unreliable and insufficient flow in streams, and solar PV has proven not to be price/yield competitive to wind from a business perspective.

The identified solution therefore seeks an optimal combination of wind and diesel power production under the framework conditions and assumptions set up.

2.1 Prerequisites and other types of background material/information

The following main prerequisites and assumptions are made:

- Average needed power production capacity (flat profile all year round): 0.8 MW
- Capacity variations: 0.6 – 1.0 MW
- Diesel oil price: 0.65 GBP/litre
- Wind data used (site specific) is taken from the software tool EnergyPro database. ERA5 data from 2017 is used.

At the Sand Bay location near Stanley, a 2 MW wind farm was set up in two phases (in 2007 and 2010 respectively). Each of the phases consists of three Enercon 335 kW wind turbines.

2017 production data is available for site 1. The wind direction is primarily from the south-west, west and north in this order. See attachment 1.

The ERA5 wind data from EnergyPro has been used on the Stanley farm to calibrate the EnergyPro model.[1]

The wind speed duration curves for 2016 and 2017 are very similar and in line with official monthly average wind data from MetOffice for the period 2009 to 2016. In 2018 however, the average wind speed was 10-15 % lower.

2.2 Wind power

The wind energy technology has developed significantly since 2010 resulting in larger turbines, higher towers, larger rotors and significantly larger nameplate capacity. 10 years ago, the typical turbine capacity was between 0,5 MW and 1,5 MW. Today's land-based wind turbines are typically of the size 1,5 MW to 3,5 MW capacity. Very few manufacturers produce turbines in the size of around 1 MW. Turbines smaller than 1 MW will be available on the broker market and after refurbishment they can be upgraded and expected to have a remaining lifetime of 15 to 18 years.

As an example, Enercon's smallest turbine series E-44, E48 and E53 are of a rated capacity between 800 and 900 kW. The E53 series has the steepest power curve.

An alternative could be an EWT turbine (Energya Wind Technologies B.V.). EWT manufactures small turbines in the range of 500 kW to 1 MW.

The following power production and business case calculations are based on the Enercon E53, which best fits the statistic wind data on site.

A data sheet including power curves for each of the Enercon wind turbines mentioned is found in Appendix 2.

2.3 Diesel power

A diesel engine of 1 MW capacity is needed to supplement the wind turbine to top up the necessary power for regulation purposes and to secure the power during days with very low wind. A standard diesel engine solution with high electricity efficiency is planned for.

The heat cannot be used and must be cooled away to the surroundings.

2.4 Other technologies

Other technologies for power production could be solar power. However, based on price experience and because of the large area needed for this size of capacity, solar power is not considered a realistic alternative.

A Litium-Ion battery package to cope with excess wind power production might be a good solution in the long term. However, at present such a battery package is far too expensive, but the market prices are decreasing rapidly these years.

[1] ERA5 surface data. The data originates from the EU funded project Copernicus Climate Change Service (C3S) and delivered by ECMWF.

3 Business case

3.1 General assumptions

The following general assumptions are made:

- Exchange rate GBP/EUR: 1.11
- Exchange rate GBP/USD: 1.26
- Annual electricity demand: approx. 7,000 MWh/y (0.8 MW x 8,760 h/y)
- Time horizon: 25 years
- Lifetime of equipment 25 years
- Discounting rate: 5 %
- Commercial price of diesel: 0.65 GBP/litre

3.2 Investments and operating expenses

3.2.1 Wind turbine

Wind turbine prices have fallen considerably the last 5-10 years.

Large (2-3,6 MW) land-based wind turbines are now constructed in wind parks with more than 100 turbines for less than 1.0 M€/MW (0.9 GBP/MW). Stand-alone turbines will be somewhat more expensive to install. Recent small-scale projects indicate a price per MW in the area of 1.3 to 1.35 MGBP.

At the time of the Sand Bay project (2007-2010), the specific investment was 4-5 MGBP/MW. It is, however, not clear whether a diesel power backup was included or not, but it is likely that the diesel engines existing at the time were maintained.

In this business case, it is assed that a stand-alone solution of 800-900 kW can be set up at a specific investment price of 1.5 M€/MW (1.35 GBP/MW). The investment needed in an 800 kW turbine then amounts to approx. 1.1 MGBP.

The fixed operation and maintenance (O&M) costs are assessed at approx. 36,000 GBP/y and the variable costs at 4.5 GBP/MWh respectively.

The electrical efficiency of the diesel engine is somewhat conservatively assumed to be 40 % in average.

A data sheet with more details can be found in Appendix 3.

3.2.2 Diesel engine

A diesel engine package is a fully mature technology and prices have not changed except for the general market inflation.

The assessed specific price for a 1 MW package amounts to 1 M€/MW (0.9 GBP/MW).

The fixed O&M costs are assessed at approx. 18,000 GBP/y and the variable costs at 7.5 GBP/MWh respectively.

3.3 Mare Harbour

The system setup is shown in the figure below.

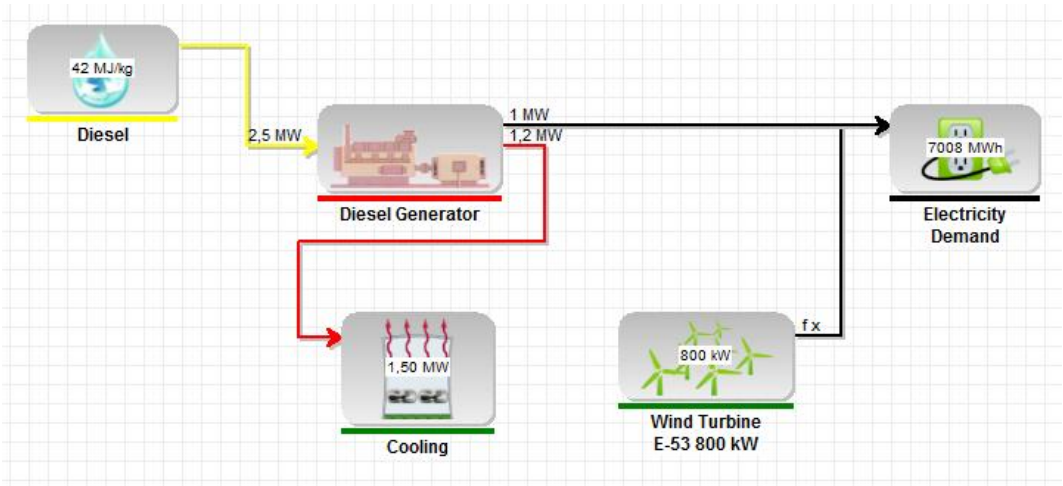


Figure 2 System setup.

The ERA5 wind data position, which is close to Mare Harbour approx. 10 km northeast, is:

- Longitude: -58.3 W
- Latitude: -51.8 S

The wind speed and the duration curve used for the analysis are shown in the figures below.

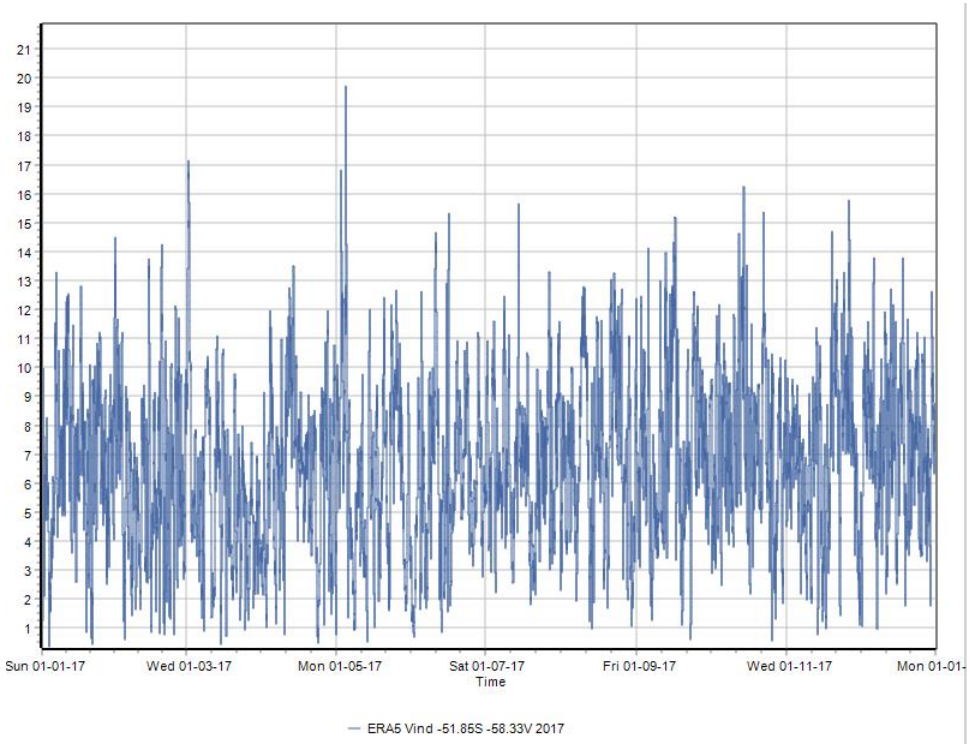


Figure 3 Wind speed over the year (ERA5 data from 2017).

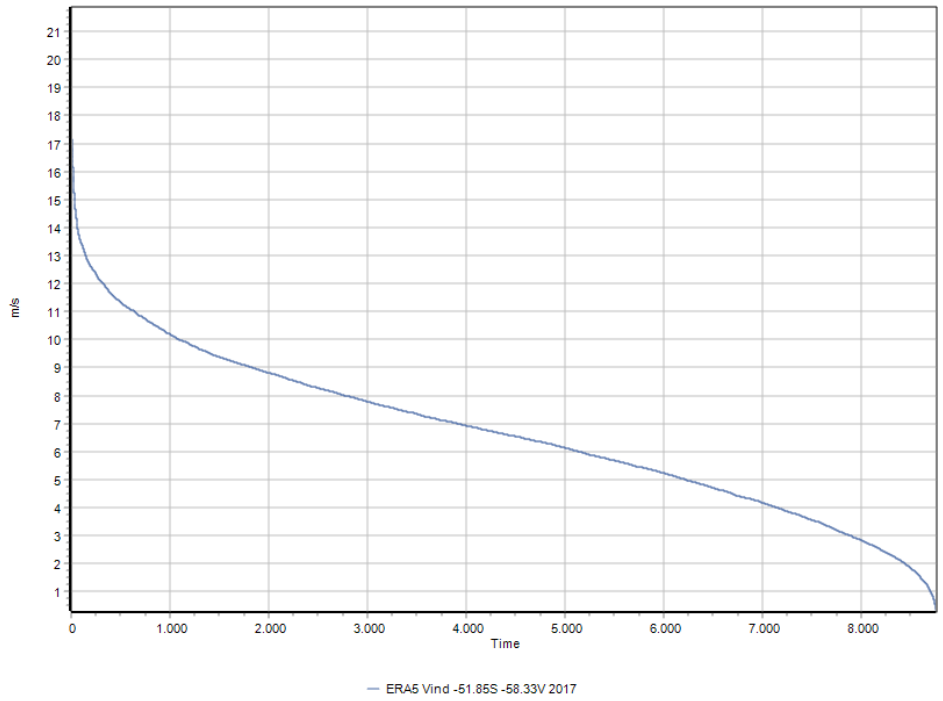


Figure 4 Wind speed duration curve (ERA5 data from 2017).

The production pattern is shown in the figure below. The electricity production share from the wind turbine is approx. 60 %. The remaining 40 % comes from the diesel engine.

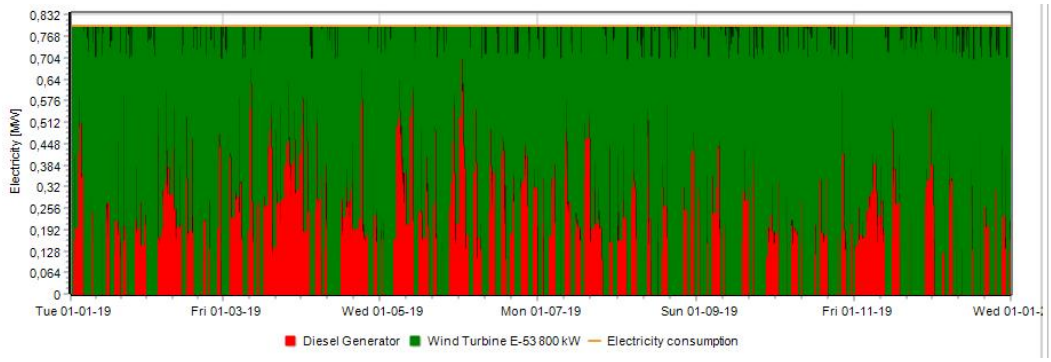


Figure 5 Production pattern.

The annual and monthly production data is found in Appendix 4.

The first 5 years of operation costs are shown below.

During the 25-year time period, the Levelized Costs of Electricity (LCOE), investments taken into account, arising from wind and diesel power respectively are very different. As can be seen in the table below, the diesel power is produced at 210.1 GBP/MWh, whereas the wind power is produced at only 31.5 GBP/MWh. The combined LCOE amounts to 83.2 GBP/MWh.

F-land Smolt Mare Harbour								
Business Case		Discounting rate		5.0%				
		NPV	0	1	2	3	4	5
			2020	2021	2022	2023	2024	2025
Investments (CAPEX)								
Diesel generator	[GBP]	**900,901**	900,901					
Wind turbine	[GBP]	**1,081,081**	1,081,081					
Production								
Diesel consumption	[liter]			752,495	752,495	752,495	752,495	752,495
Diesel Generator	[MWh]	**39,576**		2,808	2,808	2,808	2,808	2,808
Wind Turbine	[MWh]	**58,842**		4,175	4,175	4,175	4,175	4,175
Sum	[MWh]	**98,418**		6,983	6,983	6,983	6,983	6,983
Operating Expenses (OPEX)								
Diesel	[GBP]	**6,893,655**		489,122	489,122	489,122	489,122	489,122
O & M costs								
O & M Diesel Generator - fixed	[GBP]	**253,945**		18,018	18,018	18,018	18,018	18,018
O & M Diesel Generator - variable	[GBP]	**267,404**		18,973	18,973	18,973	18,973	18,973
O & M Wind Turbine - fixed	[GBP]	**507,890**		36,036	36,036	36,036	36,036	36,036
O & M Wind Turbine - variable	[GBP]	**265,055**		18,806	18,806	18,806	18,806	18,806
Sum O & M costs	[GBP]	**1,294,294**		91,833	91,833	91,833	91,833	91,833
Total costs	[GBP]	**8,187,949**		580,955	580,955	580,955	580,955	580,955
Production cost - diesel	[GBP/MWh]	**210.1**						
Production cost - wind	[GBP/MWh]	**31.5**						
Production cost - total	[GBP/MWh]	83.2						

Figure 6 Investments, operating expenses and Levelized Cost of Electricity (LCOE).

In Figure 7 Comparison between combined wind-diesel solution and stand-alone diesel solution (base case) below, a comparison is made between the combined wind-diesel solution and a stand-alone diesel solution. The diesel stand-alone solution is costlier in terms of total costs as the cost for diesel fuel will be the dominant price element.

MARE HARBOUR	Unit	Wind turbine	Diesel engine	Diesel engine
		Combined solution		Stand-alone
Capacity	MW	0.80	1.00	1.00
Investment	Million GBP	1.08	0.90	0.90
O&M per annum - fixed	GBP per annum	36,000	18,000	18,000
O&M/MWh - variable	GBP/KWh	4.50	6.80	6.80
Production split	%	60%	40%	100%
Annual production	KWh	4,175	2,808	6,983
Annual O&M costs (excl fuel)	GBP	54,788	37,094	65,484
Unit O&M costs (excl fuel)	GPB/KWh	13	13	9
Fuel costs	GBP	-	489,122	1,216,359
Total operating costs	GBP year 1	581,004		1,281,844

Figure 7 Comparison between combined wind-diesel solution and stand-alone diesel solution (base case).

3.4 New Haven

The system setup is the same as for the Mare Harbour site.

The ERA5 wind data position, which is relatively close to New Haven approx. 40 km southwest in the Falkland Sound near Swan Island, is:

- Longitude: -59.6 W
- Latitude: -51.8 S

The wind speed and the duration curve used for the analysis are shown in the figures below.

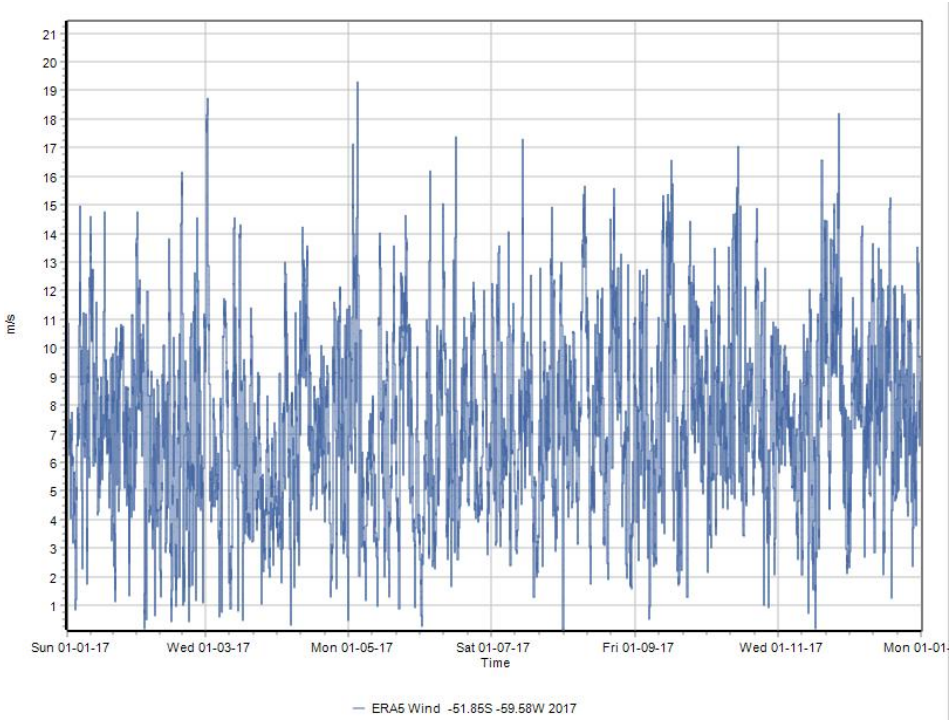


Figure 8 Wind speed over the year (ERA5 data from 2017).

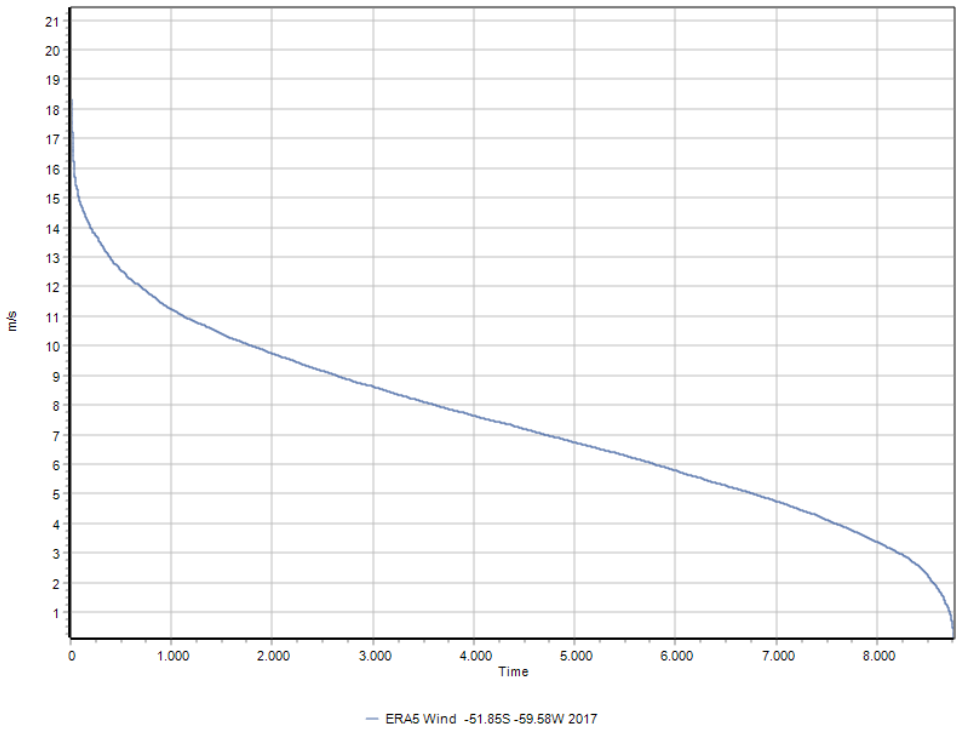


Figure 9 Wind speed duration curve (ERA5 data from 2017).

The production pattern is shown in the figure below. The electricity production share from the wind turbine is approx. 65 %. The remaining 35 % comes from the diesel engine.

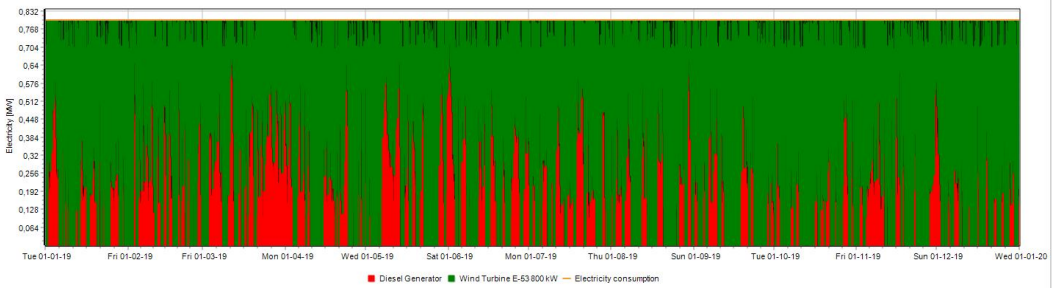


Figure 10 Production pattern.

The annual and monthly production data is found in Appendix 5.

The first 5 years of operation costs are shown below.

During the 25-year time period, the Levelized Costs of Electricity (LCOE), investments taken into account, arising from wind and diesel power respectively are very different. As can be seen from the table below, the diesel power is produced at 217.0 GBP/MWh, whereas the wind power is produced at only 28.7 GBP/MWh. The combined LCOE amounts to 71.0 GBP/MWh.

F-land Smolt New Haven

Business Case — Discounting rate 5.0%

		NPV	0	1	2	3	4	5
			2020	2021	2022	2023	2024	2025
Investments (CAPEX)								
Diesel generator	[GBP]	**900,901**	900,901					
Wind turbine	[GBP]	**1,081,081**	1,081,081					
Production								
Diesel consumption	[liter]			622,633	622,633	622,633	622,633	622,633
Diesel Generator	[MWh]	**32,627**		2,315	2,315	2,315	2,315	2,315
Wind Turbine	[MWh]	**65,692**		4,661	4,661	4,661	4,661	4,661
Sum	[MWh]	**98,319**		6,976	6,976	6,976	6,976	6,976
Operating Expenses (OPEX)								
Diesel	[GBP]	**5,703,981**		404,711	404,711	404,711	404,711	404,711
O & M costs								
O & M Diesel Generator - fixed	[GBP]	**253,945**		18,018	18,018	18,018	18,018	18,018
O & M Diesel Generator - variable	[GBP]	**220,456**		15,642	15,642	15,642	15,642	15,642
O & M Wind Turbine - fixed	[GBP]	**507,890**		36,036	36,036	36,036	36,036	36,036
O & M Wind Turbine - variable	[GBP]	**295,909**		20,995	20,995	20,995	20,995	20,995
Sum O & M costs	[GBP]	**1,278,200**		90,691	90,691	90,691	90,691	90,691
Total costs	[GBP]	**6,982,181**		495,403	495,403	495,403	495,403	495,403
Production cost - diesel	[GBP/MWh]	**217.0**						
Production cost - wind	[GBP/MWh]	**28.7**						
Production cost - total	[GBP/MWh]	71.0						

Figure 11 Investments, operating expenses and Levelized Cost of Electricity (LCOE).

In Figure 12 Comparison between combined wind-diesel solution and stand-alone diesel solution (base case) below, a comparison is made between the combined wind-diesel solution and a stand-alone diesel solution. The diesel stand-alone solution is costlier in terms of total costs as the cost for diesel fuel will be the dominant price element.

NEW HAVEN	Unit	Wind turbine	Diesel engine	Diesel engine
		Combined solution		Stand-alone
Capacity	MW	0.80	1.00	1.00
Investment	Million GBP	1.08	0.90	0.90
O&M per annum - fixed	GBP per annum	36,000	18,000	18,000
O&M/MWh - variable	GBP/KWh	4.50	6.80	6.80
Production split	%	67%	33%	100%
Annual production	KWh	4,661	2,315	6,976
Annual O&M costs (excl fuel)	GBP	56,975	33,742	65,437
Unit O&M costs (excl fuel)	GPB/KWh	12	15	9
Fuel costs	GBP	-	404,711	1,219,554
Total operating costs	GBP year 1	495,428		1,284,991

Figure 12 Comparison between combined wind-diesel solution and stand-alone diesel solution (base case).

4 Recommendations

Today's small wind turbine market is thin. Enercon has, however, wind turbines in the range of 800-900 kW, which fit very well together with a diesel engine for the specified smolt sites.

It is recommended going on with a wind turbine/diesel engine solution to carry out a proper feasibility study where potential supplier are contacted for price quotations, performance data, O&M contractual options, warranties etc. Based on the first years of costs for O&M and savings on fuel purchase, it seems that the wind-diesel solution will have a payback time of less than two years, roughly, based on the standard experienced turbine costs. This will have to be assessed further in the next phase with actual price quotations from manufacturers and EPC contractors.

Furthermore, potential main contractors should be identified for a dialogue on later participation in a tendering phase. Issues to be settled during these talks will be foundation for the turbines, erection of turbines, construction of diesel-house also to house the transformer equipment etc.

5 Next steps

The next steps are foreseen to be:

- Proper site-specific feasibility study.
- Contact to potential wind turbine suppliers for price and technology discussions.
- Identification of potential main contractors interested in later tendering of the project.
- Tendering of equipment (wind turbine and diesel engine).

The consultancy budget estimate for the next phase is:

Table 1 Budget estimate for next phase.

Detailed Feasibility Study	Hours	Pris (DKK)	Total
Feasibility study and detailed business case	115	1400	161.000
Contact to turbine manufacturer (indicative price quote)	15	1400	21.000
Contact to turbine EPC (indicative price quote)	15	1400	21.000
Procurement of turbine, engine and EPC (specifications, tender, contracts)	50	1400	70.000
Meetings, project management etc.	20	1400	28.000
Total (excl expences)	215		301.000

Following the stages with the detailed feasibility study, tendering and investment decision and contract priced above comes the implementation phase which, from a consultancy side, includes supervision, commissioning surveillance and handover assistance.

Falkland Islands Government

Power and Electrical Section, Public Works Department, Stanley, Falkland Islands
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SAND BAY WIND FARM

Wind Turbine Manufacturer	Enercon GmbH
Wind Turbine Rating	335 kW
Wind Farm Rating	2,010 kW
Phase 1 Production start date	9th August 2007
Phase 2 Production start date	15th February 2010
Cut in wind speed (m/s)	2.5
Storm wind speed (m/s)	28-34
Average site wind speed (m/s)	10.7
Hub Height	44 metres
Direction of Rotation	Clockwise
Speed Range	18-49 RPM
Number of blades	3
Tip speed	31-79 m/s
Rotor Diameter	33.4 metres
Total Project Cost	£4.6 million
Target penetration/diesel displacement	35 -40 % per annum
Target Units (1 unit = 1 kWh)	5,250,000 to 6,000,000 per annum
Phase 1 average rate	3,882,000 units per annum
Phase 1 penetration/diesel displacement	26% (1,011,682 litres)
Highest hourly output to date	1886 kW (26/7/17)
Highest Hourly Wind Penetration % to date	77% (563 kW diesel, 1,886 kW wind and 2,449 kW total demand) 26/7/17
Highest Daily	54% Wind, 46% Diesel
Highest Weekly Production	163,188 units W/E 3rd July 2015 (42.48%)
Highest Weekly Percentage	45.04% (139,822 units from the wind farm and 170,590 units from the diesel station)
Highest diesel displacement rate per hour	498 litres (109.54 Gallons)

2nd August 2017

ESTIMATED ENERGY PRODUCTION

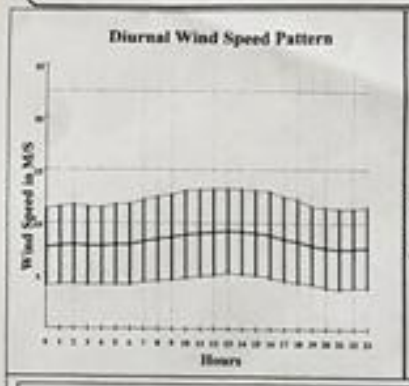
Date Range
2002-10-03 TO 2003-10-02

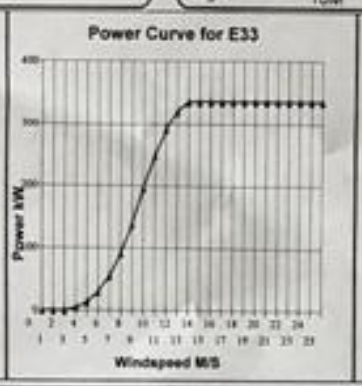
SITE 0001

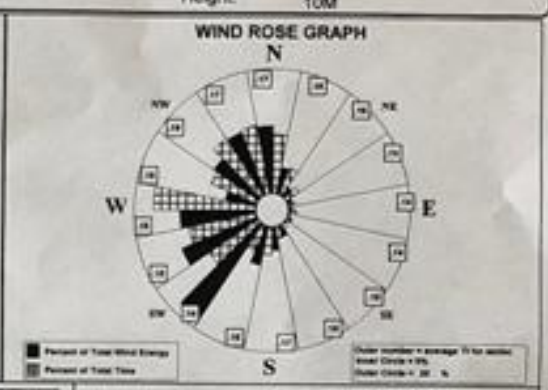
Site Information

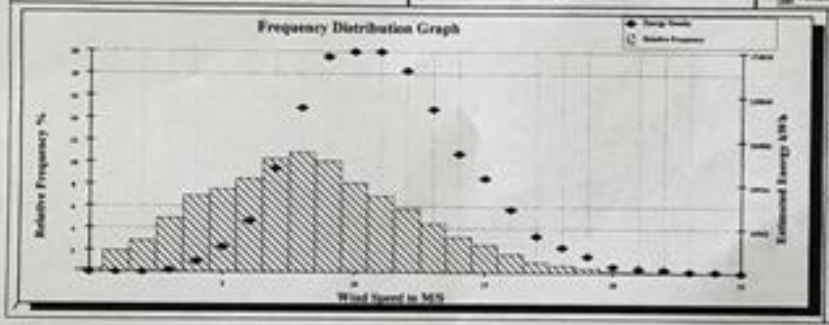
Project:	Sand Bay Wind Farm
Location:	Sand Bay
Site Elevation:	10M
Averaging Time:	60 min

Sensor 1 Information		*Sensor 2 Information*	
Channel:	1	Channel:	4
Type:	Anemometer	Type:	Direction Vane
Scale:	0.765000000	Scale:	1.000000000
Offset:	0.3500	Offset:	0.0000
Description:	Anemometer	Description:	Direction Vane
Height:	10M	Height:	10M









Statistics

Estimated Energy Output	4164060 KWH
Calculated Air Density	1.224 kg/m3
(temperature data and pressure based on elevation)	
Average Wind Speed	8.3 M/S
Average Turbulence Intensity	0.16
Mean Energy Wind Direction	SW
Mean Wind Direction	W
Capacity Factor	0.48
Average Temperature	0.0 C
Turbine Manufacturer	Enercon
Turbine Model	E33
Turbine Rating	330.0 kW
Number of Turbines	3
Estimated Annual Production	4182202 KWH/Year

Total hours = 8760 Total hours used in Calculations = 8722 Percent Data used = 99.5

Printed May 22, 2007

NRG Systems MicroSite Version 2.07

PROJECT ESTIMATED ENERGY PRODUCTION

Date Range
2002-10-03 TO 2003-10-02

PROJECT
Sand Bay Wind Farm

Site Information

Project:	Sand Bay Wind Farm
Location:	Sand Bay
Site Elevation:	10M
Averaging Time:	60 min

Project	Site	Location	Height	Turbine Manufacturer	Turbine Model	Quantity	Air Density	TI	Estimated Energy Output
Sand Bay Wind Farm	0001	Sand Bay	10M	Enercon	E33	3	1.2236	0.16	4164060

Falkland Islands Government
Power & Electrical Section
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Email: GRoss.power@pwd.gov.fk

GLENN ROSS CEng BEng(Hons) MIEE
Power Station Manager

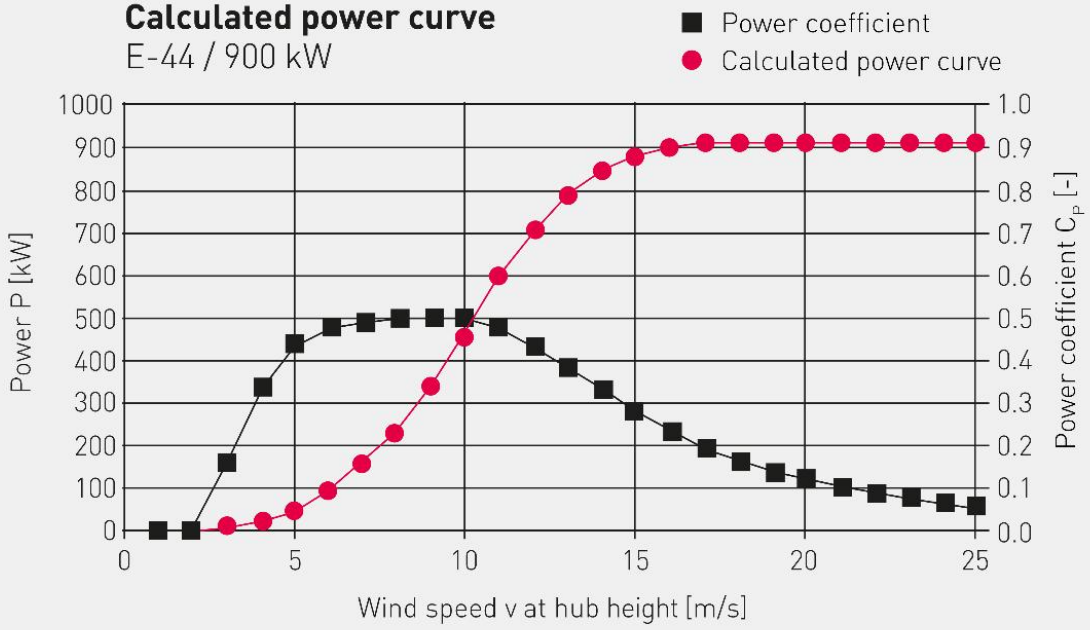
ENERCON E-44

Overview of technical details

Rated power	900 kW
Rotor diameter	44 m
Hub height in meter	45 / 55
Wind zone (DIBt)	-
Wind class (IEC)	IEC/EN IA
WEC concept	Gearless, variable speed, single blade adjustment

Calculated power curve

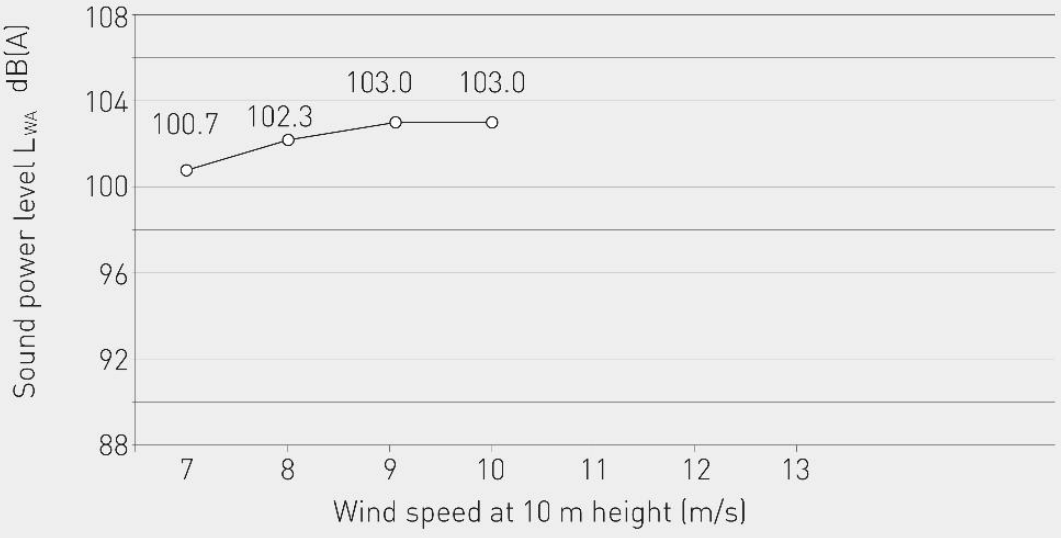
E-44 / 900 kW



The above information is without obligation. The information on the official data sheets apply (available from ENERCON Sales).

Sound power level

E-44 / 900 kW, 45 m hub height



The above information is without obligation. The information on the official data sheets apply (available from ENERCON Sales).

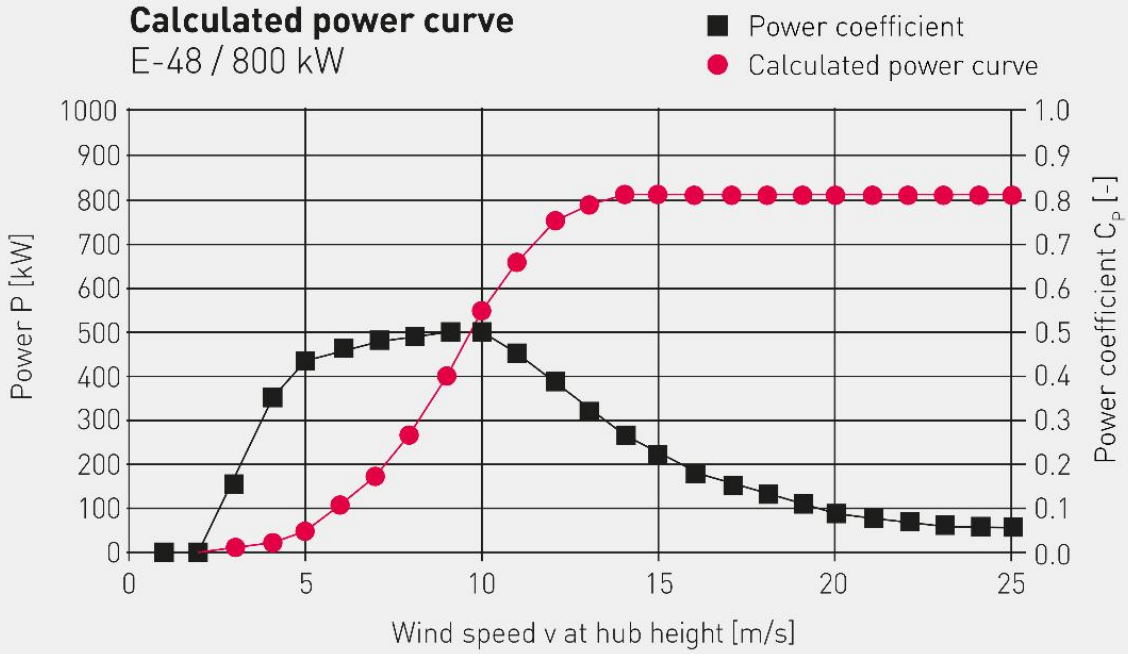
ENERCON E-48

Overview of technical details

Rated power	800 kW
Rotor diameter	48 m
Hub height in meter	50 / 55 / 60 / 65 / 76
Wind zone (DIBt)	WZ III
Wind class (IEC)	IEC/EN IIA
WEC concept	Gearless, variable speed, single blade adjustment

Calculated power curve

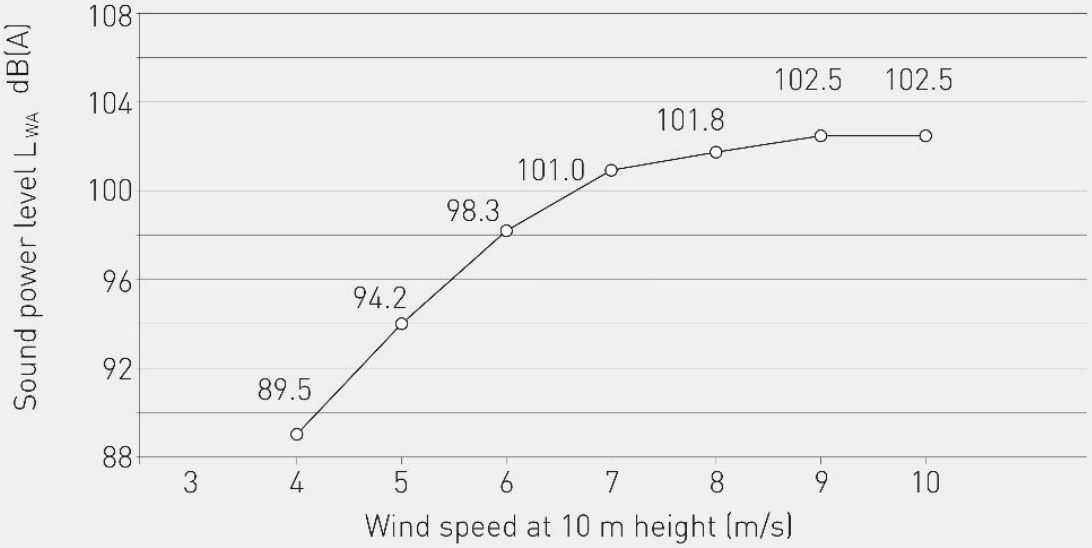
E-48 / 800 kW



The above information is without obligation. The information on the official data sheets apply (available from ENERCON Sales).

Sound power level

E-48 / 800 kW, 65 m hub height



The above information is without obligation. The information on the official data sheets apply (available from ENERCON Sales).

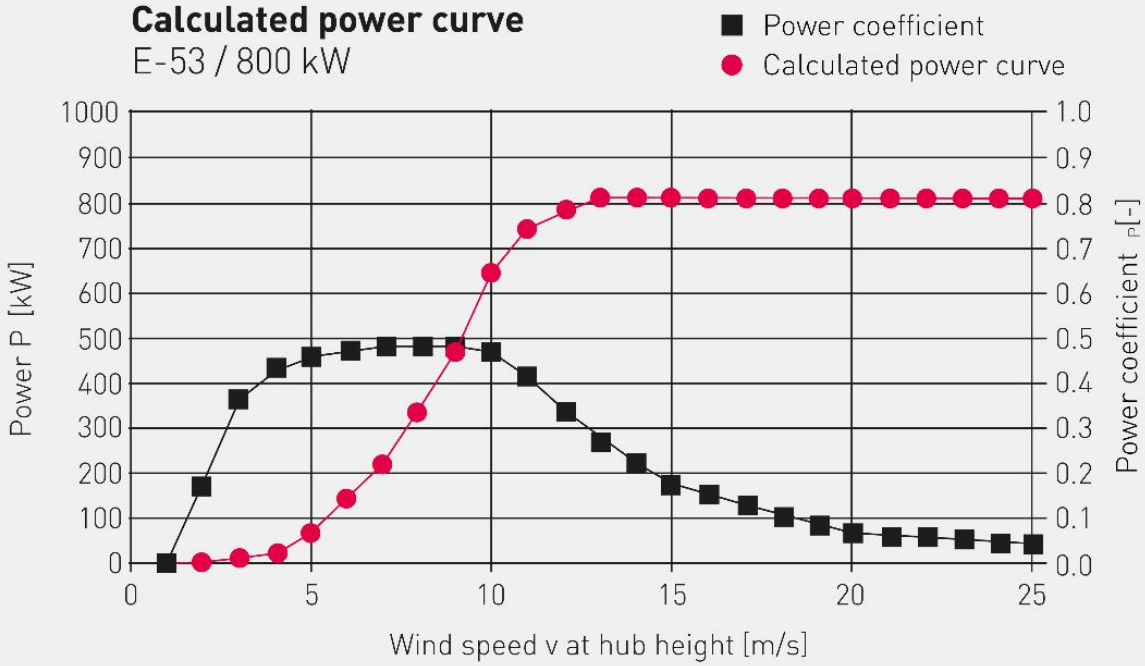
ENERCON E-53

Overview of technical details

Rated power	800 kW
Rotor diameter	52,9 m
Hub height in meter	50 / 60 / 73
Wind zone (DIBt)	WZ II exp; WZ 3 GK I, WZ4 GK II
Wind class (IEC)	IEC/NVN Class S
WEC concept	Gearless, variable speed, single blade adjustment

Calculated power curve

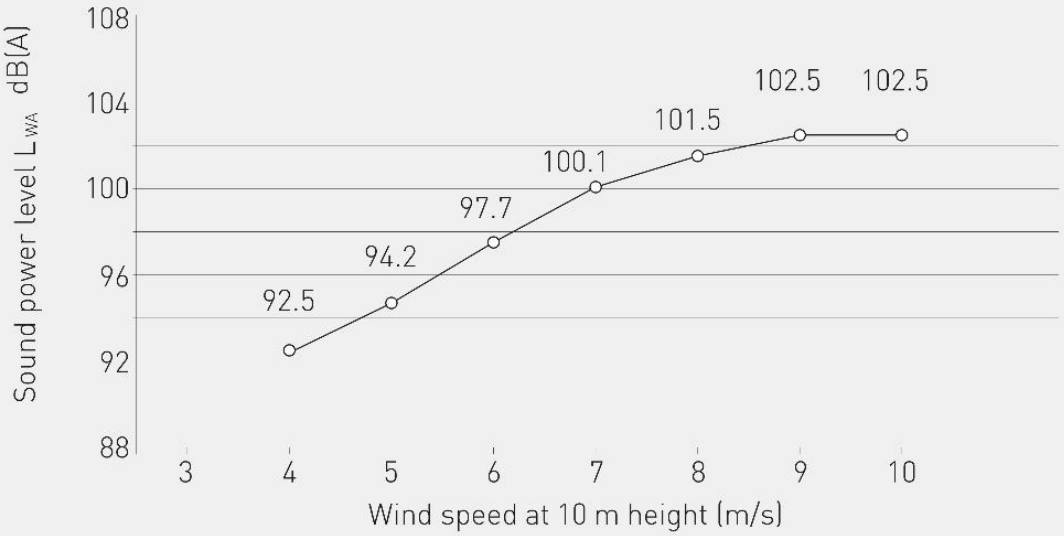
E-53 / 800 kW



The above information is without obligation. The information on the official data sheets apply (available from ENERCON Sales).

Sound power level

E-53 / 800 kW, 73 m hub height



The above information is without obligation. The information on the official data sheets apply (available from ENERCON Sales).

Exchange rate	GBP/EUR	1.11	
Exchange rate	GBP/USD	1.26	
Diesel	GBP/liter	0.65	
Investments			
Capacity Diesel Generator	MWe	1.000	
Diesel Generator - spec.	MGBP/MWe	0.90	
Diesel Generator	MGBP	0.901	
Capacity Wind Turbine	MWe	0.800	
Wind Turbine - spec.	GBP/MWe	1.35	Earlier projects: Approx. 3,5 MGBP/MWe
Wind Turbine	MGBP	1.081	
O & M			
Diesel Generator - fixed	GBP/y	18,018	
Diesel Generator - variable	GBP/MWhe	6.8	
Wind Turbine - fixed	GBP/y	36,036	
Wind Turbine - variable	GBP/MWhe	4.5	

Gas Engine:		Assessed	ENS Tek. Cat. Aug. 2016
Electrical efficiency	-	0.40	0.45
Specific investment	M€/MWe	1.00	1.00
- equipment	M€/MWe	0.65	0.65
- installation	M€/MWe	0.35	0.35
Fixed O&M	€/MWe/y	20,000	10,000
Variable O&M	€/MWhe	7.5	5.4

Wind Tubine:		Assessed	ENS Tek. Cat. Aug. 2016
Specific investment	M€/MWe	1.50	1.00
- equipment	M€/MWe	0.75	0.75
- installation	M€/MWe	0.25	0.25
Fixed O&M	€/MWe/y	50,000	25,600
Variable O&M	€/MWhe	5.0	2.8

Sand Bay (2007, 2010):			
Total project costs, 2 MW (assumed 2007 prices)	MGBP	4.60	
Total project costs (2018 prices)	MGBP	6.03	Assumed 2,5% price development in 11 years.
Specific invesment	MGBP/MWe	3.01	
Phase 2 project costs (1 MW)	MGBP	3.80	Mail from Morten Bjørn 26. Nov. 2018 - approx. 3)
Specific invesment	MGBP/MWe	3.80	

years ago ?

Vind og Diesel - F-land - Smolt Mare Harbour E-53 800 kW.epp
Vind og diesel

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Sweco Danmark A/S
Granskoven 8
DK-2600 Glostrup
43 48 60 60

Energy conversion, annual

Calculated period: 01-2019 - 12-2019

Heat productions:

Diesel Generator	3.262,4 MWh/year	
Wind Turbine E-53 800 kW	0,0 MWh/year	
Heat Rejection (total for site)	-3.262,4 MWh/year	
Total	0,0 MWh/year	100,0%

Electricity demands (not including electricity consumed by energy units):

Electricity Demand	7.008,0 MWh
Max electricity demand	0,8 MW

Electricity produced by energy units:

	All periods [MWh/year]	Of annual production
Diesel Generator	2.807,8	40,2%
Wind Turbine E-53 800 kW	4.174,7	59,8%
Total	6.982,5	100,0%
Of annual production	100,0%	

Peak electric production:

Diesel Generator	775,3 kW-elec.
Wind Turbine E-53 800 kW	800,0 kW-elec.

Electricity exchange:

Hours of operation:

	Total [h/Year]	Of annual hours
Diesel Generator	7.618,0	87,0%
Wind Turbine E-53 800 kW	8.760,0	100,0%
Out of total in period	8.760,0	

Turn ons:

Diesel Generator	173
Wind Turbine E-53 800 kW	0

Fuels:

By fuel

	Fuel consumption
Diesel	624.571,5 kg

By energy unit

Diesel Generator	7.286,7 MWh	=624.571,5	kg
Wind Turbine E-53 800 kW	0,0 MWh	=0,0	----
Total	7.286,7 MWh		

Vind og Diesel - F-land - Smolt Mare Harbour E-53 800 kW.epp

Vind og diesel

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Sweco Danmark A/S
Granskoven 8
DK-2600 Glostrup
43 48 60 60

Energy conversion, monthly

Calculated period: 01-2019 - 12-2019

	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Electricity demand [MWh]													
	7.008,0	595,2	537,6	595,2	576,0	595,2	576,0	595,2	595,2	576,0	595,2	576,0	595,2
Electricity produced by energy units [MWh]													
	6.982,5	592,7	536,2	593,9	574,0	593,8	574,4	593,1	592,3	573,3	592,7	574,1	592,0
Energy unit: Diesel Generator													
Fuel consum. [kg]	**624.571,5**	50.726,4	54.471,6	66.570,7	53.106,1	57.713,9	57.454,3	52.775,5	48.094,4	45.225,3	45.627,0	47.422,9	45.383,5
Fuel consum. [MWh]	**7.286,7**	591,8	635,5	776,7	619,6	673,3	670,3	615,7	561,1	527,6	532,3	553,3	529,5
Heat prod. [MWh]	**3.262,4**	263,6	287,1	353,5	277,7	303,9	302,3	274,7	250,4	235,0	235,0	245,8	233,5
Elec. prod. [MWh]	**2.807,8**	227,4	246,0	301,9	238,9	260,6	259,3	236,8	215,8	202,7	203,6	212,3	202,4
Turn ons	**173**	17	11	7	13	10	9	14	18	19	18	15	22
Operating hours	**7.618**	647	613	697	642	655	657	663	603	577	623	617	624
Full load operating hours	**2.808**	227	246	302	239	261	259	237	216	203	204	212	202
Energy unit: Wind Turbine E-53 800 kW													
Elec. prod. [MWh]	**4.174,7**	365,3	290,1	292,0	335,2	333,2	315,1	356,3	376,4	370,6	389,1	361,8	389,5
Turn ons	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Operating hours	**8.760**	744	672	744	720	744	720	744	744	720	744	720	744
Full load operating hours	**5.218**	457	363	365	419	417	394	445	471	463	486	452	487
Heat rejection: Lokalitet F													
Heat Rejection [MWh]	**3.262**	264	287	353	278	304	302	275	250	235	235	246	234
Elec. consump [MWh]	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Fuel consumption: Diesel													
Fuel consum. [kg]	**624.571,5**	50.726,4	54.471,6	66.570,7	53.106,1	57.713,9	57.454,3	52.775,5	48.094,4	45.225,3	45.627,0	47.422,9	45.383,5
Fuel consum. [MWh]	**7.286,7**	591,8	635,5	776,7	619,6	673,3	670,3	615,7	561,1	527,6	532,3	553,3	529,5
Peak [MW]	**1,951**	1,951	1,903	1,936	1,926	1,919	1,887	1,695	1,840	1,904	1,915	1,874	1,840

Vind og Diesel - F-land - Smolt New Haven E-53 800 kW.epp
Vind og diesel

Licensed user:
Sweco Danmark A/S
Granskoven 8
DK-2600 Glostrup
43 48 60 60

Energy conversion, annual

Calculated period: 01-2019 - 12-2019

Heat productions:

Diesel Generator	2.677,7 MWh/year	
Wind Turbine E-53 800 kW	0,0 MWh/year	
Heat Rejection (total for site)	-2.677,7 MWh/year	
Total	0,0 MWh/year	100,0%

Electricity demands (not including electricity consumed by energy units):

Electricity Demand	7.008,0 MWh
Max electricity demand	0,8 MW

Electricity produced by energy units:

	All periods [MWh/year]	Of annual production
Diesel Generator	2.313,3	33,2%
Wind Turbine E-53 800 kW	4.660,9	66,8%
Total	6.974,2	100,0%
Of annual production	100,0%	

Peak electric production:

Diesel Generator	792,7 kW-elec.
Wind Turbine E-53 800 kW	800,0 kW-elec.

Electricity exchange:

Hours of operation:

	Total [h/Year]	Of annual hours
Diesel Generator	6.738,0	76,9%
Wind Turbine E-53 800 kW	8.760,0	100,0%
Out of total in period	8.760,0	

Turn ons:

Diesel Generator	221
Wind Turbine E-53 800 kW	0

Fuels:

By fuel

	Fuel consumption
Diesel	516.785,0 kg

By energy unit

Diesel Generator	6.029,2 MWh	=516.785,0	kg
Wind Turbine E-53 800 kW	0,0 MWh	=0,0	----
Total	6.029,2 MWh		

Vind og Diesel - F-land - Smolt New Haven E-53 800 kW.epp

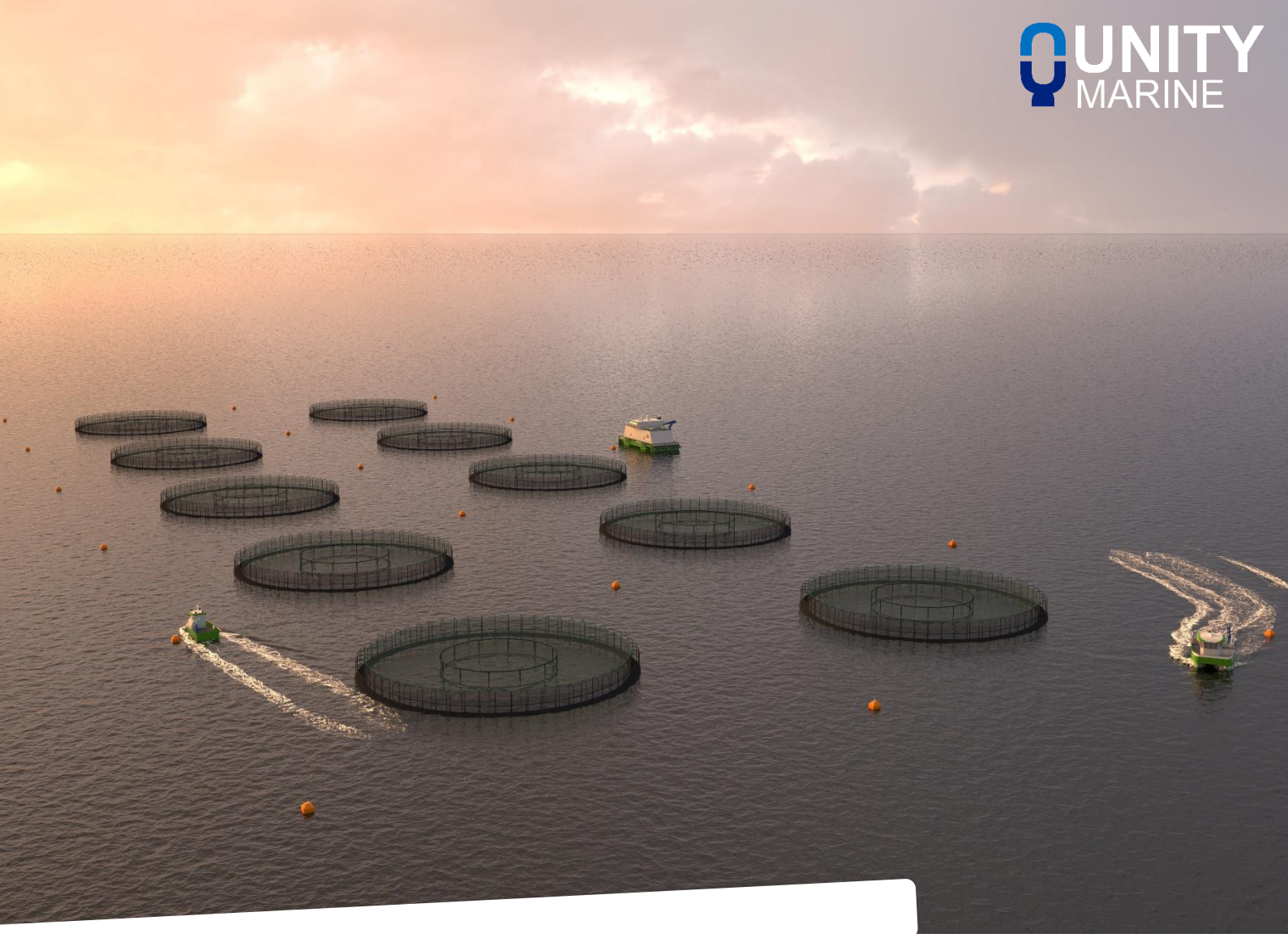
Vind og diesel

Licensed user:
Sweco Danmark A/S
Granskoven 8
DK-2600 Glostrup
43 48 60 60

Energy conversion, monthly

Calculated period: 01-2019 - 12-2019

	Total	jan	feb	mar	apr	maj	jun	jul	aug	sep	okt	nov	dec
Electricity demand [MWh]													
	7.008,0	595,2	537,6	595,2	576,0	595,2	576,0	595,2	595,2	576,0	595,2	576,0	595,2
Electricity produced by energy units [MWh]													
	6.974,2	592,0	535,4	593,2	572,8	592,5	573,0	593,5	592,4	573,4	591,8	573,0	591,2
Energy unit: Diesel Generator													
Fuel consum. [kg]	**516.785,0**	41.669,2	48.389,7	57.552,0	43.500,9	47.425,9	48.202,1	43.834,5	38.902,9	37.021,6	36.793,7	38.324,8	35.167,5
Fuel consum. [MWh]	**6.029,2**	486,1	564,5	671,4	507,5	553,3	562,4	511,4	453,9	431,9	429,3	447,1	410,3
Heat prod. [MWh]	**2.677,7**	213,7	254,5	304,0	225,2	249,2	251,5	226,0	201,0	190,8	187,1	196,8	177,9
Elec. prod. [MWh]	**2.313,3**	185,5	218,3	260,3	194,6	213,9	216,6	195,7	173,9	165,2	163,1	170,8	155,5
Turn ons	**221**	21	17	9	21	15	18	12	19	19	25	19	26
Operating hours	**6.738**	587	555	634	572	550	593	595	518	504	550	535	545
Full load operating hours	**2.313**	186	218	260	195	214	217	196	174	165	163	171	155
Energy unit: Wind Turbine E-53 800 kW													
Elec. prod. [MWh]	**4.660,9**	406,4	317,1	332,9	378,2	378,7	356,4	397,8	418,5	408,2	428,7	402,2	435,8
Turn ons	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Operating hours	**8.760**	744	672	744	720	744	720	744	744	720	744	720	744
Full load operating hours	**5.826**	508	396	416	473	473	445	497	523	510	536	503	545
Heat rejection: Lokalitet F													
Heat Rejection [MWh]	**2.678**	214	255	304	225	249	252	226	201	191	187	197	178
Elec. consump [MWh]	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Fuel consumption: Diesel													
Fuel consum. [kg]	**516.785,0**	41.669,2	48.389,7	57.552,0	43.500,9	47.425,9	48.202,1	43.834,5	38.902,9	37.021,6	36.793,7	38.324,8	35.167,5
Fuel consum. [MWh]	**6.029,2**	486,1	564,5	671,4	507,5	553,3	562,4	511,4	453,9	431,9	429,3	447,1	410,3
Peak [MW]	**1,993**	1,744	1,993	1,960	1,960	1,931	1,977	1,814	1,807	1,892	1,824	1,965	1,684



Unity Marine – Site Suitability Report

APPENDIX F

1 Content

1 Content 1
2 Document Scope 2
3 Area selection criteria 3
4 Area Survey 5
4.1 Visual data 6
4.2 Depth and Bathymetry 9
4.3 Wave and current 11
5 Overview 13
6 Conclusion 15

2 Document Scope

This document contains an initial assessment of potential for establishing a Salmon farming operation in marine areas around the Falkland Islands in the southern part of the Atlantic Ocean.

Unity Marine has surveyed 26 potential marine areas, in order to identify potential sites for farming of Salmon in the Falkland island. The sum of each survey leads to an overall evaluation of the Falkland Islands potential for salmon farming.

The suitability of a given area for salmon farming is determined by overall geographical attributes, like temperature, current, wave exposure etc. Secondly, the ecological carrying capacity of a given area and distance to infrastructure are things to be considered in an overall evaluation. Annexed to this report is a more in-depth Environmental Considerations Desktop Study and a Socio-Economic Impact Considerations.

In addition to the above attributes a series of local structural conditions defines if an area can be used for farming or not. With the present knowledge these structural conditions included:

1. Cultural heritage sites
2. Protected areas
3. Permanent sailing routes
4. Permanent moorings
5. Underwater cables

3 Area selection criteria

Existing nautical charts were used to define areas to be investigated. The existing charts have a relatively low resolution and therefor needed to be refined in order to be used in the further suitability assessment. When choosing areas of interest some selection criteria had to be made.

The initial selection criteria were:

- Minimum water depth of 30 m
- No direct trajectory to open ocean
- No apparent threshold sounds

Based on these criteria 35 areas were chosen from the northern entrance of Falkland sound, all the way down to Eagle passage and up to Choiseul Sound.

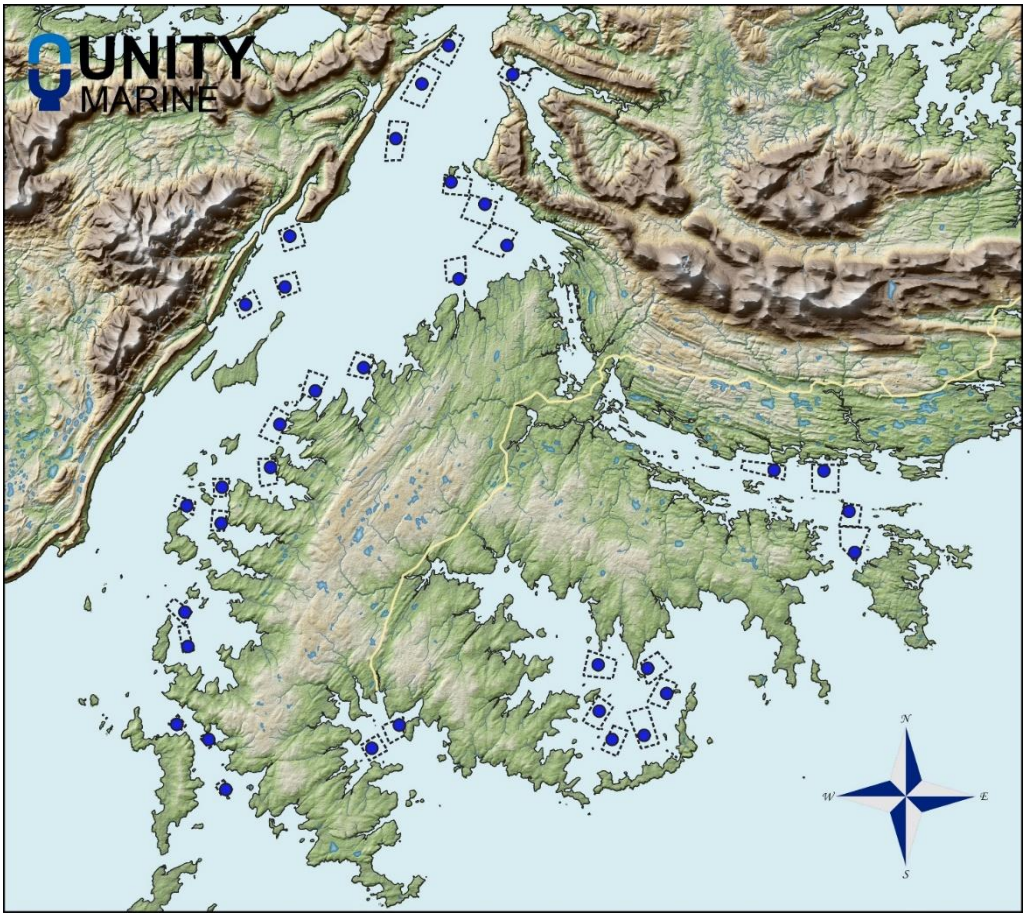


Figure 1: Potential marine sites for Salmon farming in Falkland's

Each Area identified were marked with point to indicate an area estimated to have the best suitability based on available data. The point is defined as the sampling point and is marked with a number and a name. For instance, sampling point 3.2 named "High Cliff East". An assessment area around each sample point was defined. This area represents the area where, additional depth measurements should be made.

Direct exposure to ocean waves was identified as areas that had direct exposure to open water. As an example, the areas not suitable was identified as shown below.

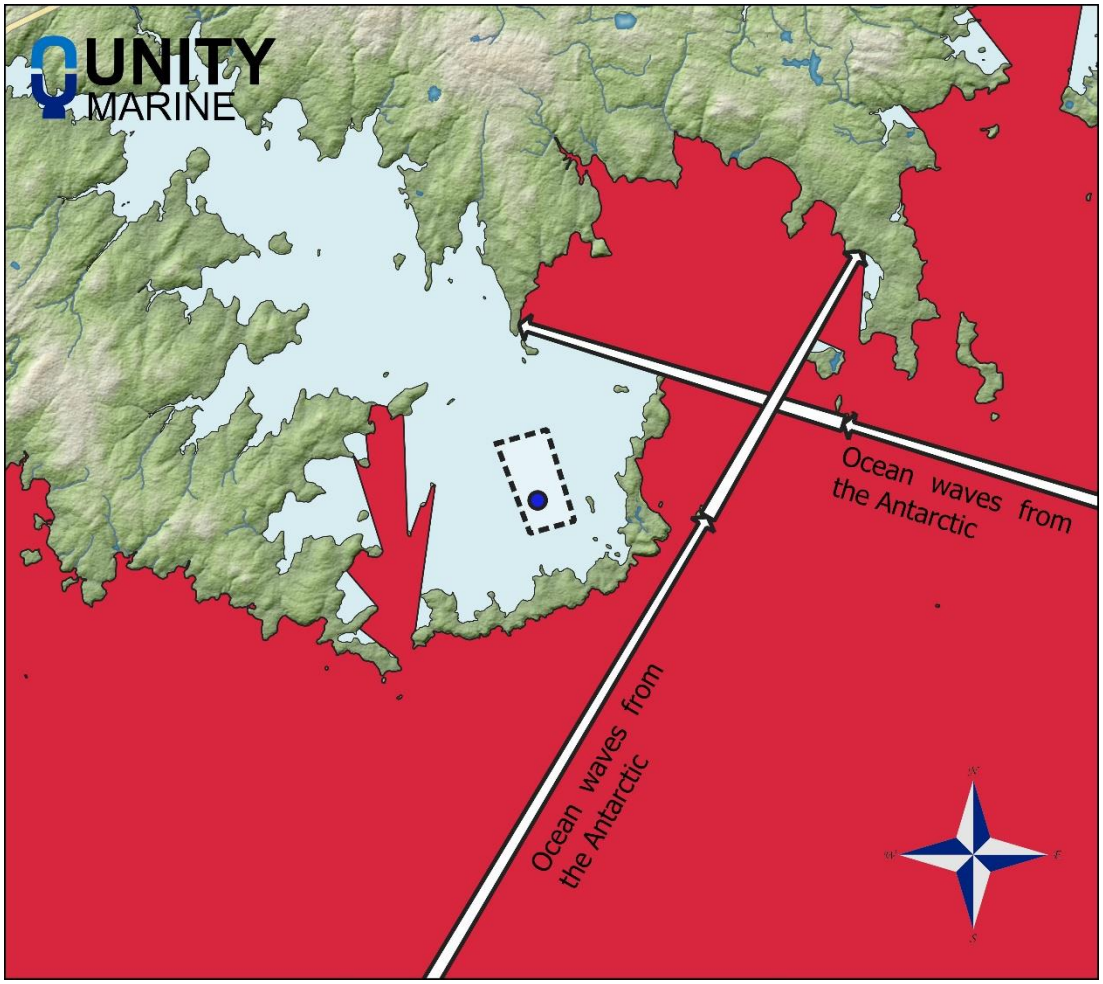


Figure 2 illustrates the simple identification method, used to determine suitable areas. The red area represents the areas where direct ocean waves from Antarctica will occur. The dottet square represents one of the areas chosen to be surveyed. The blue dot represents the specific sampling location.

In the subsequent survey the following data was collected on each sampling point, where the weather allowed.

- Pictures in 4 directions
- Bottom video footage
- Cell phone coverage
- Estimation of current
- Side sonar scanner
- Drone 360 view with pictures

4 Area Survey

The survey of the selected areas were carried out from the 18-27th of September 2018. The survey was conducted together with personnel from the South Atlantic Environmental Research Institute (SAERI). An extensive Cruise report can be found in appendix (G). A total of 1.584 km of sailing was covered during the survey.

The primary objectives were as follows:

1. To gain general knowledge of the environmental conditions and variability at the selected areas.
2. To validate the current bathymetry charts of each area.
3. To gain knowledge of seabed physical and biological characteristics.

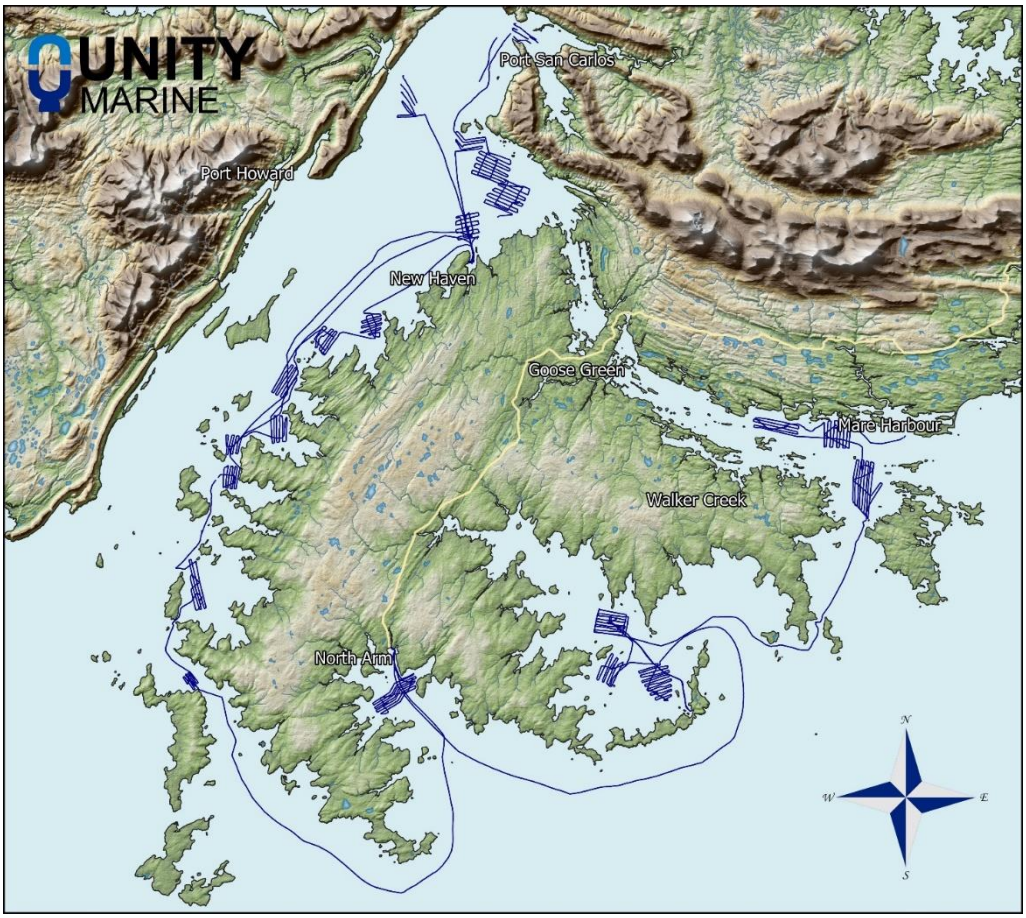


Figure 3: The surveyed areas in the Falklands.

Figure 3 shows the followed sailing route during the survey. The first part of the survey took place in Falkland Sound, with New Haven as the point of operation. The first survey days took place in the area north of Newhaven before moving to the areas south of New Haven. After sailing around Bull's point North arm and Bleaker Island was used as a point of operation. The last part of the survey took place in Choiseul sound.

4.1 Visual data

When reaching each of the sampling points pictures were taken in four different directions. An example can be seen on the pictures below. These were used for later orientation and assessment of the general conditions of each area.



Figure 4 : Shows pictures in 4 directions at a sampling point. Assessment area 3.1

Bottom camera footage were obtained by using an underwater camera. Figure 6 shows snapshots of some of the areas with high abundancy of species and biomass. The bottom camera footage showed that many of the surveyed areas had a bottom current. This could be directly seen from small bundles of debris forming into a sphere and tumbling over the bottom sediment. Also free floating seaweed was absent, which further suggest that there is a bottom current carrying the matter away.



Figure 5 The four pictures illustrate examples of some of the seabed footage in survey where a high abundancy of lifeforms identified.

The observed turbidity was low in most areas. The survey was carried out during winter which explain some low load of organic matter, but the turbidity still seems low in comparison to other areas where salmon is farmed. In some of the video footage underwater light where used during the day, but in many cases the daylight penetrated all the way to the seabed (<30 m) and additional light was not necessary.

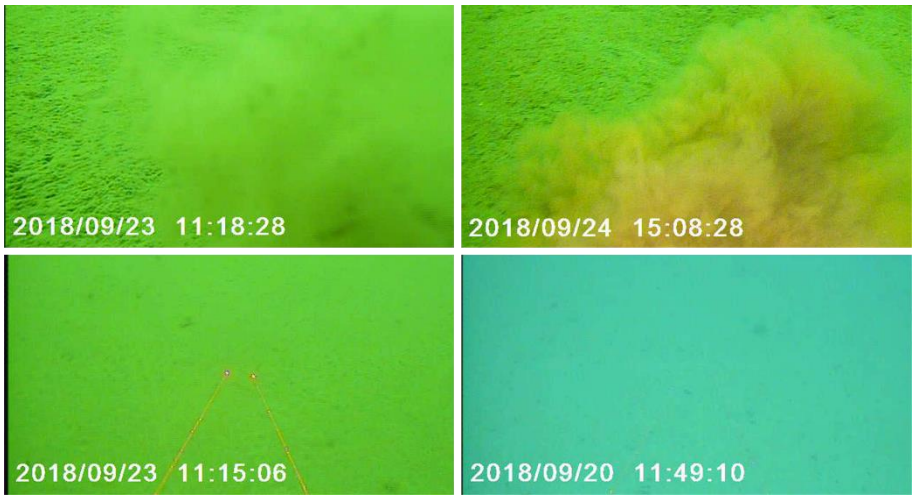


Figure 6 The four pictures illustrate examples of some of the seabed footage in survey where a low abundancy of lifeforms identified.

During the period of the survey the weather was rather rough, and the survey vessel had to lay over because of high winds. It would be expected that the bad weather would create a high turbidity by disturbing the sediment. This was however not observed.

The sea bottom could roughly be divided into areas 3 area types.

- Soft substrates, e.g. sand, mud, gravel and mixed sediments
- Hard substrates, e.g. bedrock and boulders
- Biogenic substrates, e.g. mussel beds

The predominant substrates were soft substrates and biogenic substrates.

Some of the soft substrates were scattered with stones. These areas showed a larger diversity, while the soft substrates with only sandy bottom primarily showed low abundance.

The biogenic substrates also showed a larger diversity but was more uniform.

No decoloured oxygen depleted areas were observed during the survey. Only the areas in North Arm showed a real silty bottom. Which might indicate low bottom current.

Hard substrates were only observed few times during the survey. These substrates are not preferred in relation to salmon farming as boulders and other elevations create a more turbulent current and can promote sedimentation of organic matter. Secondly anchoring and mooring can be done much gentler and more efficient in the two other substrate types.

Arial footage was obtained to identify general conditions of a site when wind conditions allowed it.



Figure 7 Arial photo from drone at a Height of 120ft. Assessment are 2.2.

4.2 Depth and Bathymetry

The depth measurement collected during the survey, contained a little more than a half a million individual datapoints. These data point have been merged with existing data sets and interpolated to give new and more accurate charts of the investigated areas.

In general, the new depth measurements showed a tendency towards deeper water than initially indicated on the existing nautical charts. Secondarily the measurements confirmed a rather flat bottom sloping towards underwater ravines. When considering the increased resolution of the individual areas it was also shown that there were very few depressions in the seabed where increased sedimentation could occur. Conditions like this has an effect on the overall evaluation of the suitability of an area. Condition could also be:

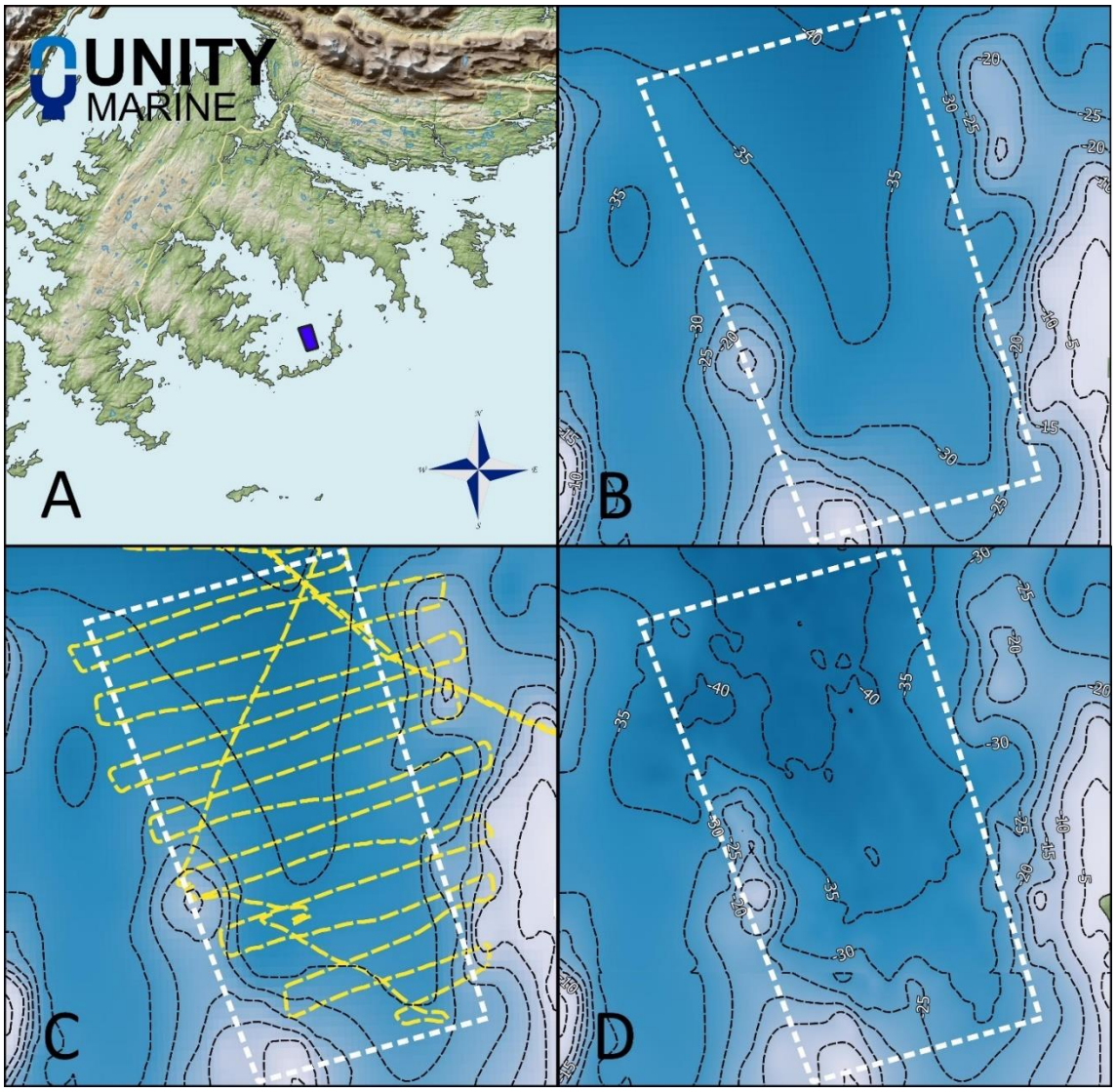


Figure 8 shows are 8.4 (Halt Island) A) shows the location of the survey area on the chart. B) shows the original bathymetric chart. C) shows the route at witch new depth measurements were taken. D) shows the new updated bathymetric chart,

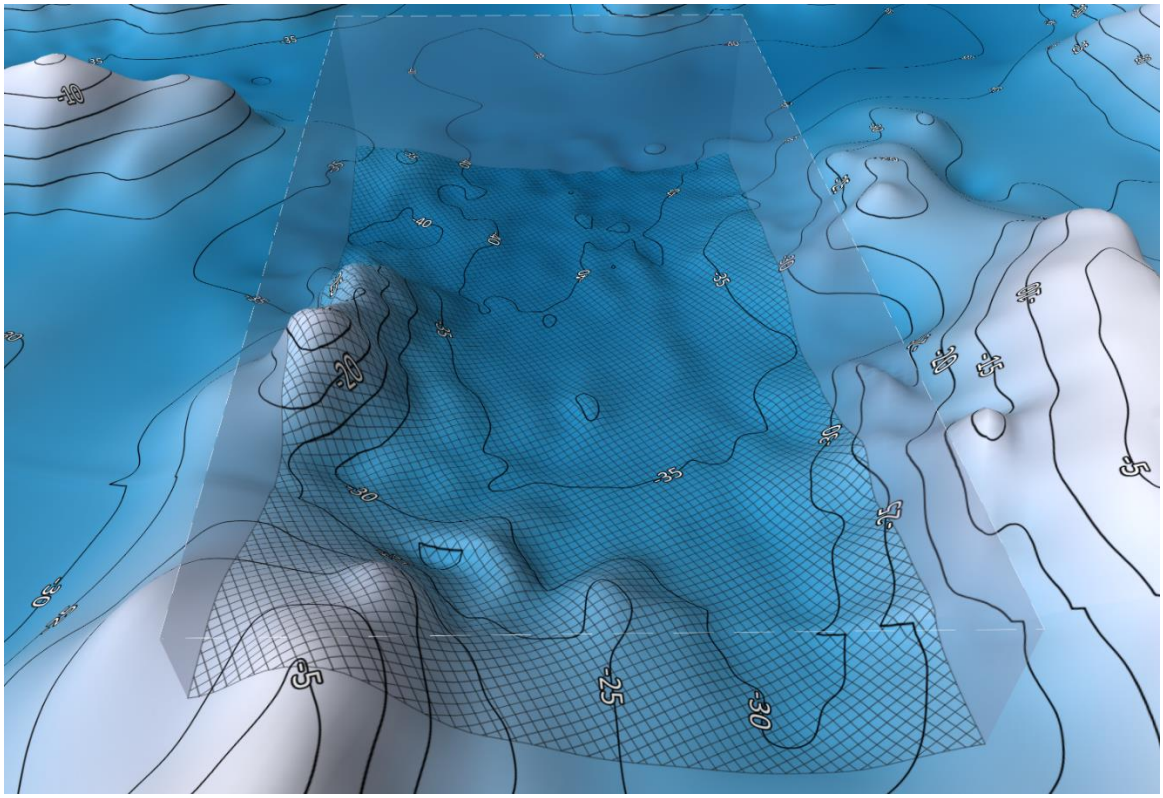


Figure 9 shows a transformed 3D illustration of the bathymetry within a survey area.

The 3D illustrations created for the individual survey areas serves as the foundation for a more detailed analysis of specific locations that may be more suitable within the individual survey areas. At each site the slope of the seabed and the characteristics of the surrounding sound were analysed to establish the most optimal locations for the establishment of a sea site. The ideal location of a sea site is characterised by a slope in the sea floor below the site to transfer farm-derived organific matter and potential nutrients from the fish farm, and thereby prevent a build-up of organic matter in the underlying sediment. The assessment of the optimal locations of a fish farm is based on knowledge derived from other farms and practical fish farming experience.

4.3 Wave and current

On the background of the updated bathymetry chart and additional available data, the setup of a wave and current study was commissioned from DHI water environments LTD in the UK. This study uses known and established wave and current models used for assessment of salmon farming globally.

It must be emphasized that the model has not yet been fed with all the data necessary to create an accurate wave and current model. The model is however prepared for additional data that will be supplied in *phase II* of the project. This would include current and wave measurement in the bottom, mid and in the surface for a period of at least three months. The model serves as an estimate of the wave and current condition which is the basis of the initial evaluations of equipment that is suitable to operate in the near shore Falkland Islands waters.

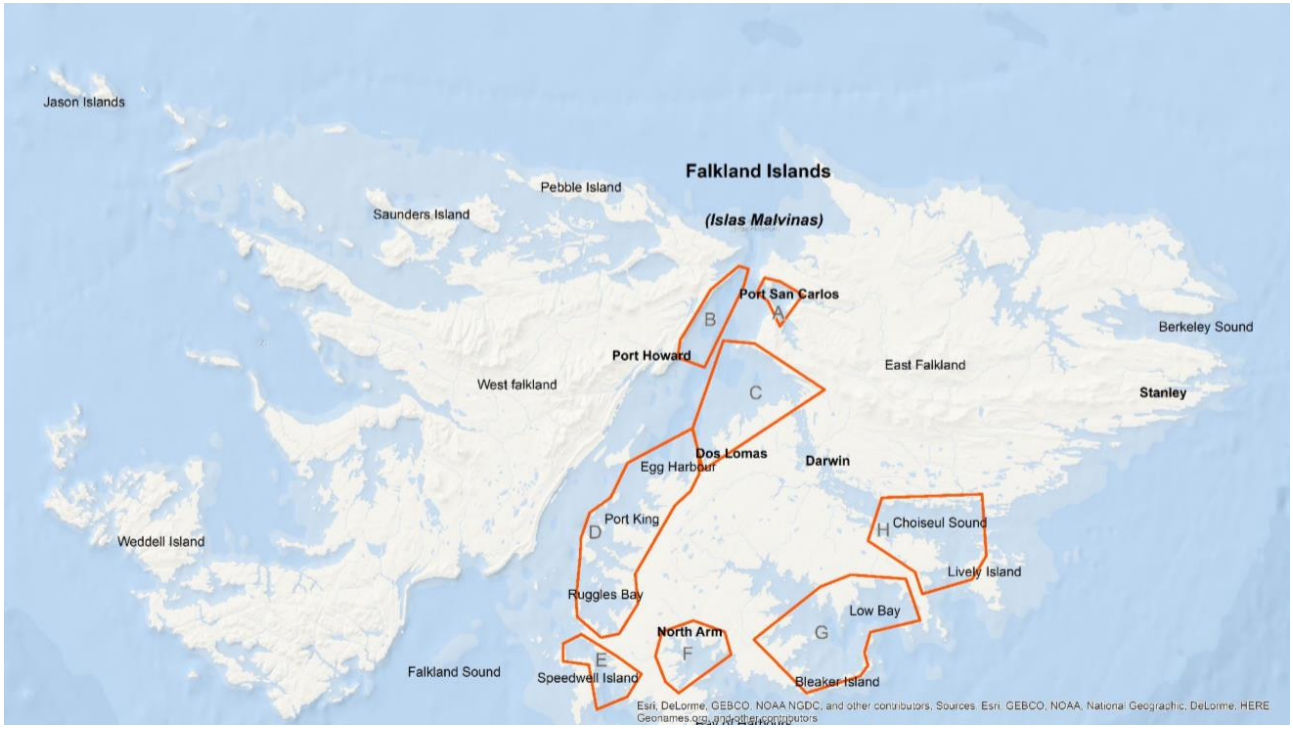


Figure 10 Shows the areas of particular focus for the model.

The figure above shows areas of particular interest to the site analysis. The wave and current characteristics were analysed in the model at higher resolution in the interest areas compared to the rest of the Falkland waters. The 10- and 50-year storm events, worst case scenarios current and wave height from both North and South shows:

- The general significant wave height and is within acceptable limits for salmon farming.
- The general current profile is within acceptable limits for salmon farming.

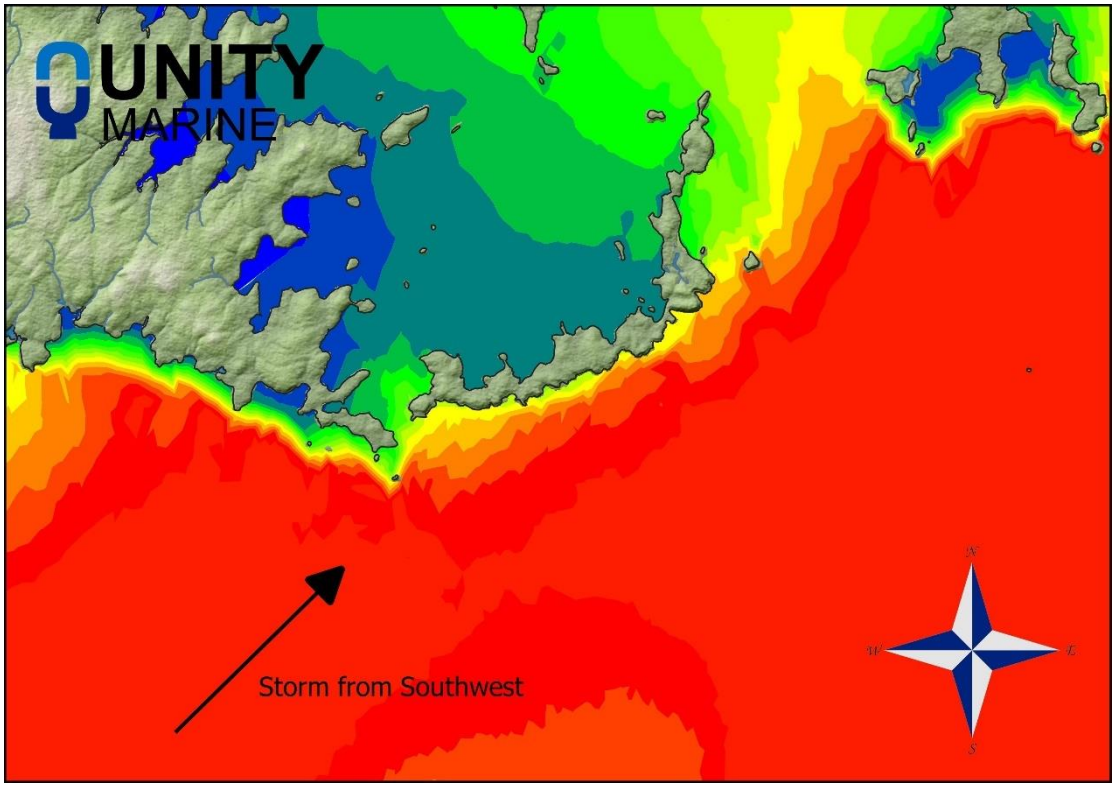


Figure 11 Significant wave height for a 1 in 50-year storm event coming from Southwest. The color gradient illustrates the different significant wave heights from Red (highest) to blue (lowest) at each location.

In some of the Falklands fjord or sounds, island functions as a barrier that prevents direct exposure of ocean waves to the inner waters. As seen in Figure 11 when high ocean waves hit the shoreline of southeast Falkland's during a 1 in 50-year storm, the ocean waves only directly affect Low bay, while Adventure Sound is protected by Bleaker Island. Without Bleaker island to block the high waves from entering the sound would make sea farm operations unfeasible in Adventure sound with conventional equipment.

5 Overview

To establish which of the sites that are suitable for fish farming the sites were evaluated for a range of different criteria. Each criterion was grouped in Marine area use, Geophysical conditions and Ease of operation. The marine areal use is important in order to ensure that a potential fish farm don't conflict with other marine human activities and that the sites it not within a marine protected area.

Marine area use:	Geophysical conditions:	Ease of operation:
• Cables • Sailing routes • Military areas • Oil and gas licensed areas • Fisheries • Cultural heritage sites • Permanent moorings • RAMSAR sites • Bird habitat areas • Nature reserves	• Water Depth (Bathymetry) • Profile of the seabed • Seabed conditions	• Distance to nearest harbour • Cell phone coverage • Sheltered from ocean waves • Significant wave height in a 10- and 50-year storm event. • The water current profile in a 10- and 50-year storm event.

Table 1: The selection criteria used for the site evaluation

Site ID	Name	Areal use	Geophysical conditions	Ease of operation:	The overall suitability of a site:
1,1	White Rock	OK	7	5	
1,2	Stone Run	OK	7	6	
1,3	Many Branch Point	OK	7	7	
1,4	Chanco Point	OK	6	7	
1,5	North West Island	A cultural heritage site in the outer perimeter of the area	8	9	
2,1	Rookery Bay	OK	7	9	
2,2	Black Island	OK	7	9	
2,3	Praltos Island	OK	7	9	
2,4	Port Howard	Military area	-	6	
2,5	North Swan Island	Military area	-	6	
2,6	Rodeo Point	Military area	-	6	
3,1	Long Point	OK	7	8	
3,2	High Cliff East	A military area partially limits the area	7	8	
3,3	High Cliff West	OK	8	8	
3,4	Cygnet Head	OK	7	9	
5,1	White Cliff Point	OK	7	8	
5,2	Great Island	OK	8	5	
5,3	Chico Point	OK	6	9	
5,4	Wolfe Island	OK	7	8	
5,5	Ruggles Bay	OK	7	9	
6,1	Phillips Bay	OK	10	7	
6,2	Semaphore Point	OK	4	2	
6,3	Shag Point	OK	3	1	
7,1	Shag Rookery Point	OK	4	9	
7,2	Devils Point	OK	4	9	
8,1	Shell point	OK	8	6	
8,2	Large Island	OK	8	6	
8,3	Winglass Point	OK	8	7	
8,4	Halt Island	OK	8	7	
8,5	North Point Island	OK	8	7	
8,6	Turn Island	OK	7	5	
10,1	White Bluff	OK	6	7	
10,2	White Point	OK	7	8	
10,3	Green Island	OK	8	6	
10,4	Cliff Point	OK	8	5	

Figure 12 Matrix of the site evaluation

6 Conclusion

The objective of this study is to show a representative picture of the general conditions for Salmon Farming in the Falkland Islands by surveying areas primarily in Falkland sound, Adventure sound and Choiseul sound. Based on the suitability survey it is concluded that there is a considerable potential for establishment of sea-based salmon Farming. The uniformity of the areas surveyed suggests that that the survey is representative and that further future investigations will likely reveal other areas that are suitable for the establishment of sea sites.

The updated Bathymetry maps verifies that the existing bathymetry maps are largely correct in relation to the shape of the bathymetry lines. The new updated depth measurements of the inner waters are a bit deeper than what the original data suggested.

Underwater footage indicates a relatively uniform benthic community structure across the surveyed areas. Substrate varies from fine silty to rough grains. Also, the footage from the bottom video indicates that a considerable bottom current is present in the majority of the surveyed areas. This will be further assessed through future specific currents assessments in each area.

The initial wave and current models indicate that salmon farms can be established with present equipment and technology. Further assessment at a later stage must be carried out to verify this and update and refine the wave and current model.

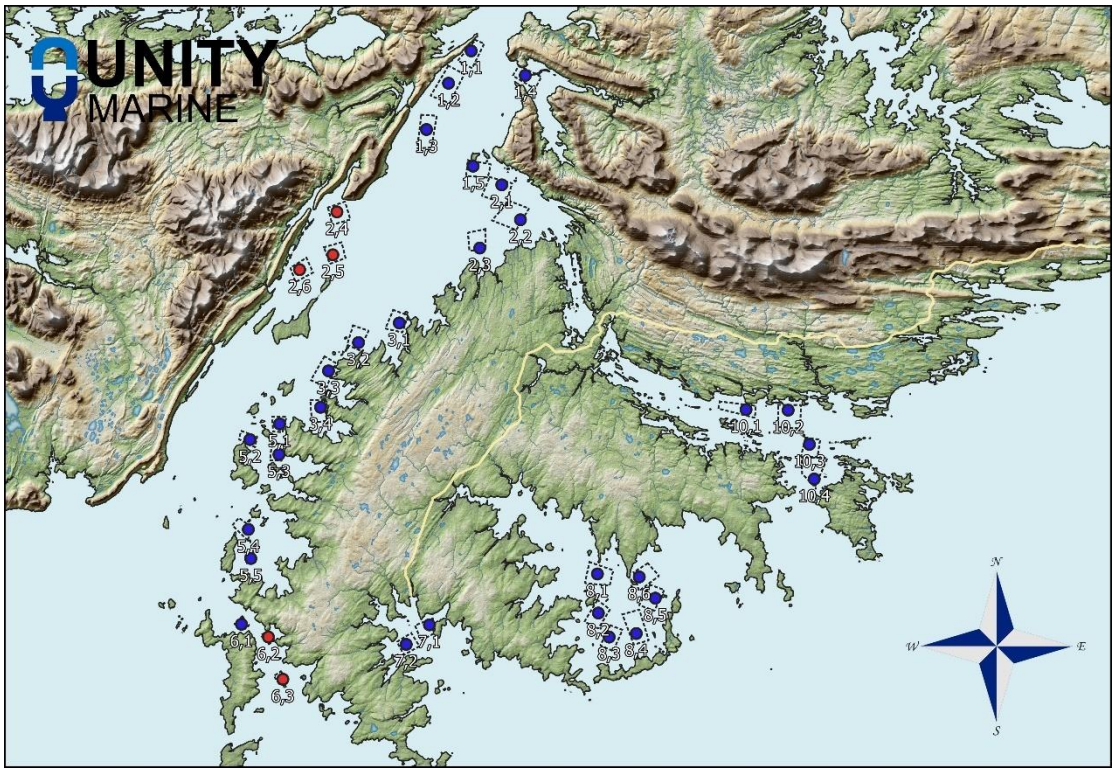


Figure 13 The pre-identified sites around East Falkland (red and blue) and the planned sites (blue).



Unity Marine – SAERI Cruise Report

APPENDIX G

F-Land

Initial Scoping for a Salmon Aquaculture Sites in the Falkland Islands

Cruise Report: 18 – 27 Sept 2018



SOUTH ATLANTIC SAERI (FALKLANDS) LIMITED

Review table

Name	**Reviewed by**	**Date**
Version 1	P Brewin; N Golding	2 October 2018
Version 2	P Brickle	11 October 2018
Final Draft version 3	P Brickle, P Brewin, N Golding, S Cartwright	15 October 2018

Prepared by: Paul Brewin and Neil Golding

Citation

SAERI (2018) Initial scoping for a salmon aquaculture sites in the Falkland Islands. Cruise Report: 18-27 Sept 2018. Report prepared by SAERI Ltd for F-Land ApS.

Photo Credits: SAERI (Neil Golding, Paul Brewin)

CONTENTS

Introduction 3

Project Objectives 3

Survey Personnel 3

Permits and Permissions 3

Risk Assessment 4

Communication and Weather Reports 4

Accomodation 4

Survey Vessel and Vehicles 4

Survey aREA 6

Science Equipment 7

Data Processing and Storage 8

Cruise Narative 9

Seabed species and habitats 12

Health & Saftey 13

Acknolwedgements 14

Appendix 1 Risk Assessment

Appendix 2 Data File Log

Appendix 3 Event Log

Appendix 4 Side-Scan Sonar Log

Appendix 5 Vessel Log

Appendix 6 Species and Habitat Log

INTRODUCTION

F-Land ApS aims to develop a state-of-the-art fully integrated aquaculture enterprise on the Falkland Islands in close cooperation with the local community, businesses, the Government and other key stakeholders.

An initial site investigation was conducted at various coastal marine locations to provide knowledge of the scale of environmental baselines surrounding pre-selected sites, and to gain general environmental familiarisation of the Falklands marine ecosystem. Sites were pre-selected by F-Land based on characteristics available through web-distributed datasets such as bathymetry, wind, waves, and land topography. Land and sea-based infrastructure characteristics were also used to constrain pre-selection of sites.

The South Atlantic Environmental Research Institute (SAERI Ltd) were engaged by F-Land in May 2018 to discuss an initial site survey. SAERI was contracted to facilitate and participate in a familiarisation research cruise of potential aquaculture farm sites around East Falklands.

PROJECT OBJECTIVES

The objectives identified were as follows:

- To gain general familiarisation of environmental conditions and variability at pre-selected sites
- To validate the '90m bathymetry' charts obtained by F-Land through a systematic single-beam echo-sounding survey of each site.
- To gain knowledge of seabed physical and biological characteristics
- To spend time interviewing SAERI personnel and other key individuals during the research cruise for detailed local experience and knowledge of the environment and important infrastructure.

SURVEY PERSONNEL

- **Jonas Højgaard** F-Land ApS. Cruise co-leader
- **Jon-Birger Løvik** F-Land ApS. Cruise co-leader
- **Dr. Paul Brewin** SAERI Ltd. Marine ecological consultant
- **Neil Golding** SAERI Ltd. Drone pilot and data specialist
- **Steve Cartwright** SMSG / SAERI Ltd. Field specialist and vessel Mate
- **Darrel Ford** Sullivan Shipping Ltd. Vessel Captain

PERMITS AND PERMISSIONS

- **Licence to Carry out Scientific Research.** Research Licence No: 33/2018. FIG Environmental Planning Department
- **Permission: Small Unmanned Surveillance Aircraft**. Certificate No: 18_OTO_P0396. FIG Civil Aviation Department
- All relevant landowners and management bodies were advised of marine activities adjacent to their properties.

RISK ASSESSMENT

SAERI conducted a comprehensive risk assessment (RA) of all operations of the cruise including land-based operations (driving, vessel embarking/disembarking), marine operations (on-board vessel safety, vessel emergency procedures), and exposure to weather (**Appendix 1**).

Drone operations were conducted in accordance with the SAERI SUSA Operations Manual (v 1.2).

COMMUNICATION AND WEATHER REPORTS

While at sea, communication by Sat-Phone was available throughout the cruise. There was limited mobile phone or data coverage while at sea, with mobile coverage extending to only the New Haven and Mare Harbour areas, and data coverage (2G or 4G) limited to only Mare Harbour. FIG Fishery Operations (FishOps) could be contacted via VHF throughout the cruise.

FishOps monitored vessel AIS throughout the cruise.

Daily and extended forecast were acquired each night via internet while on land via Passage Weather, Buoy Weather, YR weather, and UAV Forecast websites and carried to the vessel. When available, forecasts were also received from the *Concordia Bay* crew.

Prior to drone operations, MPA Control Tower were contacted to seek permission, as per the SUSA Permission requirement. A pre-site and on-site assessment was also completed prior to drone deployment off the vessel.

ACCOMODATION

Four members of the survey team stayed at Darwin Lodge near Goose Green each night, and one night at Bleaker Island Lodge. Vessel crew stayed aboard the vessel each night throughout the cruise.

SURVEY VESSEL AND VEHICLES

The launch *John Davis* was chartered from Sullivan Shipping Ltd.





- 42” Interceptor. 13mtrs x 3.55 x 1.2mtr draft. Aft deck size 4.3mtrs x 3.5mtrs. Weight 13 tons
- 2 x Yanmar Diesels (440 BHP each)

- 1x Kohler 9kw generator
- 1X Mastervolt Inverter/Charger
- Dive rescue davit and cradle (SWL 500kg)
- 1x onboard marine toilet
- 1x 153ltr fresh water tank
- Dive ramp on stern
- Zodiac tender and outboard.

COMMUNICATIONS

- 2X Icom VHF Base sets (IC-M412)
- 2X Icom VHF Handhelds (IC-M36)

NAVIGATION AIDS

- 1X Simrad Radar (RA-44C)
- 1X Simrad Autopilot (AP-50)
- 1X Simrad AIS (AI-50)
- 1X Simrad Chart plotter (NSS-EVO2)
- 1X Richie Compass

FIRE FIGHTING

- 1x 6kg Dry Powder
- 1x 5kg co2
- 1x 1kg Dry Powder
- 4x Automatic Dry Powder (ENGINE ROOM)
- 2x Carbon Dioxide and heat Detectors

SURVIVAL AIDS

- 2x Life rings (both with lights)
- 12x Auto Inflate Lifejackets (CREWSAVER 275N)
- 2x 8 Person Life rafts (SOLAS-B) With Hydro-Static Releases
- 1x Throw bag line
- 3 x survival suits

FLARES

- 4x Para Red Rocket (mk-8a)
- 2x Life Smoke (mk-9)
- 6x Red Hand Flares (mk-8)

FUEL

- Fuel capacity – 1200 litres
- 2615ltrs of fuel were used on the cruise. Engine running hours was 214.25hrs. 855.6 miles were covered from Stanley-Stanley return and on-trip.
- Fuel was delivered in drums by van to New Haven, North Arm, and Mare Harbour. 4 fuel deliveries in total.

Road Vehicles

Two 4WD vehicles (Toyota Land Cruiser and Mitsubishi Shogun) were hired from Neil McKay Ltd, Stanley.

SURVEY AREA

Thirty-five pre-selected sites were chosen (Figure 1), spanning the southern area of East Falkland. These were grouped into 10 areas (Figure 2 - 5). Groups 4 and 9 were not considered in this study and are not displayed in Figure 1.

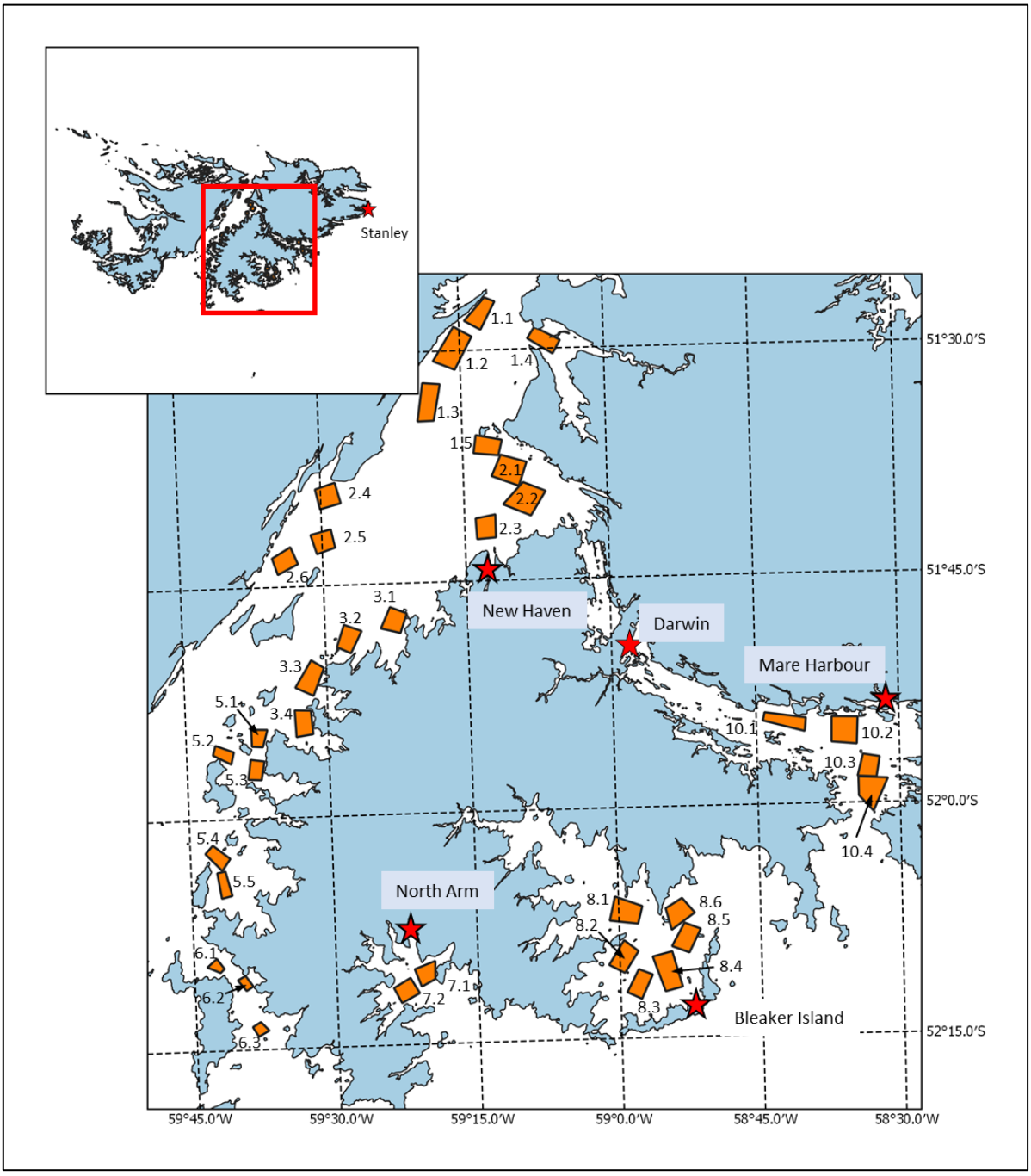
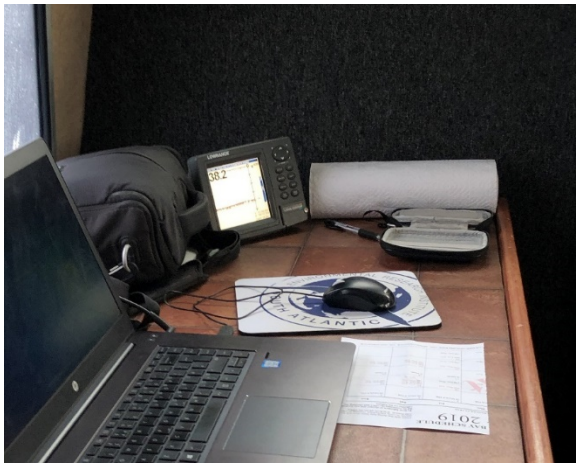


Figure 1. Site Locations.

SCIENCE EQUIPMENT

Lowrance LMS 520c Echo Sounder + 2GB SD card / Airmar P79 transponder

The Echo sounder was set to record throughout the cruise. Vessel speed was approximately 7-10 knots when surveying site boxes. When transiting between boxes at higher speeds, the sounder would occasionally lose contact with the bottom in rough weather, meaning there are some gaps in the echo tracks between sites.



Starfish Side-scan Sonar + work station

The side-scan sonar was deployed at specified points of interest within each site box. The side-scan was towed at a depth of approximately 10m from the surface (not measured, but estimated from height off the seabed), with a layback of 3m behind the vessel GPS antenna. Towing speed was approximately 3-4 knots.





Drop Camera, 2 x Laser scalers, 2 x torches and Image capture system

Drop camera video was taken at specific positions within each site box. *Ad hoc* drops were also made at points of interest based on side-scan data. The camera was deployed by hand and seabed images were captured along a line as the vessel naturally drifted in wind or current with engines in neutral. Approximately 5 mins of video was collected at each station, when weather permitted. Images were captured to microSD card.





Phantom 4 Drone + Operator

Drone filming occurred only once while at sea, due to unsuitable weather conditions for the majority of the survey period. On this occasion during calm conditions, the drone pilot went through a series of pre-flight checks and completed an on-site assessment. Mount Pleasant airfield control tower was also notified of the flight. The drone was deployed from the deck of the vessel, and was recovered at the end of the mission by the visual observed by hand, wearing appropriate PPE.





DATA PROCESSING AND STORAGE

All data was saved to an external USB drive during the cruise and backed-up each night at the lodge.

All times are UTC -3.

Echo sounding data was saved as Lowrance propriety format *.slg file and extracted using ReefMaster v2.04 (Licenced) software. Echo soundings were corrected for transducer depth (0.4m). Horizontal off-set was 0.0m (ie the GPS antenna was directly above the transducer). Tidal correction was done using the WXTide32 > Falklands, Stanley model. N.B **This should be updated for Falkland Sound**.

Echo sounding data also includes Echo 1 and Echo 2 (E1 and E2). These can be used for Bottom Composition (soft to hard bottom) calculations. Peak SV is also an assessment of Bottom Composition. See for further details;

http://reefmaster.com.au/reference/index.htm?context=450

http://www.milnetechnologies.ca/substrate.htm

Side-scan sonar data was recorded as Starfish propriety *.logDoc file, and can be viewed on Starfish Scanline v2.1. Side-scan data were not further processed.

Drop camera movie files were recorded as *.avi files, where the image capture system splits video images into a series of ~200mb files.

Drone imagery was recorded as *.mov (video) and *.jpeg (image) files.

Visualisation of depth (90m grid and echo sounding) was done in QGIS v3.2.2.

Data sharing and curation. All metadata will be deposited in the FIG IMS-GIS Data Centre at SAERI, under restricted permission, in accordance with the SAERI Data Policy v10.0 and Data Management Plan. Specific permission has been given to the DPLUS065 Coastal Habitat Mapping project being carried out by SAERI for use of data collected in this survey. All data will be backed-up on secure servers with suitable redundancy.

A log of datafiles stored in the IMS-GIS data centre are listed in **Appendix 2**.

CRUISE NARATIVE

General. Surveys began on 18 Sept and were completed on 27 Sept. The team arrived at the vessel each day at between 5am- 7am, and the vessel returned to anchorage at 7pm- 9pm. A pre- and post- day briefing was carried out each day. Once systems and routines were established (Day 1) surveys generally consisted of a first-pass over the site recording single-beam echo sounding. Depending on weather and time constraints a 5 min side-scan sonar transect was carried out over a pre-determined specific site location within the survey box and followed up by ~5 mins of drop camera video footage or until the team were satisfied that the seabed fauna and habitat could be broadly categorised.

Details of data collection at each site are detailed in the Event Log in **Appendix 3.**

Details of side-scan sonar sites are detailed separately in a Side-scan Sonar Log in **Appendix 4.**

Details of Vessel movements throughout the cruise are in the Vessel Log in **Appendix 5.**

17 Sept. F-Land team arrives at MPA and transferred to Darwin Lodge. Vessel arrives at New Haven. Vessel refuelled.

18 Sept (Day 1). Depart New Haven 0730hrs. Weather fine. Upon examination of Sites on the charts, a decision was made to not survey Sites 2.4, 2.5, 2.6. These are adjacent to Military operations and *Concordia Bay* ferry route. Organise data collection processes on vessel. Sites 2.3, 2.2, 2.1, 1.5 complete (Figure 2).

19 Sept (Day 2). Weather deteriorating. Abandon Sites 1.1 and 1.2 due to poo weather. Sites 1.3, 1.4 complete. (Figure 2). Weather increasing, very rough.

20 Sept (Day 3). Sites 3.1, 3.2, 3.3, 3.4, 5.1 completed (Figure 3). Vessel refuelled.

21 Sept (Day 4). Bad weather day. F-Land team go to Stanley. Crew carry out vessel engine servicing.

22 Sept (Day 5). Sites 5.3, 5.4, 5.5, 6.1 completed (Figure 3). Site 5.2, 6.2, 6.3 not done; these sites were de-prioritised in order to take advantage of a good weather window for passage east around Bull Point to North Arm. Transit to North Arm.

23 Sept (Day 6). Sites 7.1, 7.2 completed (Figure 4). Weather deteriorating, and operations abandoned for remainder of the day. Vessel refuelled.

24 Sept (Day 7). Sites 8.1 (part), 8.2, 8.4. completed (Figure 4). Sites 8.3, 8.5, 8.6 not completed due to weather constraints. Stay night at Bleaker Island.

25 Sept (Day 8). Sites 8.1 (part), 10.4, 10.3, 10.1, 10.2 completed (Figure 5). Disembark at Mare Harbour. Vessel refuelled.

26 Sept (Day 9). Attempt to conduct Drone survey of New Haven – abandoned due to weather. Vessel returns to Stanley. F-Land team return to Stanley.

08 Oct. Done survey of New Haven Port facility and surrounding area. 1,747 images, collected at 50m above ground level. Terrain adaptation on, so elevation will vary. UAV speed, approx. 4m/s

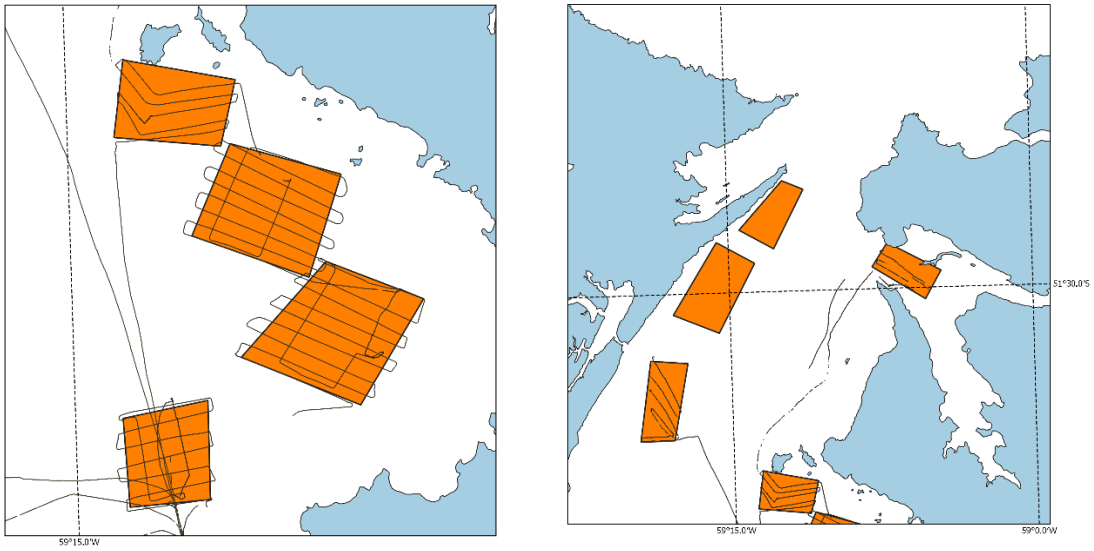


Figure 2. Sites completed and echo sounding tracks for Day 1 (left) and Day 2 (right).

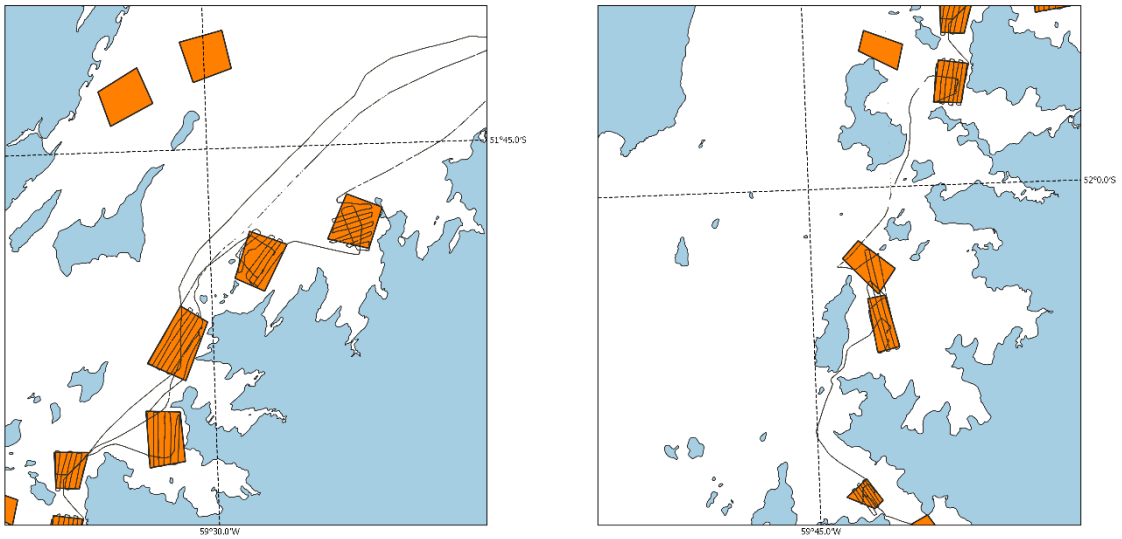


Figure 3. Sites completed and echo sounding tracks for Day 3 (left) and Day 5 (right).

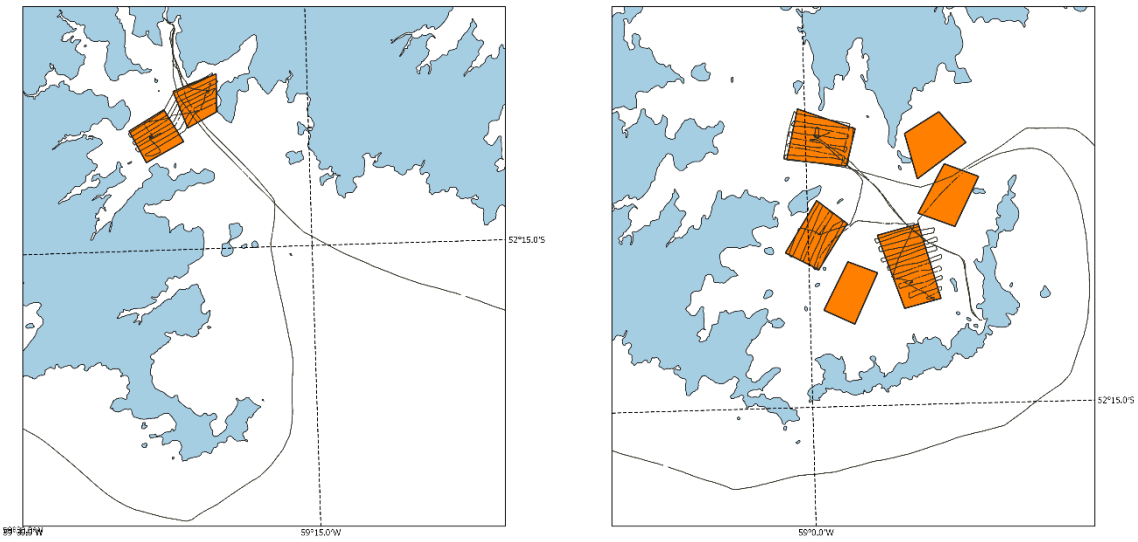


Figure 4. Sites completed and echo sounding tracks for Day 6 (left) and Day 7 (right).

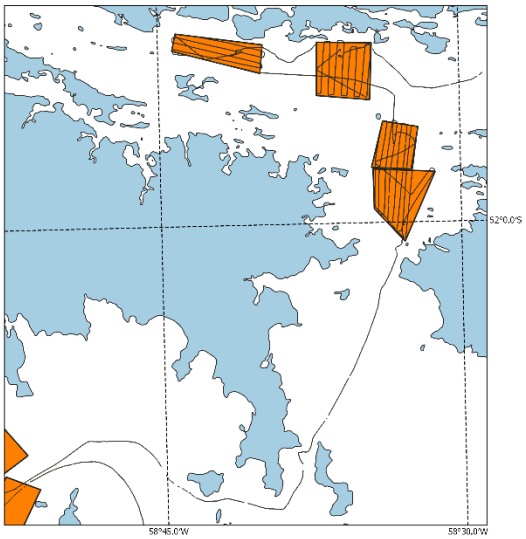


Figure 5. Sites completed and echo sounding tracks for Day 8.

SEABED SPECIES AND HABITATS

Habitat description and taxa list is found in Appendix 6.

Coarse sand, large cobble, shell. Sites 1_5

Characterised by relatively diverse variety of sponges. Likely to be numerous encrusting and mobile epifauna present but not seen. Some current with ripples in sand evident suggesting current flow.

Brachiopod beds. Silty sand, small cobble, shell. Sites 2_1

Fauna characterised by abundant brachiopods (*Magellania venosa*). Possibly lower current flow.

Ciona beds. Sandy silt, shell. Sites 2_2, 2_3

Abundant *Ciona intestinalis* (Ascidian). Notably, large branched sponge possibly *Axinella sp.* present. Likely to be diverse sediment infauna.

Shallow *Lessonia* beds. Sites 2_2, 3_2, 8_4.

Shallow sites characterised by *Lessonia favicans*, and associated turfing red algae. Likely to be diverse associated epifauna.

Coarse sand, shell, cobble patches. Site 3_2

Undulating coarse mobile sand with patches of cobble in sandy troughs. Conspicuous encrusting sponges. Likely to be higher current. Likely to be lower diversity.

Mussel beds. Sites 5_3, 5_5, 8_1, 10_1, 10_3, 10_4

Higher diversity habitats created by patches of ribbed mussels (*Aulacomya ater*), increasing hard surfaces for diverse range of encrusting species of sponges and ascidians, and interstitial spaces for mobile epifauna and infauna, notably Site 8_1 having abundant burrowing Ophiuroid (brittle stars) as seem by arms above the sediment. Site 8_1 was also particularly unique due to abundant, very large, highly branched sponges (Axinella sp ?).

***Alcyonidium* beds.** Site 6_1.

Visually dominated by large, purple, highly branched *Alcyonidium austral* bryozoan colonies. Divers range of sponges and Ascidians. Likely to be a high current area. Coarse sand, cobble.

Fine silt, soft sediments. Sites 7_1, 7_2, 8_2, 8_4, 10_2.

Characterised by plumes of sediment upon camera touching seabed. Low current. Visually dominated by *Munida* sp. Sediment can have small holes or depressions, with tracks (crabs or volute gastropods) evident. Relatively low diversity epifauna, with occasional patches of encrusting organisms on shell or cobble. Possibly high abundance but low diversity infaunal assemblage.

HEALTH & SAFTEY

There were no injuries or other health and safety issues reported during this research cruise.

One occurrence to note is that despite giving pre-flight notice to MPA flight operations, there was an RAF Typhoon fly-by very shortly after drone operations concluded on 18 Sept, which came in very close proximity to the drone flight area. It is recommended that in future, telephone confirmation immediately before launch and after drone recovery would be very sensible. It would also provide a direct channel for any feedback to the control tower if needed.

ACKNOLWEDGEMENTS

Our thanks go to the staff of Sullivan Shipping Ltd for preparation and logistical support throughout the cruise. Thanks also go to the crew of the *Concordia Bay* for vessel and crew support while in New Haven. Anton and Dolly Livermore and the staff of Darwin Lodge offered excellent logistic support and ensured we were well fed. We thank Phyl and Nick Rendell of Bleaker Island for last minute accommodation, and very interesting and useful discussions.

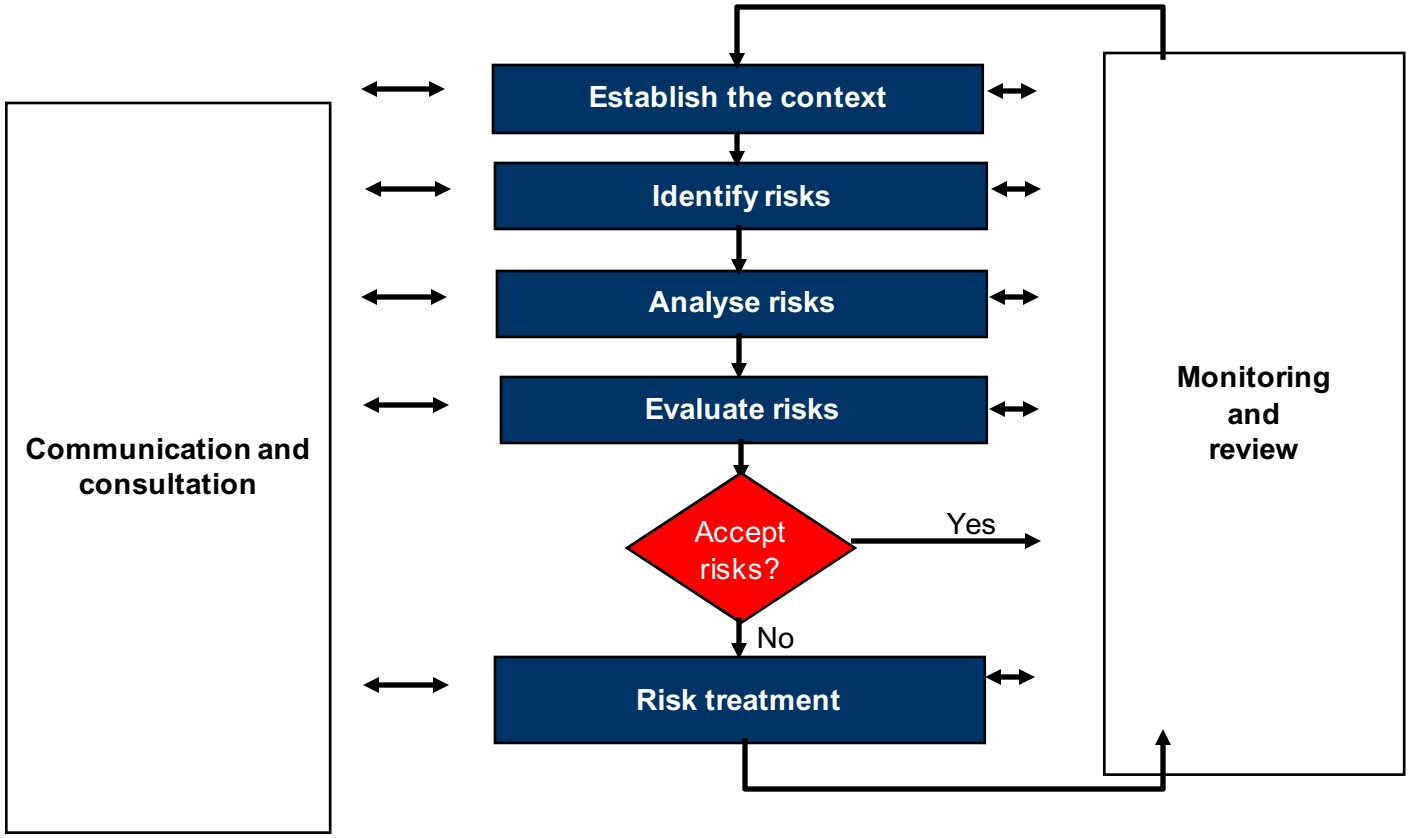
APPENDIX

1. **Risk Assessment**
2. **Data File Log**
3. **Event Log**
4. **Side-Scan Sonar Log**
5. **Vessel Log**
6. **Species and Habitat log**

Appendix 1

SAERI Risk Assessment Planning

Risk Management Process



Source: ISO 31000:2009 Risk Management - Principles and Guidelines

SAERI Field Work Risk Assessment

To be completed for every trip

Project Manager / Team Leader		Paul Brewin	
Dates of Field Work		**From:**	17-Sep-18
		To:	28-Sep-18
On-Duty Contact			
Designated Driver		Paul Brewin / Neil Golding	
Location		East Falkland, Darwin region	
Assistants		**[Private/Organisation name]**	
1	**Neil Golding**	SAERI	
2	**Paul Brewin**	SAERI	
3	**Stevie Cartwrigth**	SMSG	
4	**Jonas Højgaard**	Psico Grp	
5	**Jon-Birger Løvik**	Psico Grp	
6	**Darrel Ford**	Sullivan Shipping	

		Emergency contact name	Number
1	Paul Brewin	Russle Morrison / Sullivan / Roy Summers	51856/22627 /51400
2	Neil Golding	Russle Morrison / Sullivan / Roy Summers	51856/22627/51400
3	Stevie Cartwright	Russle Morrison / Sullivan / Roy Summers	51856/22627/51400
4	Jonas Højgaard	Russle Morrison / Sullivan / Roy Summers	51856/22627/51400
5	Jon-Birger Løvik	Russle Morrison / Sullivan / Roy Summers	51856/22627/51400
6	Daryl Ford	Russle Morrison / Sullivan / Roy Summers	51856/22627/51400
7	SAERI Contact	Al Baylis	27374/ 65467
8	Stanley Contact	FishOps	27266
9	SAT Phone on "John Davis"	Vessel	881621440067
10	Darwin House	info@darwin-house.com	31313

* By signing you, confirm you have read and understood the risk assessment and are accepting the risks associated with this field work.

Brief description of Activities

Boat based field work around coastal East Falkland, travling around Falkland Sound to Choiseul Sound. Work will be conducted during the day, and 4 members of the team will disembark each night sleeping at Darwin Lodge. Two crew will sleep on the vessel throughout. There will be no diving involved, and no coastal landings except for emarking/disembarking daily at selected sites - New Haven, North Arm, Mare Harbour, or Darwin. There will be no biological collections. Data collected will be from the vessel Sounder, the 'Starfish' towed sidescan sonar, and underwater 'drop-camera' deployed from the boat. Drone surveys will be conducted. All boating and data collection will be weather dependant.

Brewin will make nightly email Sit Reps with SAERI (Al Baylis, Paul Brickle).

Brewin, Golding, Pisco team will be staying at Darwin Lodge every night. Cartwright and Ford will be staying on the vessel each night. They will have Sat phone, VHF, and possibley mobile.

FishOps will be monitoring AIS throughout.

SAERI Integrated Risk Management

Assessment Title	SAERI Risk Assessment Planning
Risk Assessment Sponsor	Teresa Bowers
Head of Function	Paul Bricke
Risk Coordinator	Teresa Bowers

#	Risk Name	Risk Description	*Dropdown* Headline Risk	Cause(s) Description	Consequence(s) Description	Risk Indicators	*Dropdown* Primary	*Dropdown* Secondary	Existing Controls	*Dropdown* Conse-quence	*Dropdown* Likelihood rating	Risk Rating	Risk Level	Treatment Action(s)	*Dropdown* Consequence rating	*Dropdown* Likelihood rating	Residual Risk Rating	Residual Risk Level
001	Vehicle Accident	Driving Accident	Health and Safety	Lack of sleep. Camp road hazards. Darkness. Poor Conditions.	sevear injury to team. Medivac.		Safety	Operational		5	1	#REF!	#REF!	Drive to conditions. Ensure adequate sleep. No alcohol consumed the night before.	5	1	#REF!	#REF!
002	Boating Accident	Boating accident	Health and Safety	Poor weather conditions.	injury to team. Boat damage. Rescue. Medivac.		Safety	Operational		5	1	#REF!	#REF!	Consult weather reports. Carry out morning weather assessments.	5	1	#REF!	#REF!
003	Boating personal injury	Personal injury on boat	Health and Safety	Injury on boat.	injurynto team. Medivac		Safety	Operational	Take care to avoid leaving any tripping hazards on deck, do not run, keep deck in good order	3	2	9	Medium	Correct clothing worn, footwerar, gloves. Supervisoin by Crew.	2	1	3	Low
004	Weather exposure	Weatehr exposure	Health and Safety	exposure to cold and wet conditions	temporary loss of team member		Safety	Operational	Cabin always heated. Hot drinks and food available.	2	1	3	Low	Bring spare clothing.	2	1	3	Low
005	Drone injury	injury while operating drone	Health and Safety	accident deploying or recovoing drone	temporary loss of team member		Safety	Operational	Folling SUSA Ooperations Manual. Qualified pilot. Use of recovery safety gear.	2	1	3	Low	If accident, adjust Operations protocols	2	1	3	Low
006	Risk of falling overboard	Accidently falling overboard while boating	Health and Safety	unexpected manouvering. Slips. Embarking/disembarking.	Injury, hypothermia, death		Safety	Operational	Emersion suits worn on deck.	2	1	3	Low				#N/A	#N/A
007	Lifting/manoeuvring equipment	Loading gear on/off boat.	Health and Safety	back injury. Slips falls.	minor injury. Sustained back injury. Loss of team member.		Safety	Operational	consideration of conditions, footwear, team lifting rather than individuals.	2	1	3	Low				#N/A	#N/A

SAERI Risk Assessment

Risk Rating Matrix

RISK MATRIX		CONSEQUENCE				
Consequence Type		**1 - Insignificant**	**2 - Minor**	**3 - Moderate**	**4 - High**	**5 - Major**
Financial		No disruption to organisation or	Minor disruption to organisation or project.	Partial disruption to organisation or project.	Partial disruption to organisation or project.	Substantial disruption to organisation or project.
Safety		First aid case	Medical treatment case	Lost time injury	Permanent disability or single fatality	Numerous permanent disabilities or multiple fatalities
Governance		Operations running according to SAERI policies and procedures and grant rules.	Insignificant breaches of SAERI policies and procedures and grant rules.	Significant breaches of SAERI policies and procedures and grant rules.	Major breaches of SAERI policies and procedures and grant rules.	Flagrant disregard for SAERI policies and procedures and grant rules.
Operational		No disruption to organisation or employees	Minor disruption to organisation or employees	Partial disruption to organisation or employees	Disruption to organisation or employees	Substantial disruption to organisation or employees
Reputation		Minor impact; awareness/ concern from specific individuals	Limited impact; concern/ complaints from certain groups/ organizations (e.g. NGOs)period	Local impact; public concern/ adverse publicity localised within neighbouring communities	Suspected reputational damage; local/ regional public concern and reactions	Noticeable reputational damage; national/ international public attention and repercussions
Social		No disturbance to employees, third	Minor disturbance to Employees, third party inviduals	Moderate impacts on SAERI employees, third party	Significant impacts on SAERI employees, third party	Major widespread social impacts.
Compliance		Technical non-compliance. No warning received; no regulatory reporting required	Breach of regulatory requirements; report/involvement of authority. Attracts administrative fine	Minor breach of law; report/investigation by authority. Attracts compensation/ penalties/ enforcement action	Breach of the law; may attract criminal prosecution, penalties/ enforcement action. Individual licence temporarily revoked	Significant breach of the law. Individual or company law suits; permit to operate substantially modified or withdrawn
Consequence Type		**1 - Insignificant**	**2 - Minor**	**3 - Moderate**	**4 - High**	**5 - Major**
LIKELIHOOD		**RISK RATING**				
5 - Almost Certain 6 months	The unwanted event has occurred frequently; occurs in order of one or more times per year & is likely to reoccur within 6 months	**11 (Medium)**	**16 (Significant)**	**20 (Significant)**	**23 (High)**	**25 (High)**
4 - Likely 1 year	The unwanted event has occurred infrequently; occurs in order of less than once per year & is likely to reoccur within 1 year	**7 (Medium)**	**12 (Medium)**	**17 (Significant)**	**21 (High)**	**24 (High)**
3 - Possible 3 years	The unwanted event has happened at some time; or could happen within 3 years	**4 (Low)**	**8 (Medium)**	**13 (Significant)**	**18 (Significant)**	**22 (High)**
2 - Unlikely 5 years	The unwanted event has happened at some time; or could happen within 5 years	**2 (Low)**	**5 (Low)**	**9 (Medium)**	**14 (Significant)**	**19 (Significant)**
1 - Rare >10 years	The unwanted event has never been known to occur; or it is highly unlikely that it will occur within 10 years	**1 (Low)**	**3 (Low)**	**6 (Medium)**	**10 (Medium)**	**15 (Significant)**

Risk Rating	Risk Level	Guidelines for Risk Matrix
21 to 25	High	A high risk exists and therefore appropriate mitigation must be devised immediately otherwise the field work should not take place.
13 to 20	Significant	A significant risk exists and appropriate mitigation should be devised as soon as possible to reduce the risk, otherwise the field work should be altered to lessen this risk.
6 to 12	Medium	A moderate risk exists and appropriate mitigations should be devised as part of the normal planning process.
1 to5	Low	A low risk exists. No further mitigation required.

Appendix 2 : Data file log

Echosounder	Sidescan sonar	Drop-Cam video	Drone video and stills
Site_1_3/Echosounder/1.3.1.slg	Site_1_5/Sidescan/Site_1_5_StarfishLog_20180918_194106.logdoc	Site_1_5/Video/Site_1_5_20180918_192543.avi	Site_2_2/Drone/DJI_0530.JPG
Site_1_3/Echosounder/1.3.2.slg	Site_1_5/Sidescan/Site_1_5_StarfishLog_20180918_194106.xtf	Site_1_5/Video/Site_1_5_20180918_193044.avi	Site_2_2/Drone/DJI_0531.MOV
Site_1_3/Echosounder/1.3.3.slg	Site_1_5/Sidescan/Site_1_5_StarfishLog_20180918_194106.xtf_idx	Site_2_1/Video/Site_2_1_20180918_182522.avi	Site_2_2/Drone/DJI_0532.JPG
Site_1_3/Echosounder/1.3.4.slg	Site_2_2/Sidescan/Site_2_2_StarfishLog_20180918_151921.logdoc	Site_2_1/Video/Site_2_1_20180918_183023.avi	Site_2_2/Drone/DJI_0533.JPG
Site_1_3/Echosounder/1.3.5.slg	Site_2_2/Sidescan/Site_2_2_StarfishLog_20180918_151921.xtf	Site_2_2/Video/SIte_2_2_20180918_144340.avi	Site_2_2/Drone/DJI_0534.JPG
Site_1_3/Echosounder/1.3.6.slg	Site_2_3/Sidescan/Site_2_3_StarfishLog_20180918_110152.logdoc	Site_2_2/Video/Site_2_2_20180918_144840.avi	Site_2_2/Drone/DJI_0535.JPG
Site_1_4/Echosounder/1.4.1.slg	Site_2_3/Sidescan/Site_2_3_StarfishLog_20180918_110152.xtf	Site_2_2/Video/Site_2_2_20180918_145341.avi	Site_2_2/Drone/DJI_0536.JPG
Site_1_4/Echosounder/1.4.2.slg	Site_3_2/Sidescan/Site_3_2_StarfishLog_20180920_131923.logdoc	Site_2_2/Video/Site_2_2_20180918_153655.avi	Site_2_2/Drone/DJI_0537.JPG
Site_1_4/Echosounder/1.4.3.slg	Site_3_2/Sidescan/Site_3_2_StarfishLog_20180920_131923.xtf	Site_2_2/Video/Site_2_2_20180918_154155.avi	Site_2_2/Drone/DJI_0538.JPG
Site_1_4/Echosounder/1.4.4.slg	Site_5_3/Sidescan/StarfishLog_20180922_093107.logdoc	Site_2_3/Video/Site_2_3_20180918_103230.avi	Site_2_2/Drone/DJI_0539.JPG
Site_1_5/Echosounder/1.5.slg	Site_5_3/Sidescan/StarfishLog_20180922_093107.xtf	Site_2_3/Video/Site_2_3_20180918_103731.avi	Site_2_2/Drone/DJI_0540.JPG
Site_2_1/Echosounder/2.1.slg	Site_5_5/Sidescan/StarfishLog_20180922_125251.logdoc	Site_3_2/DropCamera/DC01_20180920_121603.avi	Site_2_2/Drone/DJI_0541.JPG
Site_2_2/Echosounder/2.2.1.slg	Site_5_5/Sidescan/StarfishLog_20180922_125251.xtf	Site_3_2/DropCamera/Site_3_2_20180920_114403.avi	Site_2_2/Drone/DJI_0542.JPG
Site_2_3/EchoSounder/2.3.0.slg	Site_6_1/Sidescan/StarfishLog_20180922_145919.logdoc	Site_3_2/DropCamera/Site_3_2_20180920_114904.avi	Site_2_2/Drone/DJI_0543.JPG
Site_2_3/EchoSounder/2.3.1.slg	Site_6_1/Sidescan/StarfishLog_20180922_145919.xtf	Site_5_3/DropCamera/Site_5_3_20180922_094656.avi	Site_2_2/Drone/DJI_0544.MOV
Site_2_3/EchoSounder/2.3.2.slg	Site_7_1/Sidescan/StarfishLog_20180923_114923.logdoc	Site_5_3/DropCamera/Site_5_3_20180922_095405.avi	2018_10_08_Newhaven_UAV_Survey/DJI_0952.MOV
Site_2_3/EchoSounder/2.3.3.slg	Site_7_1/Sidescan/StarfishLog_20180923_114923.xtf	Site_5_5/DropCamera/SIte_5_5_20180922_130403.avi	2018_10_08_Newhaven_UAV_Survey/DJI_0957.MOV
Site_3_1/Echosounder/3.1.1.slg	Site_7_2/Sidescan/StarfishLog_20180923_105544.logdoc	Site_6_1/DropCamera/Site_6_1_20180922_151629.avi	2018_10_08_Newhaven_UAV_Survey/DJI_0953.JPG
Site_3_2/Echosounder/3.2.1..slg	Site_7_2/Sidescan/StarfishLog_20180923_105544.xtf	Site_6_1/DropCamera/Site_6_1_20180922_152130.avi	2018_10_08_Newhaven_UAV_Survey/DJI_0954.JPG
Site_3_2/Echosounder/3.2.2.slg	Site_8_1/Sidescan/StarfishLog_20180924_173955.logdoc	Site_7_1/DropCamera/Site_7_1_20180923_120248.avi	2018_10_08_Newhaven_UAV_Survey/DJI_0955.JPG
Site_3_3/Echosounder/3.3.1.slg	Site_8_1/Sidescan/StarfishLog_20180924_173955.xtf	Site_7_2/Dropcamera/Site_7_2_20180923_111327.avi	2018_10_08_Newhaven_UAV_Survey/DJI_0958.JPG
Site_3_3/Echosounder/3.3.2.slg	Site_8_2/Sidescan/StarfishLog_20180924_145359.logdoc	Site_7_2/Dropcamera/Site_7_2_20180923_111828.avi	2018_10_08_Newhaven_UAV_Survey/DJI_0959.JPG
Site_3_4/Echosounder/3.4.1.slg	Site_8_2/Sidescan/StarfishLog_20180924_145359.xtf	Site_7_2/Dropcamera/Site_7_2_20180923_113212.avi	2018_10_08_Newhaven_UAV_SurveyDJI_0960.JPG
Site_3_4/Echosounder/3.4.2.slg	Site_8_4/Sidescan/StarfishLog_20180924_115644.logdoc	Site_8_1/DropCamera/Site_8_1_20180925_061432.avi	2018_10_08_Newhaven_UAV_Survey/DJI_0961.JPG
Site_5_1/Echosounder/5.1.1.slg	Site_8_4/Sidescan/StarfishLog_20180924_115644.xtf	Site_8_2/DropCamera/Site_8_2_1_20180924_150652.avi	2018_10_08_Newhaven_UAV_Survey/ 1747 images
Site_5_1/Echosounder/5.1.2.slg	Site_10_1/Sidescan/StarfishLog_20180925_151327.logdoc	Site_8_2/DropCamera/Site_8_2_2_20180924_151153.avi	
Site_5_1/Echosounder/5.1.3.slg	Site_10_1/Sidescan/StarfishLog_20180925_151327.xtf	Site_8_4/DropCamera/Site_8_4_1_20180924_121018.avi	
Site_5_3/Echosounder/Site_5_3_1.slg	Site_10_2/Sidescan/StarfishLog_20180925_174052.logdoc	Site_8_4/DropCamera/Site_8_4_2_20180924_121518.avi	
Site_5_3/Echosounder/Site_5_3_2.slg	Site_10_2/Sidescan/StarfishLog_20180925_174052.xtf	Site_8_4/DropCamera/Site_8_4_Waypoint_740_20180924_122508.avi	
Site_5_3/Echosounder/Site_5_3_3.slg	Site_10_4_&_10_3/Sidescan/StarfishLog_20180925_114415.logdoc	Site_10_2/DropCamera/Site_10_2_20180925_175540.avi	
Site_5_5/Echosounder/Site_5_5_1.slg	Site_10_4_&_10_3/Sidescan/StarfishLog_20180925_114415.xtf	Site_10_2/DropCamera/Waypoint_794_795_20180925_180650.avi	
Site_5_5/Echosounder/Site_5_5_2.slg	Site_10_4_&_10_3/Sidescan/StarfishLog_20180925_124408.logdoc	Site_10_4_&_10_3/DropCamera/Site_10_3_20180925_125603.avi	
Site_5_5/Echosounder/Site_5_5_3.slg	Site_10_4_&_10_3/Sidescan/StarfishLog_20180925_124408.xtf	Site_10_4_&_10_3/DropCamera/Site_10_4_1_20180925_115716.avi	
Site_6_1/Echosounder/Site_6_1_1.slg		Site_10_4_&_10_3/DropCamera/Site_10_4_2_20180925_120217.avi	
Site_6_1/Echosounder/Site_6_1_2.slg			
Site_6_1/Echosounder/Site_6_1_3.slg			
Site_7_1/Echosounder_duplicate_of_7_2/Site_7_1_&_7_2.slg			
Site_7_1/Echosounder_duplicate_of_7_2/Site_7_1_&_7_2_transit_1.slg			
Site_7_1/Echosounder_duplicate_of_7_2/Site_7_1_&_7_2_transit_2.slg			
Site_7_1/Echosounder_duplicate_of_7_2/Transit_to_Area_7.slg			
Site_7_2/Echosounder/Site_7_1_&_7_2.slg			
Site_7_2/Echosounder/Site_7_1_&_7_2_transit_1.slg			
Site_7_2/Echosounder/Site_7_1_&_7_2_transit_2.slg			
Site_7_2/Echosounder/Transit_to_Area_7.slg			
Site_8_1/Echosounder/Site_8_1_1.slg			
Site_8_1/Echosounder/Site_8_1_2.slg			
Site_8_1/Echosounder/Site_8_1_3.slg			
Site_8_1/Echosounder/Site_8_1_4.slg			
Site_8_2/Echosounder/Site_8_2_1.slg			
Site_8_2/Echosounder/Site_8_2_2.slg			
Site_8_4/Echosounder/Site_8_4_1.slg			
Site_8_4/Echosounder/Site_8_4_2.slg			
Site_8_4/Echosounder/Transit_To_Adventure_Sound.slg			
Site_10_1/Echosounder/10_1.slg			
Site_10_1/Echosounder/10_1_&_Transit.slg			
Site_10_2/Echosounder/10_2_1.slg			
Site_10_2/Echosounder/10_2_2.slg			
Site_10_2/Echosounder/10_2_transit_to_Mare_Harbour.slg			
Site_10_4_&_10_3/Echosounder/10_3_&_Transit.slg			
Site_10_4_&_10_3/Echosounder/10_4_&_Transit.slg			
Site_10_4_&_10_3/Echosounder/Site_10_4_&_10_3.slg			
Site_10_4_&_10_3/Echosounder/Transit_To_Area_10.slg			

Appendix 3: Event Log

Date	SiteName	Operation	Deploy	Camera On Bottom	Retrieval off bottom	EchoSounder/Sidescan LogTimeStart	EchoSounder/Sidescan LogTimeFinish	Filename	vessel_waypoint	water_depth	Notes
18/09/2018	2.3	echo sounder				08:13:00	08:47:00	2.3.slg			
18/09/2018	2.3	echo sounder				08:49:00	08:55:00	2.3.1.slg			
18/09/2018	2.3	echo sounder				09:03:00	11:39:00	2.3.2.slg			
18/09/2018	2.3	drop camera	10:32:00	10:34:00	10:38:00				700	30	waypoint when camera on bottom
18/09/2018	2.3	sidescan				11:04:00	11:43:00	Site_2_3_StarfishLog_20180918_110152.logdoc			One file logged, but two sections of data
18/09/2018	2.3	echo sounder				11:42:00	11:57:00	2.3.3.slg			
18/09/2018	2.2	echo sounder						2.2.1.slg	701	20	deviation off course due to kelp (shallow - 20m)
18/09/2018	2.2	drop camera	14:46:00	14:49:00					702	35.9	Start of drop camera line
18/09/2018	2.2	drop camera			14:51:00				703	36	End of drop camera line
18/09/2018	2.2	drone									Vessel located on centre point of box - drone flown straight up and down.
18/09/2018	2.2	sidecan				15:23:00	15:28:00	Site_2_2_StarfishLog_20180918_151921.logdoc			homogenous bottom
18/09/2018	2.2	drop camera	15:38:00	15:40:00					704	20	cable running stright down.
18/09/2018	2.2	drop camera			15:44:00				705	22.2	lessonia on bottom with tunicates
18/09/2018	2.1	echo sounder				15:50:00	18:34:00	2.1.1.slg			
18/09/2018	2.1	drop camera	18:26:00	18:28:00					706	34.3	
18/09/2018	2.1	drop camera			18:31:00				707	34.1	
18/09/2018	1.5	echo sounder				18:40:00	20:55:00	1.5.1			
18/09/2018	1.5	drop camera	19:25:00	19:28:00					708	34.3	
18/09/2018	1.5	drop camera			19:31:00				709	34	
18/09/2018	1.5	sidecan				19:40:00	19:52:00	Site_1_5_StarfishLog_20180918_194106.logdoc		34	rocky signature on port side
19/09/2018	1.3	echo sounder				05:03:00	06:40:00	1.3.1.slg			
19/09/2018	1.3	echo sounder				06:40:00	07:50:00	1.3.2.slg / 1.3.3.slg			sea much rougher today. White horses - changed direction at 07:15 due to rolling vessel/weather/losing bottom contact with sounder.
19/09/2018	1.3	echo sounder				07:50:00	08:10:00	1.3.4.slg			
19/09/2018	1.3	echo sounder				08:21:00	08:34:00	1.3.5.slg			
19/09/2018	1.3	echo sounder				09:06:00	09:25:00	1.3.6.slg			lost GPS module
19/09/2018	1.4	echo sounder				09:34:00	09:57:00	1.4.1.slg / 1.4.2.slg			lost GPS module
19/09/2018	1.4	echo sounder				10:07:00	10:24:00	1.4.3.slg			GPS back on - sea state too poor - kept losing bottom contact - stopped logging
19/09/2018	1.4	echo sounder				10:33:00	10:41:00	1.4.3.slg			started logging again after anoth GPS modeul fail
19/09/2018	1.4	echo sounder				10:45:00	11:00:00	1.4.3.slg			
19/09/2018	1.4	echo sounder				11:05:00	11:30:00	1.4.3.slg			
19/09/2018	1.4	echo sounder				11:30:00	11:49:00	1.4.4.slg			
20/09/2018	3.1	echo sounder				08:00:00	11:00:00	3.1.1.slg			Departing Newhaven harbour - transit to Site 3.1
20/09/2018	3.2	echo sounder				11:00:00	13:15:00	3.2.1.slg			
20/09/2018	3.2	drop camera	11:44:00	11:45:00					710	27	drop camera - sandy bottom with patches of cobbles
20/09/2018	3.2	drop camera			11:48:00				711	27	
20/09/2018	DC01	drop camera	12:15:00	12:16:00					712	20	Occasional clumps of lessonia. Shelly bottom with cobbles.
20/09/2018	DC01	drop camera			12:18:00				713	20	
20/09/2018	3.2	sidescan				13:15:00	13:36:00	starfishlog_20180920_131923.logdoc		30	
20/09/2018	3.2	echosounder				13:36:00	13:44:00	3.2.2.slg			
20/09/2018	transit	echosounder				13:44:00	14:04:00	3.3.1.slg			
20/09/2018	3.3	echosounder				14:04:00	16:02:00	3.3.2.slg			
20/09/2018	transit	echosounder				16:02:00	16:07:00	3.4.1.slg			
20/09/2018	3.4	echosounder				16:07:00	17:36:00	3.4.2.slg			
20/09/2018	transit	echosounder				17:36:00	17:49:00	5.1.1.slg			
20/09/2018	5.1	echosounder				17:49:00	18:55:00	5.1.2.slg			
20/09/2018	transit home	echosounder				18:55:00	21:00:00	5.1.3.slg			
22/09/2018	transit to site	echosounder				05:30:00	07:44:00	Site_5_3_1.slg			transit and shallow (<20m) water around 3.3 & 3.4
22/09/2018	5.3	echosounder				07:44:00	09:29:00	Site_5_3_2.slg			transit through 5.1
22/09/2018	5.3	sidescan				09:31:00	09:38:00	StarfishLog_20180922_093107.logdoc			
22/09/2018	5.3	echosounder				09:41:00	10:08:00	Site_5_3_3.slg			
22/09/2018	5.3	drop camera	09:45:00	09:47:00					714	32.5	
22/09/2018	5.3	drop camera			09:49:00				715	32.5	flat seabed - mussel beds - coarse sediment bottom and current visible
22/09/2018	5.3	drop camera	09:53:00	09:54:00					716	34.5	
22/09/2018	5.3	drop camera			09:56:00				717	34.5	undulating seabed - mussel beds-coarse sediment
22/09/2018	transit	echosounder				10:10:00	11:09:00	Site_5_5_1.slg			transit to Site 5.4
22/09/2018	5.5	echosounder				11:09:00	12:52:00	Site_5_5_2.slg			Site 5.5

Appendix 3: Event Log

Date	SiteName	Operation	Deploy	Camera On Bottom	Retrieval off bottom	EchoSounder/Sidescan LogTimeStart	EchoSounder/Sidescan LogTimeFinish	Filename	vessel_waypoint	water_depth	Notes
22/09/2018	5.5	sidescan				12:52:00	12:59:00	StarfishLog_20180922_125251.logdoc			
22/09/2018	5.5	echosounder				13:03:00	13:19:00	Site_5_5_3.slg			
22/09/2018	5.5	drop camera	13:03:00	13:04:00					718	32	muddy sediment with mussel beds
22/09/2018	5.5	drop camera			13:06:00				719	32	
22/09/2018	transit	echosounder				13:19:00	14:05:00	Site_6_1_1.slg			transit
22/09/2018	6.1	echosounder				14:05:00	14:59:00	Site_6_1_2.slg			
22/09/2018	6.1	sidescan				14:59:00	15:06:00	StarfishLog_20180922_145919.logdoc			
22/09/2018	6.1	echosounder				15:07:00	18:23:00	Site_6_1_3.slg			
22/09/2018	6.1	drop camera	15:16:00	15:17:00					720	35	
22/09/2018	6.1	drop camera			15:20:00				721	36	
23/09/2018	transit to area 7	echosounder				07:30:00	07:56:00	Transit_to_Area_7.slg			
23/09/2018	7.1 & 7.2	echosounder				07:56:00	10:54:00	Site_7_1_&_7_2.slg			box 7.1 & 7.2 combined
23/09/2018	7.2	sidescan				10:54:00	11:01:00	StarfishLog_20180923_105544.logdoc			recording from 10:55
23/09/2018		echosounder				11:04:00	11:48:00	Site_7_1_&_7_2_transit_1.slg			
23/09/2018	7.2	drop camera	11:13:00	11:14:00					722	29	soft mud with patches of mussel shell towards end of tow. - cable streaming out from boat to the south
23/09/2018	7.2	drop camera			11:18:00				723		
23/09/2018	7.2	drop camera	11:32:00	11:32:00					724	31	
23/09/2018	7.2	drop camera			11:34:00				725		
23/09/2018	7.1	sidescan				11:49:00	11:56:00	StarfishLog_20180923_114923.logdoc		27.6	
23/09/2018	7.1	echosounder				11:56:00	12:34:00	Site_7_1_&_7_2_transit_2.slg			transit between sites and return to North Arm
23/09/2018	7.1	drop camera	12:03:00	12:03:00					726	27	
23/09/2018	7.1	drop camera			12:05:00				727	26.2	
24/09/2018	transit	echosounder				05:35:00	08:34:00	Transit_To_Adventure_Sound.slg			transit to Adventure Sound
24/09/2018	8.4	echosounder				08:34:00	11:57:00	Site_8_4_1.slg			Site 8.4
24/09/2018	8.4	sidescan				11:57:00	12:03:00	StarfishLog_20180924_115644.logdoc			poor data quality
24/09/2018	8.4	drop camera	12:10:00	12:11:00					728	35.5	muddy sand with munida and burrows?
24/09/2018	8.4	drop camera			12:13:00				729		
24/09/2018	8.4	echosounder				12:10:00	12:58:00	Site_8_4_2.slg			
24/09/2018	8.4	drop camera	12:25:00	12:25:00					740		location where Lessonia was not apparent on the sounder.
24/09/2018	8.4	drop camera			12:26:00				741		likely to be Lessonia flavicans - looked very different to tree kelp
24/09/2018	8.2	echosounder				12:58:00	14:50:00	Site_8_2_1.slg			Site 8.2
24/09/2018	8.2	sidescan				14:50:00	15:03:00	StarfishLog_20180924_145359.logdoc			Poor data quality
24/09/2018	8.2	echosounder				15:03:00	15:17:00	Site_8_2_2.slg			transit to drop camera in 8.2, drop camera ops and transit to 8.1
24/09/2018	8.2	drop camera	15:07:00	15:07:00					742	35.4	muddy sand with munida and burrows?
24/09/2018	8.2	drop camera			15:11:00				743		
24/09/2018	transit	echosounder				15:17:00	15:32:00	Site_8_1_1.slg			transit to drop camera in 8.2, drop camera ops and transit to 8.1
24/09/2018	8.1	echosounder				15:32:00	17:38:00	Site_8_1_2.slg			site 8.1
24/09/2018	8.1	sidescan				17:39:00	17:46:00	StarfishLog_20180924_173955.logdoc			Poor data quality
24/09/2018	8.1	echosounder				17:46:00	18:15:00	Site_8_1_3.slg			
25/09/2018	8.1	drop camera	06:15:00	06:16:00					744	35.4	muddy sand with munida and burrows?
25/09/2018	8.1	drop camera			06:16:00				745		
25/09/2018	transit & 8.1	echosounder				05:35:00	07:12:00	Site_8_1_4.slg			from bleaker to 8.1
25/09/2018	transit	echosounder				07:12:00	08:50:00	Transit_To_Area_10.slg			transit from 8.1 to 10.4 & 10.3
25/09/2018	10.4 & 10.3	echosounder				08:50:00	11:45:00	Site_10_4_&_10_3.slg			Site 10.4 & 10.3 - echosounder boxes combined
25/09/2018	10.4	sidescan				11:45:00	11:51:00	StarfishLog_20180925_114415.logdoc			
25/09/2018	transit & 10.4	echosounder				11:59:00	12:44:00	10_4_&_Transit.slg			camera work in 10.4 and transit
25/09/2018	10.4	drop camera	11:59:00	11:59:00					746		

Appendix 3: Event Log

Date	SiteName	Operation	Deploy	Camera On Bottom	Retrieval off bottom	EchoSounder/Sidescan LogTimeStart	EchoSounder/Sidescan LogTimeFinish	Filename	vessel_waypoint	water_depth	Notes
25/09/2018	10.4	drop camera			12:02:00				747		
25/09/2018	10.3	sidescan	12:44:00			12:46:00	12:52:00	StarfishLog_20180925_124408.logdoc			
25/09/2018	10.3 & transit	echosounder				12:54:00	13:33:00	10_3_&_Transit.slg			10.3 camera work and transit to 10.1
25/09/2018	10.3	drop camera	12:55:00	12:55:00					748		
25/09/2018	10.3	drop camera			12:58:00				749		
25/09/2018	10.1	echosounder				13:33:00	15:22:00	10_1_&_Transit.slg			10.1
25/09/2018	10.1	echosounder				15:22:00	15:45:00	10_1.slg			interesting features
25/09/2018	10.1	sidescan				15:13:00	15:20:00	StarfishLog_20180925_151327.logdoc			
25/09/2018	10.1	drop camera	15:28:00	15:28:00					790		rocky slabs and coarse sediment
25/09/2018	10.1	drop camera			15:31:00				791		
25/09/2018	10.2	echosounder				15:45:00	17:41:00	10_2_1.slg			
25/09/2018	10.2	sidescan				17:41:00	17:47	StarfishLog_20180925_174052.logdoc			
25/09/2018	10.2	drop camera	17:55:00	17:55:00	17:58				792 & 793		
25/09/2018	10.2	echosounder				17:49:00	18:15:00	10_2_2.slg			
25/09/2018	extra coastal	drop camera	18:06:00	18:06:00	18:07:00				794 & 795	14	lessonia camera drop
25/09/2018		echosounder				18:27:00	18:35:00	10_2_transit_to_Mare_Harbour.slg			transit to Mare Harbour
08/10/2018	NH	drone									Land based drone survey of New Haven Port and surrounds.

Appendix 4: Side scan Sonar Log

collection_id	date	area_code	station_no	log_file	set _no	dictaphone_no	heading_degrees	start_depth_m	start_location_lat	start_location_long	start_time24hr	boat_speed_knots	end_depth_m	end_location_lat	end_location_long	end_time24hr	habitat_descr	Surveyors	Seastate	Boat	Notes
1	2018-09-18	Site 2	2.3	Site_2_3_StarfishLog_20180918_110152.logdoc			180	32	-51.6778	59.21073	11:04	2.3	32.8	-51.6883	-59.2068	11:19		NG/PB	5-10 knot winds	John Davis	Cable out - 30m, Starfish range set to 30m. Cable in water 1.4m across water
2	2018-09-18	Site 2	2.3	Site_2_3_StarfishLog_20180918_110152.logdoc			180	32	-51.6883	-59.2068	11:19	2	29.3	-51.70505	-59.21038	11:43		NG/PB	5-10 knot winds	John Davis	Range set to 100m
3	2018-09-18	Site 2	2.2	Site_2_2_StarfishLog_20180918_151921.logdoc			20	39.4	-51.6671	-59.1311	15:23	2	29.9	-51.66342	-59.12862	15:28		NG/PB	5-10 knots	John Davis	Range set to 100m
4	2018-09-18	Site 1	1.5	Site_1_5_StarfishLog_20180918_194106.logdoc			310	34	-51.60758	-59.21944	19:44	2	34.4	-51.60438	-59.22348	19:52		NG/PB	5-10 knots	John Davis	Range set to 100m
1	2018-09-20	Site 3	3.2	starfishlog_20180920_131923.logdoc			43	30	-51.83176	59.45621	13:20	2.6	32.8	-51.80814	-59.45045	13:00	sand with ripples	NG/PB	15-20 knot winds	John Davis	Cable out - 30m, Starfish range set to 100m. Cable in water 1.4m across water - camera tow showed sand
1	2018-09-22	5	5.3	starfishlog_20180922_093107				30	-51.95216	-59.62396	09:31	2.8	32	-51.94734	-59.62345	09:38					Cable out - 30m, Starfish range set to 100m.
2	2018-09-22	5	5.5	starfishlog_20180922_125351				30	-52.07818	-59.68935	12:52	2.8	33	-52.07273	-59.68864	12:59					Cable out - 30m, Starfish range set to 100m.
3	2018-09-22	6	6.1	starfishlog_208_09_22_145919				29.4	-52.1605	-59.71384	14:59	3.3	40.7	52 09.433	59 42.204	15:06					Cable out - 30m, Starfish range set to 100m.
1	2018-09-23	Area 7	7.2	starfishlog_2018_09_23_10_55_44.logdoc				28.8	-52.19212	-59.3825	10:54	2.8	33	-52.18955	-59.37546	11:00		NG/PB	2		30m layback - 100m swathe width. Only hit record from 10:55
2	2018-09-23	Area 7	7.1				36.9	27.6	-52.17065	-59.3347	11:50	2.9	29.5	-52.16609	-59.33236	11:56		NG/PB	2		30m layback - 100m swathe width.
1	2018-09-24	Area 8	8.4	starfishlog_20180924_1155644			66.7	33.4	-52.18686	-58.91917	11:57	2.9	36.4	-52.18569	-58.91185	12:03	soft sediment	NG/PB	4	John Davis	30m layback - 100m swathe width.
2	2018-09-24	Area 8	8.2	starfishlog_20180924_145359			41	36	-52.16082	-58.9896	14:53	3.5	35.4	-52.15568	-58.9845	15:01	soft sediment	NG/PB	4	John Davis	30m layback - 100m swathe width.
3	2018-09-24	Area 8	8.1	starfishlog_20180924_173955			62	38	-52.11085	-58.99072	17:40	3.3	37.3	-52.10919	-58.98216	17:46	soft sediment	NG/PB	4	John Davis	30m layback - 100m swathe width.
1	2018-09-25	Area 10	10.4	StarfishLog_20180925_114415			31	33.6	-51.99948	-58.54836	11:45	3.3	31.3	-51.99396	-58.54658	11:51		NG/PB	3	John Davis	100m range set / 30m cable out
2	2018-09-25	Area 10	10.3	StarfishLog_20180925_124408			219	27	-51.95509	-58.55381	12:46	2.1	30.5	-51.96891	-58.55541	12:52		NG/PB	3	John Davis	100m range set / 30m cable out
3	2018-09-25	Area 10	10.1	StarfishLog_20180925_151327			254	23.9	-51.91019	-58.68098	15:13	2.5	30.5	-51.91204	-58.68767	15:20		NG/PB	3	John Davis	100m range set / 30m cable out
4	2018-09-25	Area 10	10.2	StarfishLog_20180925_174052			190	28	-51.01107	-58.59799	17:41	2.5	33.1	-51.91435	-58.59683	17:47		NG/PB	3	John Davis	100m range set / 30m cable out

Appendix 5: Vessel Log

NO: 109 **DATE:** 16.09.18

BARINTHUS

12-18 ↓ 19kn
18-23 ↓ 12 KN.

ARR	DEP	LOCATION	DETAILS
	10.35	FIPASS	Dep. Salmon Cultus
	13.30	PRONG POINT	Lively Island.
	14.45	BLEAKER JUMP	
	15.35	BULL POINT	
	16 33	ANNIE ISLAND	Speedwell
	1740	RUGGLES	WORTH POINT
	19.00	SWAN ISLAND	
20.00		NEW HAVEN	Alongside C. Bay
		17-09-18	
0700	1700	New haven.	Maintenance, Fuel, Prep.
		18.09.18	
	07.45	NEW HAVEN	
09.00	11.55	SITE P2.3	Survey. Side Scan, Drop Cam. Photos
12.20	15.46 ~~15.35~~	SITE P2.2	Black Island. —"
16.00	16.41	SITE P2.1	Rookery Bay —"
16.55	20.20	SITE P1.5	Northwest Islands —"
2100		NEW HAVEN	Drop max Recheck
			06:00 13KN ← 20.00 ↑ 23kn. 11.00 16 KN ← 14.00 19 KN ↑ 17.00 22 KN ←

NO: 110 DATE: 19.09.18

BARINTHUS

ARR	DEP	LOCATION	DETAILS
	06.10	NEW HAVEN	
07.05	08.35	MANY BRANCH	Sounder only
09.30	11.04	CHANCHO POINT	Sounder only
12.45		NEW HAVEN	Work end due to wind turning
		20.09.18	
	08.05	NEW HAVEN	
0900	11.12	3.1 SITE 211 Johnstones	Sounder
11.30	13.50	SITE 3.2	Sounder + Drop Cam. + Side Scan. High cliff East
14.10	15.55	SITE 3.3	High cliff West Sounder only
16.10	17.36	SITE 3.4	Cygnet HEAD Sounder only
17.50	1855	SITE 5.1	White cliff Point Sounder only
19.15	19.25	SITE 3.3	Sounder I Run Diagnally
20.45		NEW HAVEN	Fuel, Engine Service + Generator
	05.35	22.09.18	
07.00	07.20	SITE 3.3	Re Run Transect
07.30	07.40	SITE 3.4	— " —
07.46	07.57	SITE 5.1	Collect sounder data through site 5.1
07.57	10.05	SITE 5.3	Collect Sounder data SITE 5.3 Drop cam + Side

NO: 111 DATE: 22.09.18

BARINTHUS

ARR	DEP	LOCATION	DETAILS
11.05	11.20	SITE 5.4	Transect through only
11.25	13.10	Site 5.5	Ruggles Bay Transects through 5.5 + 5.4 Sounder Side Scan + Drop Cam
14.10	15.30	SITE 6.1	Speedwell. Sounder, Side Scan, Drop Cam
15.40	15.45	SITE 6.2	Transect only
15.50	16.00	SITE 6.3	Transect only
18.30		NORTH ARM	Drop Pax Peaks at Bull Point (2)
	07.35	NORTH ARM	
08.00	12.15	SITE 7.1 + 7.2	Side Scan, Drop Cam, Sounder. Commerson (1)
12.30		NORTH ARM	Drop Pax, Refuel.
	0540	NORTH ARM	24.09.18
08.34	12.30	(SITE 8.4) LOW BAY	ARRIVED ON SITE: SOUNDER / SIDESCAN CAMERA x2
12.30 ~~11.40~~	12.58	TRANSIT TO SITE 8.2	2 Commerson 52°09.295 58°57.557
12.58	15.20	SITE 8.2	SOUNDER Side Scan, Drop Cam.
15.50	14.05	SITE 8.1	1 x Commerson 52° 07.625' 58° 57.859' Sounder
18.40	~~05~~.45	BLEAKER.	Drop Pax ⚓
0610	07.10	25.9.18 SITE 8.1	Continue Sounding + Drop Cam.
07.45	08.10	TRISTE + MOSLEY	Transit through Pass
08.55	13.15	SITE 10.4/3	Sounder, Side Scan, Drop Cam

NO: 112 DATE: 25.09.18

BARINTHUS

ARR	DEP	LOCATION	DETAILS
/	/	CHOISEUL SOUND	
13:30	15:45	SITE 10.1	Sounder, Side Scan, Drop Cam
15:55	18:30	SITE 10.7	Sounder, Side Scan.
18:50	/	MARE HARBOUR	Drop PAX Refuel.
~~06:05~~	06:05	26.09.18 MARE HARBOUR	
08:45		FIPASS	

Appendix 6: Site habitat and taxa description

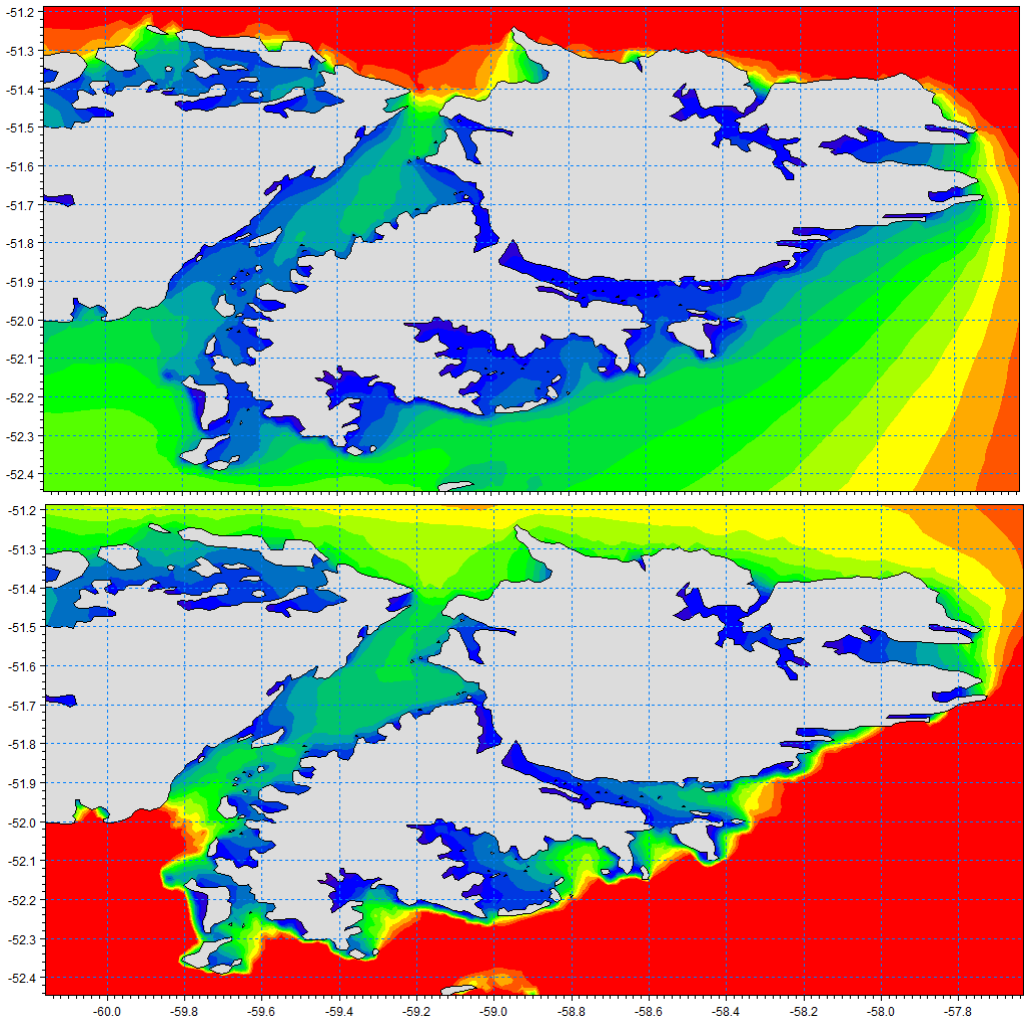
Site / File	seabed type	Taxa	Group	Abundance; Low(1):High(5)	Notes
Site_1_5_20180918_192543.avi	coarse sand / gravel / mussel shell / cobble	*Siphonachalina fortis*	Porifera (Sponges)	2	Some ripples in sand
Site_1_5_20180918_193044.avi	Sponge beds	*Haliclona sp.*	Porifera (Sponges)	2	
		Iphon sp	Porifera (Sponges)	2	
		Iphon proximum	Porifera (Sponges)	1	Iophon on scallop
		Branched hydroid	Cnidaria	3	
		Zygoclamys patagonica	Mollusc (scallop)	1	
		Munida sp	Crustacea (Lobster krill)	3	
		Octocoral sp ?	Soft coral	2	
		Branched bryozoan	Bryozoa	3	
Site_2_1_20180918_182522.avi	fine sand / silt / mussle shell / cobble	*Magellania venosa*	Brachopods (lamp shell)	4	
Site_2_1_20180918_183023.avi	Brachiopod beds	*Odontaster pencillatus*	Echinoderm (cushion star)	1	
		Siphonachalina fortis	Porifera (Sponges)	2	
		Axinella sp. ?	Porifera (Sponges)	2	
		Large grey branched sponge	Porifera (Sponges)	1	
		Munida sp	Crustacea (Lobster krill)	1	
		Paralomas granulosa	Arthorpods (crabs)	1	
		Peltarion spinulosum	Arthorpods (crabs)	1	
		Ciona intestinalis	Ascidian (sea squirt)	1	
SIte_2_2_20180918_144340.avi	fine sand / silt / mussle shell	*Ciona intestinalis*	Ascidian (sea squirt)	5	
Site_2_2_20180918_144840.avi	Ciona beds	*Munida sp*	crustacea (Lobster krill)	3	
Site_2_2_20180918_145341.avi		*Axinella sp. ?*	Porifera (Sponges)	2	
		Branched bryozoan	Bryozoa	3	
Site_2_2_20180918_153655.avi	silt / cobble? / bedrock?	*Lessonia flavicans*	Tree kelp	5	camera dropped into macrosystis patches
Site_2_2_20180918_154155.avi	Lessonian beds	*Ciona intestinalis*	Ascidian (sea squirt)	3	
		turfing red	folios red algae	5	
		Odontaster pencillatus	echinoderm (cushion star)	1	
Site_2_3_20180918_103230.avi	fine sand / silt / mussle shell / cobble	*Ciona intestinalis*	Ascidian (sea squirt)	5	a lot of drift macrosystis
Site_2_3_20180918_103731.avi	Ciona beds	*Cosmasterias lurida*	echinoderm (starfish)	1	
		Anasterias antarctica ?	echinoderm (starfish)	1	
		Axinella sp. ?	Porifera (Sponges)	3	
		Munida sp	crustacea (Lobster krill)	1	
		Magellania venosa	Brachopods (lamp shell)	1	
DC01_20180920_121603.avi	silt / sand / mussle shell	*Lessonia flavicans*	tree kelp	3	
Site_3_2_	Lessonian beds	folios red	red seaweed	5	
		filmentous red	red seaweed	4	
Site_3_2_20180920_114403.avi	coarse / fine sand, rolling drifts of sand patches of cobble	*Anasterias antarctica ?*	echinoderm (starfish)	1	tracks across sand
Site_3_2_20180920_114904.avi		*Axinella sp. ?*	Porifera (Sponges)	2	weird parellel tracks
		Siphonachalina fortis	Porifera (Sponges)	2	
		Munida sp	Crustacea (Lobster krill)	4	
Site_5_3_20180922_094656.avi	coarse / fine sand,	*Aulacomya ater*	Mollusc (ribbed mussel)	4	White jelly in watercolumn
Site_5_3_20180922_095405.avi	rolling drifts of sand patches of cobble	*Peltarion spinulosum*	Crustacea (burrowing crab)	2	video very jerky
	mussle patches.	*Munida sp*	Crustacea (Lobster krill)	2	Munida in watercolumn
		Siphonachalina fortis	Porifera (Sponges)	4	
		Haliclona sp.	Porifera (Sponges)	1	
		Axinella sp. ?	Porifera (Sponges)	2	
		Tedania murdochi ?	Porifera (Sponges)		
		Octocoral sp ?	Soft coral		
SIte_5_5_20180922_130403.avi	silt / shell / mussel shell / mussel bed	*Odontaster pencillatus*	Echinoderm (cushion star)	1	Munida in watercolumn
		Munida sp	Crustacea (Lobster krill)	3	
		Aulacomya ater	Mollusc (ribbed mussel)	4	
		Filmentous red	red seaweed	4	
		Patageonotothen sp	Fish	1	
		Magellania venosa	Brachopods (lamp shell)	2	
		Octocoral sp ?	Soft coral	1	
		Haliclona sp.	Porifera (Sponges)	1	
Site_6_1_20180922_151629.avi	coarse sand / cobble / small boulder	*Alcyonidium australe*	Bryozoa	4	Large burple branched bryozoan
Site_6_1_20180922_152130.avi	Alcyonidium beds	*Haliclona sp.*	Porifera (Sponges)	2	
		Tedania murdochi ?	Porifera (Sponges)	2	
		Amphimedon maresi ?	Porifera (Sponges)	2	
		Axinella sp. ?	Porifera (Sponges)	3	
		Arbacia dufresnii	Echinoderm (sea urchin)	1	
		Branched Hydroids	Cnidarians	3	
		Polyzoa sp	Ascidian (sea squirt)	1	

Site / File	seabed type	Taxa	Group	Abundance; Low(1):High(5)	Notes
		Aplidium sp	Ascidian (sea squirt)		
		Didemnidae sp	Ascidian (sea squirt)	2	
Site_7_1_20180923_120248.avi	soft sediments. silt / cobble / shell	*Aulacomya ater*	Mollusc (ribbed mussel)	4	Munida in watercolumn
		large Branched white Sponge?		2	tracks in sediment
		Branched bryozoan	Encrusting on mussel and rock		
		Branched Hydroids	Encrusting on mussel and rock		
Site_7_2_20180923_111327.avi	soft sediments. silt / cobble / shell	*Munida sp*	Crustacea (Lobster krill)	3	Crab tracks seen.
Site_7_2_20180923_111828.avi	mostly bare soft sediment, holes, pock marks.	*Haliclona sp.*	Porifera (Sponges)	1	occasional small patch of sponge or hard substrate
		Aulacomya ater	Mollusc (ribbed mussel)	1	
Site_7_2_20180923_113212.avi	silt. Soft Seds	*Aulacomya ater*	Mollusc (ribbed mussel)	3	
	Mussle patches.	*Munida sp*	Crustacea (Lobster krill)	1	
		Eurypodius longirostris	Crustacea (Spider crabl)	1	
Site_8_1_20180925_061432.avi	silt. Soft Seds	*Aulacomya ater*	Mollusc (ribbed mussel)		
	Mussle beds (patchy)	*Axinella sp. ?*	Porifera (Sponges)	3	
		Ophiuroids?	Echinoderm (brittle star)	3	Arms sticking up out of the sediment
		Magellania venosa	Brachopods (lamp shell)	1	
Site_8_2_1_20180924_150652.avi	silt bottom. Pock marks, depressions in sediment	*Munida sp*	Crustacea (Lobster krill)	5	
Site_8_2_2_20180924_151153.avi	Abundant Munida - no other epibenthos				
Site_8_4_1_20180924_121018.avi	silt bottom. Pock marks, depressions in sediment	*Munida sp*	Crustacea (Lobster krill)	5	
Site_8_4_2_20180924_121518.avi	Abundant Munida - no other epibenthos				
Site_8_4_Waypoint_740_20180924_122508.avi	silty sand on terraced bedrock.	*Lessonia flavicans*	tree kelp	5	
	Lessonian beds	*Cosmasterias lurida*	echinoderm (starfish)	2	
		Distaplia accidentalis	Ascidian (sea squirt)	2	
Site_10_1_1_20180925_152701.avi	fine sand / silt / mussle shell / cobble	*Aulacomya ater*	Mollusc (ribbed mussel)	4	
Site_10_1_2_20180925_153202.avi	Patches of flat bedrock shelves.	*Munida sp*	Crustacea (Lobster krill)	3	
	Live mussel and Brachiopod beds	Didemnidae sp	Ascidian (sea squirt)	2	
	Munida in watercolumn	*Siphonachalina fortis*	Porifera (Sponges)	3	
		Axinella sp. ?	Porifera (Sponges)	3	
		Tedania murdochi ?	Porifera (Sponges)	3	
		Alcyonidium australe	Bryozoa	2	
		Branched Hydroids	Cnidarians	4	
		folios red	red seaweed	3	
		Magellania venosa	Brachopods (lamp shell)	2	
		Octocoral sp ?	Soft coral	2	
		Aplidium sp	Ascidian (sea squirt)	1	
		Bryozoans	Bryozoans	3	
		Odontaster pencillatus	Echinoderm (cushion star)	1	
Site_10_2_20180925_175540.avi	fine sand / silt / mussle shell	*Aulacomya ater*	Mollusc (ribbed mussel)	4	Munida in watercolumn
		Odontaster pencillatus	Echinoderm (cushion star)	1	6-arm Odontaster
		Axinella sp. ?	Porifera (Sponges)	2	
		Magellania venosa	Brachopods (lamp shell)	1	
		Pyyra sp	Ascidian (sea squirt)	2	
Waypoint_794_795_20180925_180650.avi	coarse / fine sand, shell, cobble, bedrock?	Folios red		5	
	Dense turfing red seaweed bed.	Filmentous red		4	
		Ulva sp	Green seaweed	3	
		Iridaea sp	Red seaweed	2	
		Chalinula variabilis ?	Porifera (Sponges)	1	
		Lessonia flavicans ?	tree kelp	4	
Site_10_3_20180925_125603.avi	silt / sand / mussle shell	*Aulacomya ater*	mollusc (ribbed mussel)	5	
	Mussle bed	*Munida sp*	Crustacea (Lobster krill)	2	
		Amphilectus fleecei ?	Porifera (Sponges)	3	Encrusted on mussel shell?
		Cosmasterias lurida	echinoderm (starfish)	1	
Site_10_4_1_20180925_115716.avi	coarse / fine sand, shell, cobble, bedrock?	*Lessonia flavicans*	tree kelp	3	
Site_10_4_2_20180925_120217.avi	mussle patches.	Folios red	red seaweed	3	
		Didemnidae sp	Ascidian (sea squirt)	2	
		Axinella sp. ?	Porifera (Sponges)	2	
		Siphonachalina fortis	Porifera (Sponges)	2	
		Tedania murdochi ?	Porifera (Sponges)	1	
		Magellania venosa	Brachopods (lamp shell)	1	
		Aulacomya ater	Mollusc (ribbed mussel)	3	

Falkland Islands

Aquaculture Wave and Current Feasibility Study

Technical Note



Pisco ApS

Technical Note

March 2019

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)



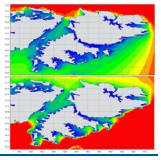
Falkland Islands

Aquaculture Wave and Current Feasibility Study

Technical Note

Prepared for Pisco ApS

Represented by Jonas Kring Højgaard



Instantaneous maximum Hm0
for North and South Storms

Project manager	Nick Elderfield
Quality supervisor	Nick Elderfield

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CONTENTS

1 Introduction and Project Appreciation 5
1.1 Objectives and Study Approach 5

2 Modelling Approach 7
2.1 Available Data Sets 8
2.1.1 Areas of Interest 8
2.1.2 Bathymetry 10
2.1.3 Offshore Boundary Conditions 13
2.1.4 Measured Tides 14
2.1.5 DHI Wave and CFSR Wind Models 14
2.2 Model Scenarios 17
2.2.1 Order of Workflow 18
2.3 Description of Workflows Undertaken 18
2.3.1 Uncoupled Hydrodynamic Model 18
2.3.2 Uncoupled Spectral Wave Model 19
2.3.3 Coupled HD-SW model 28
2.4 Validation of Models against available data 29

3 Analysis of Results 33
3.1 Uncoupled Hydrodynamic Model 33
3.1.1 Base Tidal Conditions - Scenario 1 33
3.2 Uncoupled Spectral Wave Model 35
3.2.1 Sensitivity Testing on Directional Variation - Scenarios 4 & 7 35
3.2.2 1 in 1 Year Nearshore Wave Conditions - Scenario 2 & 5 35
3.2.3 1 in 50 Year Nearshore Wave Conditions - Scenario 3 & 6 36
3.3 Fully Coupled Model 37
3.3.1 1 in 50 Year Pseudo-Storm – Scenario 3 & 6 38
3.3.2 Statistical Overview of 1 in 50 Year Storm 40
3.3.3 Snapshot of 1 in 50 Year Storm Peak 44

4 Conclusions & Recommendations 49
4.1 Summary of Findings 49
4.2 Recommendations 50

Appendix A **1**

Appendix B **13**

Appendix C **26**

Appendix D **39**

Appendix E **52**

Appendix F **65**

Appendix G **78**

Appendix H **91**

FIGURES

Figure 1.1 Potential locations of the proposed aquaculture site with naming convention used in this study 5
Figure 1.2 Snapshot of the variation of the regional Ocean Currents taken on 10 Dec 2018 14:15 GMT (from https://earth.nullschool.net) 6
Figure 2.1 8 Areas of Interest with a single representative point, overlain on Bathymetry used for both HD, SW and coupled models 9
Figure 2.2 CMAP Bathymetry points, client collected data (black points) and model mesh developed for this study showing key areas of interest 10
Figure 2.3 Entire Model Domain, with derived bathymetry, used for HD, SW and coupled models 11
Figure 2.4 Entire Mesh, and derived bathymetry, used for both HD, SW and coupled models 11
Figure 2.5 Bathymetry detail in the North Entrance (top) and South Entrance (bottom) of the Falkland Sound (see Appendix A to Appendix H for Site details) 12
Figure 2.6 Bathymetry and mesh detail in the North Entrance (top) and South Entrance (bottom) of the Falkland Sound (see Appendix A to Appendix H for Site details) 13
Figure 2.7 Locations of Tidal Predictions (red) extracted from CMAPs Tide Tables, North & South Wind Conditions (white squares) extracted from DHI wave Model and North & South Wave Conditions (white triangels) extracted from CFSR Wind Model 15
Figure 2.8 All-year wave rose at the North (left) and South (right) offshore Boundary for period 1979 – 2017 16
Figure 2.9 All-year wind rose at the North (left) and South (right) offshore Boundary for period 1979 – 2017 16
Figure 2.10 Comparison of DHI model and satellite measurements from an offshore point south of the Falklands confirming the suitability of DHI's existing wave model data basis 21
Figure 2.11 Extreme value analysis for omni significant wave height at the North Boundary (top) and South Boundary (bottom) 22
Figure 2.12 Relation between peak wave period with significant wave height at the North Boundary (top) and South Boundary (bottom) 23
Figure 2.13 - Hm0 vs DSD plots for the North and South extraction locations for All directions. 24
Figure 2.14 - Wave heights for Northerly Sites for 0 degrees with DSD 20° (top) DSD 30° (middle) and DSD 60° (bottom) 25

Figure 2.15 Significant wave heights with a 0°N (North) mean wave direction, highlighting the similarity for a 1 in 1 year (top) and 1 in 50 year (bottom) 28
Figure 2.16 Timeseries (top) and Scatter (bottom) comparison of ***DHI model*** and ***observed*** Water Levels from the Falklands, Stanley Harbour suggesting general suitability of DHI's model data basis 30
Figure 2.17 Timeseries (top) and Scatter (bottom) comparison of ***DHI model*** and ***Predicted*** Tidal component of the observed Water Levels from the Falklands, Stanley Harbour suggesting the general suitability of DHI's model data basis 31
Figure 2.18 Time series comparing the HD modelled results, to the predicted data from the Tide Tables provided by CMAP around the Falklands. From top: Stanley, Adventure Sound, North Arm, Speedwell and North West. Note the first image also shows the Observed data for Stanley. 32
Figure 3.1 Statistical maximum current speed from the Scenario 1 model for all locations. Maximum speed in the entire model run. 34
Figure 3.2 Overview of significant wave heights for 1 in 1 Year Return Period wave transformation for 0°N mean wave direction 36
Figure 3.3 Overview of significant wave heights for 1 in 1 Year Return Period wave transformation for 210°N mean wave direction 36
Figure 3.4 Overview of significant wave heights for 1 in 50 Year Return Period wave transformation for 0°N mean wave direction 37
Figure 3.5 Overview of significant wave heights for 1 in 50 Year Return Period wave transformation for 210°N mean wave direction 37
Figure 3.6 Statistical maximum of H_{mo} for entire storm period for North storm (top) and South storm (bottom) for the 1 in 50 year storm event 40
Figure 3.7 Statistical maximum Hmax for entire storm period for North storm (top) and South storm (bottom) for the 1 in 50 year storm event 41
Figure 3.8 Max Current Speed for entire storm period for North storm (top) and South storm (bottom) for the 1 in 50 year storm event 42
Figure 3.9 Max Peak Wave Period (Tp) for entire storm period for North storm (top) and South storm (bottom) for the 1 in 50 year storm event 43
Figure 3.10 Snapshot of current speeds for peak of storm event with a 0°N (North) mean wave direction for zone G2 44
Figure 3.11 Snapshot of current speeds for peak of storm event with a 210°N (South) mean wave direction for zone G2 44
Figure 3.12 Snapshot of significant wave heights for peak of storm event with a 0°N (North) mean wave direction for zone G2 45
Figure 3.13 Snapshot of significant wave heights for peak of storm event with a 210°N (South) mean wave direction for zone G2 45
Figure 3.14 Nearshore Wave parameters for Peak Storm Event propagating from offshore 0°N (North) direction for Zone G2 46
Figure 3.15 Nearshore Wave parameters for Peak Storm Event propagating from offshore 210°N (South) direction for Zone G2 47
Figure 3.16 Nearshore water level and current speed for a Peak Storm Event propagating from offshore 0°N (North) and 210°N (South) direction for Zone G2 48

TABLES

Table 2.1 Co-ordinates for representative points for each Area of Interest....8
Table 2.2 Co-ordinates for locations with Tidal Predictions used for validation purposes 14
Table 2.3 North and South Co-ordinates of the Wind and Wave Conditions extracted from DHI wave and CFSR wind models....15
Table 2.4 Uncoupled HD model set-up details 19
Table 2.5 Nearshore significant wave height for 1 and 50 year return periods for each 30° directional sector using the larger of the two offshore wave sources 26
Table 2.6 Uncoupled SW model set-up details....27
Table 2.7 Fully coupled SW model set-up details that differ from the previous uncoupled HD and SW models....29
Table 3.1 Astronomical tidal levels for locations within the 8 potential zones 33
Table 3.2 General statistics of current speeds for locations within the 8 potential zones 34
Table 3.3 General statistics of waves and currents for 1 in 50 **Storm conditions from the North (0°) and South (210°)** for locations within the 8 potential zones....38

1 Introduction and Project Appreciation

This report has been prepared for **Pisco ApS** (Pisco) by DHI as part an initial assessment of the wave and current conditions at a series of locations around the Falkland Islands. (See Figure 1.1).

Pisco are seeking advice on the suitability of various locations with respect to the above physical hydrodynamic conditions. As such, a model study is required to scope the below locations for the potential survivability for moored structures. It is understood that this preliminary assessment would be in advance of more detailed studies for selected locations that may, or may not, be undertaken.

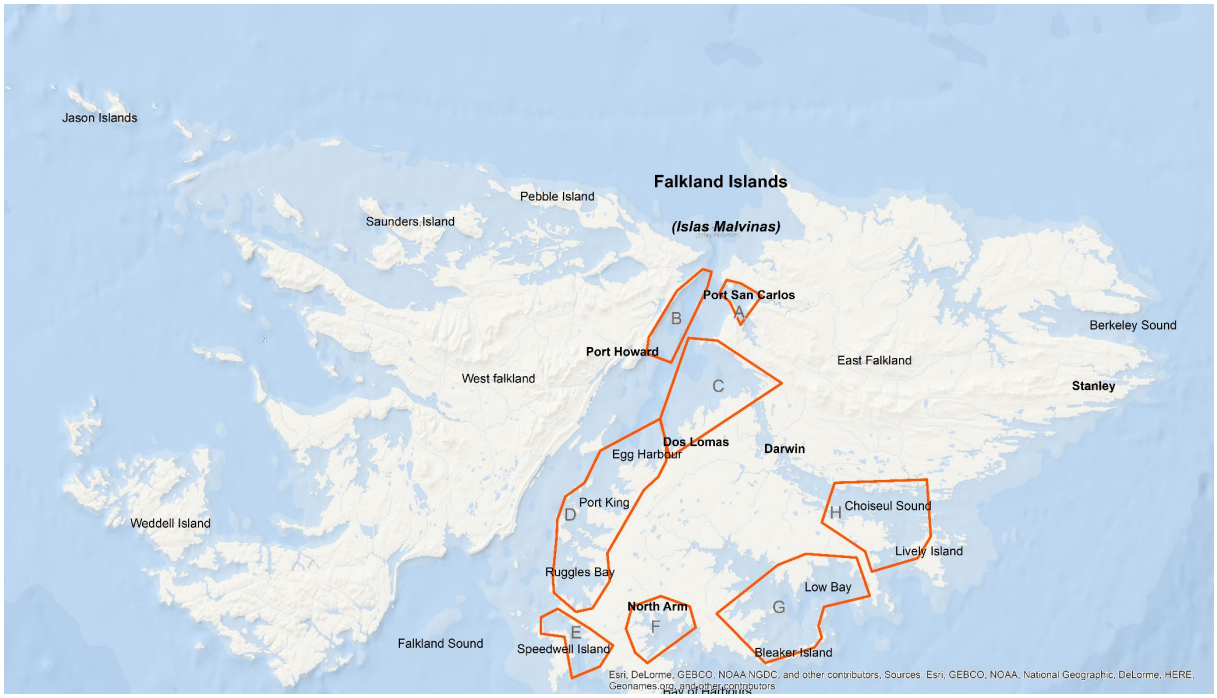


Figure 1.1 Potential locations of the proposed aquaculture site with naming convention used in this study

1.1 Objectives and Study Approach

The purpose of the study therefore is to:

- Develop an initial understanding of the extreme wave and current conditions for a range of sites based on numerical model outputs; and
- Provide comparison based on key wave and current parameters between sites.

In line with the above it is considered that there are four main tasks

- Development of Hydrodynamic (HD) model for suitable conditions to derive extreme events
- Development of Spectral Wave (SW) model for suitable conditions to derive extreme events
- Analysis and assessment of results
- Reporting on the outputs in a short technical note

Due to their remoteness, the coastal areas of the Falklands are relatively data sparse with limited information in the literature. For this study, waves and currents are the most significant environmental condition.

Much of the literature focuses on the presence of the ocean shelf scale Falklands Malvinas Current (FMC) running to the east of the Falklands and the Patagonian current between the mainland and the islands. Whilst potentially contributing to the wider ocean dynamics, it is assumed for this near coastal assessment that the FMC influence is negligible for extreme waves and currents. This should be confirmed at later stages for sites of interest.

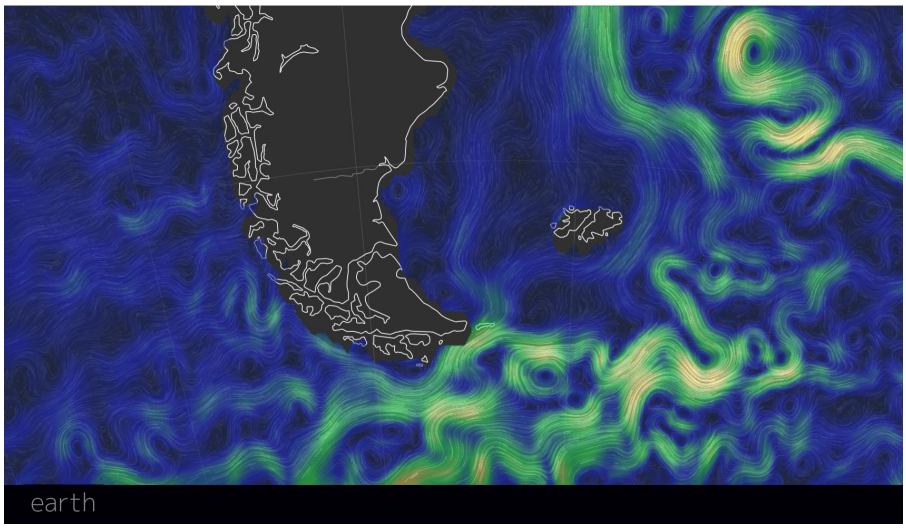


Figure 1.2 Snapshot of the variation of the regional Ocean Currents taken on 10 Dec 2018 14:15 GMT (from https://earth.nullschool.net)

Barotropic tides within the islands are of relatively low tidal amplitudes, with the lowest amplitudes in the south of East Falkland and highest on the west coast of West Falkland. This differential is considered to provide the main external forcing for tidal currents. On top of this, surges due to wind forcing (setup) and air pressure differential are likely to be another contributor to the extreme water levels and hence also the currents. Of interest here is that both tide and surges have similar magnitudes and are of equivalent importance in a study of extreme water levels. Seiching in some of the bays has been noted in other studies (Woodworth, 2005), with resonance at scales relative to the basin length/depth tidal speed ratio, however will not be specifically assessed in this study.

Waves are predominantly from the Southern Ocean or from the South Atlantic. Due to the dominant directions of the weather patterns in these basins, the largest waves are focused from SSW to NNW directions. Waves from the Southerly quadrant are typically longer period, being dominated by the Southern Ocean swell coming round Cape Horn, whilst the waves on the Patagonian shelf are more mixed with windsea and swell (Upton, 2002) . Sesonality of the storms was shown to have higher waves during the periods July-September, coincident with the Austral Winter (Upton, 2002).

2 Modelling Approach

The main aim of this study is to assess the impact of extreme environmental conditions on the potential aquaculture locations. As such, the models for this study have been developed to resolve the key areas highlighted in Figure 1.1. In addition to the extremes, typical water levels and current speeds need to be derived from the HD model.

The focus of the HD model will be to assess tidal conditions for a selected period of three (3) months. This will allow a suitable period to assess the typical tidal conditions for the sites for both water levels and current speeds.

For the wave modelling, the HD model is coupled with the wave model, to be run in fully spectral mode to allow for locally generated wind waves to be captured in combination with ocean waves from further offshore, and to also assess their effect on currents.

Initial sensitivity testing of the nearshore wave heights compared to the offshore heights is then undertaken using the models in stationary mode (i.e. with no wind or water level variation to confirm the worst-case situation), before the models are run fully spectrally for a storm. This initial test is required to determine whether the largest offshore wave conditions are also co-incident with the largest nearshore wave conditions within the proposed development zones.

The wave models are focused on a 1 in 1-year and a 1 in 50-year wave condition. The existing offshore wave data from DHI's regional model is used to derive the extreme offshore wave conditions as input. The peak storm wave heights are matched with a suitable storm period (usually less than 2 days in this area) and a pseudo storm condition is developed to incorporate wind and water level variation. The pseudo storm models have the peak storm events for the highest astronomical tide and significant wave height lined up to assess the most extreme combined conditions and do not reflect a true historical storm or storm tide. This will provide a "most likely" wave condition for the area.

Wave periods for this storm are based on an established relationship between significant wave height (H_{mo}) and peak wave period (T_p) based on the offshore conditions in the DHI database. Directions are based on the assumed most frequent directions (South-west and North-west) based on the offshore wave roses. It should be noted that this assumption of direction could miss events from other directions that end up being larger in the nearshore zone.

As these scenarios will assume a dominant wave direction, it is proposed that a sensitivity assessment is undertaken on the stationary models to assess the potential difference based on other wave conditions.

This Chapter is broken up into 4 main sections. First the Available data sets are discussed Section 2.1. The Model scenarios proposed are described further in Section 2.2. Due to the iterative nature of the wave modelling to define the nearshore condition, a description of the order in which the work was undertaken is also provided. The following section 2.3 will then describe each work-step as individual stages. A description of the Validation undertaken is then described in Section 2.4, before Section 3 highlights the results, with the full site outputs provided in the detailed Appendices A to H.

2.1 Available Data Sets

It is understood that limited measurements are available for the area. The client has provided bathymetry data for the key site of interest and DHI is aware of a tide gauge at Stanley and tidal predictions at other locations around the Archipelago. Importantly there is no wave data publicly available from the nearshore area of interest and as such the local wave model will remain un-validated.

The following sections outlines the data sets and their application in this study.

2.1.1 Areas of Interest

The client has provided 8 potential areas of interest for detailed study. These have been labelled A-H in a counter-clockwise direction starting in the North in the Falkland Sound. The client has confirmed a single representative output location in each area of interest for further statistical purposes (see Figure 2.1 and Table 2.1)

Table 2.1 Co-ordinates for representative points for each Area of Interest

Potential Site Zone	Latitude [°S]	Longitude [°W]	Depth [m]
A1	-51.4882	-59.0993	-24.4
B1	-51.5526	-59.2887	-52.3
C4	-51.6914	-59.194	-31.1
D3	-51.8498	-59.5181	-32.0
E3	-52.231	-59.6405	-30.1
F1	-52.1893	-59.3769	-29.5
G2	-52.1649	-58.9794	-26.6
H2	-51.9551	-58.5272	-23.9

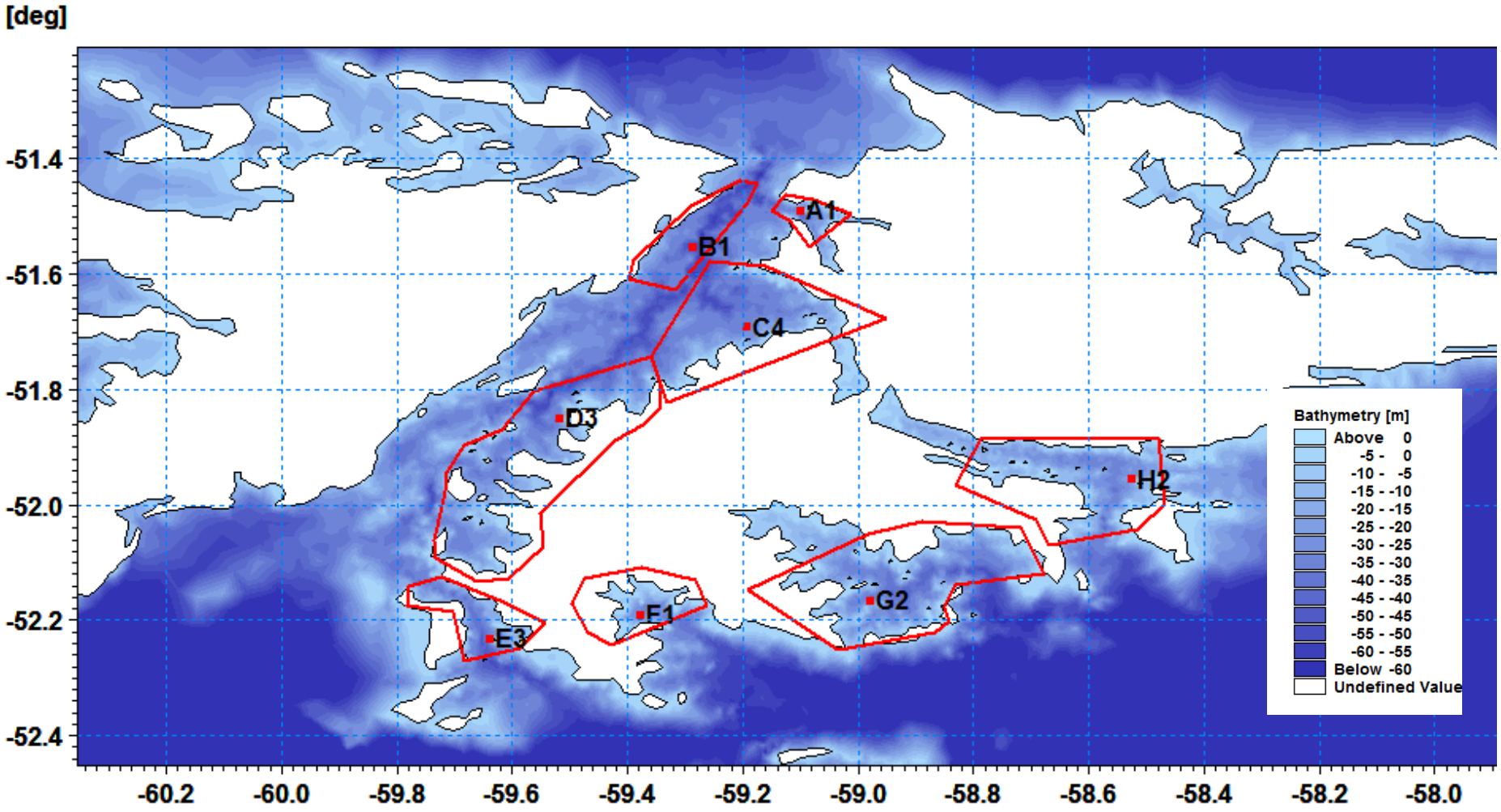


Figure 2.1 8 Areas of Interest with a single representative point, overlain on Bathymetry used for both HD, SW and coupled models

2.1.2 Bathymetry

The area of the Falklands is covered with high density charted information. As such the key bathymetry source for this area, CMAP, is well populated. Comparisons were made with the 90m data and whilst similar in depth values, the greater extent of the CMAP coverage for both East and West Falkland was considered more suitable for the model development. Client derived depth soundings were also provided and were included in the mesh to provide additional detail within the local area.

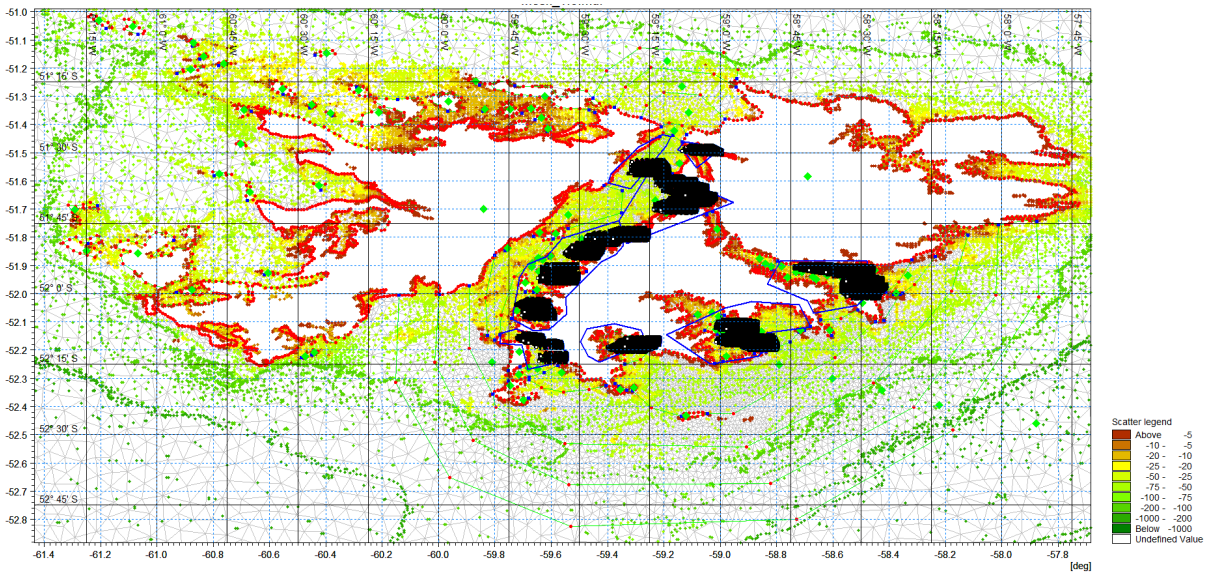


Figure 2.2 CMAP Bathymetry points, client collected data (black points) and model mesh developed for this study showing key areas of interest

2.1.2.1 Model Domain

The domain of the MIKE-21 model developed for the Falkland Islands is shown in Figure 2.3.

The model domain includes the entire Falkland Islands surrounded by 40-80 kilometres of open-ocean. The domain was selected encompass as much of the provided bathymetry data as possible, while avoiding deeper waters where the continental shelf drops in the south and east to minimise computational delays in later model calculations.

2.1.2.2 Model Mesh

The computational mesh was constructed using a flexible mesh approach with varying spatial resolution (i.e. element length) across the domain (Figure 2.4). The same computational mesh was used in all later HD, SW and coupled modelling.

The horizontal resolution of the mesh was varied throughout the model domain. The maximum element length was in the open ocean and decreased towards the areas of interest around East Falkland Island. The average element length was ~ 7.5, 4.0, 2.5, 1.8, 1.2, and 1 kilometre resolution. All 8 Areas of Interest had an average mesh resolution of 1 kilometre, this varied across the Areas of Interest and could be as small as 300m.

It was ensured that the computational mesh was adequately resolved to capture the general tidal dynamics of the Areas of interest. This was achieved by comparison of modelled water levels with observations from the tide gauge at Stanley Harbour as well

as the tidal predictions for Adventure Sound, North Arm, Speedwell Island and the North West Islands (see Section 2.1.4 and Section 2.4).

2.1.2.3 Model Bathymetry

The bathymetry data was interpolated onto the computational mesh surface making use of the bathymetry data sources above. The final mesh was converted from CD to MSL based on the variation in MSL from CMAP (see Figure 2.3 and Figure 2.4).

During this stage it was noted that there were some discrepancies between the land file used in the model (based on CMAP land) and aerial photographs of the area. Due to the timescales of this project it was assessed that the existing land file would suffice for the purposes of this assessment.

The bathymetry and mesh layout for the North and South Entrance of the Falkland Sound can be seen in Figure 2.5 and Figure 2.6 (see Appendix A to Appendix H for Site specific details).

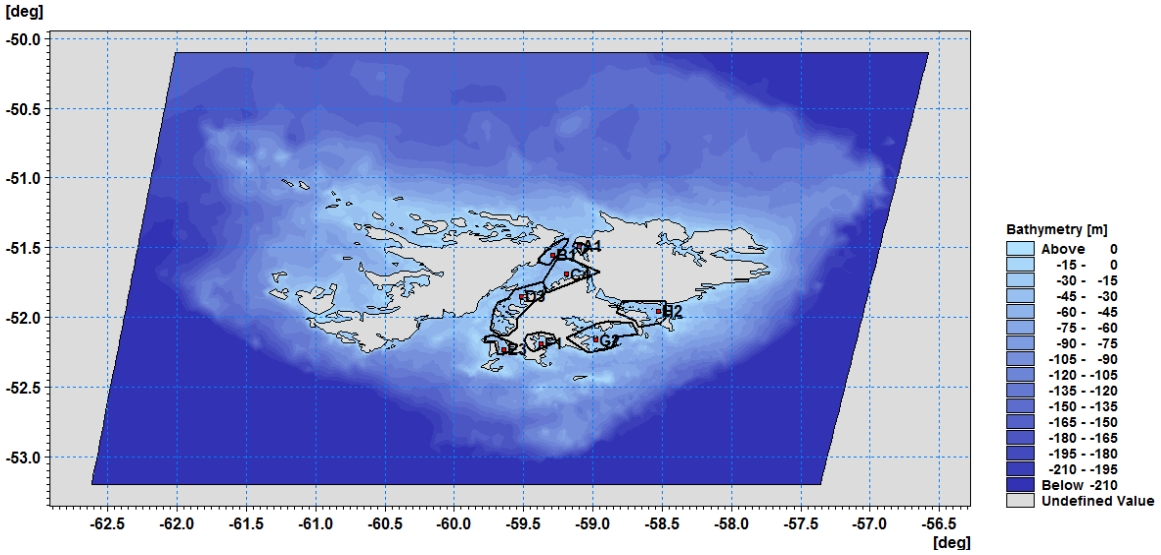


Figure 2.3 Entire Model Domain, with derived bathymetry, used for HD, SW and coupled models

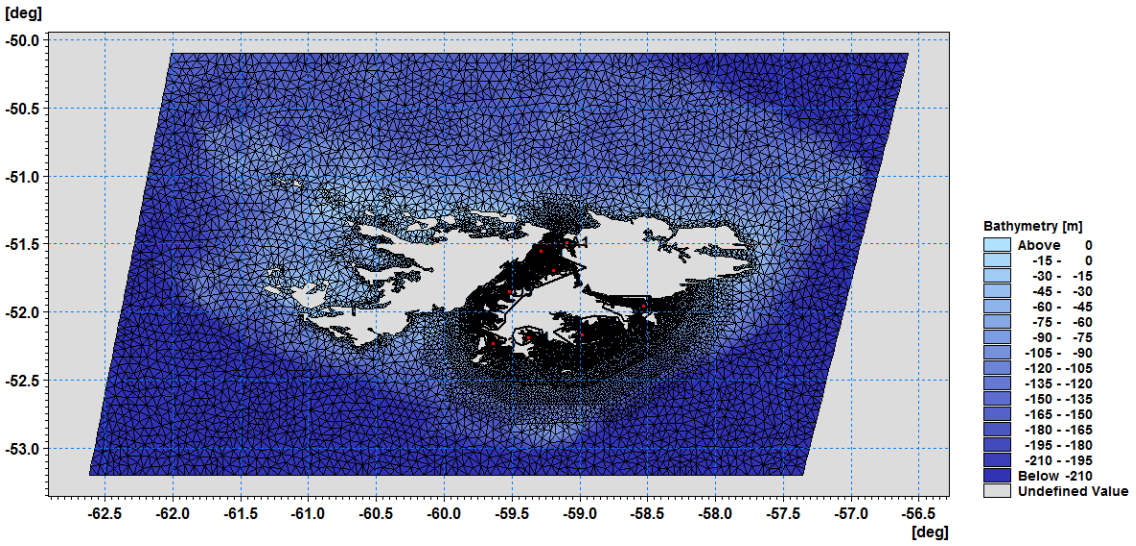


Figure 2.4 Entire Mesh, and derived bathymetry, used for both HD, SW and coupled models

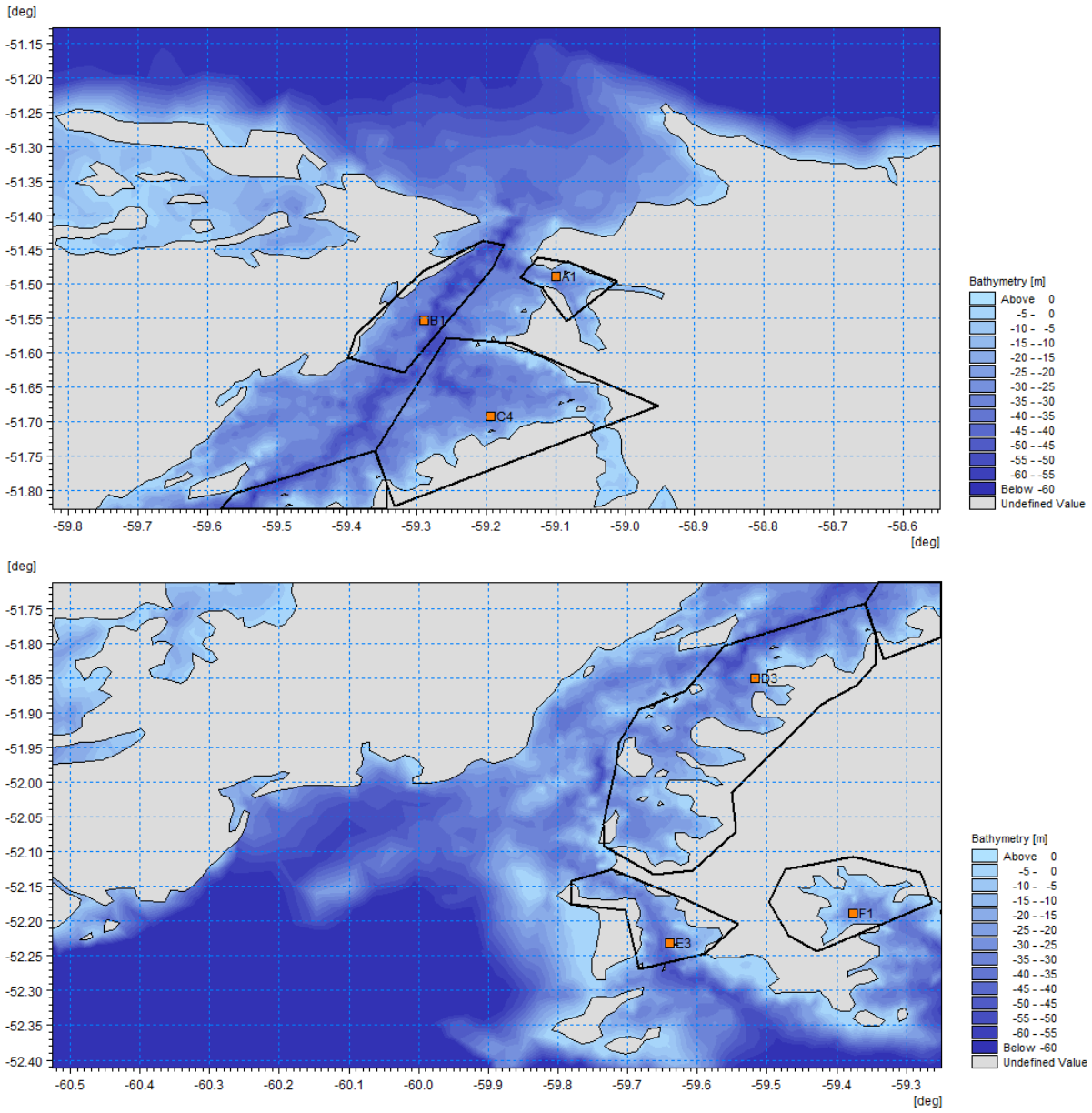


Figure 2.5 Bathymetry detail in the North Entrance (top) and South Entrance (bottom) of the Falkland Sound (see Appendix A to Appendix H for Site details)

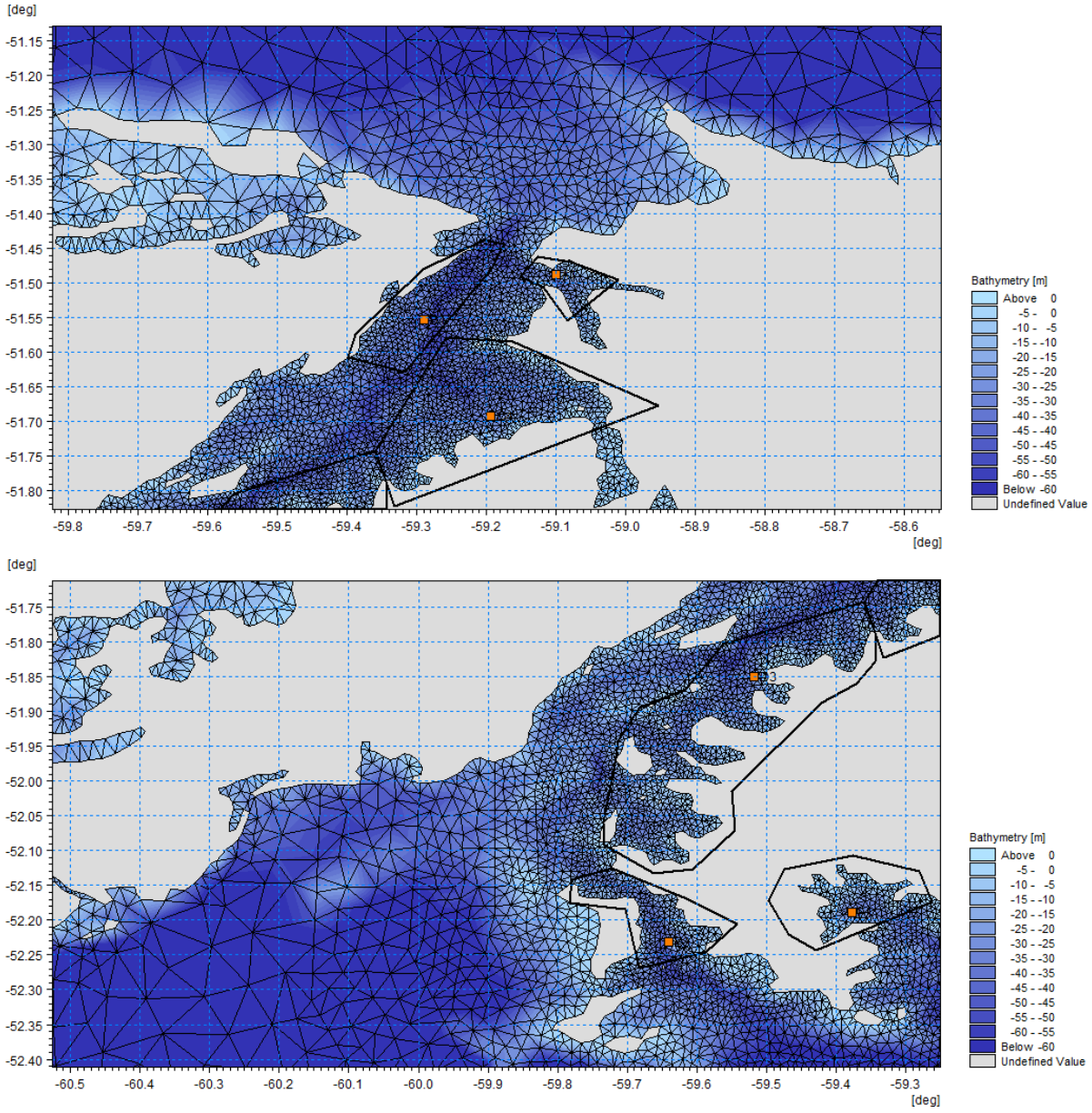


Figure 2.6 Bathymetry and mesh detail in the North Entrance (top) and South Entrance (bottom) of the Falkland Sound (see Appendix A to Appendix H for Site details)

2.1.3 Offshore Boundary Conditions

The model was forced by temporally and spatially varying water levels applied at the four open-boundaries.

The boundary conditions were derived using the DHI Global Tide model, developed by DTU Space and available in 0.125º x 0.125º resolution (Cheng, 2011). The model provides predictions of water levels based on 10 tidal constituents: Semidiurnal: M2, S2, K2, N2 – Diurnal: S1, K1, O1, P1, Q1 – Shallow water: M4.

This model assesses the effect of the barotropic tide and as such makes no allowance for other ocean tide parameters. This is considered suitable for the purposes of this initial assessment.

2.1.4 Measured Tides

Observed water levels conditions at Stanley Harbour have been sourced from the University of Hawaii Sea Level Center for the period 1992 – 2016. These will be used as a validation of the Mesh and HD models ability to predict the variation in water surface elevation (see section 2.4). In addition tidal predictions for a range of locations around the Falklands are available from CMAP tide tables (see Table 2.2 and Figure 2.7 for location details). These will be used as validation checks for the models suitability spatially (see section 2.4).

Table 2.2 Co-ordinates for locations with Tidal Predictions used for validation purposes

Potential Site Zone	Latitude [°S]	Longitude [°W]	Depth [m]
Stanley	-51.68348	-57.86682	3.2
Adventure Sound	-52.03309	-59.03187	5.3
North Arm	-52.11640	-59.36588	2.7
Speedwell Island	-52.19955	-59.68399	16.6
North West Islands	-51.58450	-59.18297	2.5

2.1.5 DHI Wave and CFSR Wind Models

DHI holds a range of existing long term hindcast data sets around the world. For this study, data from our Global wave model has been extracted for the period 1979-01-01 to 2017-12-31 (**38 years**). The model takes advantage of the latest developments in spectral wave modelling available from DHI's industry leading MIKE 21 Spectral Wave (SW) model. In addition, NCEP-NCAR CFSR wind and pressure fields have been provided for use in the pseudo storm condition runs.

At two points, North and South at the Falkland Islands (see Table 2.3 and Figure 2.7 for location details), wave conditions have been extracted from the DHI Global wave hind-cast database and wind conditions have been extracted from the CFSR wind hind cast data. Rose plots of the offshore wave conditions at sea-level are shown in Figure 2.8 and wind conditions at +10m MSL are shown in Figure 2.9.

Extreme value analysis of these offshore condition has been undertaken to provide the 1 in 1 and 1 in 50 year storm conditions (see Section 2.3.2.1 and Section 2.3.2.2).



Figure 2.7 Locations of Tidal Predictions (red) extracted from CMAPs Tide Tables, North & South Wind Conditions (white squares) extracted from DHI wave Model and North & South Wave Conditions (white triangels) extracted from CFSR Wind Model

Table 2.3 North and South Co-ordinates of the Wind and Wave Conditions extracted from DHI wave and CFSR wind models

Parameter	Location Name	Latitude [°S]	Longitude [°W]	Height above sea level of output [mMSL]	Local Depth [m]	Average Mesh Resolution[km]
Waves	North	50.42462	58.95396	0	-138	~ 7.5
	South	53.22577	60.07852	0	-572	~ 7.5
Wind	North	50.63204	58.73423	+10	-153	~ 7.5
	South	52.67638	60.12883	+10	- 192	~ 7.5



Figure 2.8 All-year wave rose at the North (left) and South (right) offshore Boundary for period 1979 – 2017

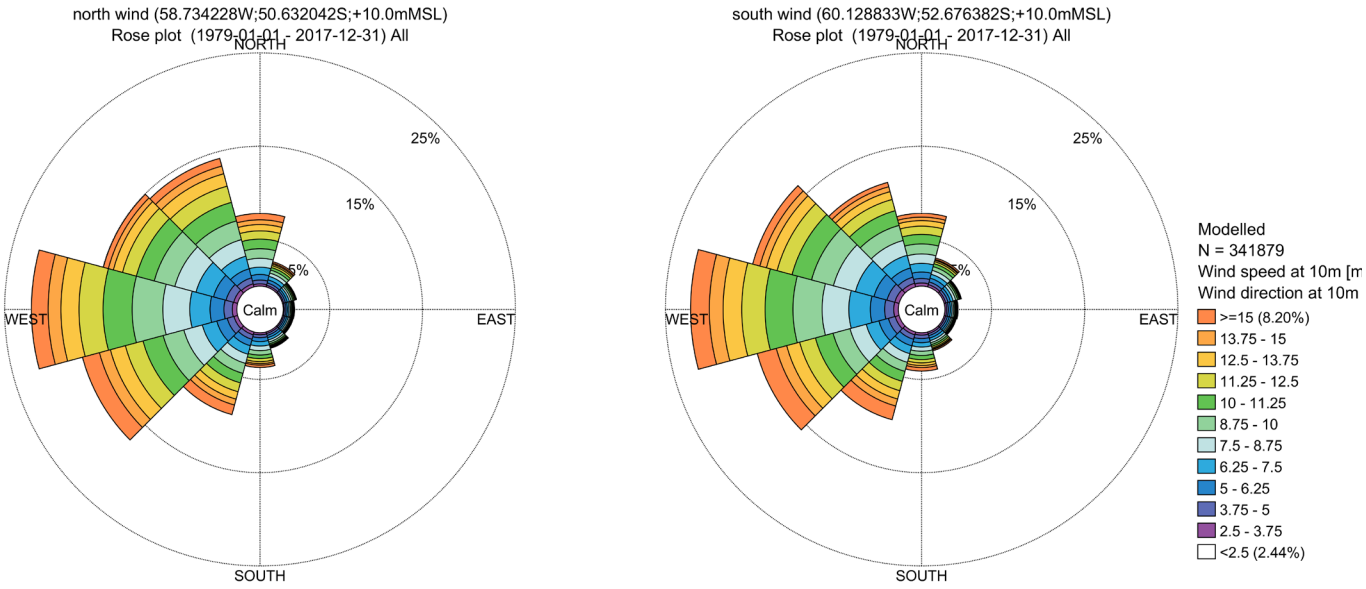


Figure 2.9 All-year wind rose at the North (left) and South (right) offshore Boundary for period 1979 – 2017

2.2 Model Scenarios

The following matrix of conditions are considered the principal output of the modelling assessment, as stated in the proposal.

Run Number	HD Model	Wave Model	Comment	Expected Outcome
1	✓	✗	One month run of HD model to achieve base tidal conditions	Key tidal components for veracity of water levels and key tidal parameters for all sites
2	✓	✓	1 in 1-year wave **Northern Sector** condition with suitable storm tide	1-year offshore wave height for waves from the North with a suitably representative storm tide to ensure surge is captured. Model run in stationary and in fully spectral modes to assess worst case and most likely case.
3	✓	✓	1 in 50-year wave **Northern Sector** condition with suitable storm tide	50-year offshore wave height for waves from the North with a suitably representative storm tide to ensure surge is captured. Model run in stationary and in fully spectral modes to assess worst case and most likely case.
4	✓	✓	Sensitivity tests on direction for **Northern** Sector +/- 30 degree	Assess impact of variation from peak wave direction for Northern Sectors
5	✓	✓	1 in 1-year wave **Southern Sector** condition with suitable storm tide	1-year offshore wave height for waves from the South with a suitably representative storm tide to ensure surge is captured. Model run in stationary and also in fully spectral modes to assess worst case and most likely case.
6	✓	✓	1 in 50-year wave **Southern Sector** condition with suitable storm tide	50-year offshore wave height for waves from the South with a suitably representative storm tide to ensure surge is captured. Model run in stationary and also in fully spectral modes to assess worst case and most likely case.
7	✓	✓	Sensitivity tests on direction for **Southern** Sector +/- 3 degree	Assess impact of variation from peak wave direction for Southern Sectors

2.2.1 Order of Workflow

The following outlines the order of the workflow undertaken to derive the scenarios above, including the outcomes of the sensitivity testing.

For reporting, results for both North and South events are discussed simultaneously to avoid repetition in describing how the work was produced.

- Mesh and bathymetry developed (as discussed in section 2.1.2)
- Boundary conditions extracted from the Global Tide Model (as discussed in section 2.1.3)
- Uncoupled HD Model
    - Determine base tidal conditions (Scenario 1)
- Uncoupled SW Model
    - EVA of N & S offshore conditions (Scenario 4 & 7)
        - 1 in 1 year for the North (Scenario 2) and South (Scenario 5).
        - 1 in 50 year for the North (Scenario 3) and South (Scenario 6).
    - Determine the 'worst' N & S nearshore conditions
        - 1 in 1 year storm sector were run for both North (Scenario 2) and South (Scenario 5).
        - 1 in 50 year storm sector were run for the North (Scenario 3) and South (Scenario 6).
    - Determine maximum events for nearshore conditions – no wind or tide
        - 1 in 1 year storm events were run for both North (Scenario 2) and South (Scenario 5).
        - 1 in 50 year storm events were run for the North (Scenario 3) and South (Scenario 6).
- Fully Coupled HD-SW Model
    - Run pseudo-storm scenarios - with wind & tide
        - 1 in 50 year storm events for the North (Scenario 3) and South (Scenario 6).

2.3 Description of Workflows Undertaken

2.3.1 Uncoupled Hydrodynamic Model

The water level observations at the Stanley Harbour Tide Gauge (described in section 2.1.4) were de-tided for the entire length of the dataset. Using the 2006 data which was selected as it contained the largest observed tidal only (no surge) height at Stanley Harbor, the HD model was run for a period of 3 months, using the mesh and bathymetry (described in section 2.1.2), boundary conditions (described in section 2.1.3) and the model setup details listed in Table 2.4. This period was selected as it was considered to be equivalent to an HAT scenario.

This modelled output was validated against both the observed water levels and predicted tide tables at Stanley Harbour, as well as against the predicted tide tables at Adventure Sound, North Arm, North West Islands and Speedwell Island (see Section 2.4). This provided the model output of the base water levels, current speeds and tidal conditions without additional wind and surge features (see Results Table 3.1 for the calculated astronomical water levels).

Table 2.4 Uncoupled HD model set-up details

HD Model Set-up Parameters	Selected Options	
Shallow-Water condition	Time Integration	Low order, fast algorithm
	Space Discretization	Low order, fast algorithm
Depth correction	None	
Flood and Dry	Standard	
Density	Barotropic	
Horizontal Eddy Viscosity	Smagorinsky formulation	
Bed Resistance	Manning Number	Constant: 40 m^(1/3)/s
Coriolis Forcing	Varying in domain	
Wind forcing	None	
Ice coverage	None	
Tidal potential	None	
Precipitation – Evaporation	None	
Infiltration	None	
Wave radiation	None	
Initial Conditions	Constant	
Boundary conditions	Specified level	Varying in time and along boundary

2.3.2 Uncoupled Spectral Wave Model

An extreme value analysis (EVA) has been undertaken of the extracted wave and wind hind-cast data (described in section 2.1.5), for the offshore outputs locations North and South of the Falkland Islands (see Figure 2.7).

For the statistical analysis of extreme events, it is important to consider the driving forces and the expected distribution of the variables being investigated. The site is subject to relatively persistent Westerly and South Westerly winds.

These extreme conditions for a 1 in 1 year and 1 in 50 year storm events using wave conditions originating from the North and South was then input into an uncoupled SW model for 12 directional sectors of 30°. The manner in which offshore storm events impacts nearshore conditions due to local factors, was considered to be of more relevance than just an assessment of the worst offshore conditions themselves. Therefore the directional impact of the North and South based offshore conditions on the coastline and nearshore areas was further investigated in a second and third uncoupled SW model, described in the following sections.

2.3.2.1 Extreme Value Analysis - Background

The analysis of extreme events is based on a frequency analysis approach, by which the relation between the sample data (e.g. the peak value of selected hind-cast storms) and the design events is obtained by use of a theoretical probability distribution as a model for the extreme events.

Extreme values with associated return periods of 1 and 50 years were estimated by fitting a probability distribution to the DHI historical hindcast data. A number of distributions, data selection and fitting techniques are available for estimation of extremes, and the estimated extremes are often sensitive to the choice of method. However, it is not possible to choose a preferred method only on its superior theoretical support or widespread acceptance within the industry. Hence, it is common practice to test a number of approaches and make the final decision based on goodness of fit.

For estimating an event with a given return period (T-year event) and associated confidence limits, the following tasks are accomplished:

- Verification of inherent assumptions such as homogeneity and independence,
- Provision of alternative theoretical distributions as candidates for representing the population events, and
- Estimation of statistical parameters of selected distributions.

The following probability distributions were used in connection with extreme value estimation:

- 2-parameter Weibull,
- Truncated Weibull,
- Gumbel.

For Weibull distributions, the extreme value analysis is conducted using the peak over threshold (POT) method, meaning that only peaks (e.g. significant wave heights, current speeds) exceeding a certain threshold are included in the analysis. Each event (typically a storm) is only represented by the peak value. It is important that the threshold is not chosen too low as this will cause ‘normal’ events to be included in the analysis, causing more extreme events to become outliers relative to the candidate distribution and typically leading to biased estimates of the design conditions. On this basis, the optimum attribute of input data and appropriate distributions for the sample data are selected. For Gumbel distribution, the extreme value is estimate by extracting the maximum value in each analysis year and fitted to annual maxima.

The selected hind-cast events are tested against the candidate distributions given above using the maximum likelihood or least-square method to estimate the distribution parameters.

Extreme Sensitivity Testing against different candidate distributions has shown that the Gumbel distribution fitted to 1 annual average peak with a least square fit provided a good fit to the extreme events. The results of the Gumbel distribution extreme value analysis are shown below in Figure 2.11.

2.3.2.2 Offshore Wave Conditions

The available offshore wave conditions for the entire model period (1979-2017) have been compared to satellite altimetry in the area to the south of the Falklands based on DHI's Metocean Data Portal (www.metocean-on-demand.com) and show a good if slight positive bias to the model data (see Figure 2.10). This supports the assessment in that the offshore wave boundary conditions being used to drive the local models are considered representative of the waves offshore of the Falkland Islands.

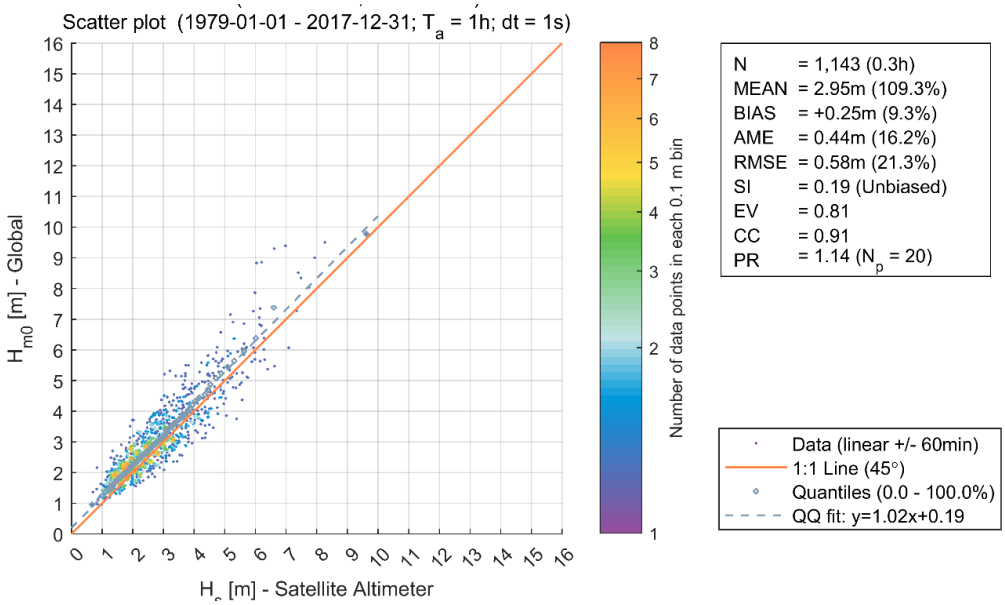


Figure 2.10 Comparison of DHI model and satellite measurements from an offshore point south of the Falklands confirming the suitability of DHI's existing wave model data basis

Omni-directional and directional offshore wave conditions at points North and South were derived via an extreme value analysis (see Section 2.3.2.1). The peak wave periods for each 30° sector associated with the design significant wave heights have been determined by regression analysis and are shown in Figure 2.12. The relationship between the peak wave periods with the associated significant wave heights has been obtained from directional associations by specific formulae.

The uncoupled SW simulations are run with a DSD of 30° and this choice is supported by interpretation from scatter plots of DSD vs. Hm0 at the offshore boundary points (see Figure 2.13). A DSD of 20° (longer period swell for the more extreme waves) and 60° (representative of wind-sea) was also tested. It was noted that this only had a limited effect on the wave penetration to most locations (see Figure 2.14). To fit with the larger wave heights, a DSD of 30° has been used for the remainder of the modelling.

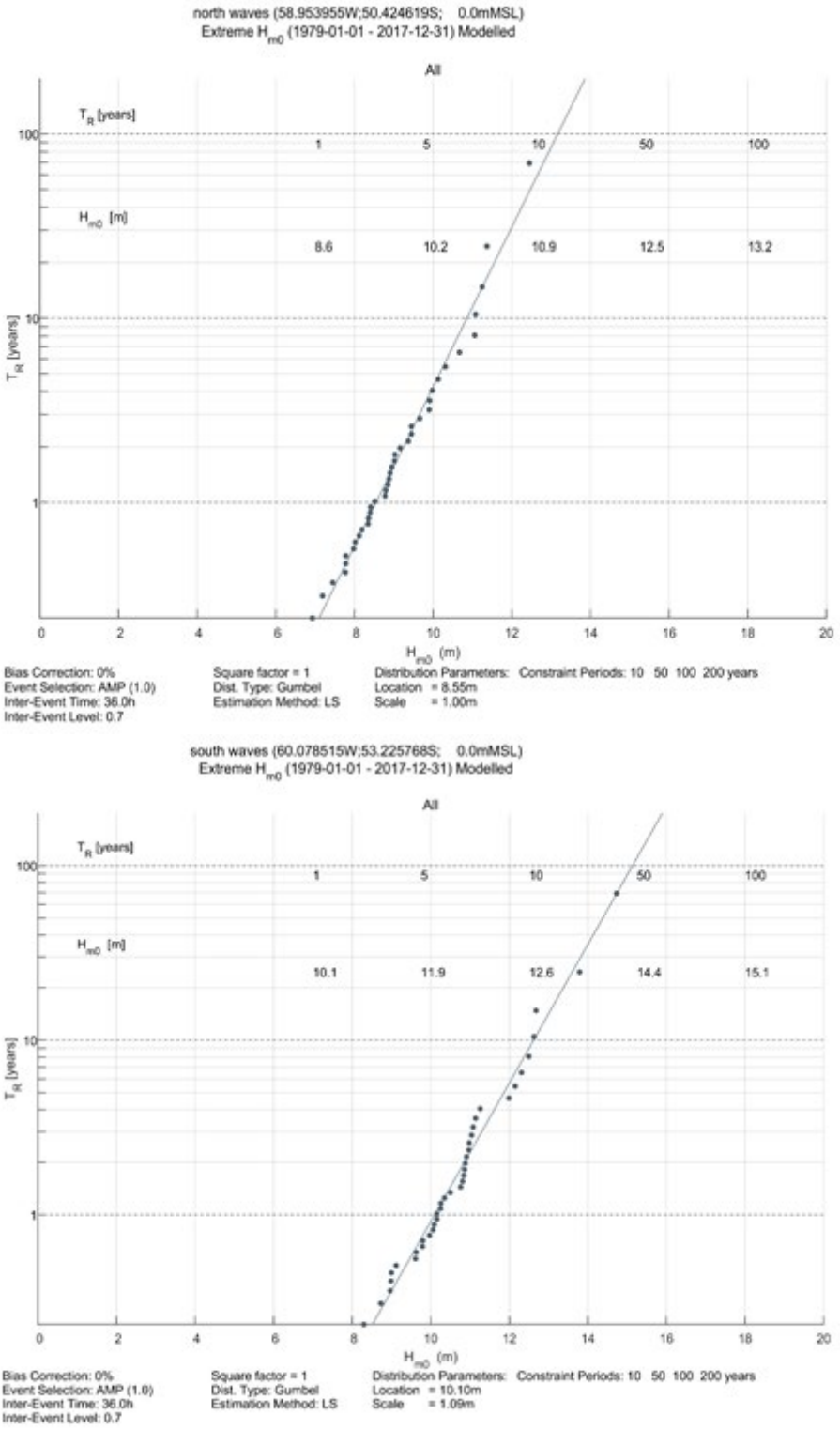


Figure 2.11 Extreme value analysis for omni significant wave height at the North Boundary (top) and South Boundary (bottom)

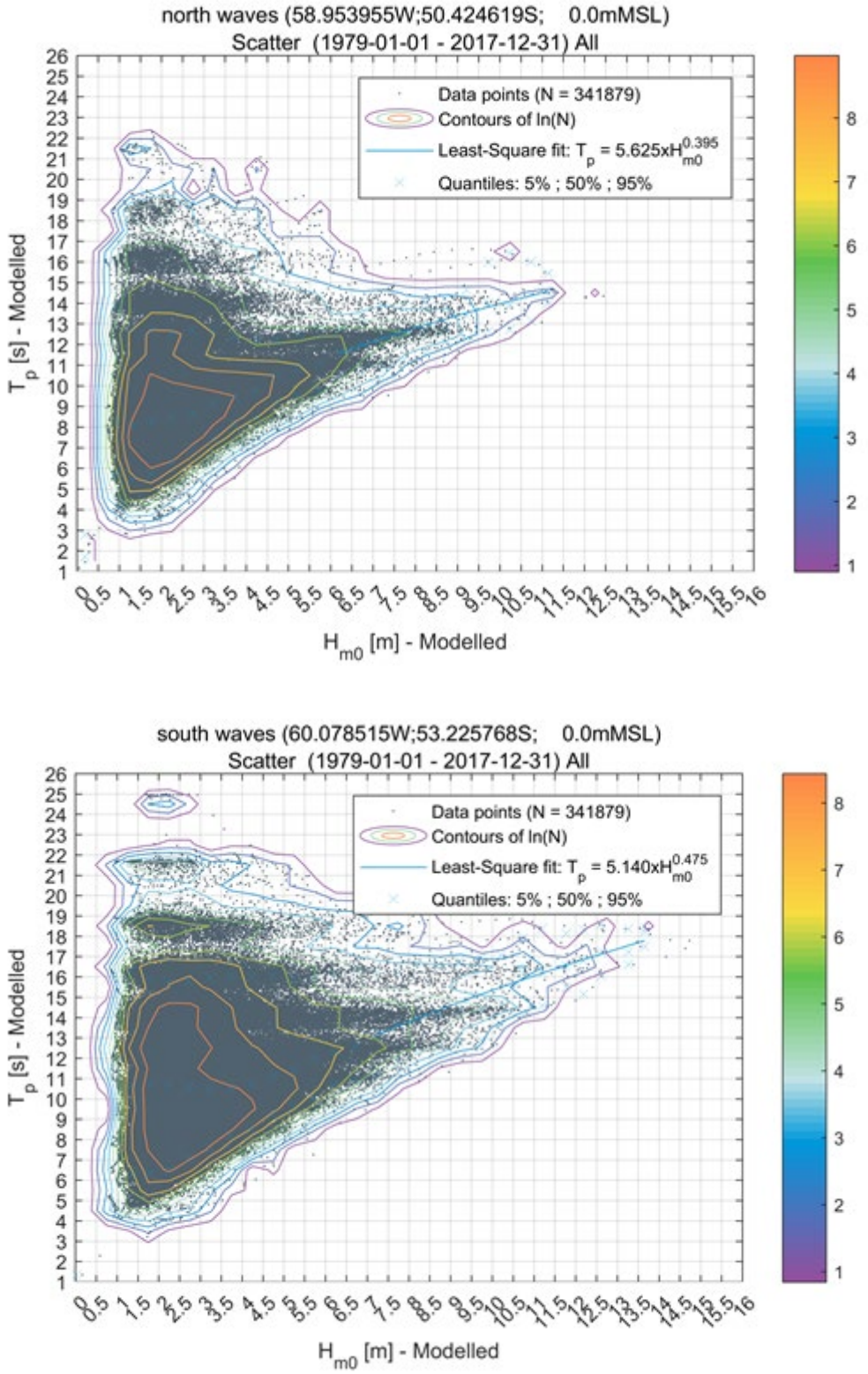


Figure 2.12 Relation between peak wave period with significant wave height at the North Boundary (top) and South Boundary (bottom)

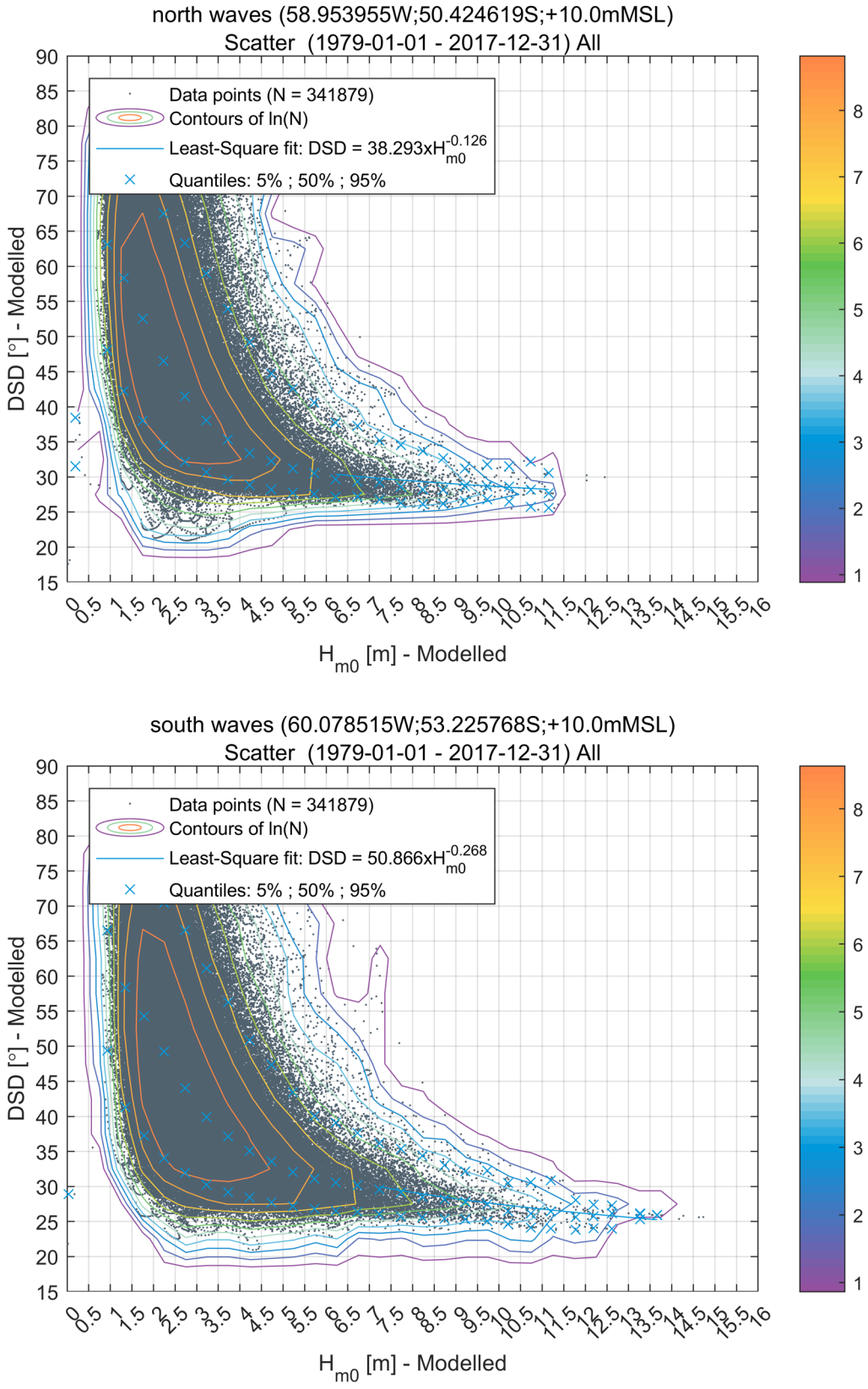


Figure 2.13 - Hm0 vs DSD plots for the North and South extraction locations for All directions.

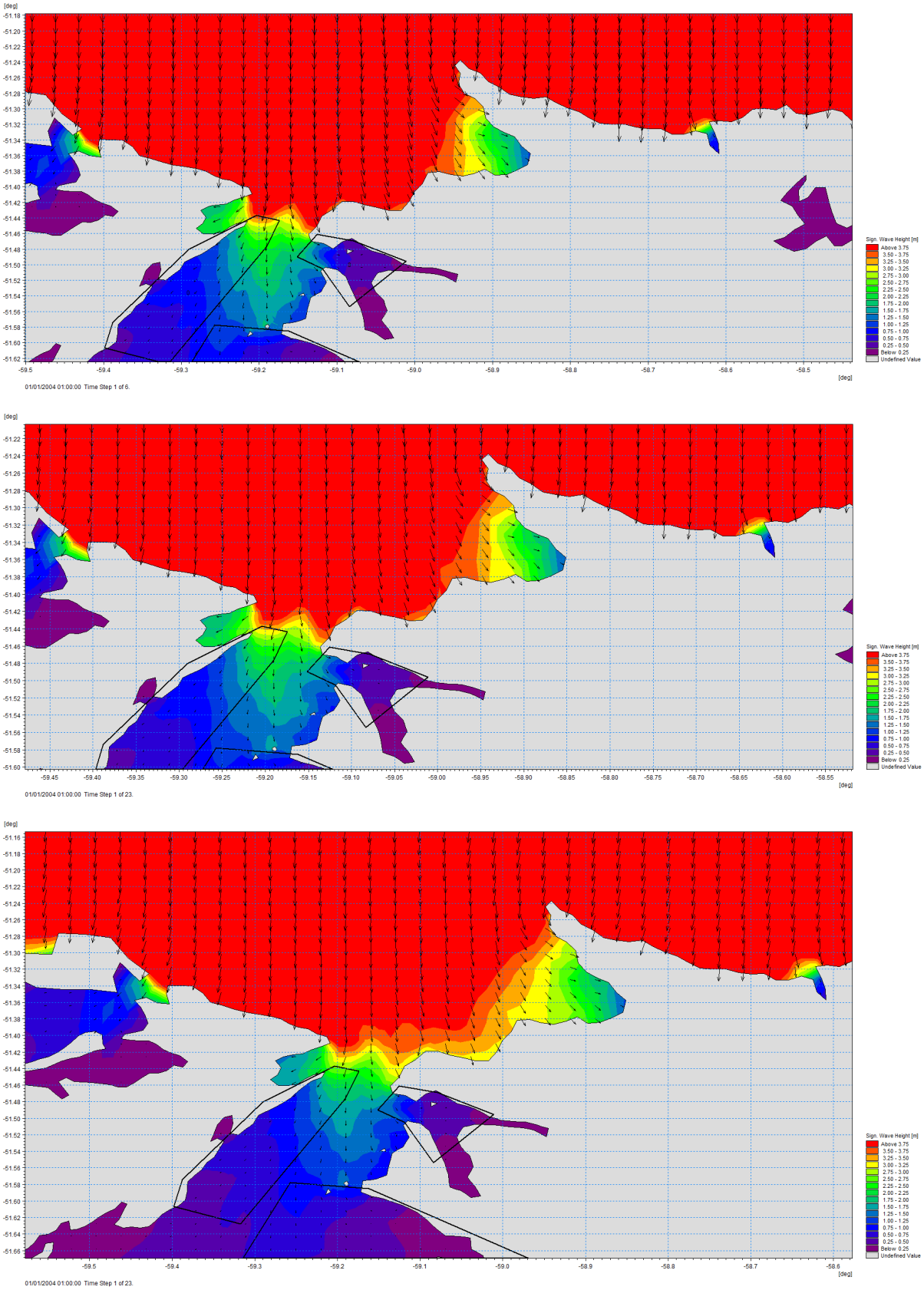


Figure 2.14 - Wave heights for Northerly Sites for 0 degrees with DSD 20° (top) DSD 30° (middle) and DSD 60° (bottom).

2.3.2.3 Nearshore Wave Conditions

Considering that the potential sites were considered to be of more relevance than just an assessment of the offshore conditions, and that wave conditions can change due to local factors in the nearshore, the nearshore peak events for each 30° sector were further analysed using the North and South offshore wave conditions in a second uncoupled SW model run in quasi-stationary mode (i.e. with no wind or water level variation to confirm the worst-case situation).

This model output provided the worst nearshore conditions of each 30° sector, for both the 1 in 1 year conditions as well as the 1 in 50 year extreme conditions using the offshore wave data extracted from the North and South. Comparing the results for each 30° directional sector, it was determined which North or South based scenario results in the most extreme period (storm event) for all the potential sites.

In order to assess the most extreme storm events, a final uncoupled in-stationary SW model was then run for the two nearshore directional sectors that experienced the most extreme conditions 0° and 210° degree (using model setup listed in Table 2.6).

This model had boundaries developed using the larger of the two offshore wave sources for these two directional storms, as shown in Table 2.5. The water level in this situation was fixed at HAT at Stanley to ensure that sufficient water depth for waves to propagate in the “worst case” situation was possible.

These models included Scenarios 2, 3, 5 and 6 for the stationary condition.

Table 2.5 Nearshore significant wave height for 1 and 50 year return periods for each 30° directional sector using the larger of the two offshore wave sources

Nearshore Directional Sector	Offshore Wave Source	Return Period [yr]			
		1		50	
		Hm0 [m]	TP [s]	Hm0 [m]	TP [s]
0	North	5.24	10.82	7.86	12.29
30	North	3.95	9.68	6.5	11.78
60	North	3.61	9.34	6.73	11.95
90	South	4.04	10.41	7.98	12.30
120	South	4.27	10.24	7.96	11.90
150	South	4.69	10.01	9.08	13.21
180	South	5.62	12.15	10.34	13.36
210	South	8.53	14.15	13.21	17.73
240	South	9.77	15.37	14.25	18.00
270	South	7.7	13.01	11.53	14.60
300	North	5.39	11.43	9.01	12.50
330	North	5.77	11.00	8.48	12.52

Table 2.6 Uncoupled SW model set-up details

SW Model Set-up Parameters	Selected Options		
Basic Equations	Spectral Formulation	Fully spectral Formulation	
	Time Formulation	Quasi Stationary	
Spectral Discretisation	Frequency	Logarithmic	# of frequencies: 25 Min frequency: 0.033 Hz Frequency factor: 1.15
	Directional	360 rose	# of directions: 24
	Separation of Wind Sea and Swell	None	
Solution Technique	Geographical Space	Low order, fast algorithm	
	Method	Newton-Raphson Iteration	
Water Level Conditions	Specify water level variation	Constant: 1.53 m (fixed HAT)	
Current Conditions	None		
Wind Forcing	None		
Ice Coverage	None		
Diffraction	None		
Wave Breaking	Specified Gamma	Constant: 0.8	
Bottom Friction	Nikuradse roughness, kn	Constant: 0.04m	
Initial Conditions	Spectra from empirical formulas		
Boundary Conditions	Wave Parameters (version 2)	Varying in time, constant along line	

2.3.3 Coupled HD-SW model

2.3.3.1 Pseudo Storm Wave Conditions

After determining the time of a suitable maximum storm event for both North and South conditions (04/01/1985 07:00:00 and 31/08/1986 12:00:00 respectively using the uncoupled SW model in section 2.3.2.3), a pseudo storm condition was developed. Both wind and wave data was extracted for ±7 days either side of these two maximum event times (1985 and 1986), the water level was extracted for ±7 days either side of the HAT period (01/03/2006 10:00:00). By artificially aligning the peaks of this wind, wave and water level data, a pseudo storm can be modelled to assess the most extreme combined conditions possible and do not reflect a true historical storm. These two pseudo North and South based storm models are fully coupled HD-SW models, using similar setup parameters to the uncoupled HD and SW models, while also incorporating wind and water level variation (see Table 2.7).

2.3.3.2 Selection of scenario to be run

Wave conditions for the 1 in 1 year and the 1 in 50 year events were seen to be reasonably similar in the uncoupled SW in-stationary runs at the sites of interest (see Figure 2.15 for an example for northerly waves). It was noted that there is a slight variability in Zone E and the northern sections of Zone A and B, however as no further validation data is available, it was proposed that only the 1 in 50 year storm run should be selected for the fully coupled model runs.

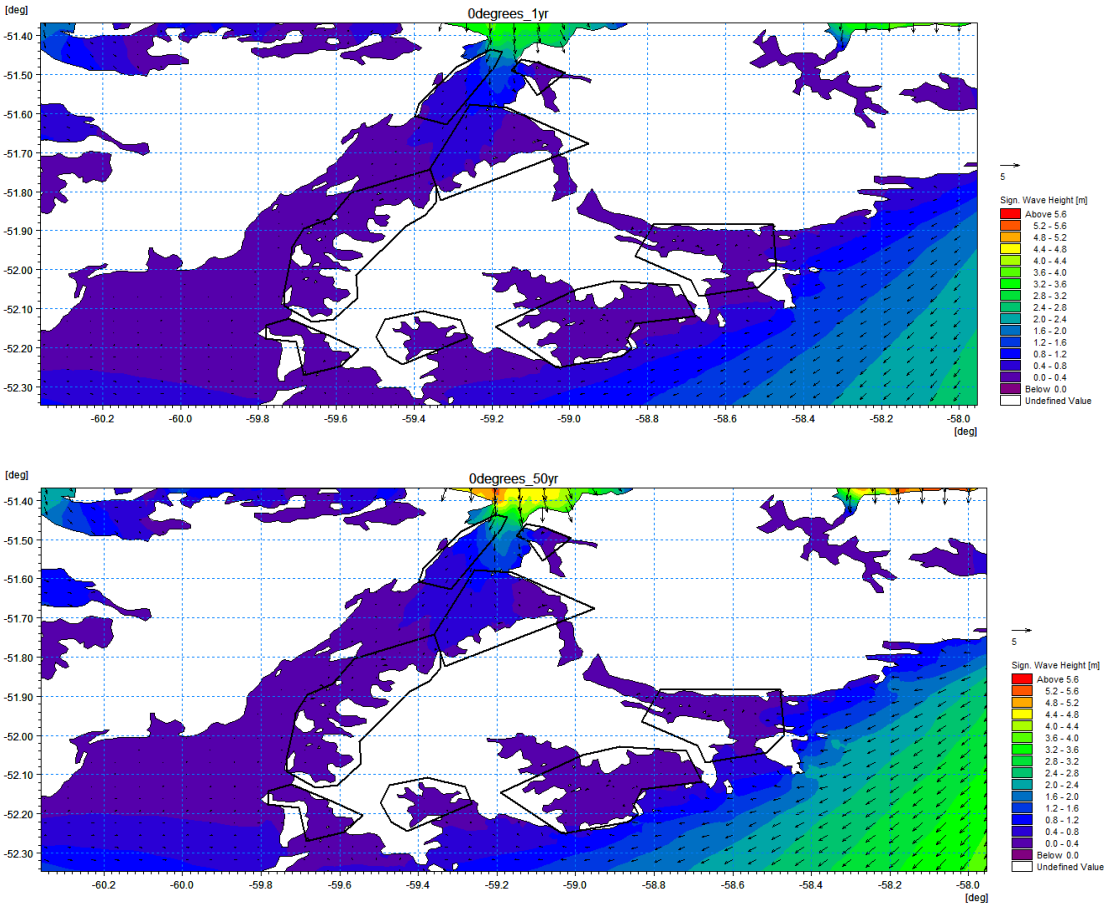


Figure 2.15 Significant wave heights with a 0°N (North) mean wave direction, highlighting the similarity for a 1 in 1 year (top) and 1 in 50 year (bottom)

Wave periods for the fully coupled storm conditions were based on the established relationship between significant wave height (H_{mo}) and peak wave period (T_p) based on the nearshore conditions in the DHI database.

These models included Scenarios 2, 3, 5 and 6 for the fully spectral storm condition.

Table 2.7 Fully coupled SW model set-up details that differ from the previous uncoupled HD and SW models

Coupled Model Set-up Parameters	Selected Options	
Hydrodynamic Module		
Basic Equations	Time Formulation	Instationary Formulation
Wind Forcing	Varying in time and domain	
Wind Friction	Varying with Wind Speed	
Initial Conditions	Constant	
Spectral Wave Module		
Basic Equations	Spectral Formulation	Fully spectral Formulation
	Time Formulation	Instationary Formulation
Solution Technique	Geographical Space	Low order, fast algorithm
Water Level Conditions	Water Level variation from HD simulation	
Current Conditions	Current variation from HD simulation	
Wind forcing	Varying in time and domain	

2.4 Validation of Models against available data

The observed and predicted Water Levels, from Stanley Harbour Tide Gauge and tide tables provided by CMAP, where compared to the HD model and show a good if slight positive bias to the model data. As expected, the total observed water levels in the measurements at Stanley (inclusive of surges and other residuals) shows greater discrepancies to the DHI model (which is exclusive of surges and other residuals) (see Figure 2.16). Conversely (and as expected) the DHI model and the predicted tidal elevations for Stanley Harbor were compared and as both were exclusive of surges and other residuals provide a closer match (see Figure 2.17).

The HD model output was then further compared to 4 other predicted tide tables at Adventure Sound, North Arm, Speedwell Island and North West Islands (see Table 2.2) to ensure the model was geographically representative around the islands and not just calibrated to Stanley Harbour (see Figure 2.18).

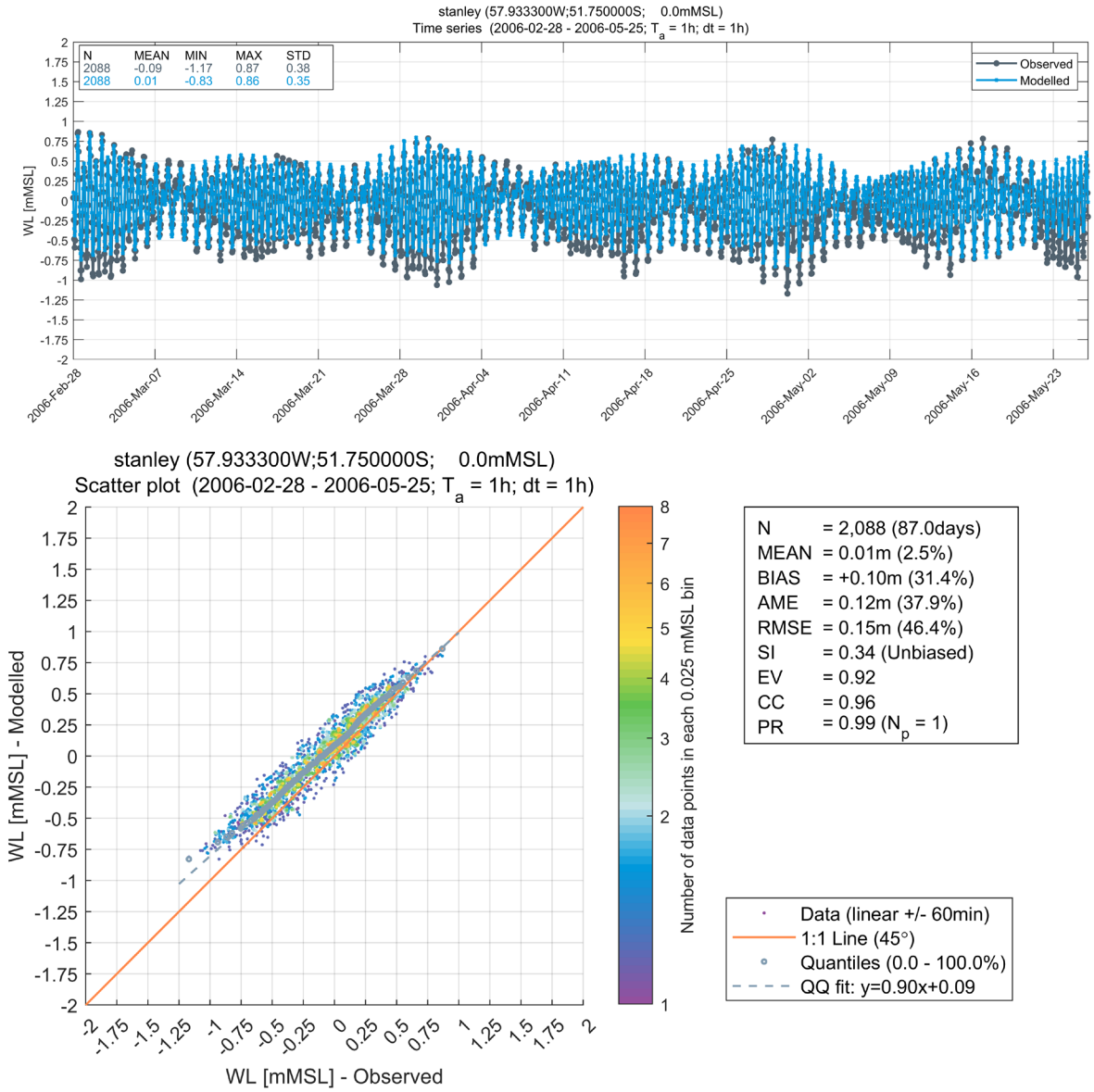


Figure 2.16 Timeseries (top) and Scatter (bottom) comparison of ***DHI model*** and ***observed*** Water Levels from the Falklands, Stanley Harbour suggesting general suitability of DHI's model data basis

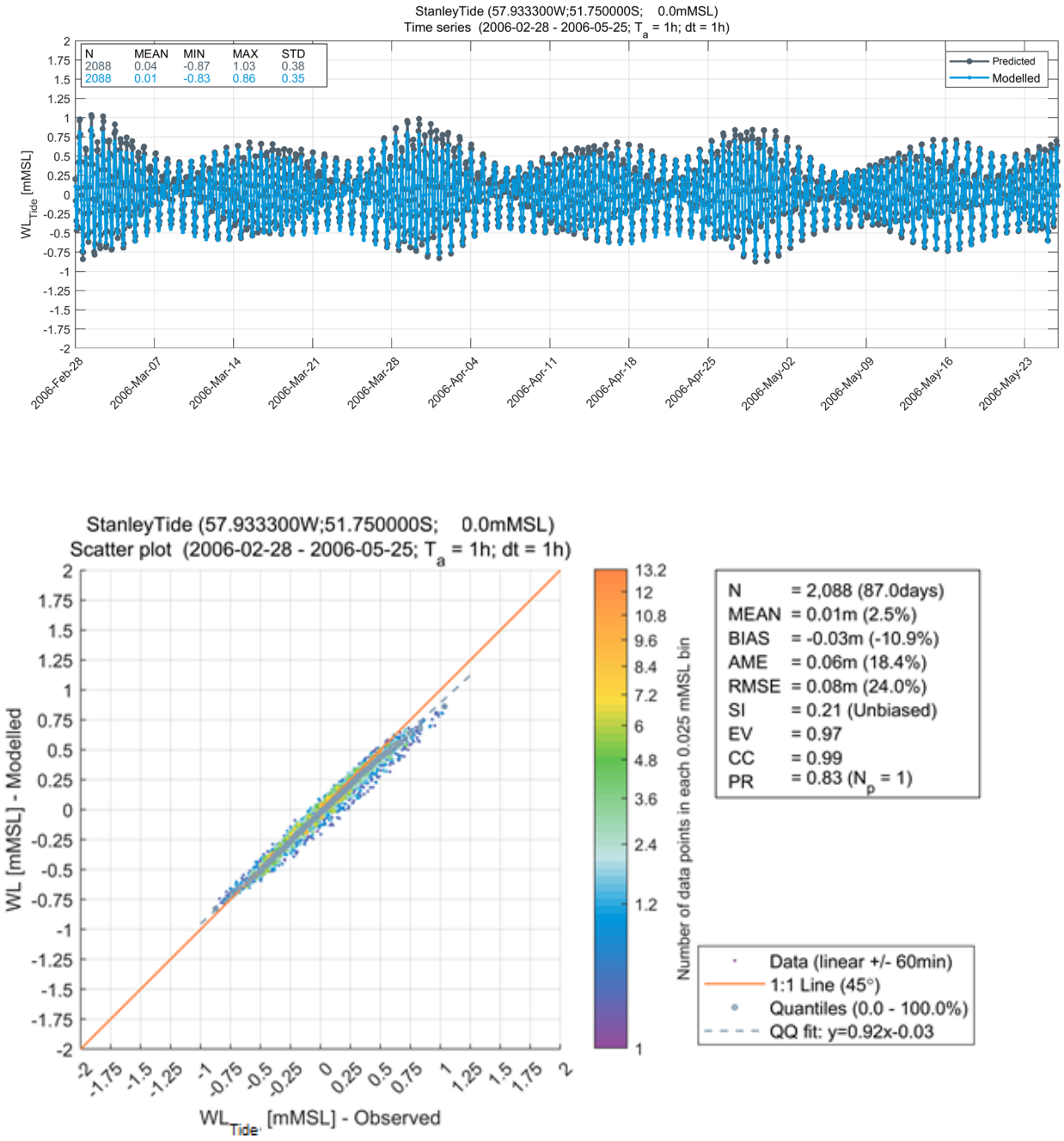


Figure 2.17 Timeseries (top) and Scatter (bottom) comparison of ***DHI model*** and ***Predicted*** Tidal component of the observed Water Levels from the Falklands, Stanley Harbour suggesting the general suitability of DHI's model data basis

The predicted tides and modelled tides generally show a good comparison (Figure 2.18)

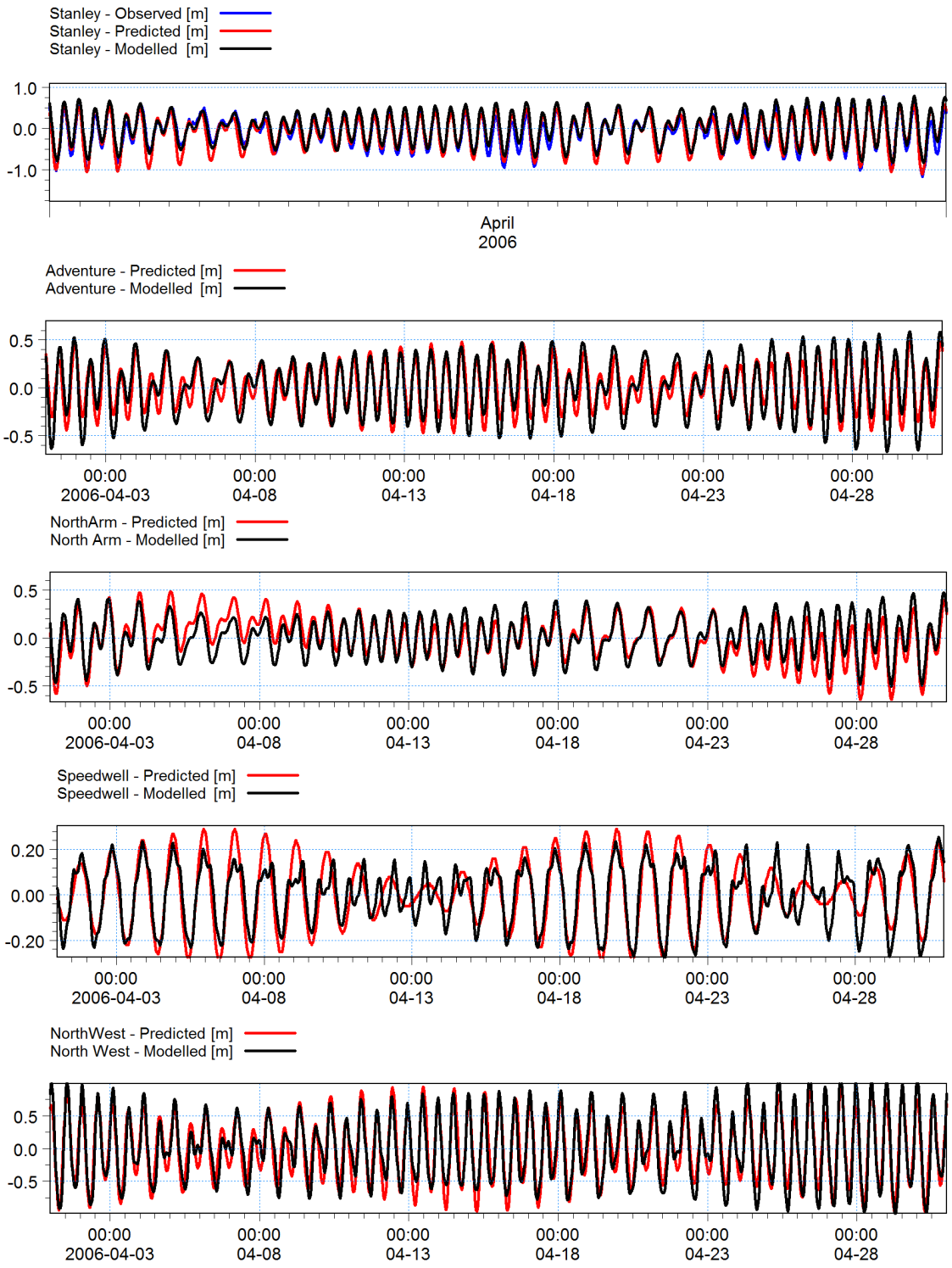


Figure 2.18 Time series comparing the HD modelled results, to the predicted data from the Tide Tables provided by CMAP around the Falklands. From top: Stanley, Adventure Sound, North Arm, Speedwell and North West. Note the first image also shows the Observed data for Stanley.

3 Analysis of Results

As outlined in Section 2.2, Scenarios are paired, with results for both North and South boundaries being discussed simultaneously for comparison. This section provides, summary images for discussion, with full site specific images found in Appendix A to Appendix H.

In summary, for the analysis, the scenarios tested were as follows:

- Firstly, the base tidal conditions from the uncoupled HD model (Scenario 1).
- Secondly, sensitivity testing of directional variation on an uncoupled SW model run of conditions for North (Scenario 4) and South (Scenario 7).
    - A maximum storm event for both North and South based scenarios was determined for later use in further uncoupled SW and fully coupled Models.
- Thirdly, an uncoupled SW model run for
    - 1 in 1 year storm events were run for both North (Scenario 2) and South (Scenario 5).
    - 1 in 50 year storm events for the North (Scenario 3) and South (Scenario 6).
- Finally a fully coupled HD-SW model was run for
    - 1 in 50 year storm events for the North (Scenario 3) and South (Scenario 6).

3.1 Uncoupled Hydrodynamic Model

3.1.1 Base Tidal Conditions - Scenario 1

From the Scenario 1 Hydrodynamic model, an assessment of the key tidal parameters was undertaken including astronomic levels and mean and maximum current speeds. The exact forcing conditions are listed in Table 2.4.

A tidal analysis of the 3 month time series was undertaken to derive the below parameters using the IOS method.

Table 3.1 Astronomical tidal levels for locations within the 8 potential zones

Location	A1	B1	C4	D3	E3	F1	G2	H2
HAT	+1.44	+1.33	+1.36	+0.96	+0.26	+0.48	+0.64	+0.77
MHWS	+0.89	+0.81	+0.81	+0.33	+0.12	+0.21	+0.28	+0.55
MHWN	-0.42	+0.39	+0.39	-0.08	+0.08	+0.01	-0.03	+0.22
MSL	+0.01	+0.01	+0.00	+0.00	+0.00	+0.01	+0.01	+0.01
MLWN	-0.41	-0.37	-0.37	-0.24	+0.05	+0.13	+0.18	-0.20
MLWS	-0.88	-0.80	-0.79	-0.32	-0.11	-0.20	-0.26	-0.53
LAT	-1.19	-1.09	-1.09	-0.81	-0.29	-0.51	-0.66	-0.78
Tidal Range (MHWS-MLWS)	1.77	1.61	1.60	0.65	0.23	0.41	0.54	1.08

It is apparent from the above that the largest tidal range is seen at the north of the channel between East and West Falkland with a lower range in the south-east as expected from the general trend in the tide noted in Section 1.1. Of note however is that

the tidal range becomes a minimum at Zone E and remains relatively low at Zones F and G.

From the time series of each location, the mean and maximum current speeds experience in the 3 month period were extracted and are summarised below.

Zones D and E have the largest current speeds, with Zone B being the next largest. Values for the highest current speeds are of the order 0.6m/s or ~1 knot. Mean current speeds are typically at least half of the maximum speeds.

Very low current speeds, indicative of poorly flushed regions are seen at Zones F and G.

Table 3.2 General statistics of current speeds for locations within the 8 potential zones

Potential Site Zone	Parameter	Mean	Max
A1	CS_{total} [m/s]	0.05	0.16
B1	CS_{total} [m/s]	0.20	0.59
C4	CS_{total} [m/s]	0.07	0.17
D3	CS_{total} [m/s]	0.27	0.65
E3	CS_{total} [m/s]	0.24	0.63
F1	CS_{total} [m/s]	0.01	0.02
G2	CS_{total} [m/s]	0.02	0.06
H2	CS_{total} [m/s]	0.061	0.168

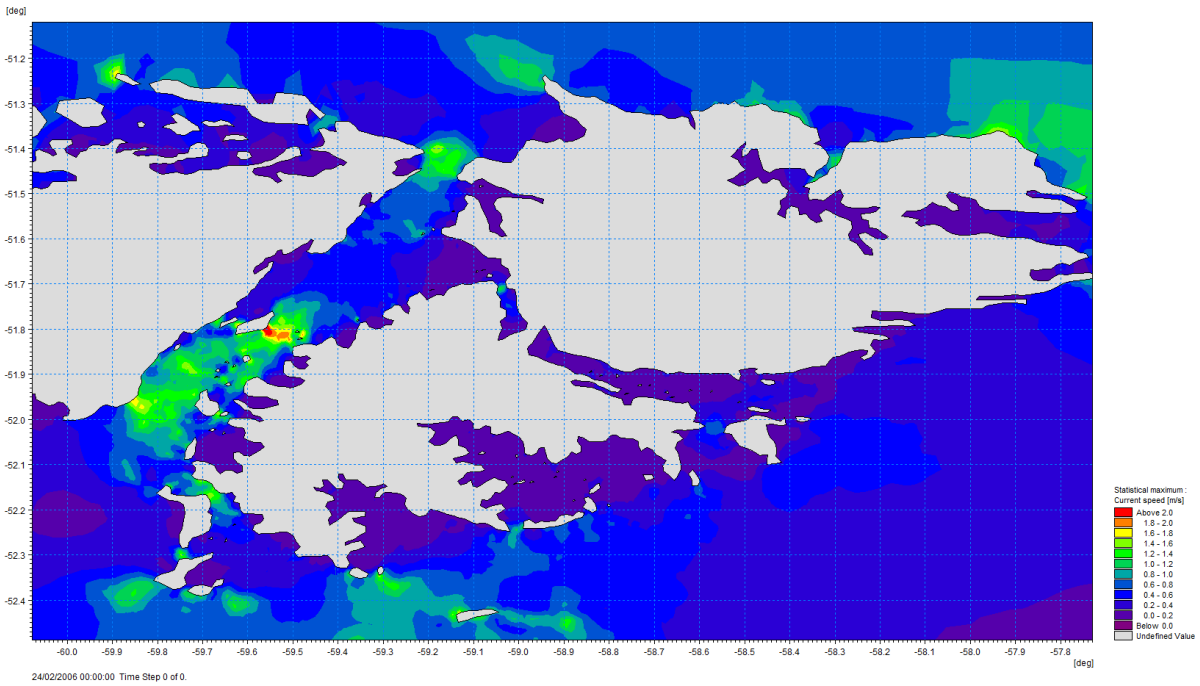


Figure 3.1 Statistical maximum current speed from the Scenario 1 model for all locations. Maximum speed in the entire model run.

3.2 Uncoupled Spectral Wave Model

The initial wave modelling stages sought to develop uncoupled wave model runs which would inform the selection of extreme wave conditions. Temporal resolution of the modelled waves is 30 min, and waves are considered representative of 1-hour sea states.

Section 3.2.1 provides an overview of the directional sensitivity testing for the nearshore conditions. Section 3.2.2 provides an overview of the 1 in 1 year wave conditions for the worst nearshore sector while Section 3.2.3 provides an overview of the 1 in 50 year wave conditions.

3.2.1 Sensitivity Testing on Directional Variation - Scenarios 4 & 7

As a longer term hindcast period couldn't be run within the timeframe of the project, an assessment was made on which wave directions led to the worst conditions for the proposed sites. This took into consideration the offshore directions primarily with the waves originating from the North and South West, and working their way around the islands.

Through the directional sensitivity testing it was noted that all potential nearshore zones (A-H) were primarily affected by the 0° and 210° scenarios, except for Zone H which was also affected by waves from the East (60-90°N). Due to project time constraints this easterly component was not investigated further, as the project focus was on the more frequent and larger northerly and southerly wave scenarios.

3.2.2 1 in 1 Year Nearshore Wave Conditions - Scenario 2 & 5

The following figures show the dominant offshore directional sectors of 0°N and 210°N, which experienced the most extreme wave patterns for the 1 in 1 year stationary models. Arrows on the figures indicate mean wave magnitude and direction. The exact forcing conditions are listed in Table 2.6.

It is clear that waves from 210°N were typically larger in the southern sites rather than the northern sites as would be expected by the propagation of storms in the Southern Ocean. The directional arrows show that the different storm events propagate around the islands with varying strength. This can explain why the 'protected' southern sites E, F, G and H can experience, relatively small, easterly wave conditions during a storm that originates in the north, and why the very northern sites can experience a very small north-western component during storms that originate in the south.

It is noted in the stationary runs (with no wind forcing) that relatively limited wave propagation (compared to the open ocean wave heights) takes place into the channel between East and West Falkland for both northerly and southerly waves. In addition, for the southerly zones the waves are effectively reduced for most sites by the underlying bathymetry surrounding the offshore islands and the relatively narrow channels at the entrance to many of the estuaries.

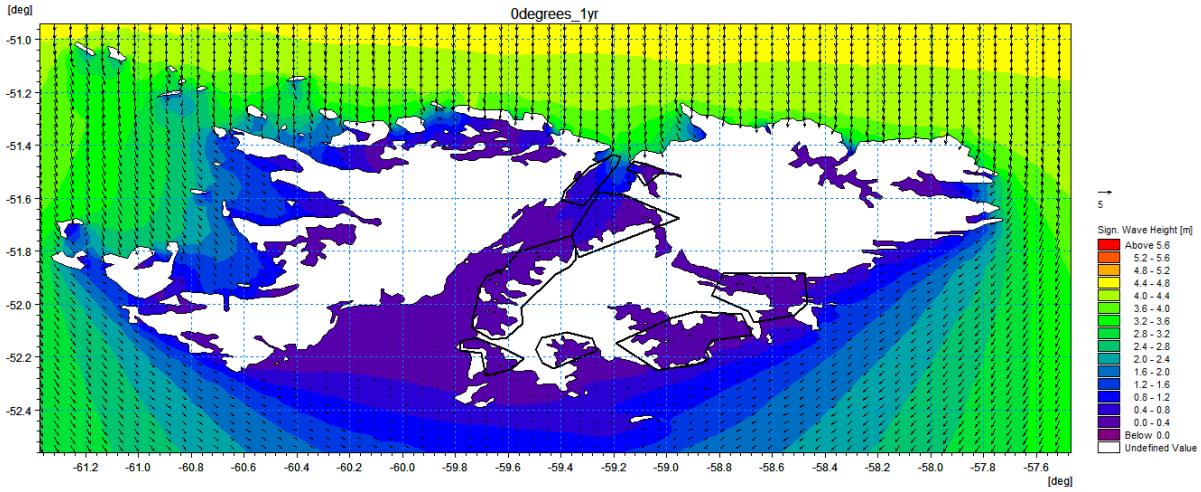


Figure 3.2 Overview of significant wave heights for 1 in 1 Year Return Period wave transformation for 0°N mean wave direction

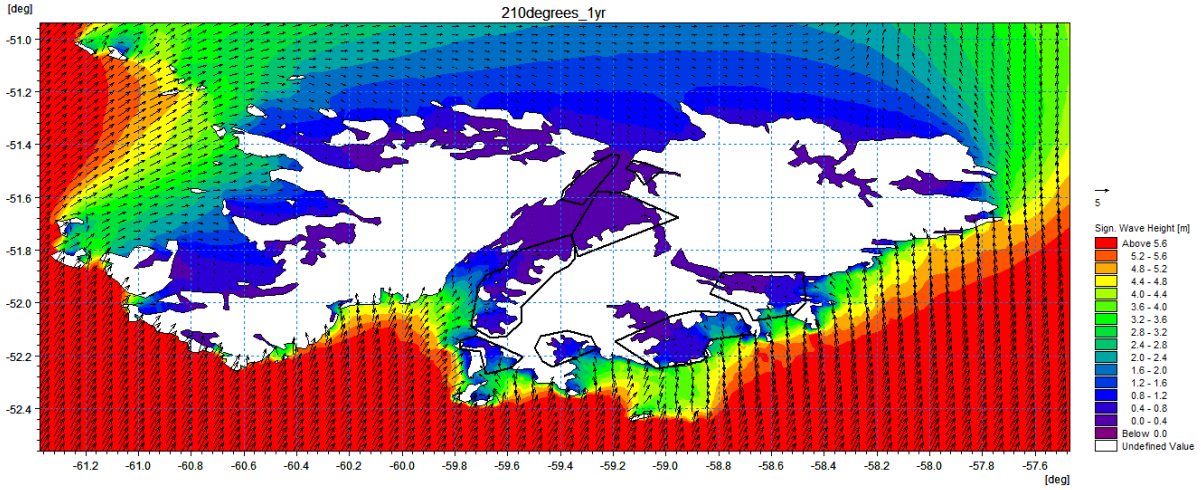


Figure 3.3 Overview of significant wave heights for 1 in 1 Year Return Period wave transformation for 210°N mean wave direction

3.2.3 1 in 50 Year Nearshore Wave Conditions - Scenario 3 & 6

The following figures show the dominant offshore directional sectors of 0°N and 210°N, which experienced the most extreme wave patterns for the 1 in 50 year stationary models. Arrows on the figures indicate mean wave magnitude and direction. The exact forcing conditions are listed in Table 2.6.

A similar pattern to the 1 in 1 year waves is seen with respect to penetration of waves into the channels and estuaries of the zones of interest.

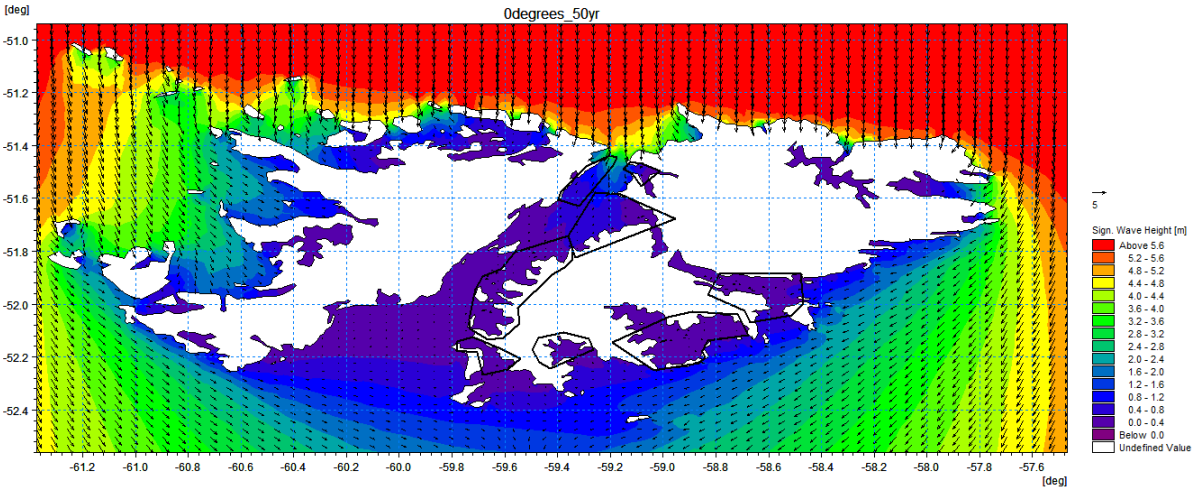


Figure 3.4 Overview of significant wave heights for 1 in 50 Year Return Period wave transformation for 0°N mean wave direction

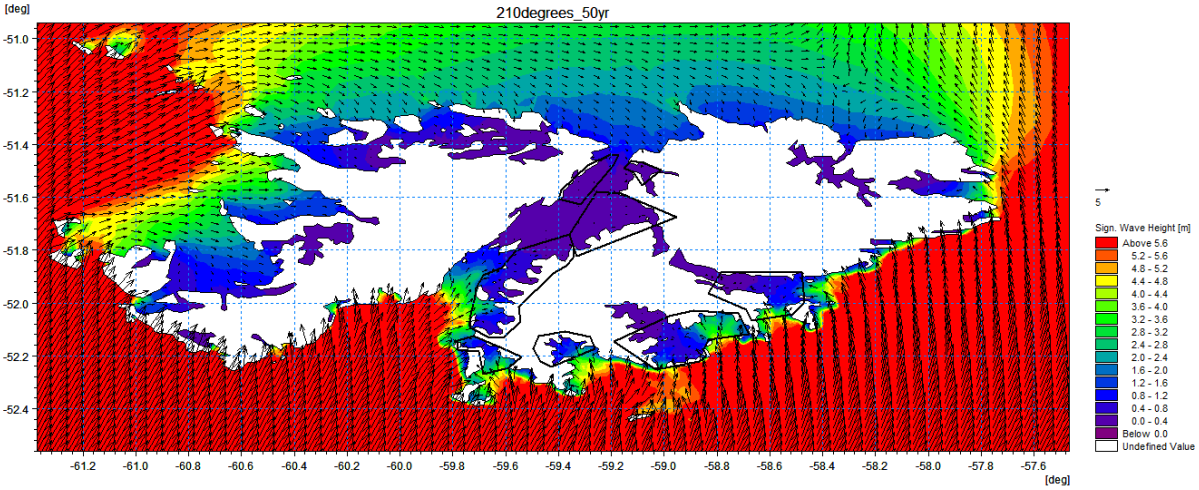


Figure 3.5 Overview of significant wave heights for 1 in 50 Year Return Period wave transformation for 210°N mean wave direction

3.3 Fully Coupled Model

The fully coupled model was run for the pseudo-storm conditions outlined in Section 2.3.3.1.

Section 3.3.1 provides table outputs, Section 3.3.2 provides an overview of the maximum values for the entire storm event whilst, Section 3.3.3 provides outputs from a snapshot of a moment in time of the storm event where the maximum value of the parameter occurred at the site.

3.3.1 1 in 50 Year Pseudo-Storm – Scenario 3 & 6

The results of the 1 in 50 year pseudo-storm are presented in full in Appendix A-H. The following table provides a summary of the key statistics at the Site output locations.

Table 3.3 General statistics of waves and currents for 1 in 50 **Storm conditions from the North (0°) and South (210°)** for locations within the 8 potential zones

Site	Parameter	North			South		
		Min	Max	Mean	Min	Max	Mean
A1	WL [m]	-1.1	1.6	0.1	-1.0	1.7	0.2
	CS [m/s]	0.0	0.5	0.1	0.0	0.4	0.1
	H_{m0} [m]	0.2	1.3	0.6	0.1	2.2	0.8
	H_{max} [m]	0.4	2.6	1.2	0.2	4.3	1.7
	T_P [s]	1.6	11.4	4.9	1.5	10.2	4.1
	MWD [°]	6	355	271	2	358	257
B1	WL [m]	-1.0	1.5	0.1	-0.9	1.6	0.2
	CS [m/s]	0.0	0.7	0.2	0.0	0.6	0.2
	H_{m0} [m]	0.2	2.2	0.7	0.3	2.7	0.9
	H_{max} [m]	0.4	4.3	1.4	0.5	5.3	1.8
	T_P [s]	1.9	10.9	5.0	1.8	8.3	4.3
	MWD [°]	0	359	134	3	360	203
C4	WL [m]	-1.0	1.6	0.1	-0.9	1.6	0.2
	CS [m/s]	0.0	0.2	0.1	0.0	0.2	0.1
	H_{m0} [m]	0.2	2.3	0.7	0.1	2.5	0.9
	H_{max} [m]	0.5	4.5	1.4	0.2	4.9	1.8
	T_P [s]	1.7	11.2	3.8	1.8	8.1	4.0
	MWD [°]	3	359	288	0	360	263
D3	WL [m]	-0.8	1.1	0.1	-0.6	1.3	0.2
	CS [m/s]	0.0	0.7	0.3	0.0	0.6	0.3
	H_{m0} [m]	0.2	1.9	0.7	0.1	2.6	0.9
	H_{max} [m]	0.4	3.7	1.3	0.3	5.0	1.9
	T_P [s]	2.0	6.0	3.3	1.8	14.8	4.0
	MWD [°]	0	359	273	0	360	246

Table 3.3 General statistics of waves and currents for 1 in 50 **Storm conditions from the North (0°) and South (210°)** for locations within the 8 potential zones

Site	Parameter	North			South		
		Min	Max	Mean	Min	Max	Mean
E3	WL [m]	-0.7	0.5	0.1	-0.6	0.7	0.2
	CS [m/s]	0.0	0.7	0.3	0.0	0.6	0.2
	H_{m0} [m]	0.1	1.6	0.7	0.2	2.4	1.0
	H_{max} [m]	0.2	3.2	1.3	0.4	4.4	2.0
	T_P [s]	1.7	11.3	5.2	1.9	16.9	9.9
	MWD [°]	4	360	252	0	358	207
F1	WL [m]	-0.7	0.6	0.1	-0.6	0.9	0.2
	CS [m/s]	0.0	0.1	0.0	0.0	0.1	0.0
	H_{m0} [m]	0.1	1.2	0.4	0.1	1.1	0.4
	H_{max} [m]	0.1	2.4	0.8	0.2	2.0	0.8
	T_P [s]	1.5	11.3	4.6	1.6	16.9	9.9
	MWD [°]	0	360	219	0	360	121
G2	WL [m]	-0.5	0.8	0.1	-0.5	1.1	0.2
	CS [m/s]	0.0	0.1	0.0	0.0	0.1	0.0
	H_{m0} [m]	0.1	1.4	0.5	0.1	1.4	0.6
	H_{max} [m]	0.2	2.8	1.1	0.3	2.8	1.2
	T_P [s]	1.5	11.2	3.1	2.0	17.0	6.0
	MWD [°]	0	360	238	0	360	213
H2	WL [m]	-0.7	0.9	0.1	-0.6	1.2	0.2
	CS [m/s]	0.0	0.3	0.1	0.0	0.3	0.1
	H_{m0} [m]	0.1	1.4	0.6	0.2	2.2	0.9
	H_{max} [m]	0.2	2.8	1.2	0.5	4.4	1.8
	T_P [s]	1.4	11.8	4.2	2.0	17.1	5.4
	MWD [°]	2	360	233	0	360	220

3.3.2 Statistical Overview of 1 in 50 Year Storm

The following images display the statistical maximum value **at any point** in the storm model run for the fully coupled model for H_{mo}, Hmax, CS, and Tp respectively(see Appendix A to Appendix H for Site specific details of the same).

H_{mo} shows limited penetration of the larger waves in the southern entrance, while Hmax can be seen to penetrate further suggesting that the larger waves in the seastate can penetrate further into the entrances.

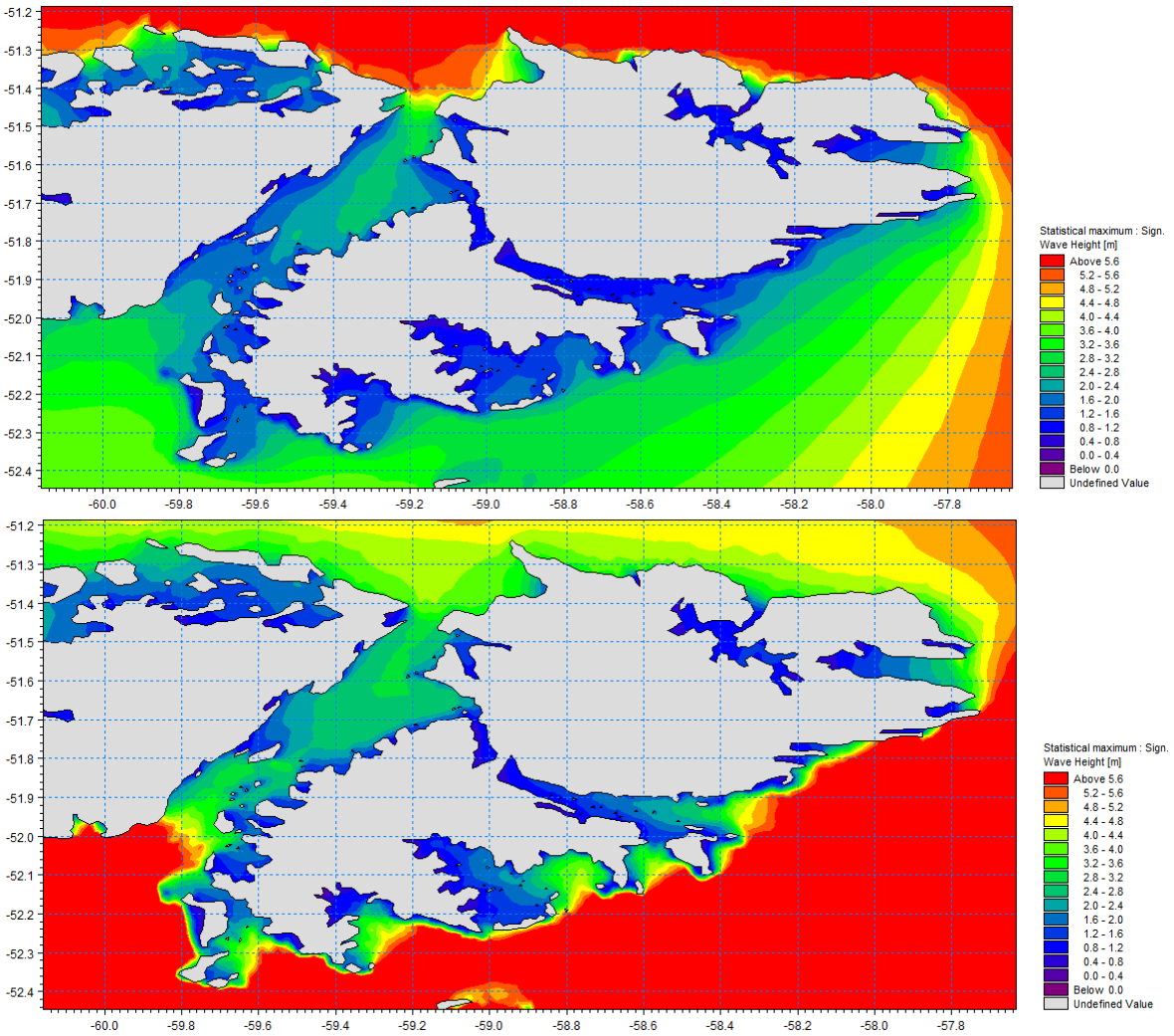


Figure 3.6 Statistical maximum of H_{mo} for entire storm period for North storm (top) and South storm (bottom) for the 1 in 50 year storm event

Hmax values are seen to be generally higher for the southerly storms, in line with the knowledge of the offshore wave conditions (larger, longer period waves from the Southern Ocean). Some areas (particularly along the south coast of east Falkland) show greater penetration of Hmax in the southerly storms. Relatively large waves penetrate through the northern channel, which whilst narrower than the southern entrance is deeper.

The relatively shallow (10-25m deep) area across the southern entrance leads to the relatively high blocking of waves at the southern end.

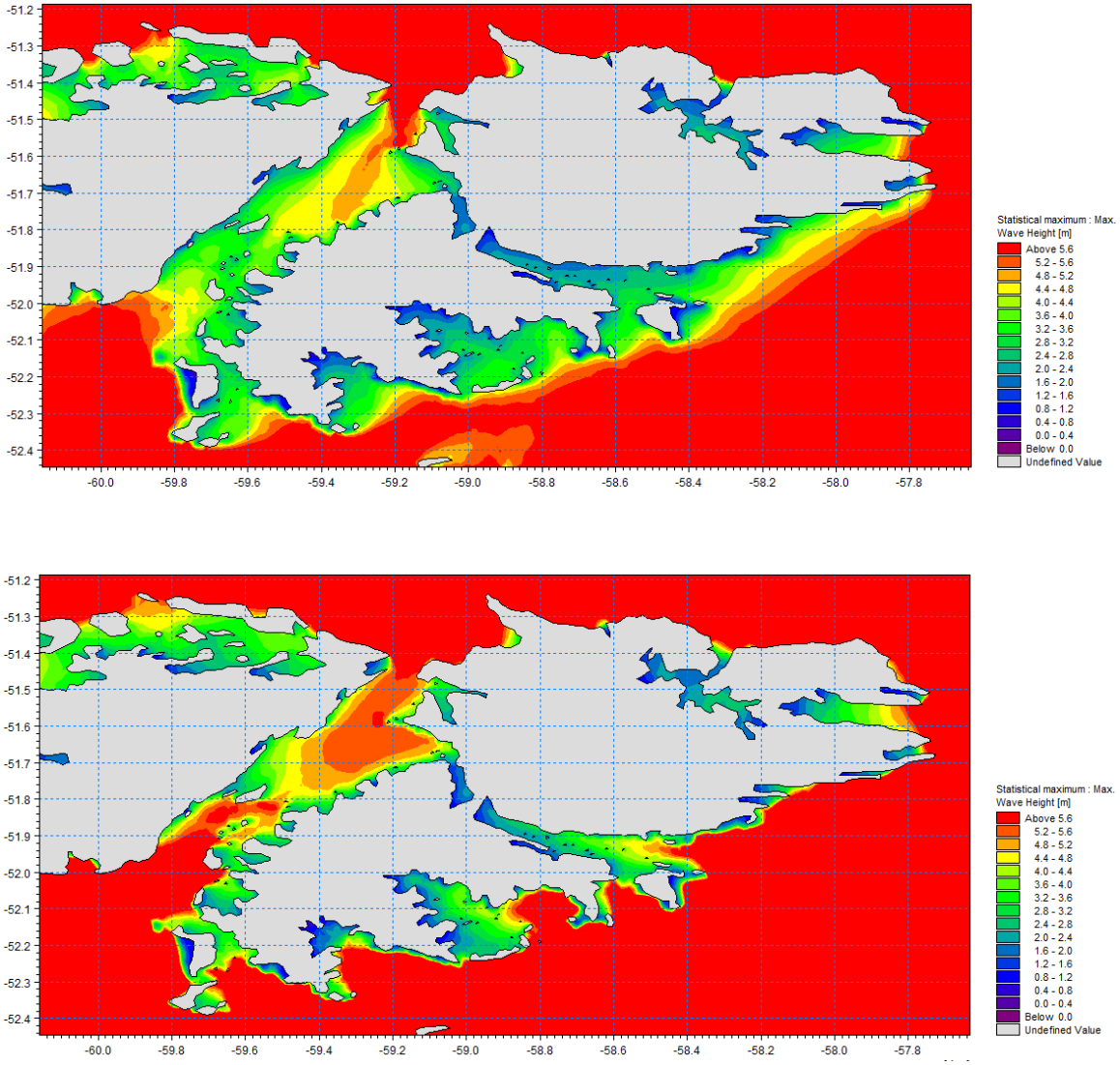


Figure 3.7 Statistical maximum Hmax for entire storm period for North storm (top) and South storm (bottom) for the 1 in 50 year storm event

The shallow area at the southern end of the entrance also leads to higher current speeds, with current speeds from 3-4 knots (1.5 – 2ms^{-1}). The extent of these higher speeds is more widespread due to the relative extent of the shallow area. Conversely, at the northern entrance, the speeds are higher in a more locally concentrated narrowing of the channel rather than spread over the whole area.

These high speed areas are seen to dissipate rapidly into some of the more sheltered bays along the west and south coasts of East Falklands. The fact that the pattern of current speeds in the storms closely matches that of the HD model on its own (Figure 3.1) suggests limited effect within the channels of the tide.

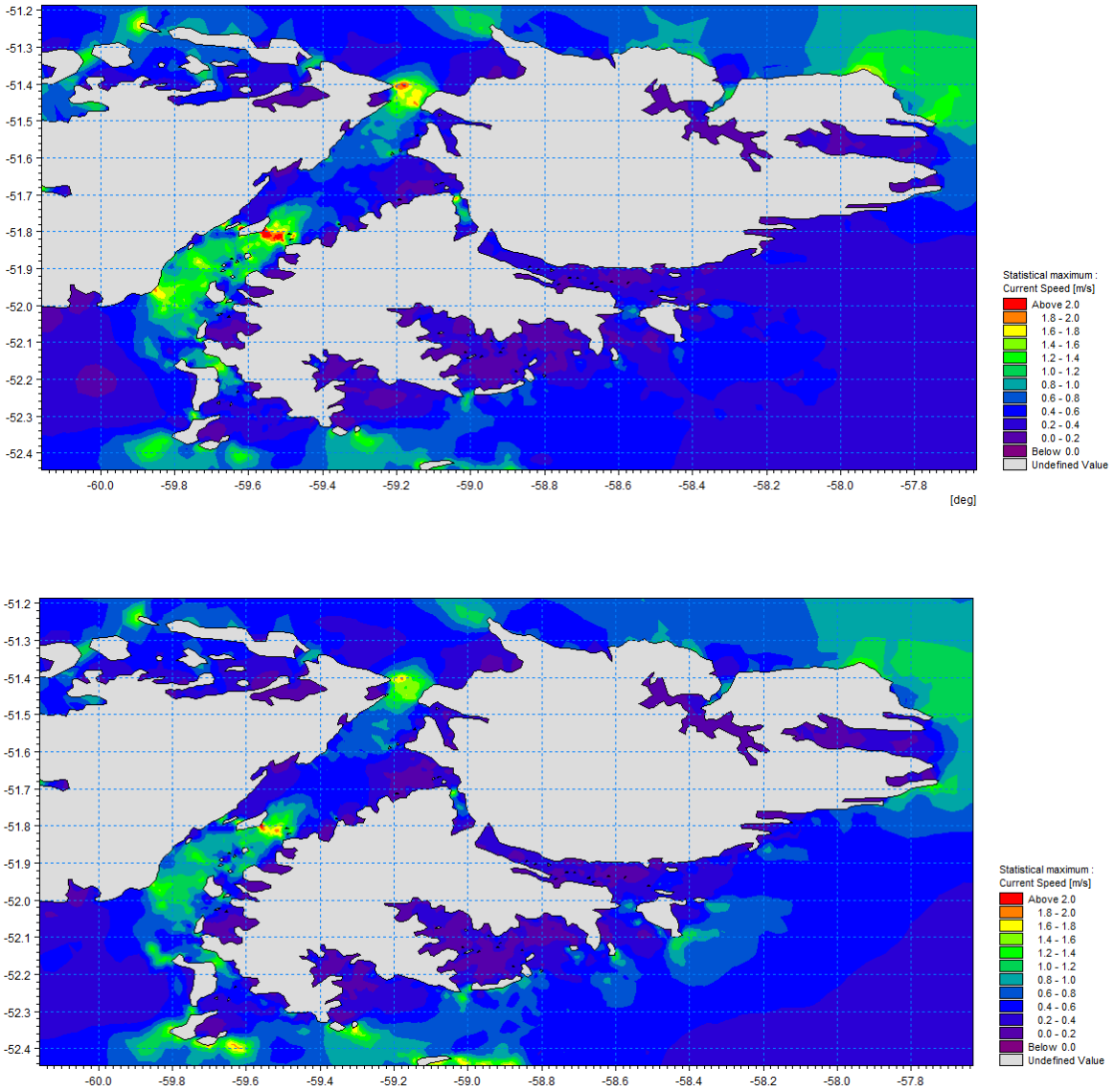


Figure 3.8 Max Current Speed for entire storm period for North storm (top) and South storm (bottom) for the 1 in 50 year storm event

Tp has very little variation over much of the site in the northern storm scenario whist the southern storm shows a higher variability and which overall has a higher peak wave period as expected when comparing Southern Ocean and South Atlantic storms.

The slightly lower periods of the northern directions penetrate further into the area between the two channels, leading to longer periods in these conditions than compared to the generally more energetic southern storms. Importantly for most sites, the peak wave periods can be seen to achieve at least 8-10s in most locations, suggesting the presence of swell waves even in the most sheltered of sites.

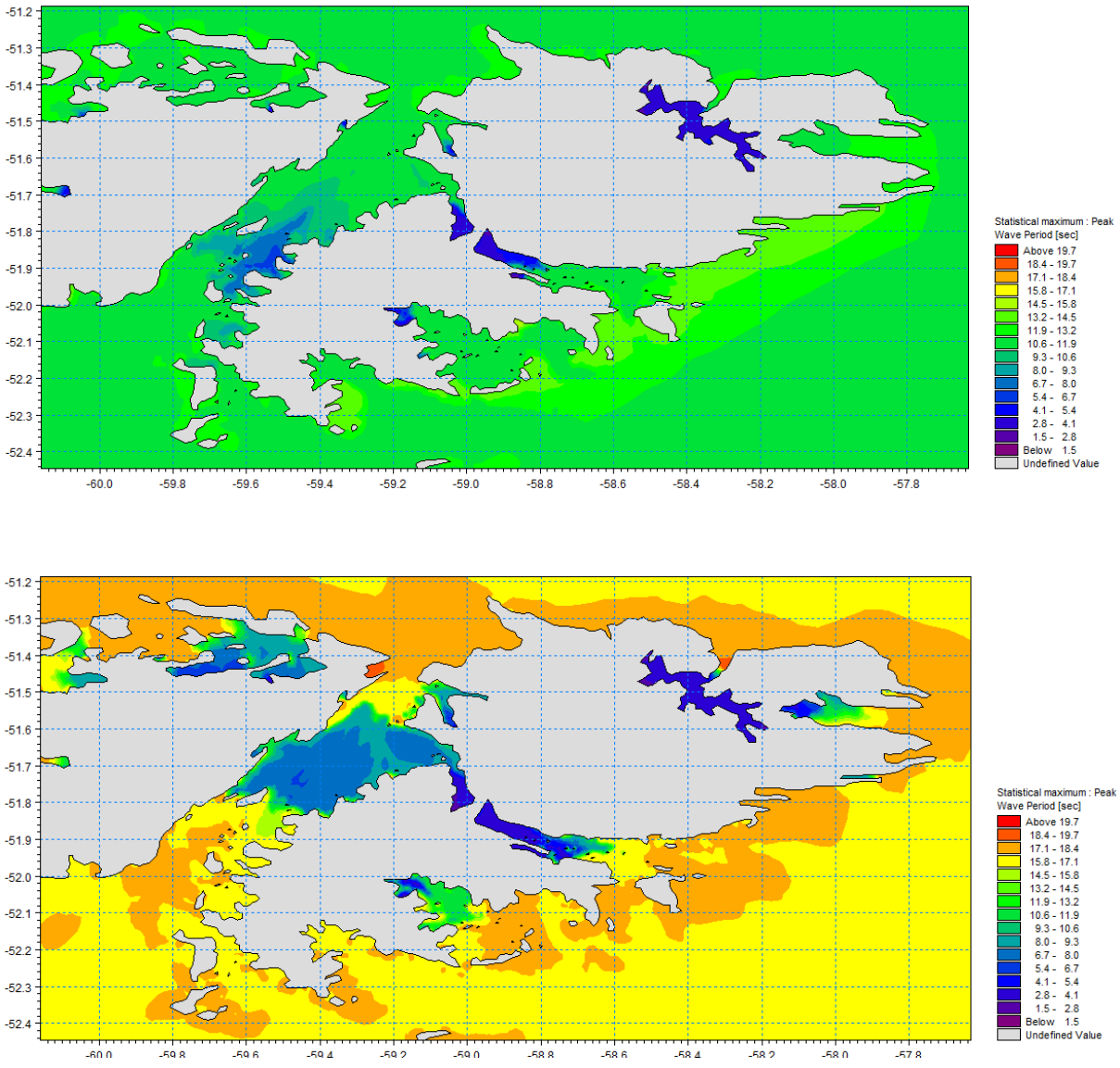


Figure 3.9 Max Peak Wave Period (Tp) for entire storm period for North storm (top) and South storm (bottom) for the 1 in 50 year storm event

3.3.3 Snapshot of 1 in 50 Year Storm Peak

The following figures show some of the nearshore significant wave heights and current speed patterns for the peak values and time for the storm model run. As an example Zone G2 is shown in the following figures, with waves propagating from the North (0°N) and South (210°N).

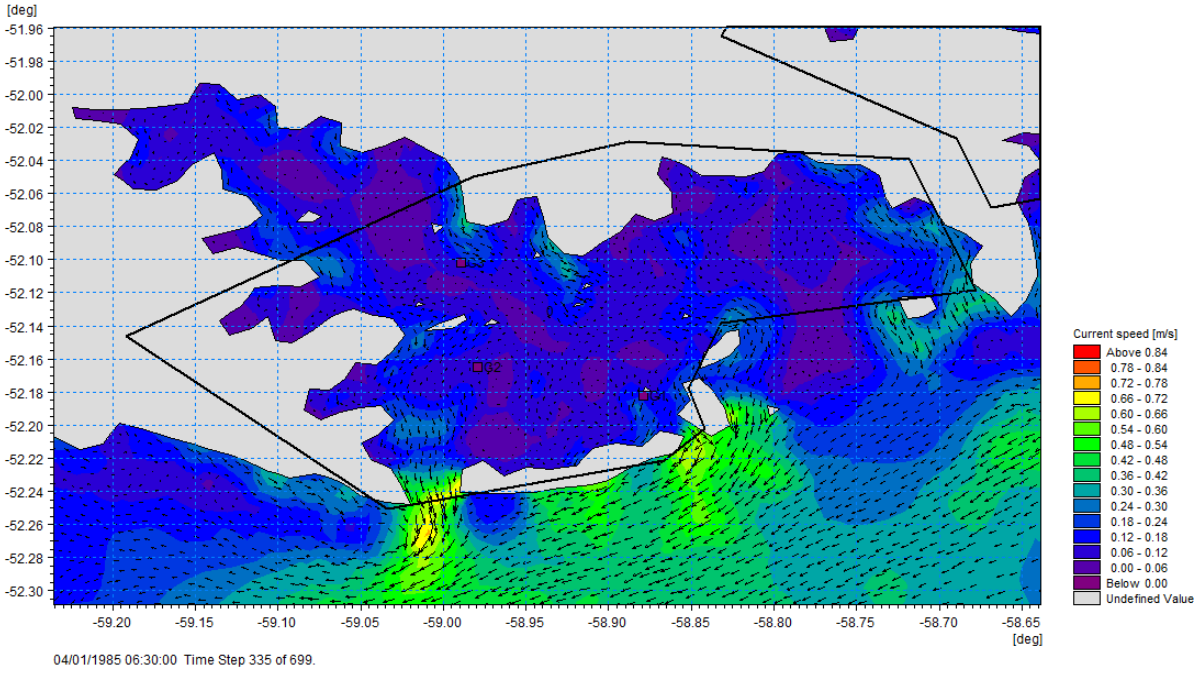


Figure 3.10 Snapshot of current speeds for peak of storm event with a 0°N (North) mean wave direction for zone G2

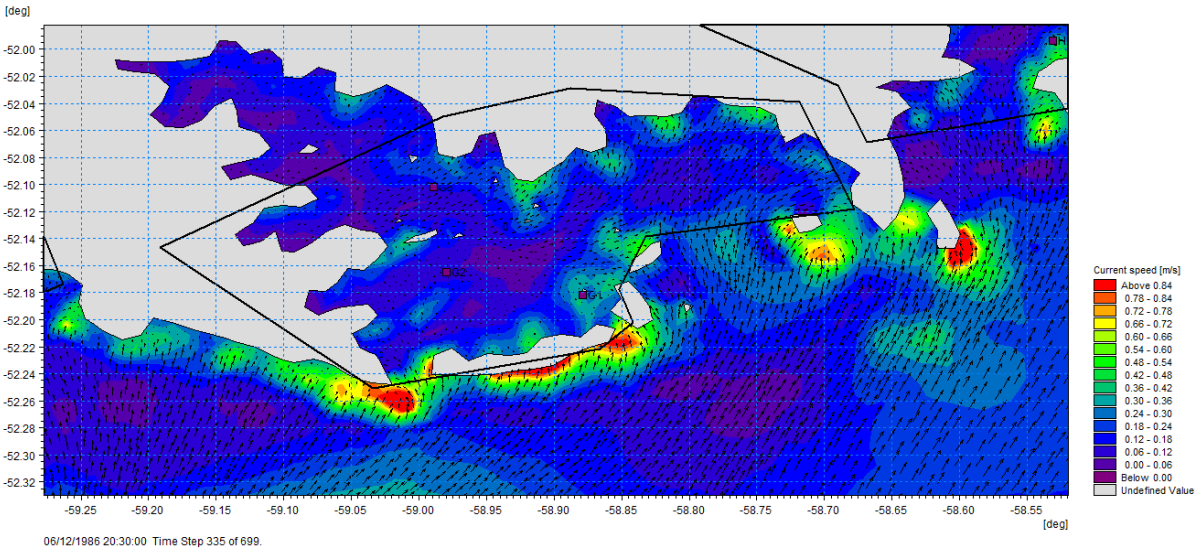


Figure 3.11 Snapshot of current speeds for peak of storm event with a 210°N (South) mean wave direction for zone G2

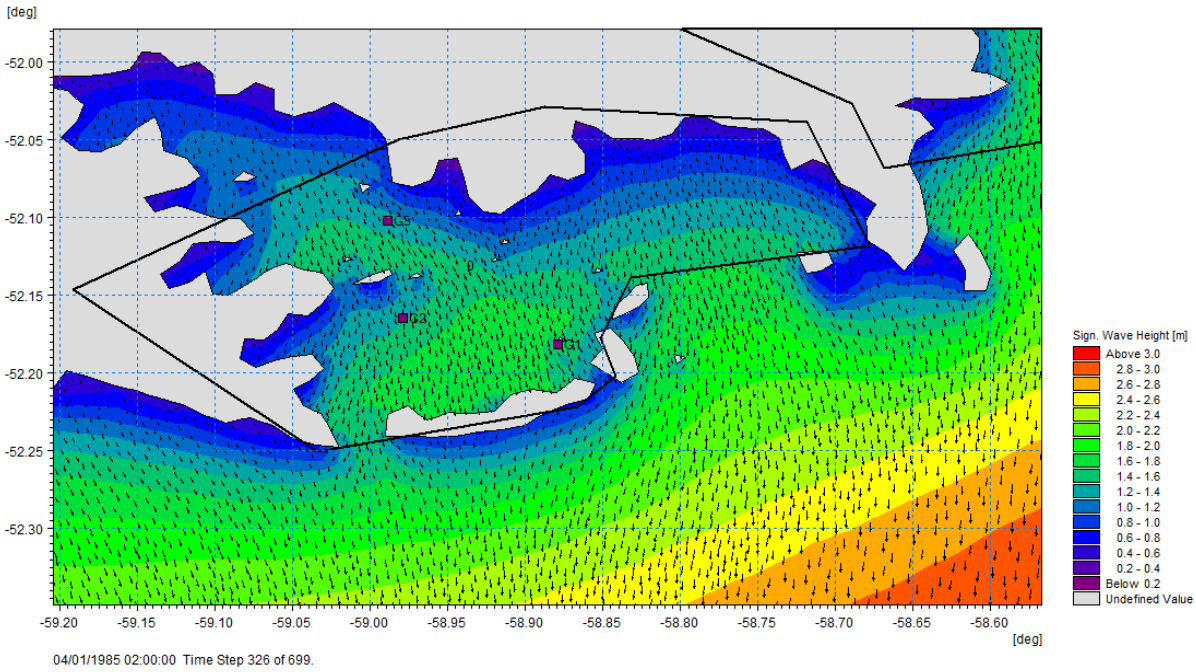


Figure 3.12 Snapshot of significant wave heights for peak of storm event with a 0°N (North) mean wave direction for zone G2

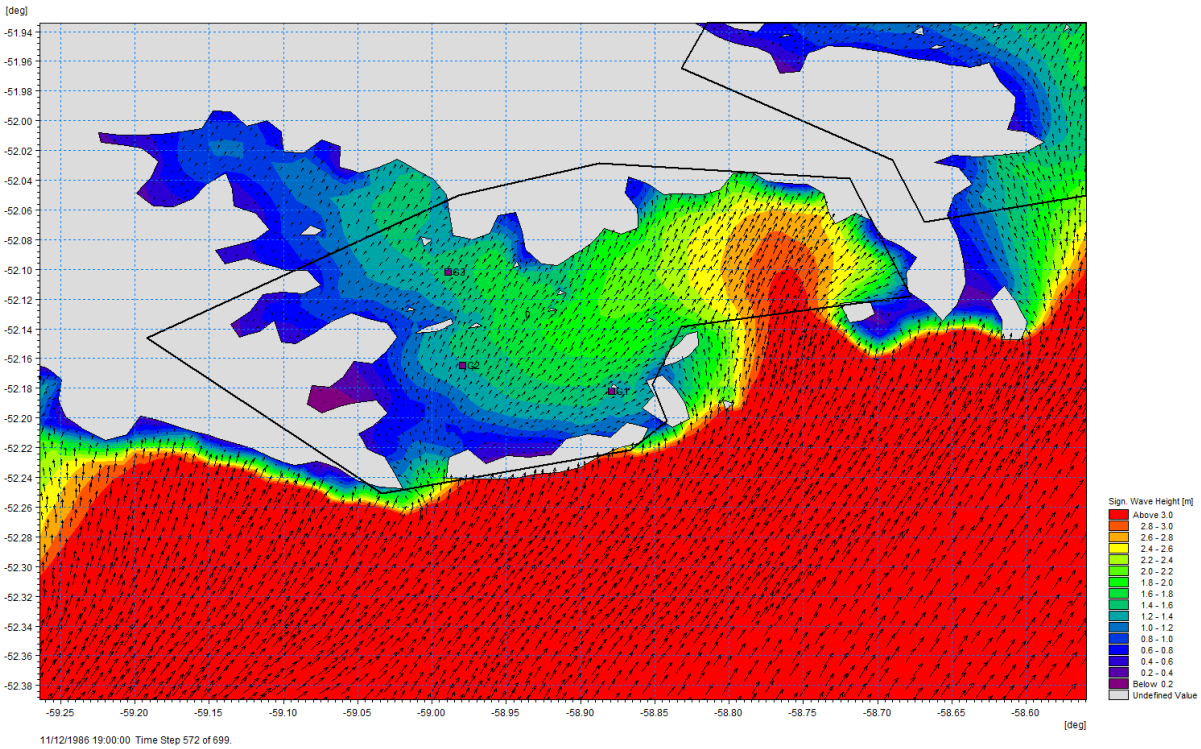


Figure 3.13 Snapshot of significant wave heights for peak of storm event with a 210°N (South) mean wave direction for zone G2

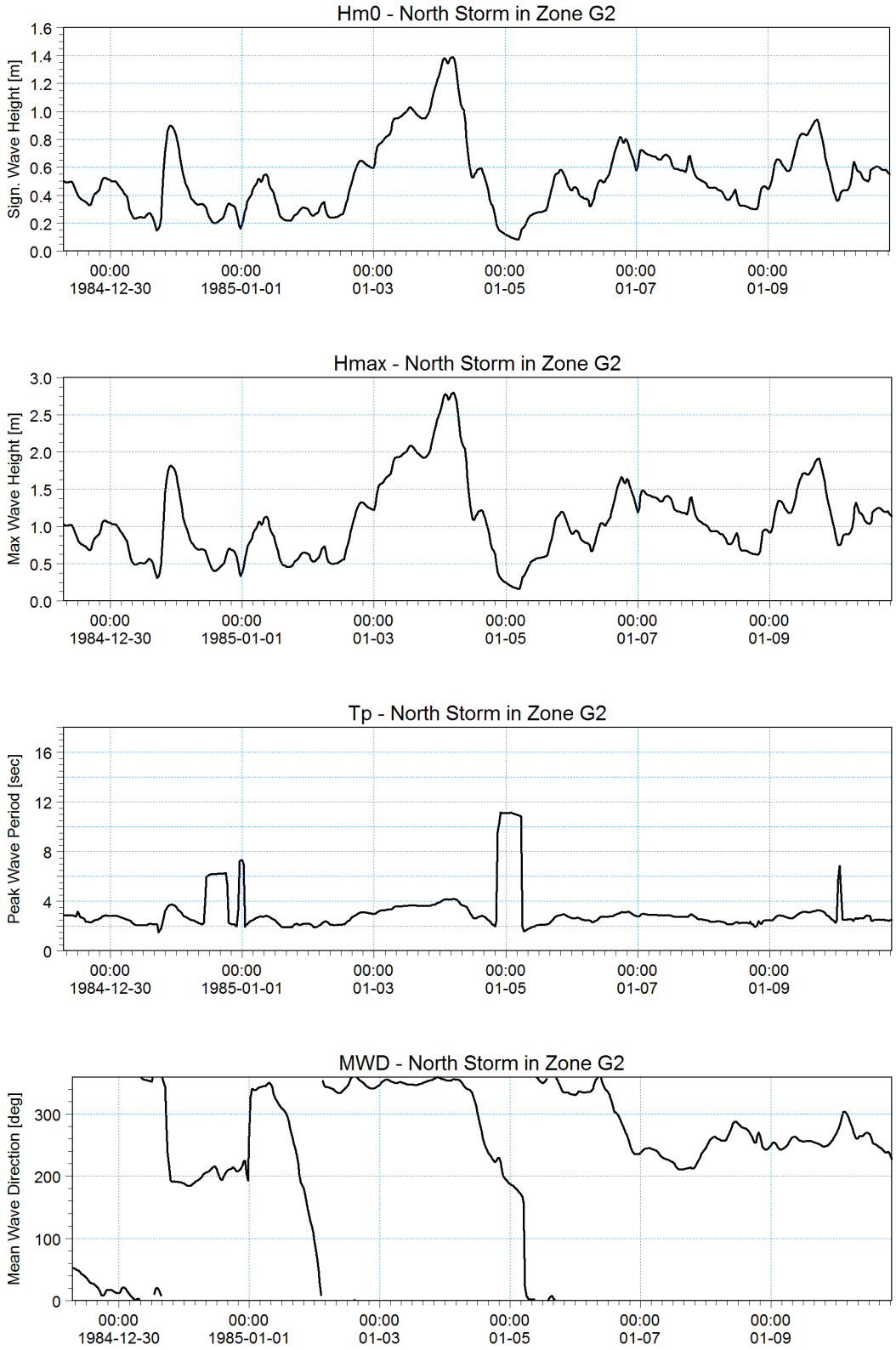


Figure 3.14 Nearshore Wave parameters for Peak Storm Event propagating from offshore 0°N (North) direction for Zone G2

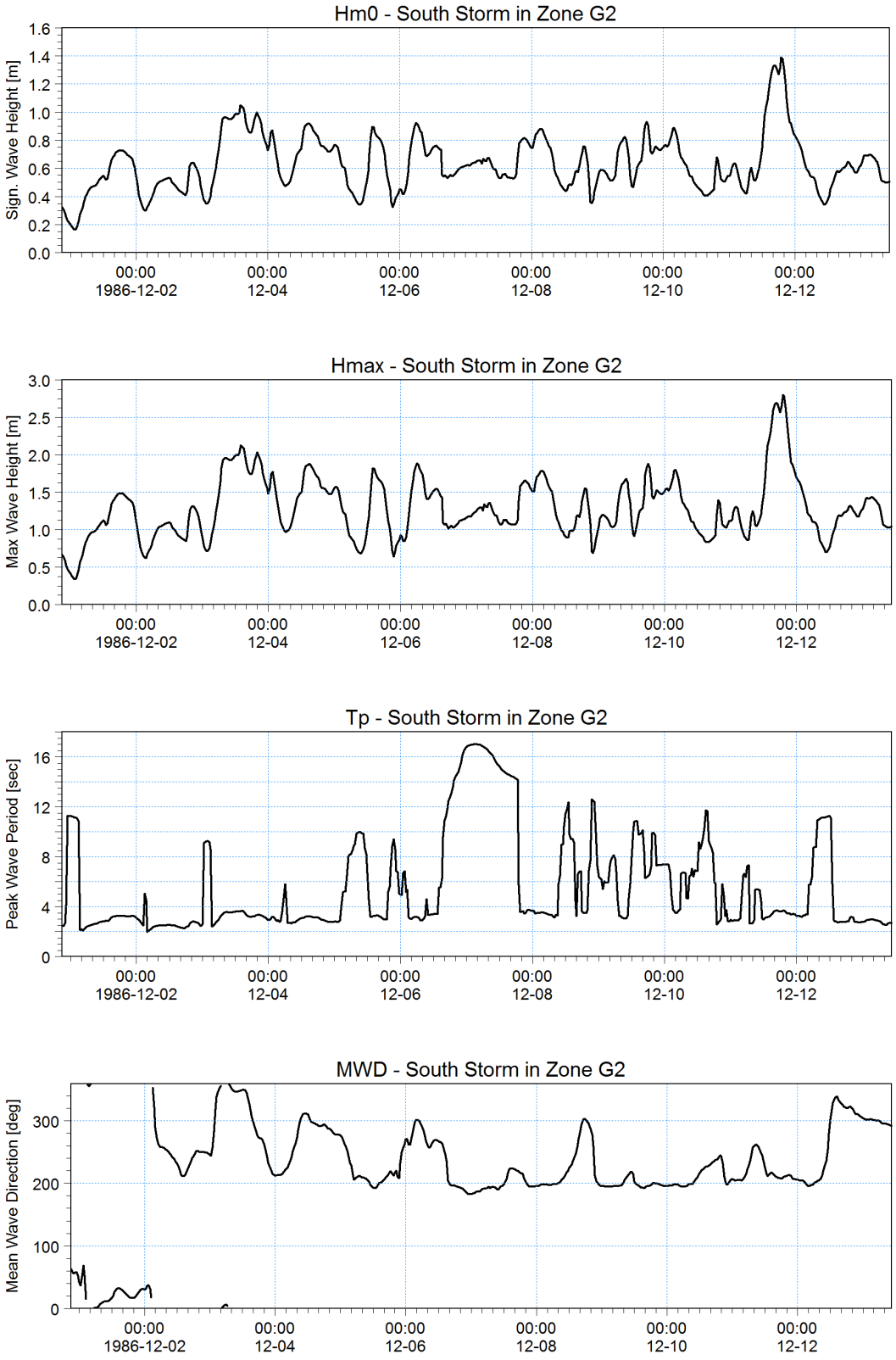


Figure 3.15 Nearshore Wave parameters for Peak Storm Event propagating from offshore 210°N (South) direction for Zone G2

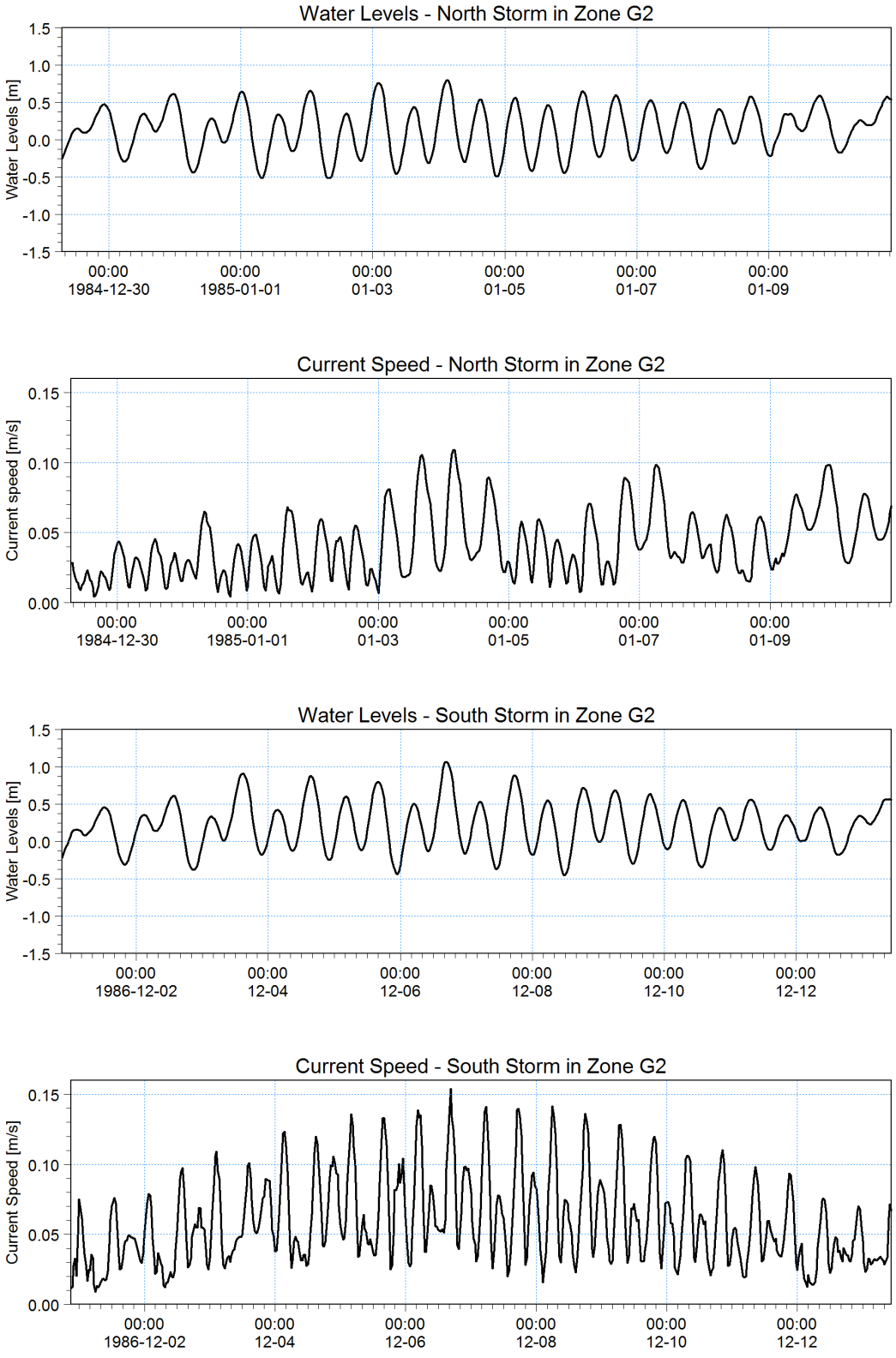


Figure 3.16 Nearshore water level and current speed for a Peak Storm Event propagating from offshore 0°N (North) and 210°N (South) direction for Zone G2

4 Conclusions & Recommendations

4.1 Summary of Findings

The modelling undertaken has been developed to provide an initial assessment of the likely wave, currents and water level conditions from the proposed sites.

The approach was developed to use the stationary wave modelling to define the specific conditions of interest. With this knowledge the models were run for pseudo storms with time as a variable to ensure that the effect of winds and storm surge was included. The pseudo storms were run for the equivalent of a 1 in 50 year wave condition.

In addition, a hydrodynamic model was run to ascertain the normal water level and current conditions.

The normal tidal range varies from a maximum at the northerly and easterly zones, with a minimum at Zone E. This has an inverse correlation as would be expected based with the current speeds, with the highest values at Zones D and E.

Under storm conditions it can be seen that all sites experience surges of between 0.1 and 0.45m on top of HAT levels. In addition, current speeds show some slight increase under storm conditions at the output locations with typical increase of 20-40%. Only Sites A1 and H2 showed maximum current speeds more than doubling, however they were noted to be relatively low to start with.

Of note from the fully coupled model, southerly storms can have a significant impact, even at the northerly sites. This is particularly seen on the current speeds where there are increases significantly above the normal current speeds (2-3 times the values) associated with the storms.

With respect to wave heights, maximum significant wave heights were typically more affected by the southerly storms for all sites. The maximum significant wave heights were found in the Falkland Sound at site B1 at 2.7m and site D3 at 2.6m. The lowest maximum significant wave heights were found in the east at site F1 at 1.4m and site G2 at 1.4m.

Hmax, the largest waves in the sea state, followed the pattern seen for significant wave heights with maximum values of 5.3m and 5.0m at B1 and D3 respectively.

Peak Wave period was highest in the southern and eastern sites, D3, E3, F1, G2, and H2, for the southern storm scenario. Peak wave periods are typically 10-11s for northerly storms and significantly higher (15-17s) for the southerly storms. It is noted that both of these are dominated by swell period waves which could have an impact on any floating assets in the area.

The Mean Wave Direction during a northerly storm sites in the Falkland Sound and in the east typically come from the southwest. The protected bays in zone D, such as Ruggles Bay, Port King and Egg Harbour, are more likely to experience a mean wave direction from the northerly direction, as are sites in zone A and C from the North West and Zone B from the North East (see Table 3.3).

The Mean Wave Direction during a southerly storm heavily influences the whole region. Protected areas, in the lee of landmasses in the eastern Zones F, G and H are also likely to experience a mean wave direction from a more South Easterly to Easterly direction (see Table 3.3).

4.2 Recommendations

From this initial study there is a recommendation to further refine the above assessments to inform future planning stages if greater certainty is required. These recommendations include:

1. Validation campaign for waves
2. Undertake a full long term hindcast

It is noted that the Falklands are relatively data poor for key metocean conditions such as wave and current measurements. It is suggested that to gain greater confidence in the conditions that a campaign of data collection is undertaken to allow future calibration/validation of numerical models of the area. As a minimum this should include measurement of wave conditions for a minimum of one or two storms and could be extended to include other variables such as current speeds. To ensure that there are sufficient storms captured, a campaign targeting the Austral Winter (July-September) should be planned. Ideally this would include a campaign of several devices, targeting either areas of specific interest (e.g. planned sites or locations in the nearshore, offshore of a series of locations). DHI can provide both the planning and the execution of such a study if required in the future.

It is noted from the present study that there is some uncertainty on the direction that leads to the most likely storm wave conditions at the nearshore sites. It is suggested that this can be resolved by running a full hindcast model for a minimum of 20 years to allow the model to determine the frequency of storms from the full range of directions. In addition, it is suggested that if further modelling is undertaken that there is a need for higher resolution coastlines and confirmation of the bathymetry at key locations away from the specific sites of interest.

5 References

Cheng, Y. &. (2011). Multimission empirical ocean tide modeling for shallow waters and polar seas. *JGR Oceans*, https://doi.org/10.1029/2011JC007172.

Upton, J. &. (2002). An overview of the oceanography and Meteorology of the. *AQUATIC CONSERVATION: MARINE AND FRESHWATER ECOSYSTEMS, 12*, 15–25.

Woodworth, P. P. (2005). Sea level changes at Port Stanley, Falkland Islands. *Journal of Geophysical Research*, Vol. 110, C06013.

APPENDICES

Appendix A

Setup information and results for Site A1

Bathymetry and Mesh

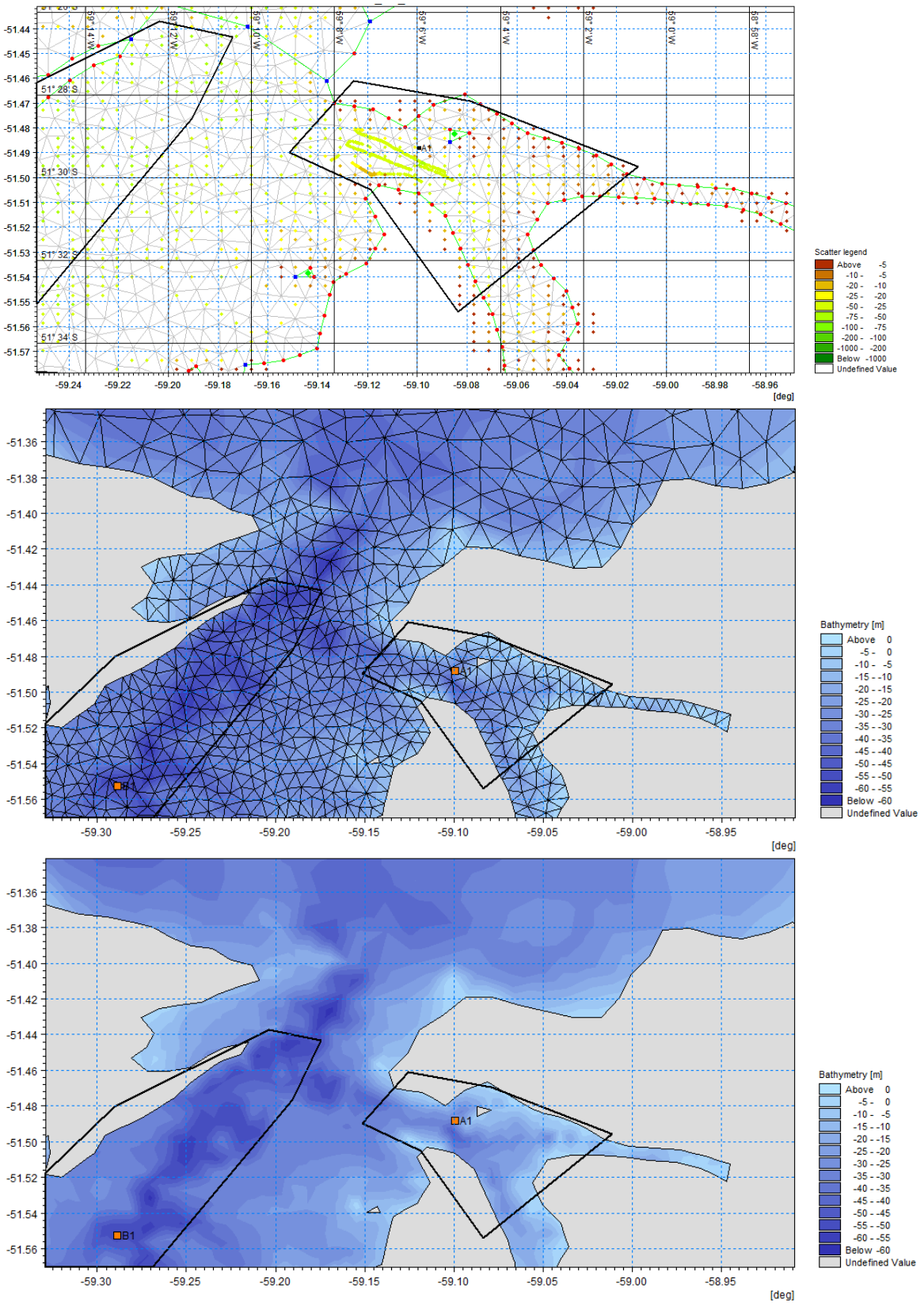


Figure A1 (Top) Input data - CMAP & provided bathymetry data points and CMAP land data (Middle) Created Mesh with underlying Bathymetry (Bottom) Interpolated Bathymetry

Uncoupled SW Model – 1 in 1 year storm

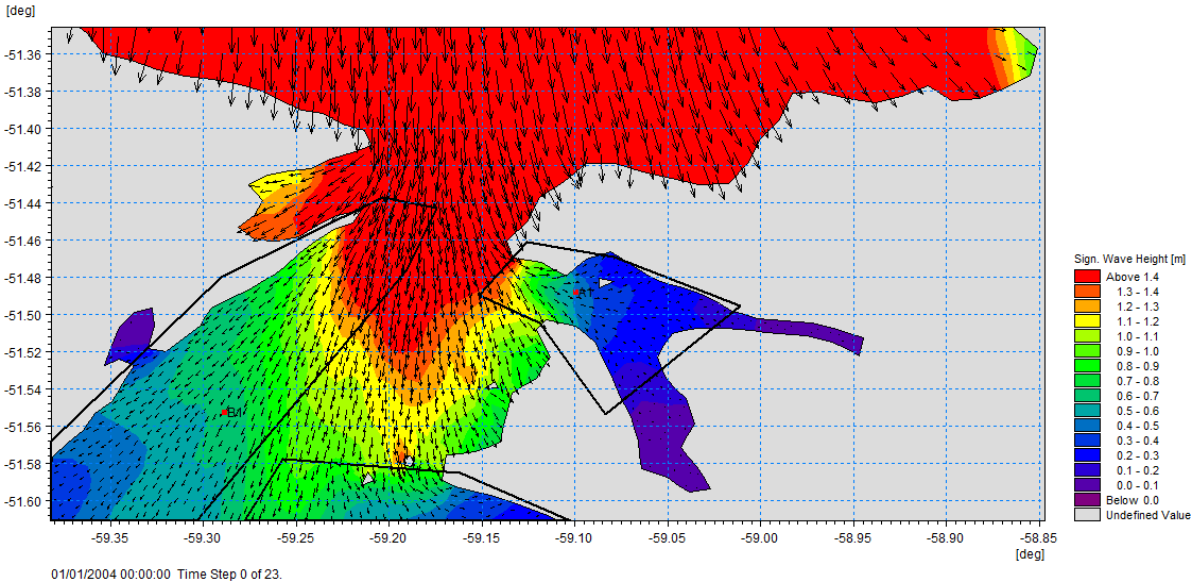


Figure A2 Significant wave heights for 1 in 1 Year Return Period wave transformation for 0°N mean wave direction

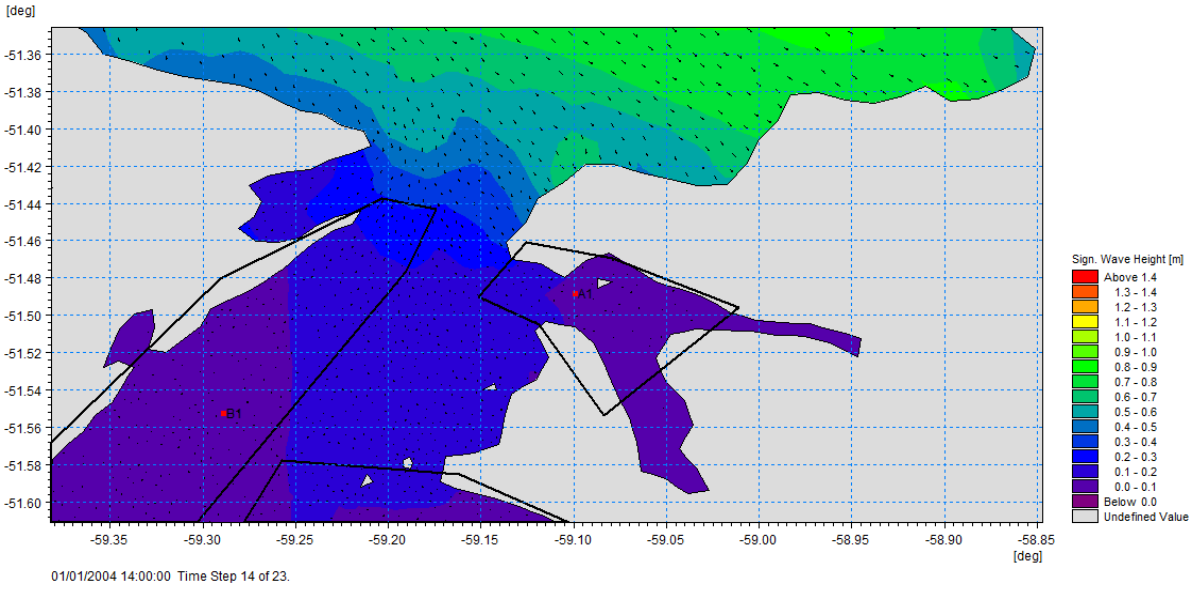


Figure A3 Significant wave heights for 1 in 1 Year Return Period wave transformation for 210°N mean wave direction

Uncoupled SW Model – 1 in 50 year storm

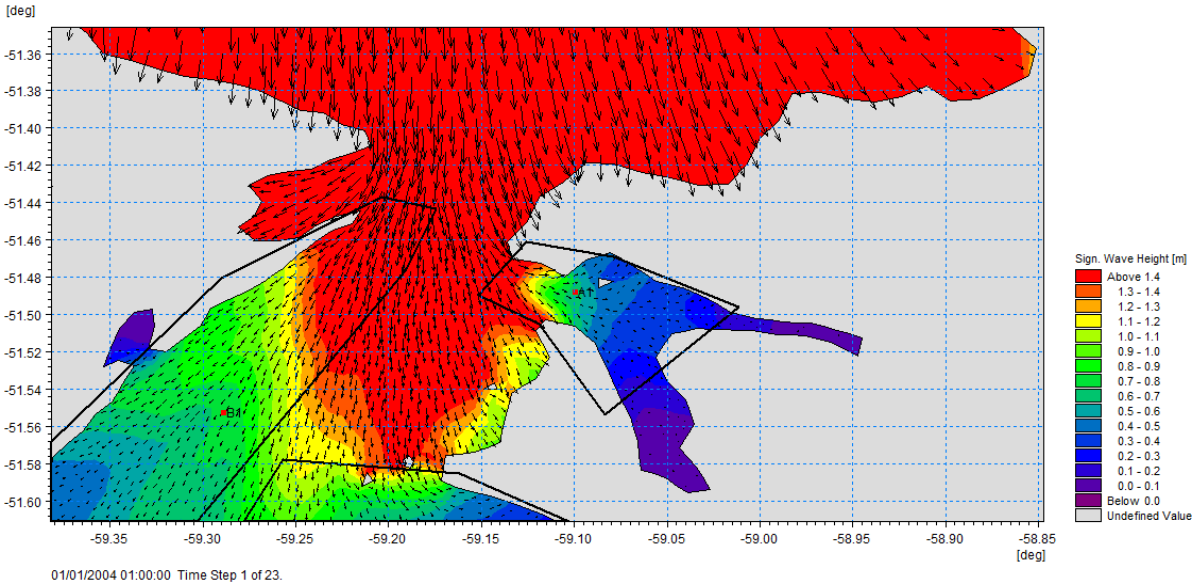


Figure A4 Significant wave heights for 1 in 50 Year Return Period wave transformation for 0°N mean wave direction

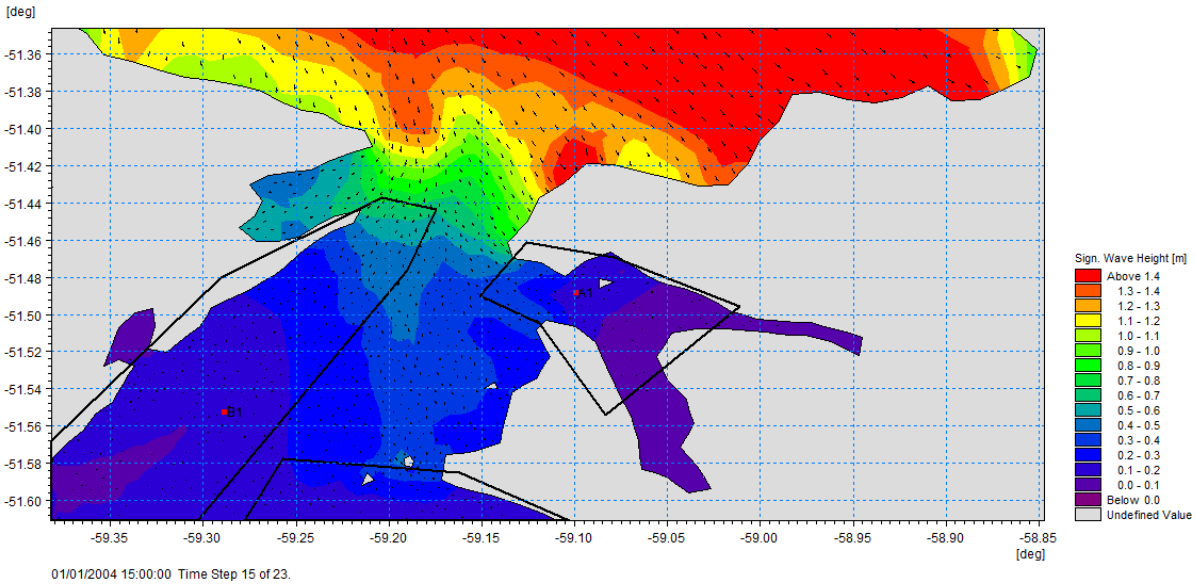


Figure A5 Significant wave heights for 1 in 50 Year Return Period wave transformation for 210°N mean wave direction

Coupled Model – Statistical Overview

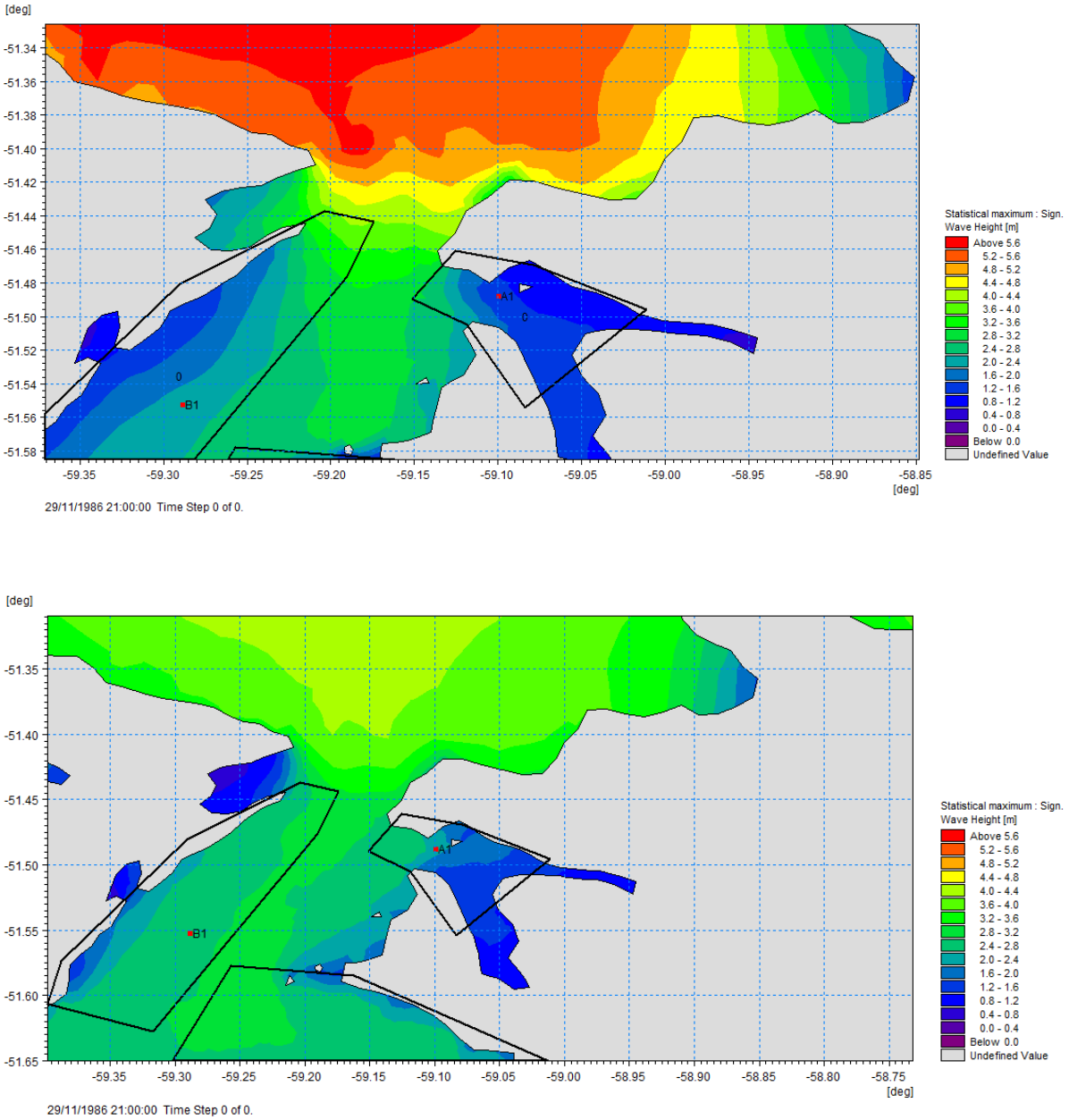


Figure A6 Statistical maximum H_{mo} for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

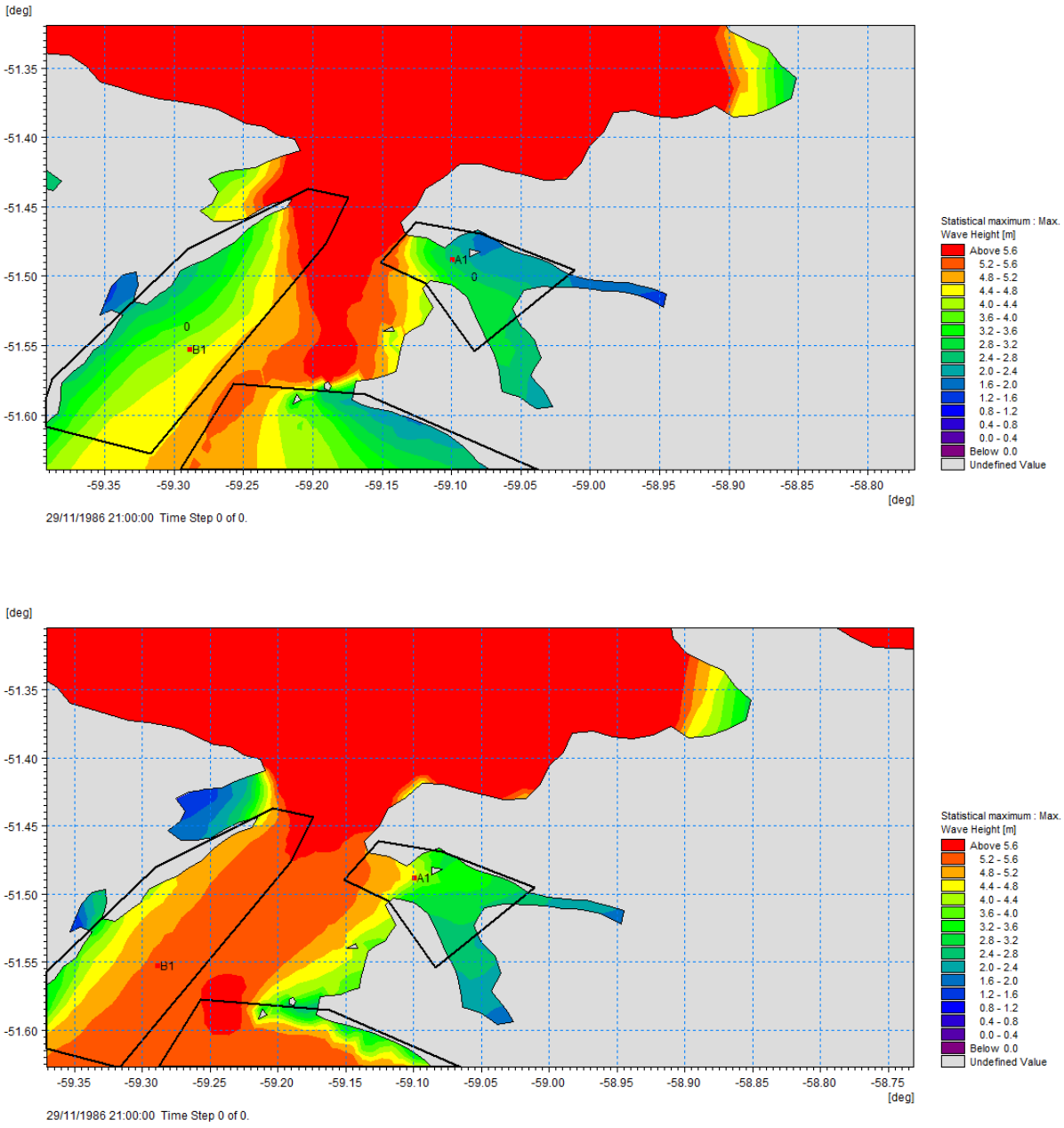


Figure A7 Statistical maximum Hmax for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

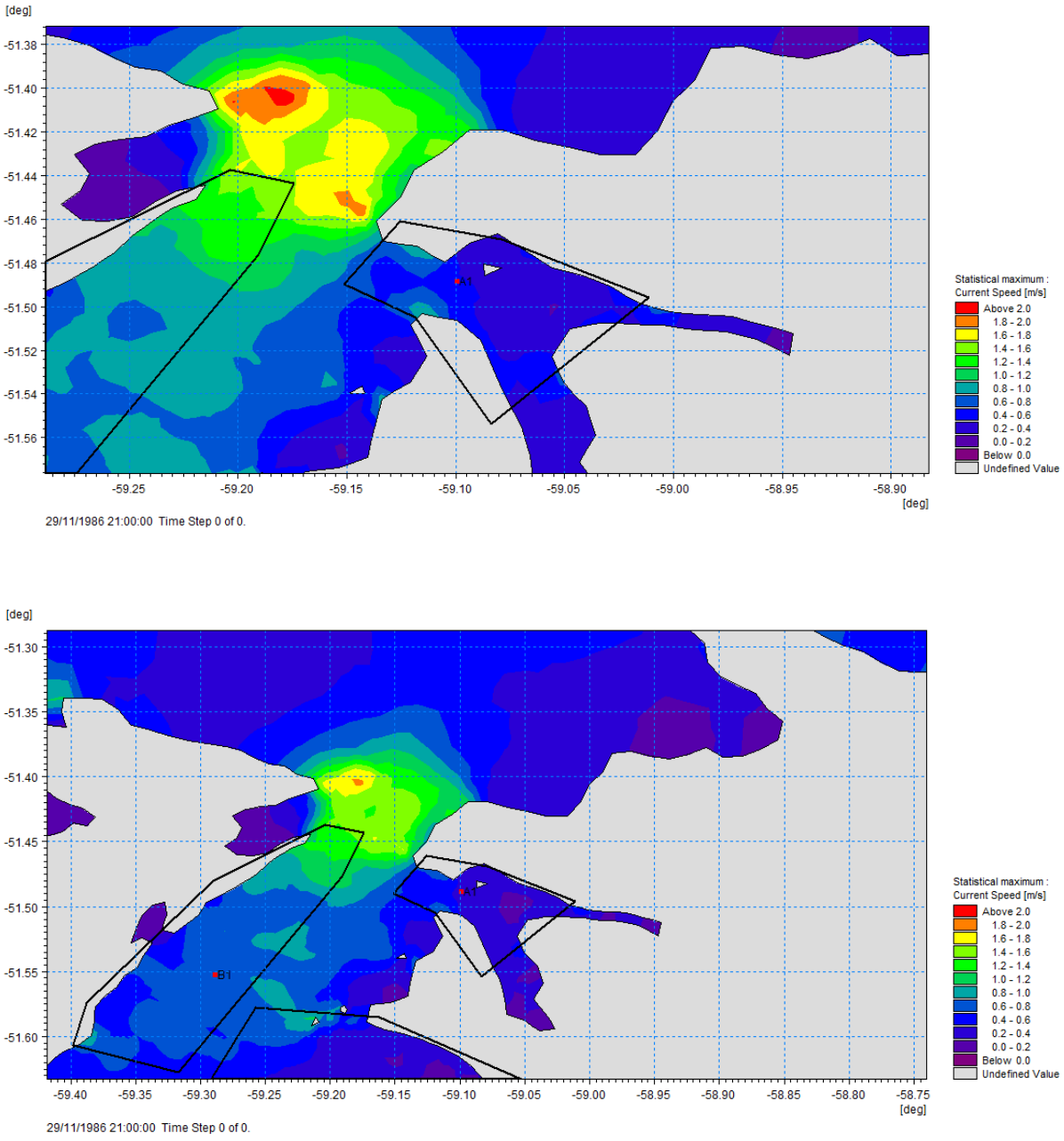


Figure A8 Max Current Speed for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

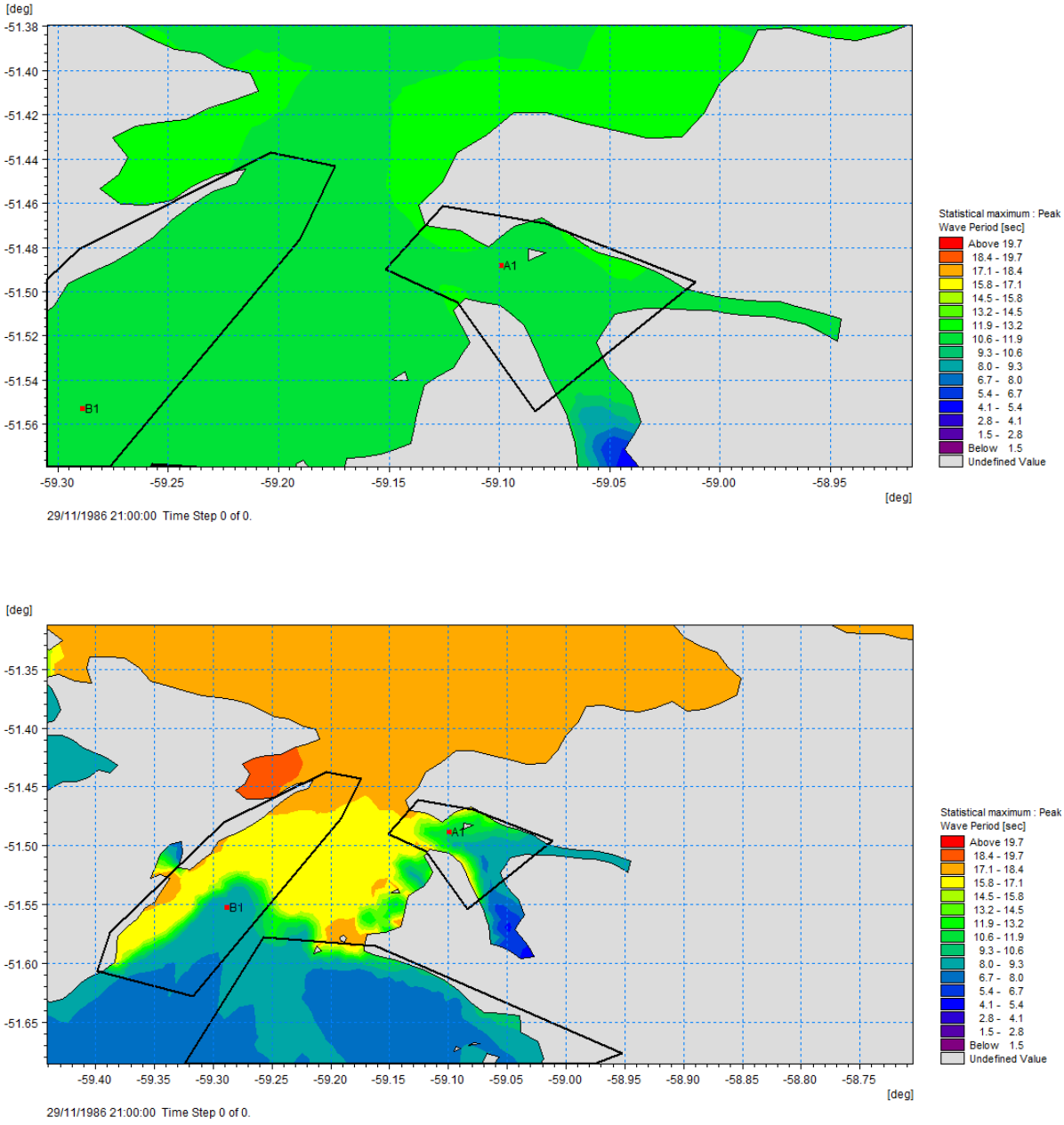


Figure A9 Max Peak Wave Period (Tp) for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

Coupled Model – Pseudo Storm Results

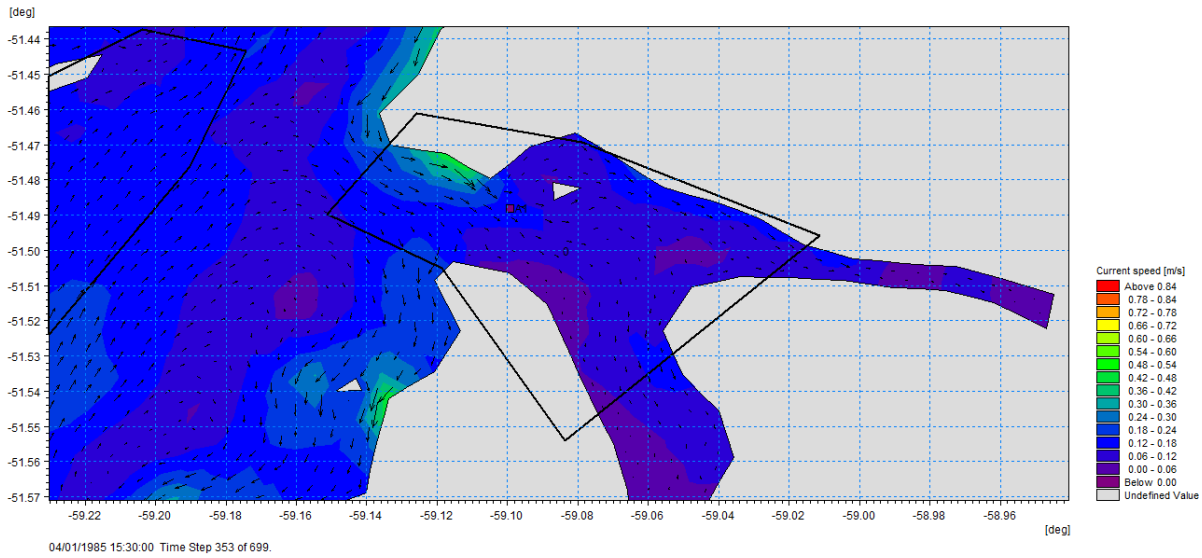


Figure A10 Snapshot of current speeds for peak of 1 in 50 year storm event with a 0°N (North) mean wave direction for zone A1

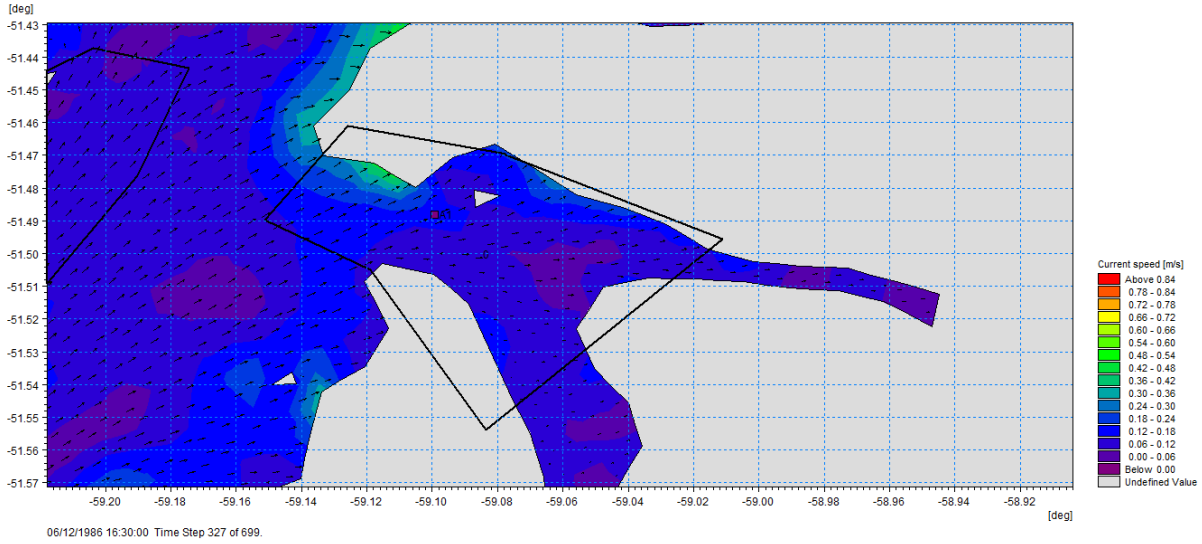


Figure A11 Snapshot of current speeds for peak of 1 in 50 year storm event with a 210°N (South) mean wave direction for zone A1

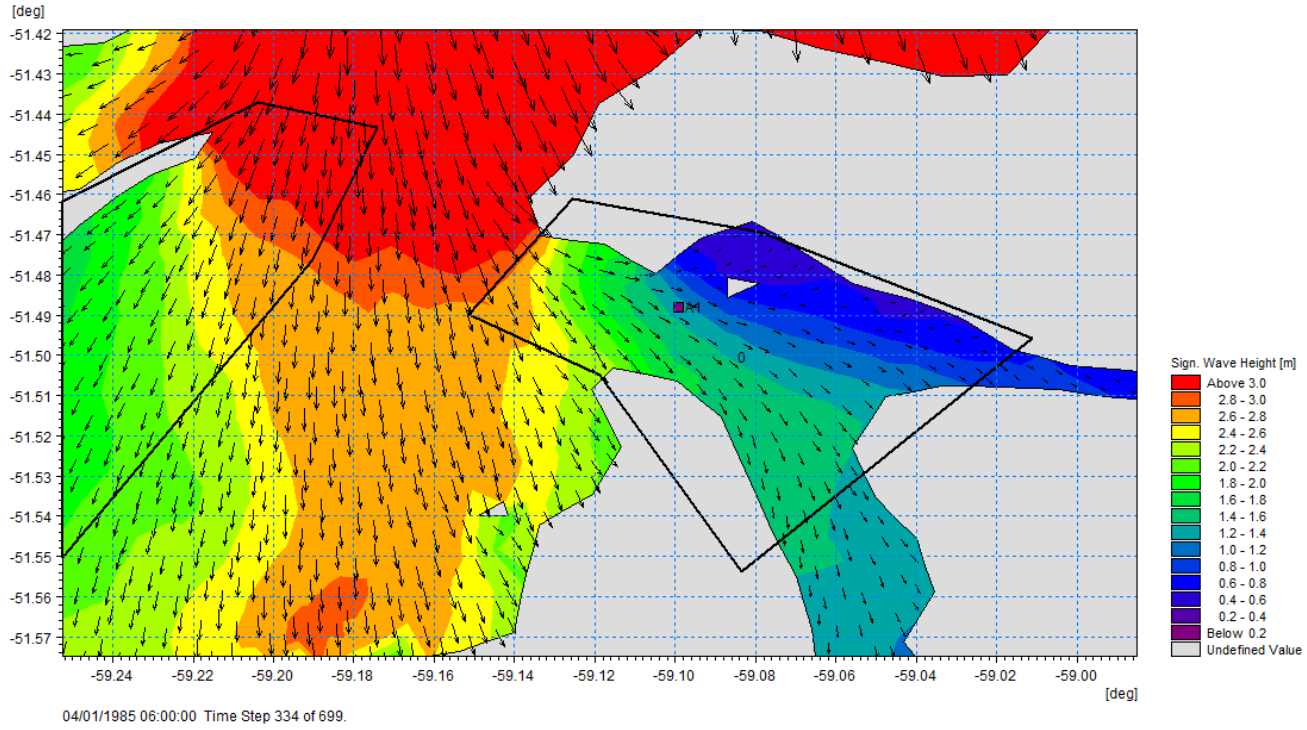


Figure A12 Snapshot of Significant Wave Heights for peak of 1 in 50 year storm event with a 0°N (North) mean wave direction for zone A1

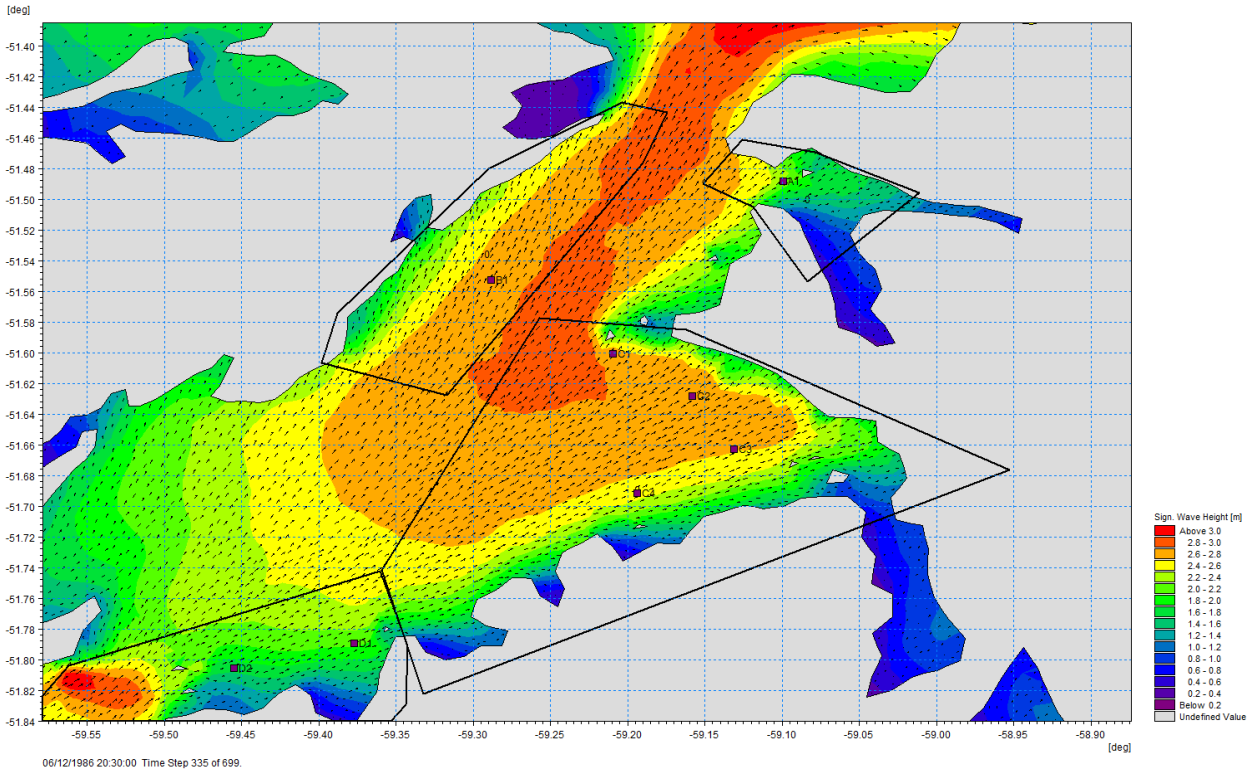


Figure A13 Snapshot of Significant Wave Heights for peak of 1 in 50 year storm event with a 210°N (South) mean wave direction for zone A1

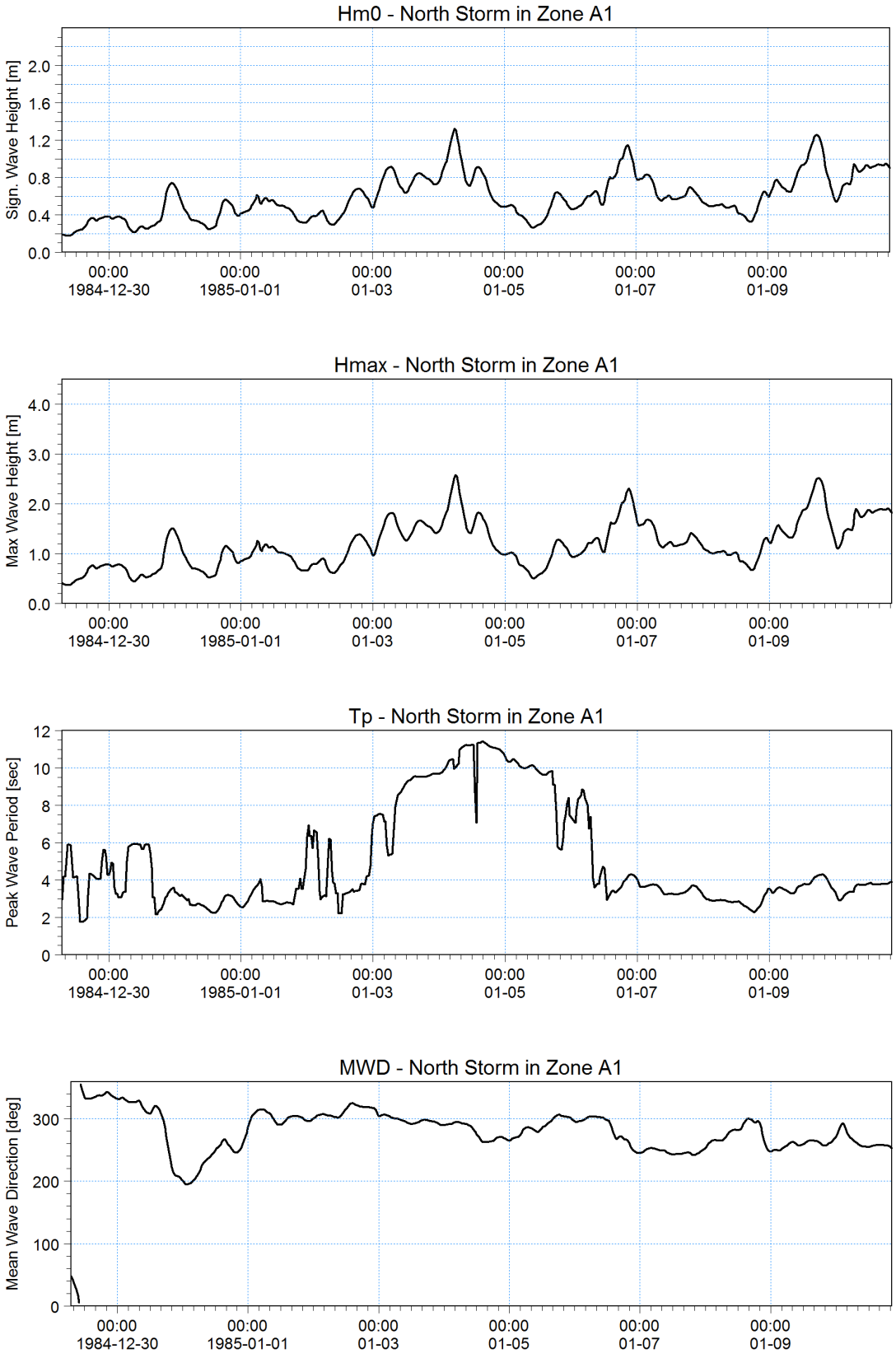


Figure A14 Coupled Model nearshore wave parameters for Peak 1 in 50 year storm Event propagating from offshore 0°N (North) direction for Zone A1

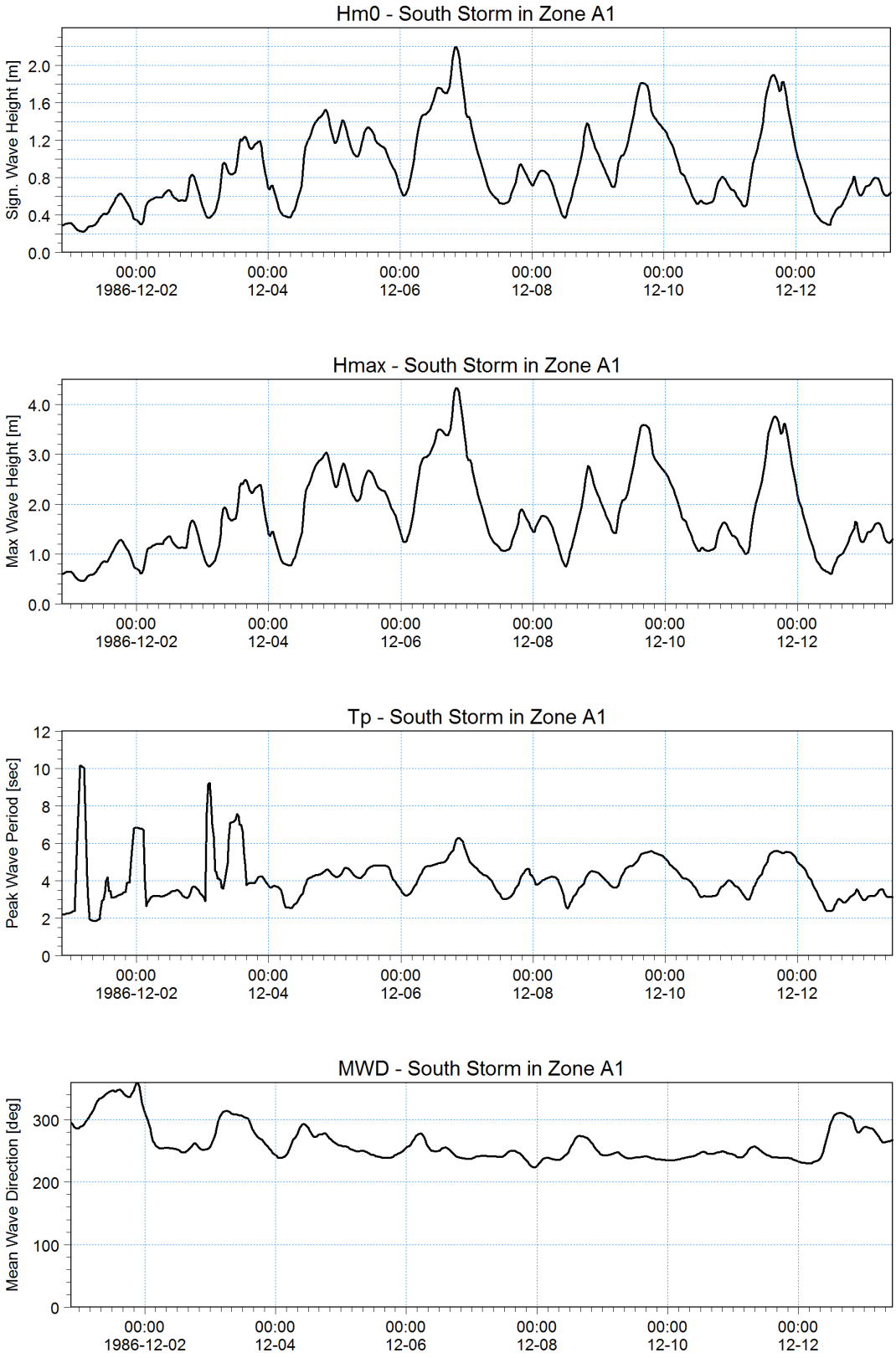


Figure A15 Coupled Model nearshore wave parameters for Peak 1 in 50 year storm Event propagating from offshore 210°N (South) direction for Zone A1

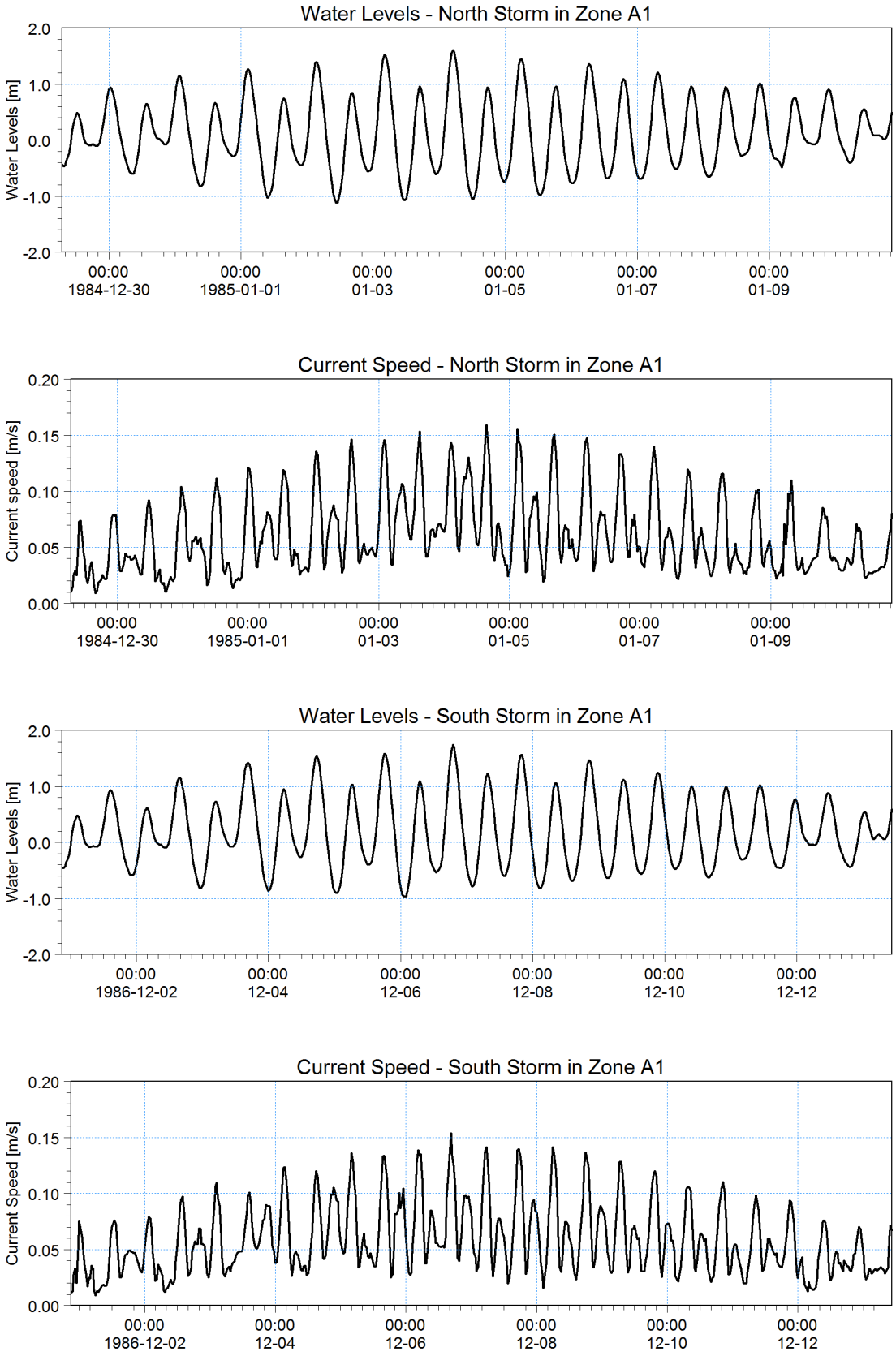


Figure A16 Coupled Model nearshore water level and current speed for a Peak 1 in 50 year storm event propagating from offshore 0°N (North) and 210°N (South) direction for Zone A1

Appendix B

Setup information and results for Site B1

Bathymetry and Mesh

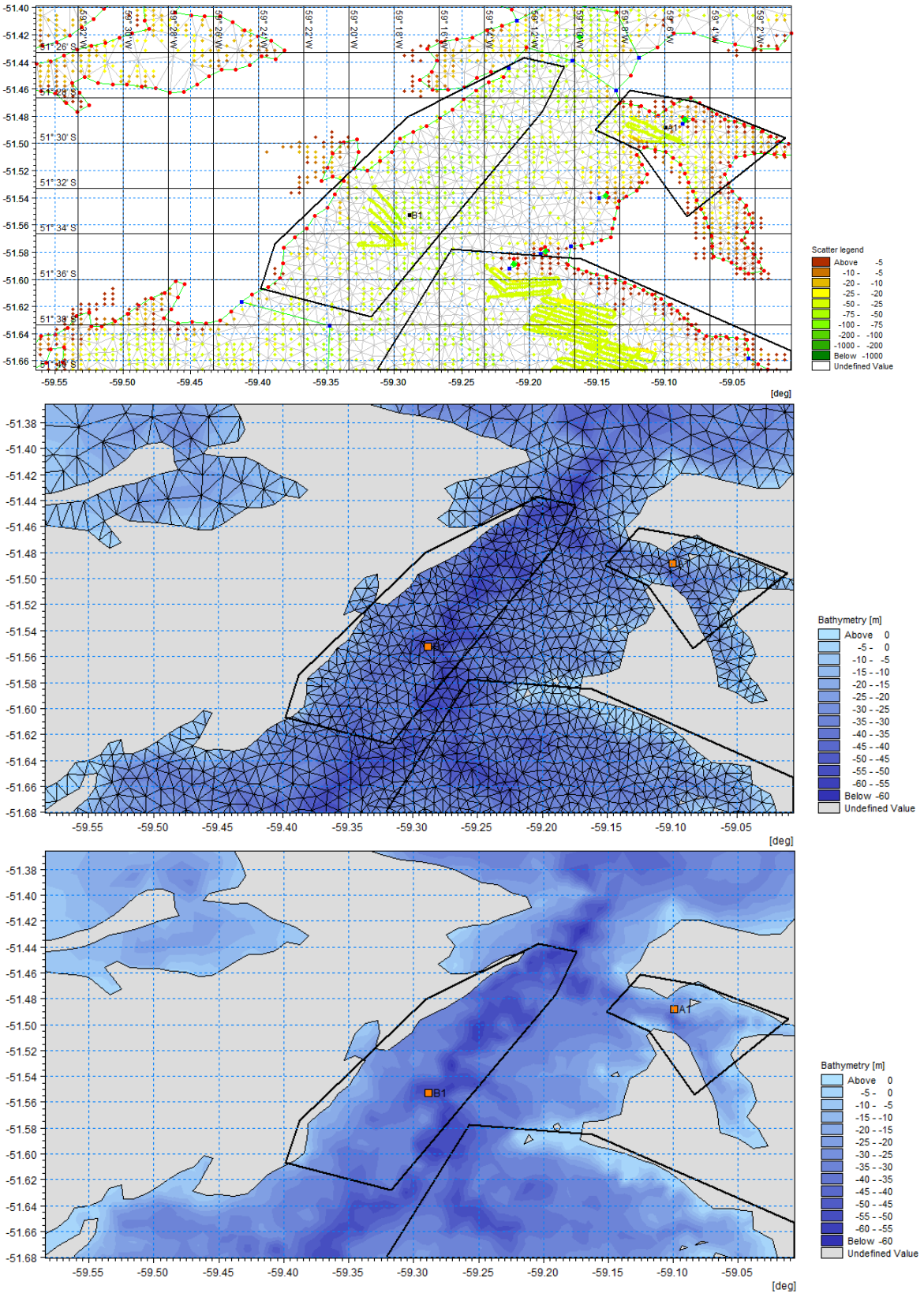


Figure B1 (Top) Input data - CMAP & provided bathymetry data points and CMAP land data (Middle) Created Mesh with underlying Bathymetry (Bottom) Interpolated Bathymetry

Uncoupled SW Model – 1 in 1 year storm

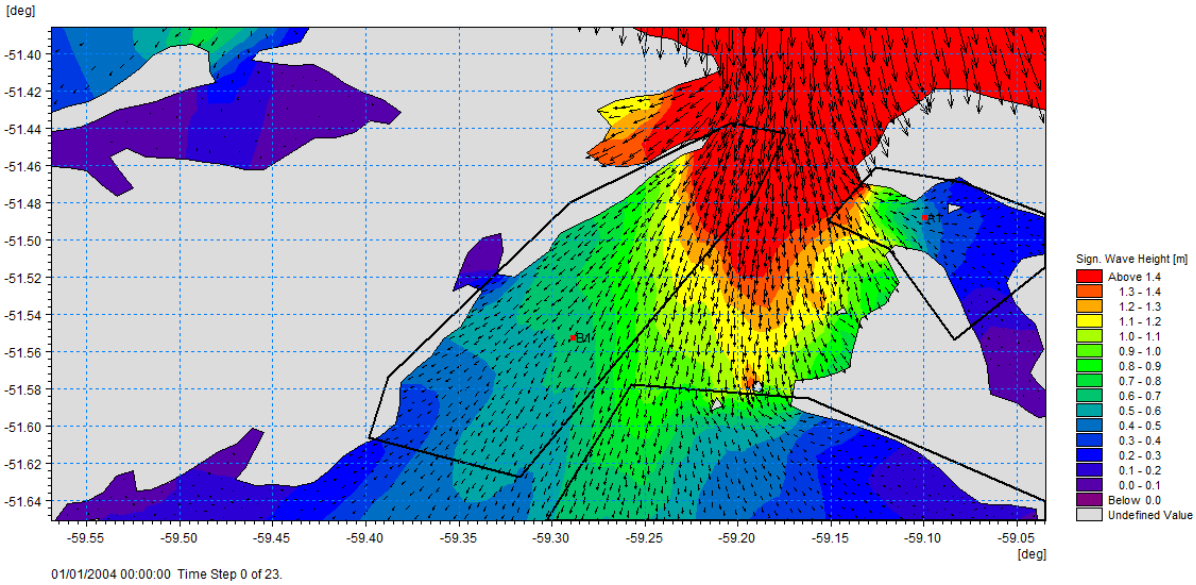


Figure B2 Significant wave heights for 1 in 1 Year Return Period wave transformation for 0°N mean wave direction

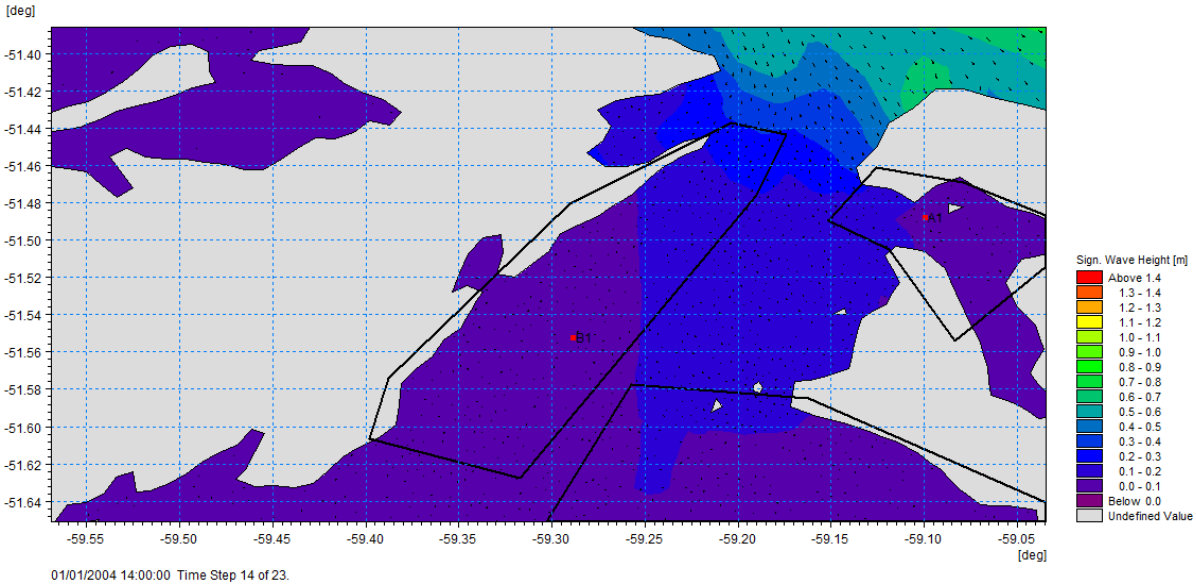


Figure B3 Significant wave heights for 1 in 1 Year Return Period wave transformation for 210°N mean wave direction

Uncoupled SW Model – 1 in 50 year storm

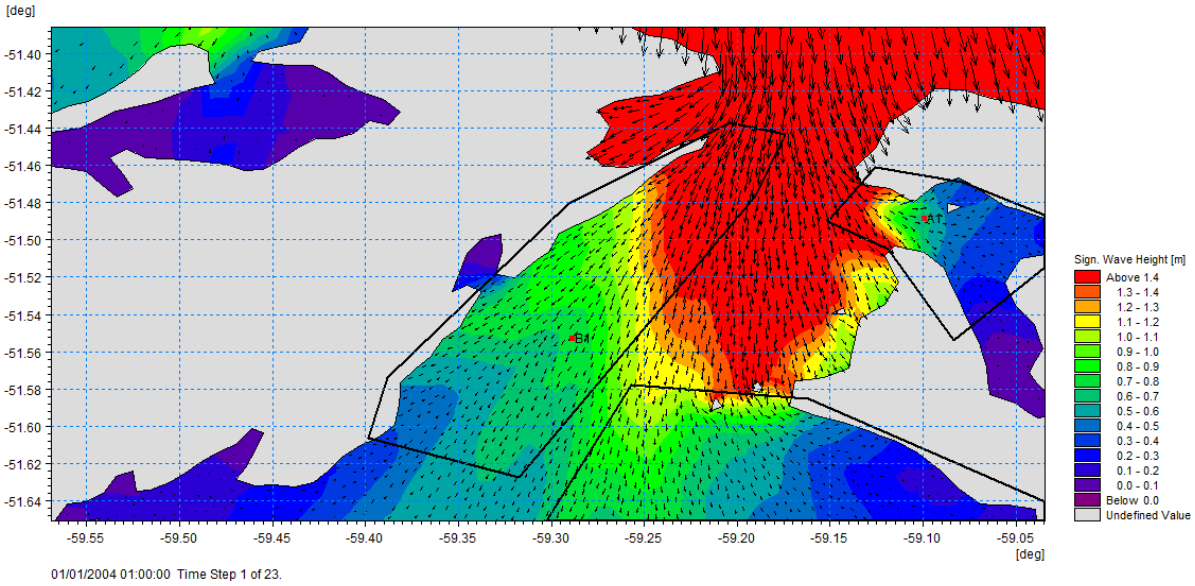


Figure B4 Significant wave heights for 1 in 50 Year Return Period wave transformation for 0°N mean wave direction

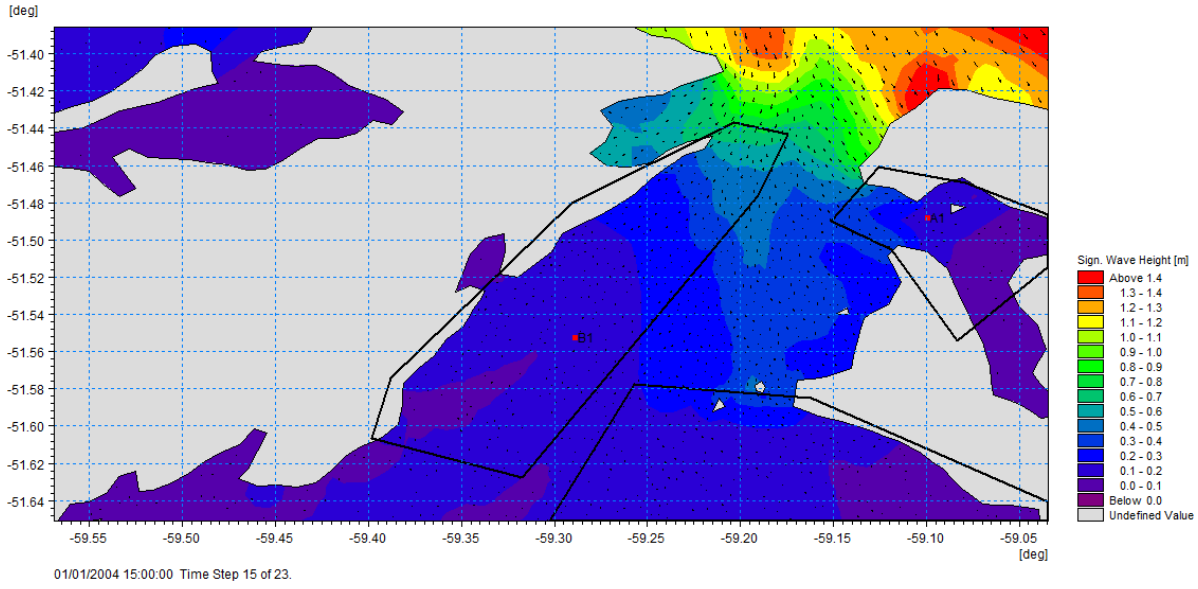


Figure B5 Significant wave heights for 1 in 50 Year Return Period wave transformation for 210°N mean wave direction

Coupled Model – Statistical Overview

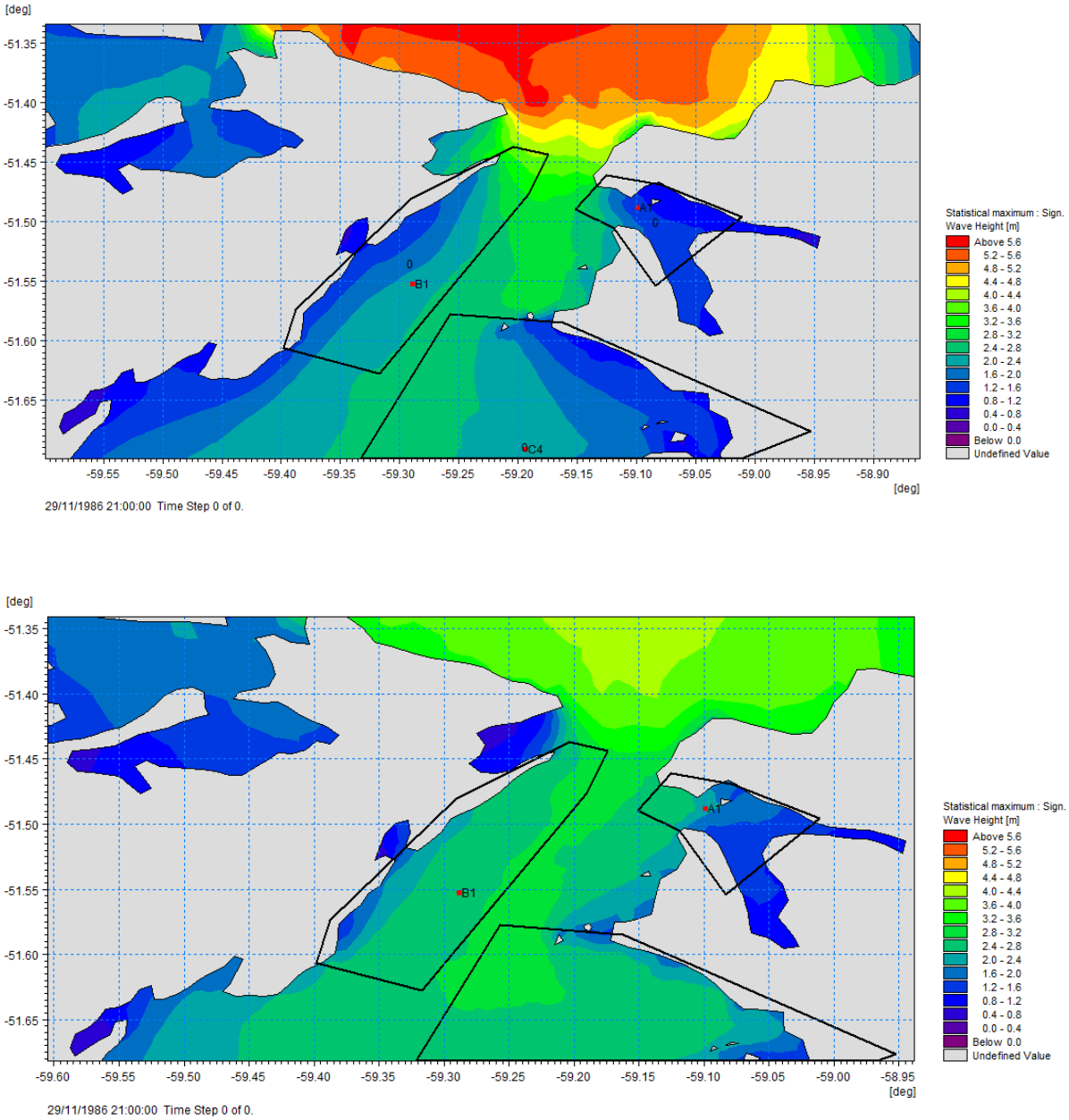


Figure B6 Statistical maximum H_{mo} for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

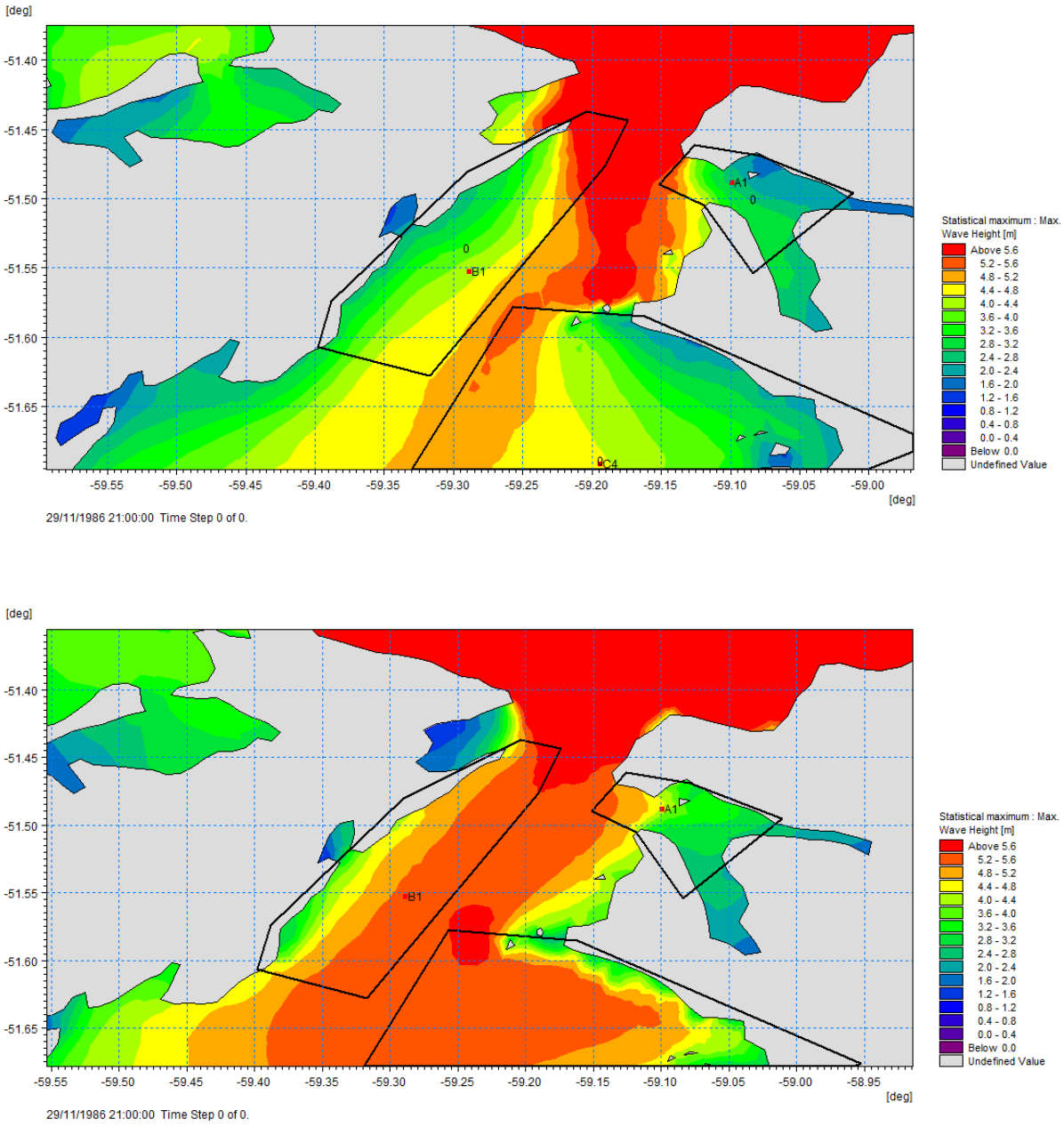


Figure B7 Statistical maximum Hmax for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

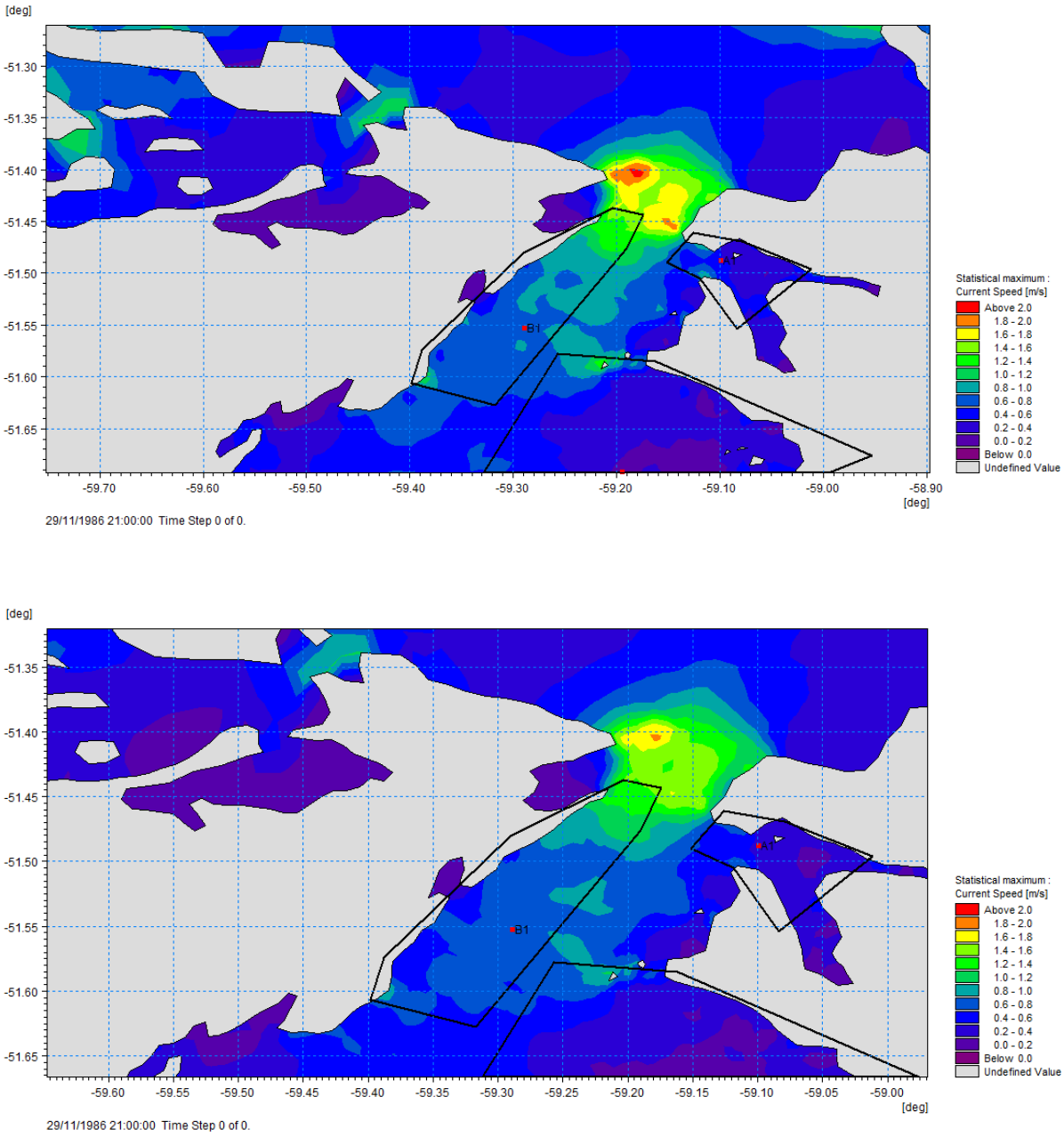


Figure B8 Max Current Speed for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

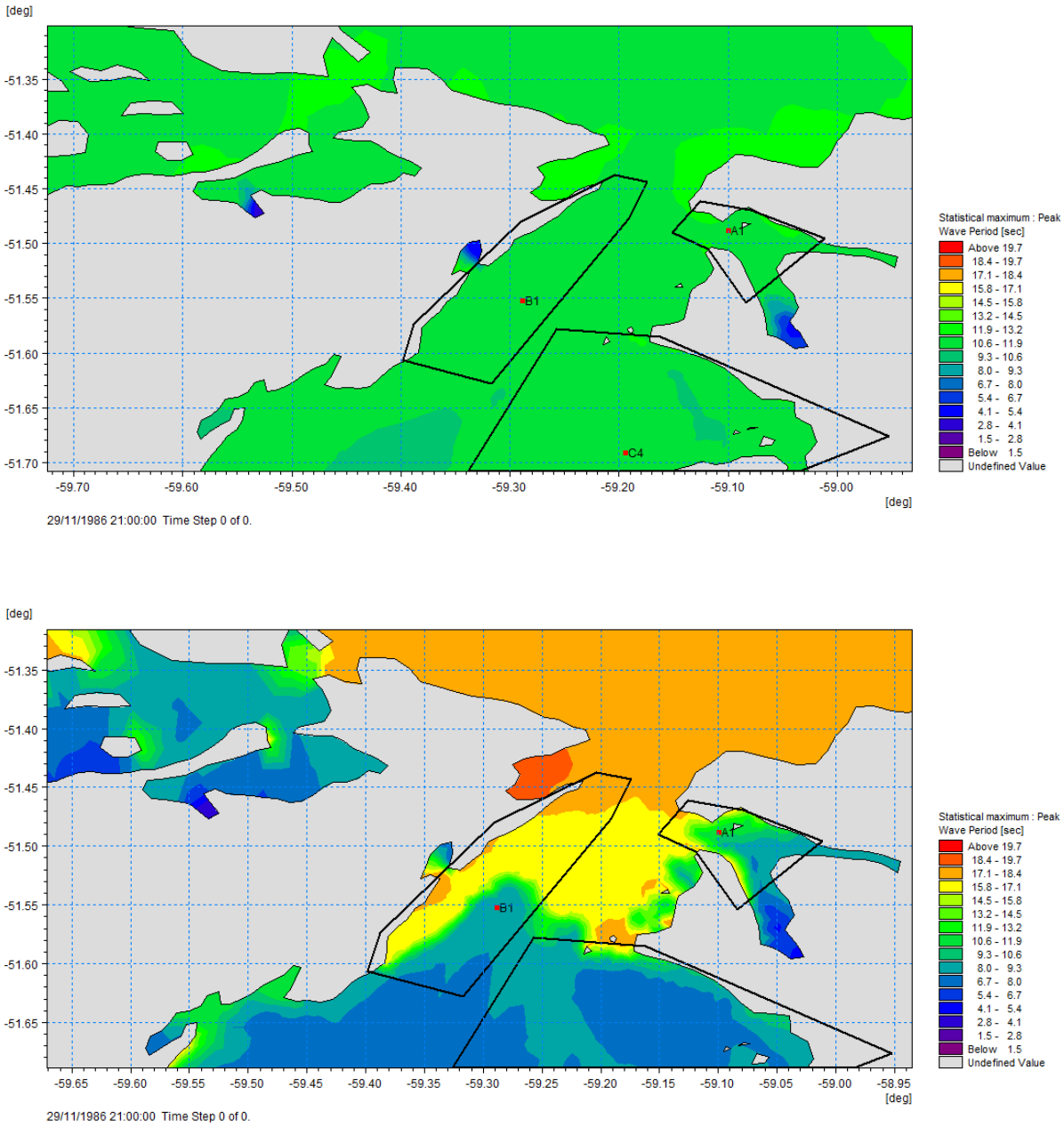


Figure B9 Max Peak Wave Period (Tp) for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

Coupled Model – Pseudo Storm Results

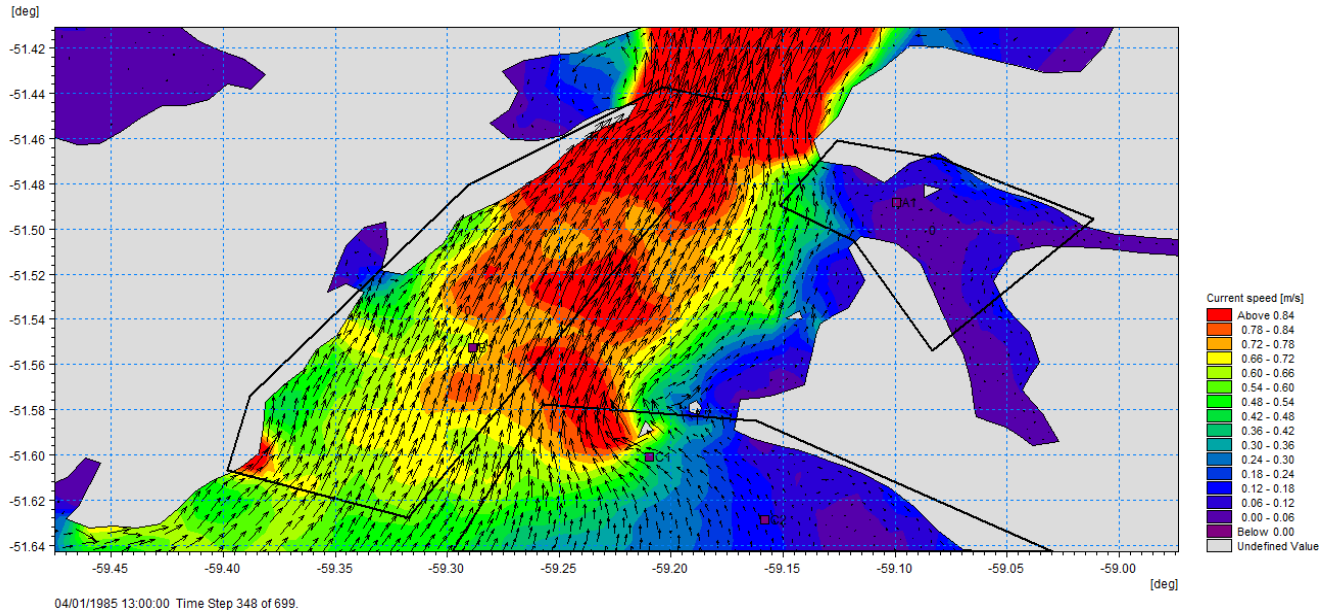


Figure B10 Snapshot of current speeds for peak of 1 in 50 year storm event with a 0°N (North) mean wave direction for zone B1

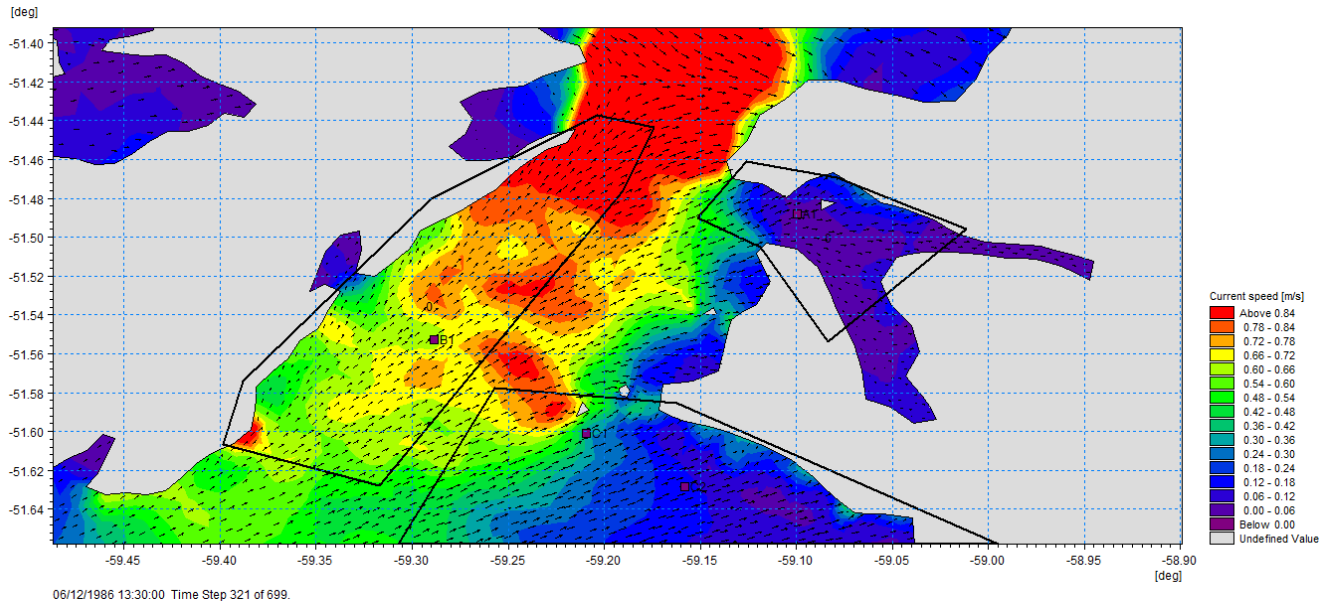


Figure B11 Snapshot of current speeds for peak of 1 in 50 year storm event with a 210°N (South) mean wave direction for zone B1

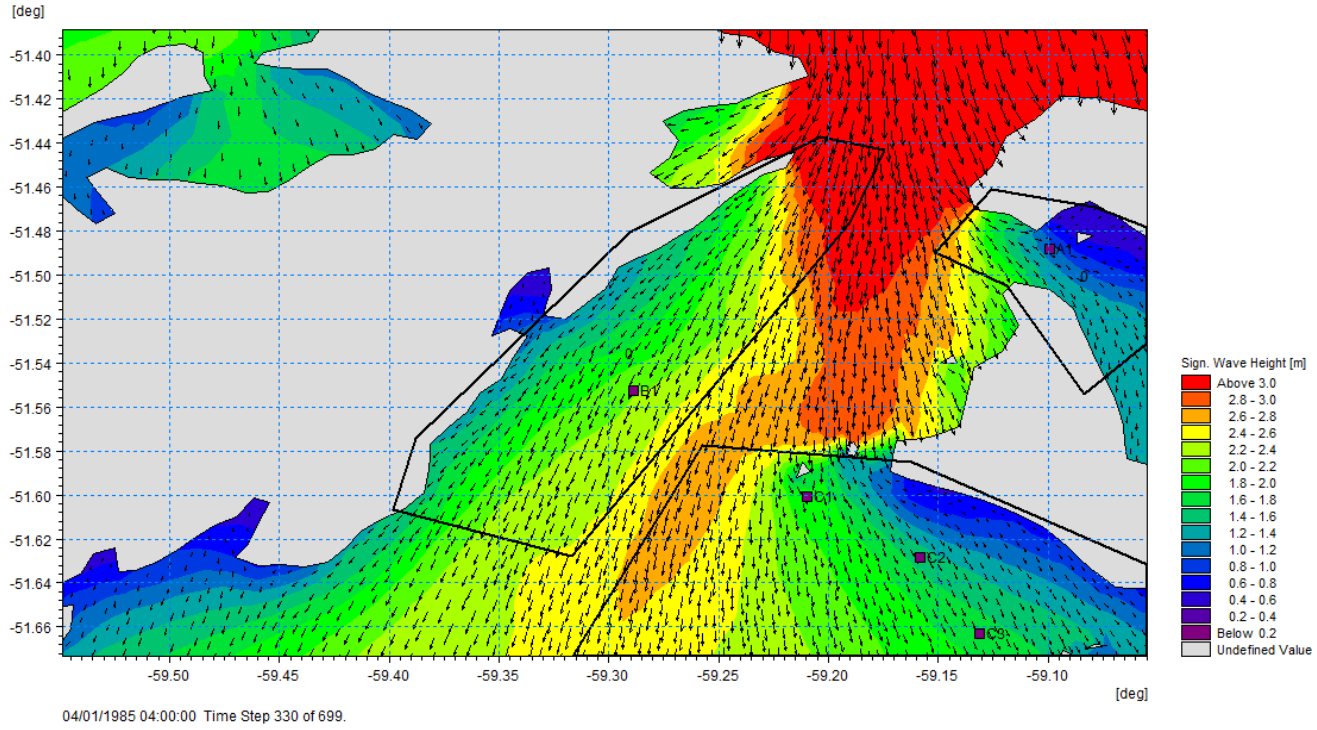


Figure B12 Snapshot of Significant Wave Heights for peak of 1 in 50 year storm event with a 0°N (North) mean wave direction for zone B1

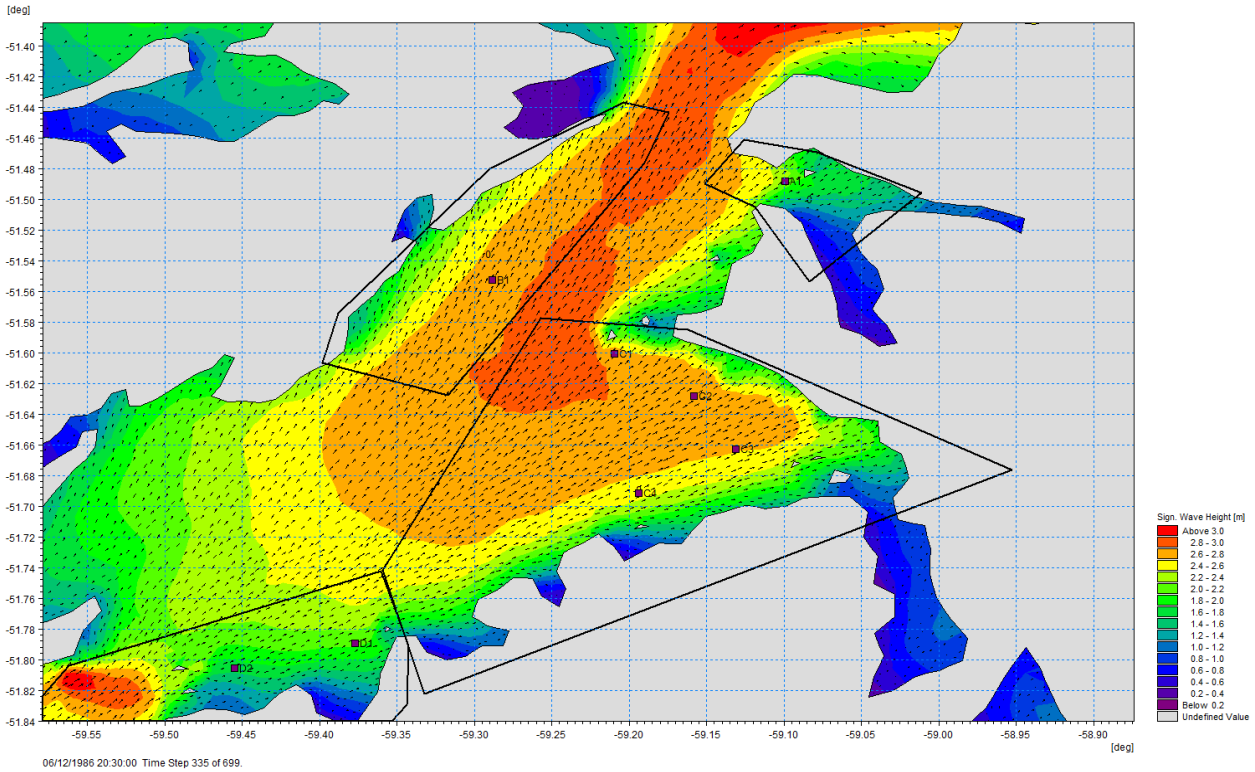


Figure B13 Snapshot of Significant Wave Heights for peak of 1 in 50 year storm event with a 210°N (South) mean wave direction for zone B1

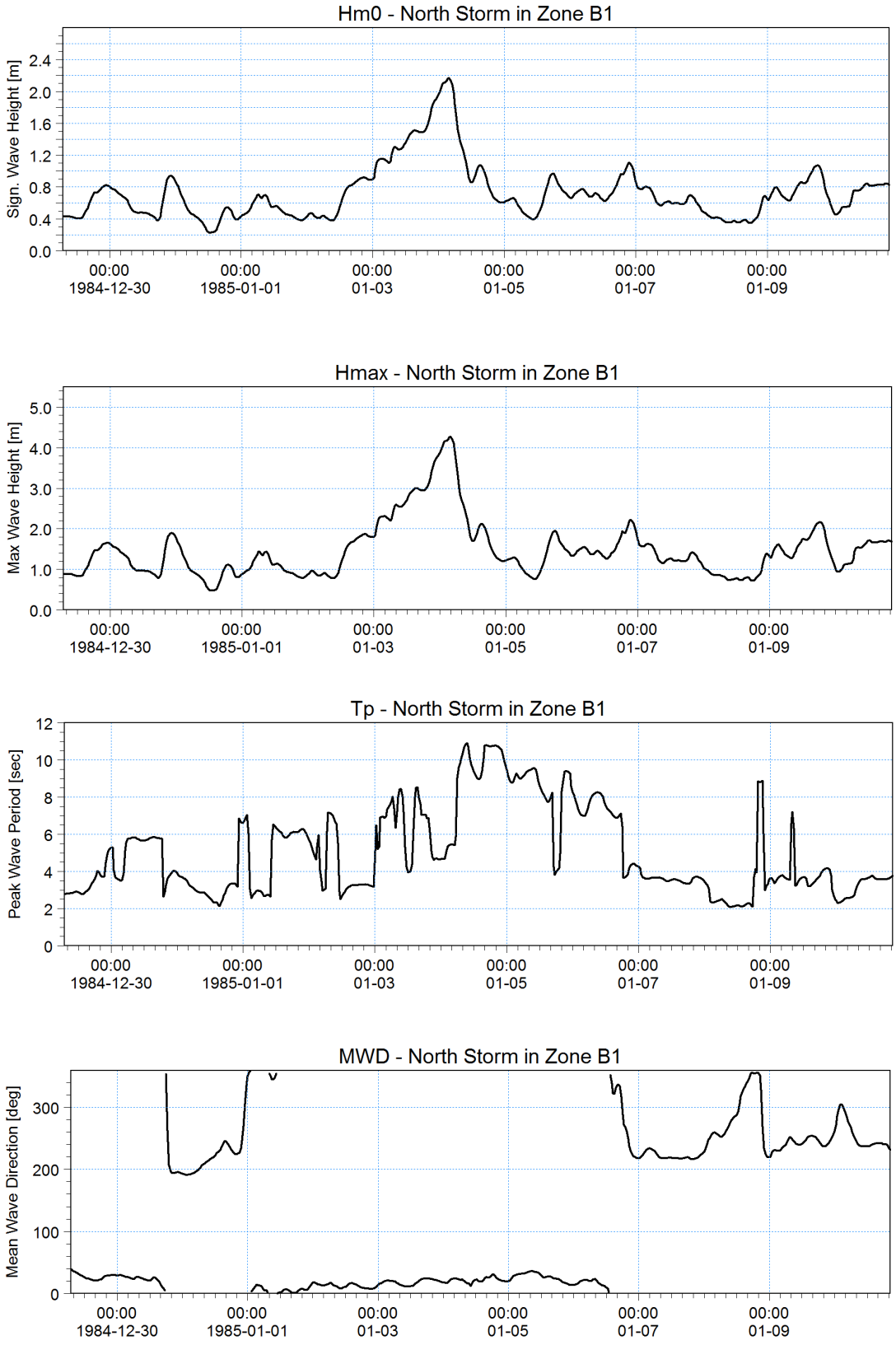


Figure B14 Coupled Model nearshore wave parameters for Peak 1 in 50 year storm Event propagating from offshore 0°N (North) direction for Zone B1

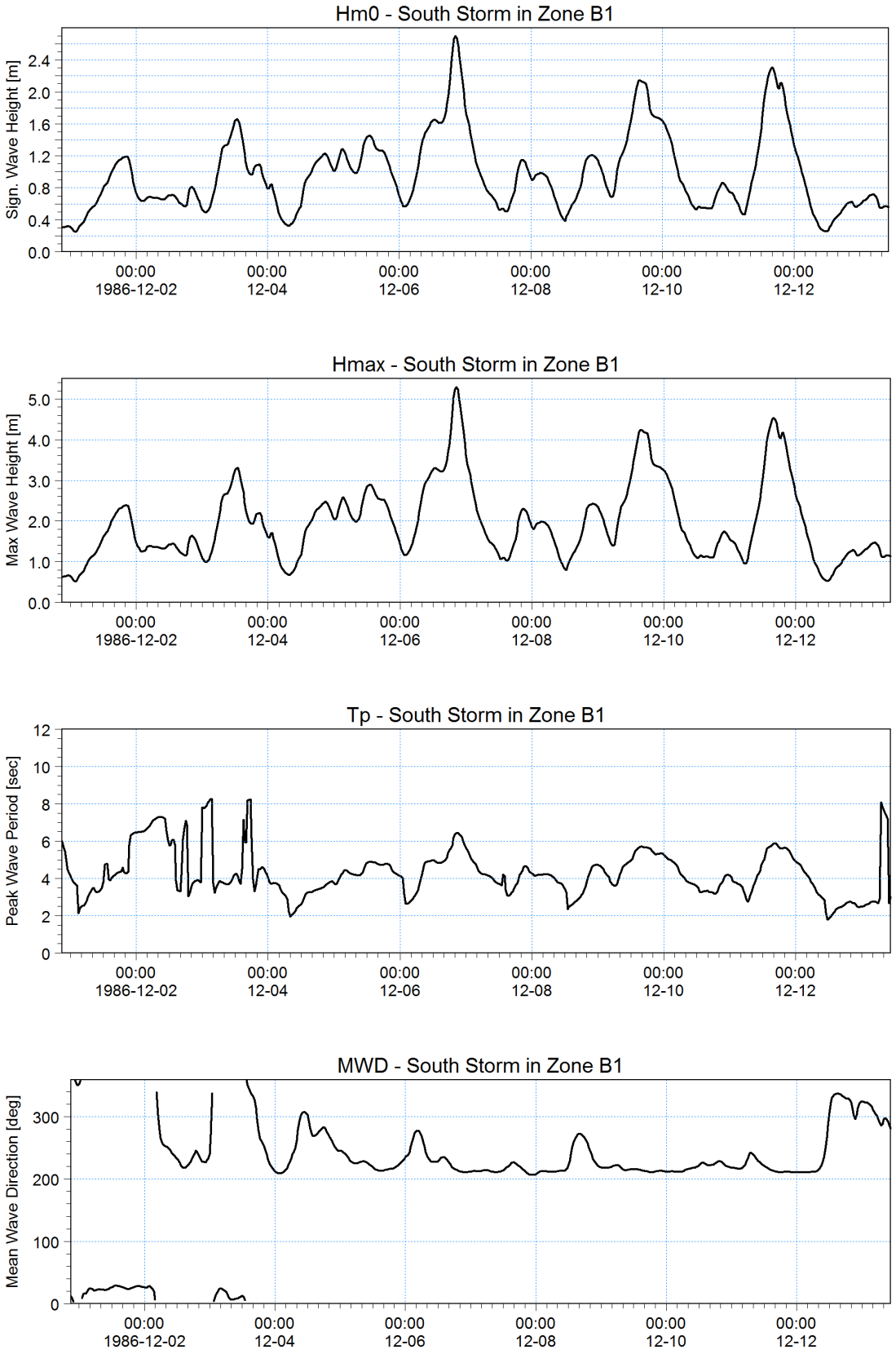


Figure B15 Coupled Model nearshore wave parameters for Peak 1 in 50 year storm Event propagating from offshore 210°N (South) direction for Zone B1

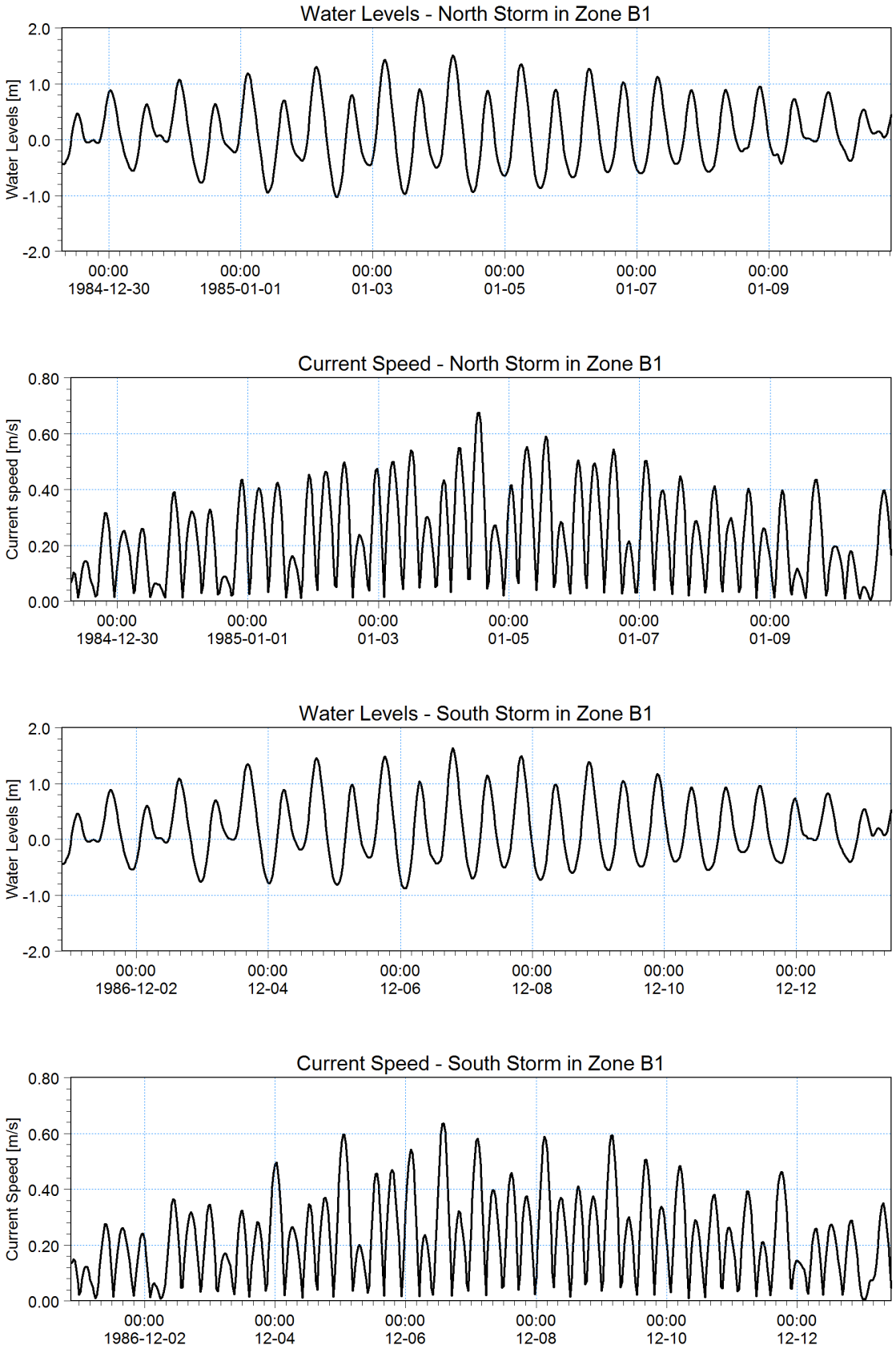


Figure B16 Coupled Model nearshore water level and current speed for a Peak 1 in 50 year storm Event propagating from offshore 0°N (North) and 210°N (South) direction for Zone B1

Appendix C

Setup information and results for Site C4

Bathymetry and Mesh

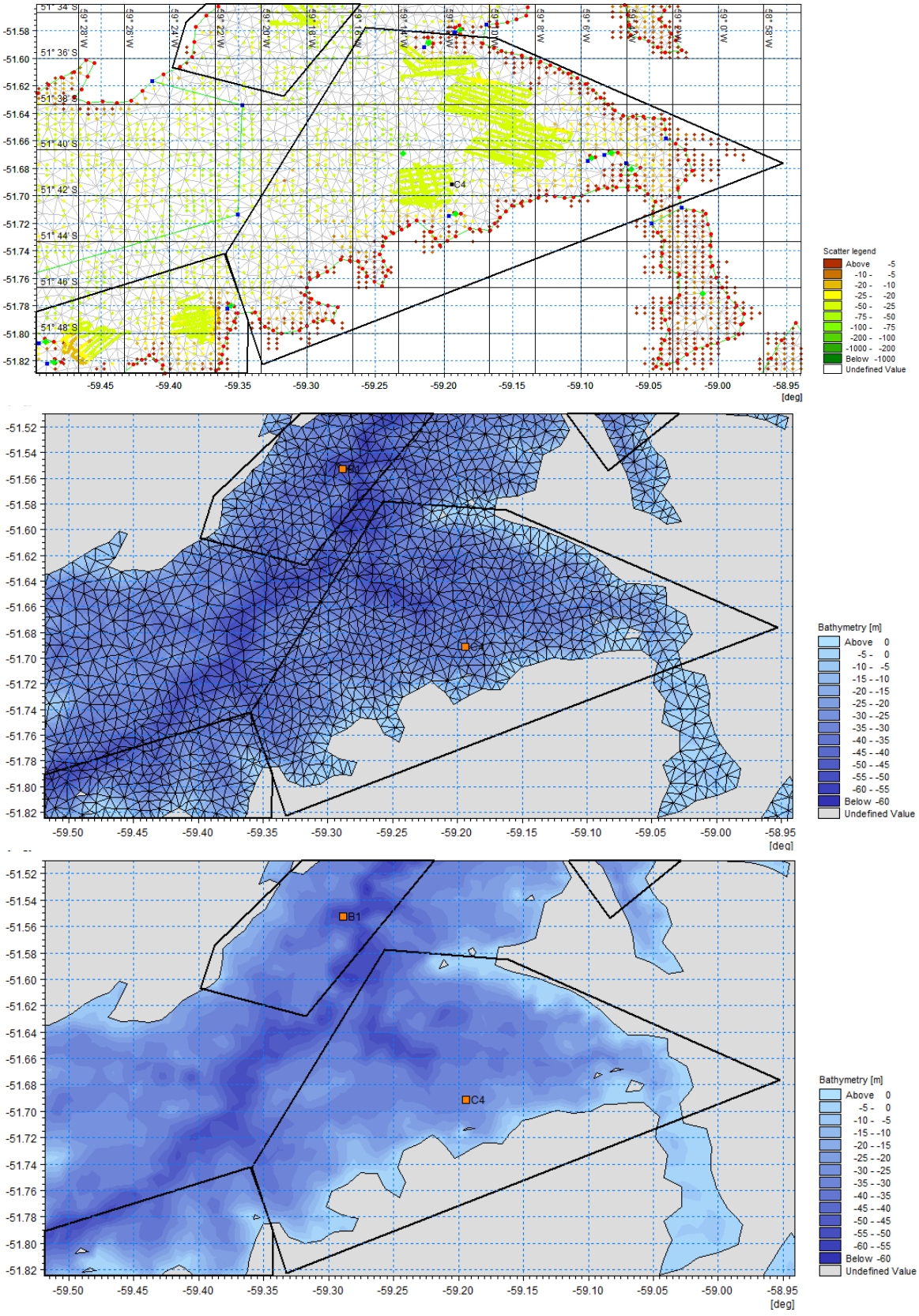


Figure C1 (Top) Input data - CMAP & provided bathymetry data points and CMAP land data (Middle) Created Mesh with underlying Bathymetry (Bottom) Interpolated Bathymetry

Uncoupled SW Model – 1 in 1 year storm

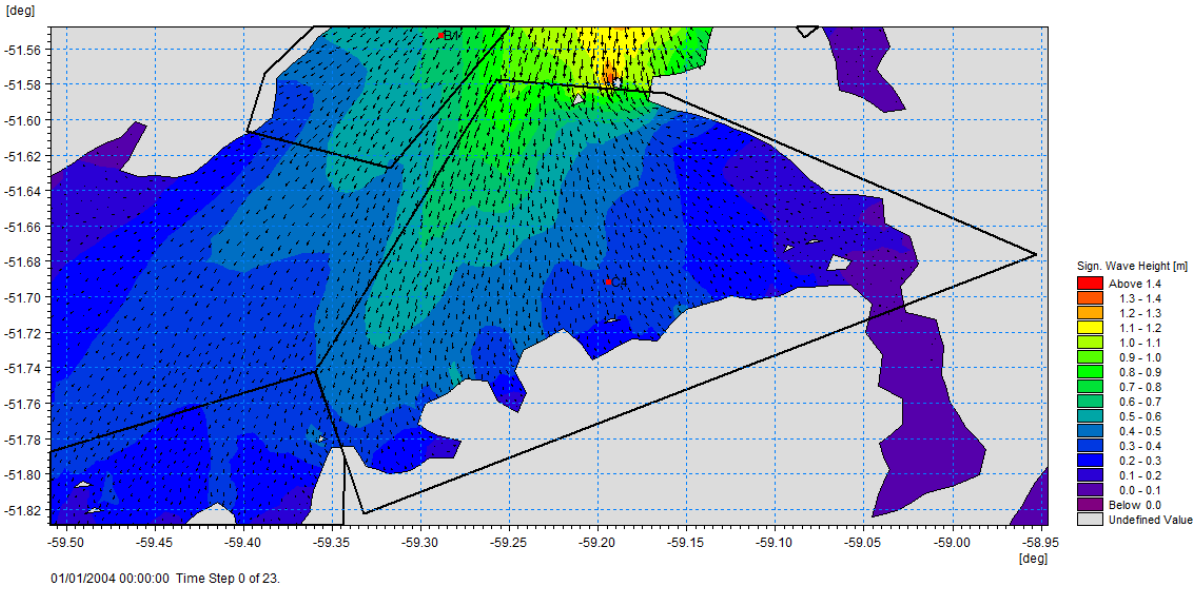


Figure C2 Significant wave heights for 1 in 1 Year Return Period wave transformation for 0°N mean wave direction

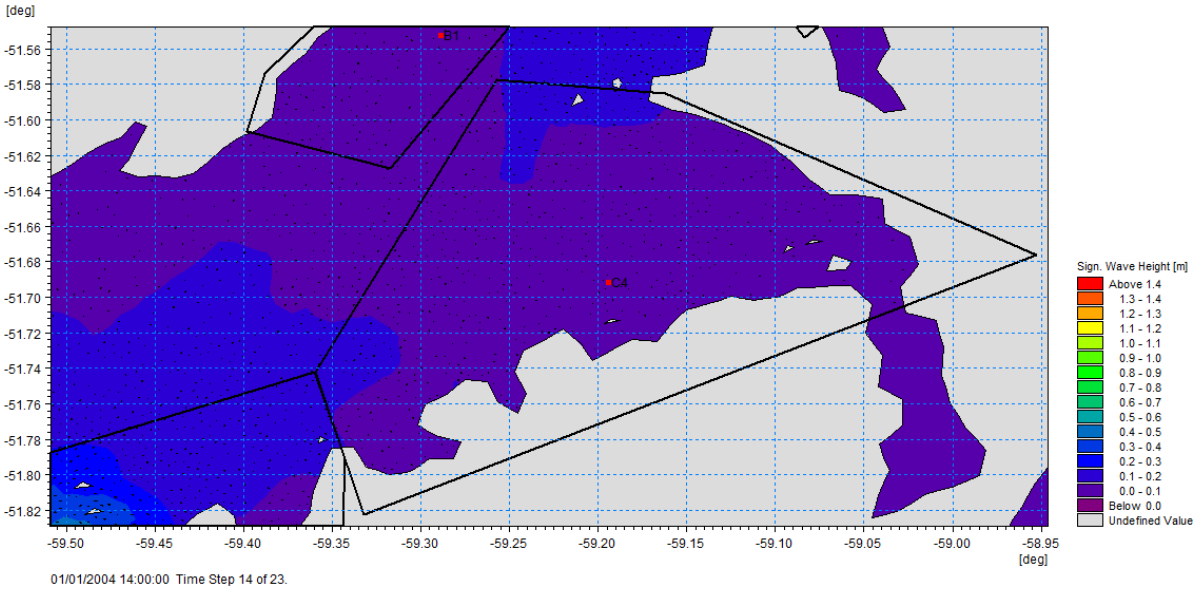


Figure C3 Significant wave heights for 1 in 1 Year Return Period wave transformation for 210°N mean wave direction

Uncoupled SW Model – 1 in 50 year storm

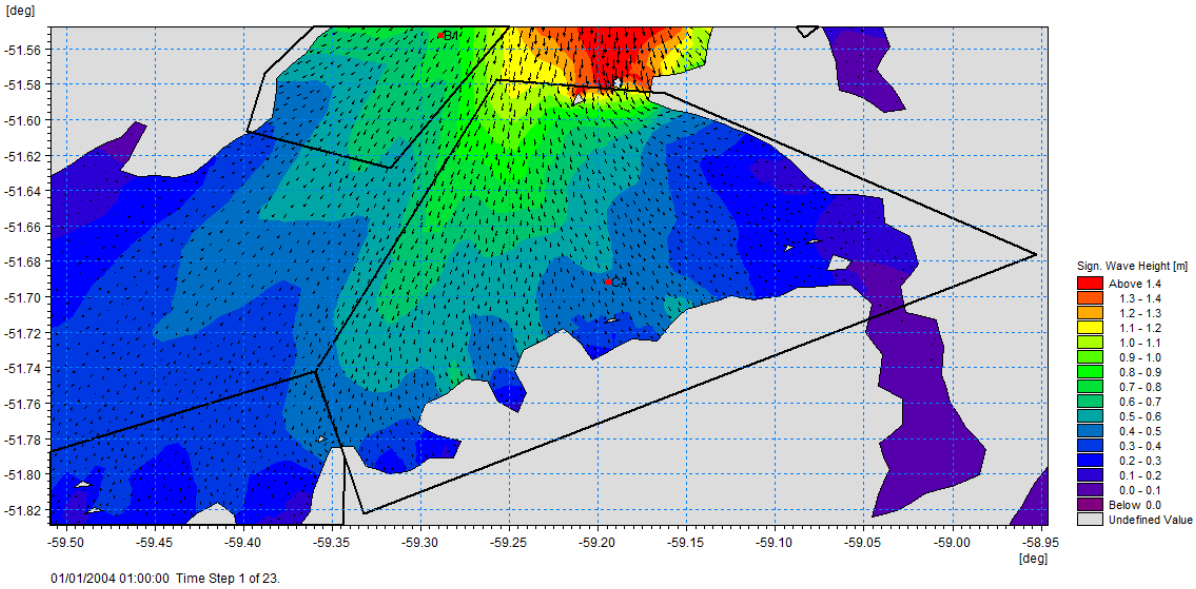


Figure C4 Significant wave heights for 1 in 50 Year Return Period wave transformation for 0°N mean wave direction

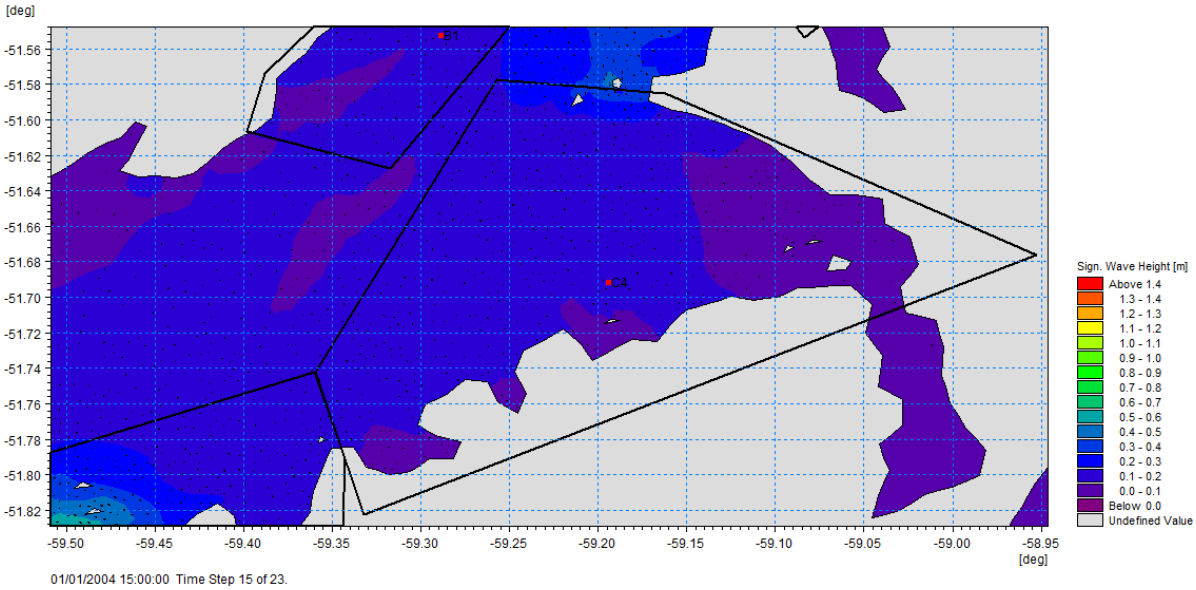


Figure C5 Significant wave heights for 1 in 50 Year Return Period wave transformation for 210°N mean wave direction

Coupled Model – Statistical Overview

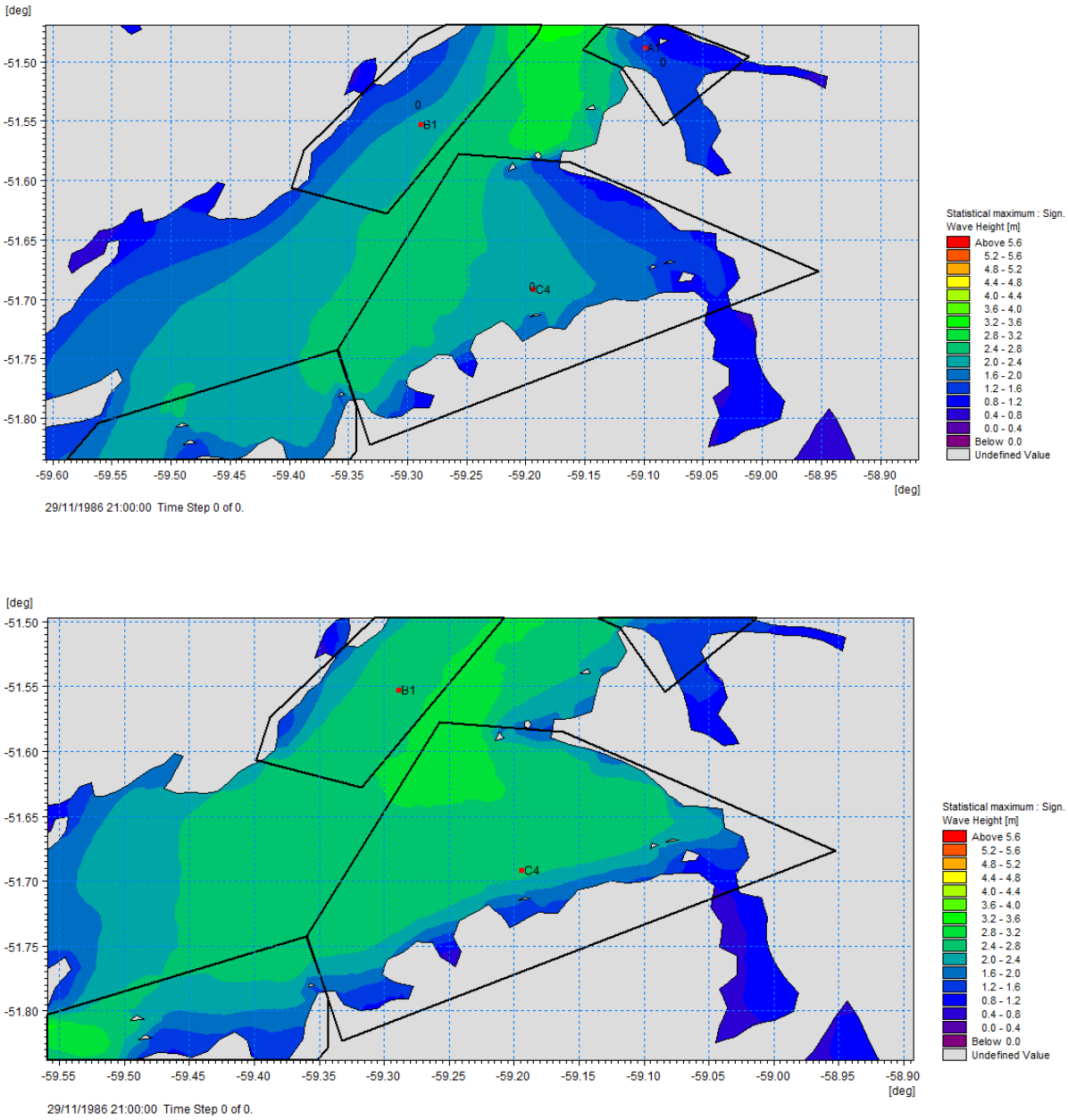


Figure C6 Statistical maximum H_{mo} for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

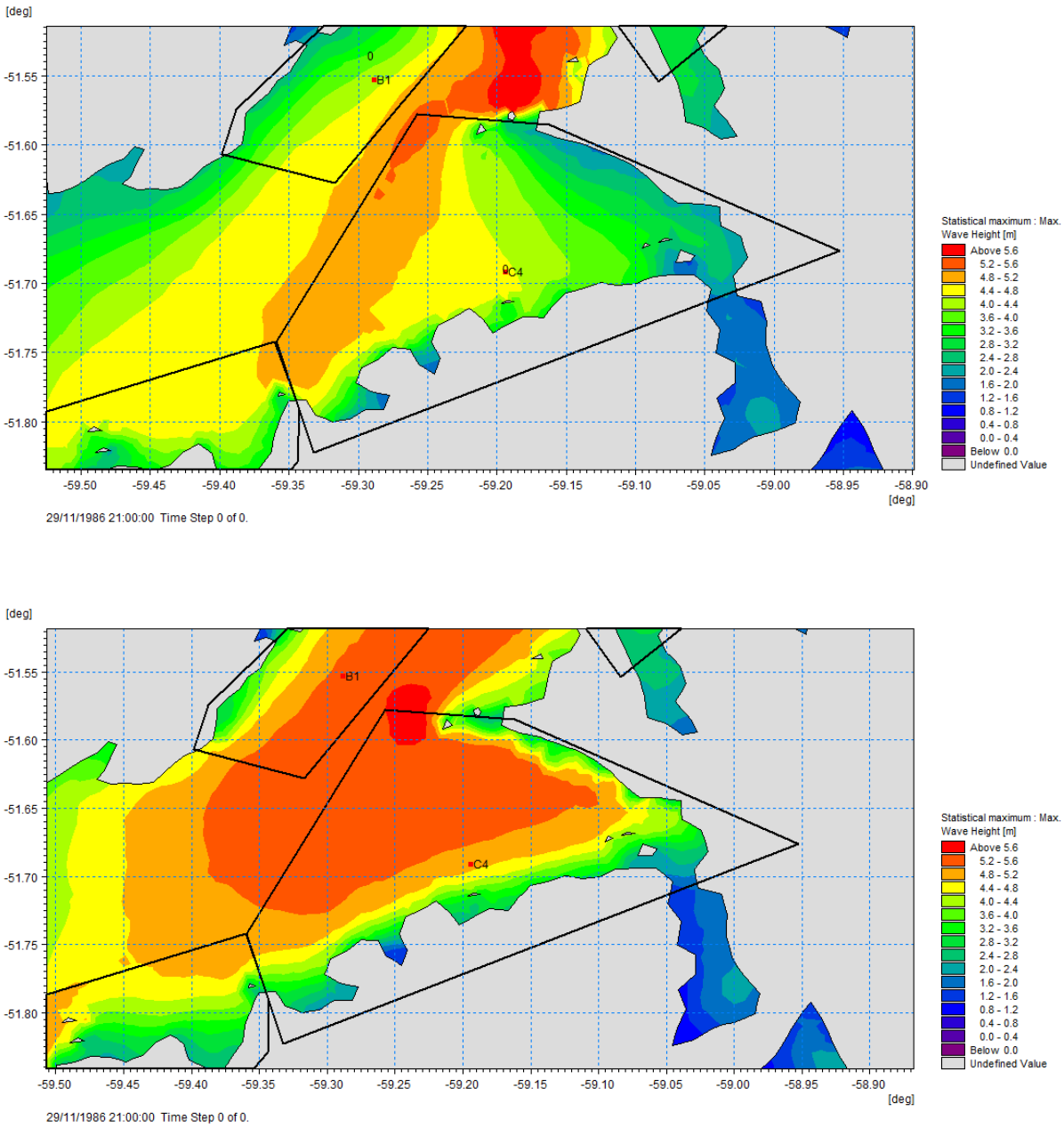


Figure C7 Statistical maximum Hmax for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

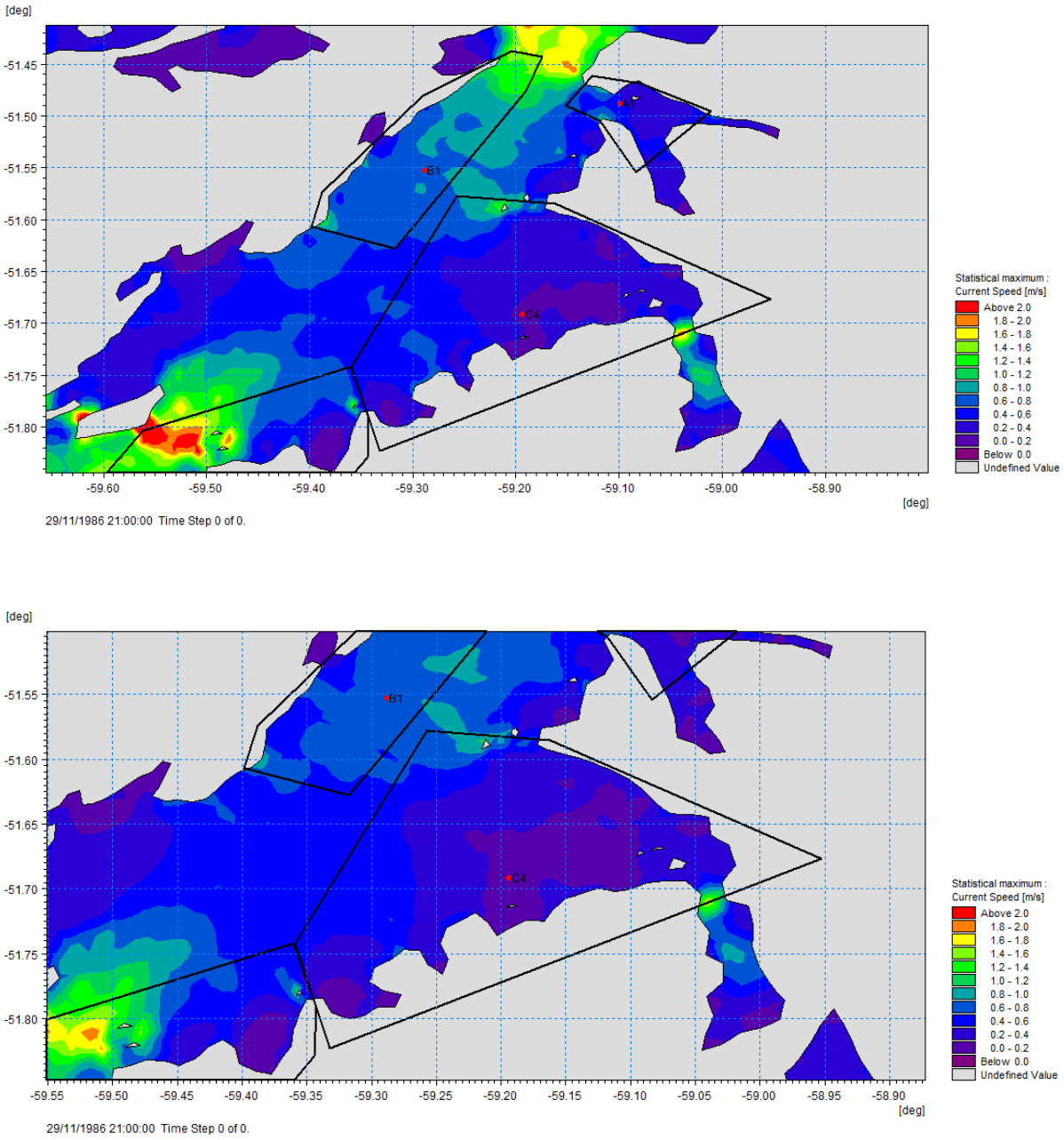


Figure C8 Max Current Speed for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

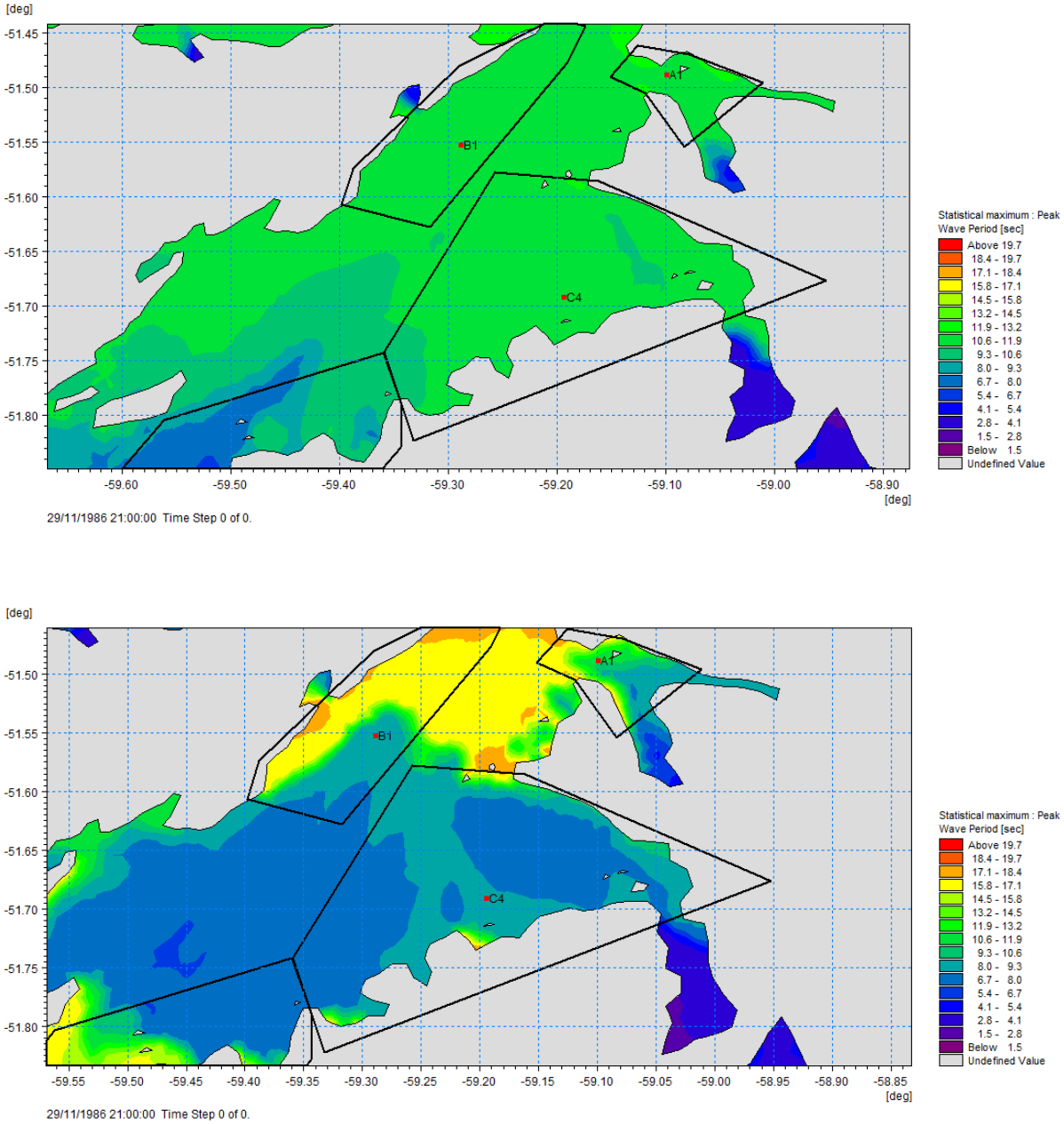


Figure C9 Max Peak Wave Period (Tp) for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

Coupled Model – Pseudo Storm Results

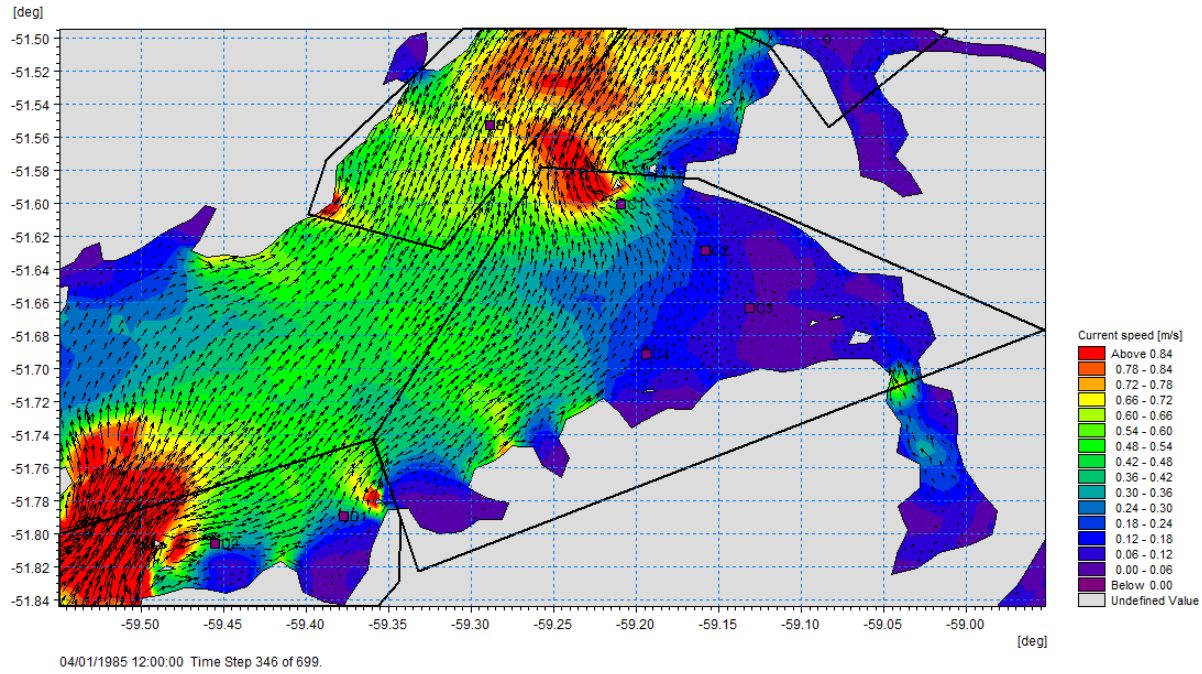


Figure C10 Snapshot of current speeds for peak of 1 in 50 year storm event with a 0°N (North) mean wave direction for zone C4

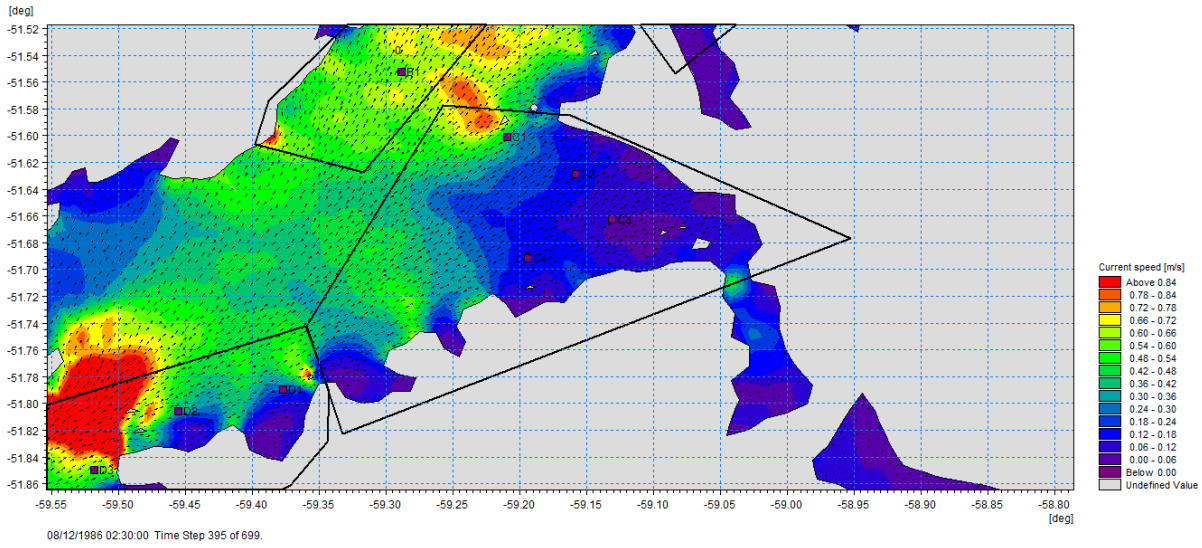


Figure C11 Snapshot of current speeds for peak of 1 in 50 year storm event with a 210°N (South) mean wave direction for zone C4

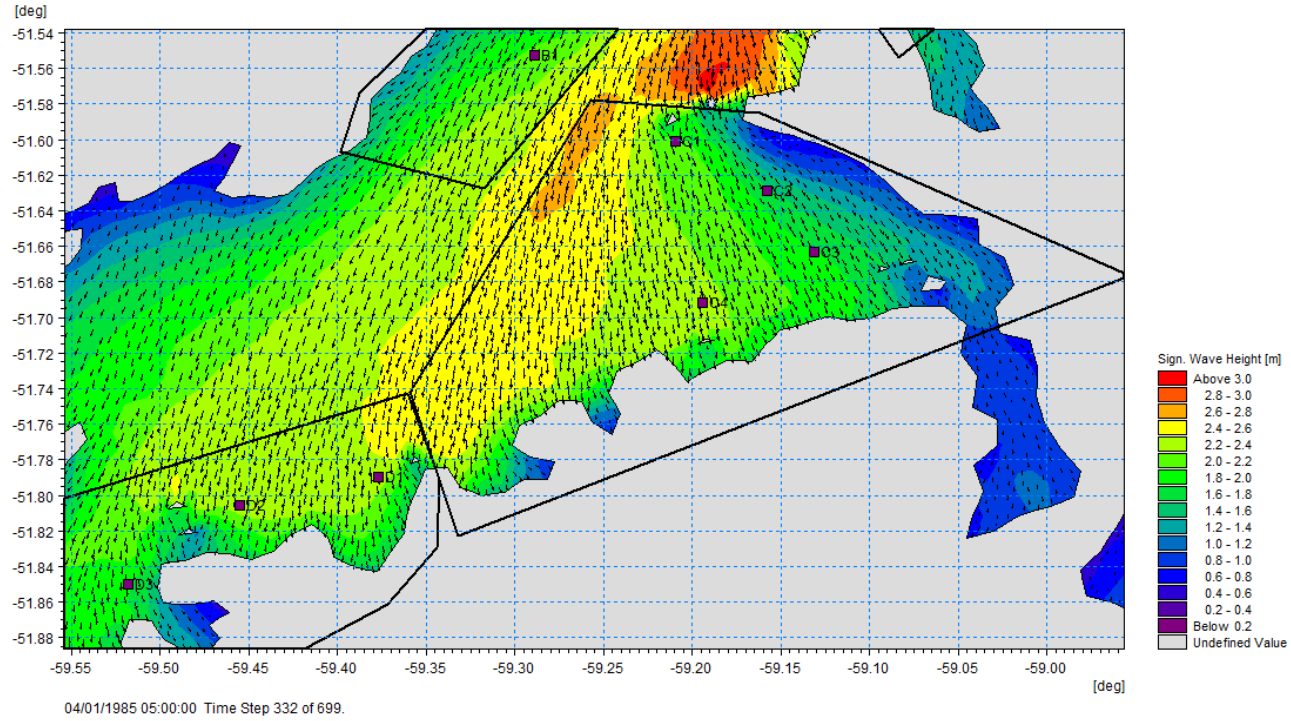


Figure C12 Snapshot of Significant Wave Heights for peak of 1 in 50 year storm event with a 0°N (North) mean wave direction for zone C4

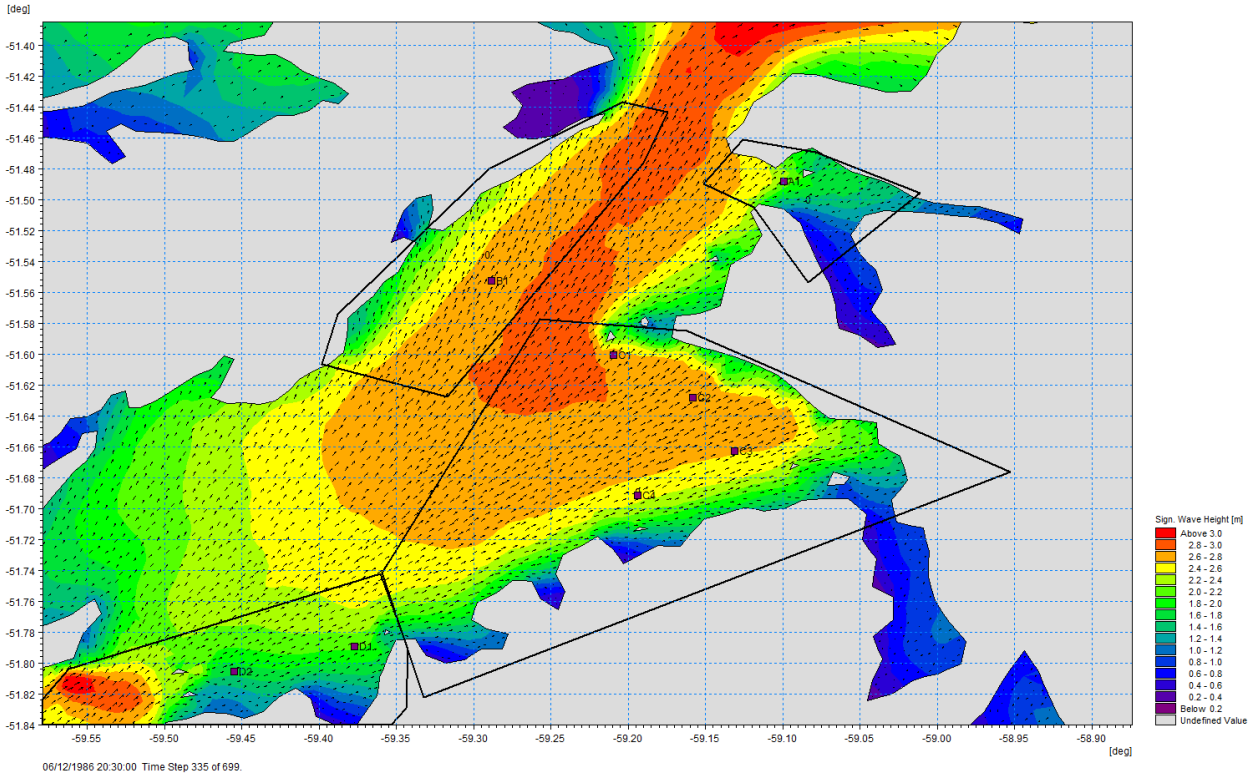


Figure C13 Snapshot of Significant Wave Heights for peak of 1 in 50 year storm event with a 210°N (South) mean wave direction for zone C4

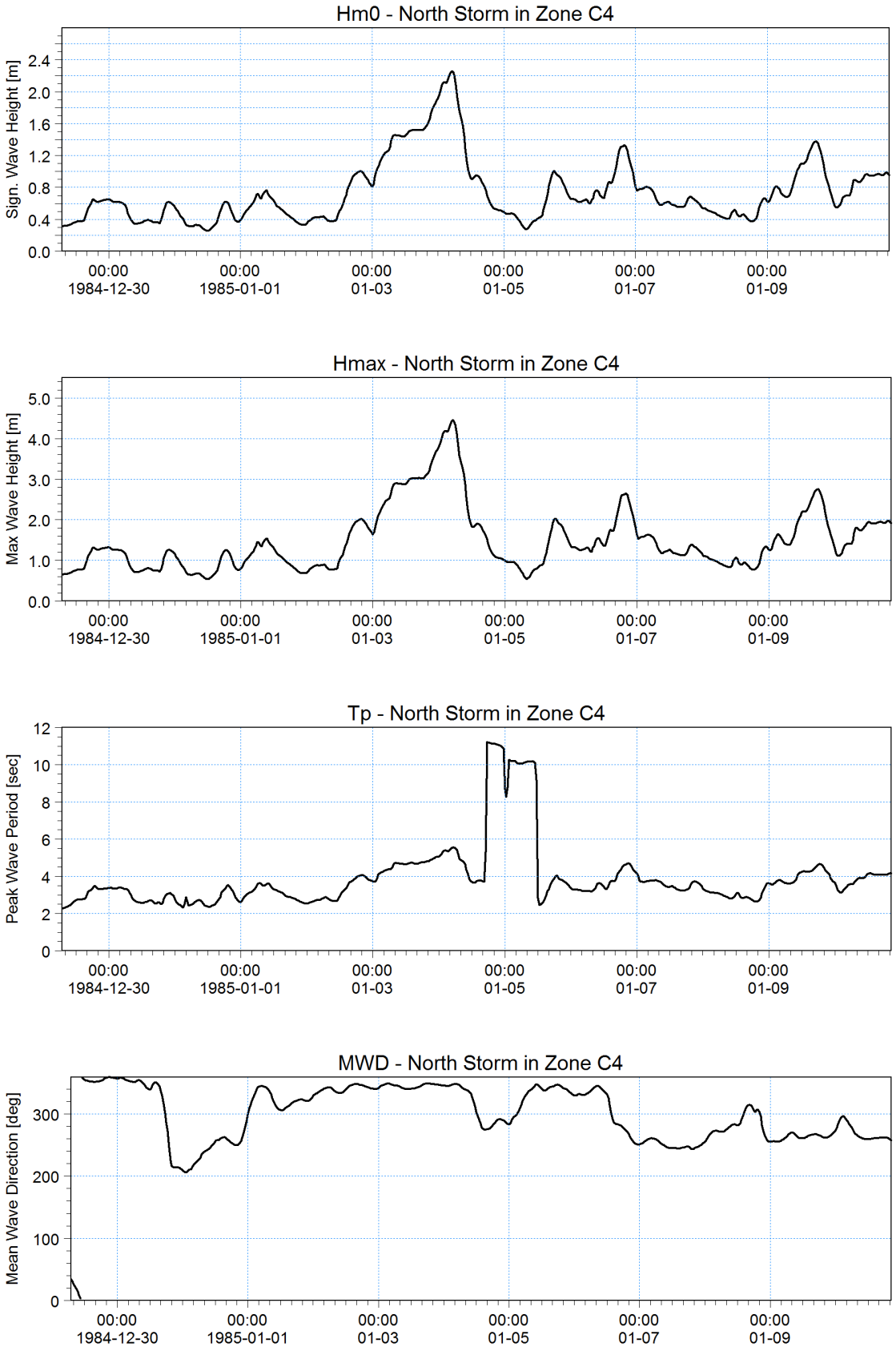


Figure C14 Coupled Model nearshore wave parameters for Peak 1 in 50 year storm Event propagating from offshore 0°N (North) direction for Zone C4

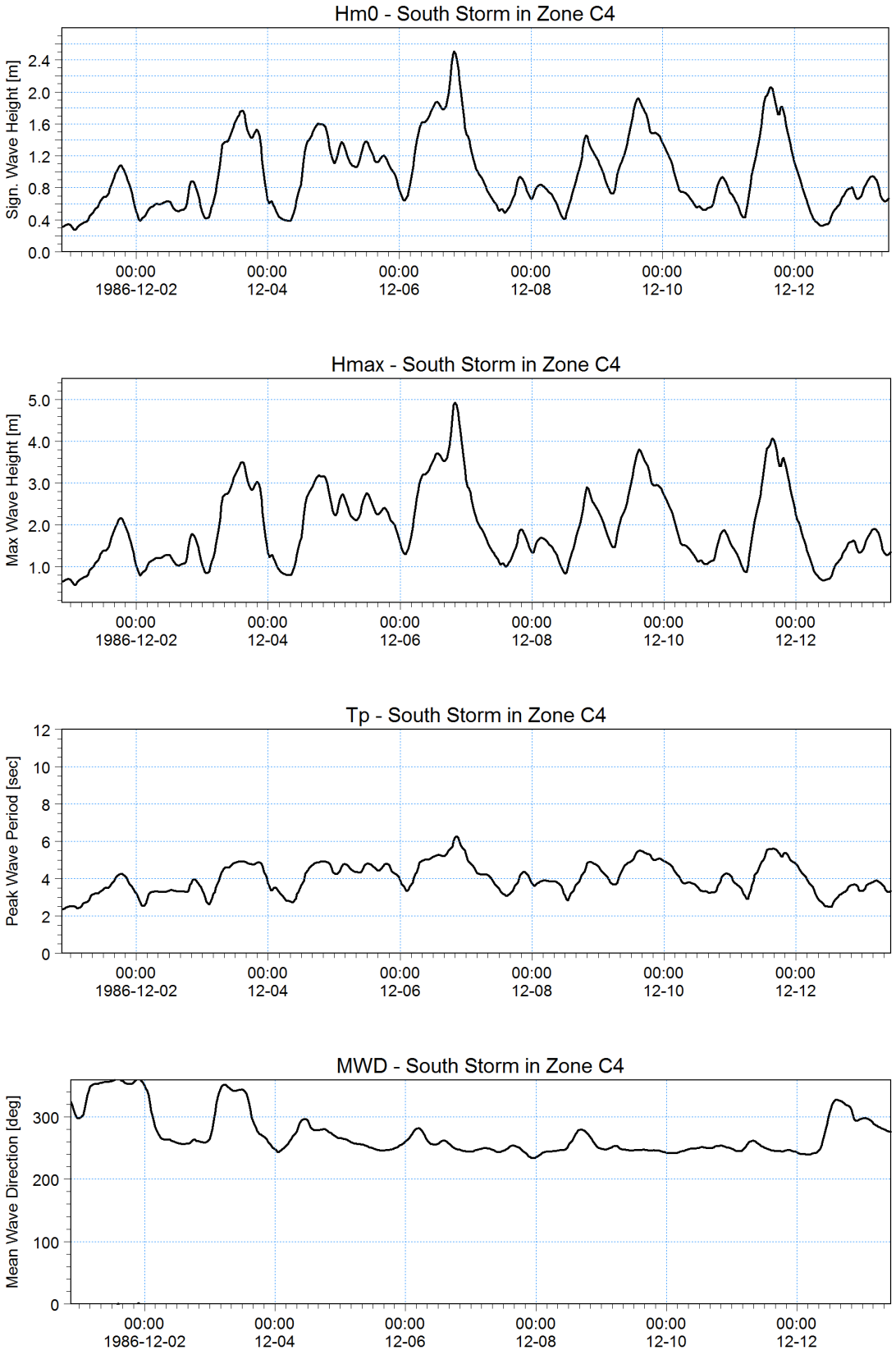


Figure C15 Coupled Model nearshore wave parameters for Peak 1 in 50 year storm Event propagating from offshore 210°N (South) direction for Zone C4

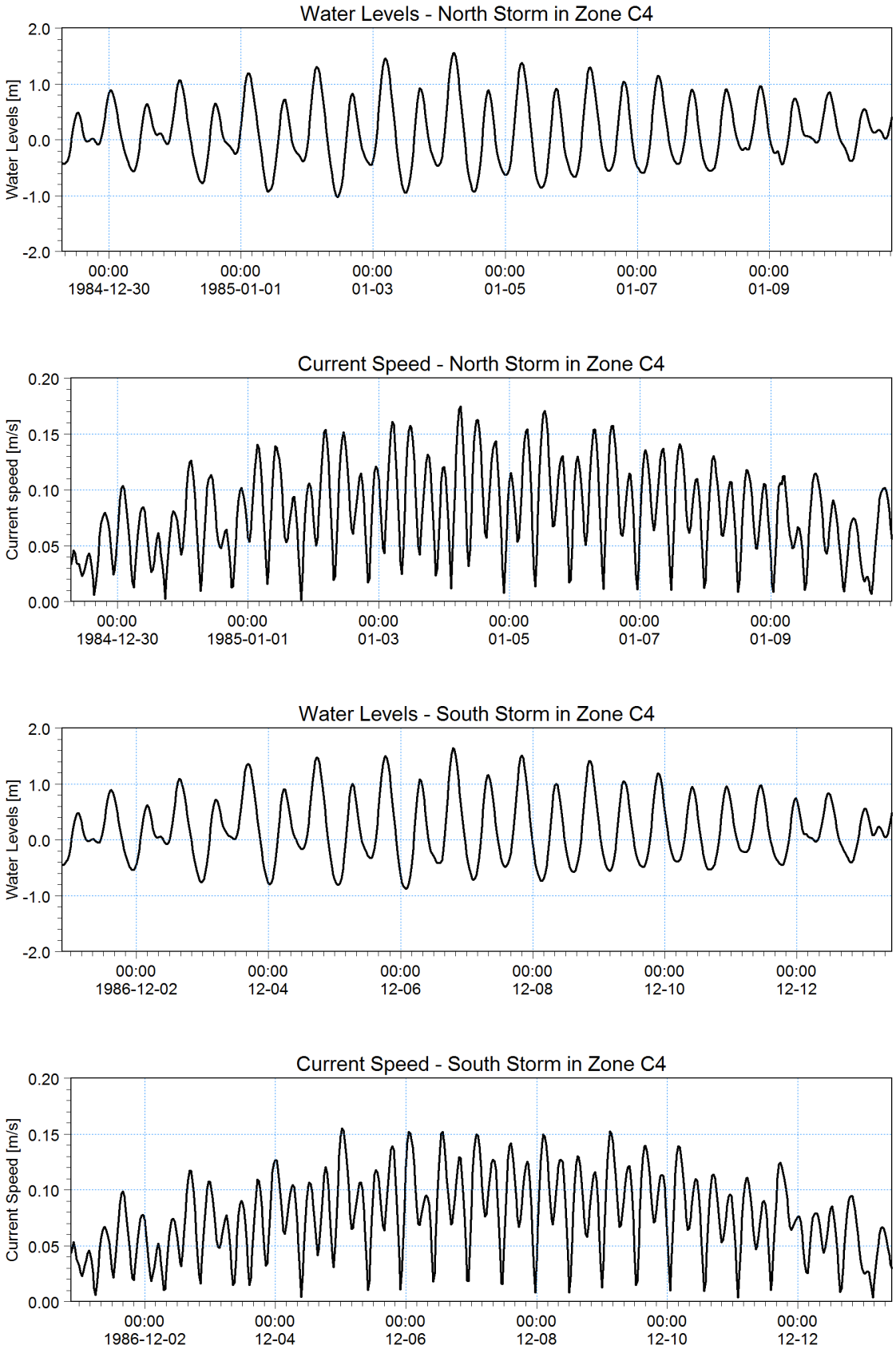


Figure C16 Coupled Model nearshore water level and current speed for a Peak 1 in 50 year storm Event propagating from offshore 0°N (North) and 210°N (South) direction for Zone C4

Appendix D

Setup information and results for Site D3

Bathymetry and Mesh

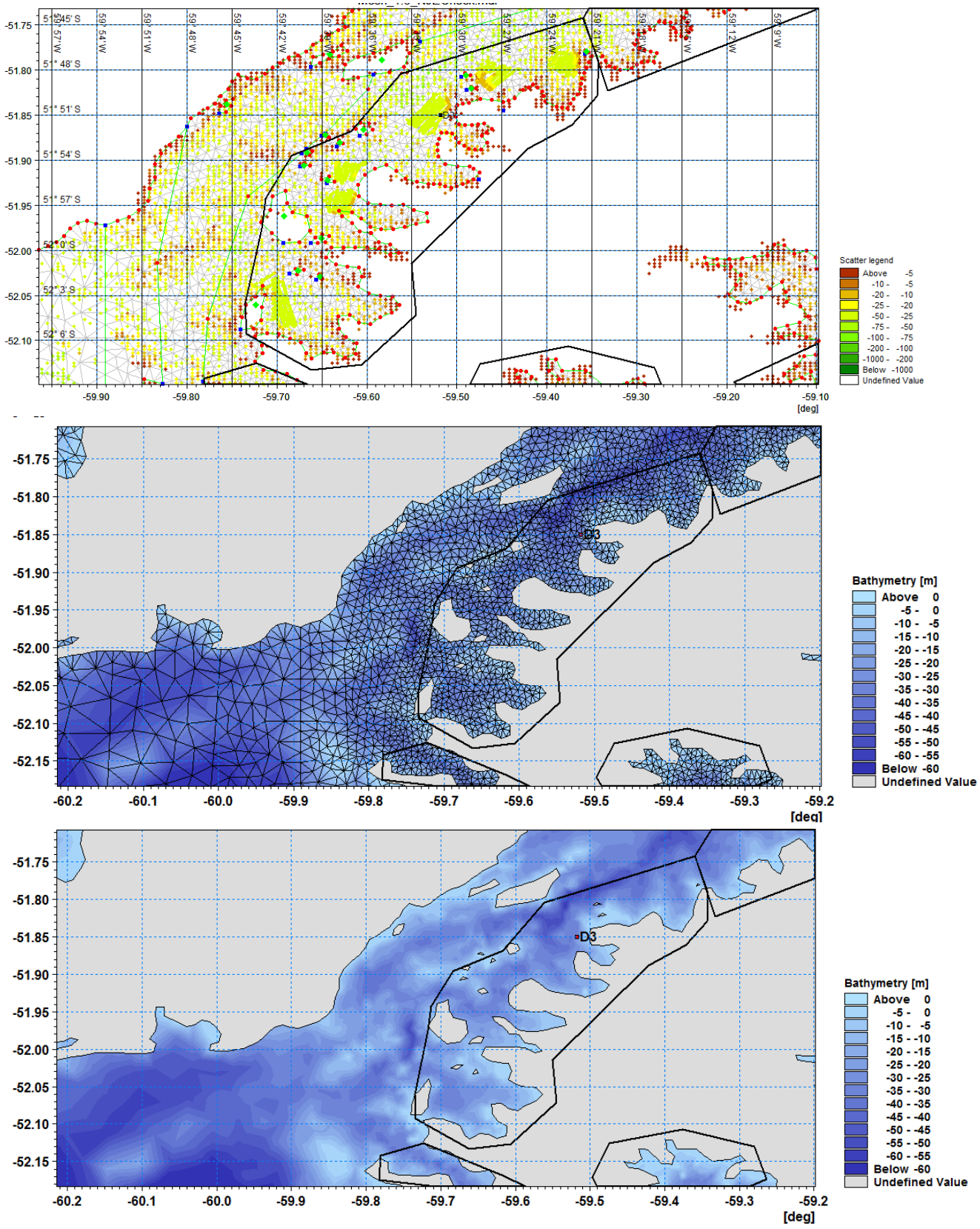


Figure D1 (Top) Input data - CMAP & provided bathymetry data points and CMAP land data (Middle) Created Mesh with underlying Bathymetry (Bottom) Interpolated Bathymetry

Uncoupled SW Model – 1 in 1 year storm

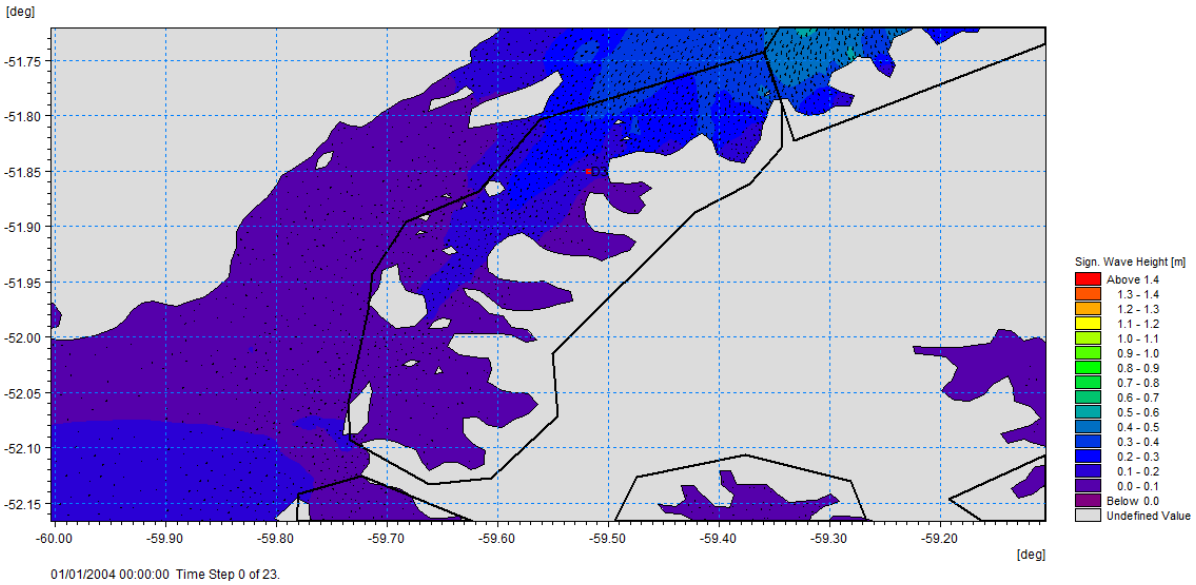


Figure D2 Significant wave heights for 1 in 1 Year Return Period wave transformation for 0°N mean wave direction

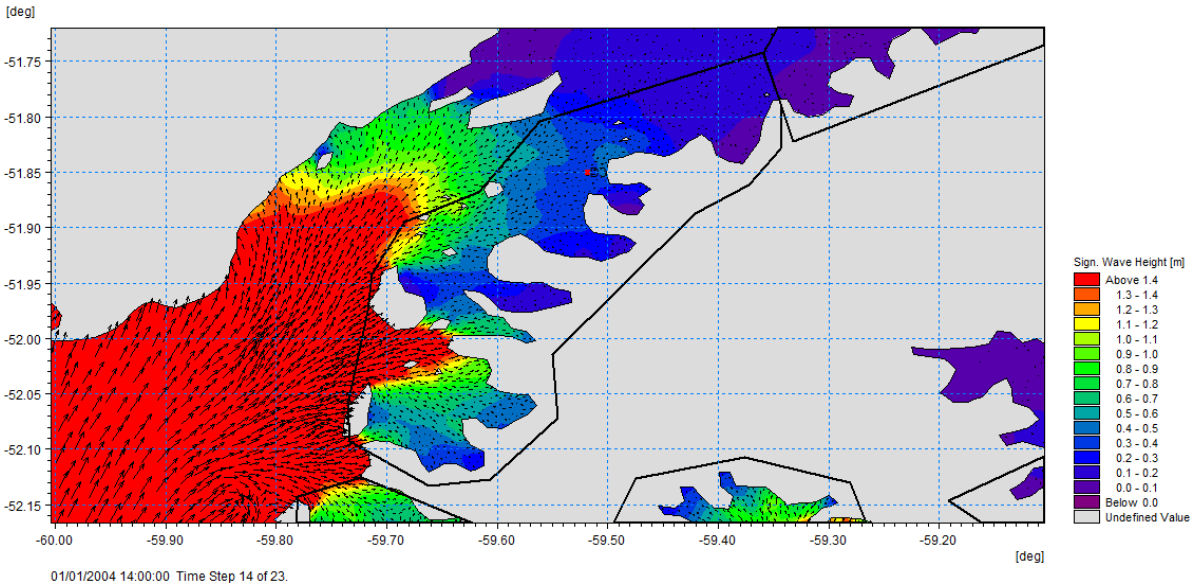


Figure D3 Significant wave heights for 1 in 1 Year Return Period wave transformation for 210°N mean wave direction

Uncoupled SW Model – 1 in 50 year storm

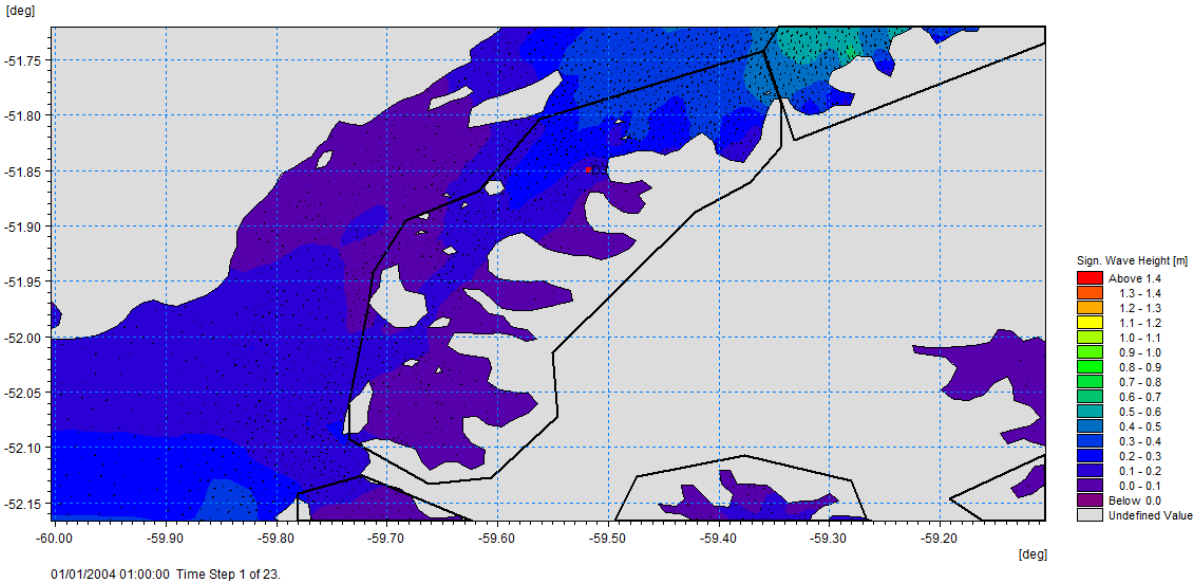


Figure D4 Significant wave heights for 1 in 50 Year Return Period wave transformation for 0°N mean wave direction

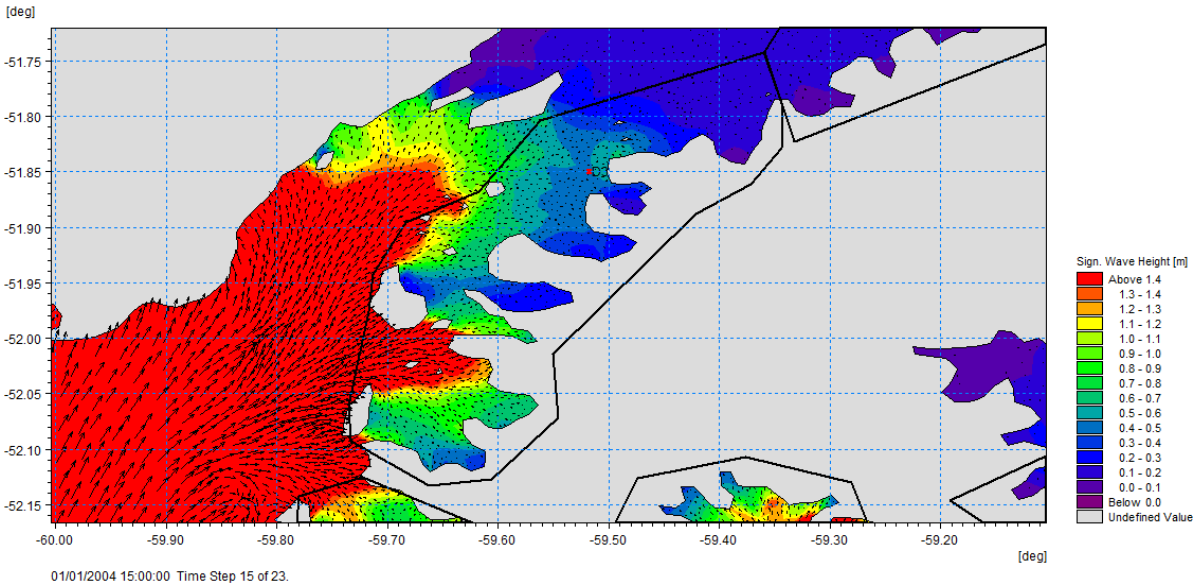


Figure D5 Significant wave heights for 1 in 50 Year Return Period wave transformation for 210°N mean wave direction

Coupled Model – Statistical Overview

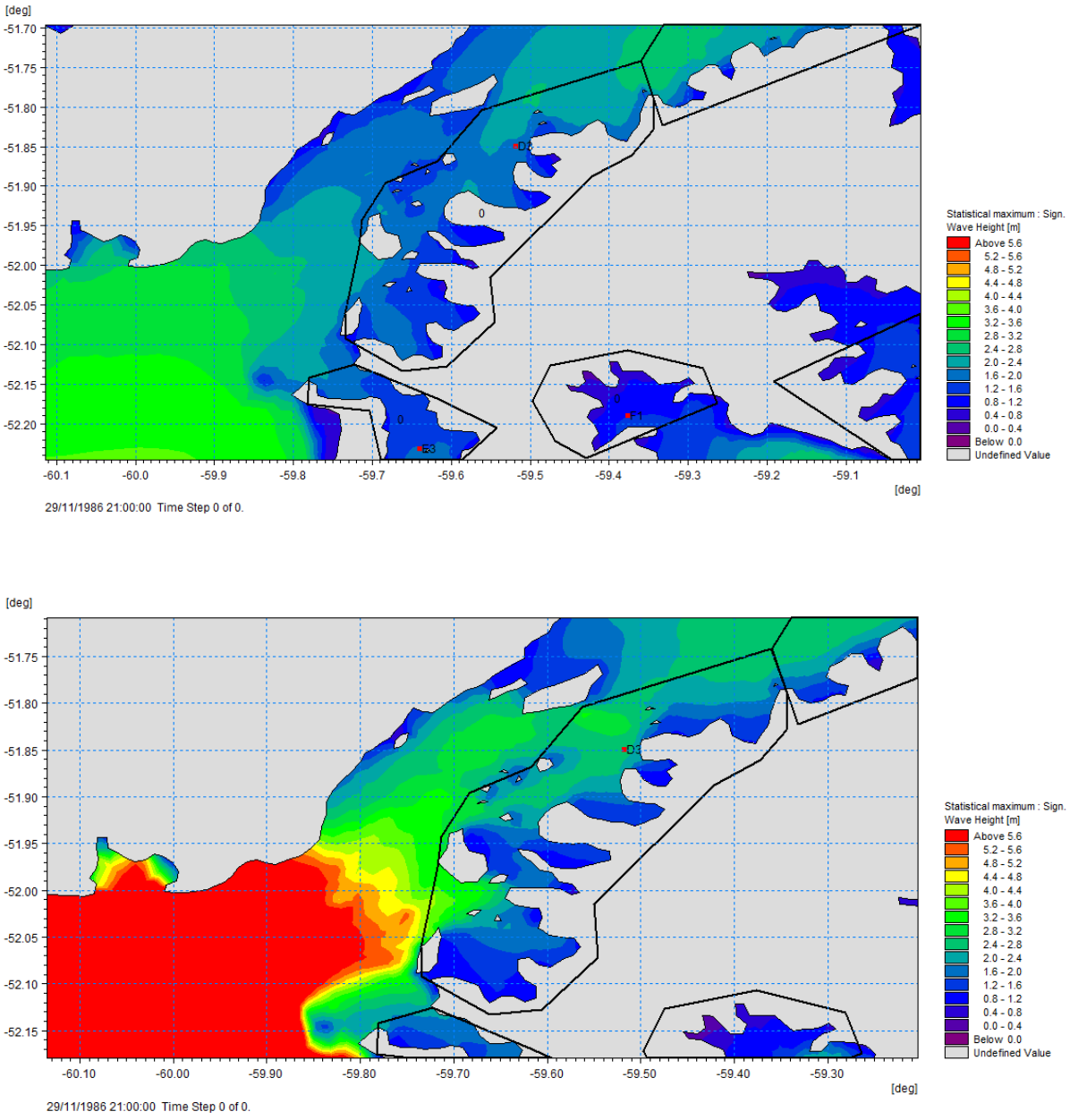
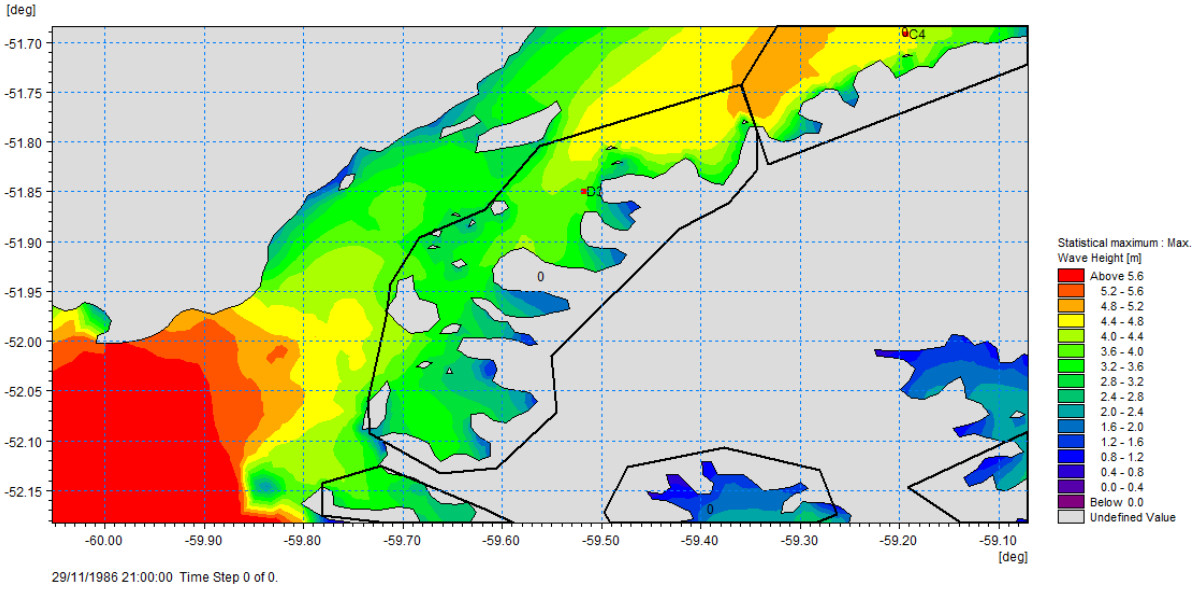


Figure D6 Statistical maximum H_{mo} for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event



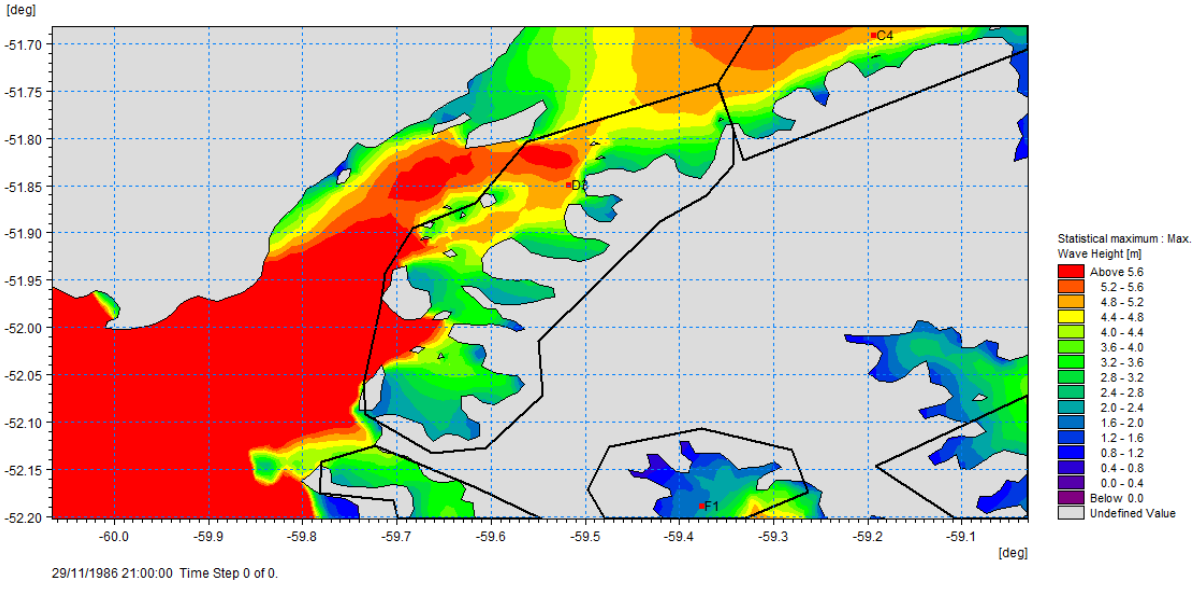


Figure D7 Statistical maximum Hmax for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

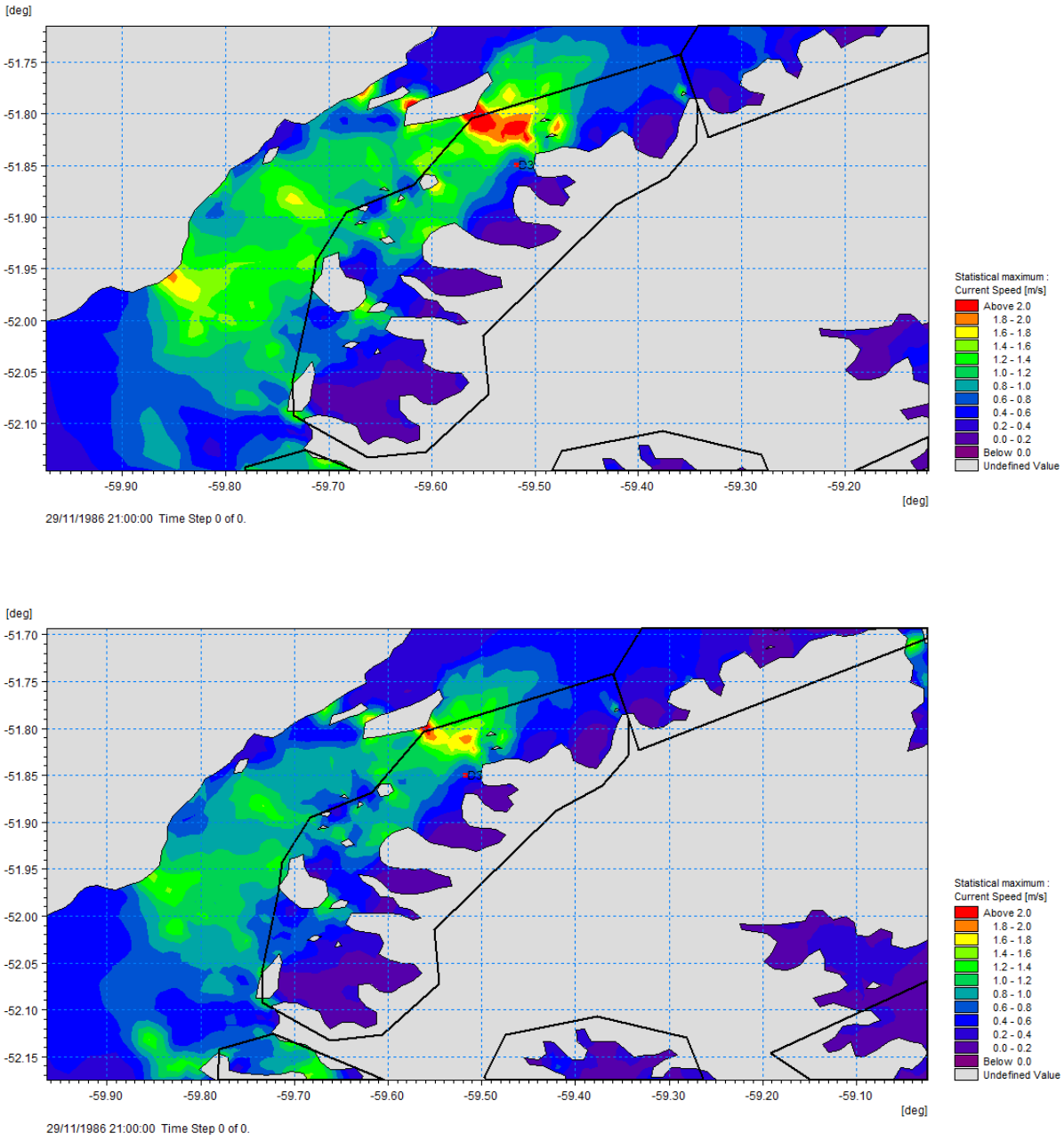


Figure D8 Max Current Speed for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

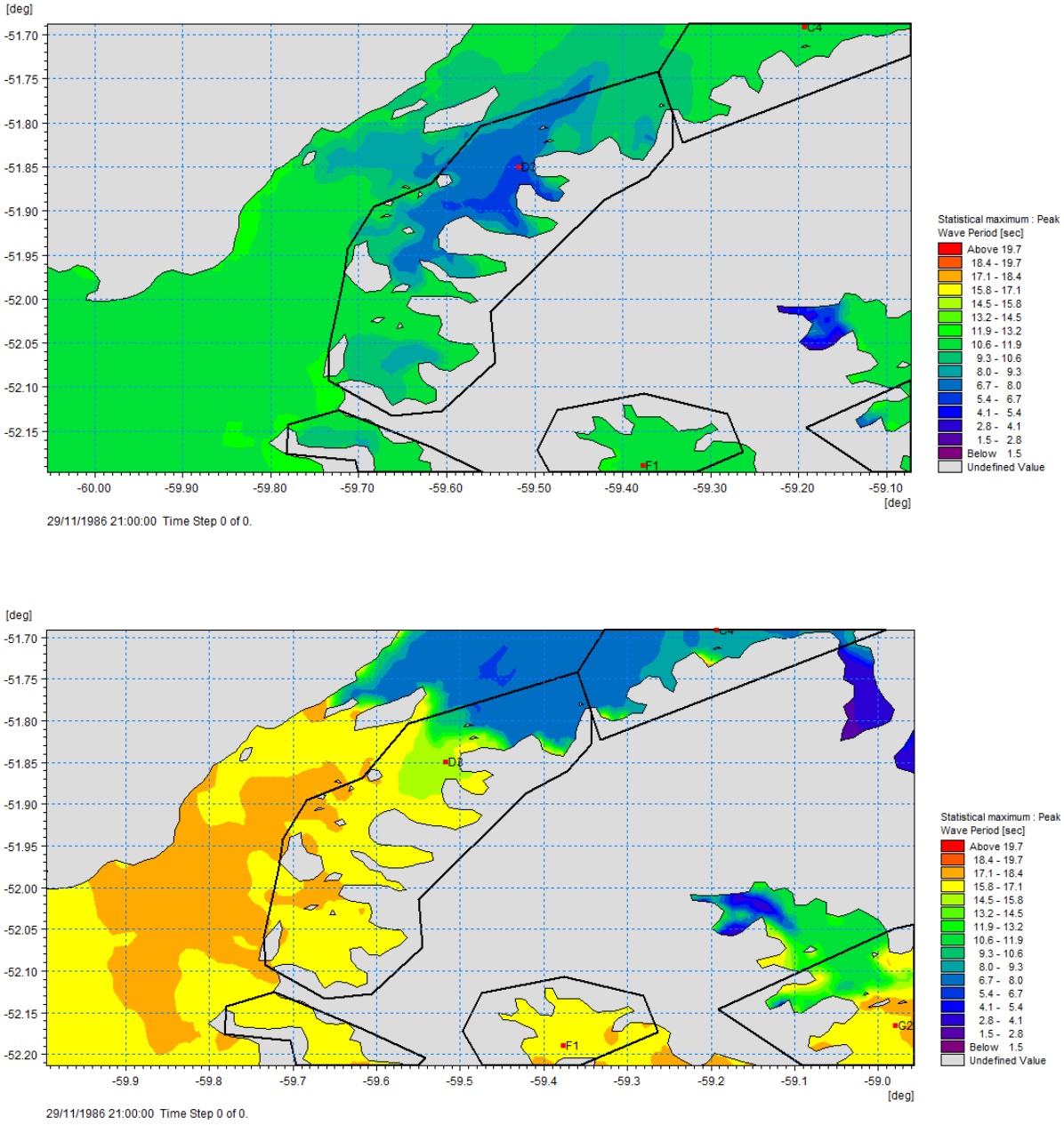


Figure D9 Max Peak Wave Period (Tp) for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

Coupled Model – Pseudo Storm Results

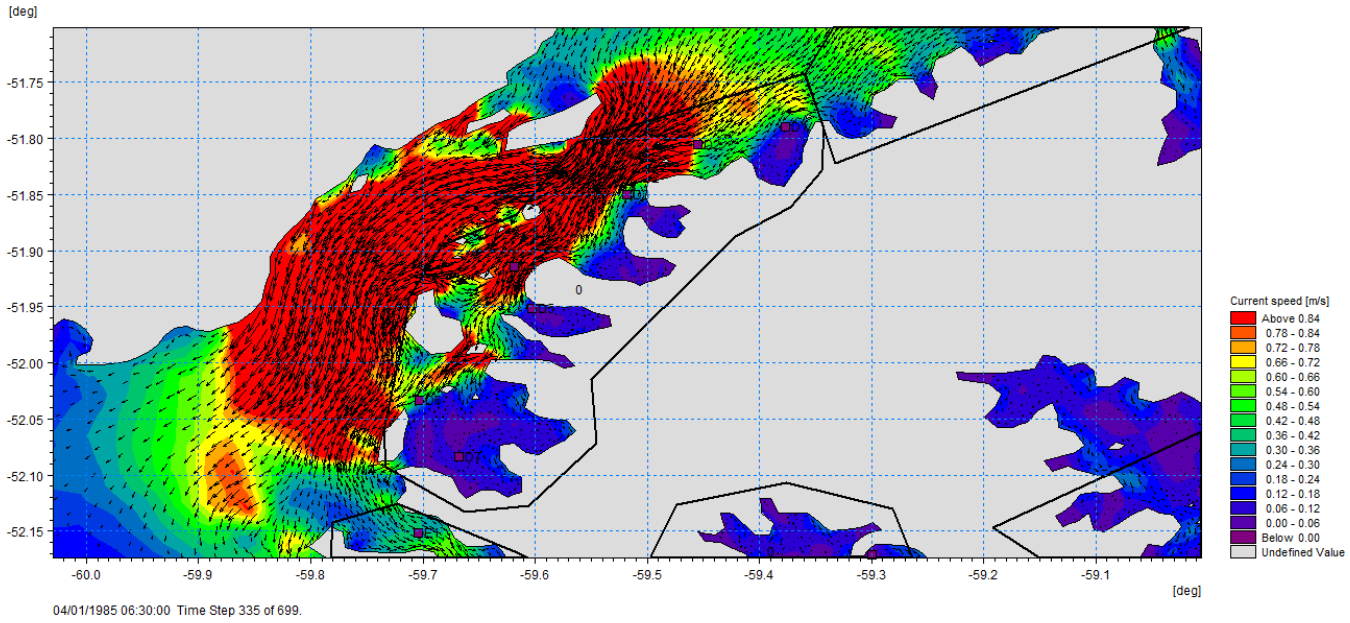


Figure D10 Snapshot of current speeds for peak of 1 in 50 year storm event with a 0°N (North) mean wave direction for zone D3

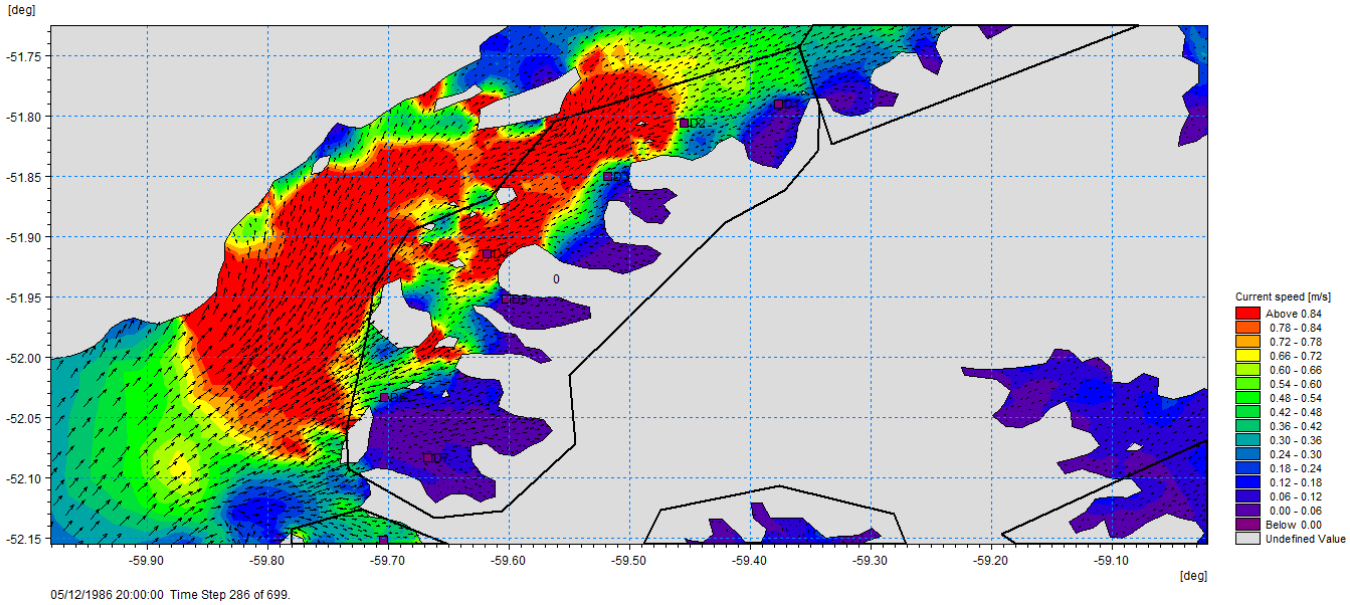


Figure D11 Snapshot of current speeds for peak of 1 in 50 year storm event with a 210°N (South) mean wave direction for zone D3

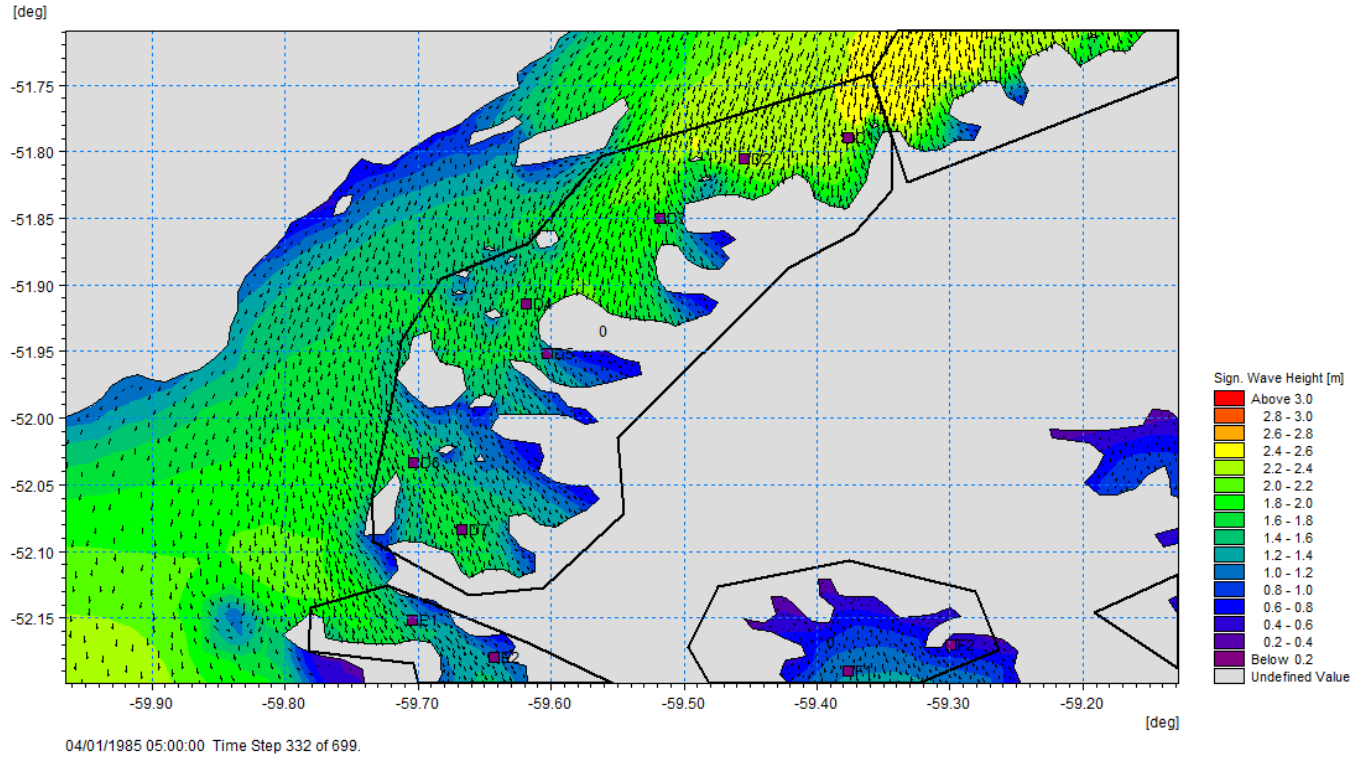


Figure D12 Snapshot of Significant Wave Heights for peak of 1 in 50 year storm event with a 0°N (North) mean wave direction for zone D3

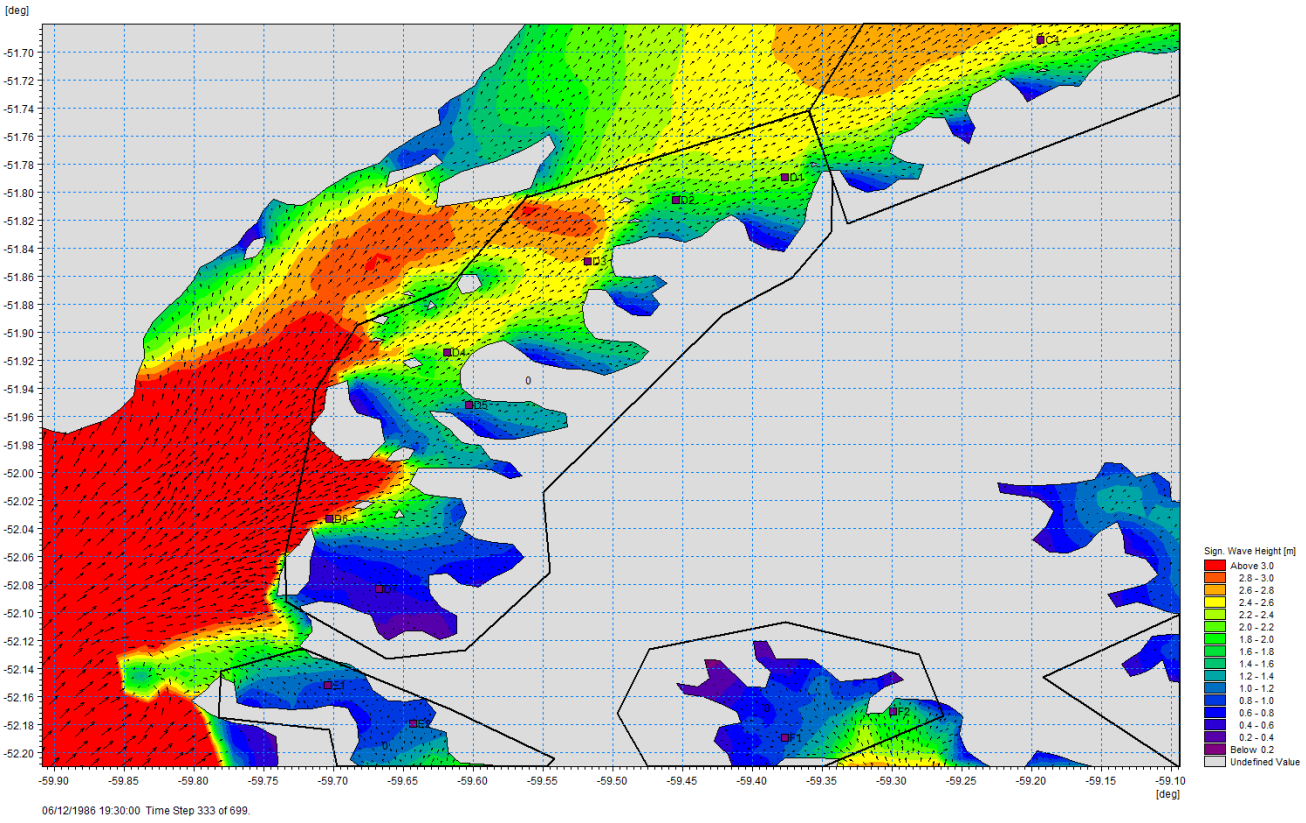


Figure D13 Snapshot of Significant Wave Heights for peak of 1 in 50 year storm event with a 210°N (South) mean wave direction for zone D3

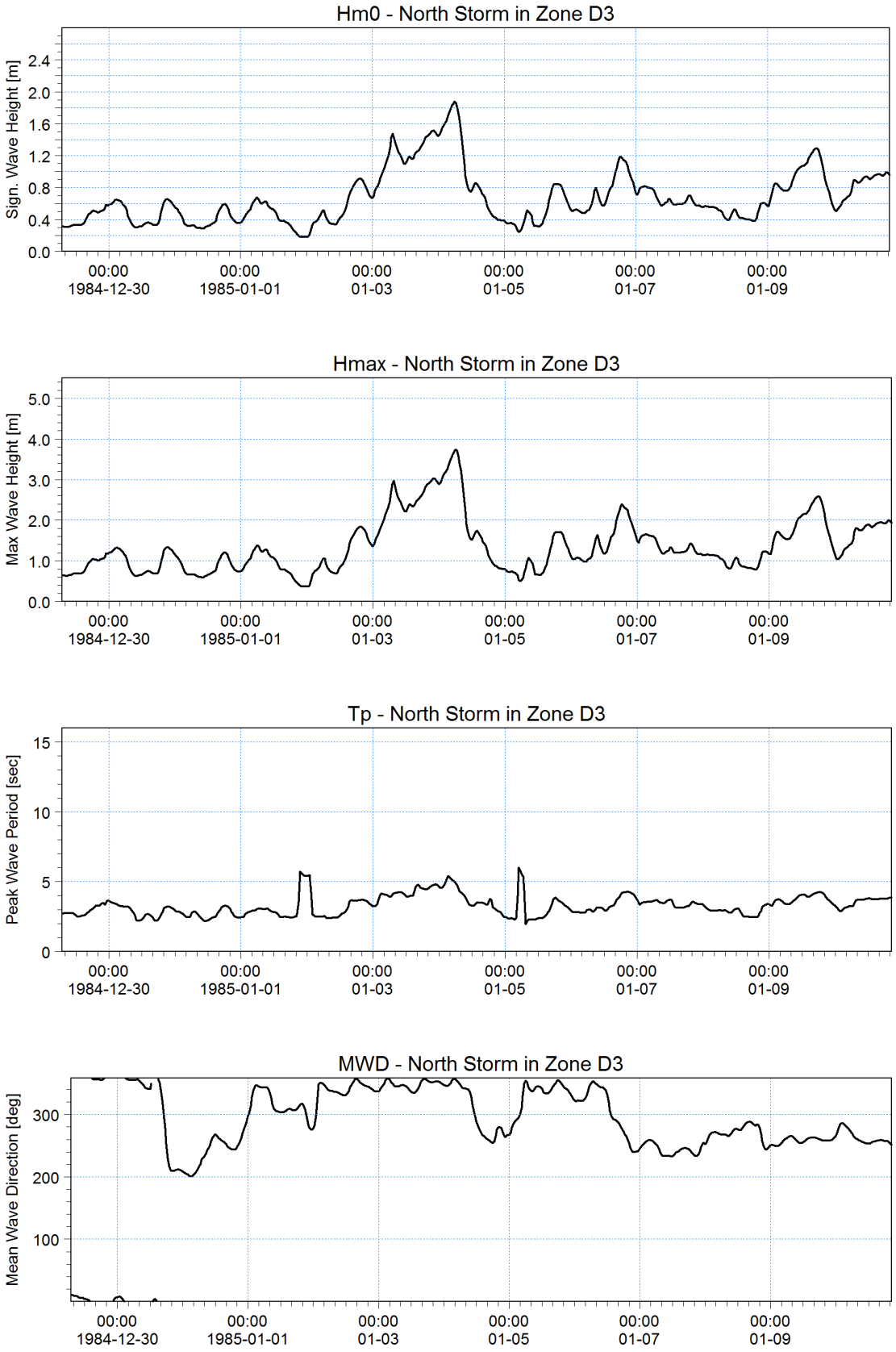


Figure D14 Coupled Model nearshore wave parameters for Peak 1 in 50 year storm Event propagating from offshore 0°N (North) direction for Zone D3

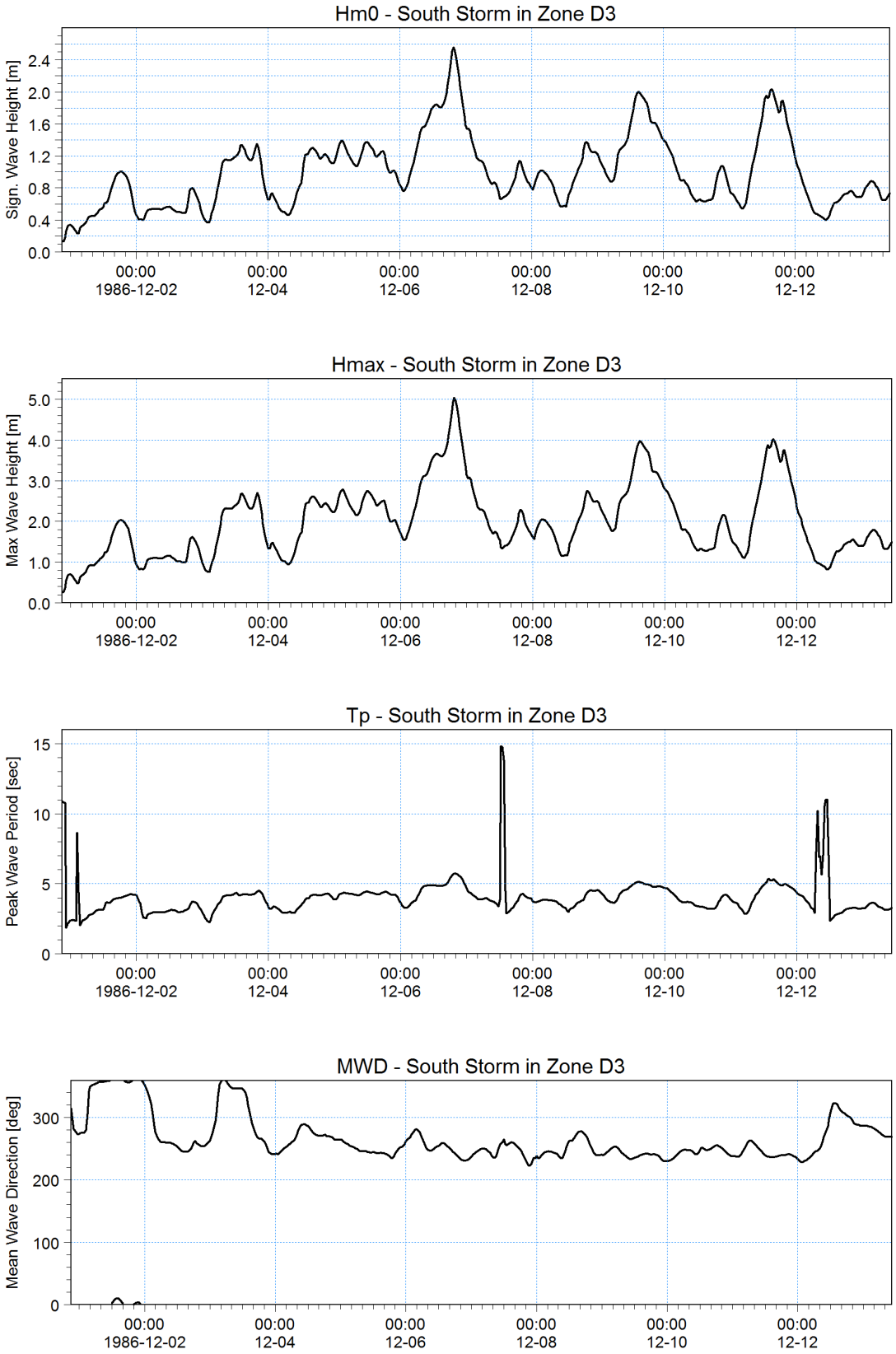


Figure D15 Coupled Model nearshore wave parameters for Peak Storm Event propagating from offshore 210°N (South) direction for Zone D3

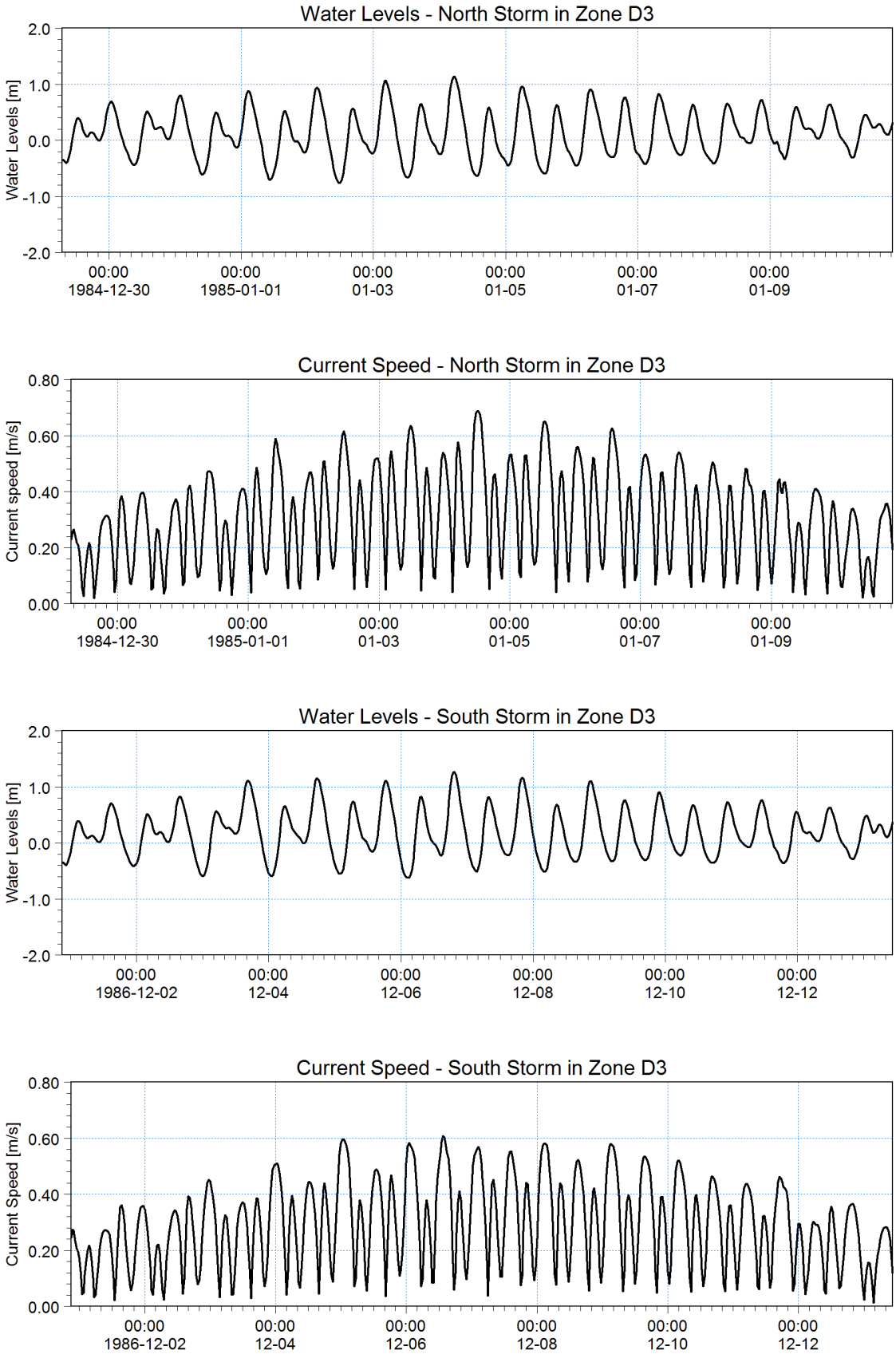


Figure D16 Coupled Model nearshore water level and current speed for a Peak Storm Event propagating from offshore 0°N (North) and 210°N (South) direction for Zone D3

Appendix E

Setup information and results for Site E3

Bathymetry and Mesh

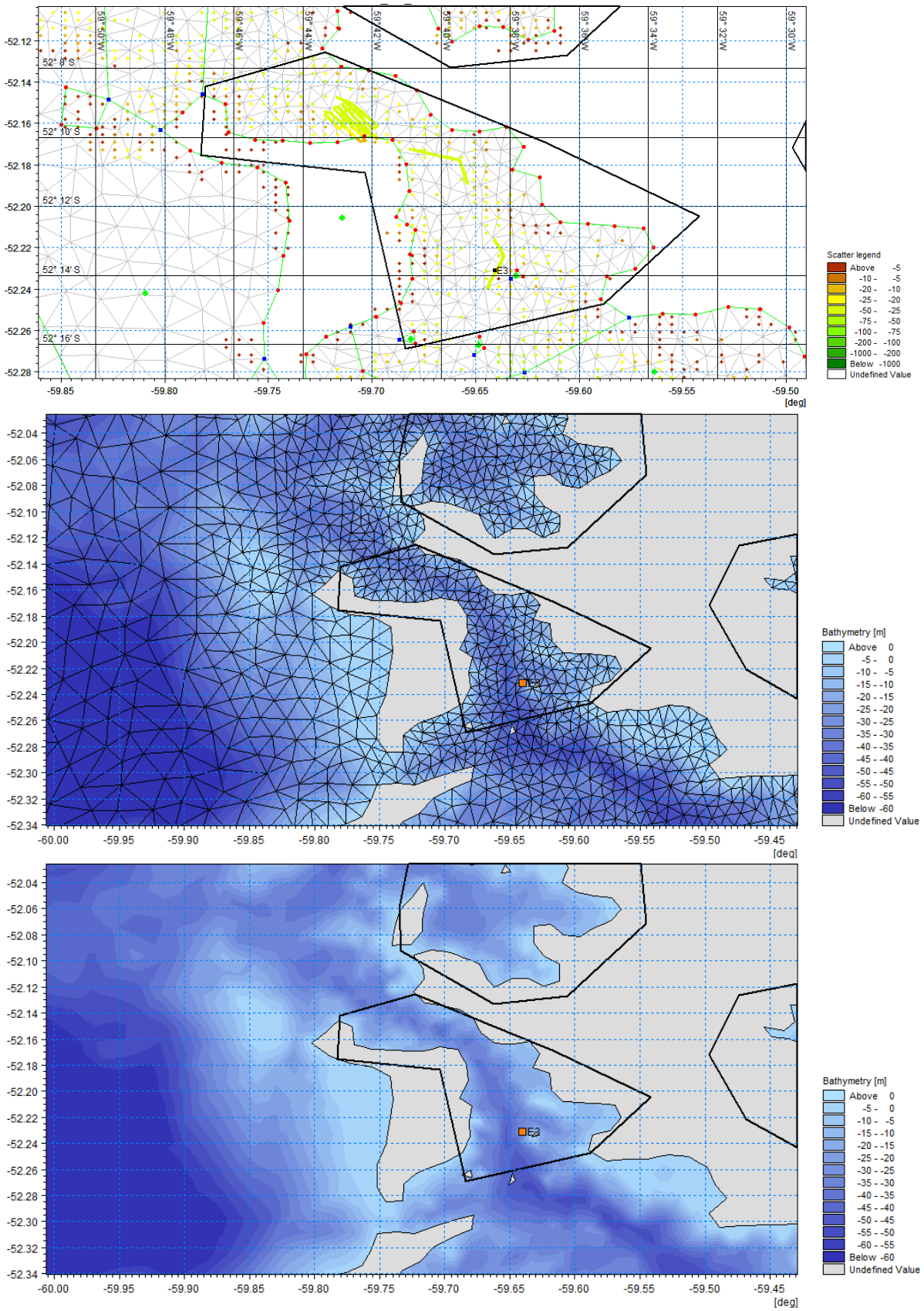


Figure E1 (Top) Input data - CMAP & provided bathymetry data points and CMAP land data (Middle) Created Mesh with underlying Bathymetry (Bottom) Interpolated Bathymetry

Uncoupled SW Model – 1 in 1 year storm

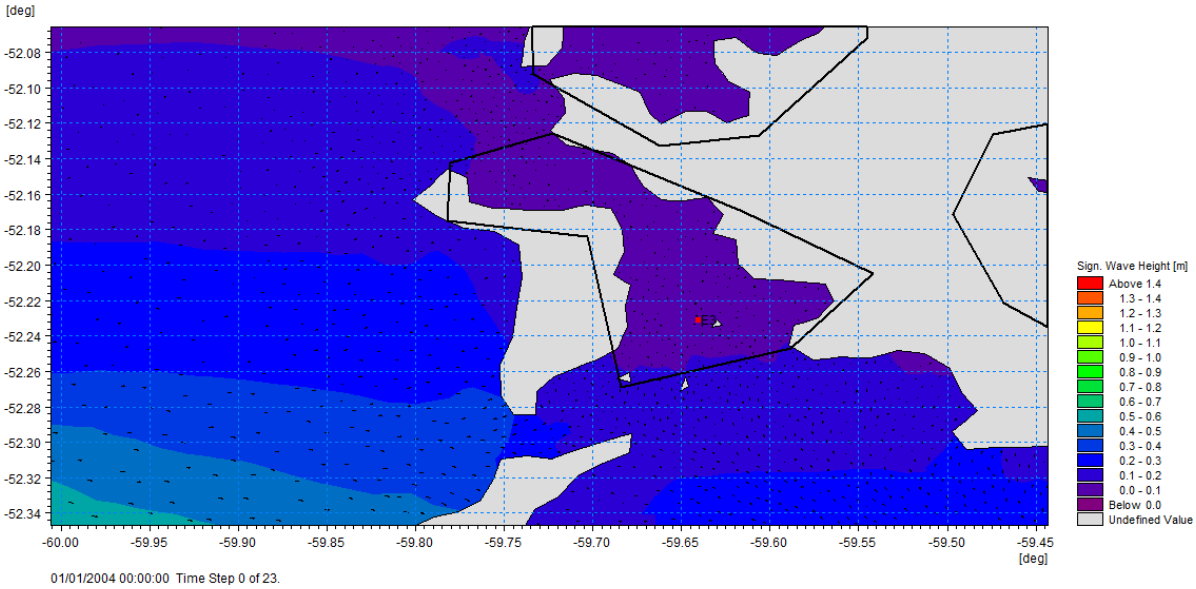


Figure E2 Significant wave heights for 1 in 1 Year Return Period wave transformation for 0°N mean wave direction

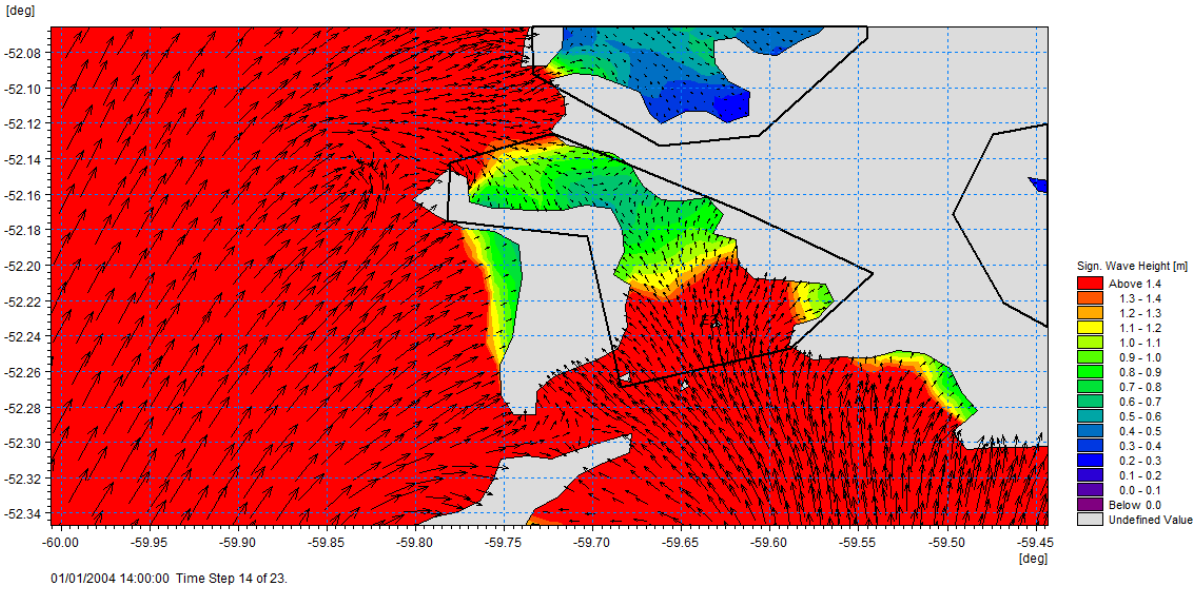


Figure E3 Significant wave heights for 1 in 1 Year Return Period wave transformation for 210°N mean wave direction

Uncoupled SW Model – 1 in 50 year storm

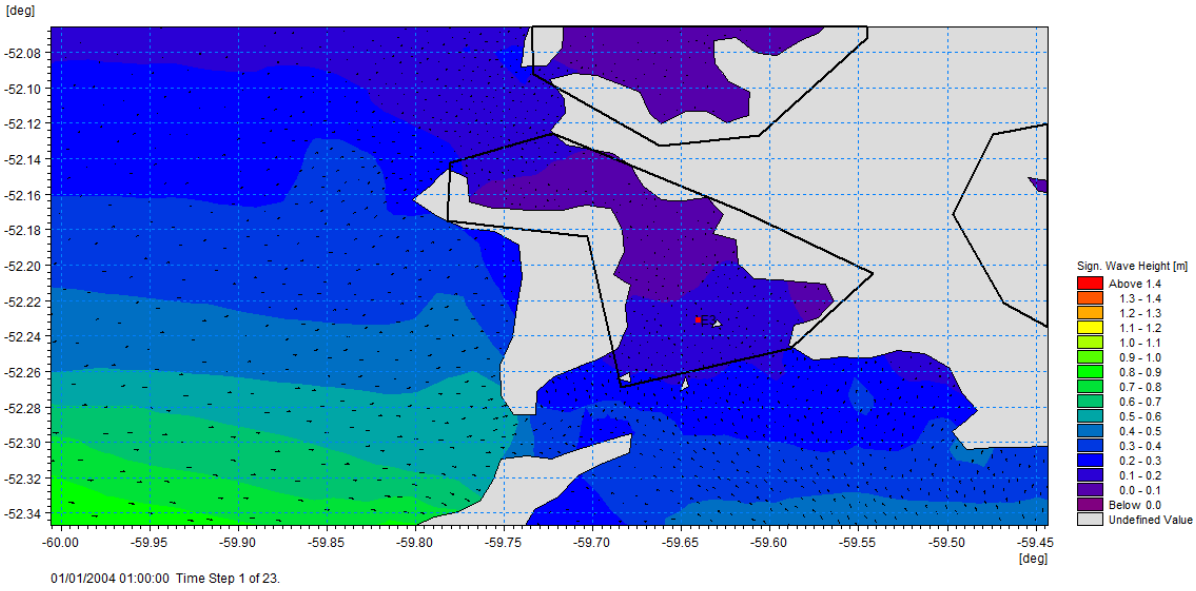


Figure E4 Significant wave heights for 1 in 50 Year Return Period wave transformation for 0°N mean wave direction

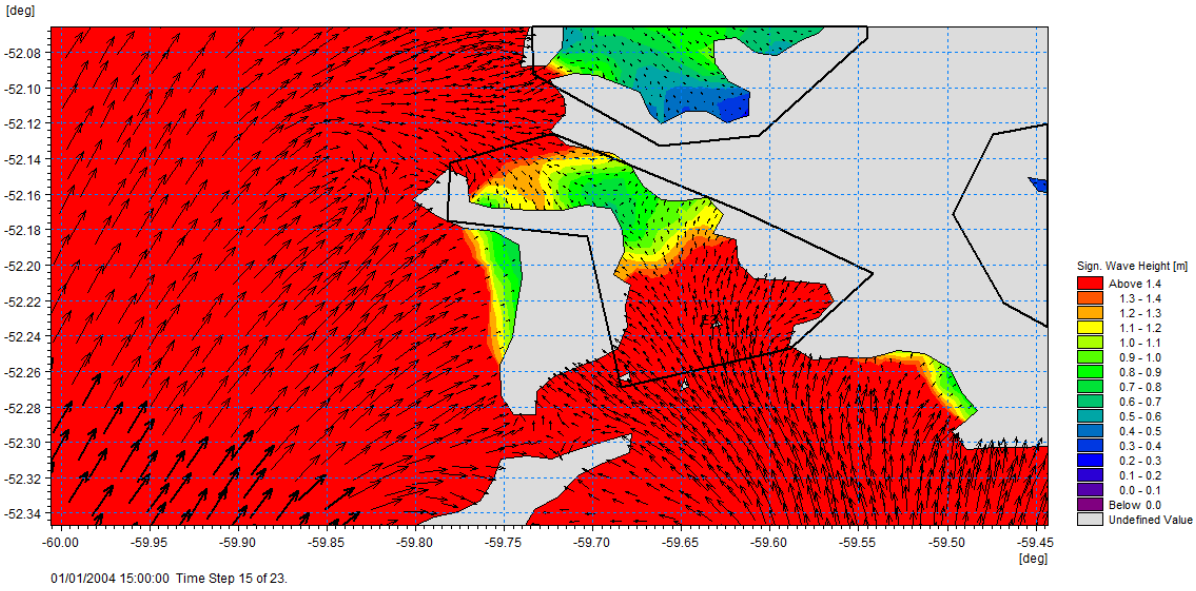


Figure E5 Significant wave heights for 1 in 50 Year Return Period wave transformation for 210°N mean wave direction

Coupled Model – Statistical Overview

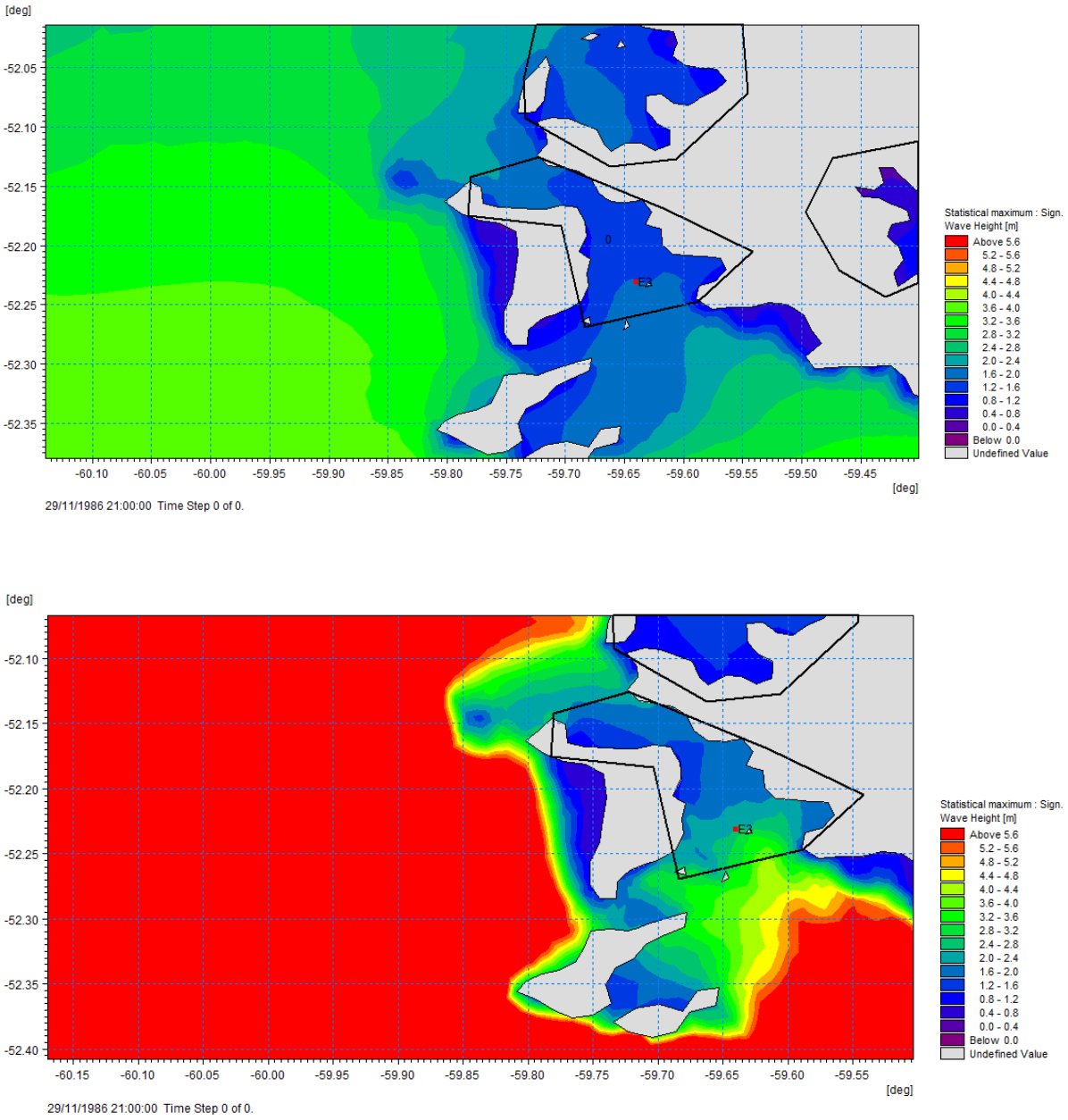
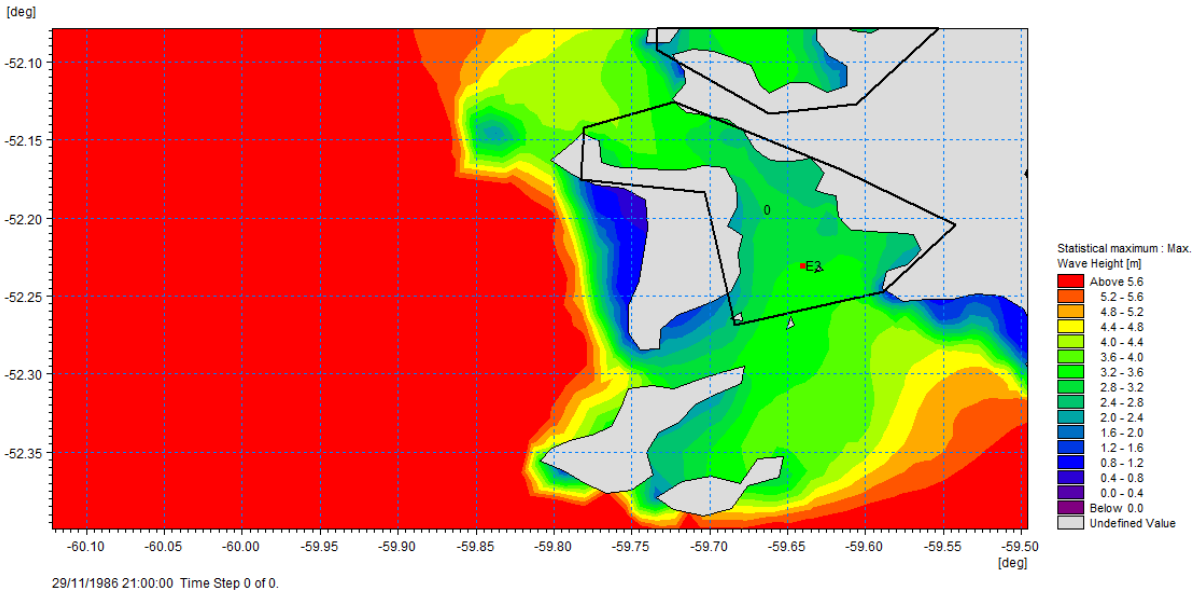


Figure E6 Statistical maximum H_{mo} for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event



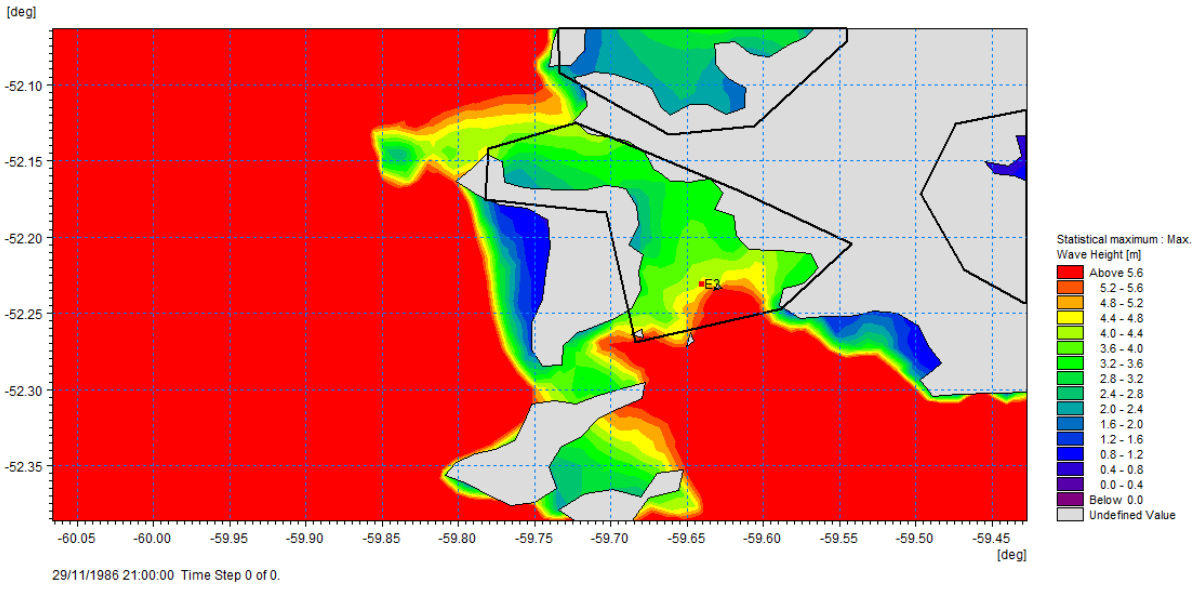


Figure E7 Statistical maximum Hmax for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

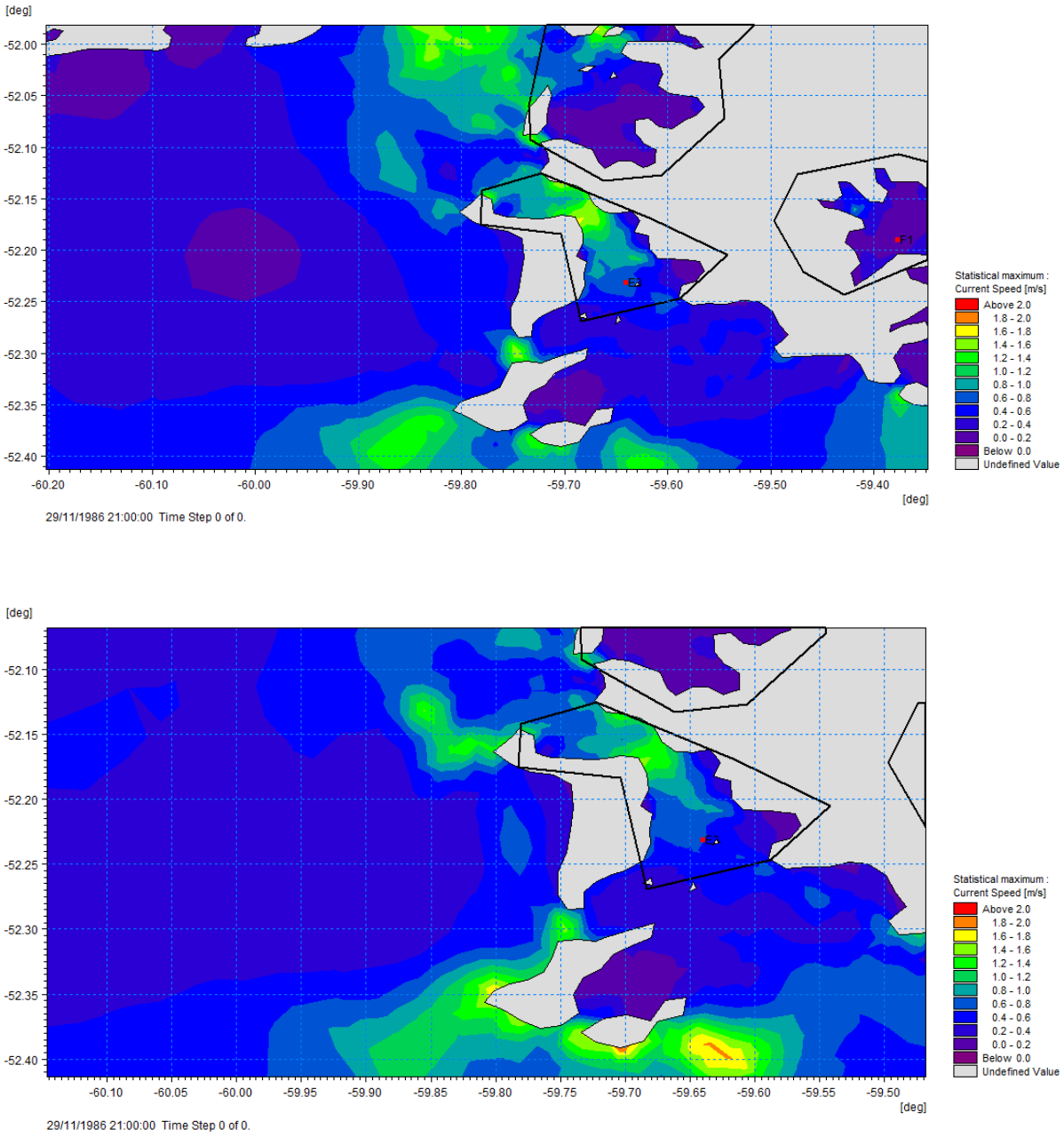


Figure E8 Max Current Speed for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

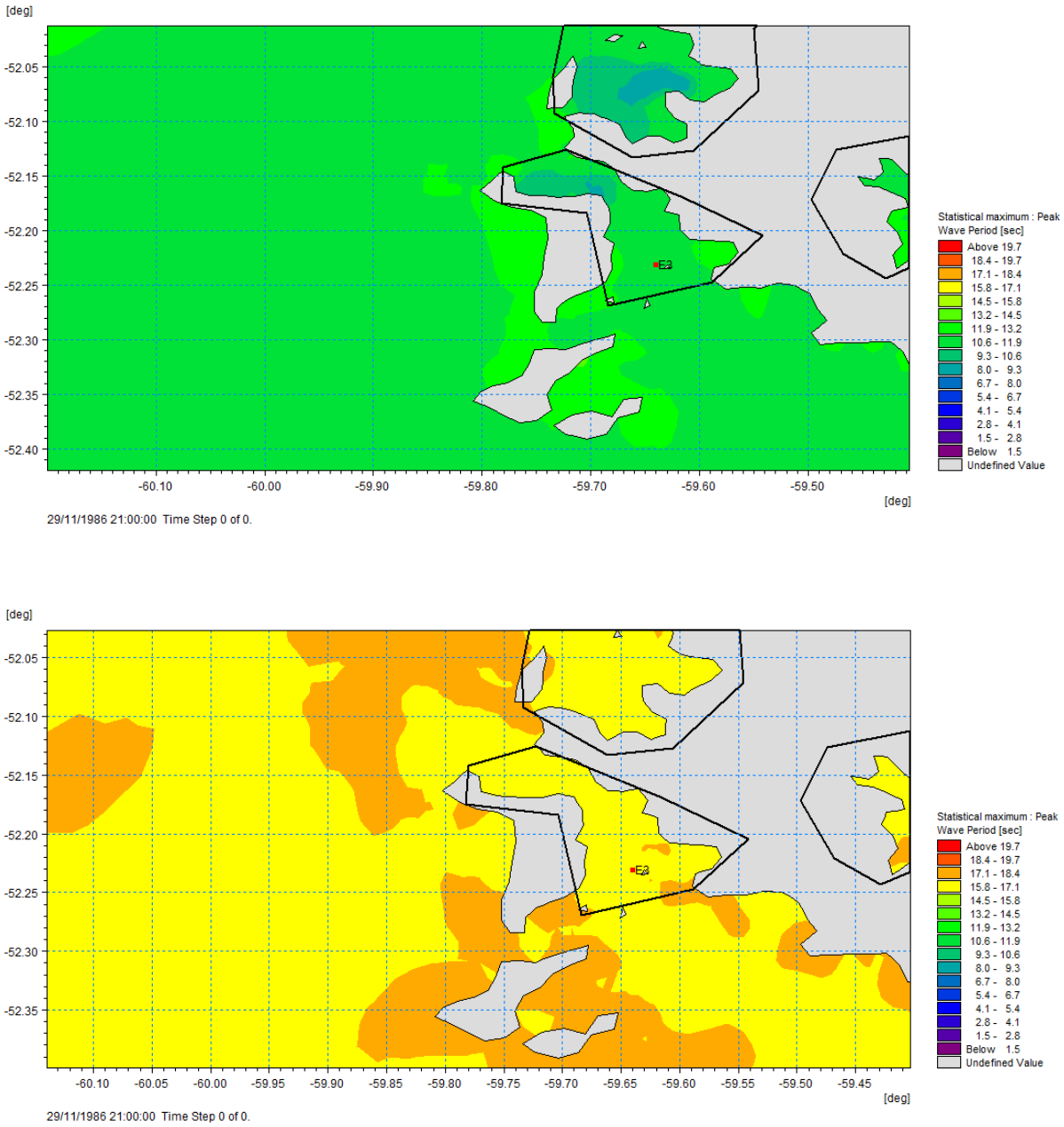


Figure E9 Max Peak Wave Period (Tp) for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

Coupled Model – Pseudo Storm Results

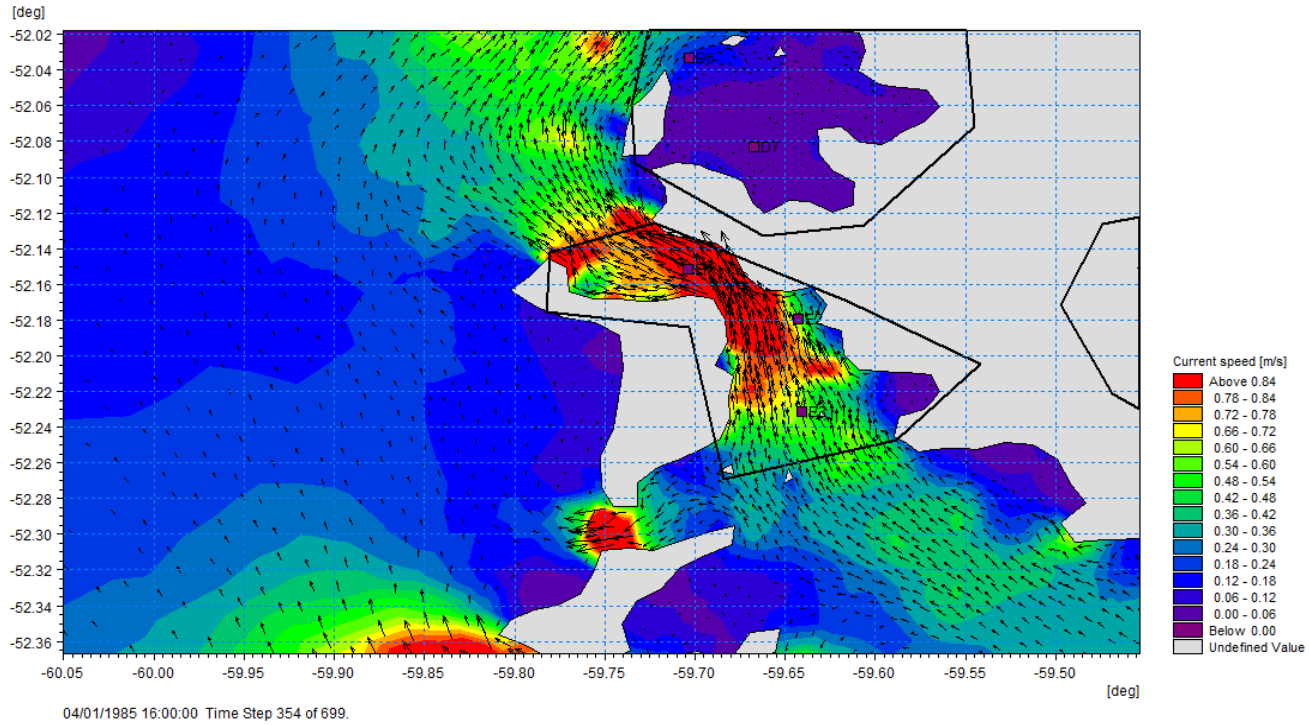


Figure E10 Snapshot of current speeds for peak of storm event with a 0°N (North) mean wave direction for zone E3

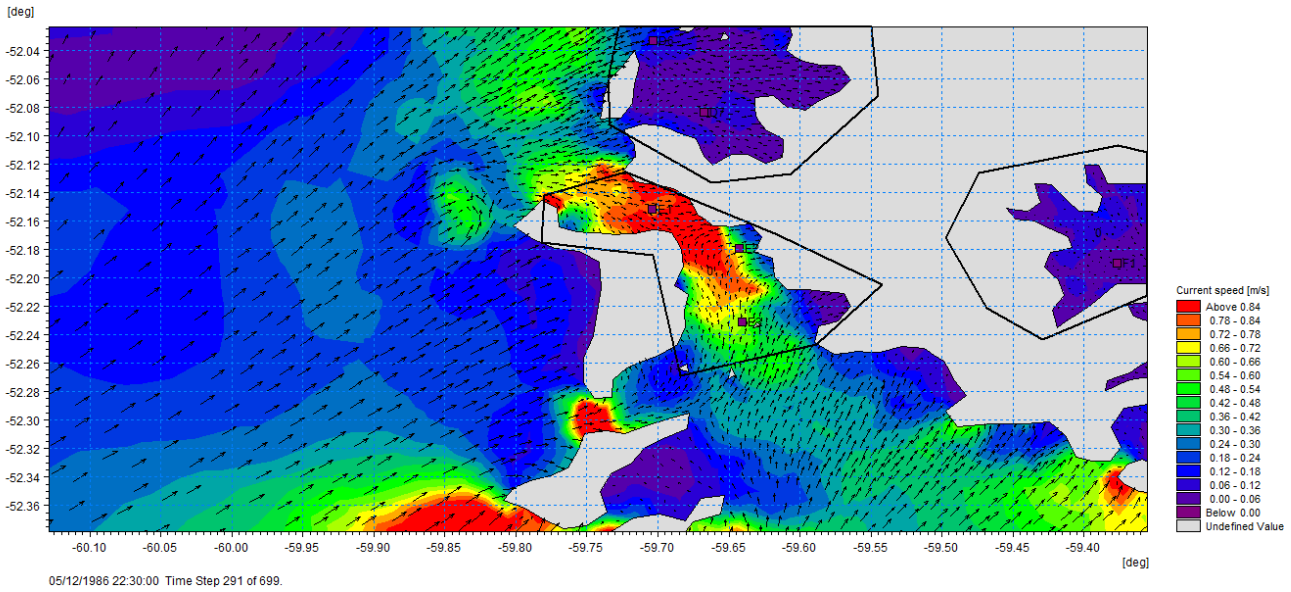


Figure E11 Snapshot of current speeds for peak of storm event with a 210°N (South) mean wave direction for zone E3

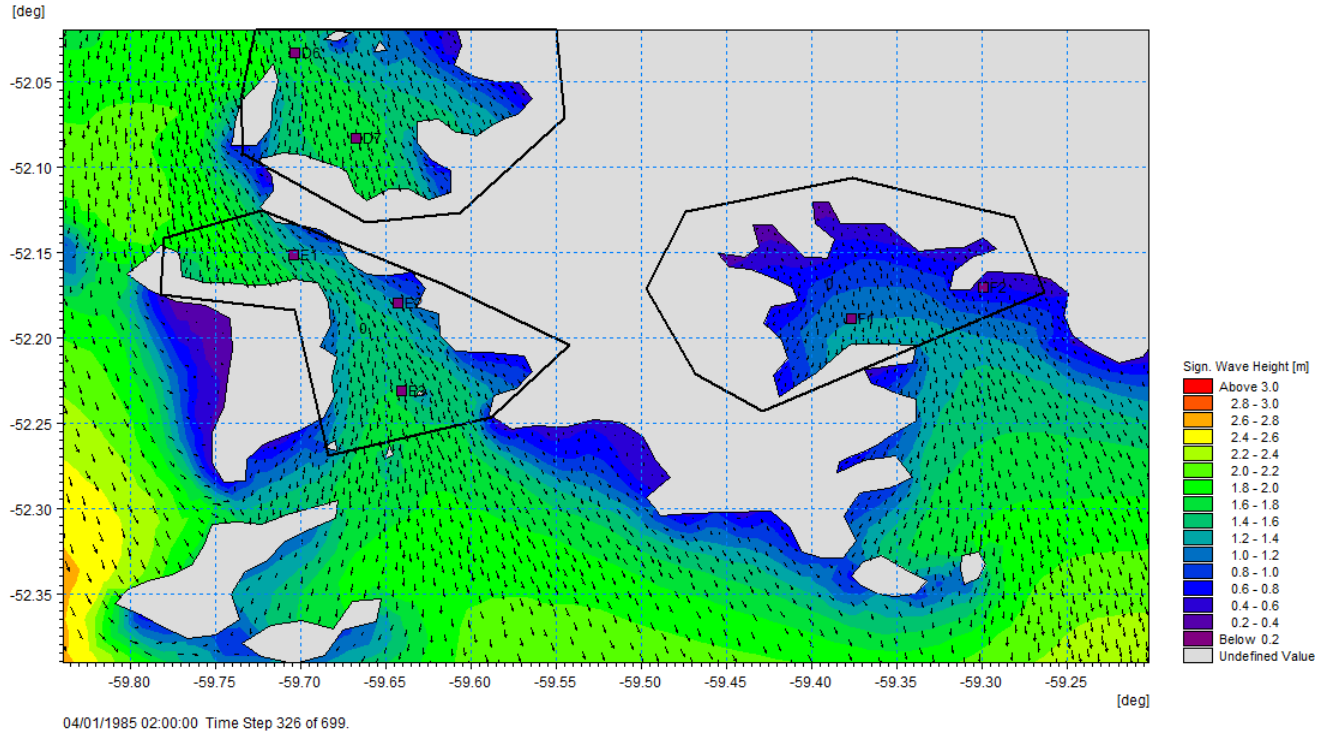


Figure E12 Snapshot of Significant Wave Heights for peak of storm event with a 0°N (North) mean wave direction for zone E3

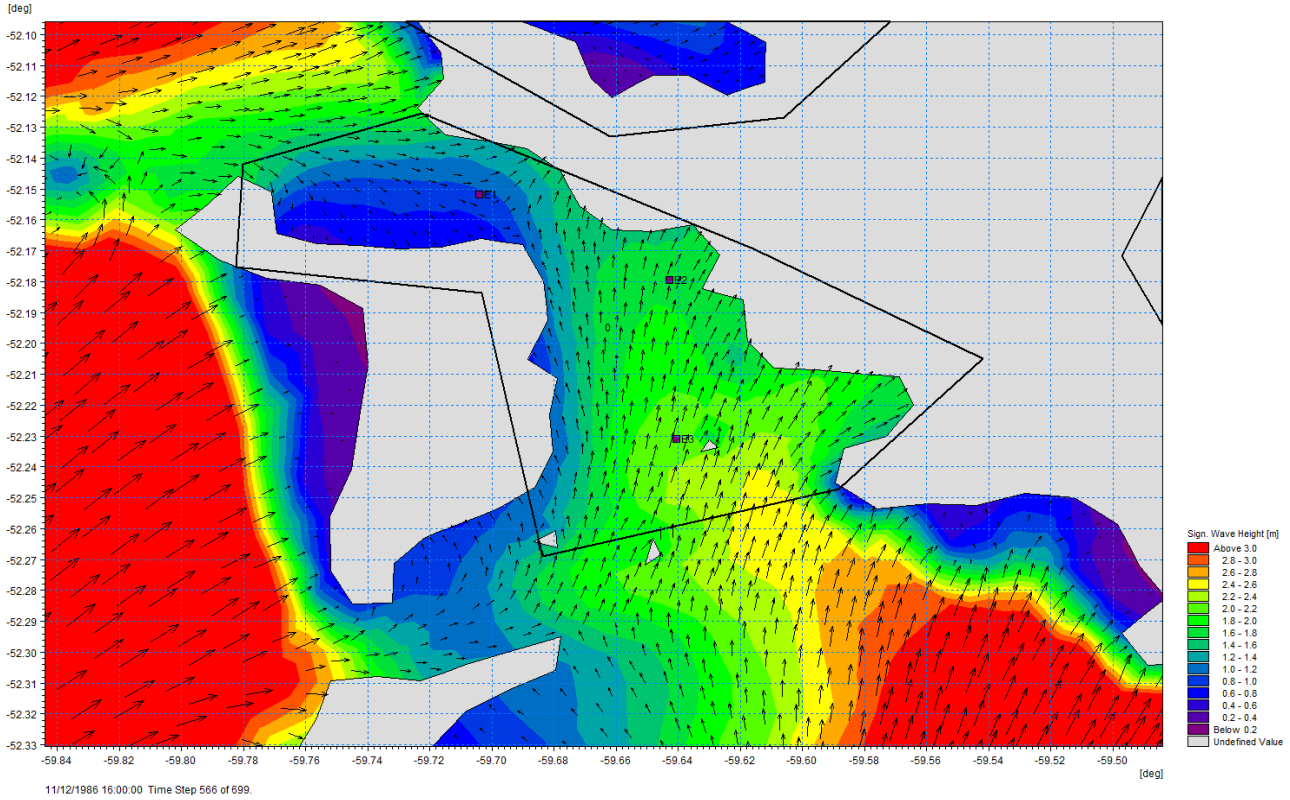


Figure E13 Snapshot of Significant Wave Heights for peak of storm event with a 210°N (South) mean wave direction for zone E3

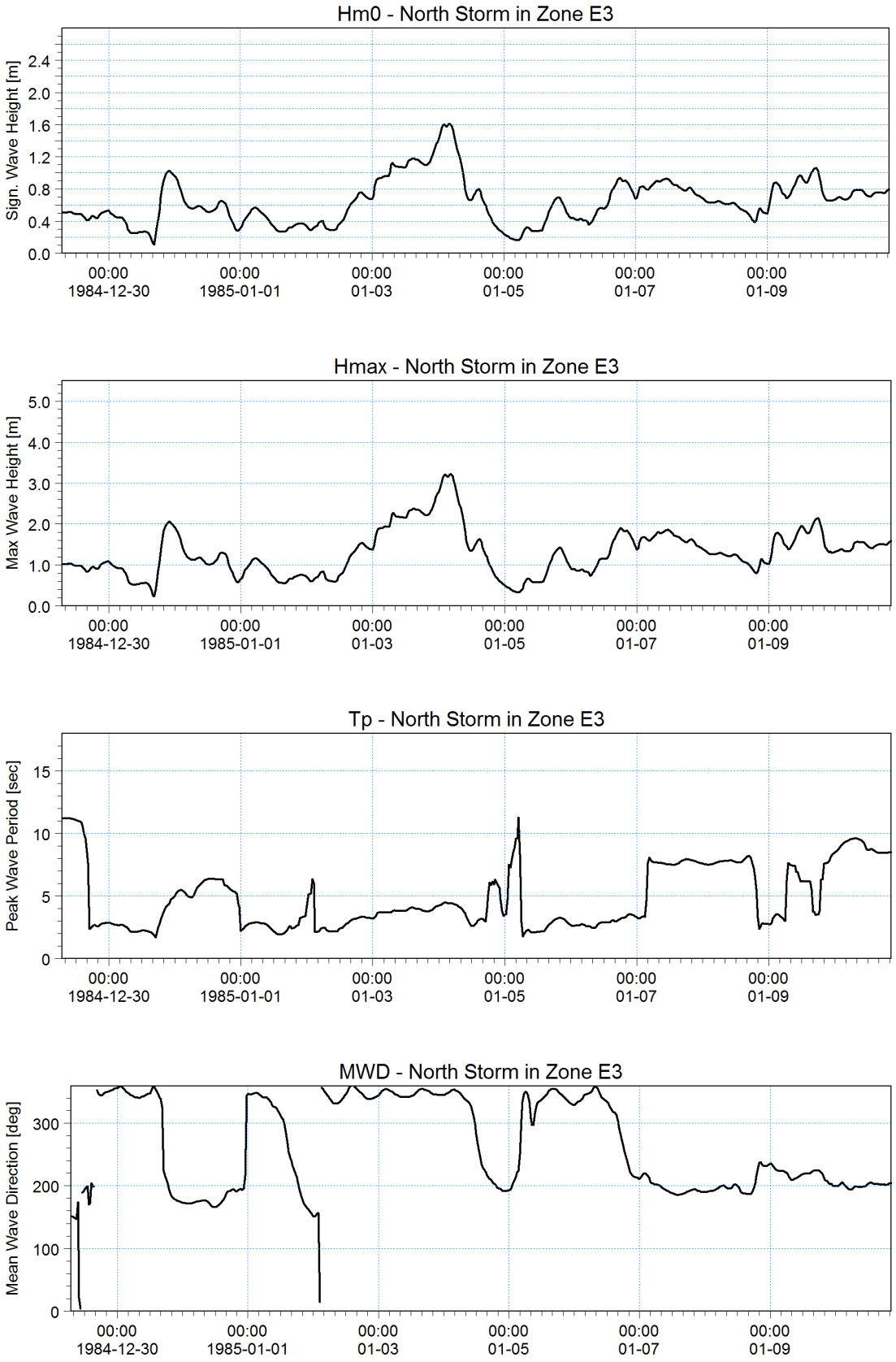


Figure E14 Coupled Model nearshore wave parameters for Peak Storm Event propagating from offshore 0°N (North) direction for Zone E3

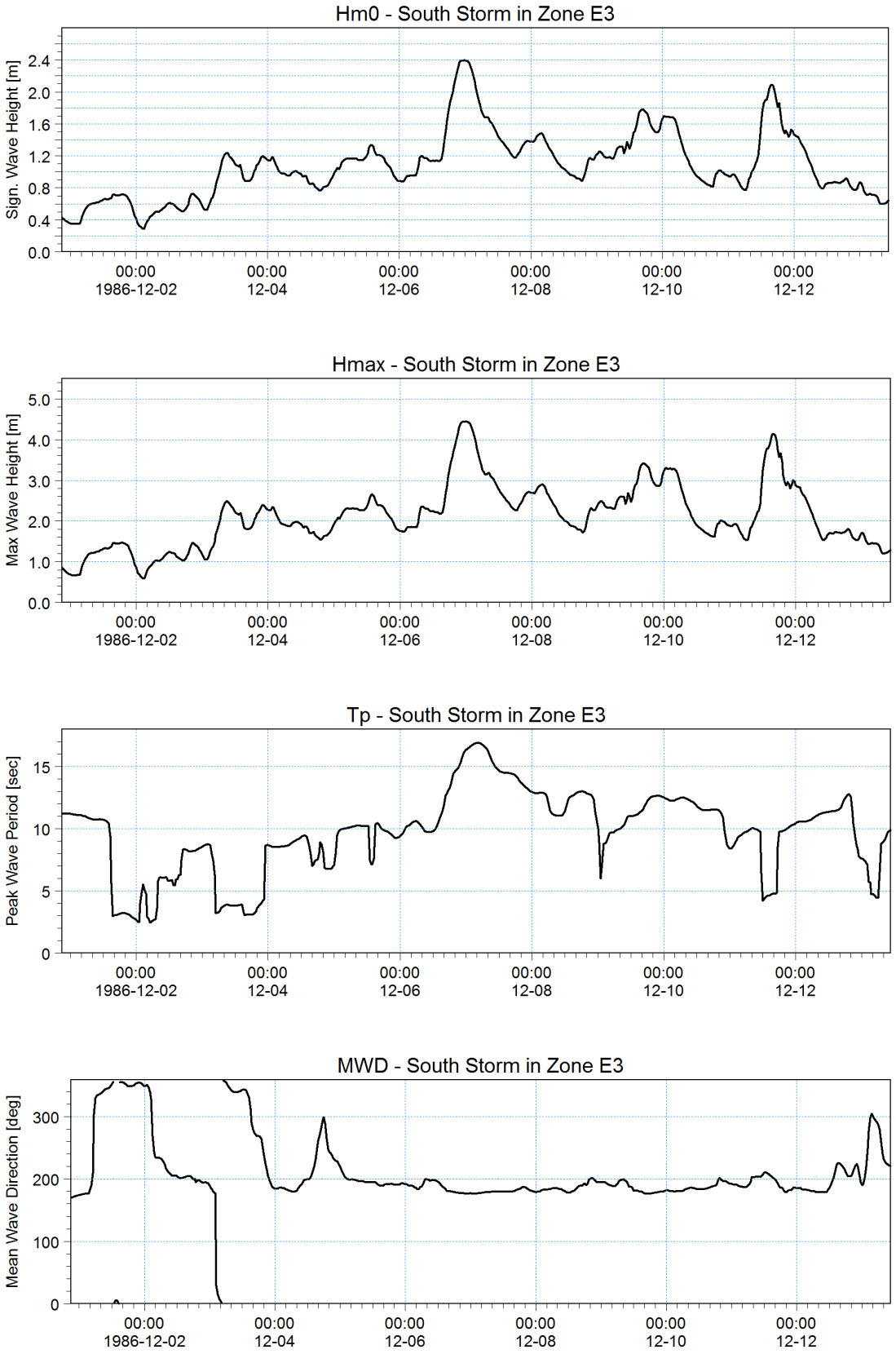


Figure E15 Coupled Model nearshore wave parameters for Peak Storm Event propagating from offshore 210°N (South) direction for Zone E3

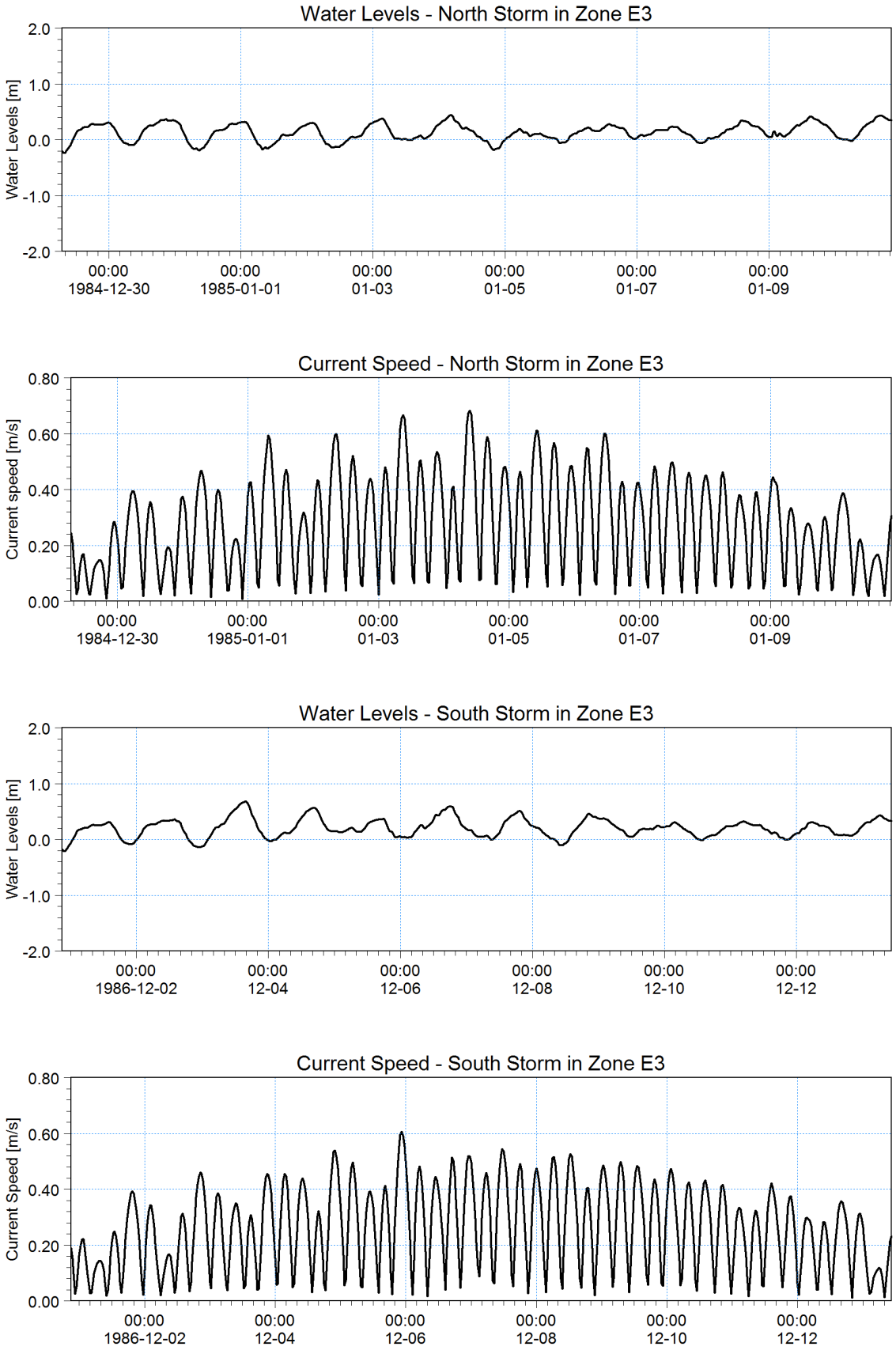


Figure E16 Coupled Model nearshore water level and current speed for a Peak Storm Event propagating from offshore 0°N (North) and 210°N (South) direction for Zone E3

Appendix F

Setup information and results for Site F1

Bathymetry and Mesh

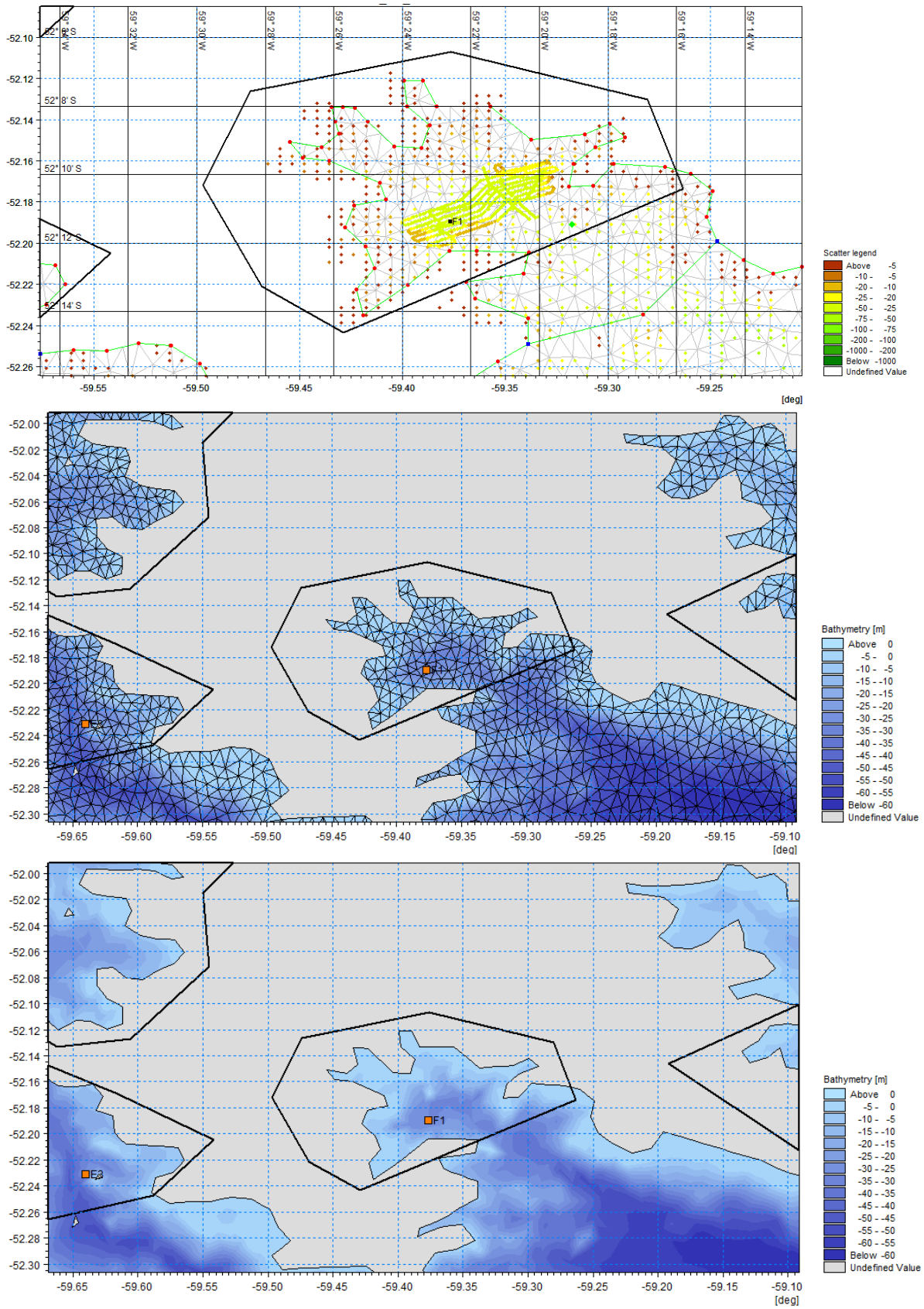


Figure F1 (Top) Input data - CMAP & provided bathymetry data points and CMAP land data (Middle) Created Mesh with underlying Bathymetry (Bottom) Interpolated Bathymetry

Uncoupled SW Model – 1 in 1 year storm

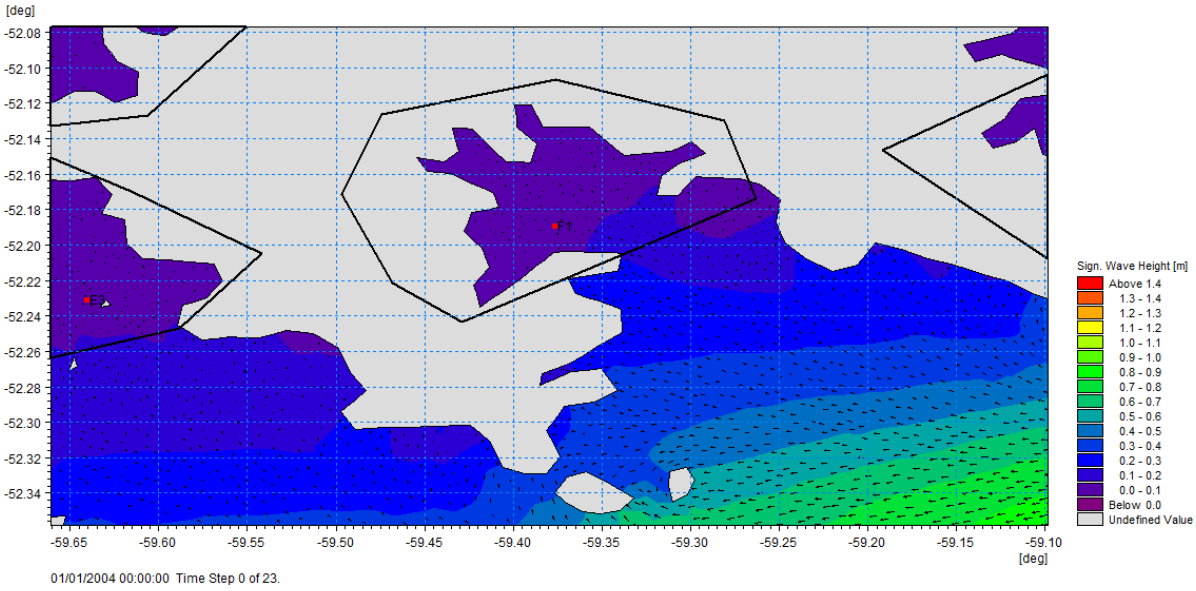


Figure F2 Significant wave heights for 1 in 1 Year Return Period wave transformation for 0°N mean wave direction

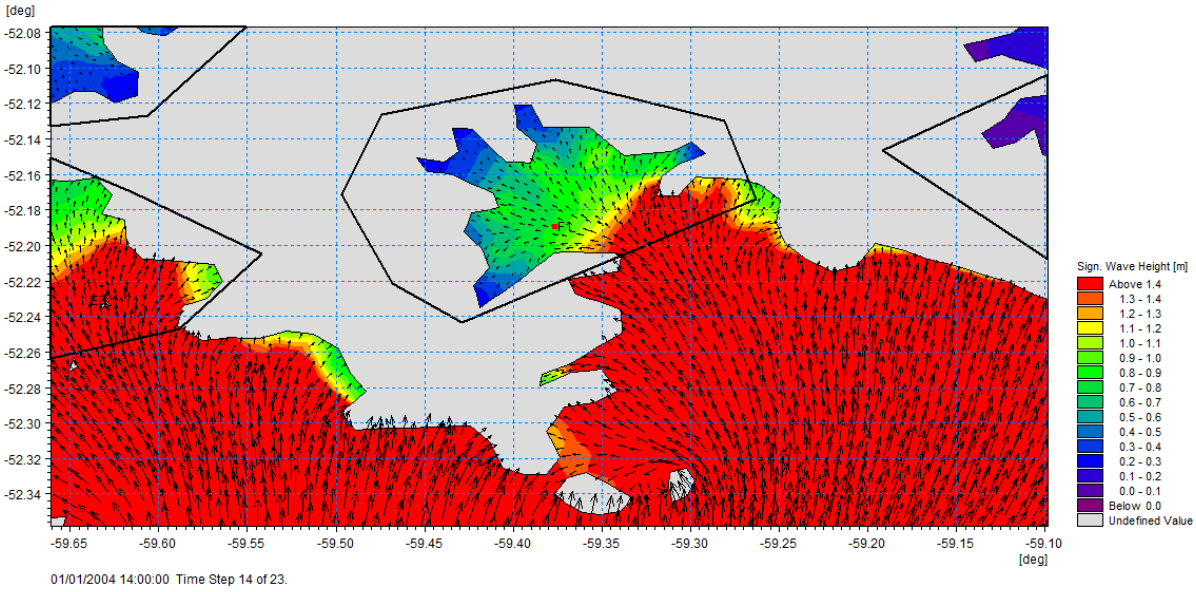


Figure F3 Significant wave heights for 1 in 1 Year Return Period wave transformation for 210°N mean wave direction

Uncoupled SW Model – 1 in 50 year storm

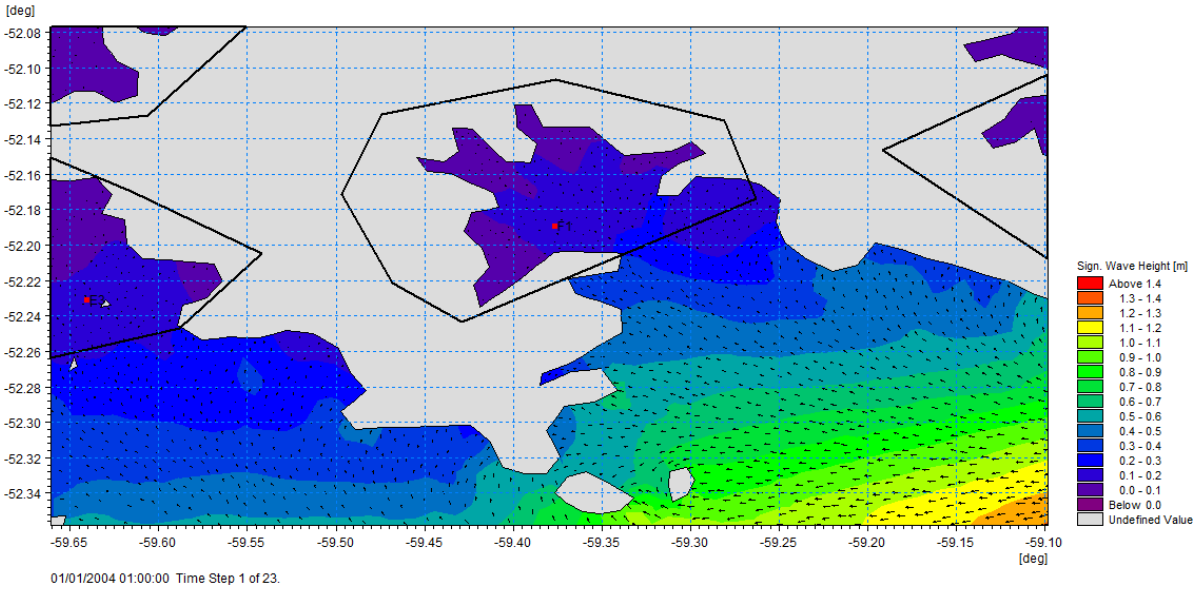


Figure F4 Significant wave heights for 1 in 50 Year Return Period wave transformation for 0°N mean wave direction

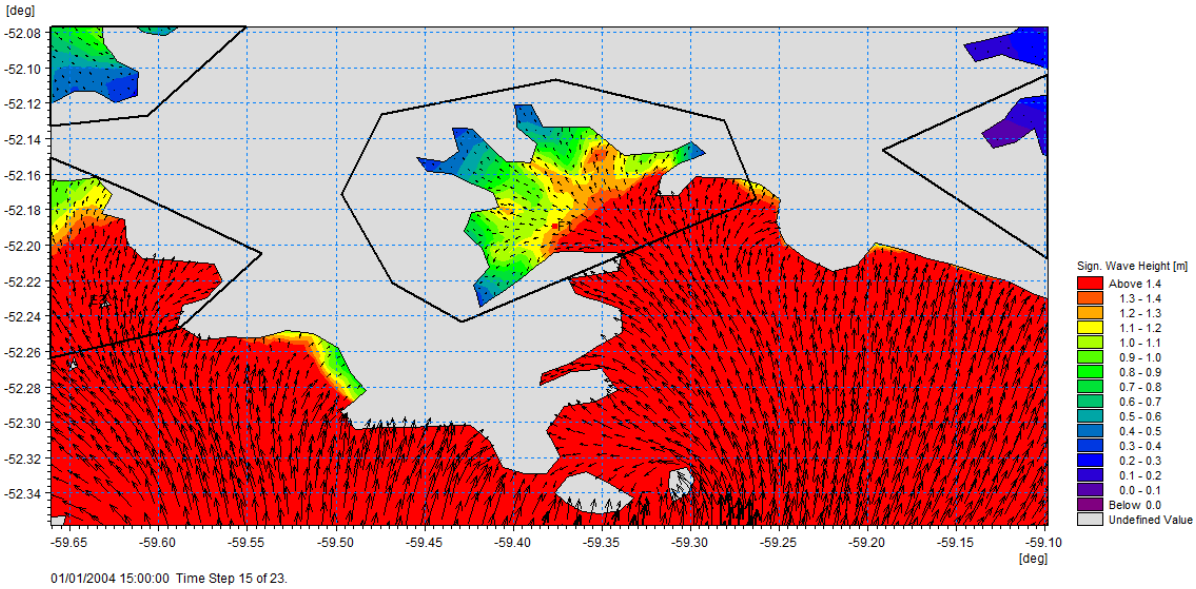


Figure F5 Significant wave heights for 1 in 50 Year Return Period wave transformation for 210°N mean wave direction

Coupled Model – Statistical Overview

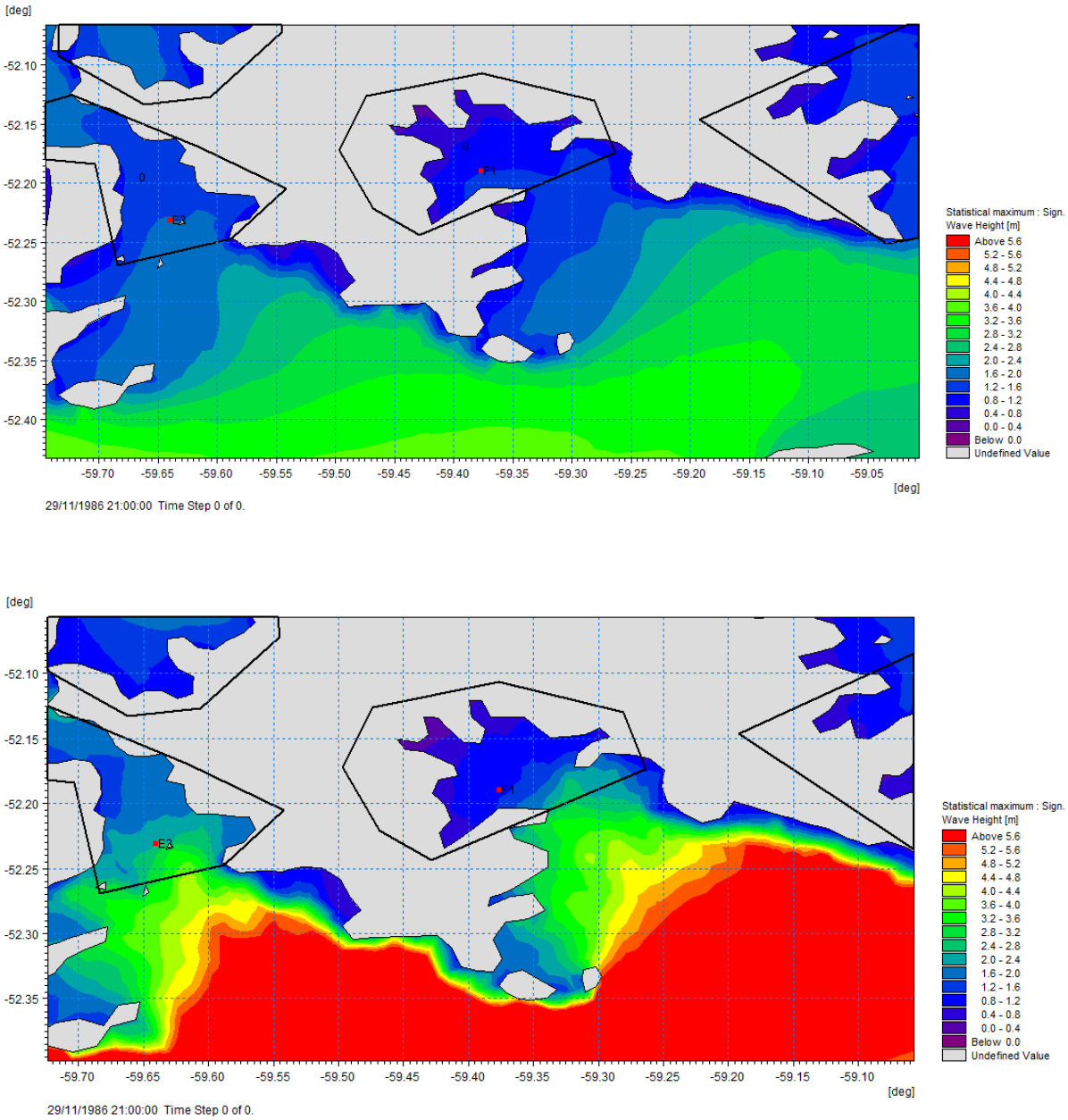
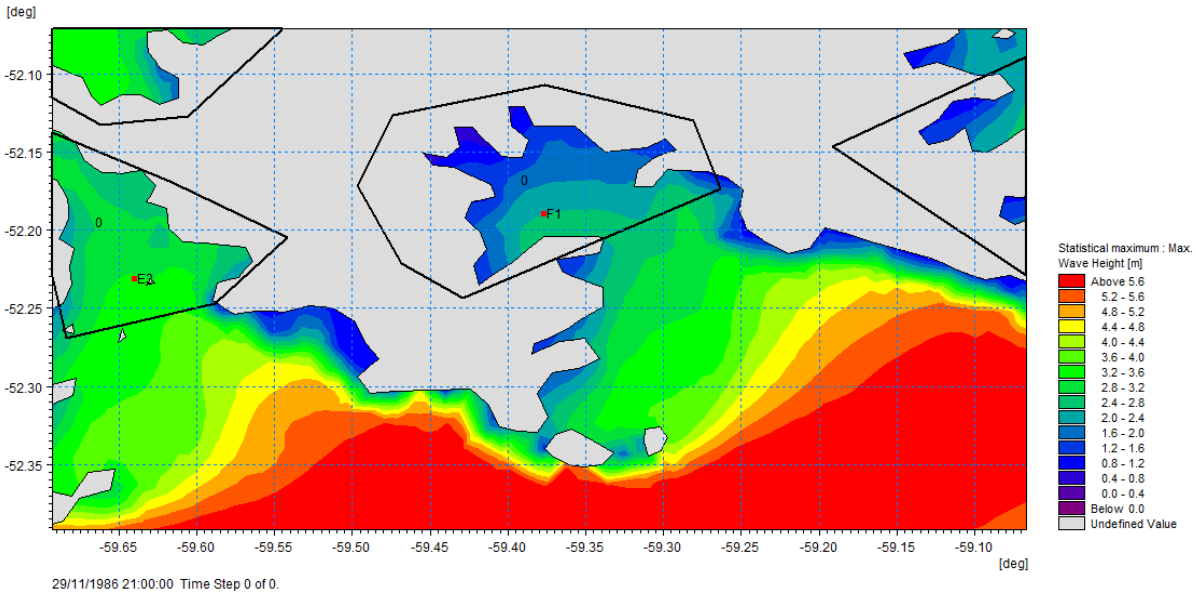


Figure F6 Statistical maximum H_{mo} for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event



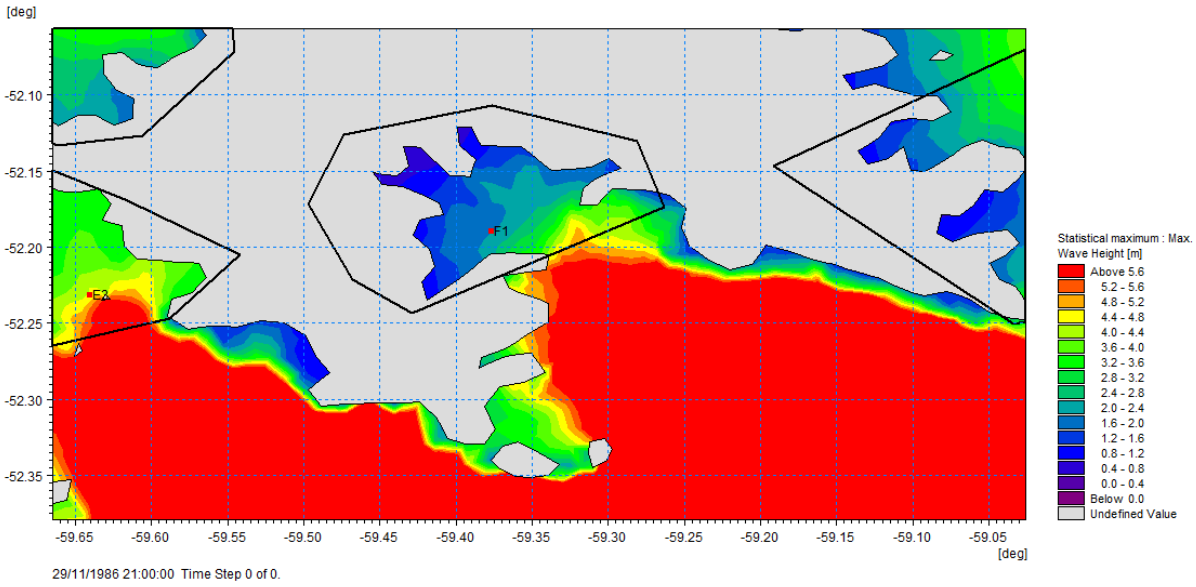


Figure F7 Statistical maximum Hmax for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

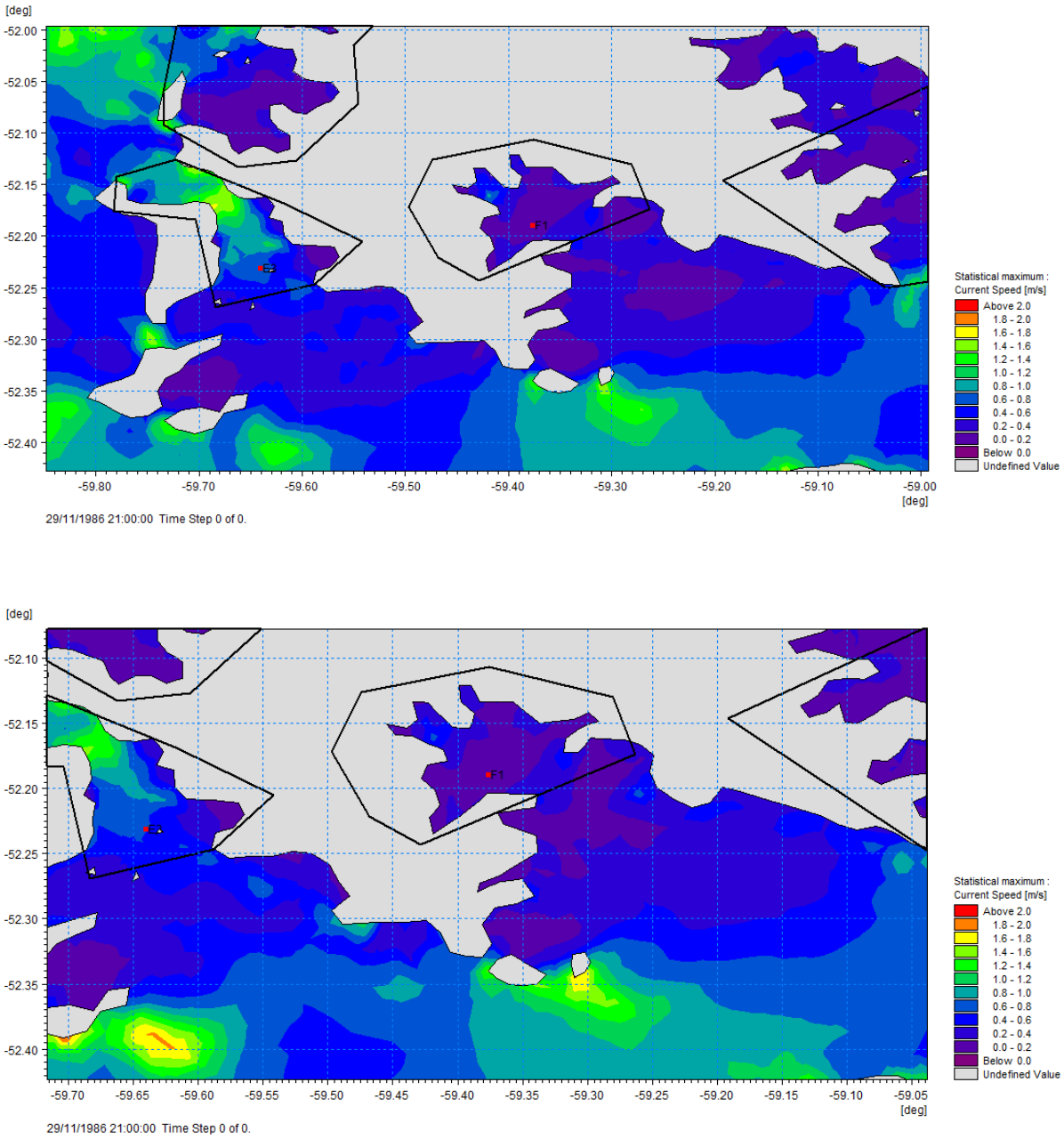


Figure F8 Max Current Speed for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

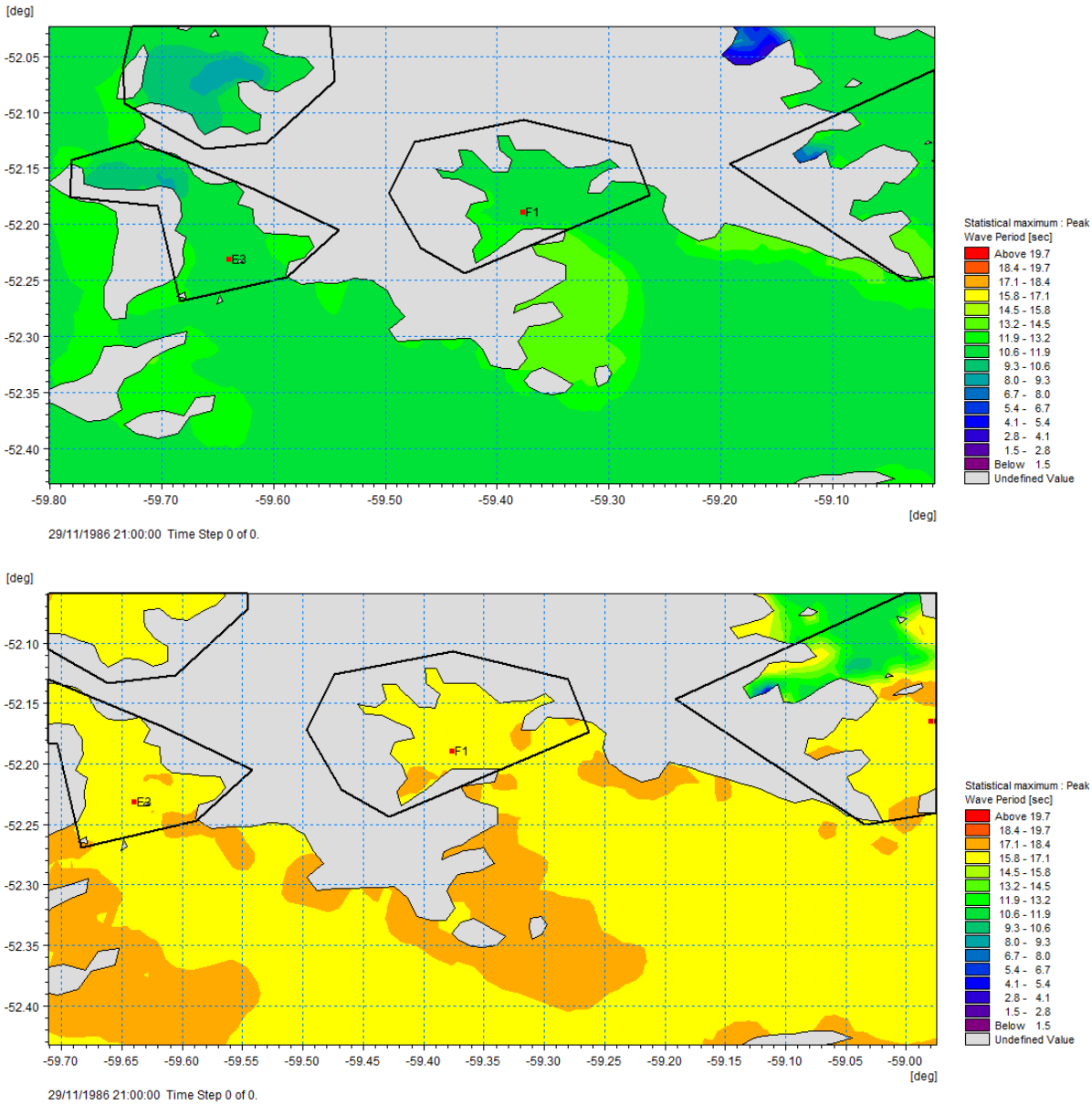


Figure F9 Max Peak Wave Period (Tp) for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

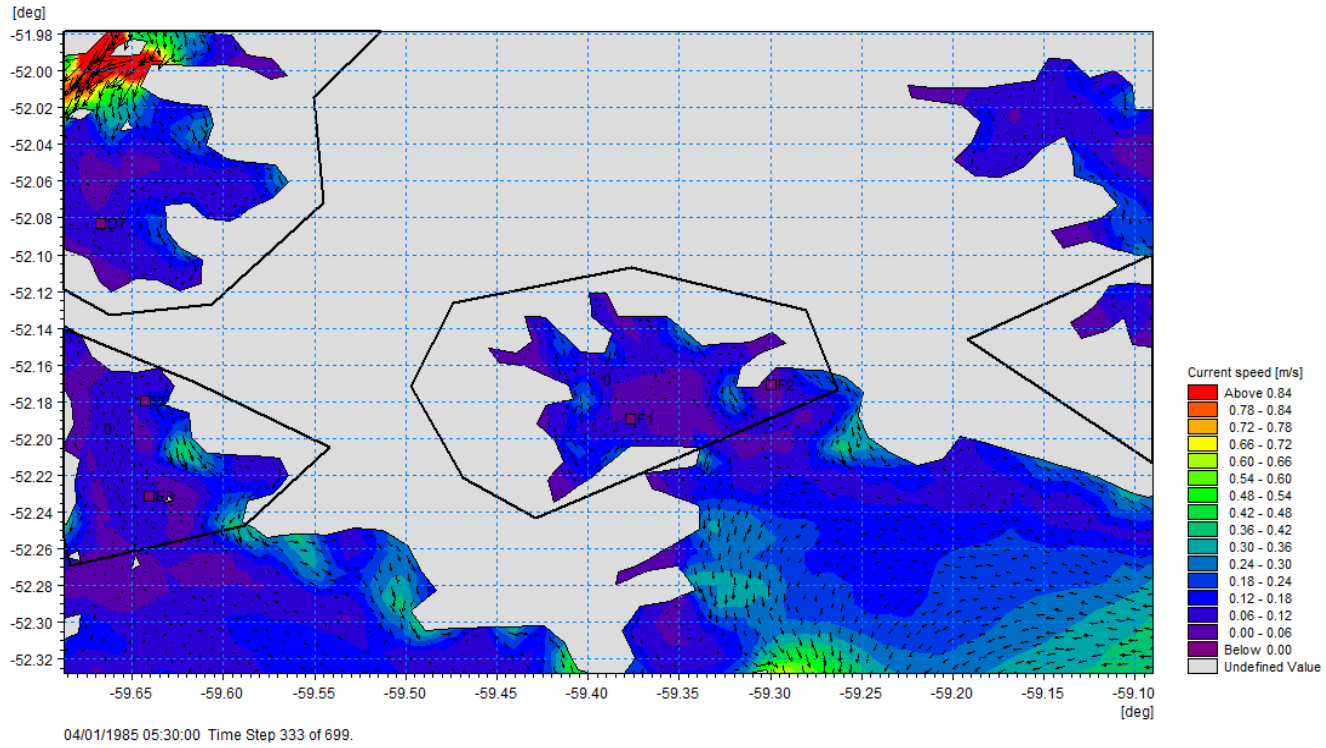


Figure F10 Snapshot of current speeds for peak of storm event with a 0°N (North) mean wave direction for zone F1

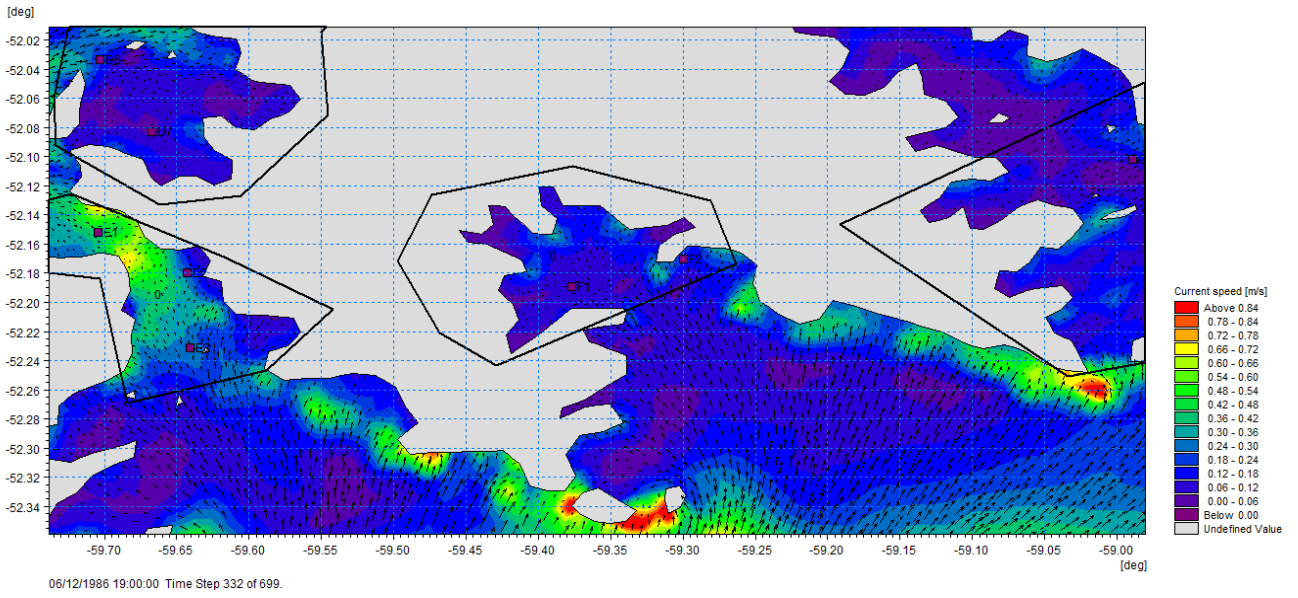


Figure F11 Snapshot of current speeds for peak of storm event with a 210°N (South) mean wave direction for zone F1

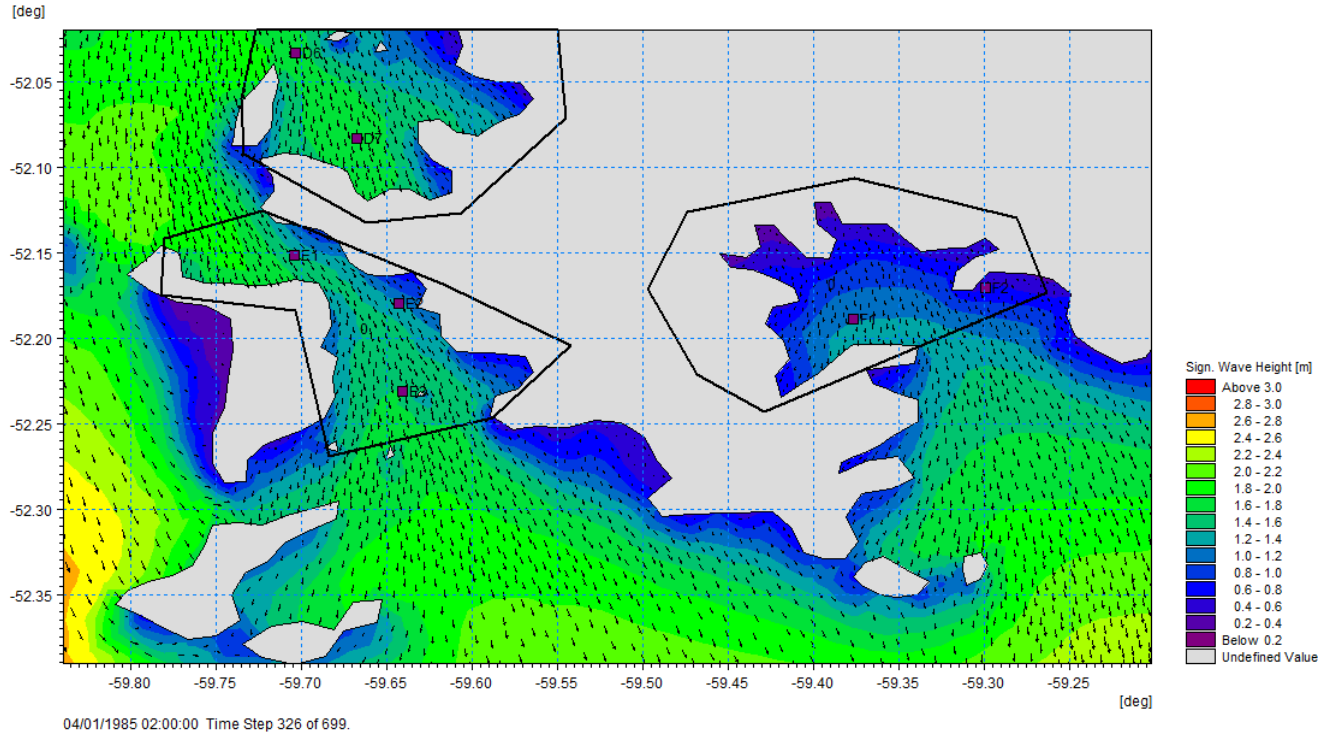


Figure F12 Snapshot of Significant Wave Heights for peak of storm event with a 0°N (North) mean wave direction for zone F1

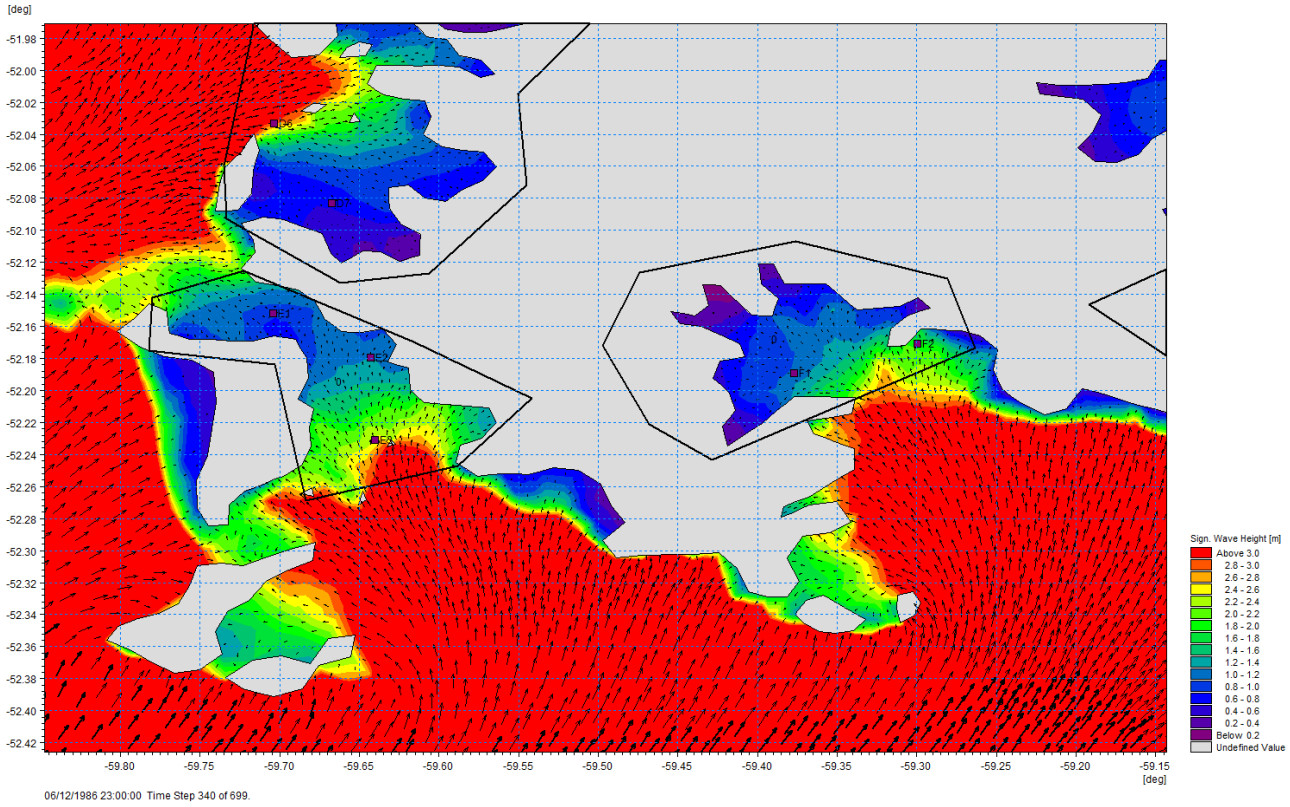


Figure F13 Snapshot of Significant Wave Heights for peak of storm event with a 210°N (South) mean wave direction for zone F1

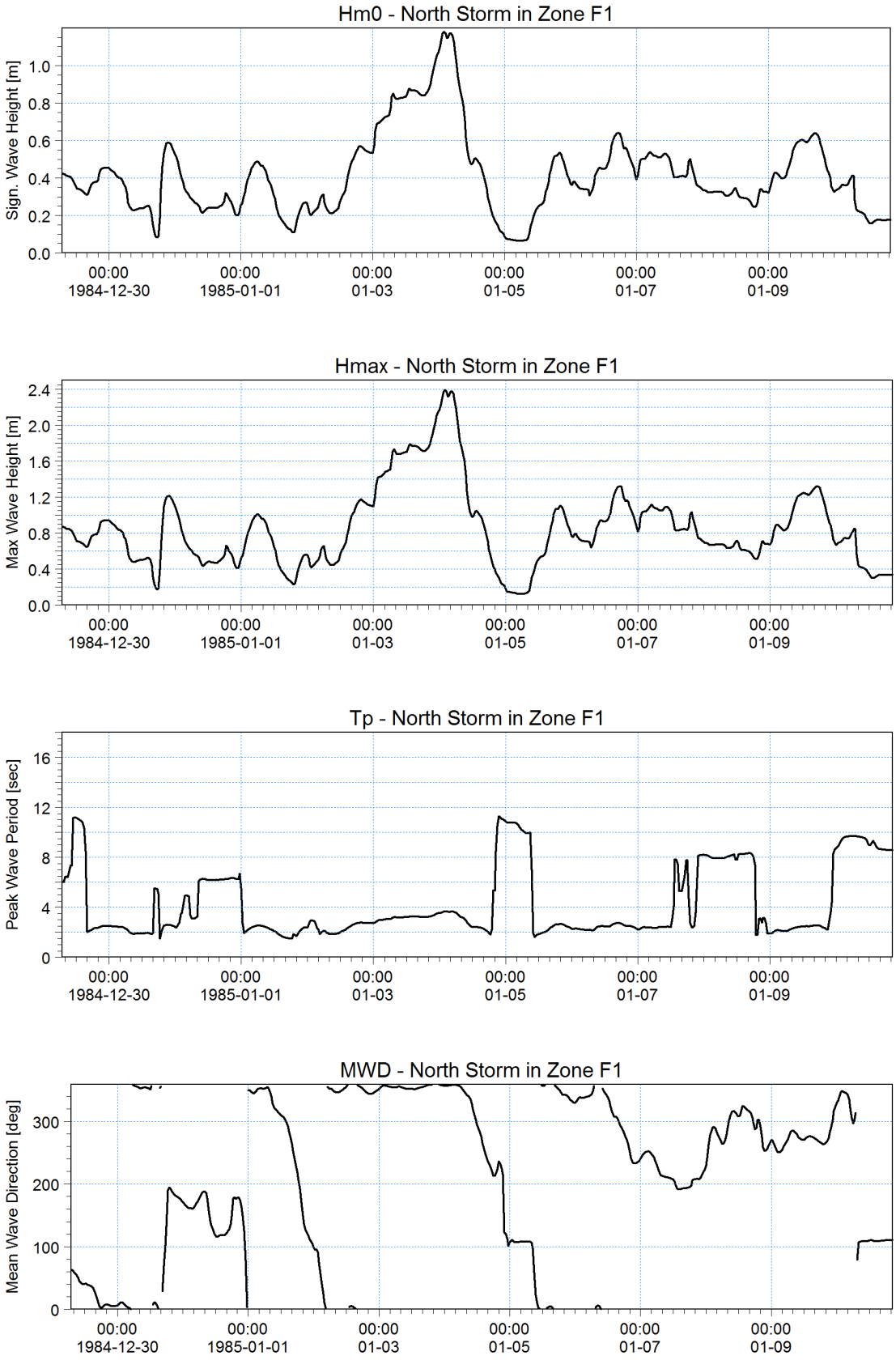


Figure F14 Coupled Model nearshore wave parameters for Peak Storm Event propagating from offshore 0°N (North) direction for Zone F1

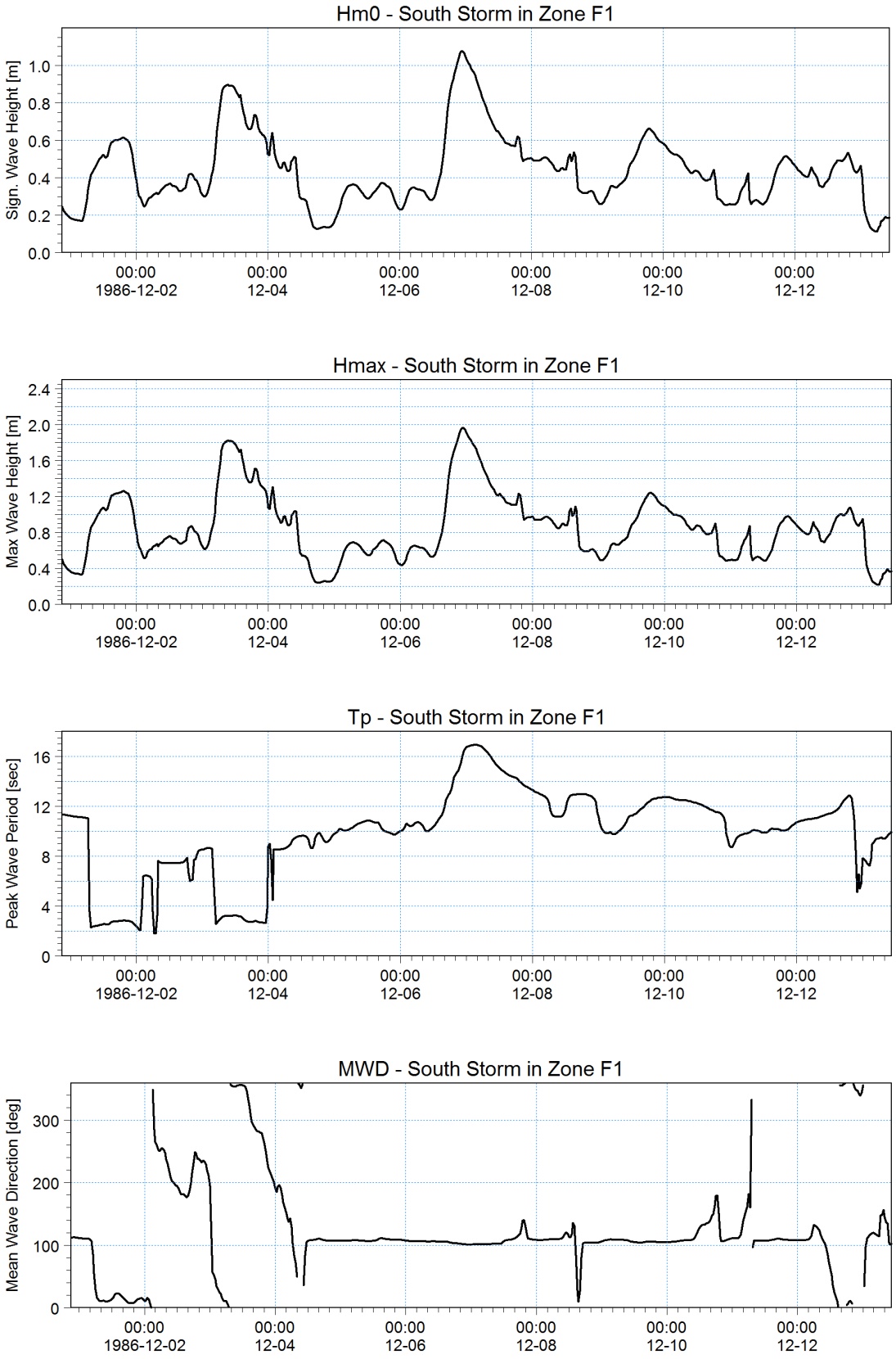


Figure F15 Coupled Model nearshore wave parameters for Peak Storm Event propagating from offshore 210°N (South) direction for Zone F1

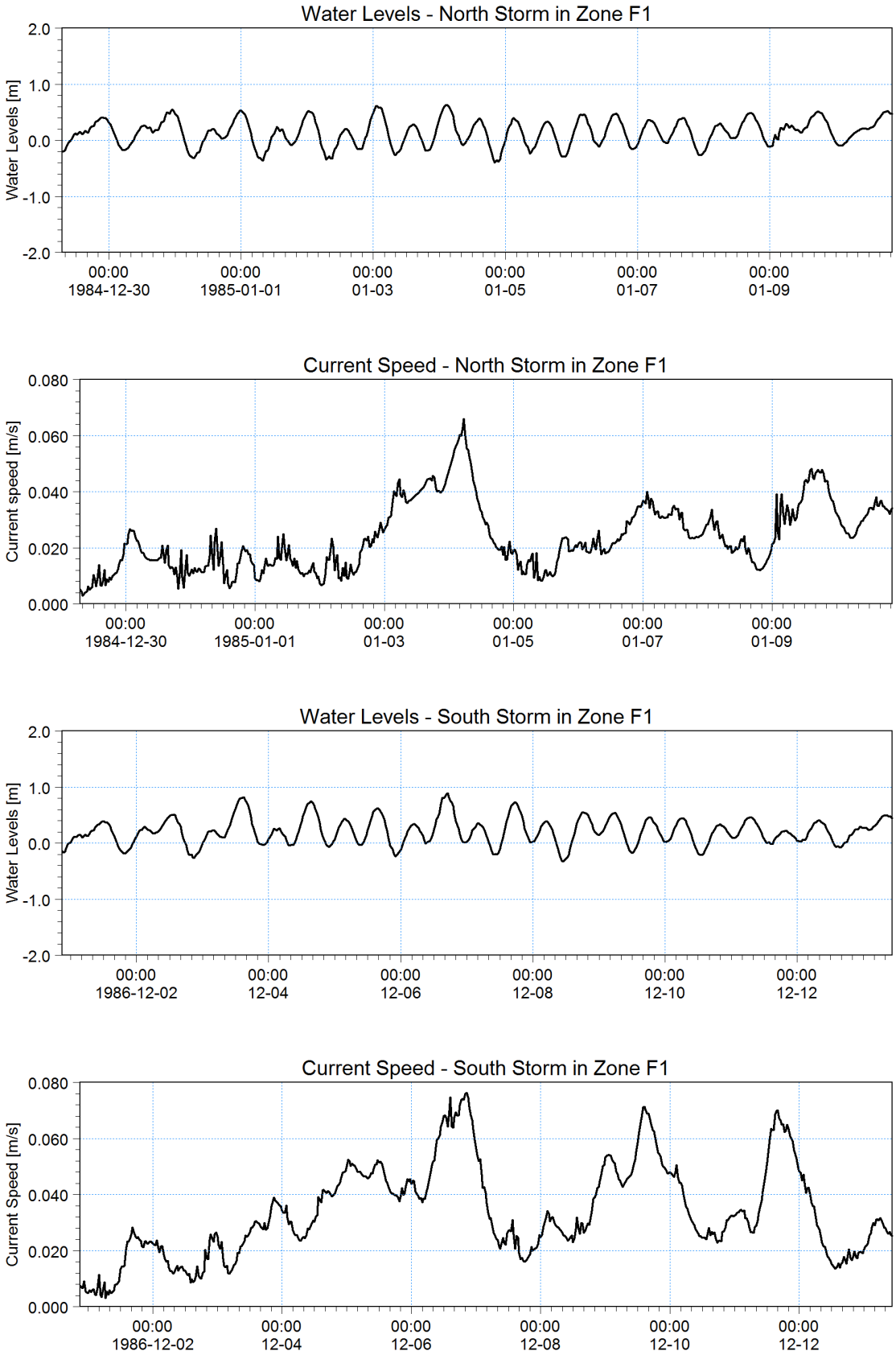


Figure F16 Coupled Model nearshore water level and current speed for a Peak Storm Event propagating from offshore 0°N (North) and 210°N (South) direction for Zone F1

Appendix G

Setup information and results for Site G2

Bathymetry and Mesh

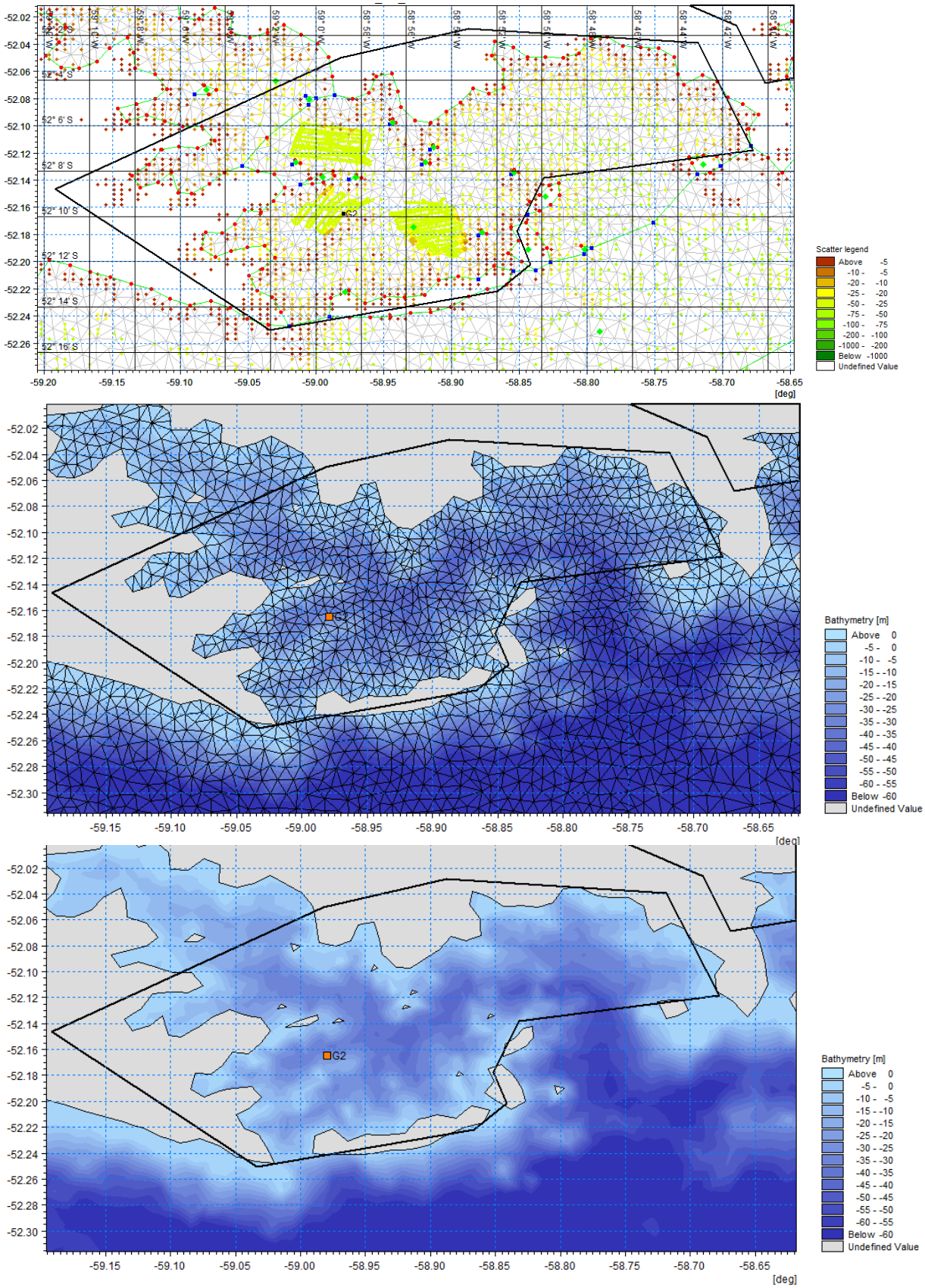


Figure G1 (Top) Input data - CMAP & provided bathymetry data points and CMAP land data (Middle) Created Mesh with underlying Bathymetry (Bottom) Interpolated Bathymetry

Uncoupled SW Model – 1 in 1 year storm

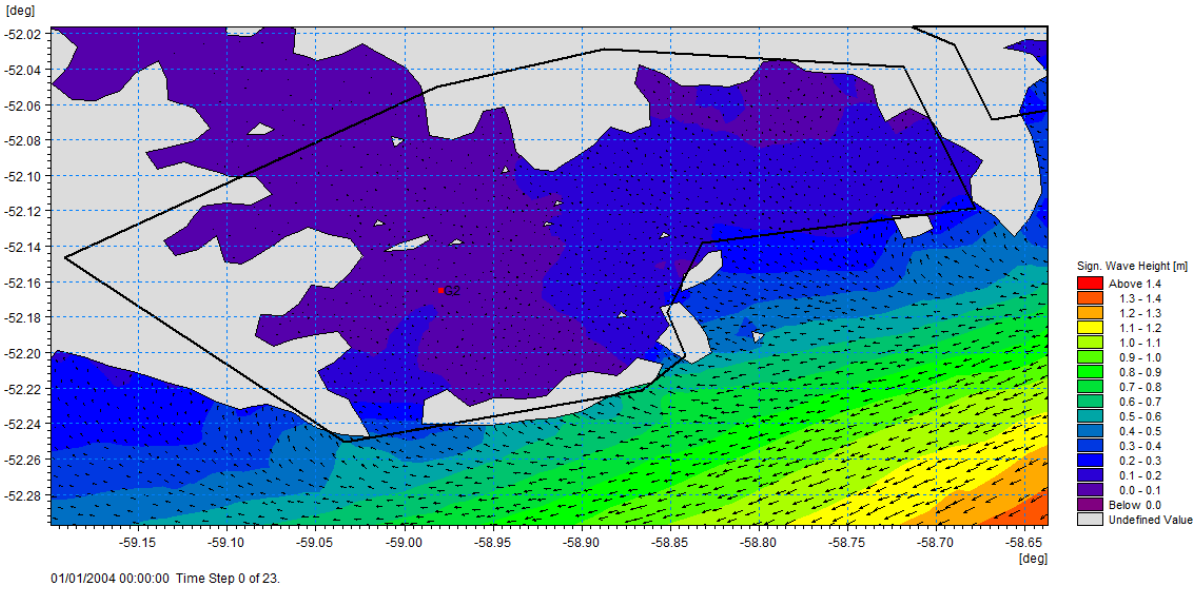


Figure G2 Significant wave heights for 1 in 1 Year Return Period wave transformation for 0°N mean wave direction

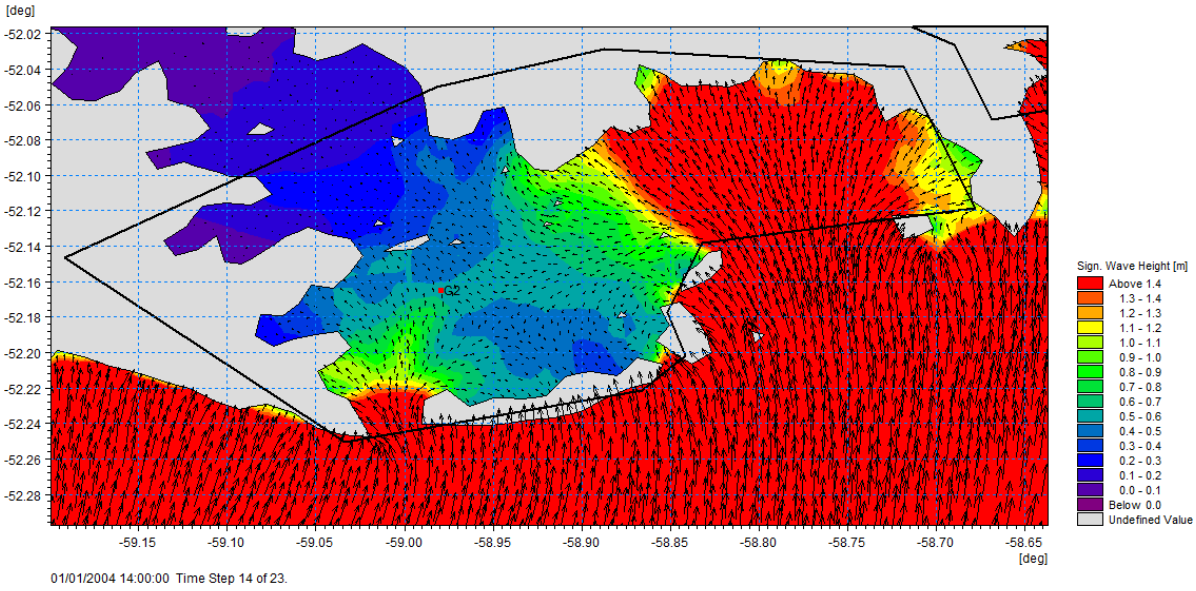


Figure G3 Significant wave heights for 1 in 1 Year Return Period wave transformation for 210°N mean wave direction

Uncoupled SW Model – 1 in 50 year storm

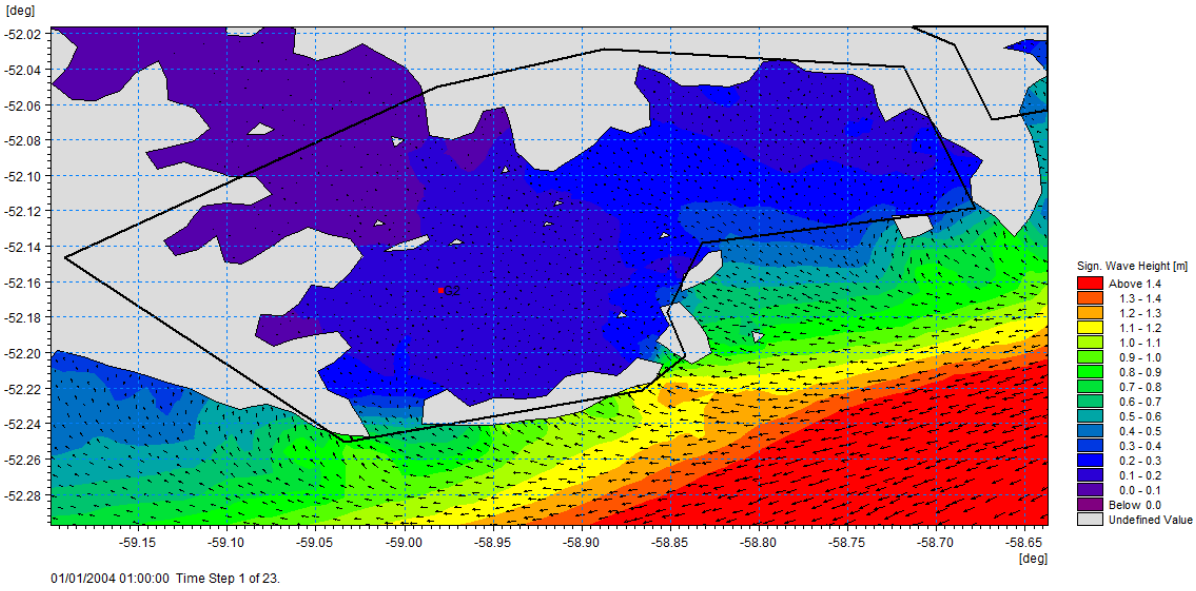


Figure G4 Significant wave heights for 1 in 50 Year Return Period wave transformation for 0°N mean wave direction

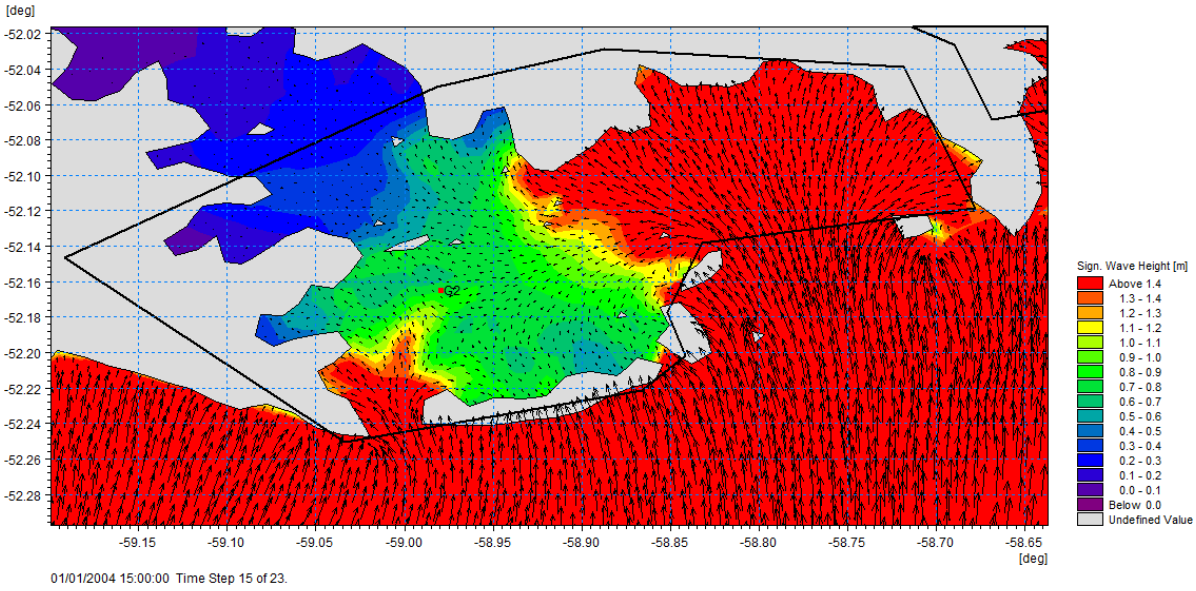


Figure G5 Significant wave heights for 1 in 50 Year Return Period wave transformation for 210°N mean wave direction

Coupled Model – Statistical Overview

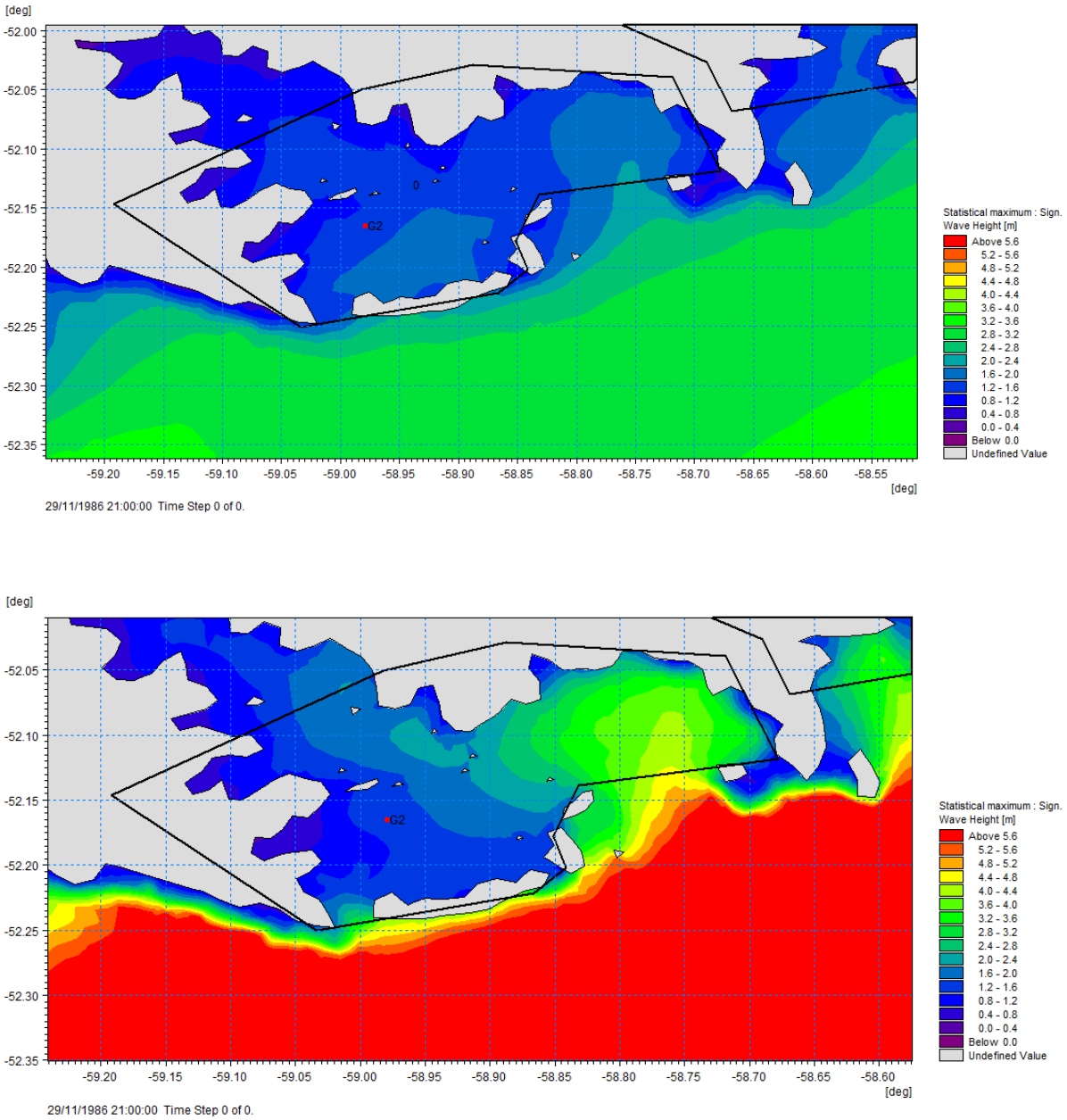


Figure G6 Statistical maximum H_{mo} for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

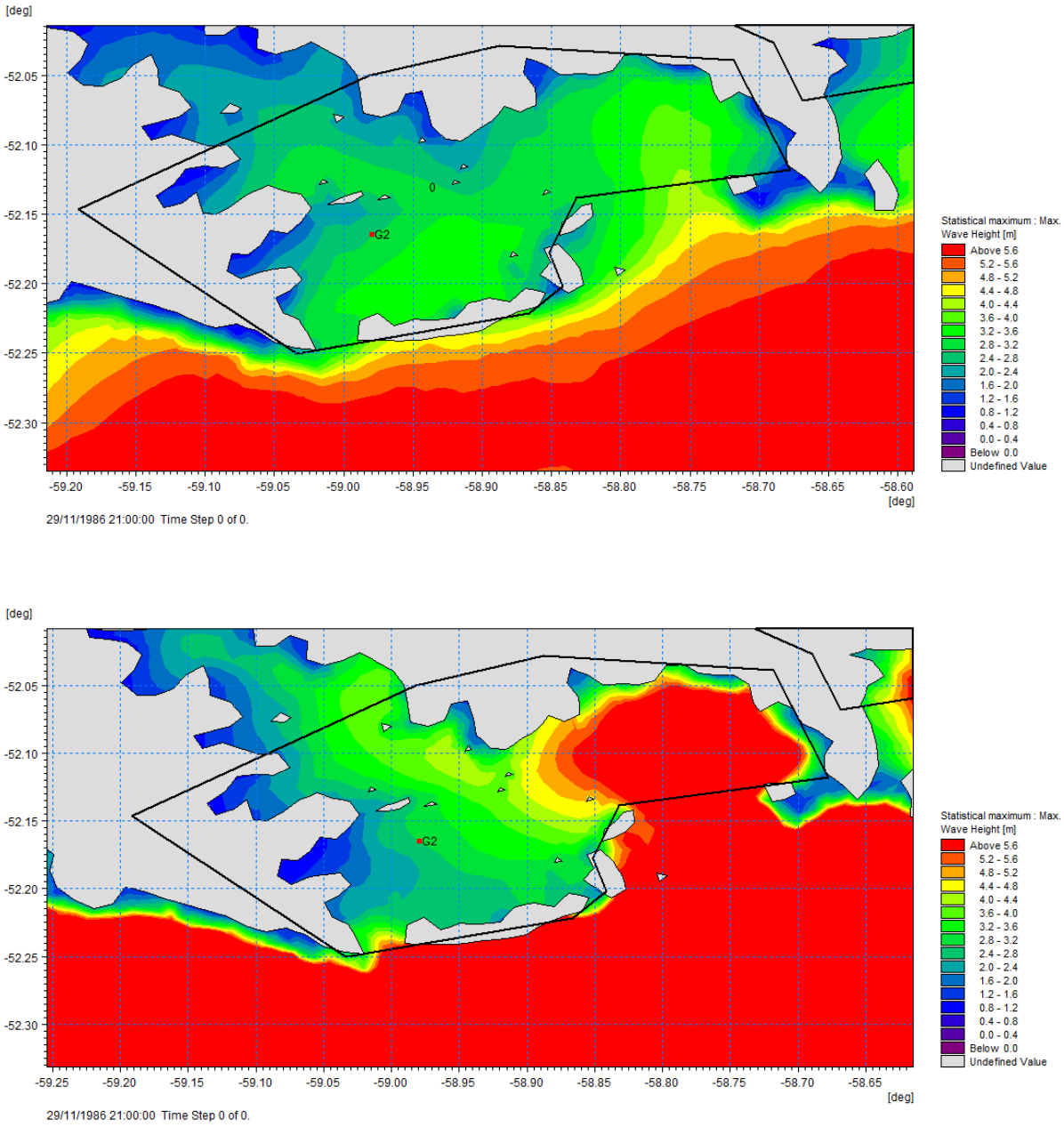


Figure G7 Statistical maximum Hmax for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

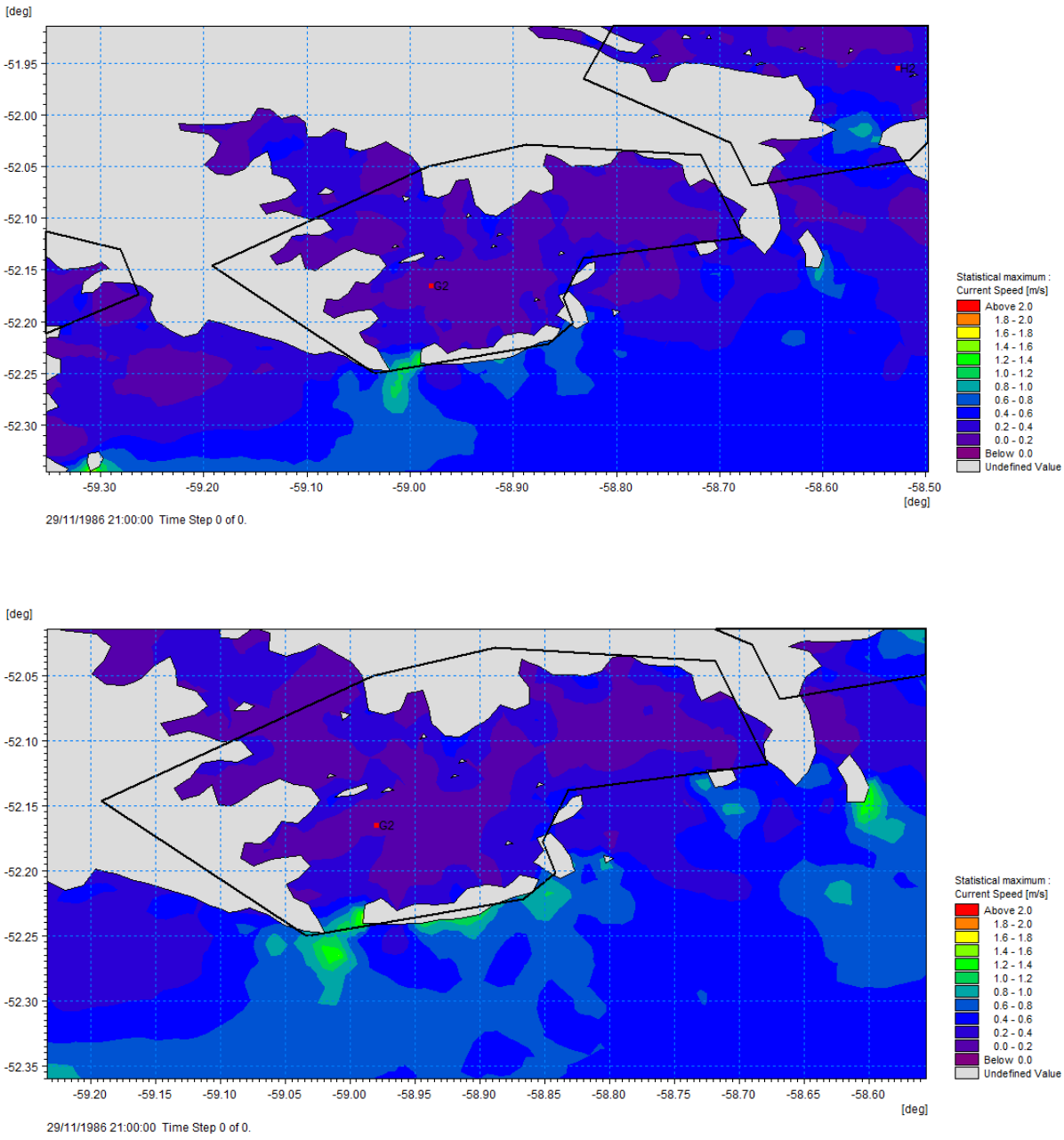


Figure G8 Max Current Speed for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

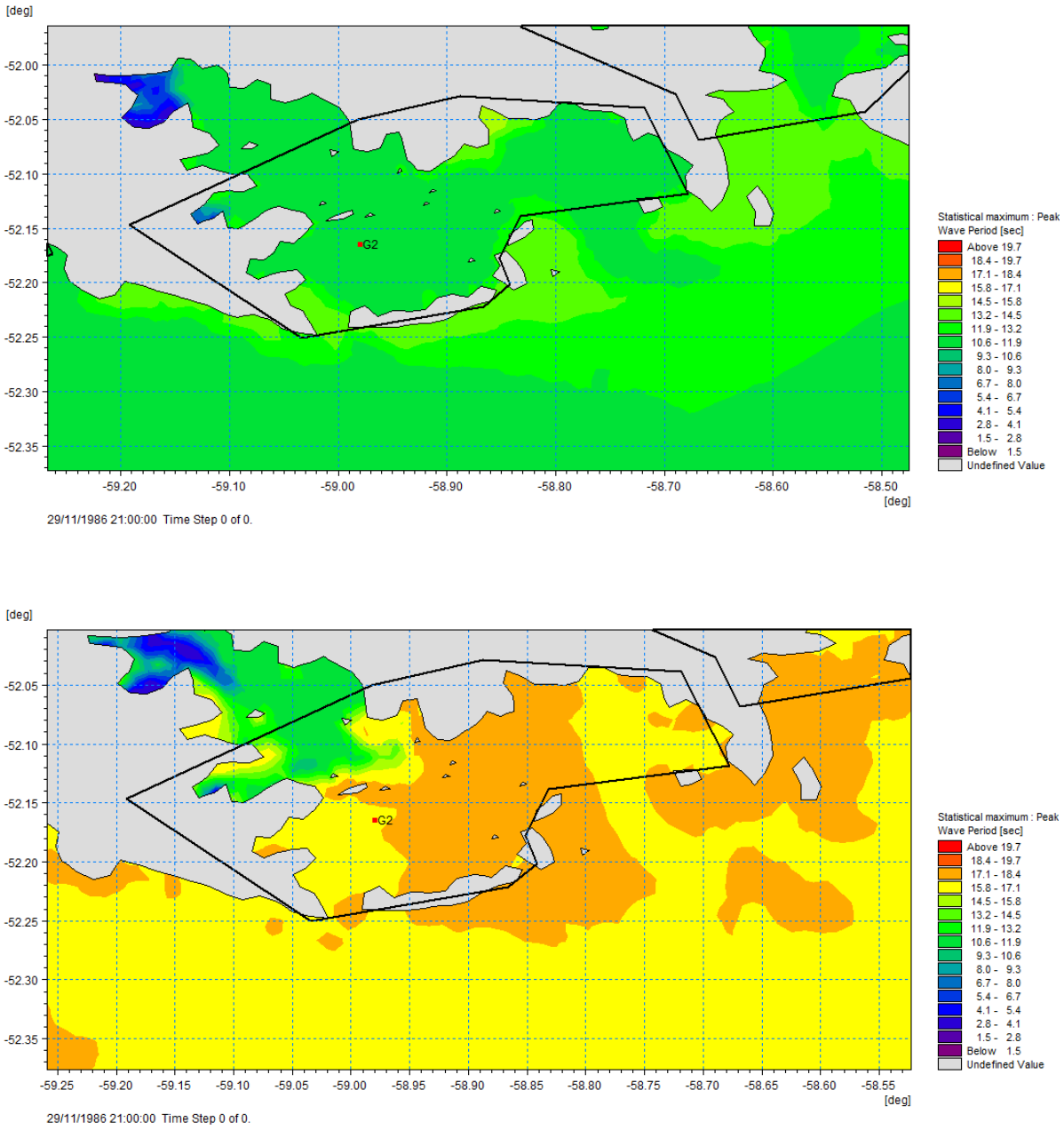


Figure G9 Max Peak Wave Period (Tp) for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

Coupled Model – Pseudo Storm Results

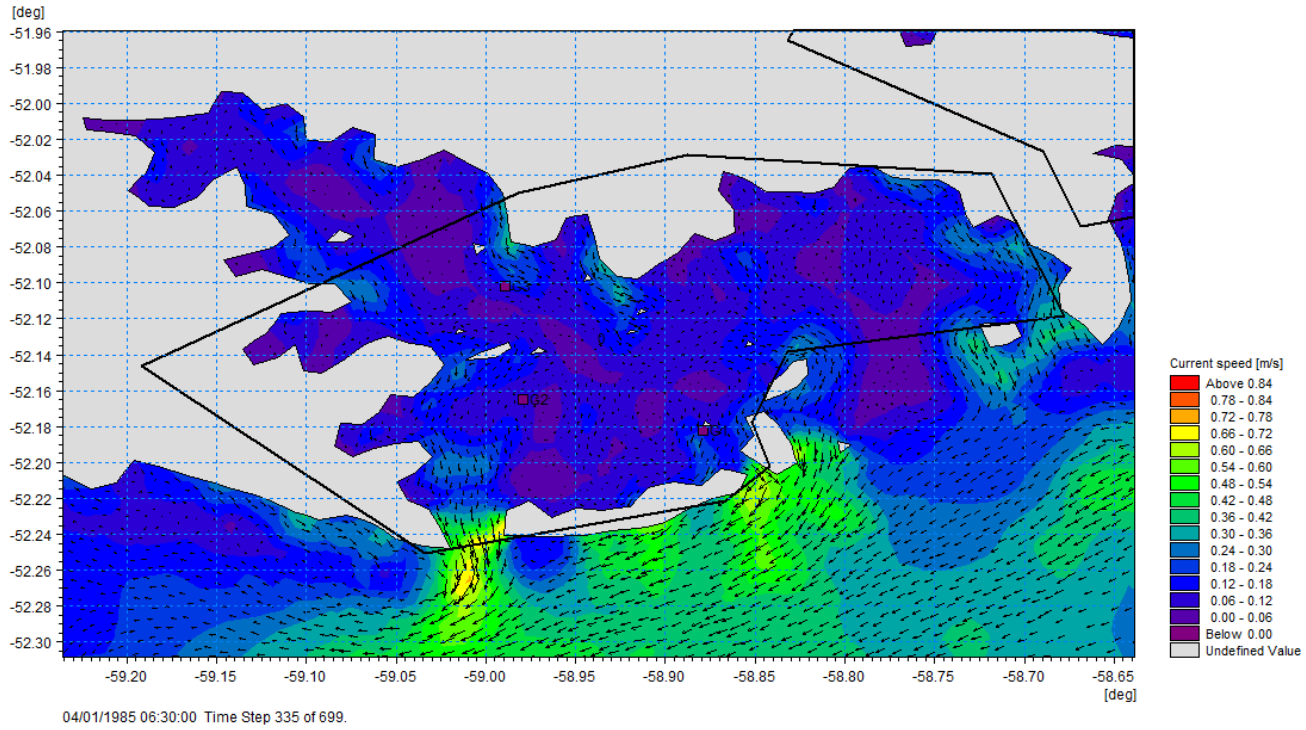


Figure G10 Snapshot of Current Speeds for peak of storm event with a 0°N (North) mean wave direction for zone G2

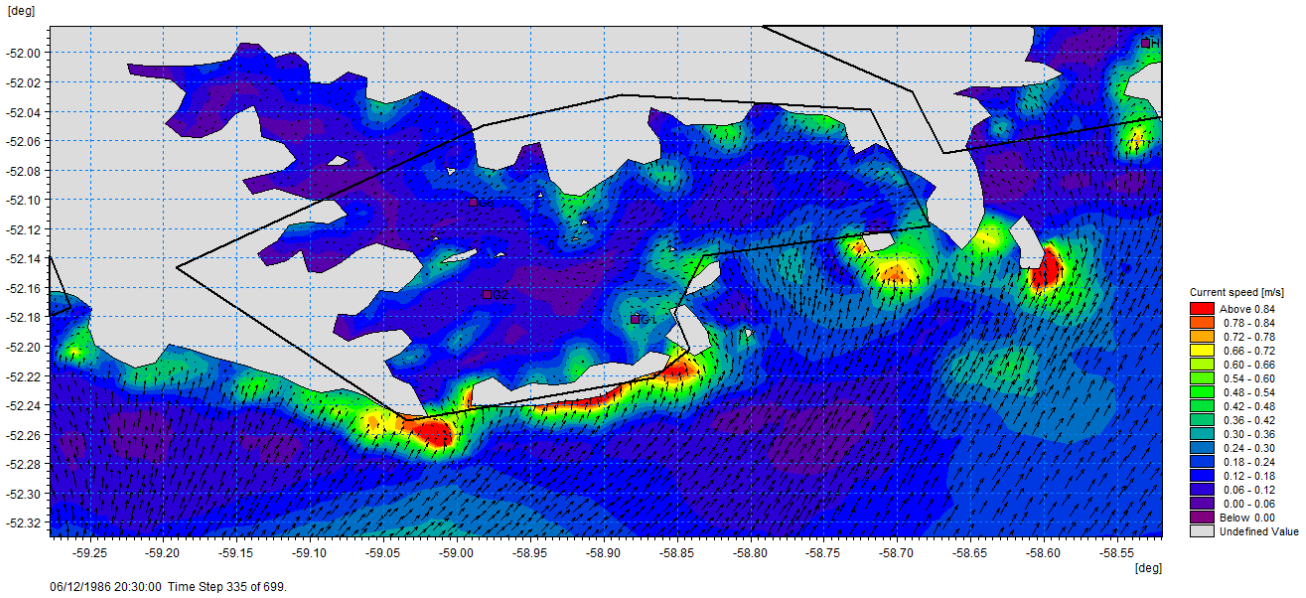


Figure G11 Snapshot of Current Speeds for peak of storm event with a 210°N (South) mean wave direction for zone G2

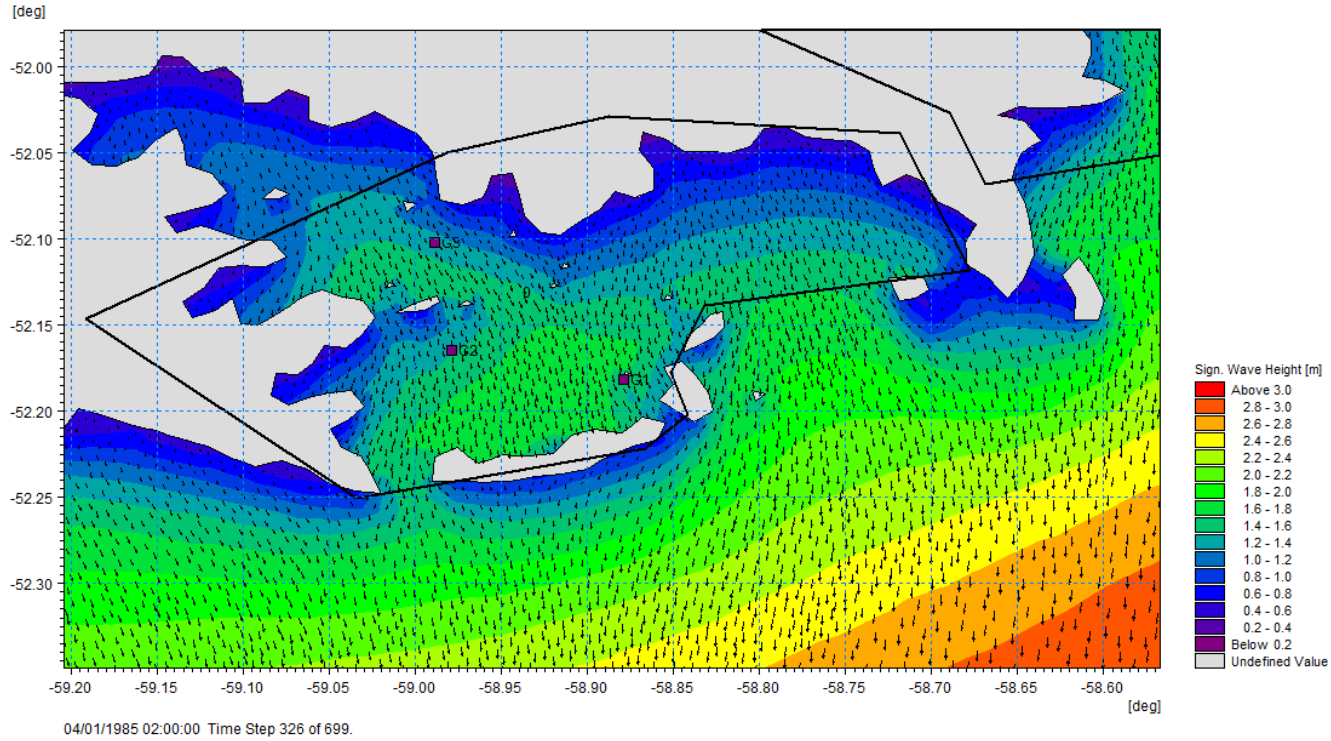


Figure G12 Snapshot of Significant Wave Heights for peak of storm event with a 0°N (North) mean wave direction for zone G2

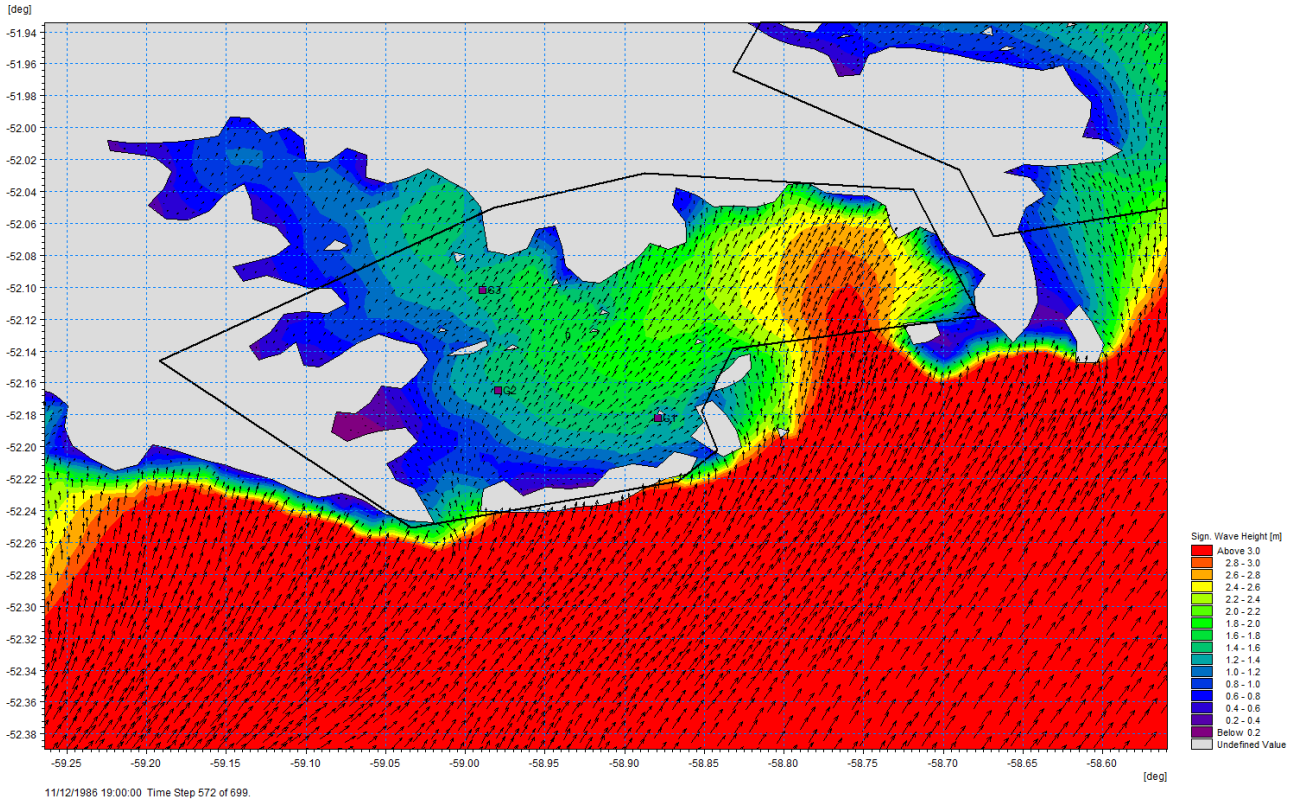


Figure G13 Snapshot of Significant Wave Heights for peak of storm event with a 210°N (South) mean wave direction for zone G2

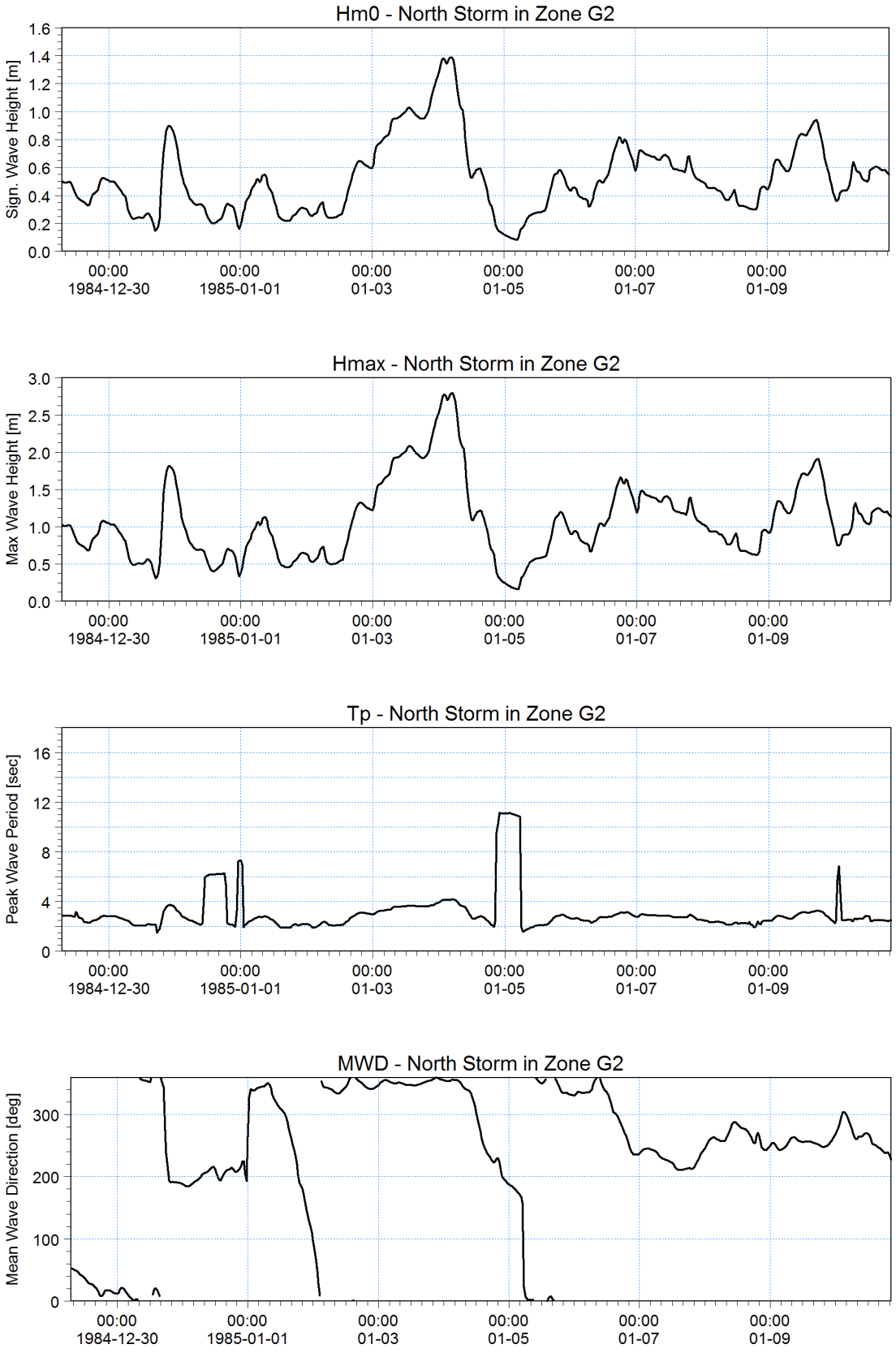


Figure G14 Coupled Model nearshore wave parameters for Peak Storm Event propagating from offshore 0°N (North) direction for Zone G2

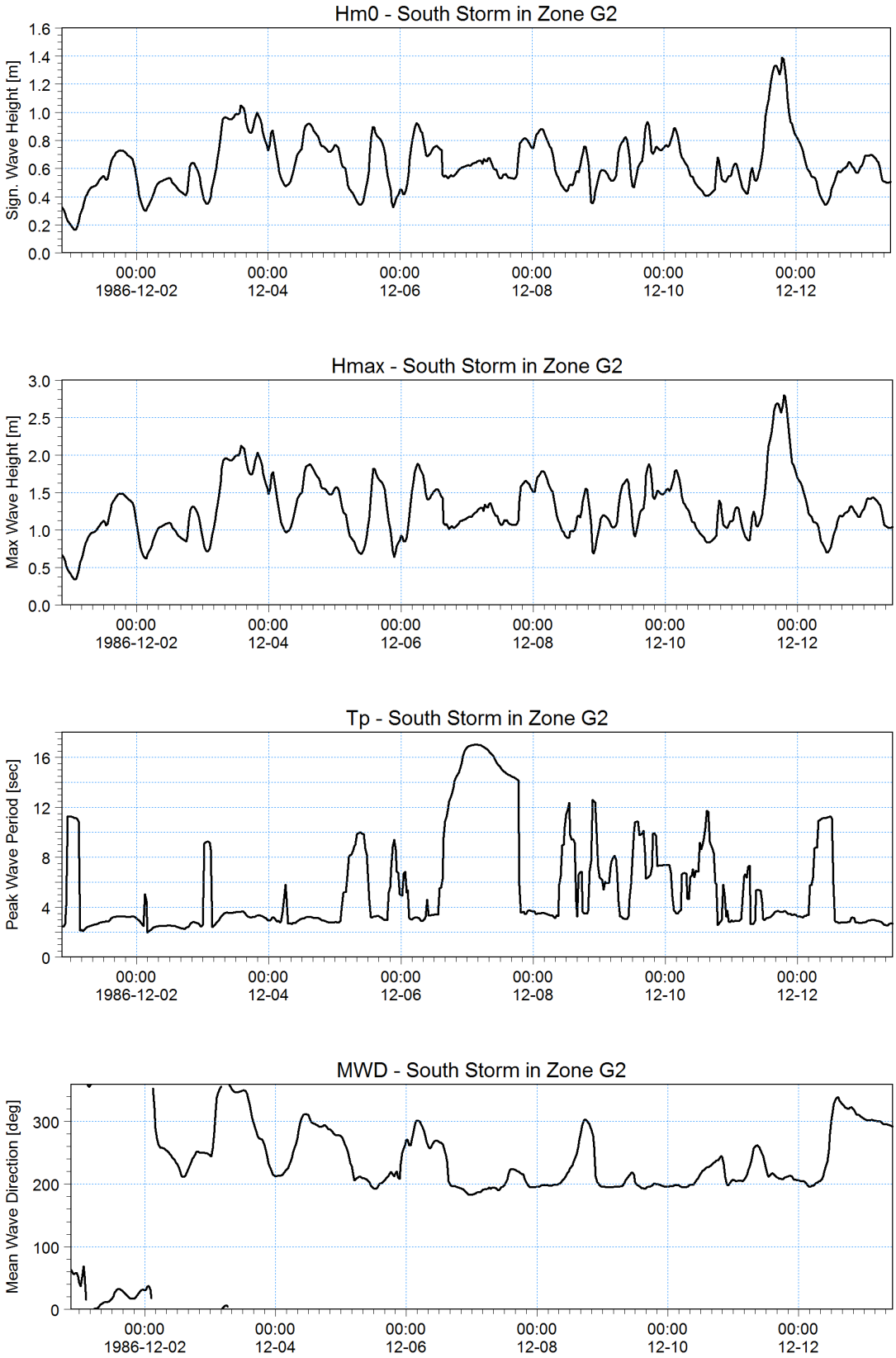


Figure G15 Coupled Model nearshore wave parameters for Peak Storm Event propagating from offshore 210°N (South) direction for Zone G2

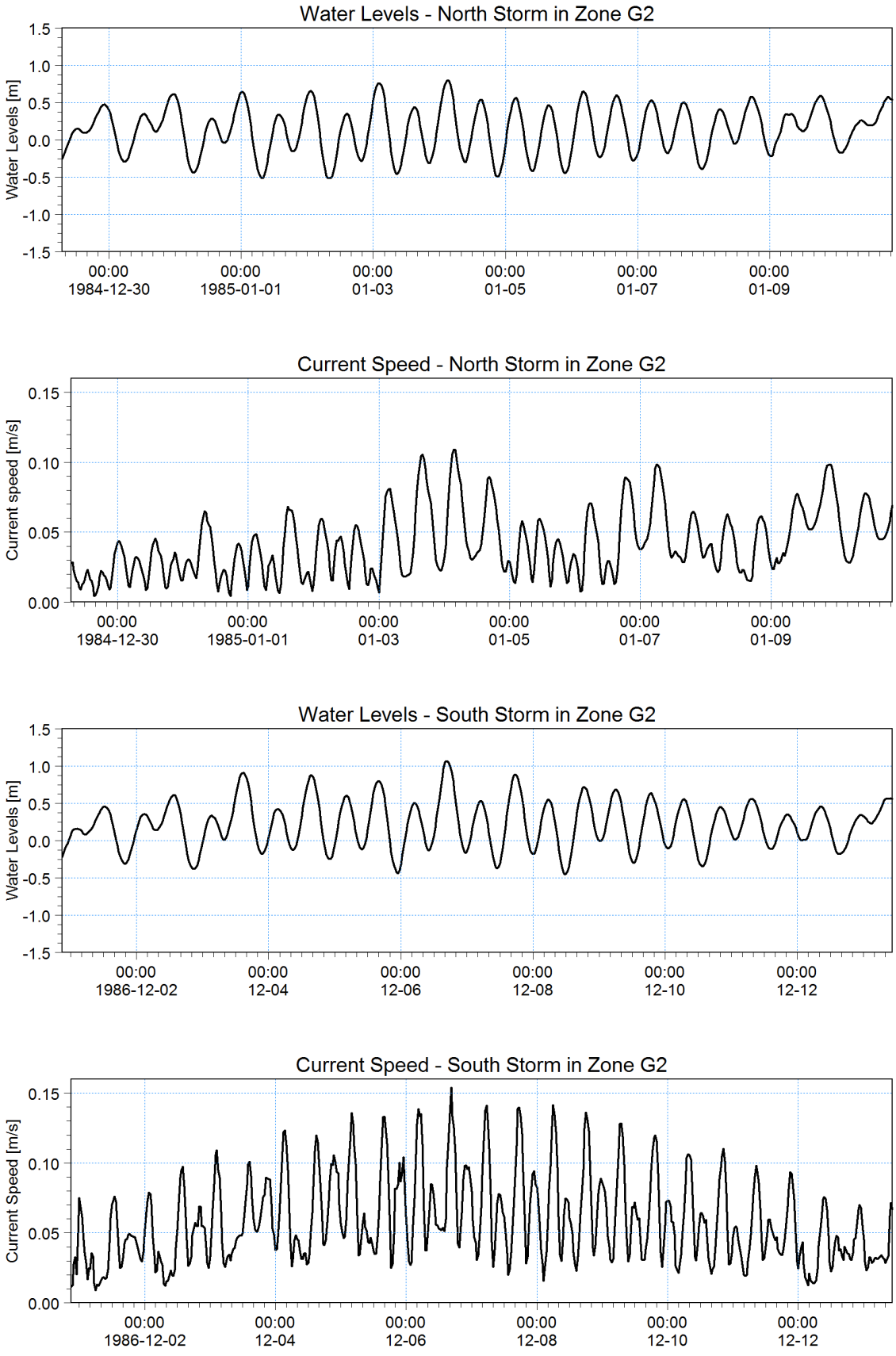


Figure G16 Coupled Model nearshore water level and current speed for a Peak Storm Event propagating from offshore 0°N (North) and 210°N (South) direction for Zone G2

Appendix H

Setup information and results for Site H2

Bathymetry and Mesh

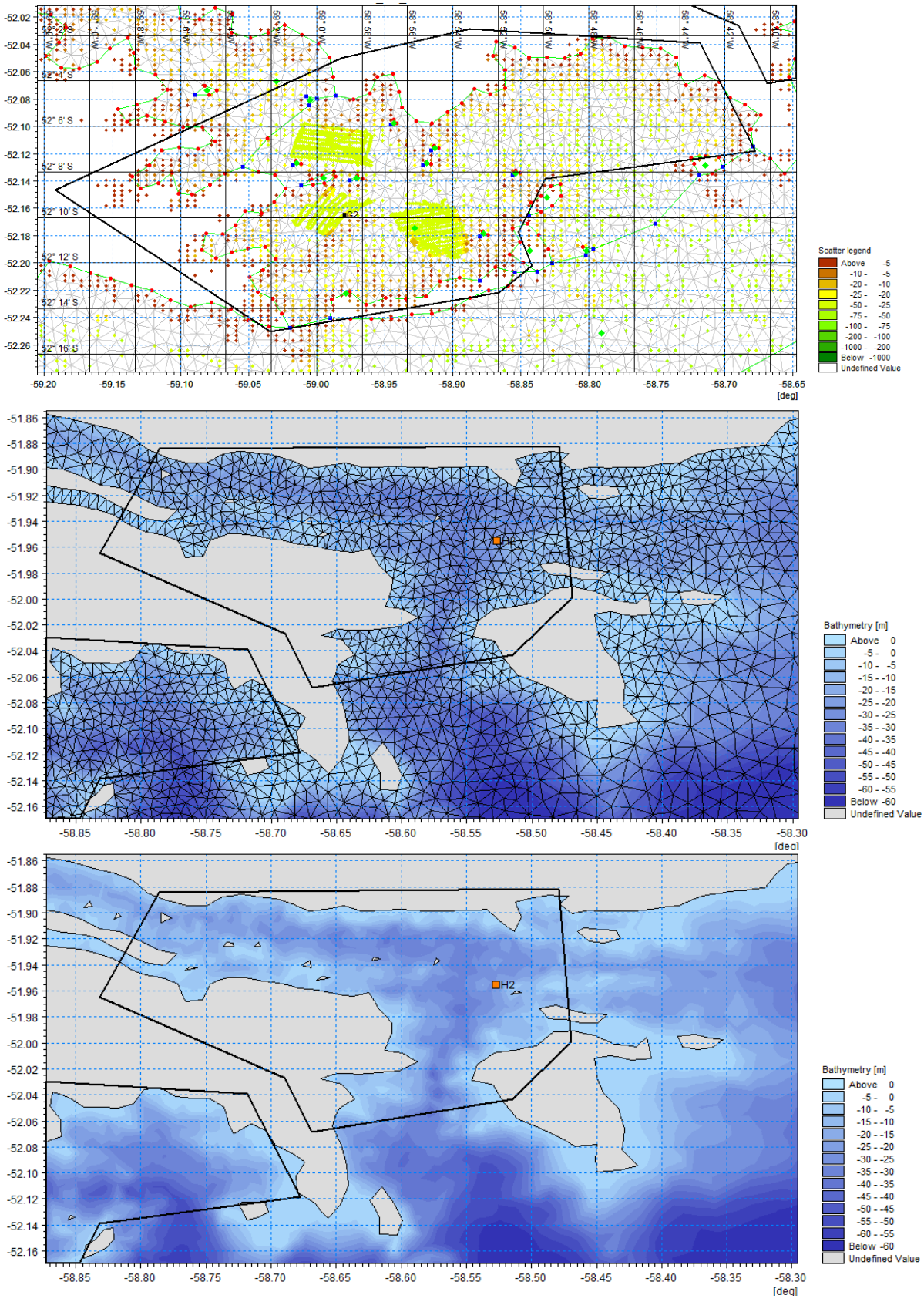


Figure H1 (Top) Input data - CMAP & provided bathymetry data points and CMAP land data (Middle) Created Mesh with underlying Bathymetry (Bottom) Interpolated Bathymetry

Uncoupled SW Model – 1 in 1 year storm

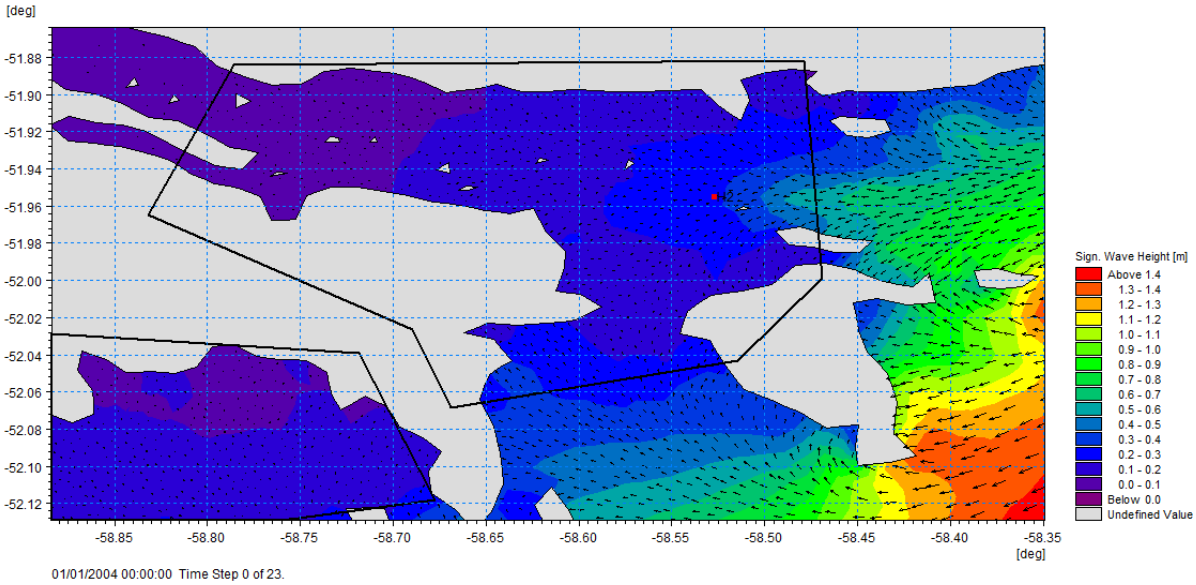


Figure H2 Significant wave heights for 1 in 1 Year Return Period wave transformation for 0°N mean wave direction

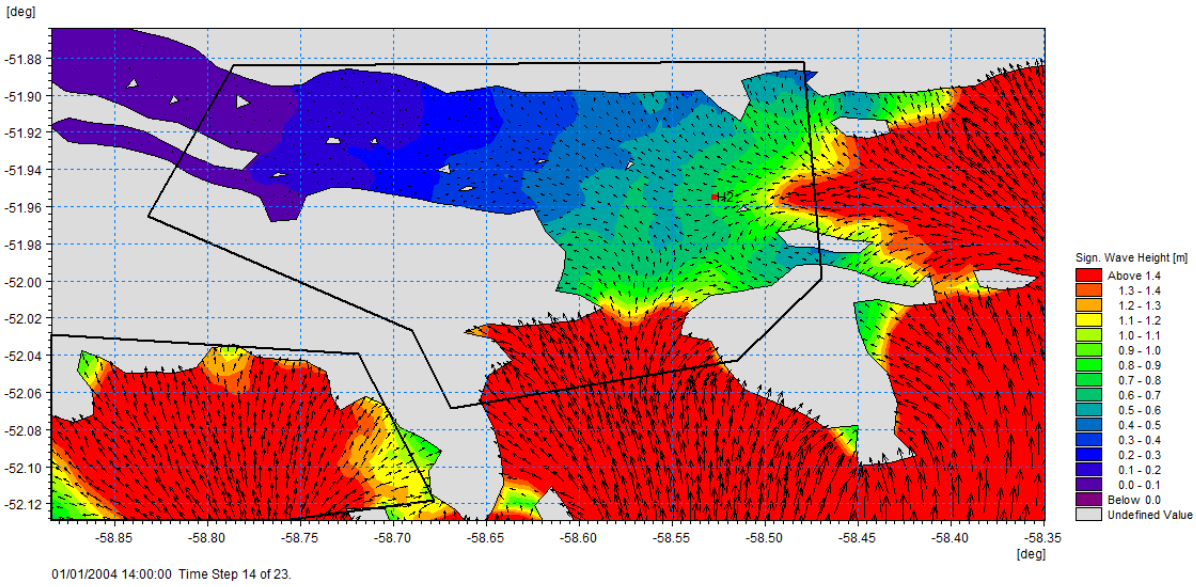


Figure H3 Significant wave heights for 1 in 1 Year Return Period wave transformation for 210°N mean wave direction

Uncoupled SW Model – 1 in 50 year storm

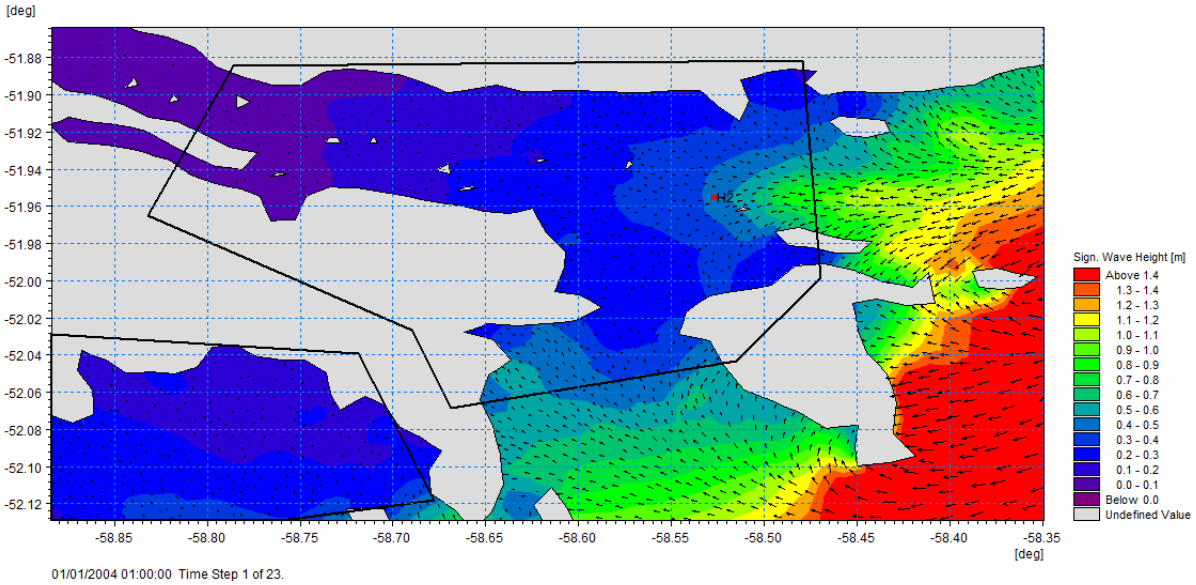


Figure H4 Significant wave heights for 1 in 50 Year Return Period wave transformation for 0°N mean wave direction

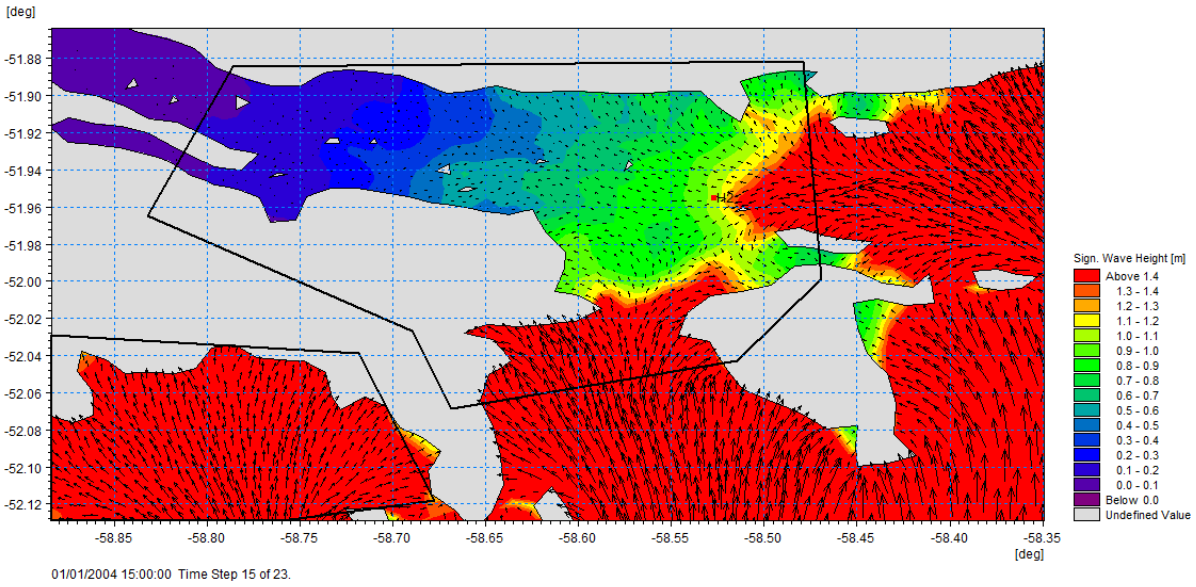


Figure H5 Significant wave heights for 1 in 50 Year Return Period wave transformation for 210°N mean wave direction

Coupled Model – Statistical Overview

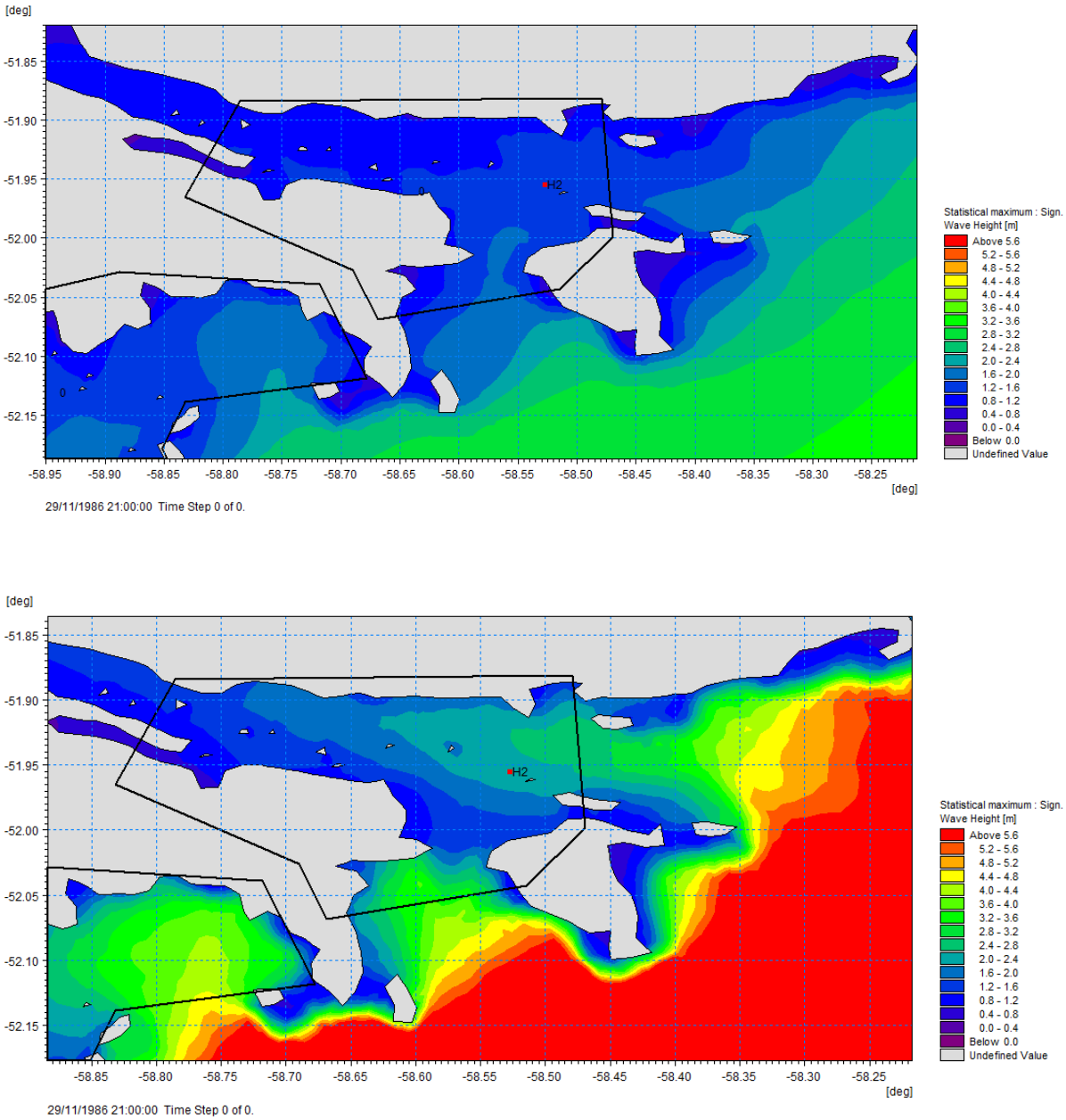


Figure H6 Statistical maximum H_{mo} for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

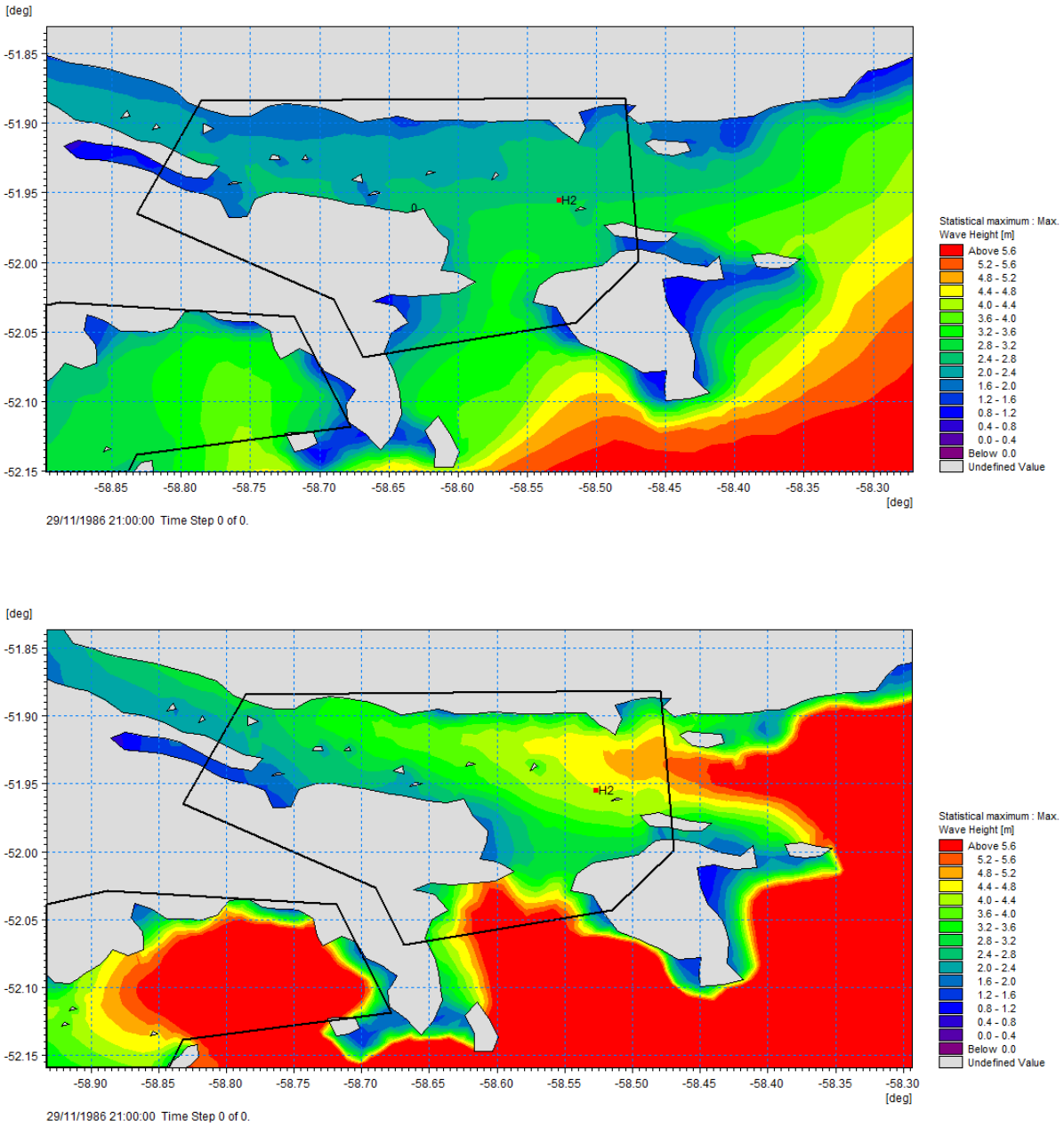


Figure H7 Statistical maximum Hmax for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

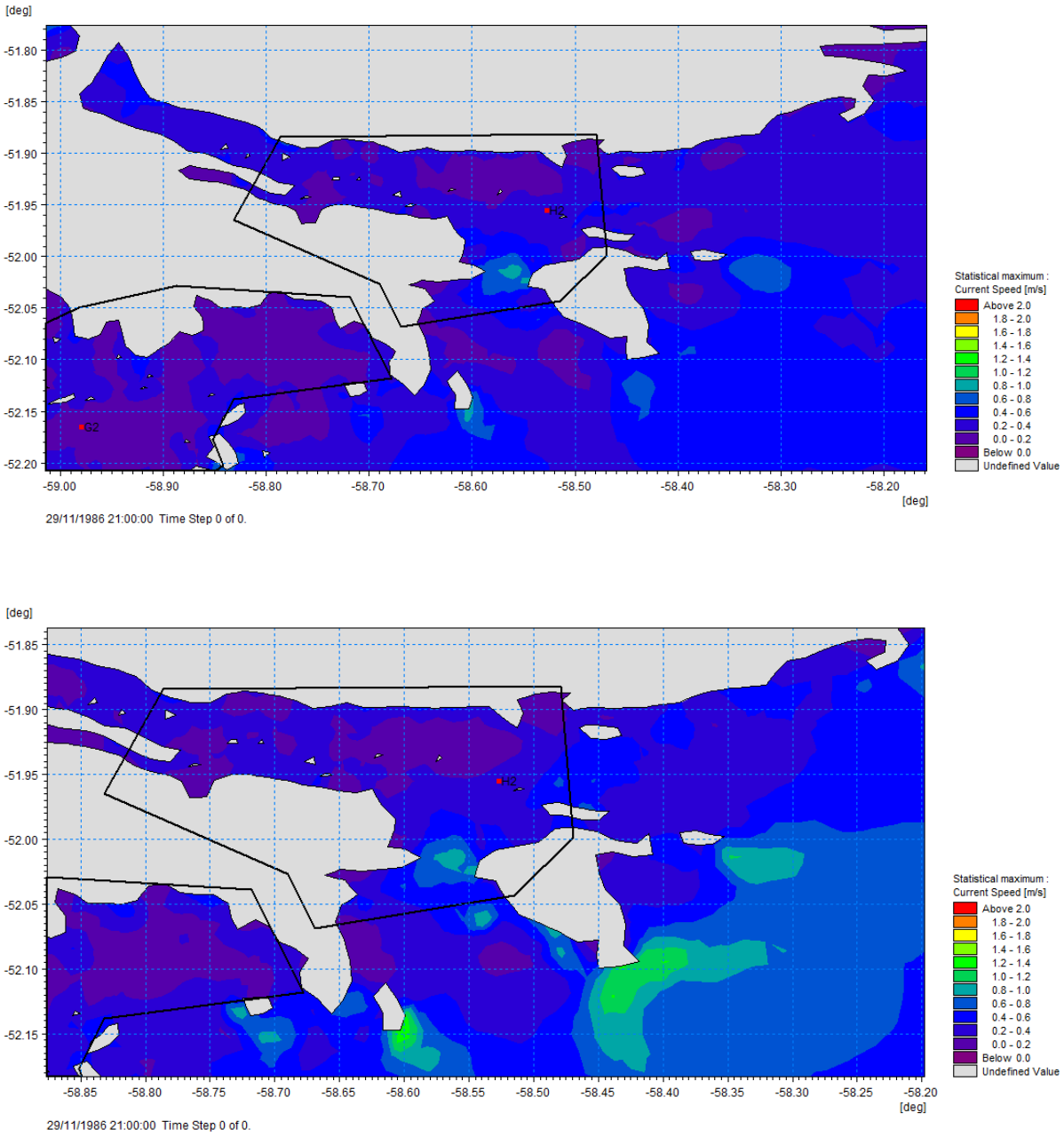


Figure H8 Max Current Speed for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

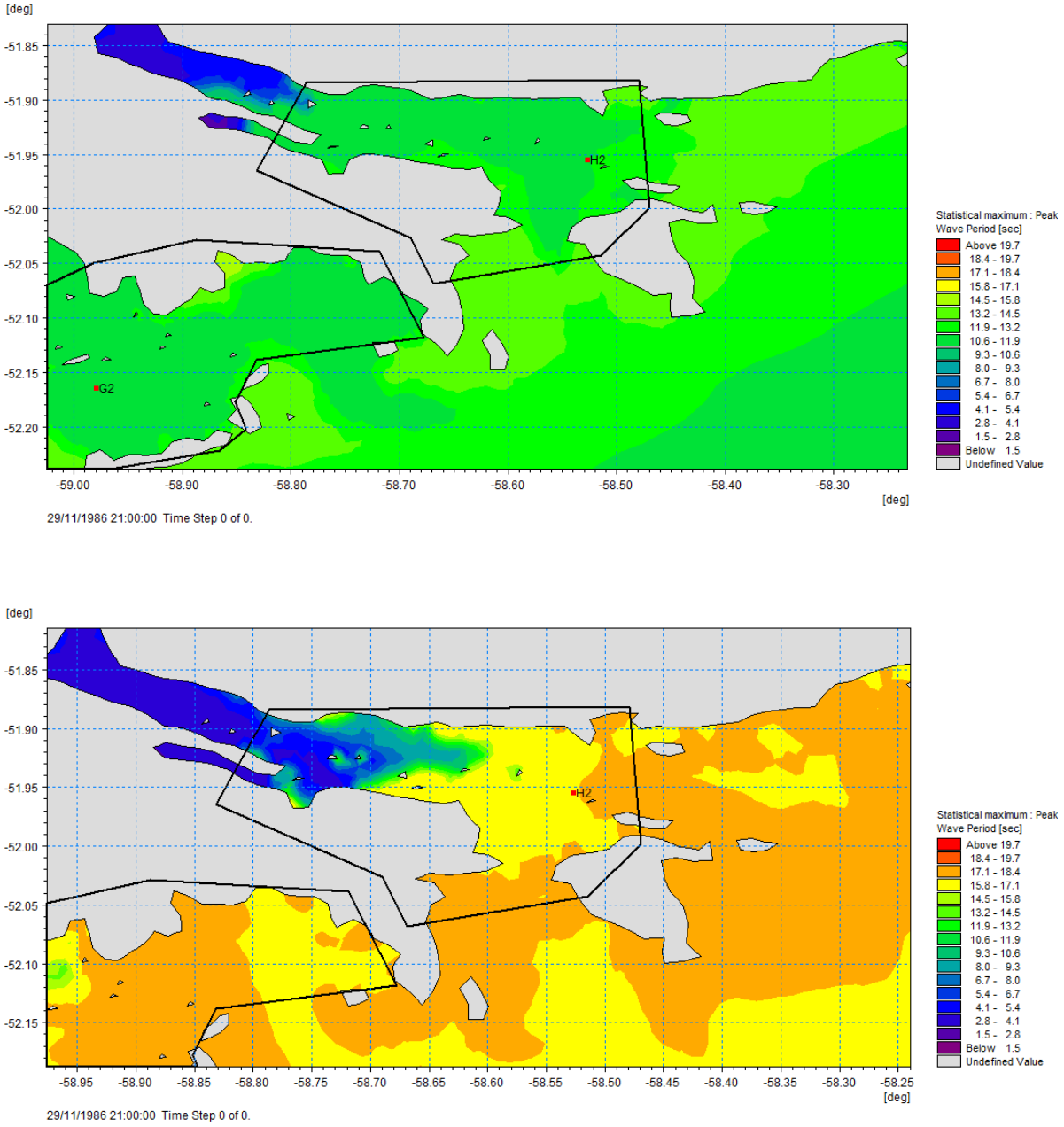


Figure H9 Max Peak Wave Period (Tp) for entire storm period for North (top) and South (bottom) for the 1 in 50 year storm event

Coupled Model – Pseudo Storm Results

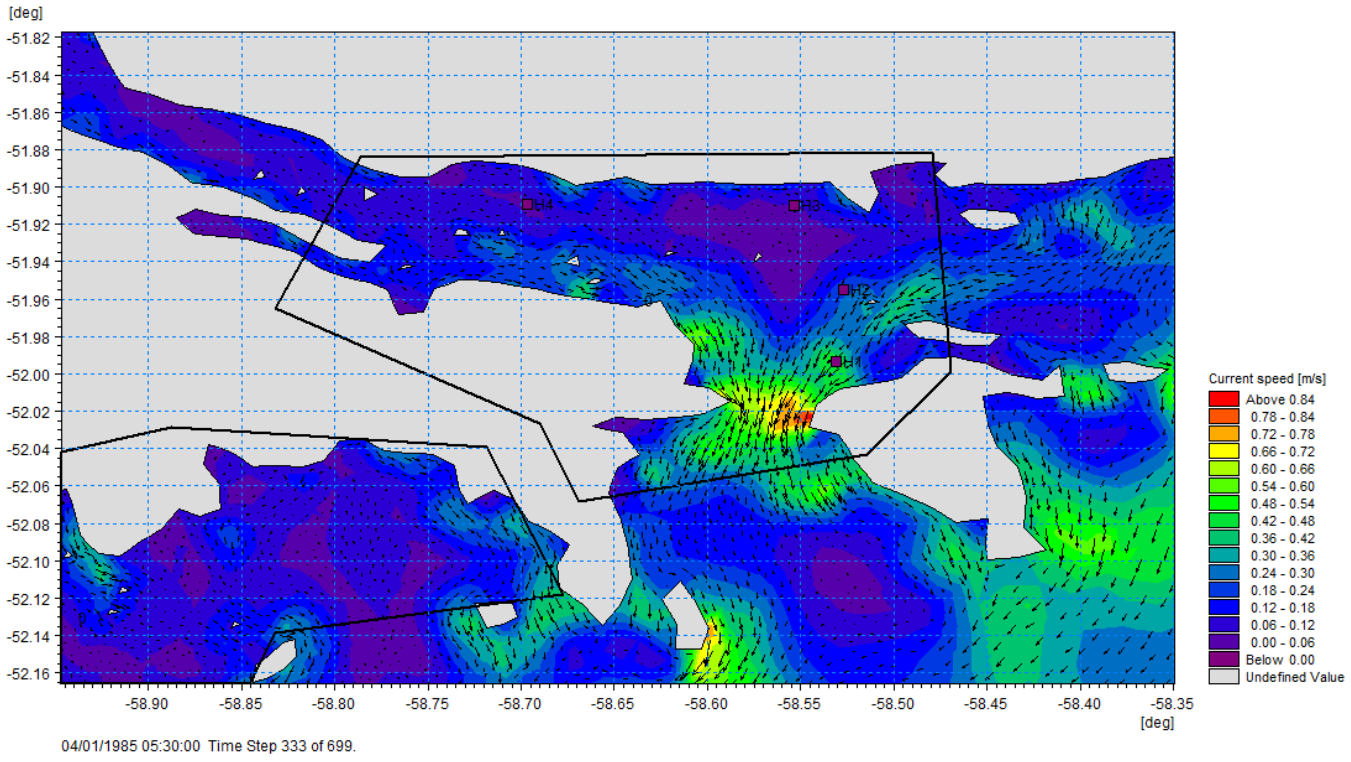


Figure H10 Snapshot of current speeds for peak of storm event with a 0°N (North) mean wave direction for zone H2

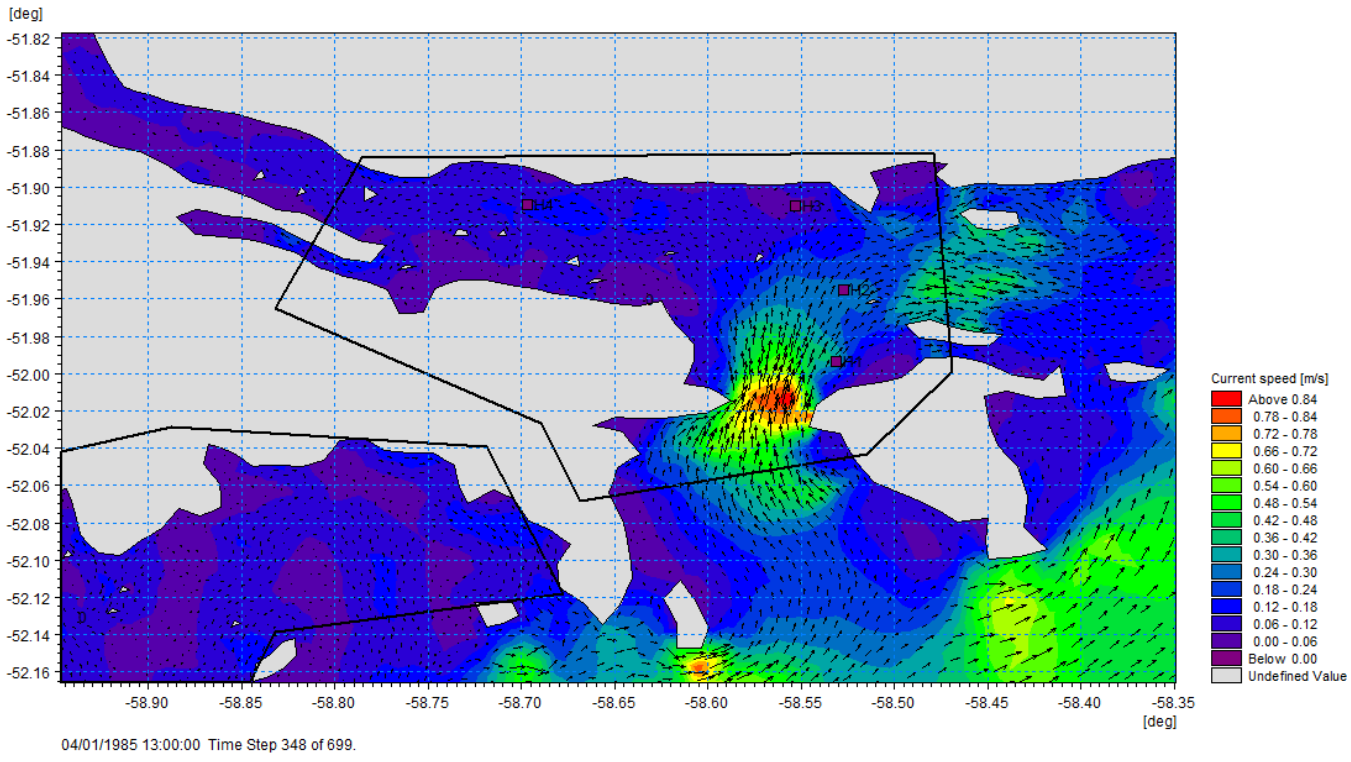


Figure H11 Snapshot of current speeds for peak of storm event with a 210°N (South) mean wave direction for zone H2

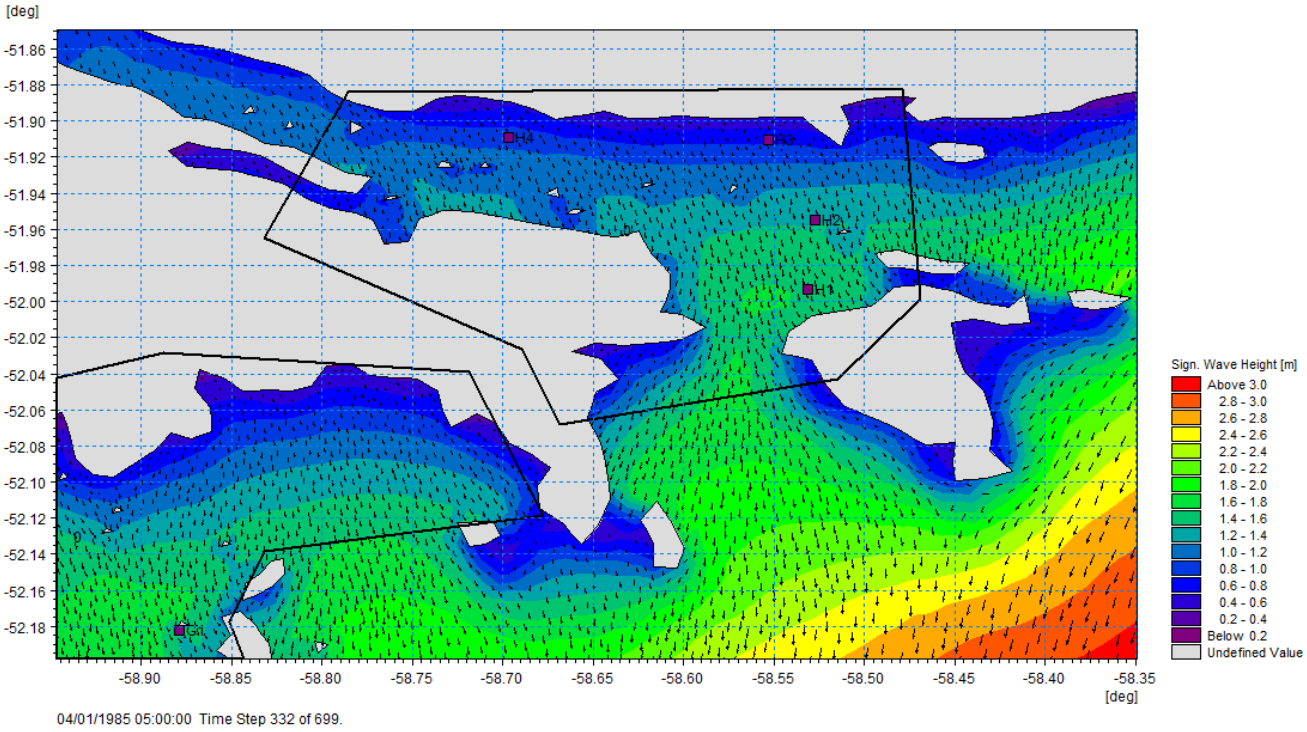


Figure H12 Snapshot of Significant Wave Heights for peak of storm event with a 0°N (North) mean wave direction for zone H2

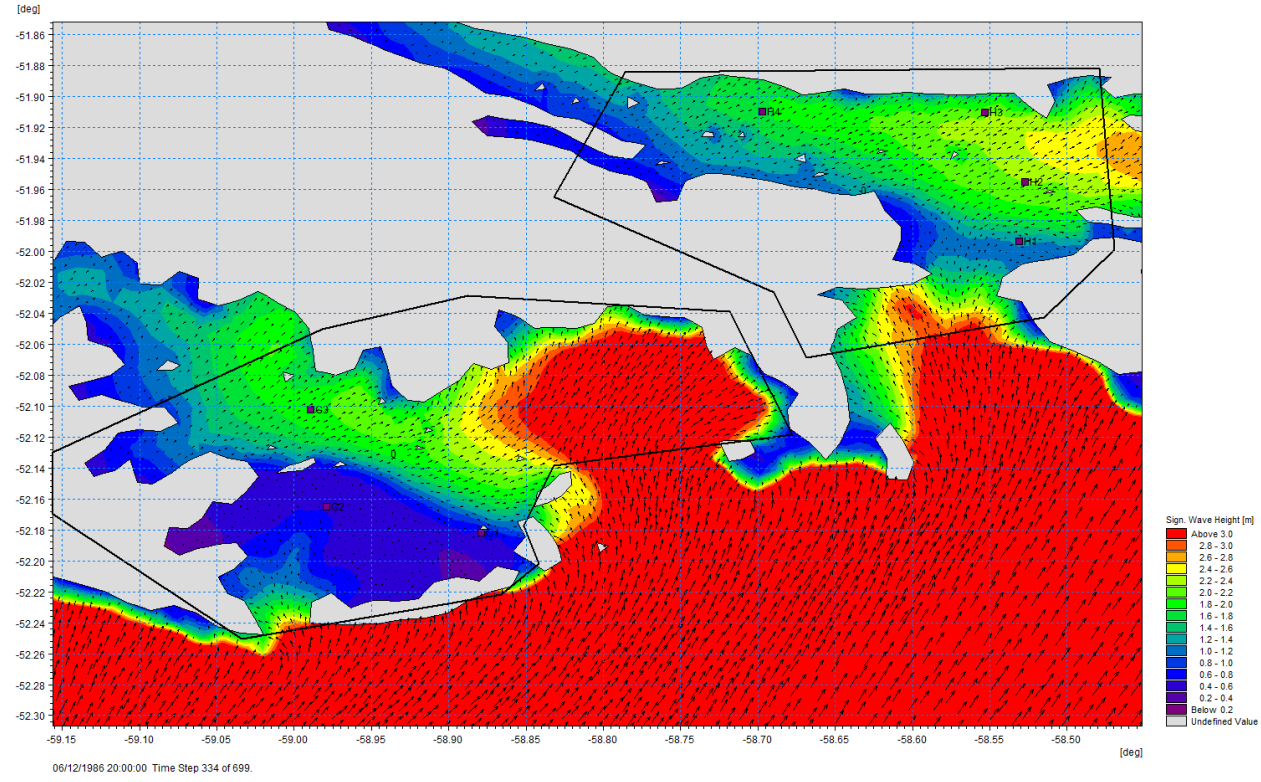


Figure H13 Snapshot of Significant Wave Heights for peak of storm event with a 210°N (South) mean wave direction for zone H2

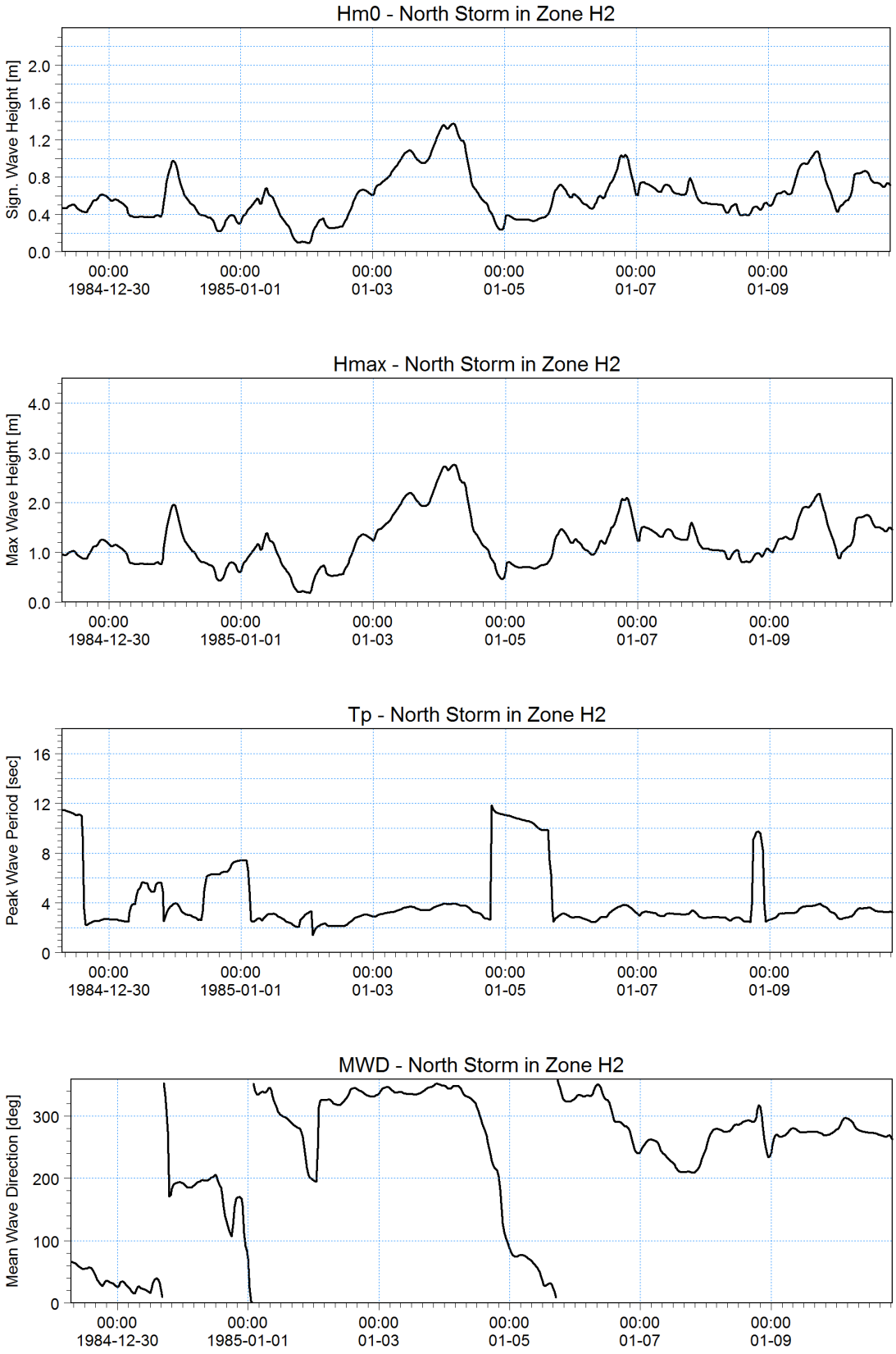


Figure H14 Coupled Model nearshore wave parameters for Peak Storm Event propagating from offshore 0°N (North) direction for Zone H2

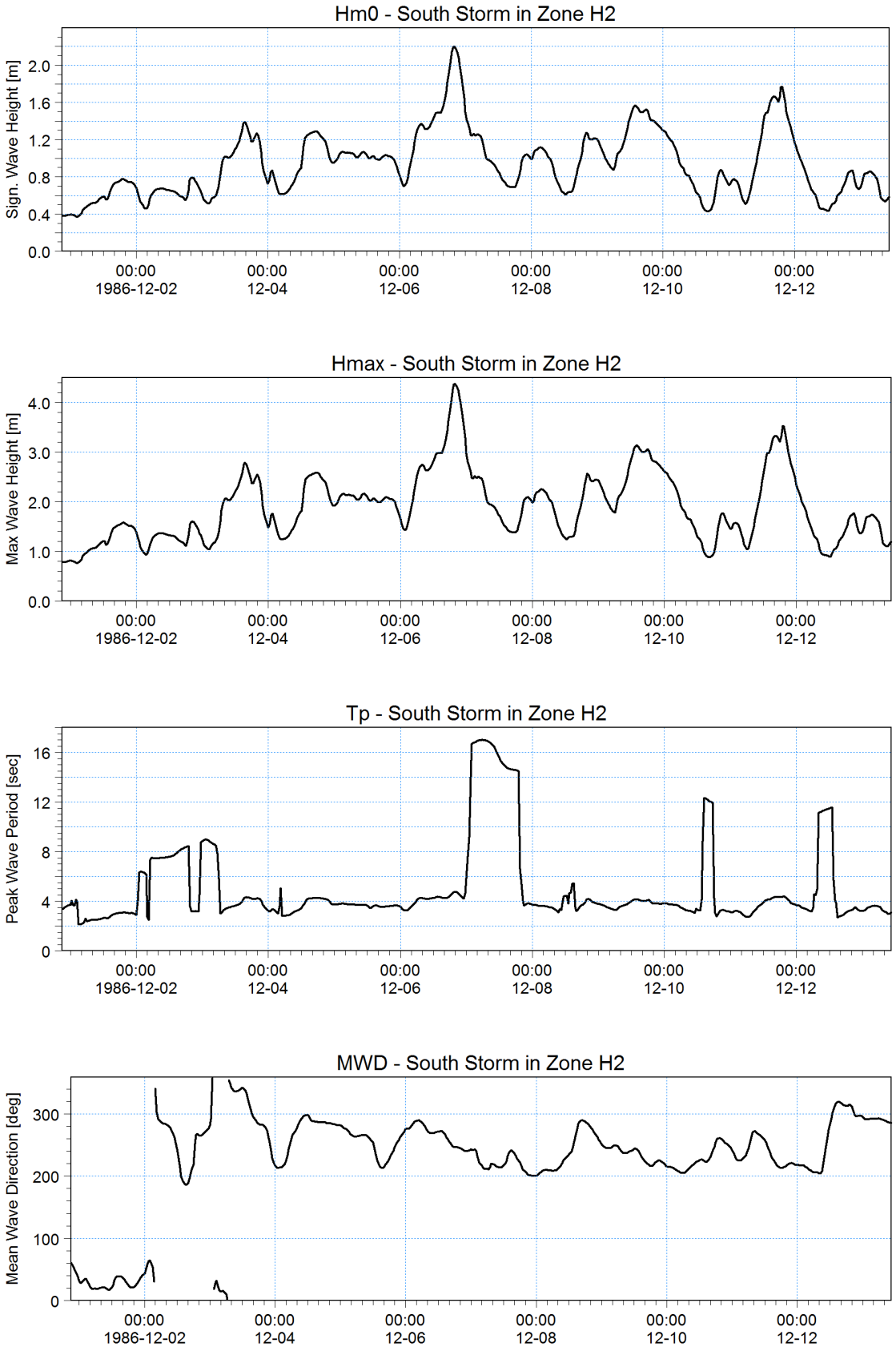


Figure H15 Coupled Model nearshore wave parameters for Peak Storm Event propagating from offshore 210°N (South) direction for Zone H2

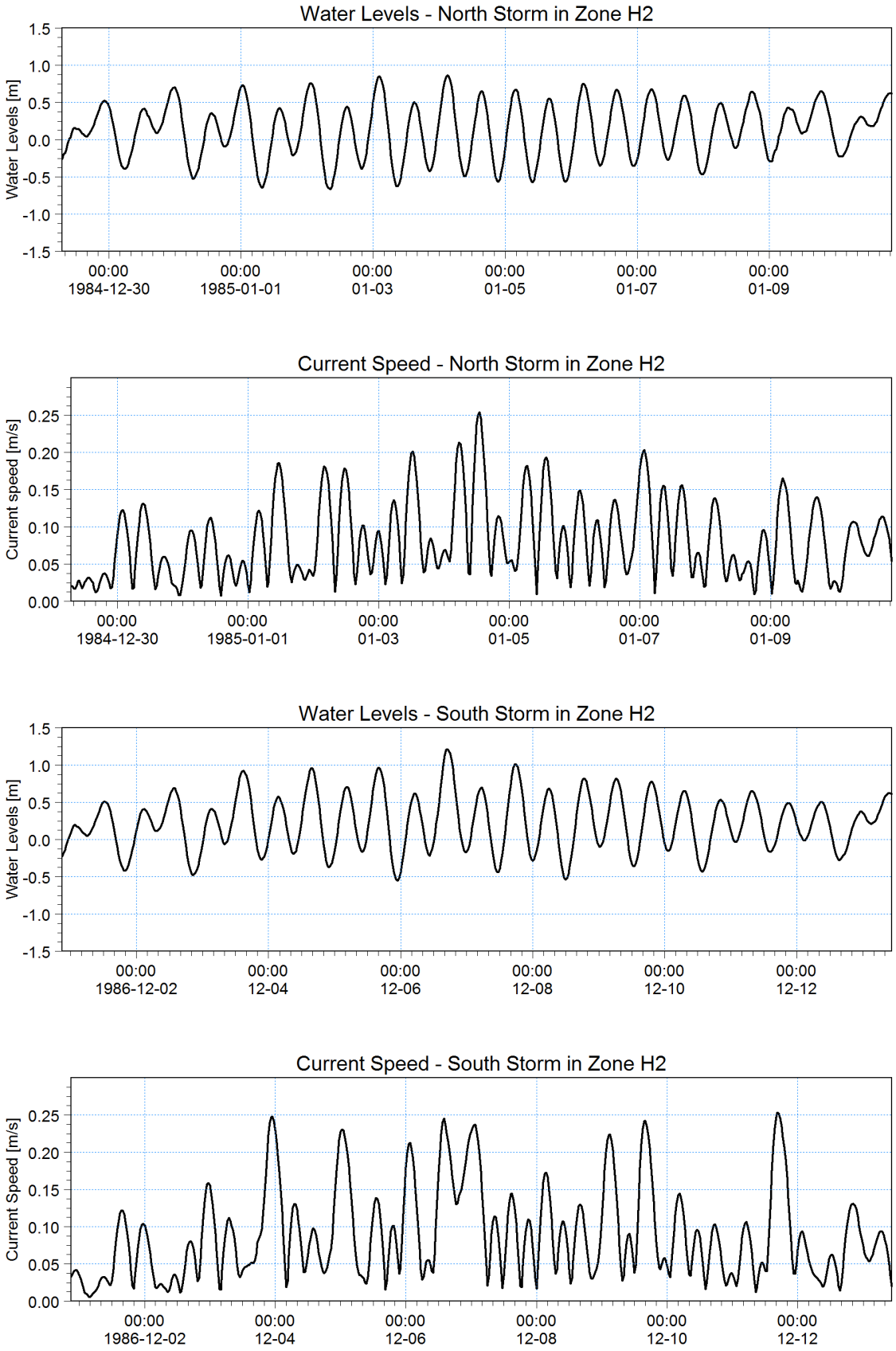


Figure H16 Coupled Model nearshore water level and current speed for a Peak Storm Event propagating from offshore 0°N (North) and 210°N (South) direction for Zone H2



Unity Marine – Service Vessels

APPENDIX I

Polarcirkel 1050





Polarcirkel 1050 is offered with other engine alternatives, here´s a version with two inboard motors and drive.



The new workboat can also be offered in two smaller versions on request, Polarcirkel 910 or Polarcirkel 1000.

Rugged and flexible workboats for rough weather conditions

Helgeland Plast has now developed a new prototype for a larger cabin boat. This boat is based on an entirely new concept. The boat has double buoyancy pontoons manufactured from 500 mm PE tubing. The hull is approximately identical to our other boats, featuring a 21° V-bottom, however, this model has 3 pressure-tested chambers. This ensures very good buoyancy.

The prototype has been equipped with two 265 hp motors, and the boat has a maximum speed of around 40 knots. Window wipers are installed for all front windows. A number of useful details are included, such as stainless steels shackles, lots of cabin space, slanted stern tube with incorporated steps and comfortable padded seats.

The boat is equipped with a large cabin type walk-around. Inside the cabin, there are four padded seats and a large bench seating three persons.



Polarcirkel 1050



A Dacon resque net can be integrated in the pontoon. A useful and handy tool if there´s an accident.



A compact optional life-raft can also be offered to ensure your safety.



The new Polarcirkel series is delivered with 4 adjustable chairs with padding as standard solution.



AKVA group is the world´s largest supplier of aquaculture technology, promoting well known brand names such as: Wavemaster, Polarcirkel, Fishtalk and Akvasmart.









The new 1050-series has well arranged dashboard. All antennas, radars o.e. are mounted on the roof and are easy available with an aft ladder. Exterior steering position can also be installed.



The Polarcirkel 1050 models have got new spacious cabins with entrance aft and emergency exit at the front. Both pilot and co-pilot have sliding windows.

Polarcirkel 1050	
Length (LOA):	1050cm (32´)
Beam (BOA)	350cm (11´)
Displacement:	5.700kg
Max speed:	40 knots
Max persons:	8
V-bottom :	21°
Material, hull:	PE 100
Cabin:	Aluminum 1,9x4,2m
Pontoons:	Double, 0,5m Ø filled with polystyrene
Construction:	Buttwelded hull with 3 water proof bulkheads

Polarcirkel 1050 standard equipment:

- Bow propeller 6hp, continuously variable
- Manual bilge pump
- Electric bilge pump with sensor
- Self-bailing deck
- Hydraulic steering with servo assisted steering wheel
- Motor installation includes battery, cabling, main power switch
- Built-in fuel tanks, 630 litres
- Built-in steps in aft pontoons
- Pulpits
- Insulated motor hatch with pneumatic lifters
- Stowage space in bow
- Step mouldings
- Material: aluminium
- 14 windows, sliding windows for captain and helmsman
- Ladder to roof (mounted on rear side)
- 3 window wipers for front windows
- 4 adjustable chairs with padding
- Passenger bench on starboard side and stowage space under bench
- 6 Spotlighs (LED) in ceiling
- Exit on rear side. (Libra door)
- Mast with lanterns on roof
- Dashboard with motor control instruments, navigation equipment, etc.
- 2 cupholders
- Control handles mounted on top of dashboard
- Two 12V sockets in dashboard
- Fire extinguisher
- Large stowage space under forward pulpit (A toilet can be installed here)
- Rescue door in pulpit. Libra door.
- Defroster 10 KW
- Railing along roof and walls
- Stowage net on rear side of seat
- Compass

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polarcirkel

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Helgeland Plast AS
8607 Mo i Rana.
Besøksadresse: Båsmosjyen 4,
8616 Mo i Rana
Telefon: 75 14 37 50
Faks: 75 14 37 51

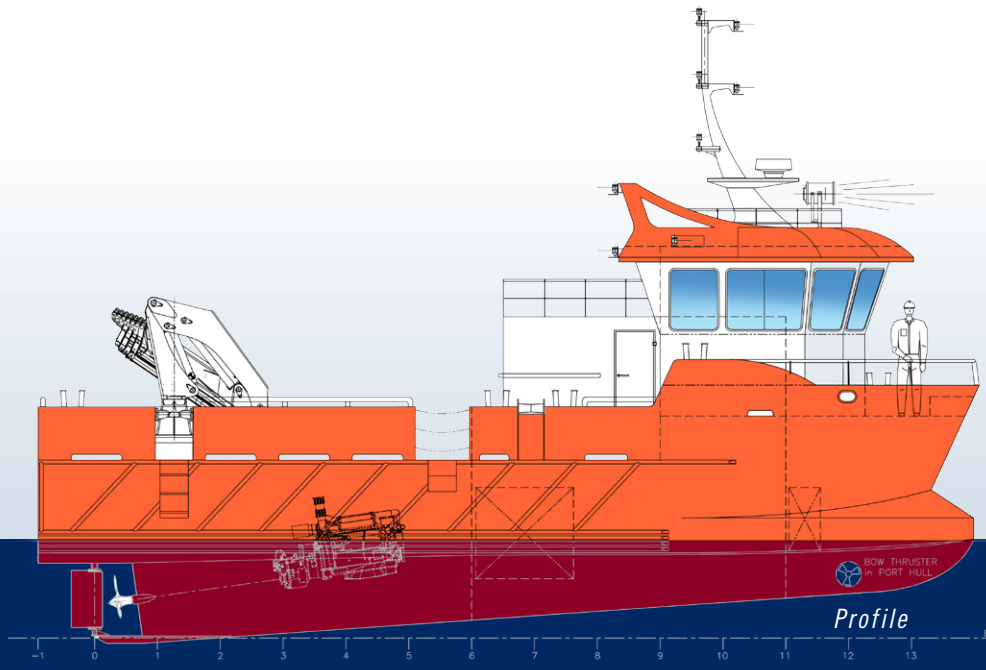
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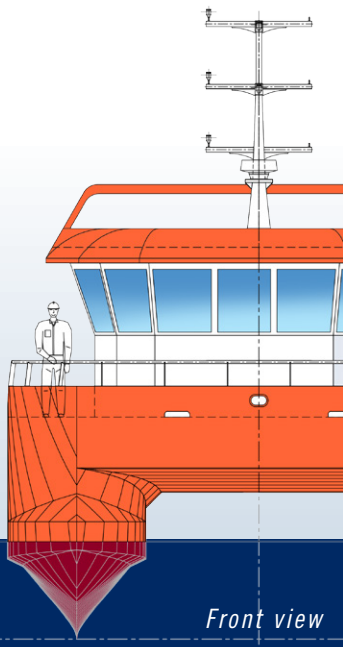
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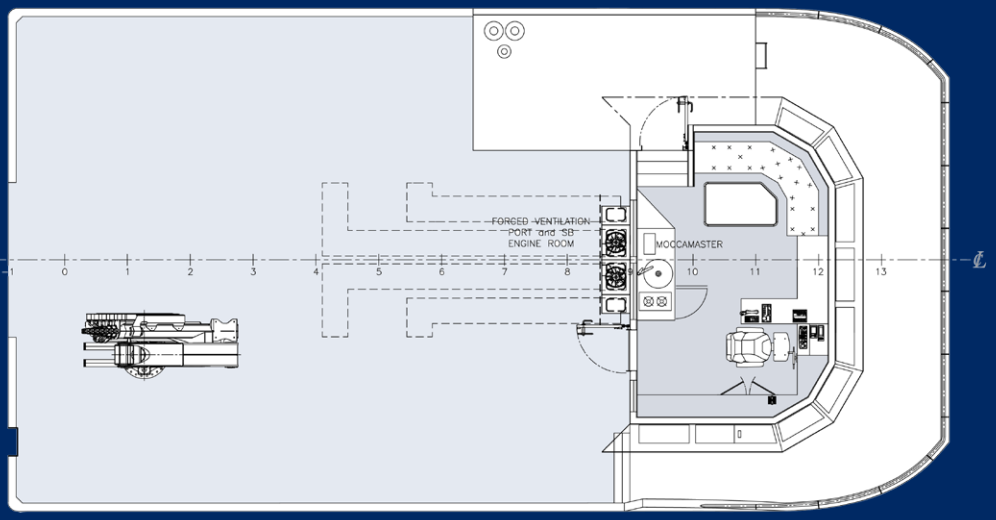
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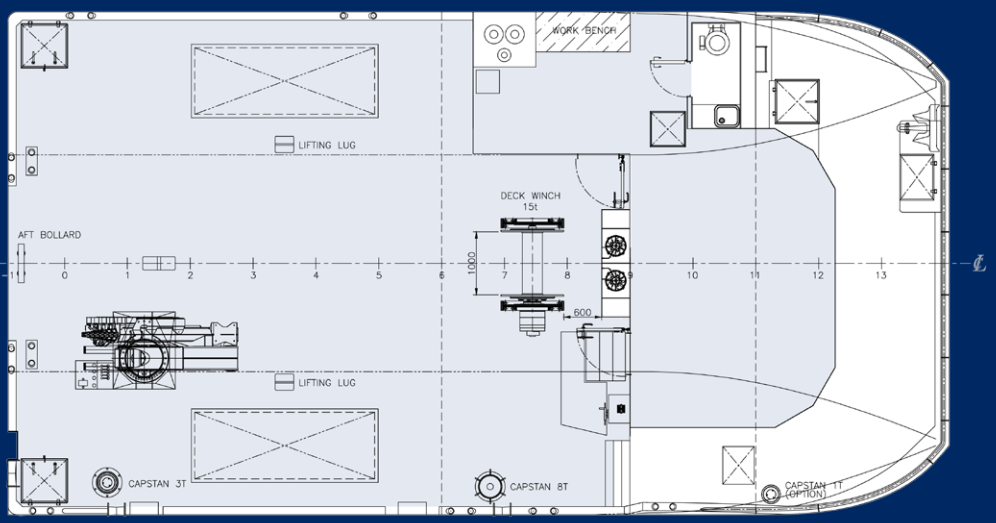
Profile



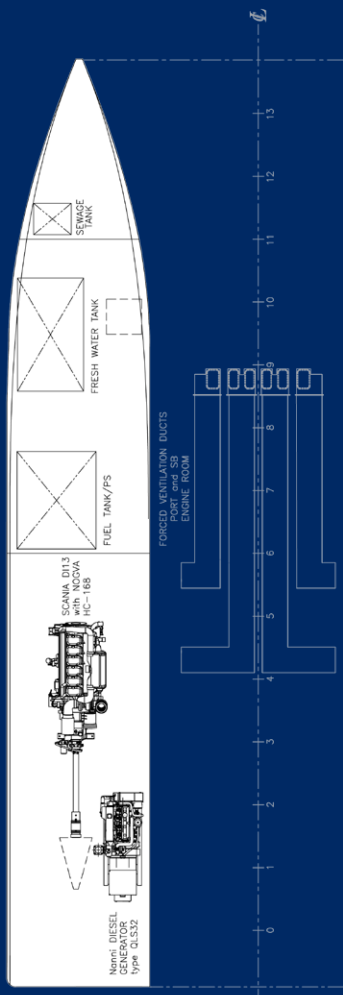
Front view



Forecast. deck

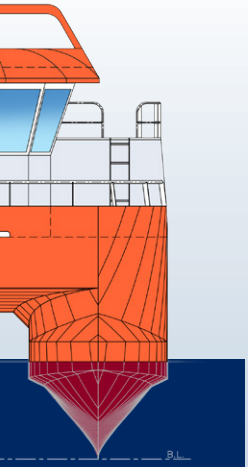


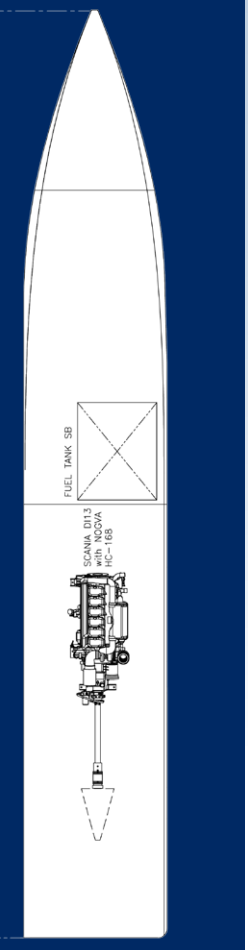
Main deck



below main deck

NABICAT 1498/800 PM





Beskrivelse:
Denne beskrivelse med tilhørende arrangementstegning beskriver en katamaran som skal betjene oppdrettsanlegg.

Generelt:
Båten er bygd i henhold til DNV – Nordisk båtstandard, og etter Sjøfartsdirektoratets nye regelverk gjeldende fra 1. januar 2015 for denne type fartøyer.

Hoveddimensjoner:

Lengde o.a.:	14,98 m
Bredde o.a.:	8,00 m
Bredde skrog:	2,20 m
Dybde i riss:	2,60 m

Kapasiteter:

Brennoljetanker:	2 x 2000 ltr
Vanntank:	1 x 2000 ltr
Hastighet i ulastet tilstand:	Ca 15 knop v/25% fylling med 100% MCR

Annet:
Tverrskips rammespant – c/c = 1000 mm
Langsskips stringers – c/c = 300 mm
Platetykkelser:
- Styrhus: 5 mm
- Styrbord side og dekk: 7 mm
- Babord side: 6 mm
- Skrog: 6 mm

Høy kvalitet i alle detaljer:
- Helisolert maskinrom - for bedre arbeidsmiljø
- Helkledde innvendige rekker - for enkelt renhold og desinfisering
- Helsveisede spant - for økt styrke og soliditet
- Brede skrog gir veldig god stabilitet og oppdrift
- Båten har gjennomgående høy finish såvel utvendig som innvendig

Kran:
Det vil bli levert kran av type Palfinger PK 41002 (M) G, utskyt 21,5 m, kapasitet 38,2 tm. Påmontert vinsj (opsjon).

Capstan:
Som standard utrustning monteres det 2 capstaner, 3 og 8 tonn. Alle inkludert fotpedaler og nødstopp.

Navigasjonsutstyr og kommunikasjon:
- Furuono Radar og kartplotter, med integrert GPS og ekkolodd.
- VHF radio Furuno
- Autopilot Furuno Navpilot

Generator:
Nanni QLS32, 23,4 kW

Framdriftsmaskineri:

Motor:	Scania DI13 380 hk
Gearbox:	Nogva Gir HC-168, vridbart propellanlegg
Sidepropell:	1 sidepropell, 50hk Petters Marine

Annet:
- Ekstra styreposisjon bak styrhus
- 2 stk. Redningsflåte for 6 mann
- Brannslukningsutstyr

Hydraulikk:
Drives fra 2 stk. PTO med Parker pumper 105 ccm som forsyner felles hydraulikksystem for alle hydrauliske forbrukere

Moen NabWork ettskrogs multifunksjons servicefartøy, bygget i stål, er designet for bruk i ulike havbruksoperasjoner. Den er dimensjonert også for tyngre operasjoner. Båten har stor trekkraft og god posisjoneringsdyktighet. Øvrig utrustning består av gjennomprøvde produkter i høy kvalitet.



Våre **NabCat 14,98 x10,00** m én- og to-etasje båter er meget etterspurte servicekatamaraner beregnet for bruk i oppdretts- og servicenæringen. Båtene er godt utrustet, bla.a. med kraftig fremdriftsmaskineri, Nogva gear- og propellanlegg, kran med stor kapasitet, samt flere lugarer.



Vår **NabCat 13,50x7,50 m** er vår mest solgte båt - mer enn 60 eksemplarer er levert. Båten er utstyrt med Scania framdriftsmaskineri samt Nogva gear- og vridbart propellanlegg. Dette bidrar til ypperlige manøvreringsegenskaper. Den er utstyrt med en 32 t/m Palfinger kran, og leveres med fundament for liten dekksvinsj. Ved lettskip yter denne katamaranen 15 knop+.

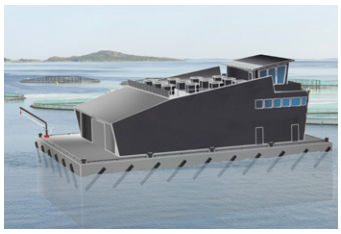


NabWork 10,65x5,00 m er et meget populært alternativ som lokalitetsbåt. Den er utstyrt med kraftig fremdriftsmaskineri samt gear-, propellanlegg og generator fra Nogva. Den er også utstyrt med sidepropeller, noe som gir den ypperlige manøvreringsegenskaper.





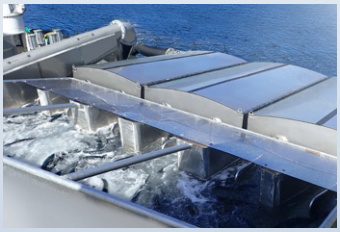
Moen Havbruksplattform har stor fôrkapasitet på 700 t i silo, samt ytterligere 200 t lastekapasitet og 100 t ensilasjekapasitet. Det er fleksibilitet i valg av antall fôringslinjer. Plattformen har generatordrift. Videre har plattformen stort dekksareal, stort lagringsareal og komfortabel bolig- og servicedel.



Sobit Fôrlukesystem bidrar til enklere og sikrere fôrmottak. Systemet, som er er skreddersydd for nye og eksisterende fôrflåter, gir full kontroll med fôrnivået i siloene til enhver tid. Oppgradering av eldre fôrluker til nye Sobit fôrluker skjer rask og effektiv - mens full drift opprettholdes.



Moen SkaMik er en mekanisk, skånsom og miljøvennlig avlusningsmetode det satses stort på. Ingen kjemikaliebruk - derfor ingen resistensproblematikk. Stor kapasitet. Tilnærmet 100% fjerning, oppsamling og destruering av fastsittende og bevegelig lakselus. Teknologien er under kontinuerlig videreutvikling.



Moen Tarpus avlusningspresenninger produseres i materialer av beste kvalitet, og leveres i ulike størrelser. De består i hovedsak av sertifiserte lastestropper og en sterk polyamidduk. Dukens brudd- og strekkstyrke testes rutinemessig. De leveres i 3 utførelser: flat - konisk - profil.



Mekon ringvaskere leveres i to versjoner: RV-1, beregnet for vasking av merder uten bunnring, og RV-2, for vasking av merder med bunnring. De er selvbærende konstruksjoner, og beregnet for samtlige merdemodeller fra Ø315 - Ø500 mm.



Gjør en lønnsom investering

Solid forankret i det maritime miljøet

Moen Marin AS er et selskap med solide tradisjoner og høy kompetanse innen skipsbygging - med røtter helt tilbake til 1923. I tillegg til tradisjonell produksjon, er vår ambisjon å stadig utvikle nye konsepter hvor innovasjon og brukerbehov vektlegges høyt.

Våre satsingsområder er servicefartøyer og arbeidsbåter til oppdrettsnæringen, samt at vi har utviklet et nytt fôrflåtekonsept i samarbeid med sentrale aktører i oppdrettsnæringen. I tillegg står vi for utvikling, markedsføring og salg av flere produkter relatert til en næring som vokser og utvikles raskt.

Vi har gjennom vår tilstedeværelse og våre internasjonale nettverk etablert gode samarbeidsrelasjoner med virksomheter både i Kina, Kroatia, Estland, Latvia, og Polen. Dette bidrar til økt styrking av vår soliditet og konkurranseevne.

Vår søsterbedrift **Moen Marin Service AS** er lokalisert på Kolvereid og på Ottersøy ved Rørvik. Avdelingen på Kolvereid består av slip, verkstedhall og verkstedkai, og har stor kapasitet for service, vedlikehold og reparasjoner. Vår tørrdokk (100 x 25 x 8,5m) på Ottersøy ved Rørvik ligger tett inntil skipsleia midt på Norskekysten. Det er nylig etablert et nytt og moderne servicebygg ved dokka.

For mer info, priser og leveringsbetingelser - kontakt en av våre representanter (se kontaktlisten på vår hjemmeside moenmarin.no) eller send e-post til: salg@moenmarin.no

SERTIFISERT STYRINGSSYSTEM DNV·GL ISO 9001

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www.moenmarin.no

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NabCat 1499 x 1200 MD.

- Du vil sette pris på høy komfort, praktiske løsninger og god teknisk kvalitet





Profile SB

Beskrivelse:
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Generelt:
Båten er bygd i henhold til DNV – Nordisk båtstandard, og etter Sjøfartsdirektoratets nye regelverk gjeldende fra 1. januar 2015 for denne type fartøyer.

Hoveddimensjoner:

Lengde o.a.:	14,99 m
Bredde o.a.:	12,00 m
Bredde skrog:	4,00 m
Dybde i riss:	3,80 m

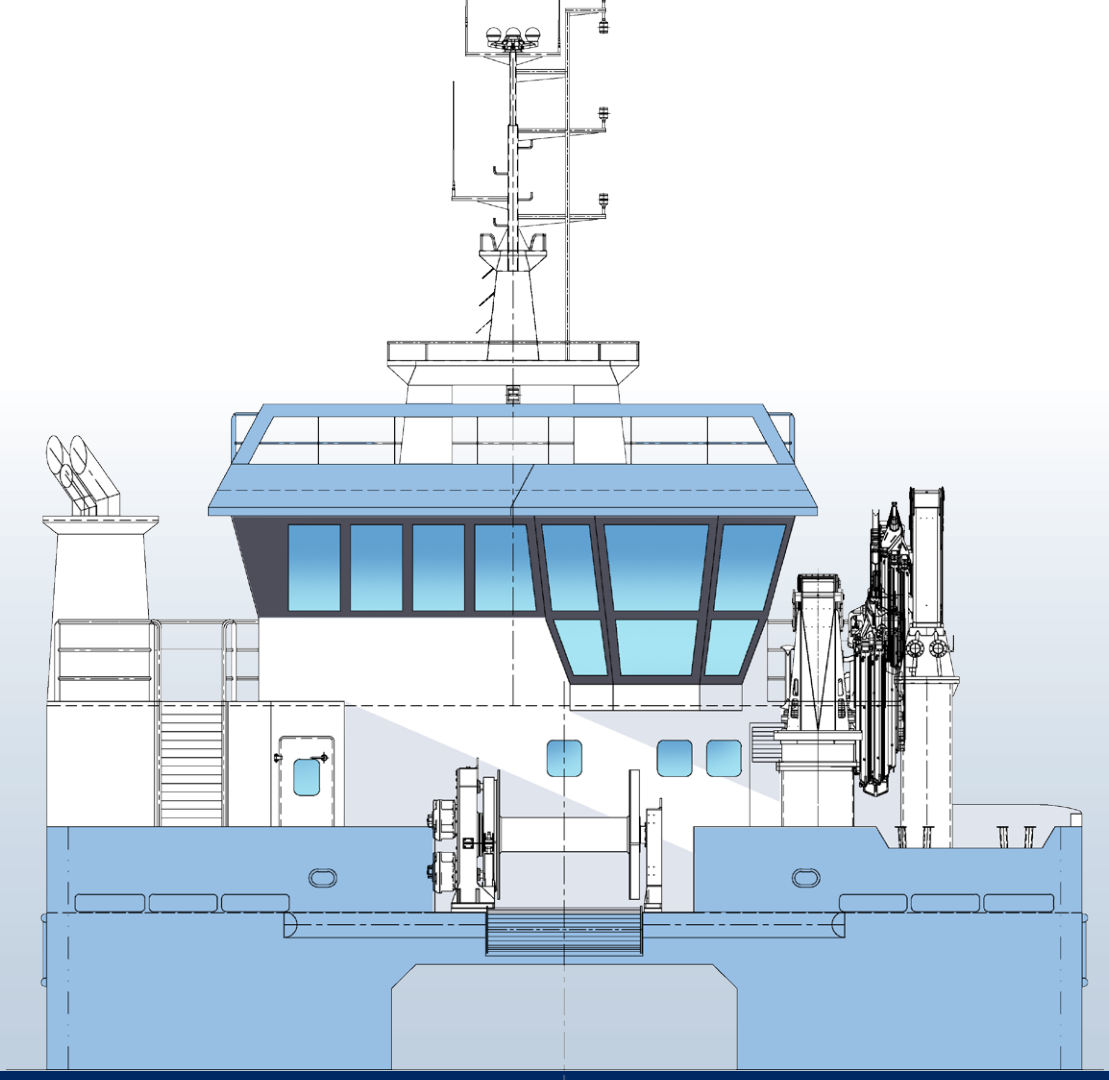
Kapasiteter:

Brennoljetanker:	2 x 4,6 m^3 og 2 x 1,6 m^3
	Totalt 12,4 m^3
Vanntank:	2 x 5000 ltr

Hastighet i
ulastet tilstand: Ca 11 knop v/25% fylling med 100% MCR

Annet:
Tverrskips spantavstand: 1000 mm
Langsskips spantavstand: 300 mm
Platetykkelser:
- Styrhus: 5 mm
- Styrbord side og dekk: 7 mm
- Babord side: 6 mm
- Skrog: 6 mm

Høy kvalitet i alle detaljer:
- Helisolert maskinrom - for bedre arbeidsmiljø
- Helkledde innvendige rekker - for enkelt renhold og desinfisering, samt for økt styrke
- Helsveisede spant - for økt styrke og soliditet
- Brede skrog gir veldig god stabilitet og oppdrift
- Båten har gjennomgående høy finish såvel utvendig som innvendig



Aft.

NABICAT 1499/1200 MD

To-etasje båt

Kraner:
Kran 1) Palfinger PK 90002 M H - full marine kran. Kapasitet ca 75,6 tm, rekkevidde 22 m, med påmontert vinsj på 6,5 t og radiostyring.
Kranen vil bli levert med marineoppgradering.

Kran 2) Palfinger PK 41002 (M) G - kapasitet ca 38,4 tm, rekkevidde 21,5 m, hybrid med påmontert vinsj på 3,5 t (opsjon). Begge kranene leveres med Scanreco fjernkontroll.

Capstaner:
Som standard utrustning monteres det 3 capstaner, 3, 3 og 8 tonn. Alle inkludert fotpedaler og nødstopp.

Navigasjonsutstyr og kommunikasjon:
- Furuno Radar og kartplotter, med integrert GPS
- VHF radio Furuno
- Furuno Ekkolodd DFF1
- Autopilot Furuno Navpilot Simrad AP70
- Olex og AIS

Generator:
230V/57 kW

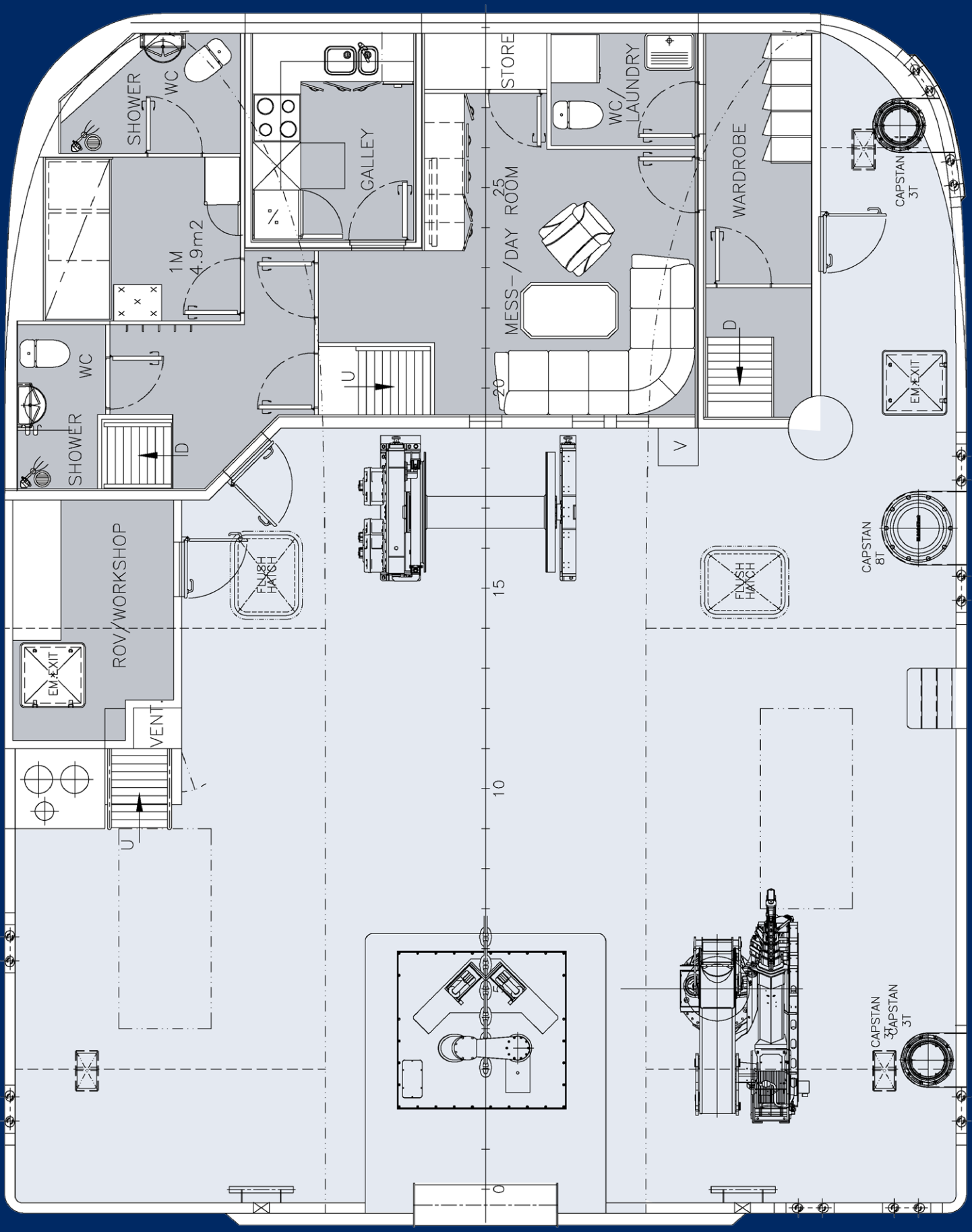
Framdriftsmaskineri:

Motor:	Nogva Scania DI 13, 500 HK
Gearbox:	Nogva Gear, HC 258, vridbart propellanlegg
Sidepropeller:	Det vil på babord side bli montert to stk. Petters Marine, PMH sidepropeller, 160 hk

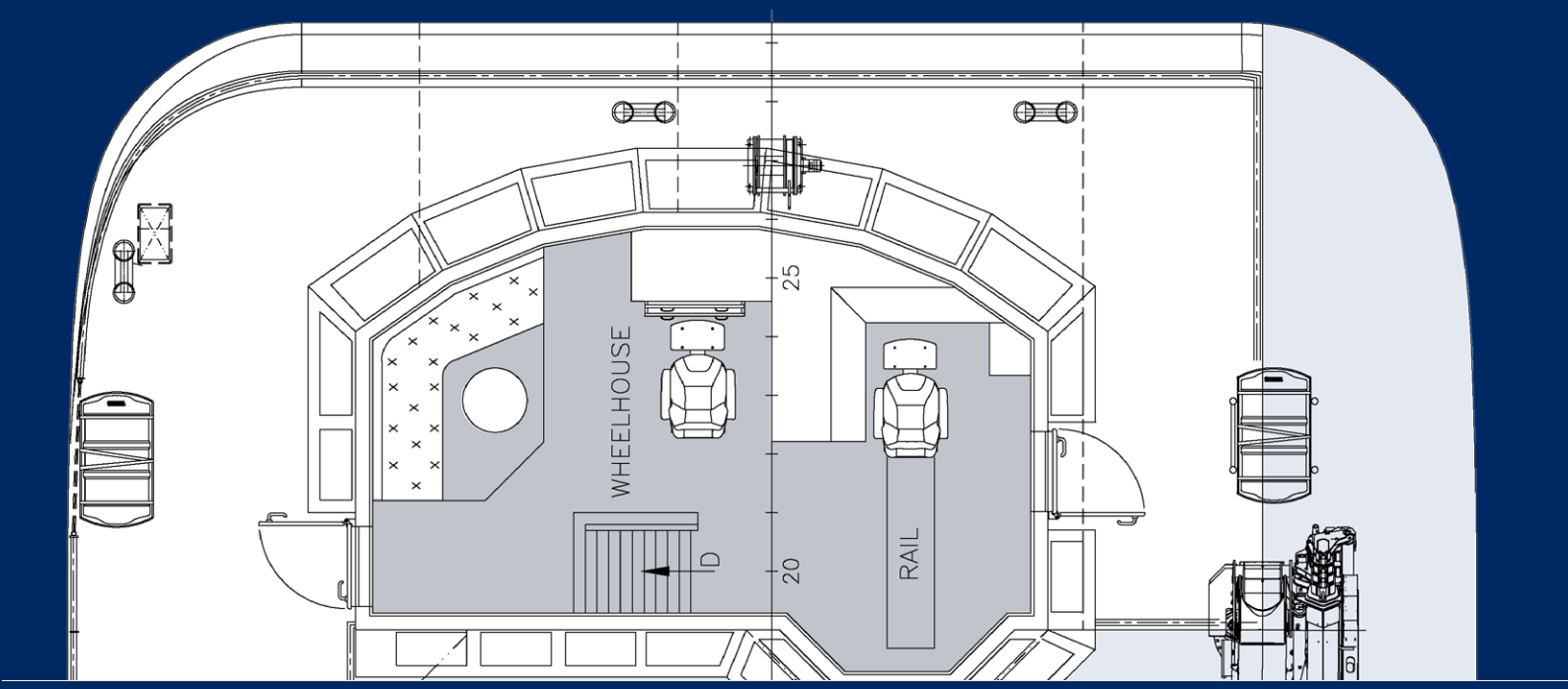
Annet:
- Ekstra styreposisjon bak styrhus
- Redningsflåter, 2 stk., for 6 mann
- Brannslukningsutstyr

Hydraulikk:
Drives fra 4 stk. PTO med Parker pumper 145 ccm som forsyner felles hydraulikksystem for alle hydrauliske forbrukere

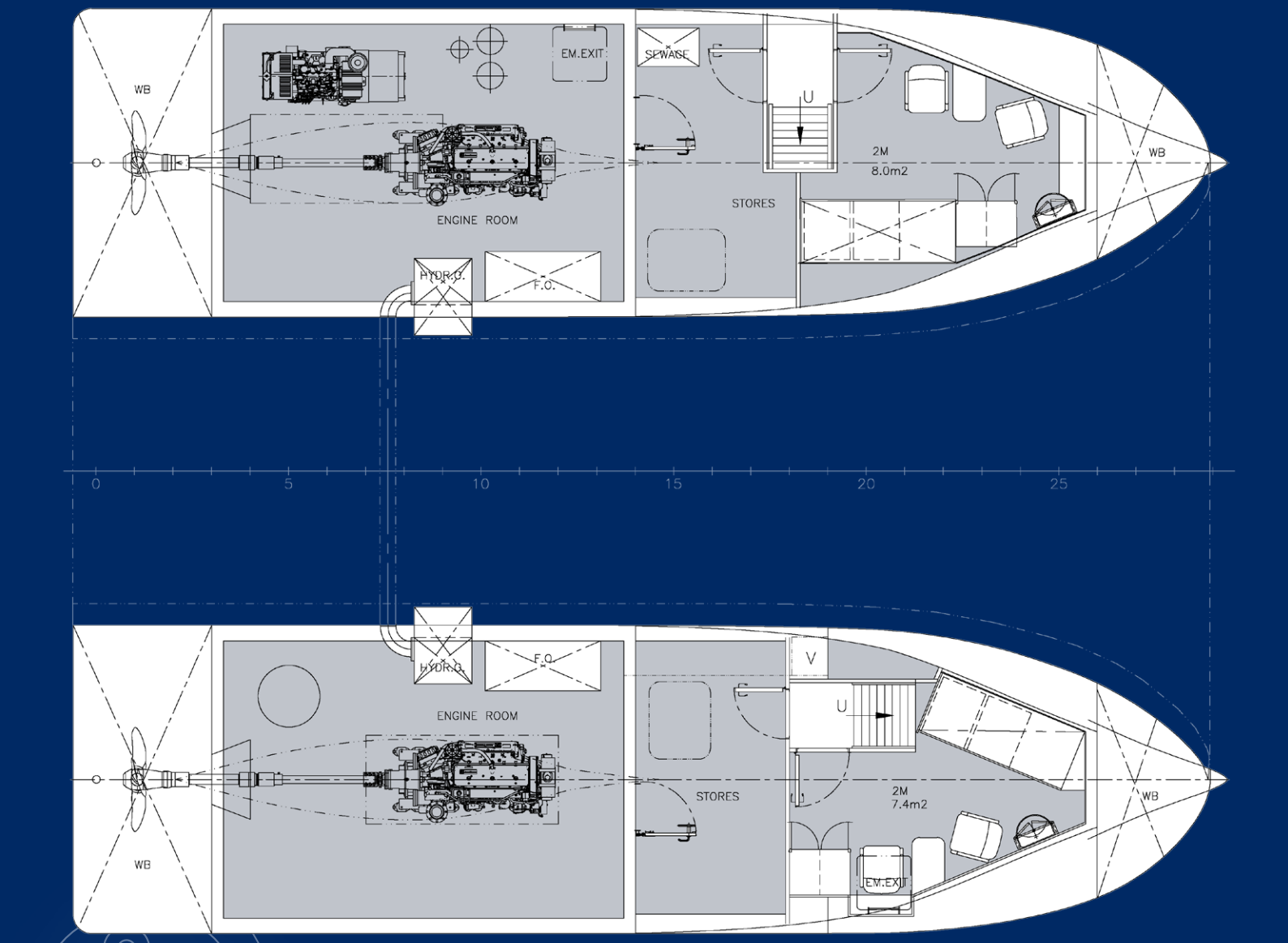
Lugarkapasitet:
Det er 2 x to-mannslugarer og 1 x én-manns-lugar.


SHOWER
WC
1M
4.9m2
GALLEY
STORE
WC/
LAUNDRY
WARDROBE
MESS-/DAY ROOM
SHOWER
WC
ROV/WORKSHOP
VENT
EM.EXIT
FLUSH HATCH
CAPSTAN 3T
CAPSTAN 8T
U
D
V
0
5
10
15
20
25

Main deck



Bridge deck



Below main deck

NABICAT 1499/1200 MD


















BOSCH

NABICAT 1499/1200 MD








NOGVA



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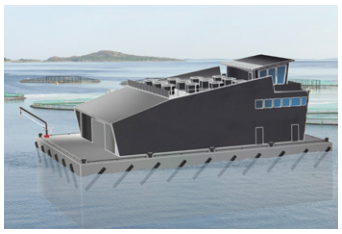
Vår **NabCat 13,50x7,50 m** er vår mest solgte båt - mer enn 60 eksemplarer er levert. Båten er utstyrt med Scania framdriftsmaskineri samt Nogva gear- og vridbart propellanlegg. Dette bidrar til ypperlige manøvreringsegenskaper. Den er utstyrt med en 32 t/m Palfinger kran, og leveres med fundament for liten dekksvinsj. Ved lettskip yter denne katamaranen 15 knop+.



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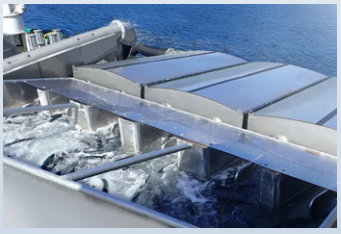
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MOEN | MARIN

Moen Marin AS | Post: Postboks 1287 Sluppen, 7462 Trondheim | Besøk: Havnegt. 9, Pirsenteret (inng. 1, 4 etg.)

www.moenmarin.no

roksethdesign.no - august 2018 - ID:7185 - 200x

NABIWORK 2398/1120 MD

PRESENTASJON



MOEN MARIN

NAB WORK 2398/1120 MD



NabWork til tjeneste!
Krefter i overflod, smidig navigasjon og topp utstyrt. En all-rounder skapt for både lettere og mer krevende operasjoner.

NAB WORK
2398/1120 MD

Beskrivelse:
Denne beskrivelse med tilhørende arrangements-tegning beskriver et ettskrogs multifunksjons servicefartøy for bruk i ulike havbruksoperasjoner.

Generelt:
Båten er bygd etter Sjøfartsdirektoratets nye regel-verk gjeldende fra 1. januar 2015 for denne type fartøyer.

Hoveddimensjoner:

Lengde o.a.:	23,98 m
Bredde spant:	11,20 m
Dybde i riss:	4,20 m

Kapasiteter:

Brennoljetanker:	40 000 ltr
Vanntank:	20 000 ltr
Ballasttanker:	100 000 ltr
Hastighet i ulastet tilstand:	Ca 10 - 11 knop v/25% fylling med 100% MCR

Kraner:

Dekkskran nr. 1:	Palfinger PK 65002MG med 3,5tons vinsj
Dekkskran nr. 2:	Palfinger PK 90002MH med 6,5 tons vinsj

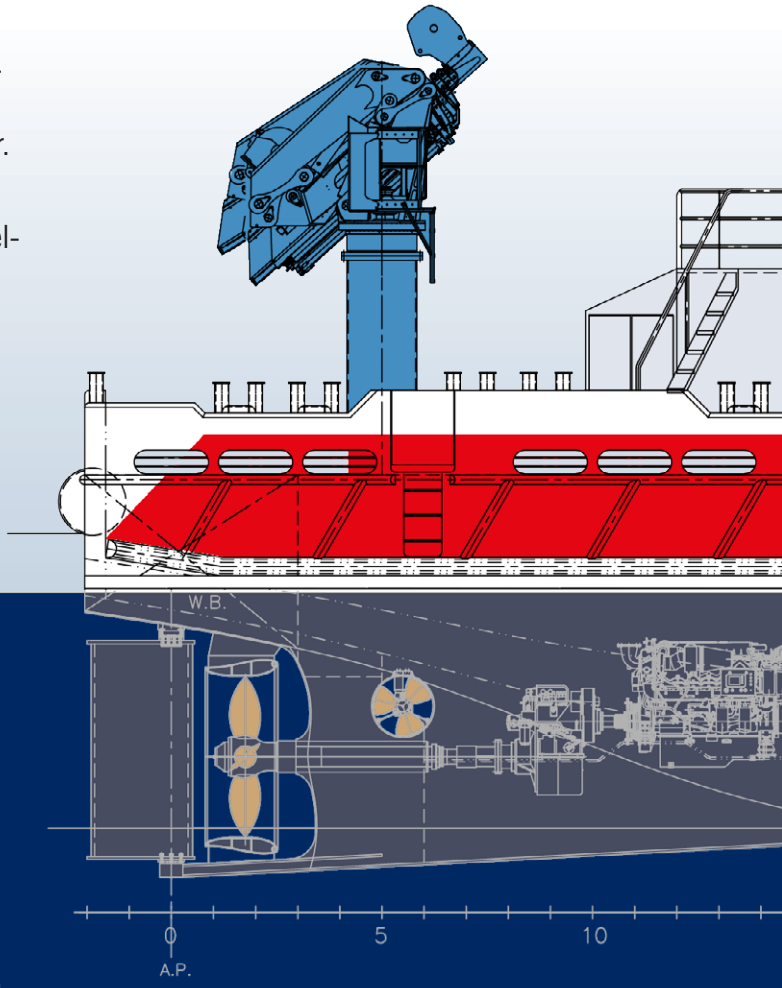
Begge kranene skal leveres med fjernkontroll av type Scanreco RC400.

Capstan:
Som standard utrustning monteres det 4 capstaner, 2 x 3 t og 2 x 8 t. Alle inkl. nødstopp.

Arbeids-/slepevinsj:
En arbeids-/slepevinsj av type 1-VA-60-AHB-SAI (60t) sammenbygd med en arbeids-/slepevinsj av type 1-VA-15-AHB (15t) fra MB-Hydraulikk.

Ankervinsj:
Fluidmar HV-ZR6,3

Navigasjonsutstyr og kommunikasjon:
- JRC Radar, JMA-5312-6
- Olex kartplotter
- TELCHART DUAL ECDIS CHART SYSTEM
- JRC Ekkolodd
- JRC Radio VHF



Motoraggregat 1:

Merke/type:	Catepillar, C18
Ytelse:	275 ekW at 1500rpm, 400V, 50 hz.

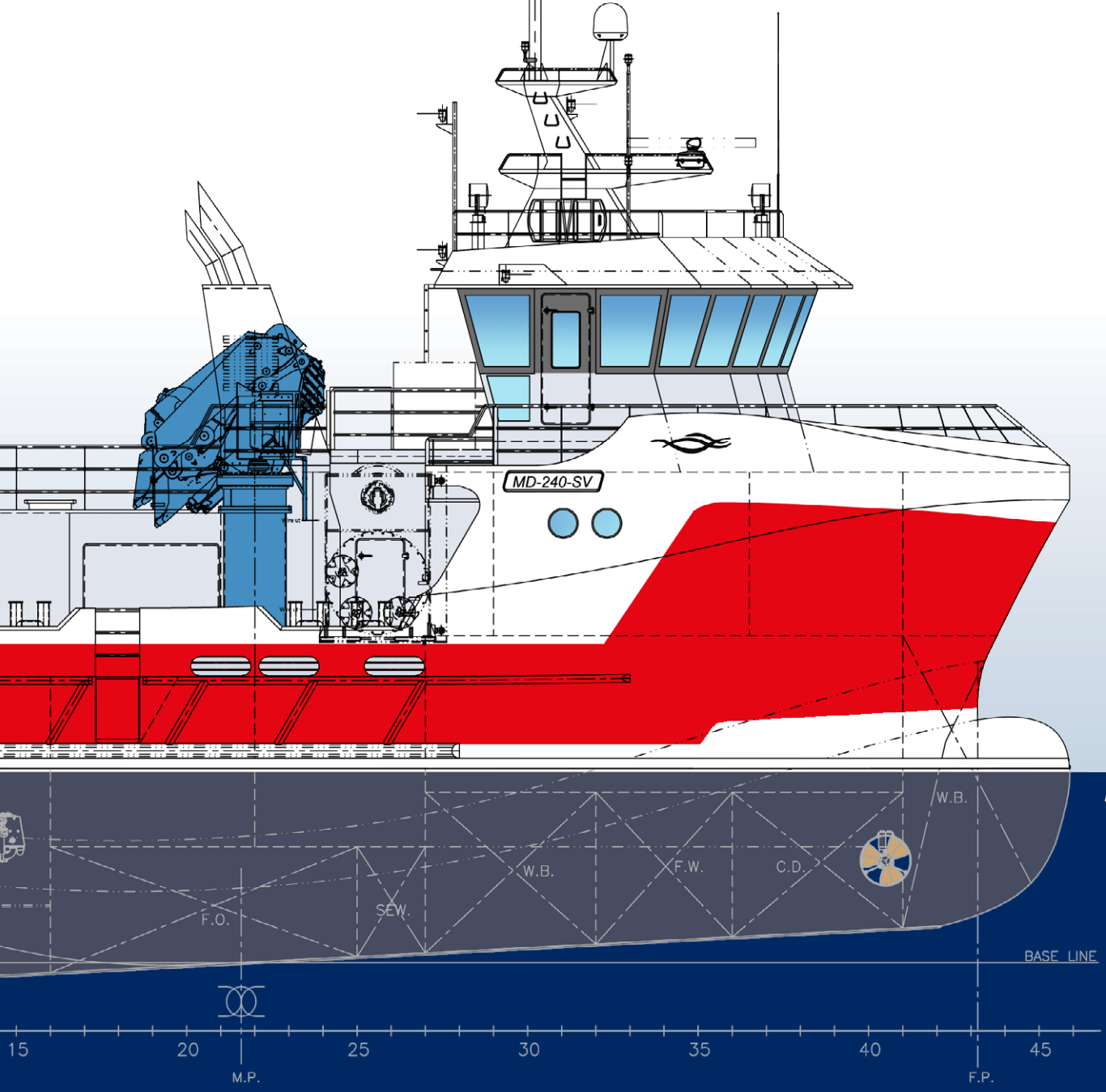
Motoraggregat 2:

Merke/type:	Catepillar, C7.1
Ytelse:	118 ekW at 1500 rpm, 400V, 50 hz

Framdriftsmaskineri:

Merke:	Catepillar, C32Acert - vannkjølt 4-takts motor, 12-sylindret v-motor med turboladere og ladeluft-kjølere, med direkte innsprøytning.
Ytelse:	746 kW (1000 hk) ved 1600-1800 o/min

Gear og propellanlegg:
Finnøy G42FK, 1900mm 4-blads propell m/propell-dyse



Sidepropeller:
2 stk sidepropeller MB Hydraulikk S-150-250-V250 med ytelse 250 hk v/1400 o/min.
Drives fra 2 stk kraftuttak (PTO) Rexroth A4VG 175 på fremdriftsanleggets reduksjonsgir.

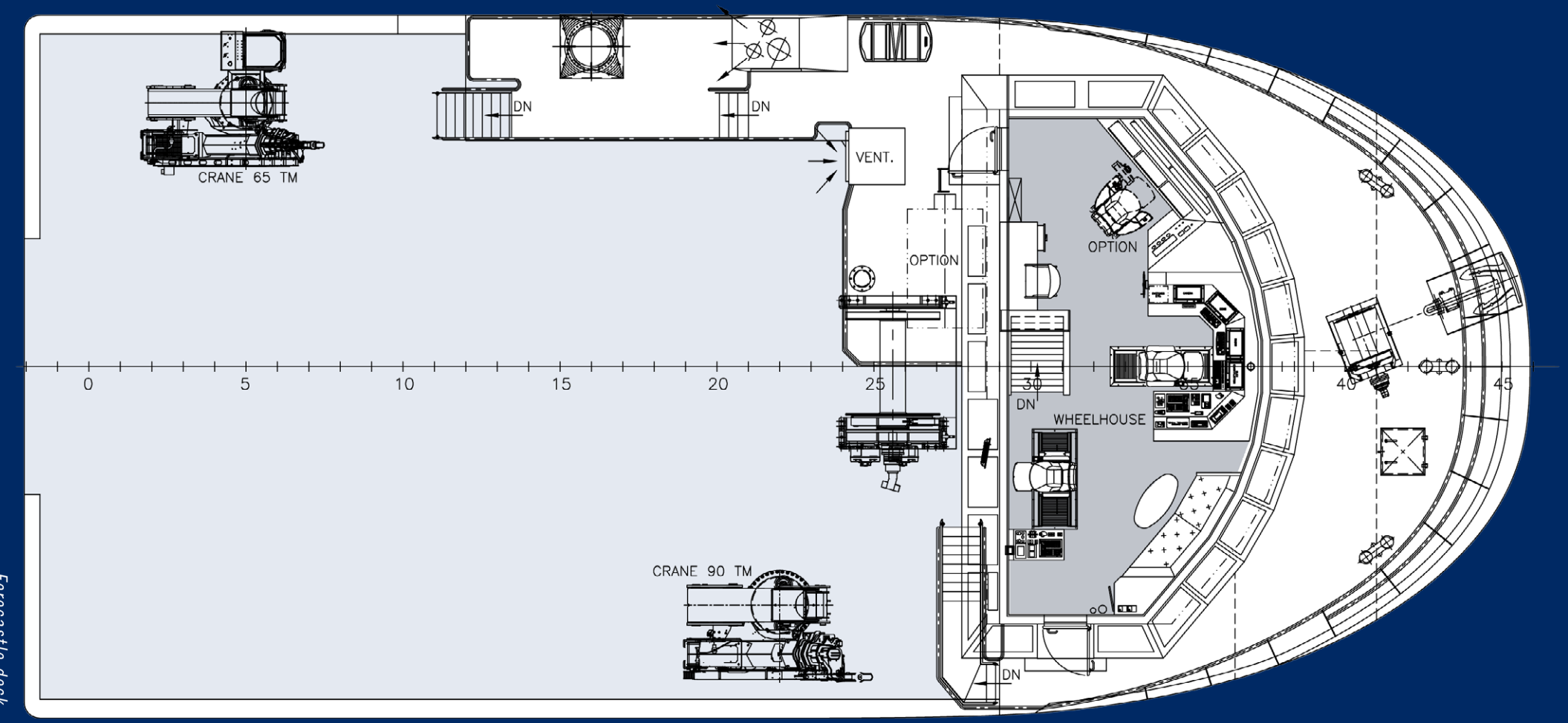
Hydraulikk:
Følgende utstyr drives fra eget elektrohydraulisk aggregat (3x60kW) installert under hoveddekk:
- 1 stk. ankervinsj
- 2 stk. dekkskraner
- 4 stk. arbeidsnokker
- 1 stk. hydraulisk høytrykksvasker
- 1 stk. arbeids-/slepevinsj
- Hydraulisk sylindere for dekksluke
- Div. dekksutstyr

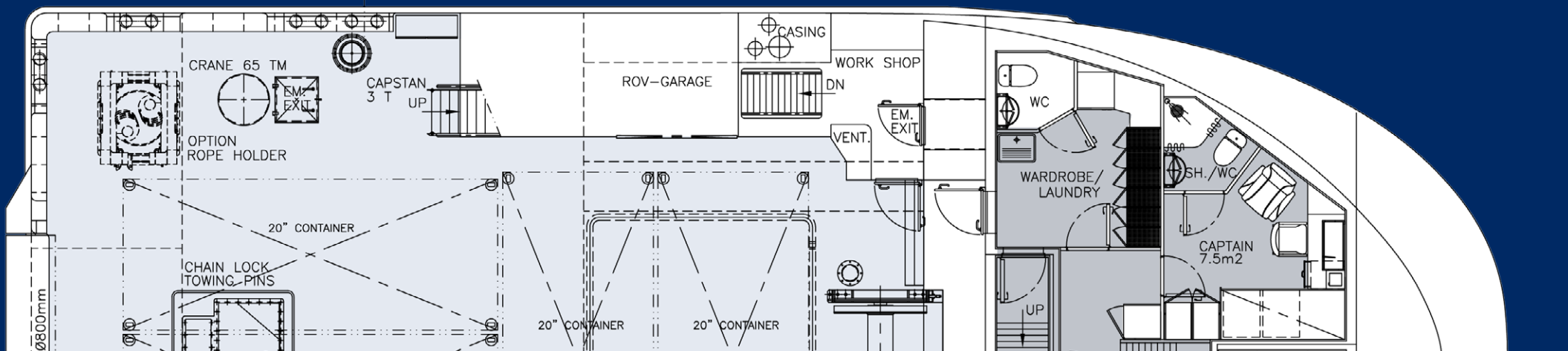
Lugarkapasitet:
Det er 6 x énmannslugarer.

Annet:
- Redningsflåter 2 x 6 manns flåter

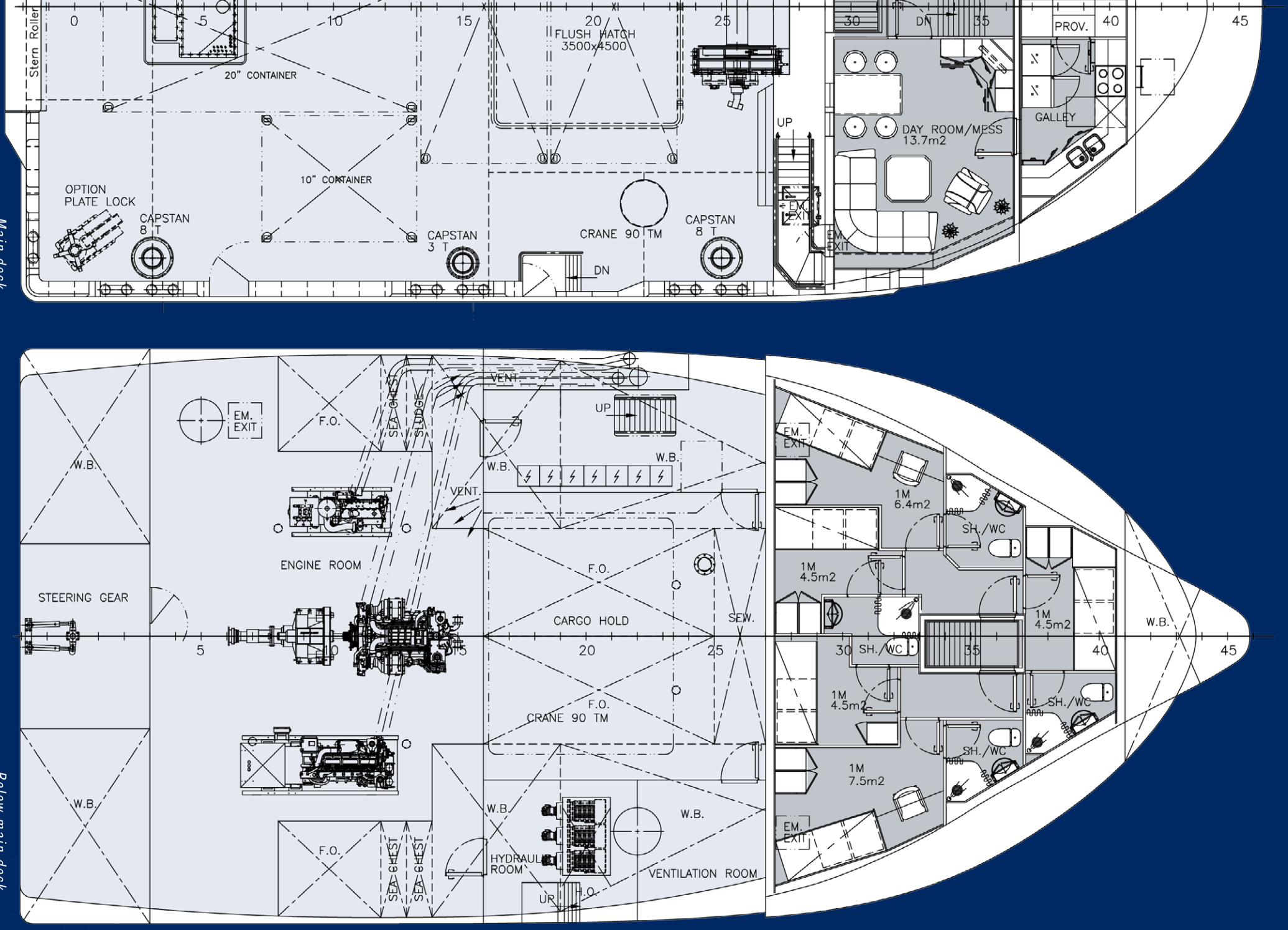
Annet/tillegg:

Kamera:	- 2 stk. kamera arbeidsdekk - 1 stk. kamera maskinrom - 2 stk. kamera skuteside - 1 stk. undervannskamera/ propellkamera
Dekksutstyr:	- Kjettinglås og tauepinner på dekk - Hekkrull - Forberedt for fibertaulås og plateholder
ROV/dykkerutstyr:	Båten er forberedt for ROV og dykkerutstyr med ROV hangar på hoveddekk, ROV- og/dykkerkonsoll i styrhus og egen plattform for ROV vinsj.





Forecastle deck


Main deck
Stern Roller
0
5
10
15
20
25
30
35
40
45
20" CONTAINER
FLUSH HATCH
3500x4500
10" CONTAINER
OPTION
PLATE LOCK
CAPSTAN
8 T
CAPSTAN
3 T
CRANE 90 TM
CAPSTAN
8 T
DN
UP
EM.
EXIT
DAY ROOM/MESS
13.7m2
GALLEY
PROV.
Below main deck
EM.
EXIT
F.O.
SEA CHEST
SLUDGE
VENT.
UP
W.B.
ENGINE ROOM
STEERING GEAR
CARGO HOLD
SEW.
F.O.
CRANE 90 TM
HYDRAUL.
ROOM
VENTILATION ROOM
UR
H.O.
1M
6.4m2
SH./WC
1M
4.5m2
1M
4.5m2
1M
7.5m2
SH./WC
SH./WC
SH./WC

NAB WORK 2398/1120 MD



NAB WORK 2398/1120 MD


FINNOY

NAB WORK 2398/1120 MD













NAB WORK 2398/1120 MD


CAT






CAT

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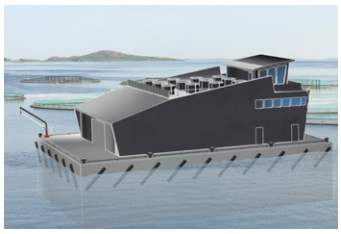


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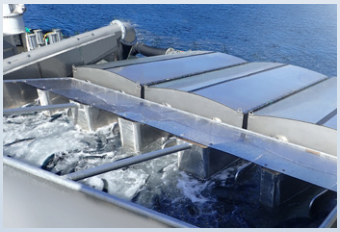
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www.moenmarin.no

roksethdesign.no - mars 2018 - ID:7151 - 200x



Unity Marine – Sea Site Equipment

APPENDIX J



PRODUCT SPECIFICATION

AKVA Group's AKVA Center Feed Barges

0	01.09.2016	Approved	AHN	AL
A	16.08.2016	Issued for IDC	AHN	AL
Rev.	**Date**	**Issued**	**Issued by**	**Approved by**

Document no.:	AC-SPS-001	**Prosject no.:**	AKVA Center

1 Table of contents

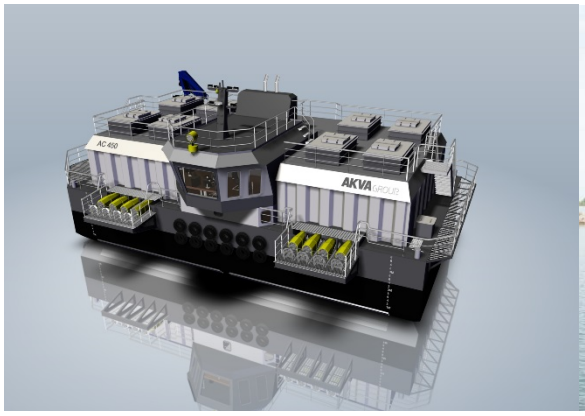
1 Table of contents 2
2 General information 3
2.1 Design and limitations 4
2.1.1 General 4
2.1.2 Structural calculations 4
2.1.3 Stability calculations 4
2.1.4 Construction 4
3 General information about AKVA group's feeding system 5
3.1 Idea and focus 5
3.1.1 Feeding system 6
4 Standard delivery 7
4.1 Safety equipment 7
4.2 Power supply 8
4.2.1 Power supply control 8
4.3 Feed silos and tank systems 9
4.3.1 Feed silos 9
4.3.2 Diesel system 9
4.3.3 Fresh water system 10
4.3.4 Sewage system 10
4.3.5 Ensilage system 10
4.4 Steel equipment 11
4.4.1 Platforms for selectors 11
4.4.2 Mooring 11
4.4.3 Other steel equipment 11
4.5 Other equipment 12
4.6 Interior 13
4.6.1 Comfort 13
4.6.2 Panorama 14
4.7 Surface treatment 15
4.8 Electrical 16
5 Optional equipment 17

2 General information

The feed barge models "Comfort" and "Panorama" is offered with capacities ranging from 350 to 850 tons. The barges are supplied with a sensible and thoughtful outfitting, adapted to the two models. The main difference between the two models is the control room. On the Panorama model, the control room is built on silo deck and covers silo deck from starboard to port side. This provides a 360 degree view from the control room. The Comfort model has a lowered control room, which only covers the starboard side of silo deck. The benefit of this model is added space on silo deck. These barge models include the latest innovations for effective food handling, storing and logistics. AKVACenter is therefore a safe and seaworthy feeding barge design, that can offer the Fishfarmer an extremely functional and comfortable work space.

The specifications for the different capacities are given in the specification summary in the last pages. All text and images in this specification is general. The information in this specification can be subject to change.

Comfort model (high control room”





Panorama model





2.1 Design and limitations

2.1.1 General

Dimensioning, strength and stability calculations are performed by an independent, third party design office. This is an independent consultant company that delivers services to customers related with shipping and naval business, building yards, repair yards and other maritime and mechanical firms. The company has solid competence within ship types such as storing ships, tank ships, fishing vessels, offshore vessels and ferries.

2.1.2 Structural calculations

The barges have been calculated structurally in accordance to the requirements given in NS9415:2009.

2.1.3 Stability calculations

The AKVACenter barges complies with the requirements in NS9415 in terms of intact and damage stability. This includes, among other things, that the barge is checked in accordance to the given requirements for the following conditions.

- Light ship
- Light ship with full water tank and diesel tank
- Fully loaded with allowed consumables
- Half loaded with allowed consumables (half of the silos are full and the rest is empty).

Furthermore, the stability calculations take into consideration that the barge shall have the possibility to be operated in waters where icing effect might occur.

In order to comply with the requirements to damaged stability, there is a requirement that the barge shall be split up in three or more watertight compartments. These shall be arranged so that the barge will still have a safe floating capability after one watertight section has been punctured, and will give the operator the chance to tow the barge into a safe place for further repair works, that will bring back to the barge the original operational condition.

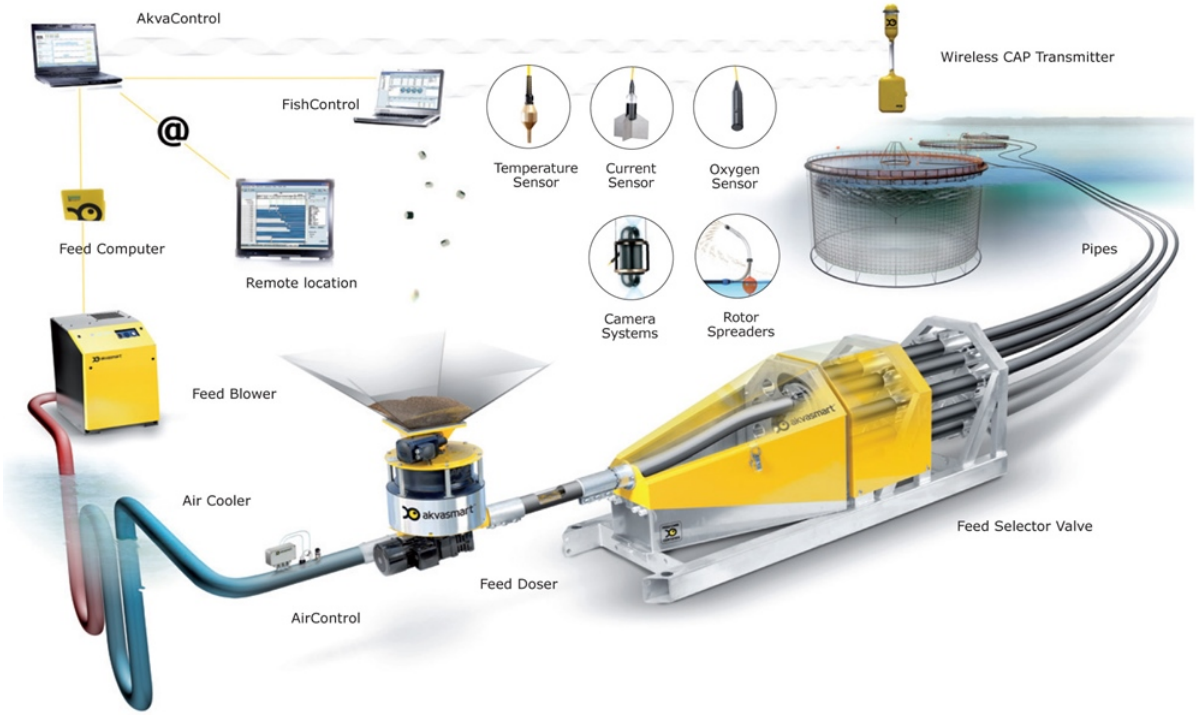
2.1.4 Construction

Steel hull, superstructures and feed silos are manufactured using marine steel type NVA or similar. The steel construction is performed in accordance to NS470 and all weldings are tested by certified NDT inspectors (NDT – non destructive testing).

3 General information about AKVA group's feeding system

3.1 Idea and focus

AKVA group developed the central feed system concept for fish breeding in 1979. Since the start we have delivered over 2000 feeding systems around the world, for salmon and other species. This has provided AKVA group with a lot of experience and knowledge about the costumer's needs. Akvasmart CCS is based on a modern and stable CCS Network System. The system connects all the single components together to a system that is very flexible and scalable. This makes the system perfect for upgrades and modifications.

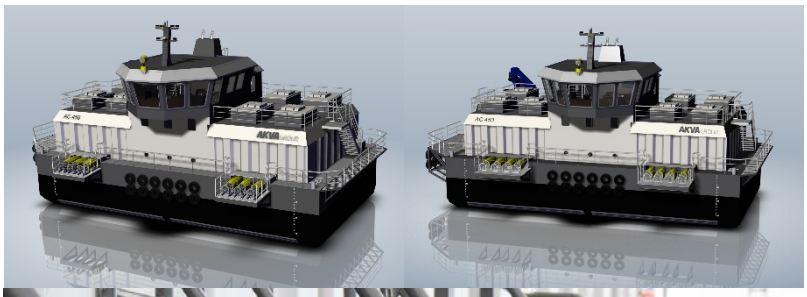


Akvasmart CCS is the most powerful central feed system made. careful food transport, friendly user software, operational security, flexibility and scalability has been central in the development process of this system. Every single system that is delivered by AKVA group gets its own certificate for careful food transports.

The system is steered by our AKVAcontrol software. This is a result of close cooperation between breeders all over the world, which have given their input on what they need and want. The software allows very flexible feeding regimes and individual system setting, which makes the software one of the most powerful and flexible software for feed system and at the same time very friendly to users.

3.1.1 Feeding system

The feeding system that will be fitted to the barge depends on the customer's need. The number of feeding lines can be anywhere from 2 to 16. For more information about the different feeding systems please visit http://www.akvagroup.com/downloads/download-catalogues .





4 Standard delivery

4.1 Safety equipment





- Fire and safety plan, shows the number and placement of the safety equipment.
- Watertight integrity plan.
- Life buoy, 5 pieces.
- Fire extinguisher, 4-6 pieces depending on capacity.
- Watertight compartments, separated by bulkheads and watertight doors. The number of watertight compartments depends on capacity and is in accordance with NS9415.
- Bilge pumps are installed in each compartment with a capacity in accordance to the requirements given in NS9415.
- Marking of escape routes, emergency exits and placement of fire extinguishers with fluorescent signs.
- Rechargeable lights are installed on the inside of the aft and forward door.
- Marking light in the mast (12V). Can be adapted to local requirements.
- Remote shut down of fuel supply to generator on main deck (in case of fire in the machine room).
- Closing valve installed in air inlet vent to the machine room, with handle on main deck (in case of fire or long-term storing of the barge). Fire and water intrusion alarm.



4.2 Power supply



The barge is delivered with a power generation capacity that is considered necessary to run the systems on the barge. The power need is calculated based on estimated consumption and will be specified in the offer to the costumer.

4.2.1 Power supply control

To meet the costumer's needs the power supply can be controlled in different ways.

4.2.1.1 Manuel mode

The operator activates the generators manually from the machine room.

4.2.1.2 Auto control with blinking

With this configuration the generator(s) will start when the feeding system starts. The blinking means that there will be a short power outage when the control switches between generators.

4.2.1.3 Auto control without blinking

Same configuration as the one above, but without the power outage.

4.2.1.4 Power management system

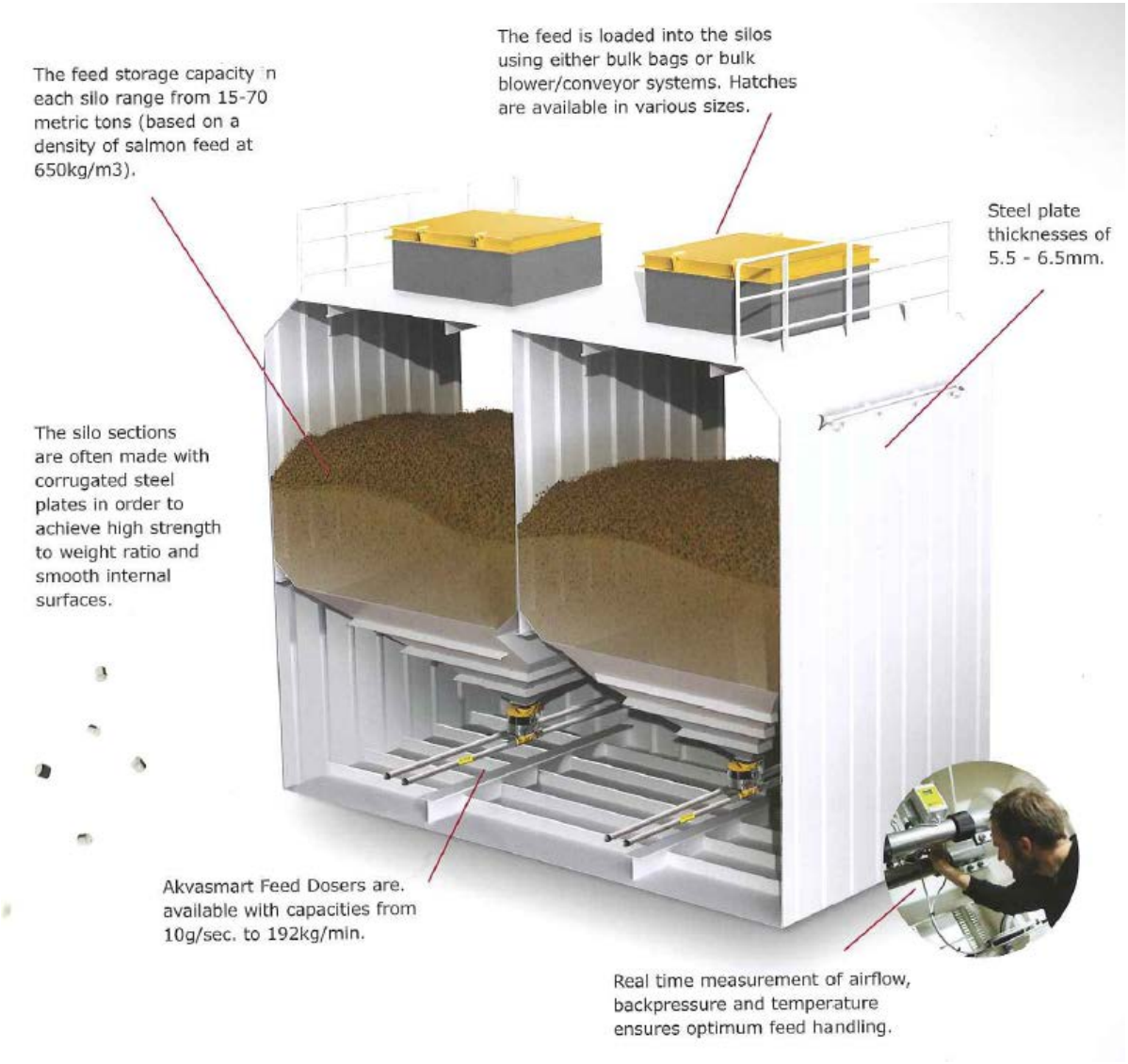
The power management is done by a computer. This optimizes the fuel consumption by balancing the generated power to the consumed power. This configuration reduces maintenance and running cost.



4.3 Feed silos and tank systems

4.3.1 Feed silos

Each feed silo has a volume ranging from 72 to 88 m^3, approximately 47 to 57 tons. The number of feed silos ranges from 8 to 16.



4.3.2 Diesel system

- Integrated tanks ranging from 2x9.5m^3 – 2x25m^3.
- Diesel pump, pipes and fittings.
- Filling and air pipe.
- Piping system between tanks to keep same level in both tanks.
- Low level sensor.



4.3.3 Fresh water system





- 4 separate PEHD tanks, 1m^3 each.
- Filling and air pipe.
- Fresh water pump, pipes and fittings.
- Low-level sensors.
- Water heater connected to the electrical system.

4.3.4 Sewage system



- Integrated 3m^3 tank.
- Filling and air pipe.
- Drain from bathroom, pipes from toilet, sink and kitchen.
- High level sensor.
- Pipe, fittings and sewage pump for emptying the sewage tank.

4.3.5 Ensilage system

- Integrated tanks on starboard and port side.
- Piping system between tanks to ensure equal fluid level in the tanks.
- High level sensor in tanks.
- Offloading pump with pipes, valves and fittings.
- Acid pump and acid tank.
- Mill tank with mill pump for mixing fish and acid.
- Control cabinet for the ensilage system.



4.4 Steel equipment

4.4.1 Platforms for selectors

Platforms with grating for selector valves and tension retainers, on starboard side. The platforms are big enough to give good access when connecting feed lines. The high placing of the platforms protects the selectors and feed lines against bad weather.

4.4.2 Mooring

There are vertical mooring pipes in each corner to lead the mooring chains up to main deck. There is room for two chains in each mooring pipe. On main deck there are locking meckanisims to lock the chains in place.
There are 1 single bollard in each corner and 2 double bollar ds on port side.

4.4.3 Other steel equipment

- Inclined silo deck and walkways on main deck to prevent collection of water and ice. These areas are also painted with anti-skid painting.
- Exterior stairs to silo deck.
- Railing with knee rail on main deck.
- Railing with knee and kick rail on silo deck.
- Watertight hatch for service of generators (4m x 1.4 m).
- Hatches to access silos (1.2m x 1.2m).
- Coaming for the feed hatches (2.8m x 1.8m).
- Natural ventilation in the machine room. The inlet vents are equipped with WIDE moisture eliminator panel.
- Weathertight exterior doors on main deck.
- Exterior ladders for boarding.
- Exterior stair for boarding, on port side.













- Manholes in all integrated tanks for inspection, cleaning, coating and painting.
- Platforms aft and forward (12m x 1m).
- Mast on top of control room, prepared for installation of extra equipment (wireless sensors, GSM, smart eye, etc.).

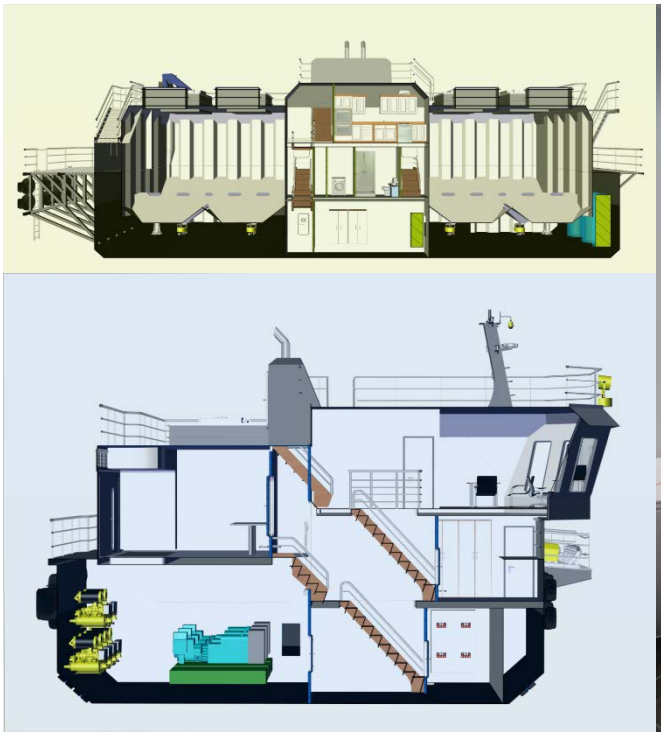
4.5 Other equipment

- Zinc anodes which are bolted in place. This means that they can be changed by divers. The amount of zinc that is fitted is according to the regulations given in NS9415.
- Two rows with fenders on port side.
- At least two sets of double and extra big fenders on port side. For mooring of feed boat.
- Concrete in machine room and technical room to provide a practical and comfortable working surface.
- PE walkways in silo rooms.
- Noise insulation in machine room.
- Painting and lighting in rooms on bottom deck, in addition to painting on the outside of the silo cones.





4.6 Interior





4.6.1 Comfort

4.6.1.1 General

- Interior including insulation, wet room wall panels, flooring, lighting, heating and electrical wiring.

4.6.1.2 2nd floor

- "Grafotherm" anti-condensation inside of the steel roof.
- Control desk and chair.
- Kitchen unit, including fridge, cooking stove, extractor hood and sink.
- Dining furniture for 4 people.
- Sofa with table.

4.6.1.3 1st floor

- 2 cabins.
- 1 disposable room.
- Bathroom with toilet, sink, cupboards, shower and floor heating.

4.6.2 Panorama



4.6.2.1 General

Interior with insulation, wet room wall panels, flooring, lighting, heating and electrical wiring.

4.6.2.2 3rd floor

- "Grafotherm" anti-condensation paint on the steel roof.
- Control desk and chair.
- Kitchen with fridge, cooking stove, extractor hood and sink.
- Table and chairs for 6 persons.



- Sofa.

4.6.2.3 2nd floor

- Bathroom with toilet, sink, cupboards and floor heating.
- 3 cabins.

4.6.2.4 1st floor

- Bathroom with toilet, sink, cupboards, shower and floor heating.
- 1 disposable room.

4.7 Surface treatment

AKVACenter Barges are painted with the highest quality paint and all welds are coated with primer. As an option the barge can be metallized.





4.8 Electrical

- Electrical configuration to match the electricity in the region where the barge is placed.
- All electrical installation is performed in accordance with NEK400.
- Voltage: 230V/AC 1 phase for most electrical equipment and 400V/AC 3-phase for the feeding system.
- Exterior equipment has an enclosure rating of at least IP56. Interior equipment, except for the generators, has an enclosure rating of IP44. The generators has an enclosure rating of IP23.
- Interior/exterior sockets are of the earthed single industrial type, or double standard ones.
- Main fuse box in the stairs leading to the machine room.
- Electrical installation in the deck house has a hidden construction.
- Secondary fuse box for lights, sockets, etc. is placed in the deck house with room for additional circuits.
- Marking lights in the mast (24V/DC).
- Working light assembled in the mast for light on the silo deck.
- Lights on starboard, port, aft and forward side, to light up the walkway on main deck.
- Double sockets near the operator desk and double sockets in all other rooms.
- Exterior sockets 230V-AC 1-phase 16A (Classic: 2 pc. Comfort 3 pc.).







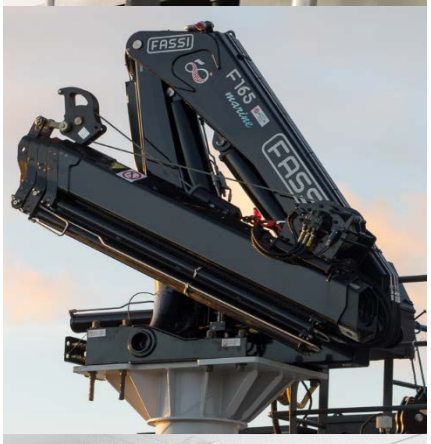


5 Optional equipment

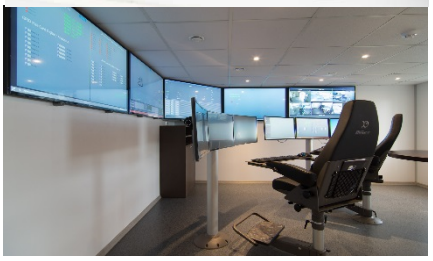
The barges that AKVA group deliveres are operated all over the world. This means that the barges and their operators will face different challenges and needs. In order to accommodate all the different needs, the barges can be fittet with a range of optional equipment. The options listed here are some of these. For a full specification of the options available, please contact AKVA group.











- Additional generators or foundation for generators.
- Noise reduction cabinet for generators and/or blowers.
- Crane foundation, which can be placed on different places on the barge.
- Certified crane.
- Protection of exterior lights.
- Seawater flushing system, for flushing of deck area.
- Veterinary room.
- Bio Aqua / Bio VAC. Modular water treatment system for sewage and greywater.
- Exterior cameras for security and safety.
- Alarm system.
- Bigger platforms than the ones that are included in the standard delivery.
- Heating cables in additional rooms.
- Window blinds.
- Cage light outlet and cabinet.
- Heating pump / air-condition in control room.
- Metallizing.
- Additional furniture such as beds.
- Closing hatch between dozers and silos.
- Washing machine and tumble dryer.
- Central vacuum cleaner.
- Ladders in silos for inspection.
- Sighting glass in silos and/or low level sensor in silos.
- Cinderella combustion toilet.
- LED lighting.
- Air compressor.
- High pressure washer / steamer.
- Automatic silo hatches.
- Aluminium silo hatches.

- Osmosis plant to produce fresh water.
- Diesel filling system for work boats.
- Additional flooring in silo room.
- Additional screens and upgraded chairs in control room.
- Industrial water system that collects rainwater, which can be used for flushing and washing.

DATABLAD

AQUAROBOTICS
Ver: 190203

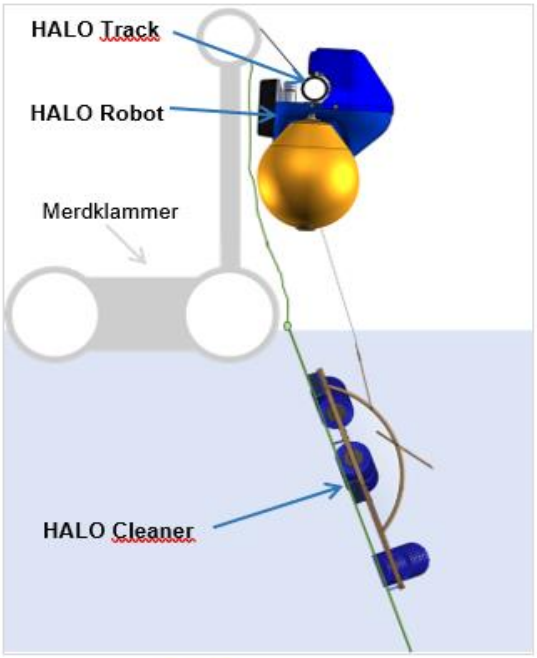
HALO-Net Maintenance System

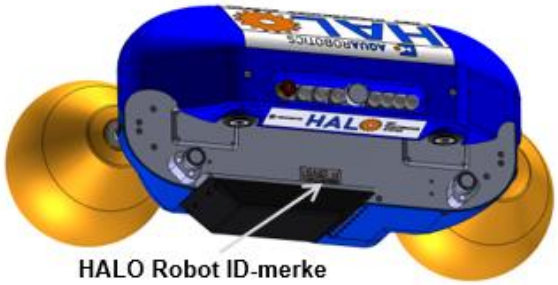


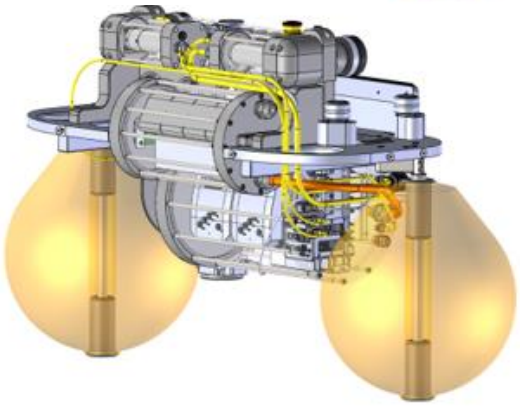
HALO-NMS er et Robotisert notrengjøringssystem som sikrer at nota alltid er ren. Nota børstes 5-10 ganger i døgnet. **ALLTID REN NOT**.

HALO – Robot	
Fysiske mål (B x L x H)	1300 x 670 x 500 mm
Vekt	Ca. 100 kg 2 stk. blåser fungerer som flytelegemer. Enheten flyter i vann.
Strømtilkobling	Tilkobles ladestasjon på HALO-Track for induktiv lading.
Batteri	26 V, 30 Ah
Strømforbruk batteridrift	Ca. 200 W gjennomsnittlig forbruk når operasjonell. Normalt 3-4 timer drift og 45 min lading.
Kommunikasjon	Tilkobles 4G eller Wifi
Styrepanel	Nødstopp og styrepanel for manuell kjøring/bevegelser
HALO – Cleaner (Børsterigg)	
Fysiske mål (B x L x H)	1230 x 1200 x 500 mm
Maks arbeidsdybde	60 m (maks. lengde på bånd)
Vekt	Ca. 29 kg I luft /19 kg i vann
Tilkobling	Tilkobles HALO-Robot ved bruk av 2 polyester bånd (stropper).
HALO – Track (Kjørebane)	
Fysiske mål	PE 110 x 10 mm rør innenfor hele merdens omkrets (ca. 1, 5 m kortere enn merdens omkrets)
Ladestasjon	Hengsle med påmontert ladestasjon for induktiv lading av HALO-Robot.
Strømtilkobling	230 V AC, 15 A (enfase)
Strømforbruk	1000 W ved aktiv lading
HALO Styresystem	
Styring	Systemet fjernovervåkes
Tilkobling	4G eller Wifi
Manuell kjøring	HALO-Robot har et bryterpanel for manuell kjøring av enheten.

Enheten er CE merket. Følgende standarder er benyttet: Norwegian Standard NS9415.E:2009 Flytende oppdrettsanlegg. Maskindirektivet "Forskrift om Maskiner" FOR-2009-05-20-544, Lavspenningsdirektivet 2014/35/EU, NEK 400 og Nytek-forskriften







EN INTRODUKSJON AV

HALO
NET MAINTENANCE SYSTEM

PATENTERT & PATENTSØKT

KONSEPTBESKRIVELSE

- **Robotisert renhold av nota**
  - Nota børstes hver eneste dag
- **Børstes flere ganger per dag**
  - Nota holdes fri for begroing
  - Fjerner alger, Blåskjell, Hydroider osv.
- **Ingen begroing**
  - All begroing fjernes før den får festet seg



Bilde av HALO-Robot

HOVEDKOMPONENTER

Halo-Robot (styre og kontrollenhet)

- Motorer og mekanismer for alle systemets bevegelser.
- Styrt enhet som kontrollerer hele renholdssystemet.
- 4G / Wifi forbindelse til Aqua Robotics

Halo-Track (kjørebane)

- PE-rør (Ø110) montert innenfor håndrekka på et ordinært plastmerd. Fungerer som kjørebane for robot-enheten.
- Røret festes ved hjelp av stropper i hvert merd-klammer.
- Inkluderer også føringsarm som holder tau, slanger, ledninger mv. klar av kjørebanen.

Halo-Cleaner (børsteenhet)

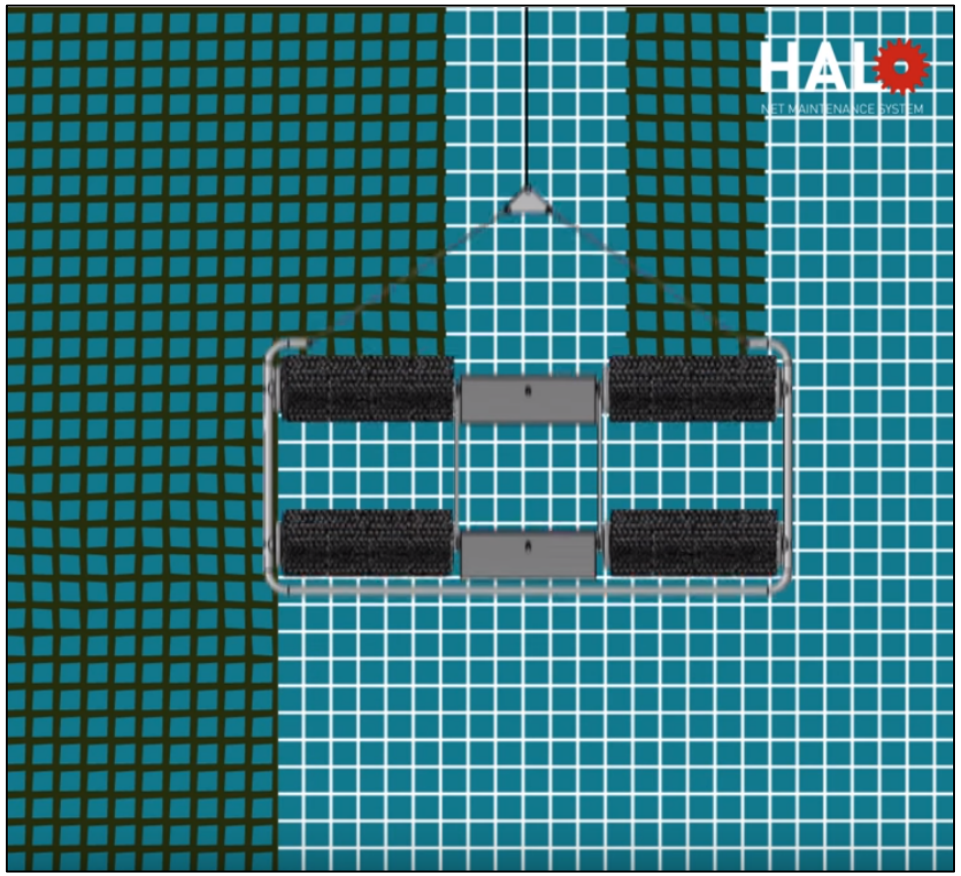
- Børstesystem som ruller mot nota.
- Foiler/vinger som presser enheten inntil notveggen.



Bilde av HALO-Track

ALLTID REN NOT

- **Fullautomatisk robotisert system**
  - Nota børstes flere ganger per dag fra topp til bunn
  - Typisk børstes øverste 10m av nota 4 ganger per dag. *
  - Dypere del børstes 2 ganger per dag.*
- **En maskin per merd**
- **Ingen manuell håndtering**
  - Engangsinstallasjon
  - HALO-NMS fjernovervåkes (trådløs kommunikasjon)
  - HALO-NMS stopper automatisk og går i dvaleposisjon ved uvær, ising osv.



Illustrasjon av HALO-Cleaner

* Avhengig av merdstørrelse, dybde og øvrige innstillinger

ALLTID REN NOT

- **Ingen notimpregnering**
  - Ikke kobberemitterende behandling av not
- **HALO-NMS egnet for spissnot, spagettinot og not med bunnring**.
- **Merdtype må være godkjent** for bruk av HALO-NMS som tilleggsutstyr
  - For øyeblikket Aqualine og Polarcirkel



Bilde av HALO-Robot og HALO-Track

LEVERANSEMODELL

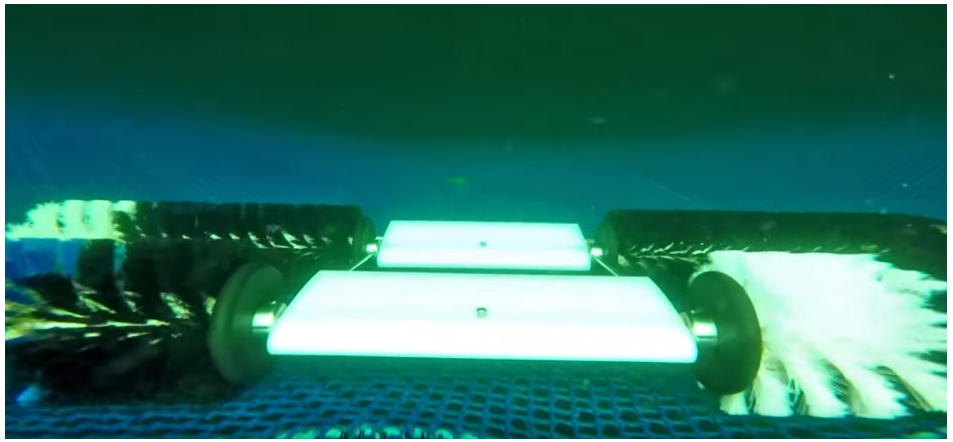
- **HALO-Net Maintenance System leveres som en tjeneste - «Alltid ren not»**
  - Engangskostnad for installasjon (OTC)
  - Deretter en månedlig kostnad (MRC)
  - Avtale over 3 år+
- **Systemet fjernovervåkes**
- **Garantert oppetid**
  - Garantert reperasjonstid ved stopp
    - Jan-Mai: innen 10 dager
    - Juni-Sep: innen 4 dager
    - Okt-Des: innen 8 dager



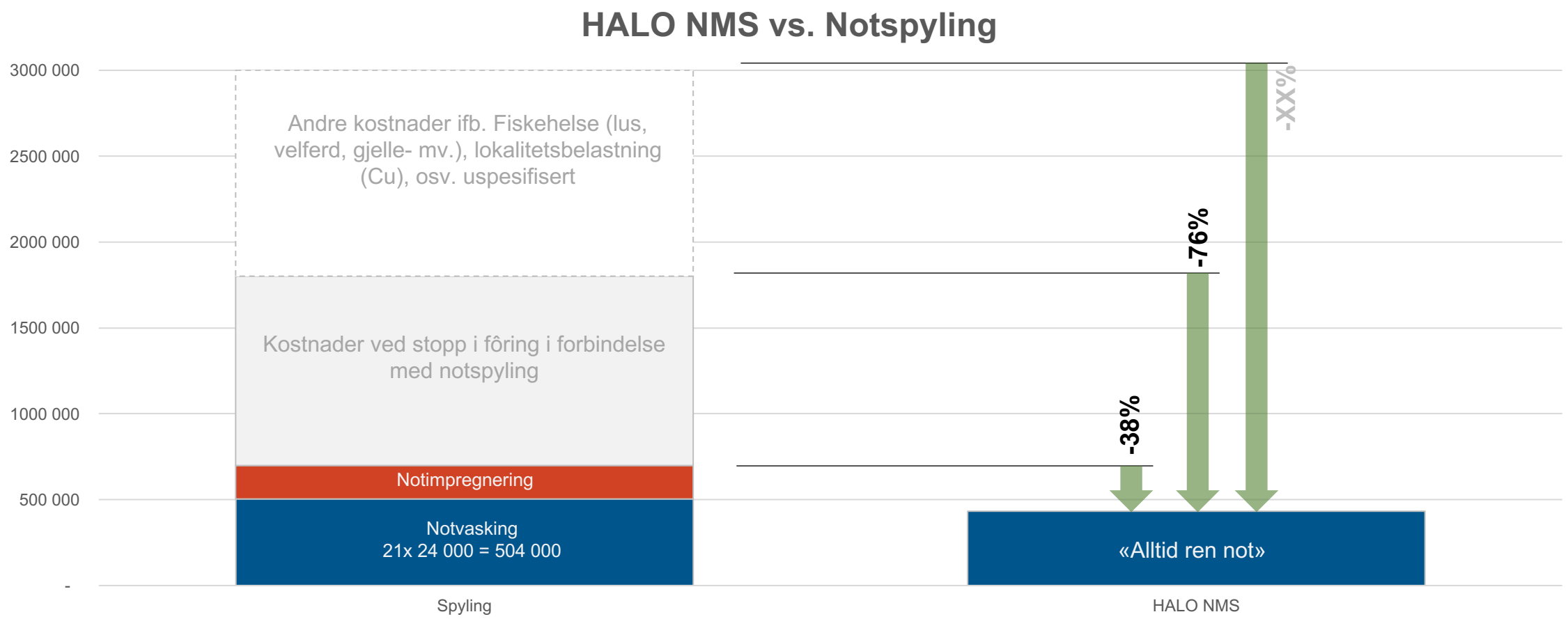
STOR VERDISKAPING

- **Ingen impregnering av not**
  - Ikke bruk av kobber (Cu) - Redusert miljøbelastning
  - Impregneringskostnader
  - Lokalitetsbelastning
- **Alltid optimalt fiskemiljø**
  - Optimal vanngjennomstrømning/oksygenforhold for fisken
  - Unngå sturing
  - Ordinær fôring også mens notrengjøring pågår
  - Bedre lusekontroll / effekt av rensefisk
- **Lavt energiforbruk**–miljøvennlig løsning
- **Økt levetid på not**





HALO-NMS: 76% REDUKSJON AV KOSTNADENE



HALO-NET MAINTENANCE SYSTEM

- Alltid ren not
- Ingen notspyling
- Alltid optimale forhold
- Ingen notimpregnering
- Ingen stopp i fôring
- Bedre effekt av rensefisk



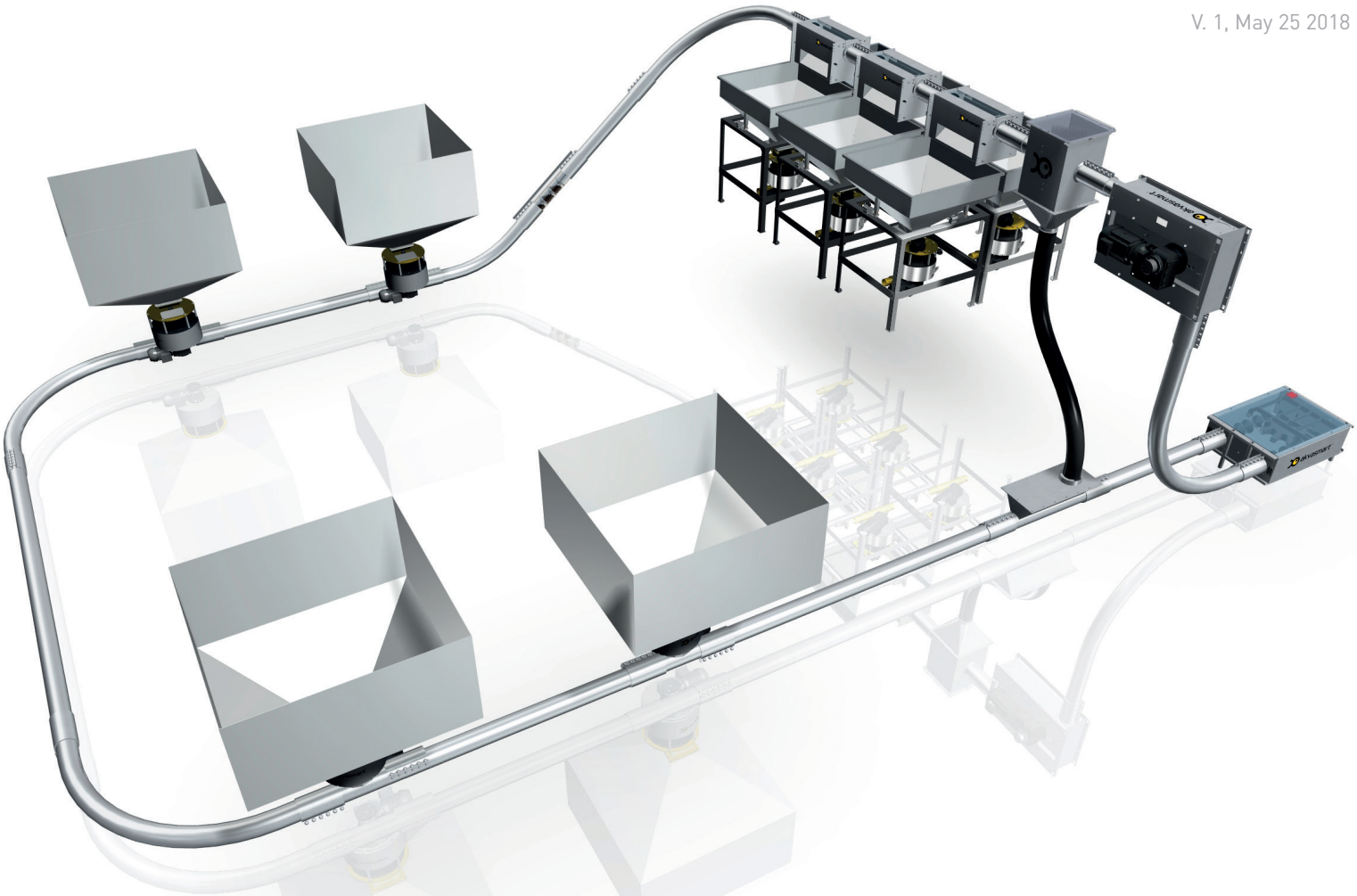
HALO-NET MAINTENANCE SYSTEM

- **Bedre effekt av rensefisk**
- **Redusert miljøbelatsning**
  - Ikke kobber på lokaliteten
- **Redusert støy & energiforbruk**
- **Fiskehelseeffekter?**

76% kostnadsreduksjon



PATENTERT & PATENTSØKT



Flexible Feeding

Distribute feed from all silos to all cages - without manual handling. Flexible Feeding is the feeding concept of the future.

Flexible Feeding is a new and smart add-on concept to the CCS Akvasmart feeding system that enables you to distribute feed from all silos to all cages on the facility.

In a traditional feeding system, each silo is connected to one specific feed line. With Flexible Feeding you will no longer have this restriction. Thus, the feed logistics and planning becomes a whole lot easier. Combine various feed types, pellet sizes etc with just a few keystrokes!

How it works

We install one buffer tank for each feed line inside the barge. A conveyor system lets you move feed from any silo to any buffer tank. With the help of load cells and the AKVAconnect control system you will have full control of how much feed each buffer tank contains. Next, the traditional feed system will bring the feed from the buffer tanks to the cages

www.akvagroup.com

AKVA GROUP™

SYSTEM OVERVIEW

AKVA GROUP

Buffer tanks

- Designed according to client specifications.
- To be placed between the Inlet valves and the Brush box, directly underneath the outlet valves.

Straight pipe

- The conveyor line should be as short as possible.

Inspection pipe

- Allows easy access for viewing the fill rate.
- To be placed after the Inlet valves.

Sweeps

- One should use as few sweeps as possible.

Inlet valves

- Transfers pellets to the conveyor / feed pipe with minimum pellet damage.

Outlet valves

- Fills up to two bufffer tanks.
- Inspection lid on top enables easy inspection/cleaning.
- To be placed between the Inlet valves and Brush box.

Brush box

- Handles excessive conveyed material, which will either be dropped back into the conveyor line or dropped into a recycle bin.
- Inspection lid on top enables easy inspection/cleaning.
- To be placed between the Outlet valves and the Drive unit

Inlet return

- To be placed underneath the Brush box in the system.

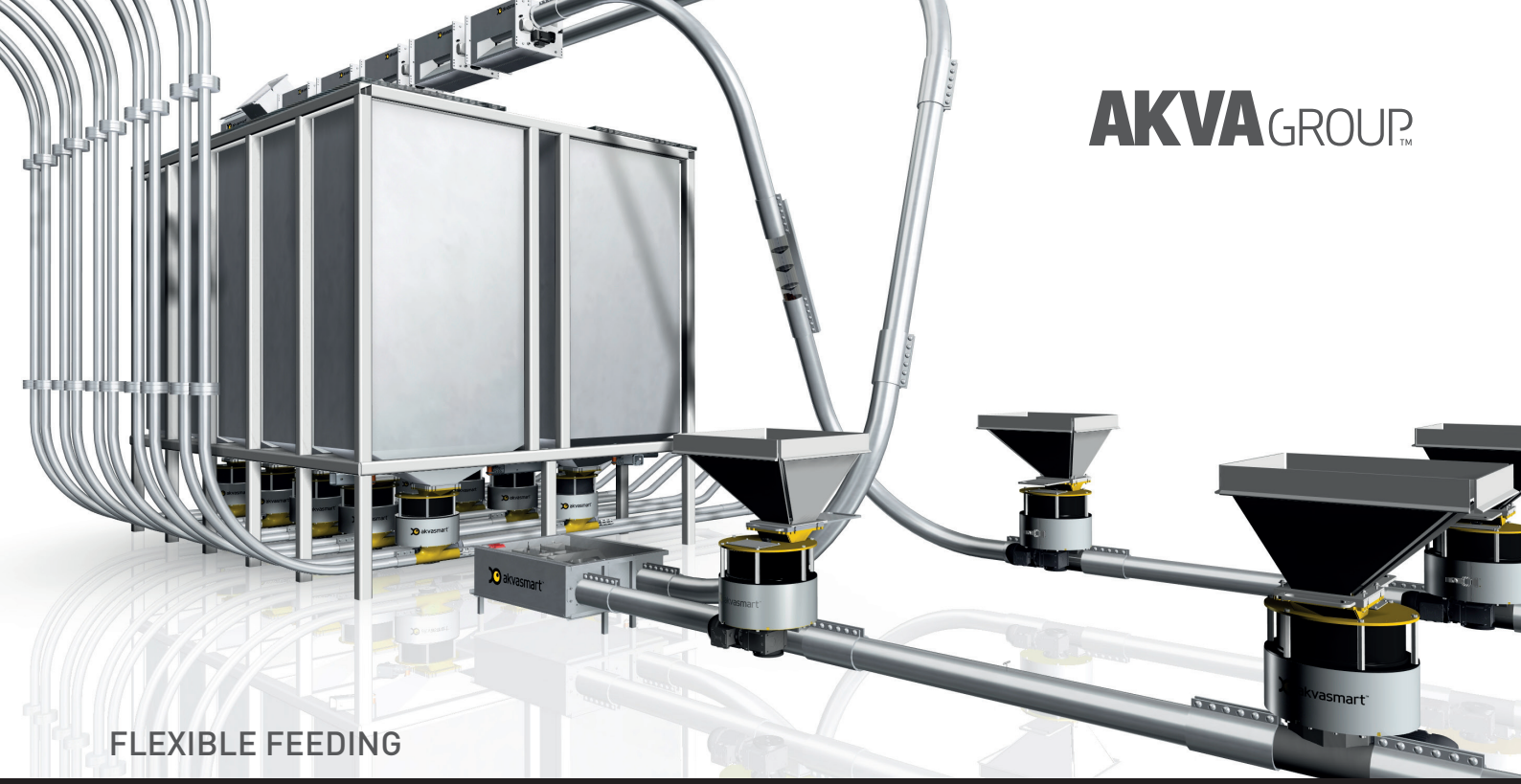
Drive unit

- Prefarrably placed above the tension unit.
- Standard version 90° turn. 180° turn also available.
- Possible to rotate in Z-Axis.
- No conveyed material will enter the drive unit.

Tension unit

- To be placed at an easy accessable location.
- Possible to rotate in Z-Axis.
- No conveyed material will enter the tension unit.

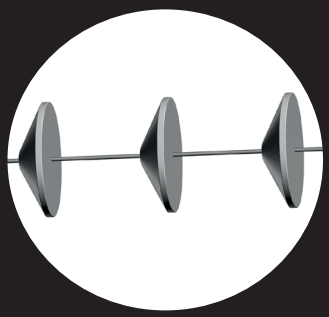
Flexible Feeding is designed and developed by AKVA group. The system can be installed in both new and existing feed barges, according to client specifications.



FLEXIBLE FEEDING

SPECIFICATIONS

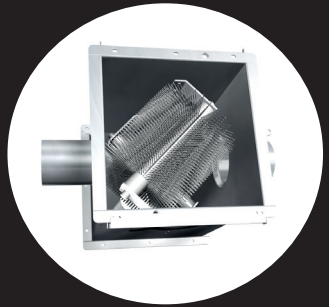
Flexible Feeding system	
Wire	5/8'' SS, max total length 80 m
Diverter outlet	3-way Selector, SS and Aluminum
Pipe	6'' SS
Drive unit	400 Vac, 3ph, 4 kW, SS enclosure with Nylon Sprocket
Brush box	Dual brushes in SS enclosure with funnel for overflow
Wire discs	Nylon discs
Tension unit	Manual tension adjustment, SS enclosure with Nylon Sprocket. Includes sensors for : ■ Machine Safety ■ Tension ■ Wire Speed & Dosage ■ Home Function
Load Cells	Digital SS Sensors, triplet configuration for each Buffer tank. Capacity of 1 or 3 tons.
Buffer tanks	Capacity of up to 9 tons
Control cabinet	400 Vac, 3ph. Typical (8 silos, 8 lines) consumption of 11 kW for single conveyor
Control Software	AKVAconnect version 2.16 or later



Discs and wire



Diverter outlet



Brush box

www.akvagroup.com



AKVA FNC8 v 2.0

A powerful and robust remote net cleaning rig. Easy to operate and maintain with a new and intuitive visual presentation.

The Flying Net Cleaner 8 has a cleaning efficiency that outperforms nearly every other option. It is built with standard ROV components that are easy to clean and disinfect. It also has several built-in auto features and advanced IP camera systems and sensors for complete monitoring during the entire cleaning process.



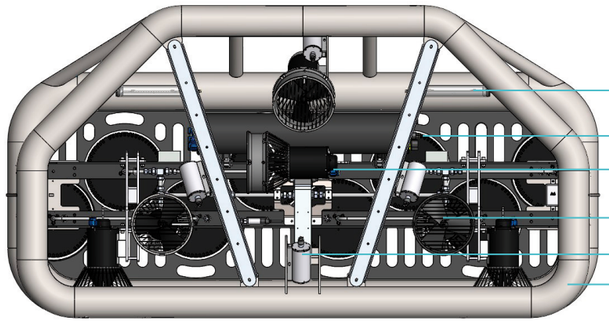
Principal advantages

- Robust components and rugged design
- Easy to operate with automated functions
- Open construction, easy to maintain and disinfect
- Thrusters propulsion (no damages from wheels or tracks)
- Minimal waste spread
- Graphic visual presentation
- Advanced control system prepared for autonomous operation

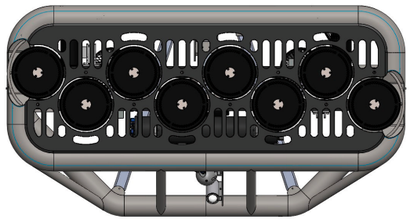
www.akvagroup.com

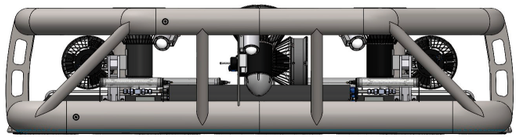
AKVA GROUP

SPECIFICATIONS



Four LED lights with 3000lux
Eight cleaning discs in POM
Four Ethernet IP HD cameras
Six thrusters with 2000W
Fiber tether
Xylan coated frame, AISI 316





AKVA FNC8 v 2.0

FNC

Wehicle LWH	265 x 110/140 x 66 cm
Max. working depth	50 m
Frame	AISI 316 and Anodized AL6082-T6
Buoyancy	Air filled tubing
Weight in air	360 kg
Cleaning area FNC	260 cm width
Cleaning area per hour	5.000 m²/hour (theoretical)
Max. working pressure cleaning system	250 bar
Maximum water cons./ nozzles 24 x 1.2 mm.	500 L/min
Nozzle sizes, standard	Water consumption, approx. 330 L/min (1,2 mm nozzles @ 250 bar)
Power input (recommended 63 Amp.)	230V AC – 15 kW, 3 phase 50 – 60 Hz.
Thrusters	6 ea. Thrusters 2000W
Speed along net	0-1,5 meter/s
Camera	4 x Ethernet IP HD cameras
Lights	4 x Sperre LED-Light 3000lux
Auto functions	Auto Depth, Auto Heading Water press. cleaning unit
Sensors	Depth sensor Moist sensor, electronics Disc speed sensors (optional)
Communication	Fibre optical
Water supply hose, high pressure	100 meter 1 inch complete with fitting, WP 250 bar

TOPSIDE POWER AND CONTROL STATION

Control system	Option 1: Pilot chair with integrated control system Option 2: Mobile pilot console with control system
Screens	One screen for 4k video, two screens for data
Overlay, data presentation	Text generator, date, time, depth, sensor information, etc.
Video recording	Recording, 4 channel
Power cabinet	Main switch, hour counter, fuses, insulation monitoring, V/A meter
Graphic visualization	Graphic presentation of FNC orientation
Position and graphic visualization (option)	Shows FNC 3D position in the cage

STANDARD TOOLING AND SPARES

Tooling kit, 1. standard. Included	Instrument megger/ multimeter Fuses, Silcone oil, Molycote 111, Molycote 44, Laser pen tools

OPTIONAL FNC VEHICLE EQUIPMENT

Tooling and spares kit 2	
Tooling and spares kit 3 over seas	
Rollers and ducts for fluttering nets	Demands approx 100 liter/ min. of extra water @200 bar

OPTIONAL SYSTEM EQUIPMENT

Mobile control room	Control container 2x2 m
Tubs for disinfectIon and transportation	Made in heavy PE material
Winch for tether and high pressure water hose	Capacity 100 meters per cable/hose. Electric driven with slip ring for fiber and power
Water supply hose, high flexible, high pressure	1 meter 1 inch complete with fitting, WP 280 bar



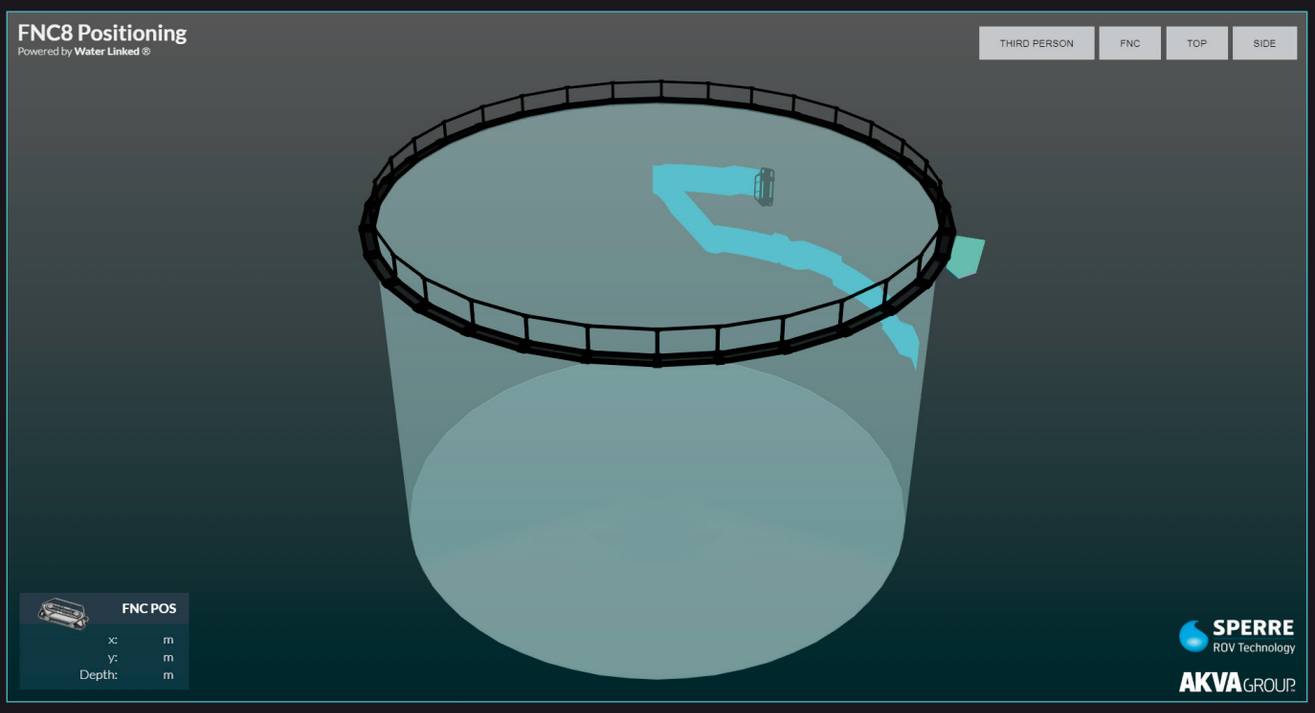
FNC control rack



Pilot chair



Pilot console



The new graphic visual presentation shows the FNC8 cleaner's position in 3D, giving you full control of how it moves in the cage.

High pressure pumps - choose quality!

AKVA group offers a wide range of compatible high pressure pumps. A high-quality high-flow system is key to successful net cleaning.

The pump systems are delivered with a flexible and user-friendly control system that ensures safe and efficient operations.

The pump and engine are placed on a powerful, vibration dampened frame.

We offer customized solutions to suit your requirements and on-site conditions.

SPERRE
ROV Technology
Part of AKVA group

A PATENTED SOLUTION



The AKVA FNC8 is a patented solution produced by the world-leading Norwegian ROV manufacturer Sperre AS.

This ROV cleaner can be used in all types of cages. The solution constitutes an economical and safe way to clean cages - this is the future of maintenance and inspections!



SmartEye 360 Twin

Kamera som er enkelt å betjene og som gir skarpe undervanns videobilder selv under vanskelige lysforhold.

SmartEye 360 Twin er et avansert dobbelt fargekamera med unike egenskaper. Kameraet er svært lyssensitivt, og leverer svært gode undervanns videobilder selv i dypet og i mørke merder.

Kameraet kan enkelt betjenes via AKVAconnect. Pan/tilt-modulene gir 360° horisontal og 180° vertikal oversikt. Kombinert med et av våre vinsjsystem, gir SmartEye 360 Twin full oversikt over hva som foregår, både når det gjelder fôringsresponsen, tilstanden til fisken og dødfisk.

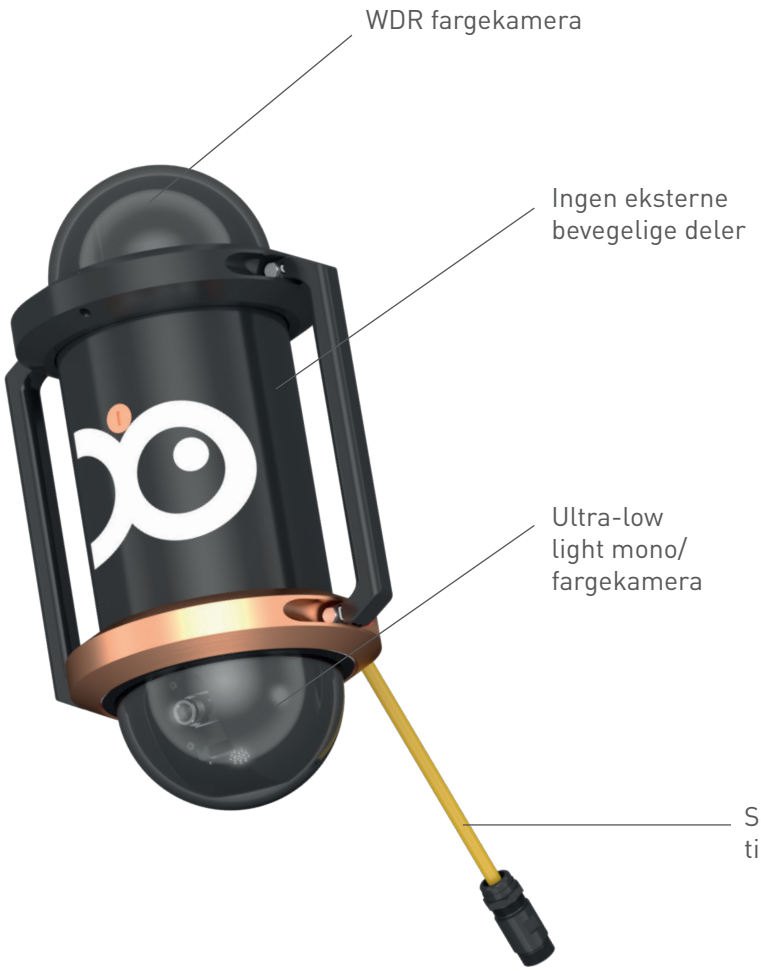
SmartEye 360 Twin har et 720p toppkamera og et 720p bunnkamera med Ultra Low-Light-linse. Dette driftssikre kamerasystemet kan kobles opp mot basestasjonen via den trådløse CAP-senderen (Cage Access Point).



SmartEye 360 Twin overgår alle sammenlignbare kameraer på markedet, med ultra-skarpe fargebilder som fanger hver eneste detalj.

www.akvagroup.com

AKVA GROUP™



Nøkkelegenskaper

- Ultra-low light (ULL) kamera - gir utmerkede videobilder i dype og mørke merder
- Skarpe fargebilder og/eller monokrome bilder
- Synkronisert for 360 graders bevegelse
- Enkel å bruke med håndkontroll
- Ingen eksterne bevegelige deler - hindrer lekkasje og reduserer behovet for service
- Tilgjengelig med innebygd dybde- og temperatursensor

SmartEye 360 Twin

Kameraspesifikasjoner

	360 TWIN	360 TWIN
Farge opp/ned	Farge/Mono	Farge/Farge
Type	Analog	Analog
Oppløsning	CVBS / 720 TVL / 570 TVL	CVBS / 720 TVL
Min. belysning	0.05 lx / 0.0000025 lx	0.05 lx / 0.008 lx
Synsvinkel	Fix: 62°/54°	Fix: 62°/67°
Kabel	75m (246ft)*	50m
Dybderating	75m (246ft)*	75m
Strøm	12V DC	12V DC
Vekt, kamera + kabel	16.8 kg	13 kg

AKVA GROUP

SmartEye Overvåkingskamera





SmartEye Overvåkingskamera tar gode skarpe bilder, selv på kveldstid og under vanskelige lysforhold.



Med et enkelt håndgrep kan du zoome inn viktige detaljer i et oversiktsbilde og få et skarpt, detaljert nærbilde.

Har du problemer med uvedkommende på anlegget?

SmartEye Overvåkingskamera gir deg muliheten til kontroll av eventuelle uvedkommende, skadedyr, fôrnedslaget eller en ekstra sikkerhet hvis du arbeider alene på lokaliteten. SmartEye Overvåkingskamera er et avansert kamera med unik funksjonalitet og kan opereres både fra merden, arbeidsbåten, kontrollrommet eller over internett. Klart og godt fargebilde med opptil 24x optisk zoom gir deg en detaljert oversikt over anlegget. Overvåkingskameraet er en del av SmartEye systemet.



Både sjøfugl og sel kan gjøre stor skade i oppdrettsanleggene.

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SmartEye Overvåkingskamera



I uvær kan et overvåkingskamera kombinert med en fjernstyrt videoserver gi deg full oversikt over lokaliteten på PC skjermen.



Med SmartEye kontrollenhet kan du med et enkelt håndgrep styre både pan, tilt og zoom funksjonene.



Unngå ubehagelige overraskelser. Finn ut hva som skjer ved merdkanten når du ikke er fysisk tilstede?



AKVA group er verdens ledende leverandør av teknologi til fiskeoppdrett, og står bak flere kjente sterke merkenavn som: Wavemaster, Polarcirkel, Fishtalk og Akvasmart.



Kameret har 360° pan og 90° tilt.

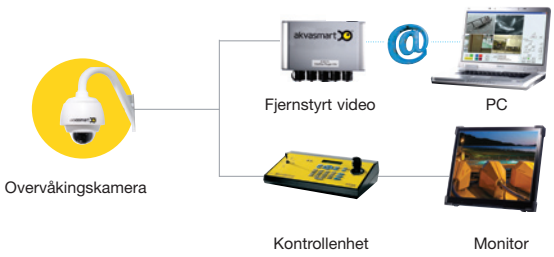


Overvåkingskamera med 90° til 10° zoom. (24x optisk).



Enkelt grensesnitt som gir deg et brukervennlig system.

SmartEye Overvåkingskamera flytdiagram:



SmartEye Overvåkingskamera	Fargekamera
Oppløsning:	480 TV linjer ¼ "CCD Ex View
Lysfølsomhet:	0,07lux
Linse:	3,5 – 91mm
Fokuseringsmåte:	Automatisk
Panorering:	360° uendelig
Tilt:	-10° til 190°
Driftstemperatur:	-35° til +50°C
Størrelse - L x Ø:	300 mm x Ø190
Vekt:	5,8 kg
Strømtilførsel:	24VAC (via styreskap)
Effektforbruk:	30W

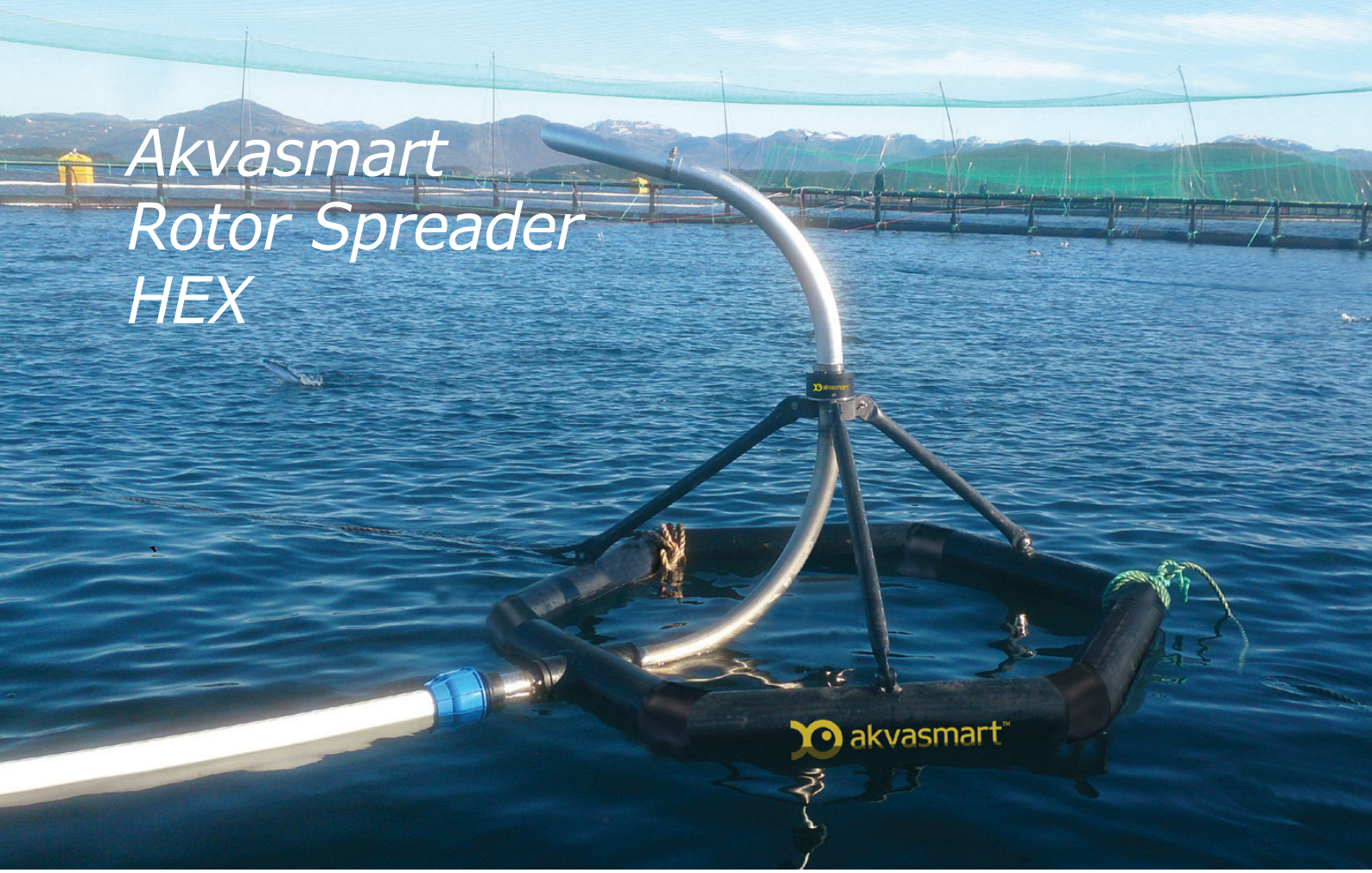
The Global Leader in Aquaculture Technology

● Steel Cages ● Net Services ● Plastic Cages ● Boats ● Docks & Marinas ● Piping ● Software ● Accounting Services ● Feed Systems ● Feed Barges ● Sensor Systems

akvasmart™

NO-Akvasmart-Sensors-Camera-SmartEye-Surveillance-20070801

Akvasmart Rotor Spreader HEX





Combined with an Air Control System a reduction of transport air speed will provide significant reduction in feed dust and pellet breakage.



Preventing only 1% feed waste in a larger fish farm can add a total of 50 - 100.000 US$ to the bottom line each year!

Excellent feed care with adjustable feed spread in cages

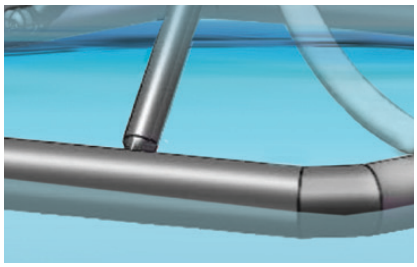
One of the most important factors for gentle feed handling is regulating transport air speed. "Speed kills" also when it comes to feed systems, and reduction of transport air speed provides significant reduction in feed dust and pellet breakage. Using the Air Control System combined with the highly effective, low friction start Akvasmart Rotor Spreader HEX (CF-90) allows reduction in air speed while still getting excellent feed spread.

Light weight aluminium rotor pipes allows lower air speed for start up and rotation, meaning less dust and pellet breakage, power consumption, back pressure, noise, air temperature and wear and tear on the feed pipes.

The principal advantages of the new rotor spreader

- Provides steady installation, even in rough seas
- Excellent and adjustable feed spread in cages
- Foam filled HDPE pipes - Will never sink
- Light weight - easy to install and to move around
- No protruding parts, eliminates the risk of damaging surrounding equipment or net

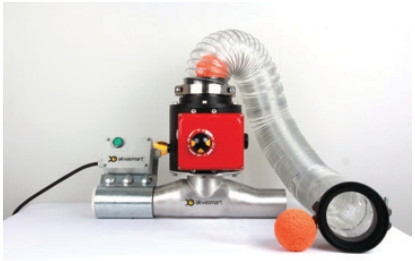
Akvasmart Rotor Spreader HEX



No protruding parts, eliminates the risk of damaging surrounding equipment or net.



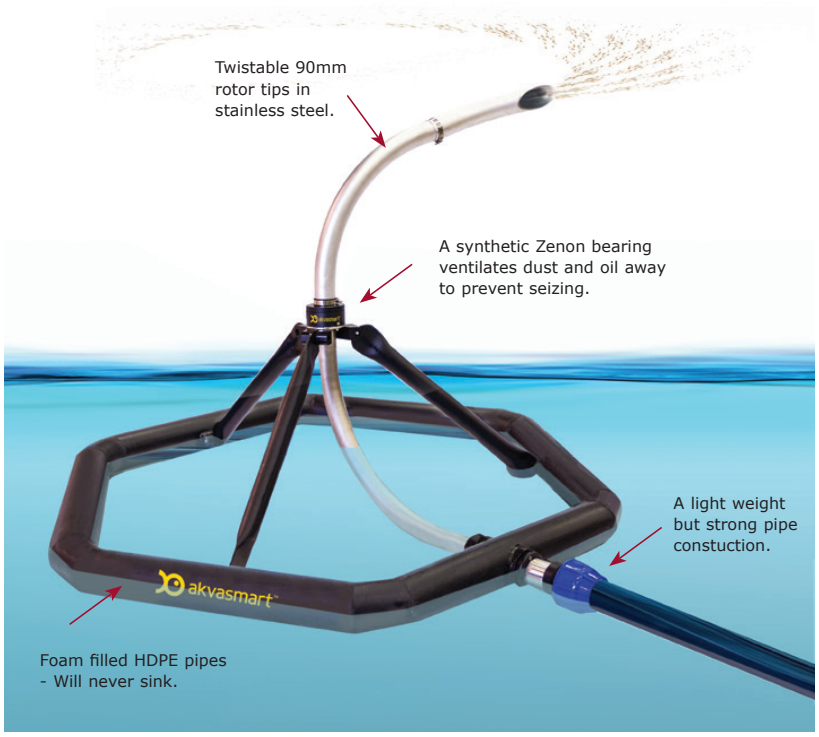
Akvasmart Rotor Spreaders are designed for all types of cages. More than 8000 spreaders are delivered world wide.



Cleaner pipes will also improve the profit. The Cleaning Sponge will be transported through the system by using pressured air.

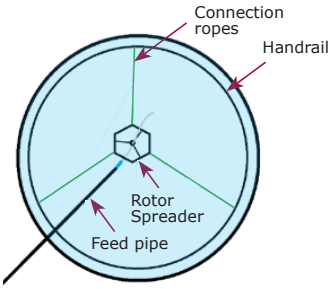


AKVA group is the world´s leading supplier of aquaculture technology, promoting well known brand names such as: Wavemaster, Polarcirkel, Fishtalk and Akvasmart.



New product design secures excellent performance and optimal feed care!

The new Akvasmart Rotor Spreader HEX is equipped with a HDPE floating element, secured with 3 or 4 lines or ropes.
The Rotor Spreader is easy to place and move during maintenance and other necessary operations.



Specifications:	CF-90
PE pipe dimension:	90mm (3”)
Max pellet size:	25mm (1”) *
Recommended RPM:	50-100*
Spread diameter (adjustable):	Approx. 5-18m Ø * Approx. 16-60’ *
Materials:	HDPE, Stainless Steel/Aluminium.
Height above water:	1,5m (4.9’)
Draft:	0,1m (3.3’)
Total weight:	35kg (77 lbs.)

* Depending on feed system and pellet type.

Your Aquaculture Technology and Service Partner

• Complete Aquaculture Projects • Recirculation Systems • Plastic Cages • Steel Cages • Moorings • Nets • Net Cleaning
• Workboats • Feed Barges • Feed Systems • Camera & Sensor Systems • Underwater Lights • Software

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E-Akvasmart Hex Base Rotor Spreader-2015

Akvasmart Winch V5





The new camera winch V5 is specially designed for Akvasmart cameras. From the advanced SmartEye 360 Twin to standard HR camera models.



Remote control via Digital CAP. The winch can be placed optimally and customized to the current direction, independent of the placement of the Digital CAP.

akvasmart™

Winch for underwater camera with suspension - withstands large cage movements and prevents spin

The orientation will be locked after suspension. Simplified with only one pully in the other end that prevents pendulum movements with the current. Here is the main features;

- Increased speed.
- Analog speed control on both drums, can run in different speed.
- Moment security, can switch off with programmed power setting.
- Remote control via digital CAP. Can be placed independently.
- Directional lap controller on the drum – can also calculate the exact position of the camera in the cage.
- Possible oxygen/temperature connection.
- LED-light in the control buttons.
- 220V operation.

The Winch V5 is prepared for:

- Online software upgrades.
- Positioning with prefered positions.
- Profiling and cyclic operation.
- Automatic camera sinking at night to prevent sprout.

Specifications:
Size l x w x h: 320x400x400 mm
Weight: 23 kg
Materials: Aluminum, POM, stainless steel
Power supply: 110V - 24V
Environmental station: 1 point
Max rpm: 140

HUON
AQUACULTURE

HUON FORTRESS PEN SYSTEM

OFFSHORE PROTECTION FOR YOUR FISH & STAFF



huonaqua.com.au

A FISH FARM PEN FOR THE FUTURE

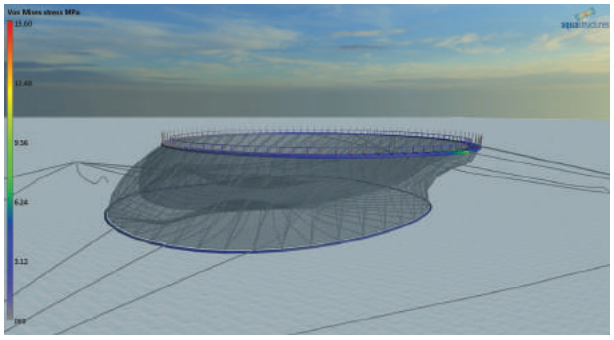
The Fortress Pen System was developed in Tasmania by our team at Huon Aquaculture in response to a need to keep seals out, provide a safe platform for our staff to work on and allow us to farm further offshore. There was nothing available on the market, so we underwent a 2-year, new pen development project with funding support from the Australian Government's Fisheries Research and Development Corporation (Atlantic Salmon Aquaculture Subprogram: trial of a stock protection system for flexible oceanic fish pens). The project began in 2012, with the first prototype pens in the water during 2013.

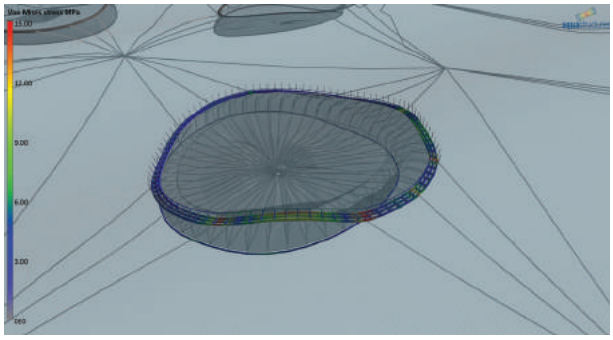
One of the key features of these pens was a patented, wide-style stanchion with flexible seal fence posts in an angled socket to allow an outer predator net to be set around the inner net while keeping a minimum distance of 2m separation between the nets. This outer predator net was connected directly to the sinker tube to reduce rigging and keep it tensioned at all times and in all weather. We then developed a unique tensioning system for the inner net that allowed it to flex with the pen, the predator net and the sinker tube. The end result is a pen that is easy for our staff to work on, keeps seals and other marine predators out and allows us to focus on the performance of our fish.

We've been using our Fortress Pens in some of the roughest farming conditions in the world for over three years and our fish have never grown better.

DESIGNED AND TESTED FOR THE TOUGHEST CONDITIONS IN THE WORLD

Huon's Fortress Pens have been designed for, and now tested in, some of the toughest Australian conditions at Storm Bay, Tasmania and Providence Bay, New South Wales. These sites are high energy, exposed sites, frequently receiving storms swells and gale force winds. Modelling by Aquastructures AS, Norway show the Fortress Pens are capable of withstanding these tough conditions and Farming these pens at these locations over the last few years have shown them to be able to withstand storm events.







HUON FORTRESS PEN

EMPLOYEE SAFETY

- Tapered walkway plates with stud grip, drainage holes and walkway spacers provide a perfect fit for every pen
- Outer predator net above water keeps staff safe from menacing seals and from being washed off the collars
- Staff access areas for easy entry on and off the pen
- Huon's Fortress Pen System recieved the Innovation in Safety award from the 2015 Tasmanian Community Achievement Awards

ON WATER MANAGMENT

- Endless rope net-tensioning systems allow the inner nets to be easily released and tensioned
- Stanchions made from impact modified Nylon provide the strength of steel, but with durability and flexibility
- Huon's Fortress Pens contain no steel parts to damage boats or chaff through nets and ropes

FISH PROTECTION

- Outer seal-fence poles and predator-proof netting to keep seals off the pen above-water
- Flexible bird poles keep bird nets supported so birds cannot get near the fish or fish feed
- Underwater the predator net provides an impenetrable barrier that keeps seals and sharks away from the fish

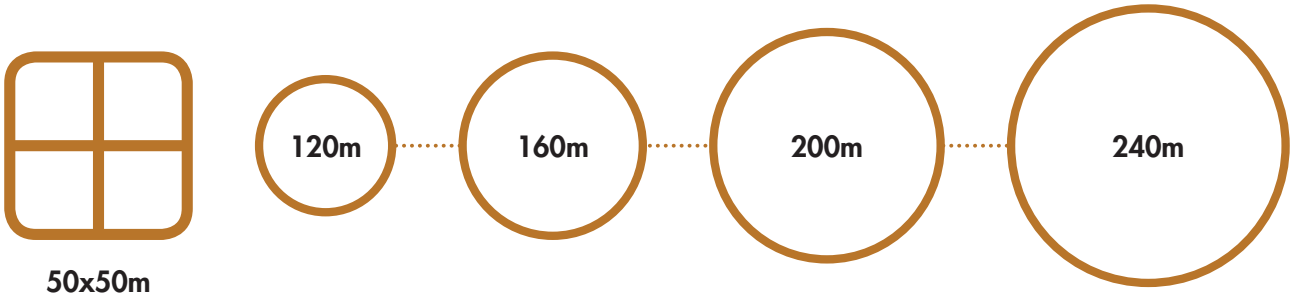
FISH PERFORMANCE

- Light-weight, super-strong nets allow excellent water flow, reducing drag and improving in-pen DO's
- Keeping seals, sharks and birds away from the fish allows them to grow without disturbance
- Nets are optimised for use with mort collectors, so any dead fish can be retrieved as required

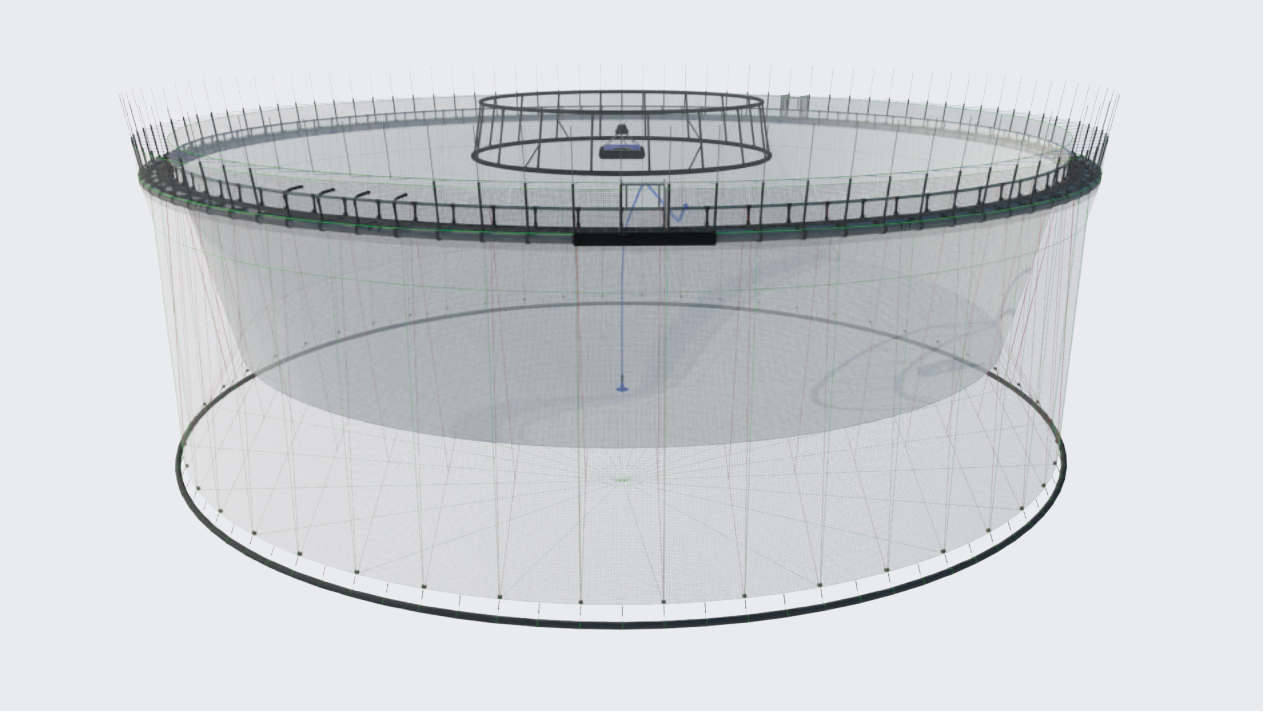
FORTRESS PEN SPECIFICATIONS

System Name	Overall Pen Circumference/Size	Collar Pipe Diameter*	Predator Net Depth†	Fish Net Depth†	Fish Net Volume†
Square	50x50m	450mm	20m	16m	40,000m^3
F120	120m	450mm	16m	13m	10,000m^3
F160	160m	450mm	22m	17m	25,500m^3
F200	200m	560mm	28m	22m	48,000m^3
F240	240m	560mm	32m	26m	72,500m^3

* All pens have 3 collars
† Net depths and volumes can be customised to suit conditions

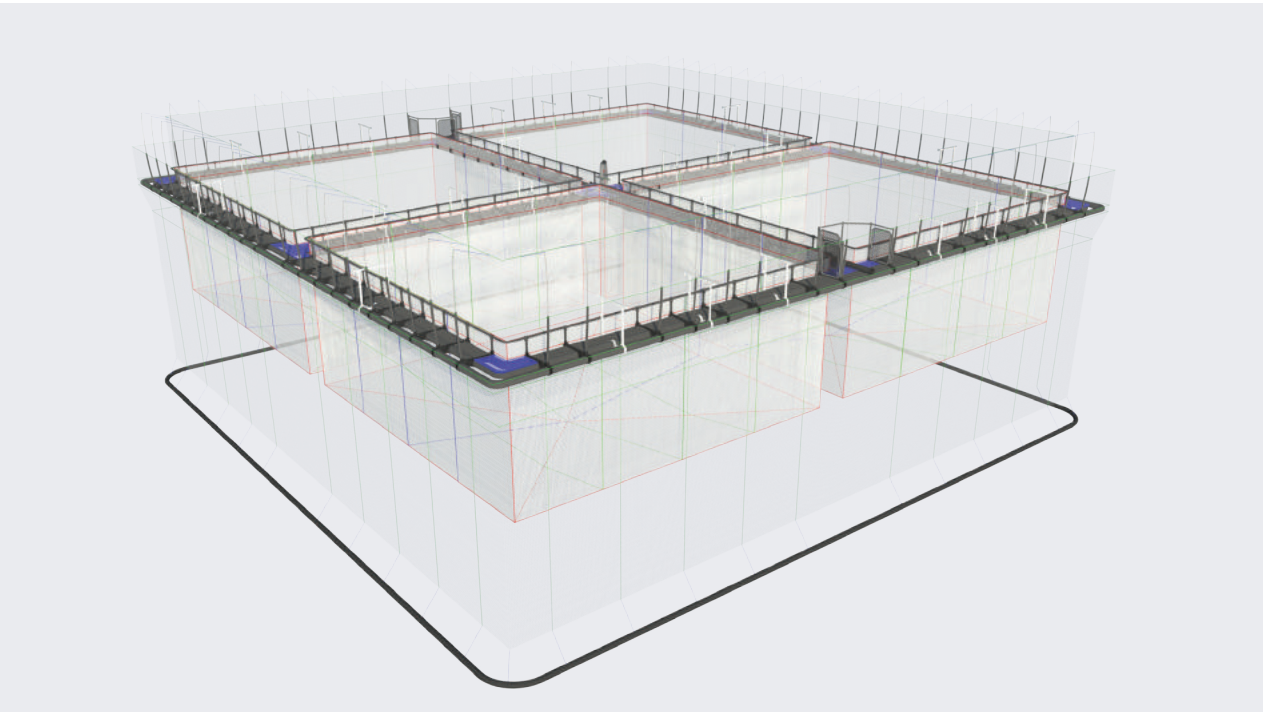


HUON FORTRESS PEN - ROUND



F240m circular pen with LiftUp, bird net stand and feed spinner

HUON FORTRESS PEN - SQUARE



Square pen with 4 pods and dual staff access points

FORTRESS PEN COMPONENTS



Moulded HDPE or Nylon pen compnents include: **1** Handrail/Seal Pole Plug **2** Pin Locker **3** Rope Tension Pulley **4** Handrail T **5** Walkway Plate **6** Walkway Spacer **7** Stanchion Block **8** Stanchion





A LITTLE BIT ABOUT US ...



We've been farming top quality salmon in the pristine waters of Tasmania for over 30 years and in that time we've learnt a thing or two about the best way to raise some of the highest quality salmon in the world.

We have built a reputation based on quality and innovation with a proud history of leading the way in aquaculture developments both in Australia and internationally. A constant desire to put the health of our marine environment, our fish and the safety of our staff at the forefront of every business decision has led to innovation across all aspects of our business. Recognition that the future of fish farming looks very different to that of today continues to drive significant change in our global aquaculture industry as companies like ours move to offshore, deeper oceanic sites and look to adopt technology such as the Huon Fortress Pen Systems that can withstand these more beneficial, but equally challenging, new farming locations.

This focus on continual improvement and innovation in the way we farm has set the foundations for Huon Aquaculture to continue to grow sustainably into the future.

Peter and Frances Bender
Co-Founders

CONTACT US

HUON AQUACULTURE

Level 13, 188 Collins St
Hobart, Tasmania 7000

+61 3 6295 8111

pen.sales@huonaqua.com.au

YOUR LOCAL SUPPLIER

huonaqua.com.au



Unity Marine – List of Procedures

APPENDIX L

List of planned procedures for Unity Marine

I 101.	**Environmental Monitoring Plan**
I 102.	**Biosecurity Protocol**
I 103.	**General Maintenance Plan**
I 104.	**Training and Education Plans**
I 105.	**Production Plans**
I 106.	**Monitoring-, control- and work plans**
I 107.	**Chemical Management Plan**
I 108.	**Fuel Management Plan**
I 109.	**Spill Management Plan (Chemicals and Fuel)**
I 110.	**Waste management plan**
I 111.	**Fish Health Management Plan**
I 112.	**Escapee Management Plan**
I 113.	**Ballast Water Management Plan (ship specific)**
I 114.	**Vessel Traffic Protocol**
I 115.	**Harvest plan**
I 116.	**Reports to authorities**
I 117.	**Production Journal**

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Unity Marine - Business Plan

APPENDIX N

1 Content

1 Content 1
2 Executive summary 2
3 Market brief 3
3.1 Global fish demand and prices 3
3.2 Global salmon market 4
3.2.1 Salmon demand 4
3.2.2 Salmon prices 5
3.3 Typical salmon sales and distribution channels 5
3.4 Traditional Salmon Value Chain 6
3.5 Conclusions 6
4 Falkland Island suitability for salmon farming 7
5 Unity Marine Business Plan 8
5.1 Business Objective 8
5.2 Development plan 8
5.3 Investment cost (CAPEX) 9
5.4 Operational Cost and Revenues 10
5.4.1 Operational Cost 10
5.4.2 Sales and revenues 11
5.5 P&L 12
5.6 Cash Flow, ROI and payback time 12
5.7 Funding 13
6 Risk Assessment 14
7 Appendix A: Figures 15

2 Executive summary

The business plan aims to briefly describe the business drivers and financial foundation for establishing a 50,000 tonnes salmon production company on the Falkland Islands.

The following key points have been established:

1. The global market for fish is characterised by a significant gap between the demand and supply of fish, resulting in relative high prices. The demand is expected to increase in the future.

2. Salmon is globally a very popular product, the market for salmon is characterized by growing demand and insufficient supply.

3. The Falkland Islands have been found to be very suitable for salmon farming, considering the natural environment and water temperatures.

4. Unity Marine plans to establish a 50,000 tonnes per annum fully integrated salmon production, with a main office, two (2) land-based hatcheries, twenty (20) sea sites, and vessels to support the operation.

5. Feed will be transported directly to the production sites, and the harvested fish will be picked up directly at the sea sites by processing ships.

6. The project will be developed, constructed and started up supporting a continuous supply from the twenty (20) sea sites, and a distributed construction load on the islands.

7. Aquaculture business establishment is characterized by significant CAPEX investments in infrastructure and several years of OPEX cost, before revenues and profits. According to Unity Marine's plans, the construction work starts in 2020, the first eggs will be imported in August 2021 and the first harvest of fish in 2023.

8. The total investment is 438 million GBP. The project payback time is ten (10) years, during which time the Unity Marine company value continuously grows with equity and bank loans covering the investments, while revenues and resulting profit are achieved when the fish have reached harvest size and can be sold.

9. At full production capacity, the expected annual revenues will be approximately 200 million GBP with an EBIT of approximately 75 million GBP.

3 Market brief

3.1 Global fish demand and prices

The demand for fish has been on a constant rise for the past four (4) decades, with variations between regions, reflecting differences in the availability of fish and other foods, local preferences, income levels and other factors. The growing demand for fish, resulting in extensive fisheries has come at a cost to the wild stocks, which in some areas has shrunk as much as 90% due to overfishing.

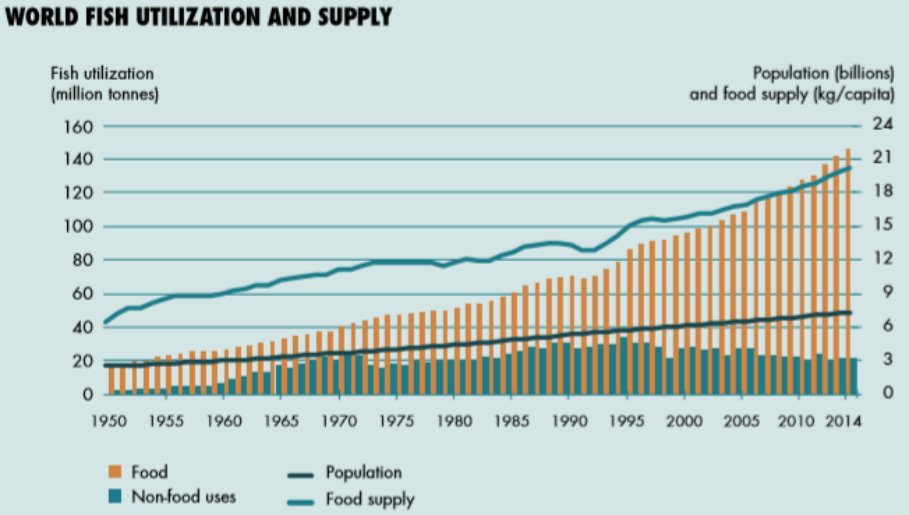


Figure 1: A growing population with an increased demand for fish, FAO 2016.

The increased demand for fish, combined with the decrease in wild stocks requires new and innovative solutions to increase the global supply of fish. The only alternative to fisheries is aquaculture. The UN Food and Agriculture Organization (FAO) stipulated in 2016 that aquaculture will need to provide an additional 23 million tons of farmed fish by 2020 to maintain the current level of fish consumption in the world.

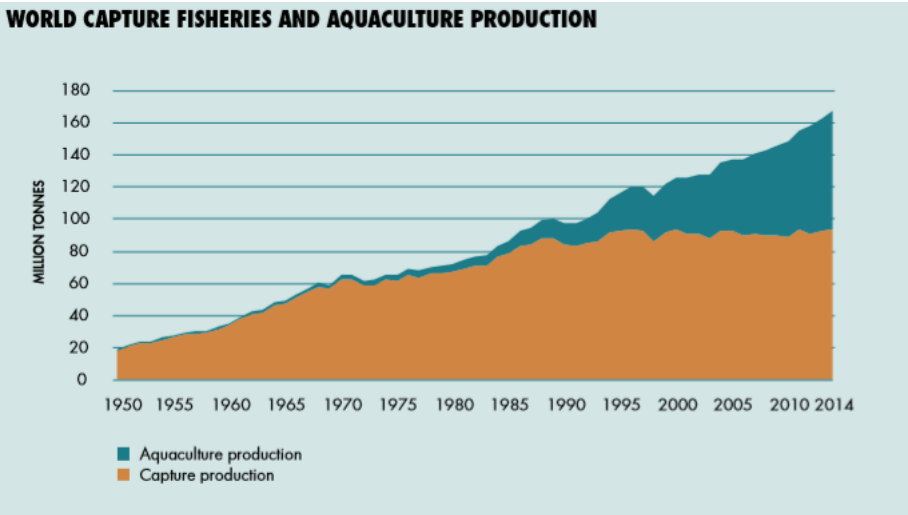


Figure 2: Fisheries and aquaculture production, FAO 2016.

Increased demand combined with limited supplies has resulted in increased prices, as it can be seen from the figure below.



Figure 3: FAO Global Fish Price Index.

3.2 Global salmon market

3.2.1 Salmon demand

Salmon consumption worldwide is increasing. What was once a luxury food for the few, is today among the most popular fish species in many parts of the world, resulting in a growing global market for salmon, currently limited by the ability to supply.

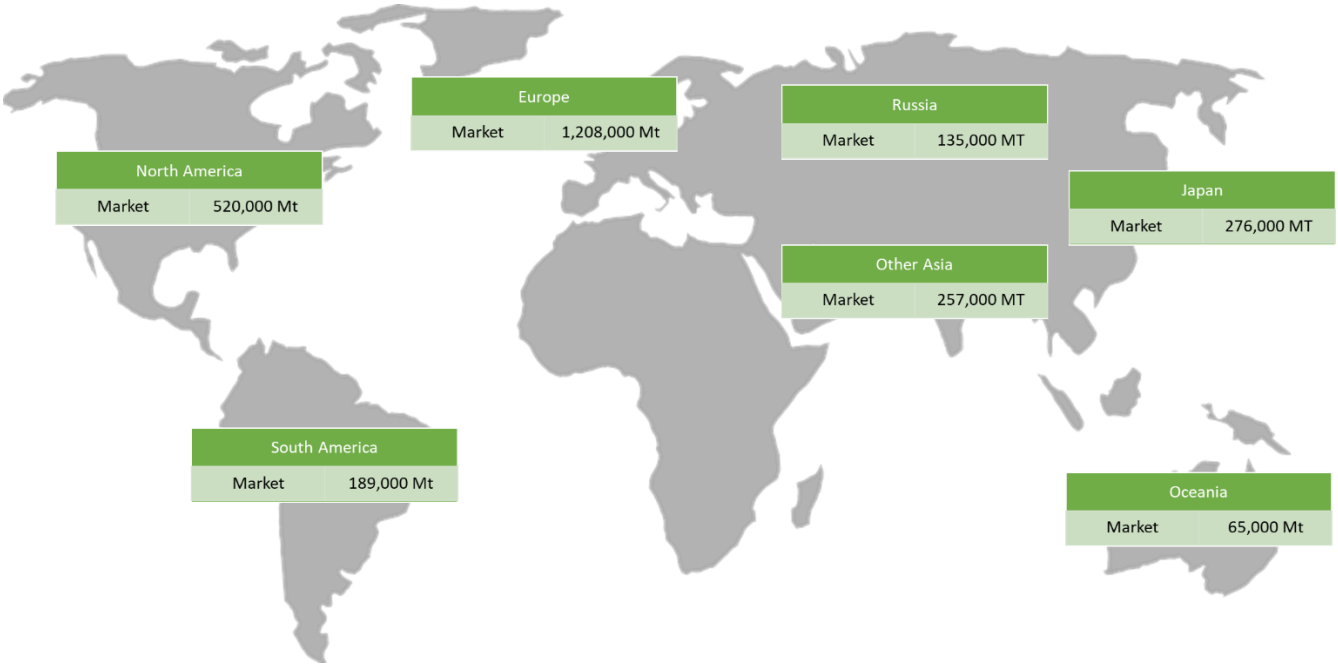


Figure 4: World Salmon Market, 2017 numbers.

The increased supply from current production assets cannot meet market demand. Consequently, salmon aquaculture operations are among the fastest growing food production systems in the world. However, growth in supply is also limited due to regulatory limitations and lack of suitable new sea sites.

The salmon farming business needs new areas for operation to meet the growing global demand.

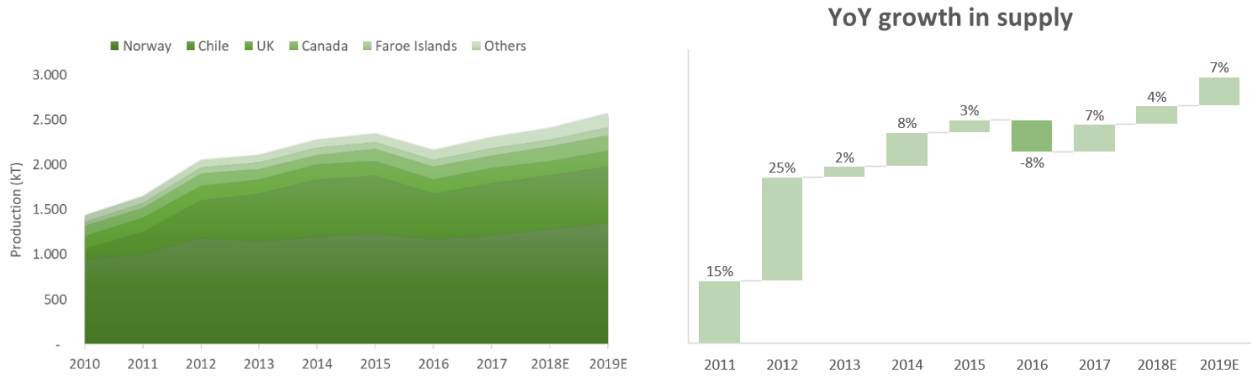


Figure 5: Production volume and growth in salmon aquaculture.

3.2.2 Salmon prices

The prices for Salmon are characterised by the same drivers as fish in general, for the same reasons, with high quality frozen salmon even reaching same prices as fresh salmon.

The salmon demand is price sensitive, with the expectation that reduced prices will lead to increased demand. However, the prices have been consistently high in the last couple of years, due to the weak growth in supply. As reference, the salmon prices stayed high during the financial crises unlike many other commodities.

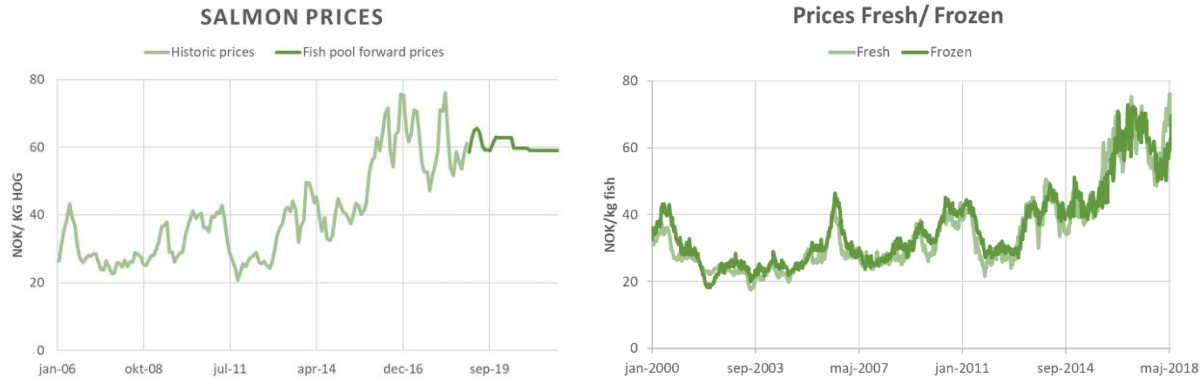


Figure 6: Development in salmon prices in NOK pr. Kg Heads On Gutted (HOG) and the prices of fresh and frozen salmon.

3.3 Typical salmon sales and distribution channels

Salmon producers typically sell their products to a sea food processing company that process the fish, and delivers to retail grocery chains, distributers, independent retailers and specialty shops. In some cases,

producers have their own processing facilities and sell directly to retail chains and stores. The food supply chain is becoming increasingly global and direct with more online sales directly to consumers.

3.4 Traditional Salmon Value Chain

In nature, Atlantic Salmon spawns in freshwater streams. When the fish are about 15 cm in length, the young salmon undergo a process called smoltification, whereby they acquire the ability to live in sea water. After smoltification, the fish swims to the sea, where they live for one (1) to four (4) years before reaching full adult size.

Naturally, the salmon aquaculture value chain follows the same pattern, starting at the hatchery, where the salmon eggs are hatched and stay until approximately 80-150 g of weight. The fish are then moved to the sea sites in well boats, where they stay until reaching full harvest size. Alternatively, the fish are moved to land-based on-growing systems.

When the fish reach harvest size they are processed and distributed to customers. Traditionally processing is done on shore, but within the last couple of years, processing ships have made their entry on the market, allowing for processing while transporting the fish, and resulting in a fresher product for the consumer.

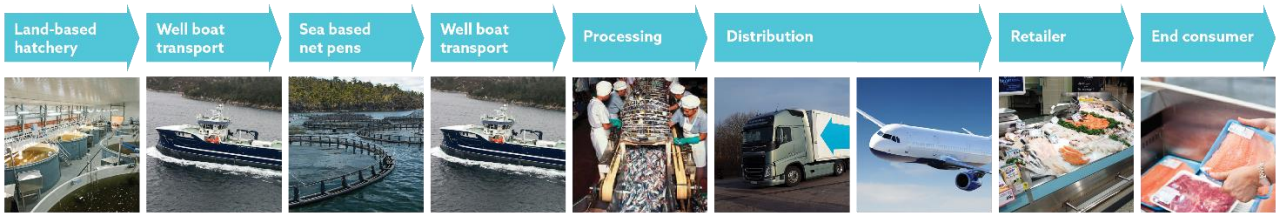


Figure 7: Typical salmon production chain.

3.5 Conclusions

A growing global population, with an increased demand for fish, combined with supply not meeting the demand results in a salmon market characterized by high demand and high prices.

4 Falkland Island suitability for salmon farming

Today salmon aquaculture takes place in many countries around the world, primarily at locations where the natural conditions (temperature, water quality, depths and wave exposure) match the requirements for salmon farming.

Land-based recirculated aquaculture systems for on growing of the fish to harvest size on land, makes it possible to establish salmon production at any location with enough water and power. However, this is often related to significantly increased investment and operational cost. Secondly, none of the land based grow out facilities have shown stable profitable business results, so far.

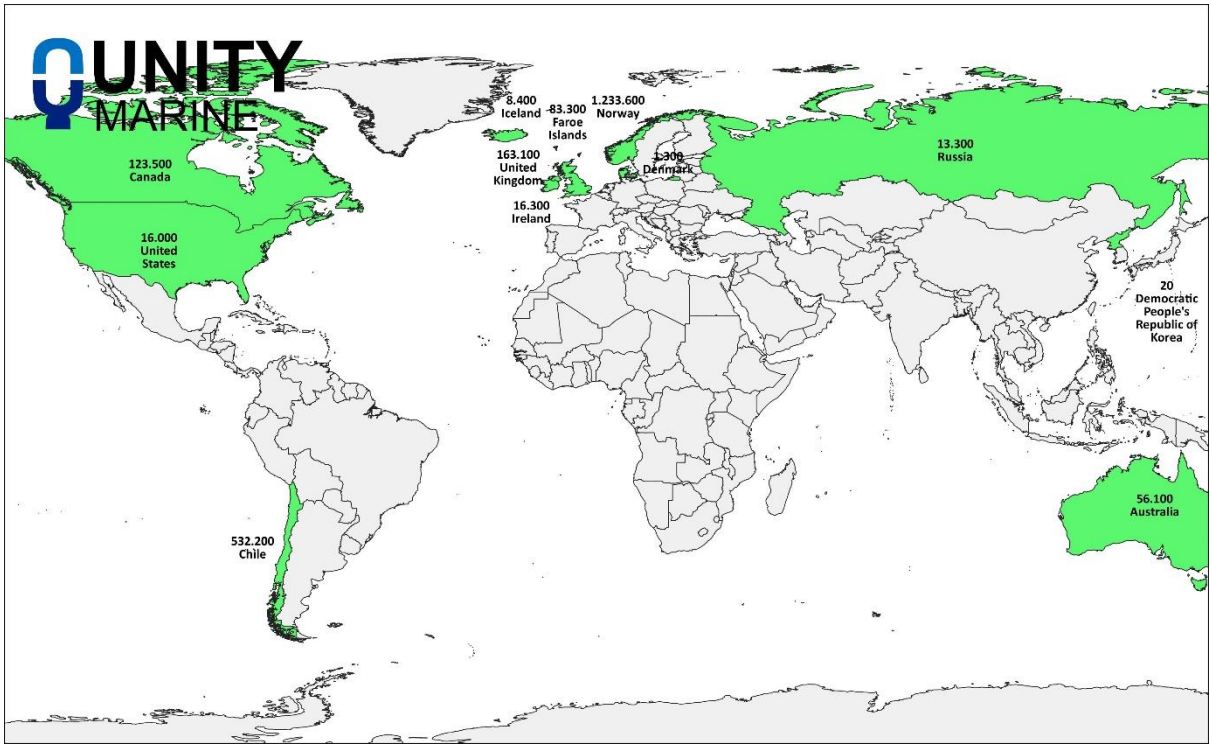


Figure 8: Atlantic salmon producing countries of the World, and the individual salmon production figures for each country respectively in 2016.

Based on initial analysis and evaluation, it is concluded that the general conditions on the Falkland Islands are ideal for Salmon farming. This is further supported by the existing aquaculture production of trout on the Islands and earlier trials on the Islands in the 1980'ies. During September 2018 site investigations was carried out in the waters surrounding East Falkland, where pre-defined areas were found to be suitable for the proposed activities. From the site surveys and from studying nautical charts of the Islands, it is the company's opinion that there are many potential sites in the inner Falkland waters.

The natural conditions on the Falkland Islands combined with the possibility of using Chile (an experienced salmon producing country) as a hub for easy transportation of feed, skilled labour and fish, makes the Falkland Islands very suitable for the suggested salmon farming activities.

5 Unity Marine Business Plan

5.1 Business Objective

Based on the attractiveness of the salmon market and the Falkland Islands suitability for salmon farming, the company suggest establishment of a salmon farming industry. Unity Marine has detailed a plan for the annual production of 50,000 tonnes, utilizing modern technology, best available practices meeting the highest of international standards, and global senior expertise in development and operation, with a relatively low labour footprint on the Falkland Islands. The Company will seek to be ASC certified and potentially completely avoid the use of antibiotics for the operation. This would allow Falkland Salmon to be distinguished to be best in class by reducing the potential environmental footprint of the operation.

The plan includes establishment of two land-based hatcheries including warehouse and workshop facilities, as well as twenty sea sites, with ten (10) net pens at each site. Feed will be shipped directly to the farming sites and processing of the fish is handled on processing ships.

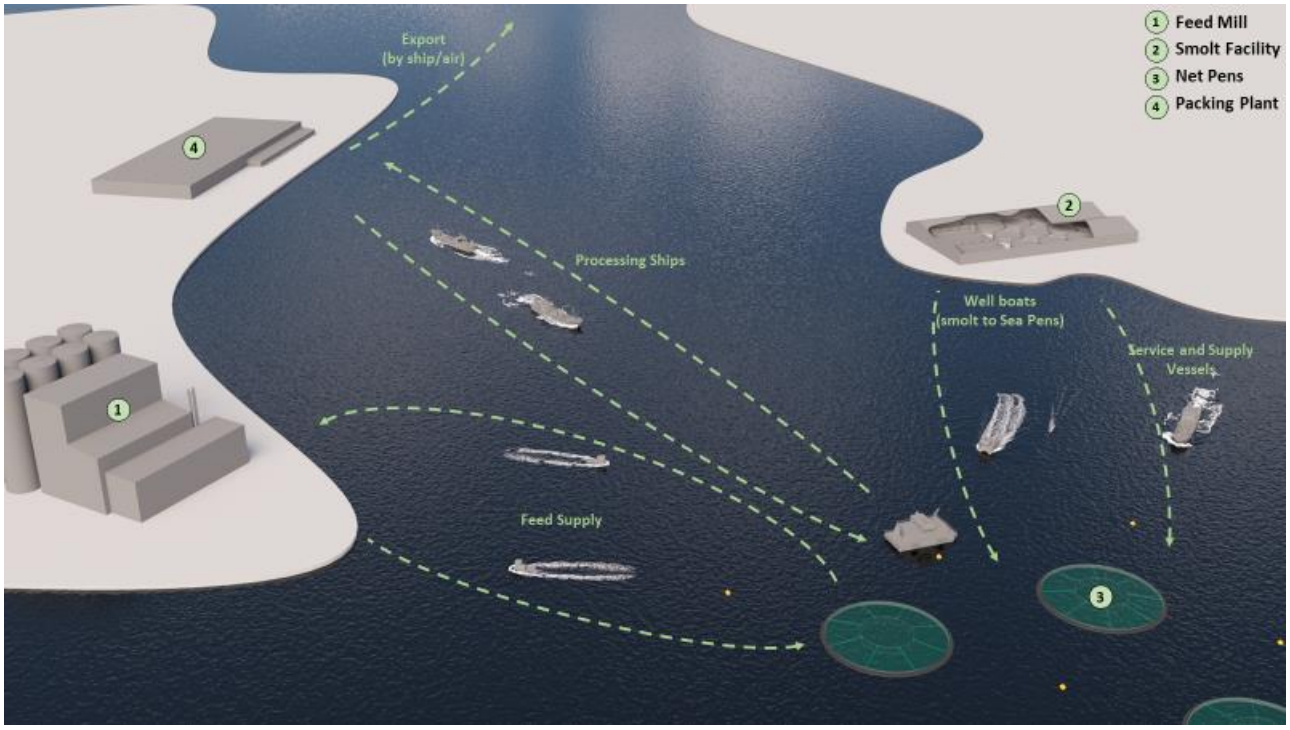


Figure 9 Principal Illustration of Unity Marine's planned operations

5.2 Development plan

The project will be implemented in four (4) phases to address the level of development through the project life cycle. There will be some overlap between some of the phases, with phase IIIb overlapping phase IV, as the first facilities will already be in operation, while the following are under development.

1. Phase I – Pre-study
2. Phase II – Design, Environmental Impact Assessment and Planning Permission

3. Phase III – Construction and installation
    a. IIIa Construction and Installation on East coast of East Falkland
    b. IIIb Construction and Installation on West coast of East Falkland
4. Phase IV - Operation

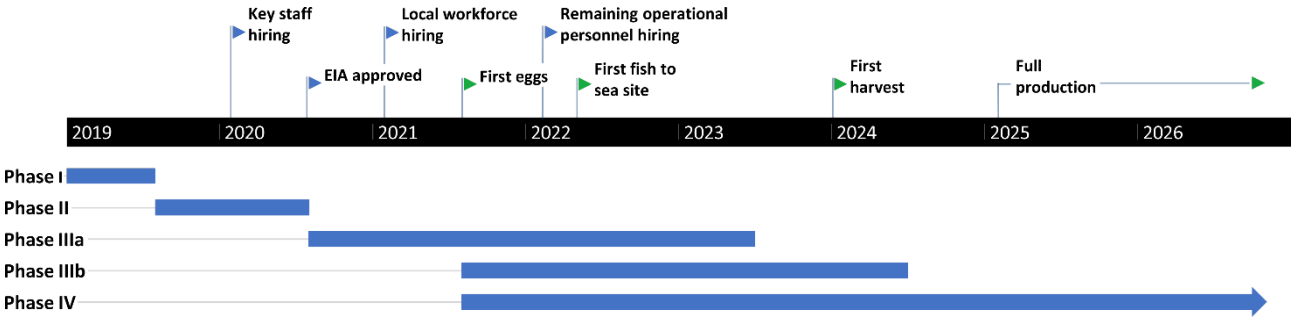


Figure 10: Proposed overall project schedule. The schedule details that the first eggs will be imported in August 2021 and the first harvest in 2023. The company will reach full production in 2025. A pre-requisite is that the construction of the first land-based hatchery is commenced in August 2020

5.3 Investment cost (CAPEX)

Development and establishment of a 50,000 Tonnes salmon business requires investments. First step is to make a solid definition and evaluation of the project, requiring a thorough pre-study report including specifications of the development and establishment, along with initial impact assessments. This is followed by an Assessment and Design phase, and finally the establishment and construction phase.

As visualised below, the investment follows the gradual development of the project, peaking in 2022 where the procurement and construction work is at its highest, with parallel activities at several sites.

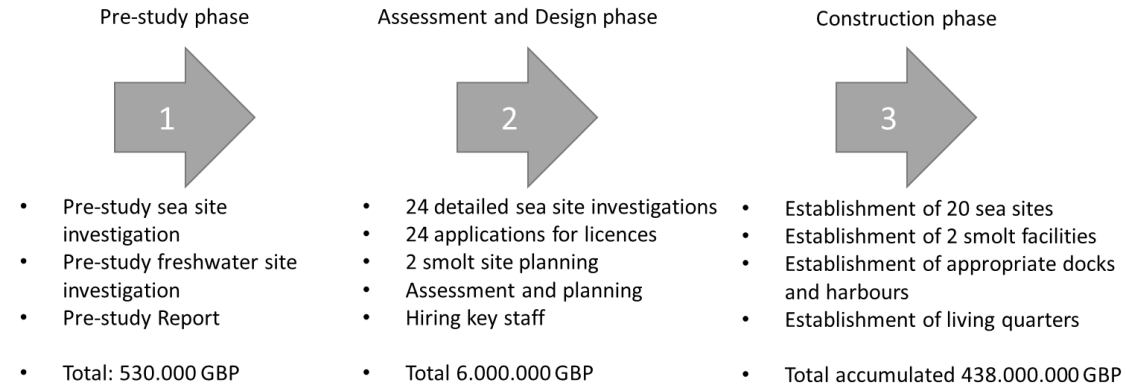


Figure 11: Investment in the development phases.

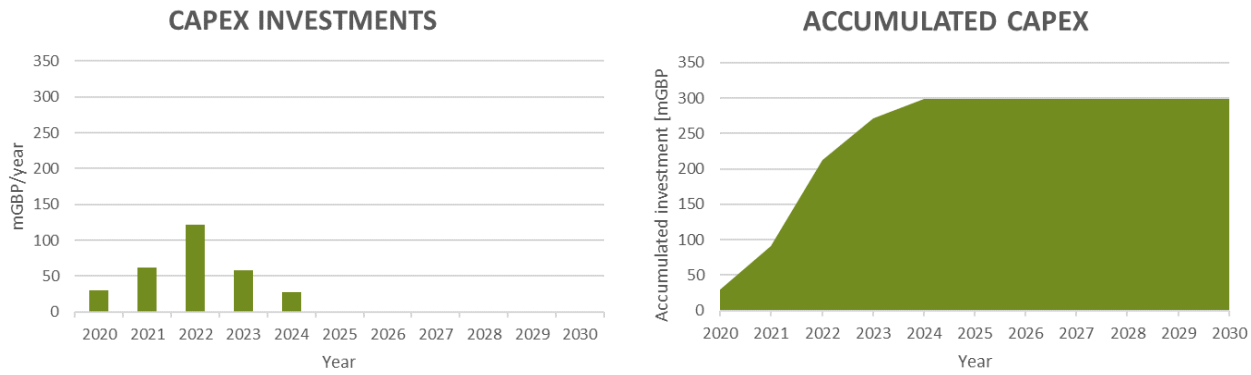


Figure 12: Expected CAPEX investments during the project.

5.4 Operational Cost and Revenues

The diagram below shows operational cost and revenues during development and operation. Establishment of an aquaculture business is generally characterized by investments in infrastructure and fish, followed by revenues and profit when the fish are harvested. The operational cost kicks in when the operational units are started up with all costs related to start up and operation. In Unity Marine's case, it means that the eggs procured in August 2021 will be harvested in late 2023.

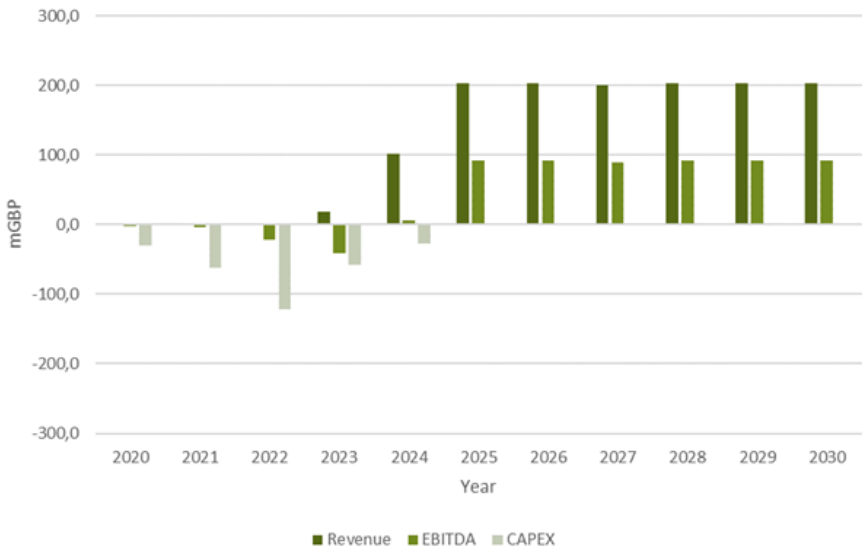


Figure 13: Investments, EBITDA and revenue.

5.4.1 Operational Cost

The operational cost covers all costs related to the farming, sales and harvest of fish. Direct costs among others include procurement of eggs that are hatched in the company's hatchery, transferred to the land-based rearing facilities, transport to the sea sites, feed, vaccines, consumables, oxygen, electricity, transportation, service and supply vessels.

In addition, comes costs not directly related to the production of fish, such offices and buildings, utilities, wages, legal fee, sales, insurance and marketing, etc.

As the fish are sold Heads On Gutted (HOG), with a HOG yield of 85%, the 50,000 tonnes annual live production of fish translate to 42,500 tonnes HOG sold product. The operating expenses (OPEX) is 35 NOK/kg HOG.

5.4.2 Sales and revenues

The production is planning so that the fish are continuously harvested, which results in a steady revenue stream. Sales of the fish will be done directly to major seafood processors, with the aim to close long-term agreements with one or two companies.

Unity Marine is currently in dialogue with companies willing to buy the entire production under the current plan. Unity Marine will receive signed expression of Interest (EOI) before the project enters the design and assessment phase.

The revenue forecast is based on a Unity Marine selling price of 52 NOK/4,68 GBP per kg HOG to the processing company. The processing company will pick up the fish at the sea sites, transport them to the packaging and transportation hub, where the fish are put on ice in boxes and distributed.

The revenues and consequently the profits are naturally sensitive to changes in the salmon price. The price impact on EBITDA is simulated below. The average salmon price in 2018 was 5,36 GBP.

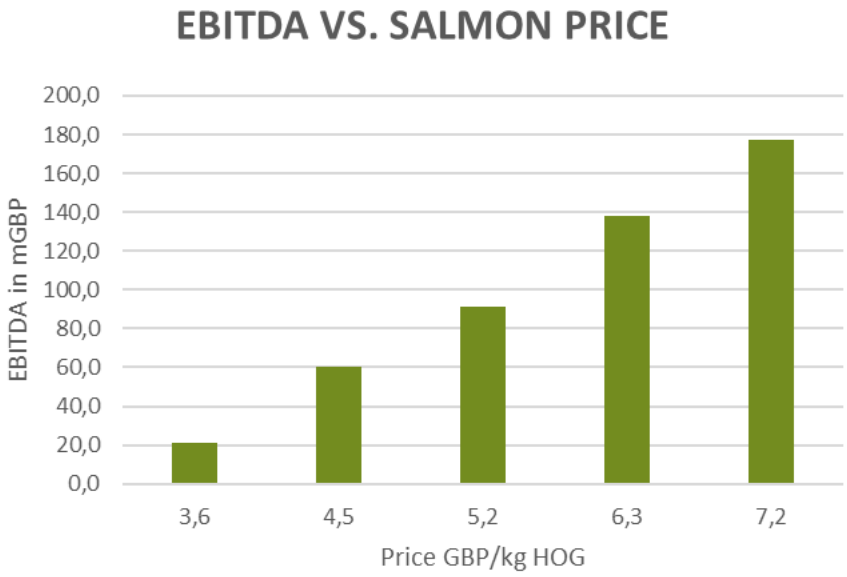


Figure 14: Salmon price impact on EBITDA simulation.

5.5 P&L

As with establishment of any aquaculture operation, significant investment in facilities, infrastructure and operational cost is required before gaining any revenues and profits. The first three (3) years are characterized by costs and no revenues, but significant growth in company value. When the fish have grown to harvest size, the revenues catches up relatively quickly, resulting in a positive net income in 2025.

Summary	Units	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenue	mGBP	0,0	0,0	0,0	17,9	101,1	202,5	202,5	200,7	202,5	202,5	202,5
OPEX	"	2,3	4,4	21,8	59,1	95,8	111,1	111,1	111,1	111,1	111,1	111,1
EBITDA	"	-2,3	-4,4	-21,8	-41,2	5,3	91,4	91,4	89,6	91,4	91,4	91,4
EBIT	"	-2,3	-5,7	-28,2	-51,8	-7,0	78,6	78,6	76,8	78,6	78,6	78,6
EBIT margin	%	n.a.	n.a.	n.a.	-290%	-7%	39%	39%	38%	39%	39%	39%
EBT	mGBP	-2,3	-6,9	-34,3	-63,9	-20,1	66,3	67,4	66,7	69,6	70,7	71,8
Net income	"	-2,3	-6,9	-34,3	-63,9	-20,1	66,3	65,8	49,4	51,5	52,3	53,1
CAPEX	"	-29,5	-61,4	-121,7	-58,4	-27,3	0,0	0,0	0,0	0,0	0,0	0,0
Net Cash Flow	"	20,8	11,8	3,6	5,3	-11,1	15,6	15,1	-1,4	0,8	1,6	2,4
Accumulated equity	"	27,1	67,7	146,7	205,3	221,1	221,1	221,1	221,1	221,1	221,1	221,1
Accumulated loan	"	27,1	67,7	146,7	205,3	213,4	195,0	176,6	158,2	139,7	121,3	102,9

Table 1: P&L Development in Unity Marine

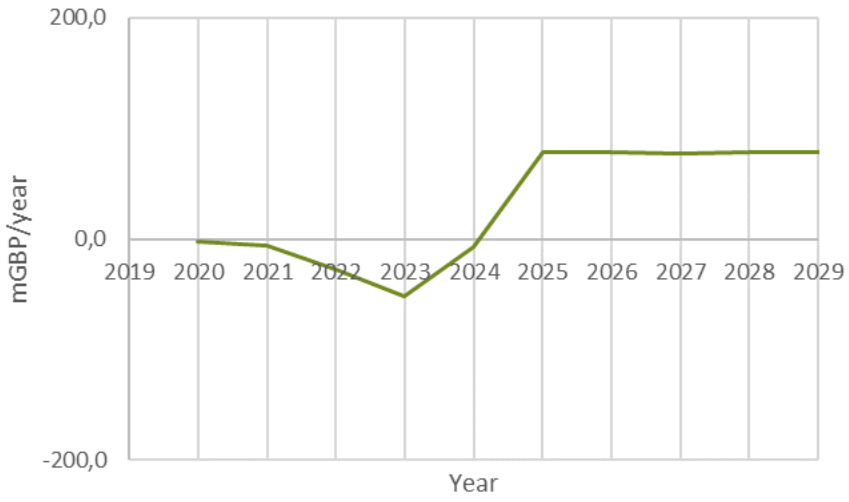


Figure 15: EBIT Development, with a positive result in 2025 at full production capacity

5.6 Cash Flow, ROI and payback time

The cash flow follows the general pattern described above. The negative operational and investment cash flow in the establishment and start-up phase is handled with equity and bank loans, followed by a positive operational cash flow when revenues catch up with the investments and operational costs. The first revenues are achieved in 2023 when the first fish are sold.

The project payback time is approximately 10 years, after which the profit exceeds the investments and operational start up costs. During this period, the company will invest in facilities and operational infrastructure, as well as fish stock, all representing a significant value, even before generating the first revenues and profit.

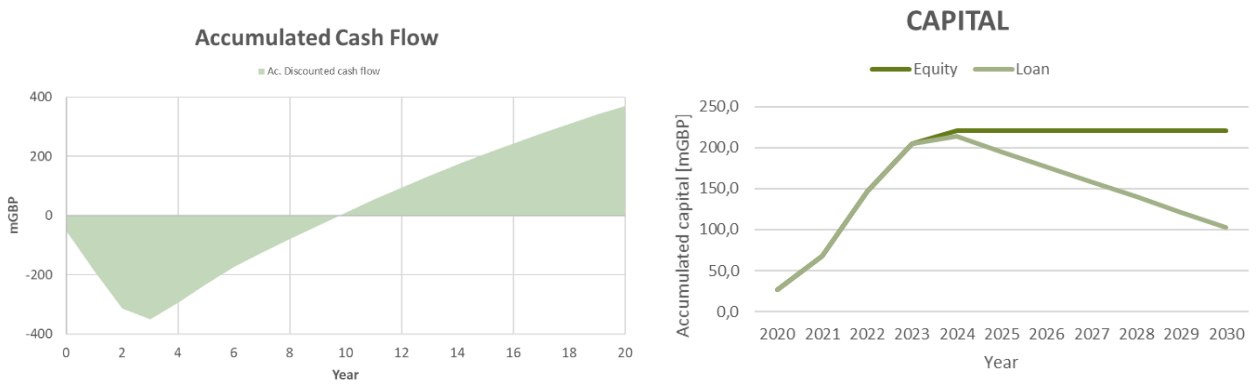


Figure 16 Project Payback Time

5.7 Funding

As described above, establishment of the operational units requires significant investments.

A local limited Falkland Island company has been established in joint venture with local businesses and investors under the name Unity Marine.

Unity Marine will ensure local ownership of minimum of 25.1%. This can be done by dividing the company ownership into “A” shares that can only be held by persons or companies with Falkland Island status. “B” shares are the principal share successive to further offerings during establishment of the company’s operations. The “B” shares will be attached with various rules and clauses in order to control the ultimate ownership. Other financial instruments may be appropriate as a supplement to ensure efficient control of the company’s owner structure.

In order to fully finance the project offering of new shares will take place before phase III of the project. “A” shares will have a pre-set pricing in order to ensure that investments from local partners can be reduced to an accessible level. The total funding of the project is 438 million GBP of which 219 million GBP will come from loan financing.

6 Risk Assessment

Experienced senior aquaculture people have been consulted in the pre-study phase. They have identified the following major risks, identified mitigation strategies and implemented these in the development, design and operational plans. During implementation the experienced management will continuously monitor development to ensure early identification of potential risks.

Risk	Impact	Mitigation Strategy
Delay of necessary permits to plan, construct and operate	Delayed start up Additional cost Delayed revenues and profit	• Local embedment of owner group • Extensive preliminary impact assessments • Local presence
Lack of skilled labour	Limited fish growth Increased mortality Loss of revenues	• International recruitment effort • Employee incentive programme • Scholarships for local children
Remote location of project	Construction delays Delayed start up Budget overrun Delayed revenues and profit	• Management team with extensive experience from similar projects • Prolonged and enhanced planning and assessment
Changes in global economy	Challenges with financing Increased financial cost	• Diversified investor group with focus on aquaculture industrial partners
Biological risk associated with introduction of pathogens	Mortality Production down time Loss of revenues	• Extensive veterinary control • Maintaining a “no farming zone” • Prophylactic use of vaccines
Damage to installations from extreme weather or predator attacks	Escape of fish Reduced revenues	• Installations certified under NS9415 • Use of predator safe nets • Use of triploid sterile salmon
Variations in global salmon prices	Increased/reduced revenue	• Vertical integration of company • Environmental branding of product • Diversification of customer base
Regional political instability	Changes in transportation routes Increased cost	• Continuous monitoring of the political situation • Secure alternative trade routes

Table 2 Risk Assessment

7 Appendix A: Figures

Figure 1: A growing population with an increased demand for fish, FAO 2016. 3

Figure 2: Fisheries and aquaculture production, FAO 2016. 3

Figure 3: FAO Global Fish Price Index. 4

Figure 4: World Salmon Market, 2017 numbers. 4

Figure 5: Production volume and growth in salmon aquaculture. 5

Figure 6: Development in salmon prices in NOK pr. Kg Heads On Gutted (HOG) and the prices of fresh and frozen salmon. 5

Figure 7: Typical salmon production chain. 6

Figure 8: Atlantic salmon producing countries of the World, and the individual salmon production figures for each country respectively in 2016. 7

Figure 9 Principal Illustration of Unity Marine's planned operations 8

Figure 10: Proposed overall project schedule. The schedule details that the first eggs will be imported in August 2021 and the first harvest in 2023. The company will reach full production in 2025. A pre-requisite is that the construction of the first land-based hatchery is commenced in August 2020 9

Figure 11: Investment in the development phases. 9

Figure 12: Expected CAPEX investments during the project. 10

Figure 13: Investments, EBITDA and revenue. 10

Figure 14: Salmon price impact on EBITDA simulation. 11

Figure 16: EBIT Development, with a positive result in 2025 at full production capacity 12

Figure 17 Project Payback Time 13



Unity Marine – Policy Considerations

APPENDIX O

1 Policy Considerations

This appendix contains considerations for the Falkland Island Government in terms of developing a robust legislative framework to secure minimal environmental impact, use of newest and best technology as well as means to secure economic development of the Falkland Islands. The recommendations relate to:

1. Robust protection of the Falkland Islands marine environment
2. Ensure that the exploitation of Falkland Island natural resources provides permanent and long-lasting economic development on the Islands
3. Minimize bureaucratic burden of government work in terms of administering the area

It is important to state that these considerations are Unity Marine's recommendations. Unity Marine is by default a non-objective part in these matters. The company therefore suggests that an independent third party is consulted. British government institutions like the Scottish Environmental Protection Agency (SEPA) could also provide guidance and experience within aquaculture legislation.

1.1 Regulation of licenses

The regulation of the industry typically includes set limits for production at each given license. The license is typically attached to a specific production site but can in some less developed regulated areas be non-site specific.

The license size is usually based on one of the following parameters:

- Maximum allowable biomass
- Discharge of nutrients
- Feed usage
- Maximum yearly production

Norway is working with a maximum allowable biomass at each site. Scotland has a maximum allowable biomass coupled with other prerequisites like efficient feed use. Maximum allowable biomass regulation allows for aggressive production planning where sites are always at peak capacity. It usually results in movement of fish between sites and staggered batch production (more than one generation on each site).

Nutrient loading in the inner Danish waters are high due to runoffs from intensive farming and discharges from all the countries surrounding the Baltic, that has to pass Danish waters on their way to the North Sea. Therefore, Denmark has set rules for maximum allowable Nitrogen, Phosphorous and BOD discharge from each site. The perceived discharge of nutrients is based on modelling of feed use, feed composition, Feed Conversion Rate (FCR), growth and other parameters, that basically transfers into a yearly allowable feed usage.

1.1.1 Recommendation

The Company suggests that the industry should be regulated by applying a set limit on the maximum allowed feed in a given year on each site. The amount of feed can be used to approximate the

amount of nutrients that is discharged from a site. This would allow the Company to explore possibilities for reducing feeding to obtain the same or better growth on the same amount of feed, thus reducing the footprint of the production. It will also allow for easy controlling from FIG as all feed is imported and thus have to be declared in customs. Data on specific feeding at each site will also be available from the control system installed at each site and will be made available to the regulating government body.

It is also suggested to set a minimum fallowing period of sea-based sites by law. This will allow for regeneration of the sea bed and will at the same time reduce the risk of spreading potential pathogens between batches. The operating company should document that the fallowing is carried out according to the rules.

A set minimum compliance level for e.g. ASC or another international certification could also be a prerequisite for obtaining licenses.

The Company therefore suggests that FIG includes the following provisions in future legislation:

1. Introduce a minimum fallowing period in between batches on each site e.g. three (3) months
2. Every fish farming license should be accompanied by a maximum allowable yearly feed amount
    a. Feed amount can be regulated based on concrete environmental data collected through each production run
3. Make compliance with best industry standards like ASC or NS:9415 a pre-requisite for obtaining licenses

It could also be considered to partly outsource some of the controlling to a third-party accredited company that could monitor:

1. Compliance with NS:9415
2. Compliance with international standard e.g. Aquaculture Stewardship Council (ASC) or whichever is considered best practice in the future

FIG should pre-qualify external companies that they trust to do the accrediting, the service should however be paid by the operating company.

Finally, it is suggested that a certain minimum operational and environmental transparency is expected by any salmon aquaculture company by law. Any company operating a fish farm in Falkland Islands waters should therefore be expected to disclose at least the following parameters:

1. Production numbers
    a. Monthly biomass reports for each site
    b. Monthly feed usage for each site
    c. Harvest reports
2. Potential environmental impacts
    a. Reporting of administered feed on the individual sites on a monthly basis
    b. Disclosing of benthic sample compliancy with set rules
    c. Public reporting of escape incidents, if any
    d. Potential wildlife mortalities, if any

3. Environmental monitoring
    a. Temperature at each site
    b. Water oxygen content on each site
    c. Water chlorophyll content on each site
4. Pathogens
    a. Report any encountered pathogen infections
    b. Report any use of treatments to counter potential pathogen infections
5. Health and safety (HSE)
    a. Public reports of accidents
6. Socio-Economic
    a. Report number of employees employed locally and abroad at any given time

An example of a similar reporting tool is Huon Aquacultures "Environmental Dashboard" that currently is providing the most detailed insight into any industry operation globally. The dashboard can be seen here https://dashboard.huonaqua.com.au/. If the level of transparency indicated above is set out as law in the Falkland Islands, then the Islands will become the global leader on aquaculture operation transparency, potentially setting the future standard in other farming countries.

1.2 NS 9415:2009

The Norwegian technical standard NS 9415:2004 was implemented through Norwegian legislation on the 1st of April, 2004. The standard introduced technical standards for marine fish farms in Norway. NS 9415 specifies requirements for the design of equipment at sea sites more specifically; feed barges, net pens, floating collars and mooring systems to ensure the equipment can withstand environmental forces as well as the handling and use of the equipment through daily operations. All equipment must be independently certified against the standard. To ensure all existing fish farms met the requirements of NS 9415, independently accredited companies conducted technical analysis of equipment being used. Farms would, if they were found to be proven capable, receive a certificate of operation for three (3) years. The certificate could be reissued repeatedly until 2012.

After 2012 all main components of a marine fish farm site had to be certified. NS 9415 went through a revision in 2009 which resulted in significant changes and improvements. The standard is hereafter referred to as NS 9415:2009.

Norway was used a case study by Jensen et al. (2010)[1] to describe the development and implementation of measures to reduce Atlantic Salmon escape. Correlative evidence suggests that NS 9415 led to a decline in yearly salmon escapes from more than 600,000 fish per year in 2001-2006 to less than 200,000 fish per year in 2007-2009. This reduction was reached despite an increase in production of 44% during the study period. The number of escapes has been consistently low since the study period with a maximum of approximately 370,000 in 2011 and a minimum of 10,000 in 2017[2].

[1] Escapes of fishes from Norwegian sea-cage aquaculture: causes, consequences and prevention, Jensen et al. 2010

[2] Årsrapport 2017, Fiskerdirektoratet, Norway 2018

NS 9415:2009 is currently considered the most robust standard regarding the design and operation of marine sea sites in the world.

1.2.1 Recommendation

The company recommends the following regarding NS 9415 in the Falkland Islands:

1. NS 9415 certification is added as a pre-requisite for obtaining a Fish Farming License in Falkland Islands waters
2. Any company operating a Marine Fish Farm must obtain third party certification from an independent accredited company that they follow the guidelines set out in NS 9415
3. The fish farming ordinance should state that it is always the newest version of NS 9415 that should be followed (currently NS 9415:2009)

If these three (3) points are followed it would allow FIG to set the best available practices standard in terms of the structural design and operation of the sea sites. As the company operating would need to seek certification from an independent accredited third party it would also allow for a minimum of handling by government officials.

1.3 Aquaculture Stewardship Council

There are a number of international standards of which the Aquaculture Stewardship Council (ASC) (co-founded by the WWF) is currently considered best practice. There is a separate Salmon standard developed under ASC.[3]

ASC set standards for the salmon farms in order to minimise impacts on the local ecosystem in a number of ways, such as the development and implementation of an impact assessment to protect birds, marine mammals and sensitive habitats, protection of the ecological quality of the seabed, ensuring farms are not sited in High Conservation Value Areas (HCVA) and minimising fish escapes to an absolute minimum. All lethal incidents with wildlife must be made publicly available.

ASC certification requires salmon farms to adhere to strict limits to minimise the use of wild fish as an ingredient for feed. In addition, the standard requires farms to ensure full traceability back to a responsibly managed source, preferably certified, both for wild fish and soy.

ASC certified salmon farms are required to measure various water parameters (phosphorus, oxygen levels, etc.) at regular intervals and remain within set limits. Responsible farming can only take place in water bodies that are classified as ‘good’ or ‘very good’ (e.g. by the EU Water Framework Directive). Copper release into the water must also be minimised and monitored.

ASC certified salmon farms are required to adhere to rigorous requirements to minimise disease outbreaks. In doing so, they must also cooperate with other farmers operating in the same area. A Fish Health Management Plan detailing steps for biosecurity management must be developed under supervision of a veterinarian and implemented on the farm. In addition, the farms need to adhere to low levels of parasites (especially sea lice) and can only use certain medicines under very strict conditions. The use of medicine before a disease is diagnosed (prophylactic use), is prohibited.

[3] https://www.asc-aqua.org/wp-content/uploads/2017/07/ASC-Salmon-Standard_v1.1.pdf

Producers need to manage farms in such a way that salmon survival rate is high. Instances of unexplained increased mortality, as well as sea lice counts are required to be publicly available.

ASC certification imposes strict requirements based on the core principles of the International Labour Organisation (ILO), these include prohibiting the use of child labour or any form of forced labour. All ASC certified farms are safe and equitable working environments where employees earn a decent wage and have regulated working hours.

1.3.1 Recommendation

The Company recommends the following regarding ASC certification or similar standard in the Falkland Islands:

1. ASC certification or future similar standard is added as a pre-requisite for obtaining a Fish Farming License in Falkland Islands waters
2. Any company operating a Marine Fish Farm must obtain third party certification from an independent accredited company that they follow the guidelines set out in ASC

If these two (2) points are followed it would allow FIG to set the best available practices standard in terms of the environmental standards for operation. As the company operating would need to seek certification from an independent accredited third party it would also allow for a minimum of handling by government officials.

1.4 Resource Tax

The fish farming licence has provisions for future incorporation of a royalty on aquaculture licence holders. There is however no mention of the size or nature of such royalty. The Falkland Islands are applying a fishing licence royalty to all vessels operating in Falkland Islands waters. The license tax is currently providing approximately a third of all FIG income. The Company feels it is natural that a royalty for operating an aquaculture industry in Falkland Island waters should likewise be considered.

The royalty or user fee structure is different from country to country. In Canada an aquaculture licence holder must pay a one-time fee of 108 CAD to obtain the license and an additional yearly fee of 2.65 CAD per allowed tonnes of biomass in the license[4]. The current crown estate lease is 27.5 GBP/ net gutted tonnes (of salmon) of production in Scotland[5]. In Scotland the lease scales with market price from year to year. There is currently no annual fee for operating in Norway, but companies pay a one-off price for a license.

In other countries like Denmark and the Faroe Islands there is no fee applied for obtaining a licence or operating a fish farm.

[4] https://www.pac.dfo-mpo.gc.ca/aquaculture/licence-permis/index-eng.html
[5] https://www.crownestatescotland.com/what-we-do/marine/asset/aquaculture

1.4.1 Recommendation

It is recommended that FIG and the Company enters into good faith negotiations of a royalty or resource tax that:

1. Provides FIG direct income for the rights to operate Fish Farming operation on the Islands
2. Provides FIG with a yearly income and not a onetime start-up fee
3. Sets the royalty at a level that does not restrict local aquaculture companies in the global competition
4. Provides security for the aquaculture industry on the Falkland Islands in periods with low market prices
5. Is based on sales/ harvest to enable the industry to establish itself on the Islands

It is therefore suggested that the royalty should be dependent on the world market price of Atlantic Salmon, so it directly reflects the current value of the exploited resource, as it is also the case in Scotland. This would both ensure high royalties in periods with high market prices and a protection of the local industry in periods with slump in global demand.

It is also recommended that the royalty should follow the harvest and subsequent sale of the product and not be set as a yearly operating fee for holding licenses. This would enable the industry to establish itself and not pay a royalty before the first fish are harvested.

It is strongly recommended that the Falkland Islands does not apply the Norwegian one-time license fee system, as the pricing of the licenses with the current aquaculture infrastructure will be low. It will also not allow FIG to secure royalties for the future generations of Falkland Islanders.