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Memo

Date:	October 2, 2018
To:	Nordic Aquafarms
From:	Nathan Dill, P.E.
Subject:	Far-field Dilution of Proposed discharge

This memorandum provides a summary of the estimated far-field plume behavior and dilution of wastewater discharge from the proposed Nordic Aquafarms Recirculating Aquaculture System (RAS) into Belfast Bay, Maine. Far-field transport, dispersion, and dilution of the RAS wastewater has been investigated through a combination of two-dimensional hydrodynamic modeling with the ADvanced CIRCulation Model (ADCIRC)[1] and numerical particle tracking with the Maureparticle[2] particle tracking model. Initial near-field dilution of the discharge was investigated with the Cornell Mixing Zone Expert system (CORMIX) model and is described in a separate memorandum[3].

FAR-FIELD DILUTION APPROACH

Near-field dilution modeling performed with CORMIX assumes a steady-state for the RAS wastewater discharge and ambient conditions. In tidal environments where the ambient current may change significantly within a few hours, the steady-state assumption is only valid for near-field mixing processes on relatively short time scales (e.g. less than an hour or so). Furthermore, the near-field modeling with the steady-state assumption may overestimate long-term dilution because it does not consider the potential for recirculation of the discharge plume with tidal reversals. For example, a plume that develops during an ebbing tide may reverse direction and travel past the outfall during the following flood tide, effectively increasing the background concentration of wastewater constituents. Over many tidal cycles the background concentration achieves a dynamic equilibrium condition where the rate of wastewater discharge is in balance with the flushing characteristics of the receiving waterbody and dispersion of the plume. To better understand far-field behavior of the wastewater plume, a two-dimensional hydrodynamic

[1] Luettich, R.A., J.J. Westering, N.W.Scheffner, 1992. "ADCIRC: An Advanced Three-Dimensional Circulation Model for Shelves, Coasts, and Estuaries, Report 1, Theory and Methodology of ADCIRC-2DDI and ADCIRC-3DL". Technical Report DRP-92-6, Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station

[2] Dill, N. L., 2007. "Hydrodynamic modeling of a hypothetical river diversion near Empire, Louisiana". LSU Master's Theses. 660. https://digitalcommons.lsu.edu/gradschool_theses/660

[3] Ransom Consulting, 2018. Near-field Dilution of Proposed Discharge Update, Memorandum to Nordic Aquafarms, September 17, 2018.

modeling and particle tracking approach is employed. A numerical hydrodynamic model is used to estimate time-dependent and spatially variable depth averaged currents. The current velocity field from the hydrodynamic model is then used to drive a particle tracking model that is in turn applied to estimate dilution and concentrations.

TWO-DIMENSIONAL HYDRODYNAMIC MODELING

An existing ADCIRC model, previously developed by Ransom[4], has been used to simulate tidal circulation in Belfast Bay to aid in evaluation of the far-field behavior of the effluent plume. ADCIRC is a state-of-the-art numerical model that solves the Generalized Wave Continuity Equation (GWCE) form of the Shallow Water Equations (SWE). The SWE are set of mathematical equations that govern the motion of fluid in the ocean and coastal areas through laws of conserved mass and momentum. ADCIRC employs the finite element method on an unstructured triangular computational grid that allows for high spatial resolution in coastal areas. ADCIRC's capabilities include simulation of water level and current velocity driven by astronomical tides, and wind and atmospheric pressure. ADCIRC has been applied in the 2-Dimensional Depth Integrated (2DDI) mode and has been forced with astronomic tides on the open ocean boundary and 280 cubic meters per second inflow at the Penobscot River Boundary. No wind forcing was included in the model simulation for this effort, which is generally considered to be conservative with respect to mixing processes. Figure 1 shows the extent of the model domain and inset detail of the model's triangular unstructured grid near the proposed outfall location.

ADCIRC Model Validation

The ADCIRC model was used to simulate tides during the period from June 20, 1999 to August 4, 1999 to provide a representative data set of tidal current velocities for this effort. This time period was selected because water level observations are available at the nearby National Oceanic and Atmospheric Administration National Ocean Service (NOAA NOS) station at Fort Point, Maine. The relative location of the Fort Point tide station and proposed outfall location is shown in Figure 2. A comparison of observed water levels to modeled water levels at the Fort Point Station is shown in Figure 3. In addition, a comparison of modeled water levels to harmonically predicted high and low tides at the subordinate NOS tide station at Belfast is shown in Figure 4. Visual inspection of the water level time series suggests good agreement between model results and observations. Although specific observations of tidal currents are not available in the vicinity of the proposed outfall location, the simulation of accurate water levels suggests that depth averaged current velocities are reasonable.

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[4] Ransom Consulting, Inc. 2017. Present and Future Vulnerability to Coastal Flooding at Grindle Point and the Narrows. Report prepared for the Town of Islesboro, Maine, August 21, 2017.

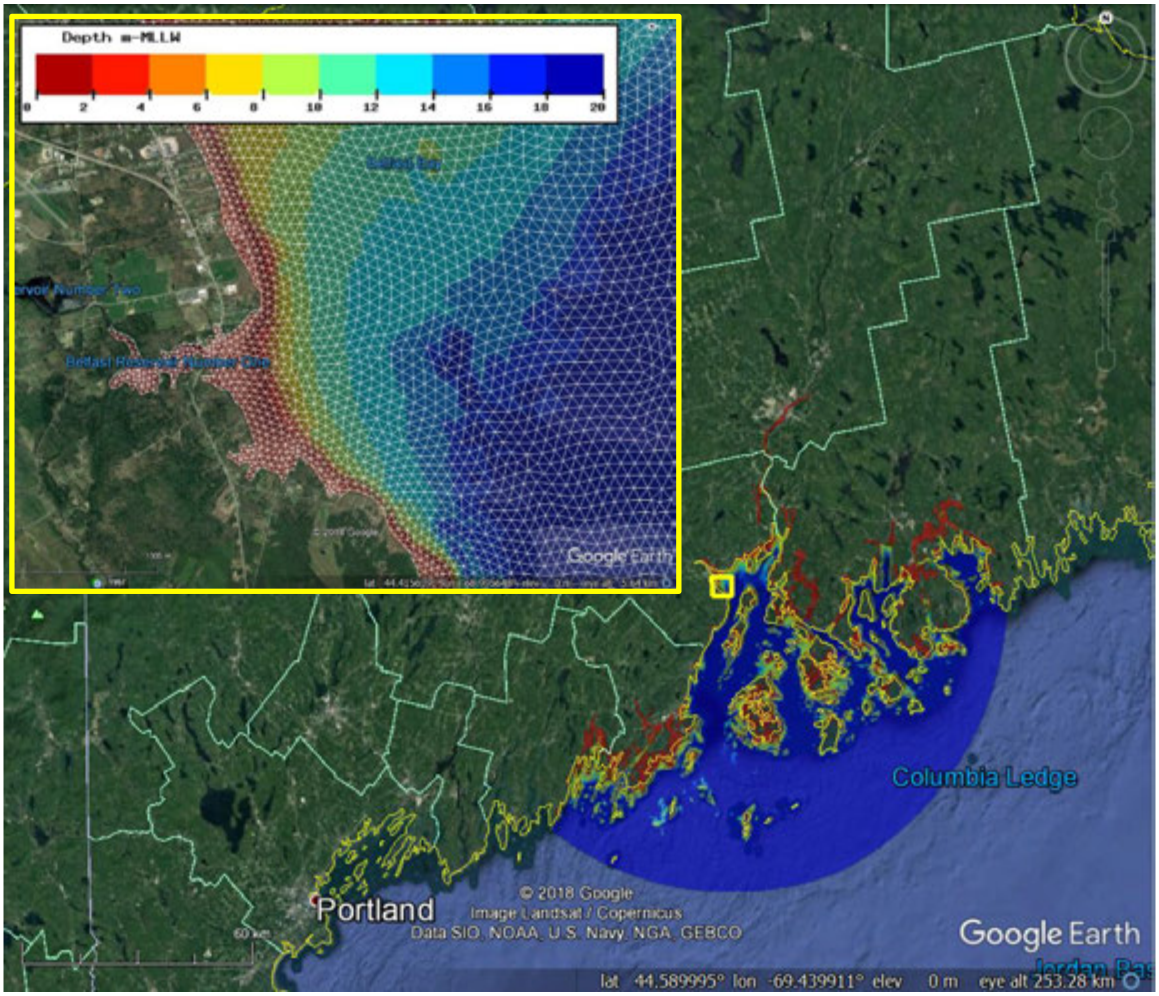

Figure 1. Penobscot Bay ADCIRC model domain and detail in Belfast Bay.

Figure 2. Location of NOAA NOS stations at Belfast (8415191) and Fort Point (8414721), and approximate location of proposed outfall.

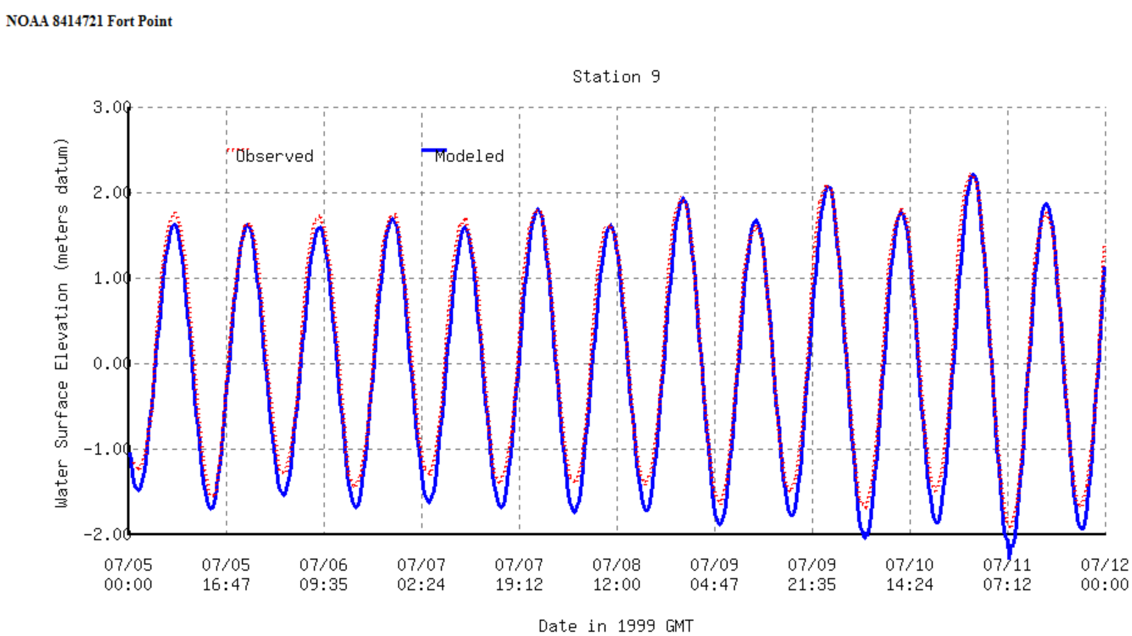

Figure 3. Comparison of modeled water level and observed hourly water level at NOS station 8414712 at Fort Point, Maine during a portion of the simulation period.

NOAA 8415191 Belfast

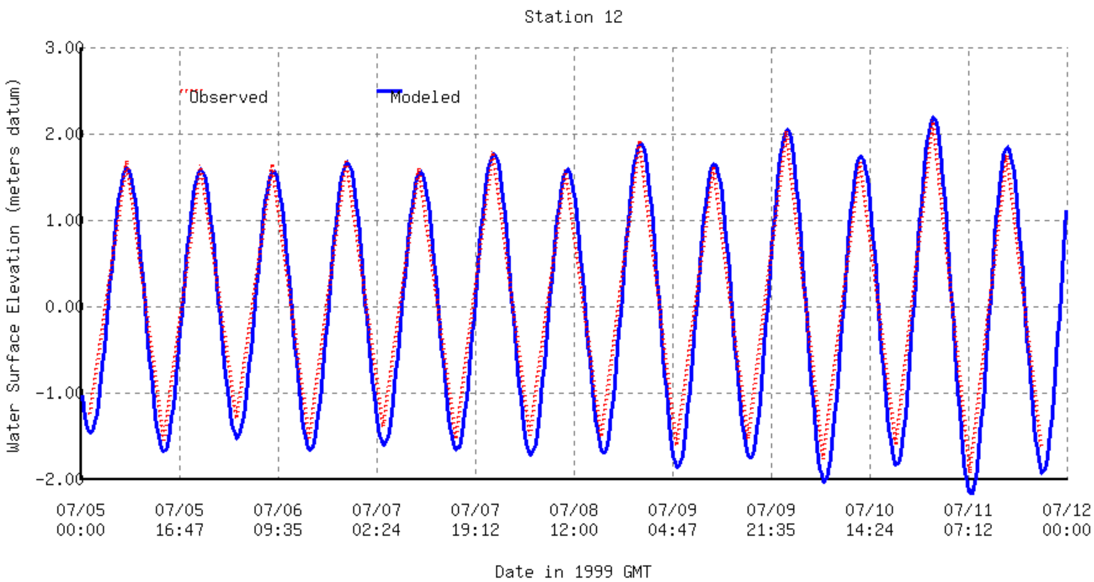

Figure 4. Comparison of modeled water level and harmonically predicted high-low tide data at NOS station 8415191 at Belfast, Maine during a portion of the simulation period.

PARTICLE TRACKING FAR-FIELD DILUTION

The particle tracking model was run with the following configuration and assumptions:

- Particles are released at a constant rate from the outfall location. Initial particle locations were randomly generated along a 50-meter line that extends east from -68.972526 degrees Longitude and 44.395004 degrees latitude. This release configuration is consistent with effluent discharge and initial dilution from the multi-port diffuser considered in the CORMIX modeling.
- Particles are released at a rate of 1 per 30 seconds over a period of 28 days, resulting in a total of 80640 particles that are tracked during the simulation.
- An effluent flow rate of 0.338 m^3/s is assumed such that each particle represents the mass of effluent constituents (e.g. Total Nitrogen) contained within 10 m^3 of effluent.
- A horizontal eddy diffusivity of 2 m^2/s is simulated through random walk displacement.
- Particles are tracked using the 2nd order Runge-Kutta method to integrate the dynamic depth averaged current velocity field.
- For dilution calculations it is assumed that the plume will become well mixed within upper portion of the water column in far-field timescales, which is assumed to have a 10-meter thickness. This assumption is reasonable during stratified conditions in the warmer seasons of the year, and conservative during winter months when CORMIX predicts full vertical mixing.
- Dilution is calculated by counting the number of particles within each model grid element and dividing the effluent volume associated with the particles by the sum of ambient volume in the upper layer and effluent volume within grid element.

- Effluent Concentrations may be calculated using the following equation using initial and background concentrations listed in Table 1; where *C* is the concentration corresponding to dilution, *S*. *Cs* is the background concentration, and *Cd* is the effluent concentration[5].

$$C = Cs + \frac{1}{S}(Cd - Cs)$$

- The effects of wind and/or waves on the mixing and current velocity field is neglected. Winds and waves tend to enhance turbulence, increasing mixing and dilution. Neglecting the effect of wind and waves tends to produce conservative estimates of dilution and plume concentrations.
- No uptake or decay of nutrients is considered, which is also considered to be conservative, as some level of uptake or decay is likely.

Table 1. Effluent Concentrations for proposed discharge and background concentrations.

	Total Suspended Solids (TSS)	**Biochemical Oxygen Demand (BOD)**	**Total Nitrogen (TN)**	**Ammonium Nitrogen (NH_4)**	**Phosphorus (P)**
Daily Discharge (kg)	185	162	673	0.07	5.8
Concentration (mg/l)	6.33	5.55	23.02	0.0024	0.20
Assumed Background Concentration (mg/l)	17	2.0	0.17†±	0.075†	0.013

†Not detected at the reporting limit for all samples
±Background concentration as per communication with MEDEP

RESULTS AND DISCUSSION

Dilution of the proposed RAS wastewater was determined at hourly intervals throughout the 28-day particle tracking simulation. Visualization of the model results show that after approximately 14 days of continuous release a dynamic equilibrium condition is reached where the rate of discharge is effectively balanced by diffusion and dispersion rates. Figure 5 shows a sequence of snapshots of the base 10 logarithm of the dilution throughout a typical tidal cycle near the end of the particle tracking simulation after the plume has had sufficient time to reach a dynamic equilibrium state. Although it varies somewhat throughout the tidal cycle and with neap and spring tidal phases, the minimum dilution near the center of the plume is approximately 30. The maximum dilution shown in the figure is approximately 300 at the edge of the colored area shown in Figure 5. Outside this area the dilution is greater. The dilution results may be used to estimate the concentration of RAS wastewater constituents using the above equation given effluent and background concentrations.

[5] Fischer, H.B., E.J. List, R.C.Y. Koh, J.Imberger, N.H.Brooks,. 1979. Mixing in Inland and Coastal Waters. Academic Press Inc., New York, NY. 483 p.

It is our understanding from communication with Maine DEP that there are no specific regulatory criteria for nutrient concentrations in Belfast Bay. However, recent investigations in the Great Bay Estuary by the New Hampshire Department of Environmental Services (NHDES) suggest that nitrogen may act as a limiting nutrient with respect to undesirable macroalgae and phytoplankton growth. NHDES also found correlation between nitrogen and dissolved oxygen concentrations suggesting a threshold above which nitrogen concentrations may lead to hypoxic conditions. Data from the Great Bay suggest that median total N concentrations should be less than 0.34-0.38 mg/l to prevent the replacement of eelgrass habitat with macroalgae growth. Furthermore, correlation of median total N concentrations with dissolved oxygen measurement suggests that total N should be less than or equal to 0.45 mg/l to prevent hypoxic conditions with dissolved oxygen concentrations less than 5 mg/l[6]. Although characteristics of the Great Bay Estuary are different than the Belfast Bay - with respect to temperature, freshwater input, tidal prism, and stratification, for example – the Great Bay criteria may be considered as guidance in the absence of specific criteria for Belfast Bay.

The State of Maine has identified two locations near the proposed outfall location where eelgrass beds are present. The location of eelgrass beds, the proposed outfall, and the median total N concentration are shown in Figure 6. The median total N concentration was determined by calculating total N concentration from hourly dilution snapshots over the final 14 days of the simulations. Values for each snapshot were then rank ordered and the 50th percentile was taken as the median.

Overall, the results indicate that the eelgrass beds will not be impacted by concentration greater than 0.3 mg/l and that the bay will not generally be exposed to total N concentrations greater than about 0.4 mg/l. However, it is important to understand that the model results are only an approximation based on numerous simplifying assumptions listed above. Actual conditions may vary from these assumptions such that actual concentrations are different than predicted. For the most part, conservative assumptions have been made so that the predicted concentrations will tend to be greater than concentrations influenced by real world conditions. For example, the model neglects the effects of wind and waves on the current velocity and mixing. These effects would tend to increase turbulence leading to increased diffusion and dispersion of the plume, and the reduce concentrations. Also, real world conditions will lead to uptake and decay of nutrients, which would tend to reduce concentrations compared to the model results where no decay has been assumed.

The information presented here is based entirely upon numerical modeling with limited knowledge of the in-situ conditions at the proposed outfall site. It is important to understand that hydrodynamic modeling is not an exact science. As such, any predictions presented here should be considered only as estimates of the proposed dilution and plume behavior. Numerous assumptions and simplifications have been made in this analysis, which contribute to significant uncertainty in the modeling results. In general, these simplifications and assumptions are reasonably conservative, such that errors would tend to over-predict negative impacts. However, it is possible that predictive error could under-estimate impacts. Thus, it is recommended that a

[6] New Hampshire Department of Environmental Services. 2009. Numeric Nutrient Criteria for the Great Bay Estuary. Prepared by Philip Trowbridge, P.E., June 2009. 73 pages.

field data collection program be designed and implemented to provide site specific data for further analysis, and to validate the accuracy of model results.

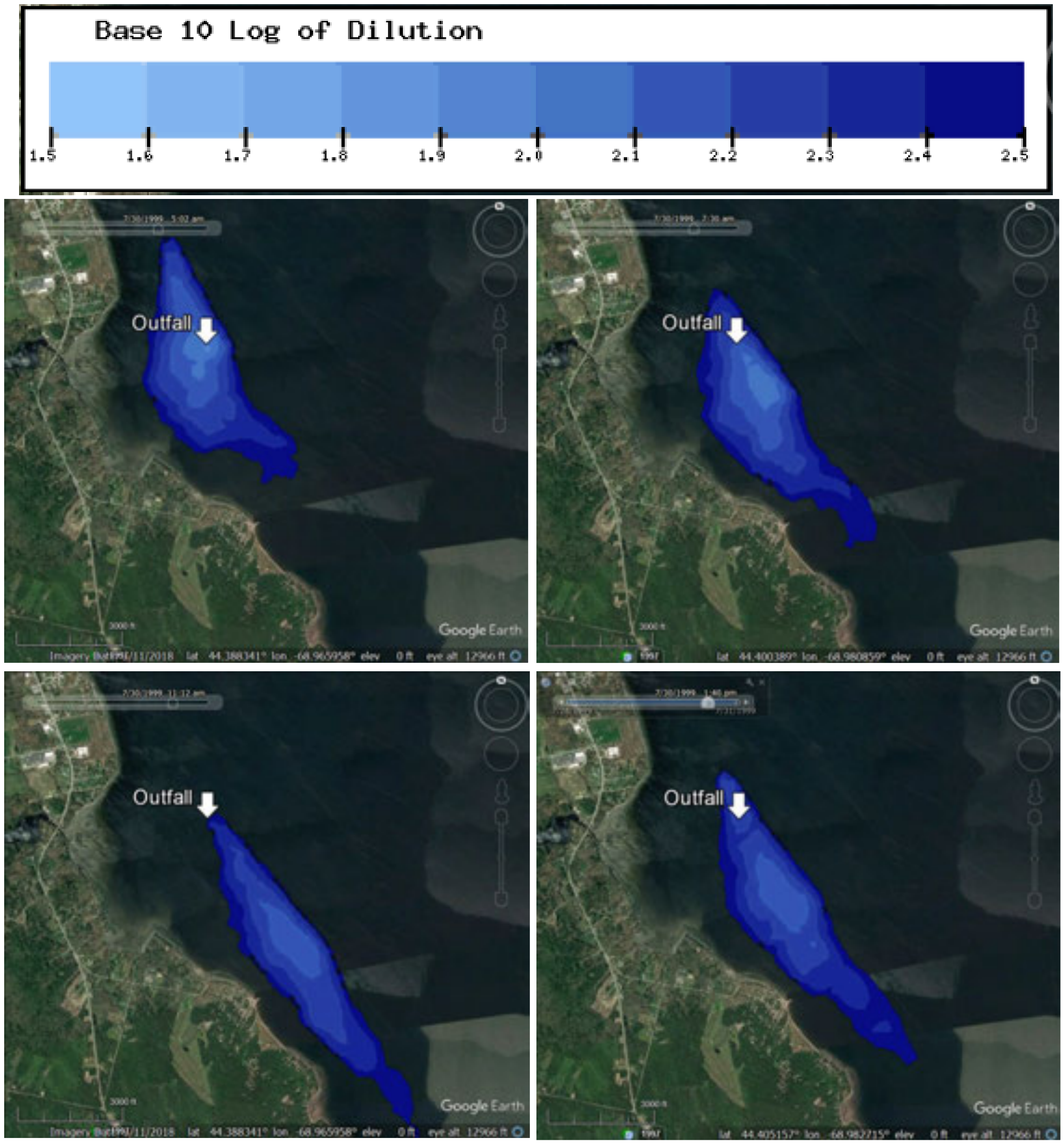

Figure 5. Snapshots of plume dilution throughout a typical tidal cycle. high slack (upper left), mid-ebb (upper right), low slack (lower left), mid-flood (lower right).

Figure 6. Time Averaged Median Total Nitrogen Concentration

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Memo

Date:	November 3, 2019
To:	Nordic Aquafarms
From:	Nathan Dill, P.E.
Subject:	Far-field Dilution of Proposed Discharge – Supplemental Information

This memorandum is being provided as a supplement to our memorandum dated October 2, 2018 regarding far-field dilution analysis of the proposed Recirculating Aquaculture System (RAS) wastewater discharge into Belfast Bay. Our October 2, 2018 memorandum provides a description of the technical approach used to evaluate far-field mixing and dilution and provides estimates of the spatial and temporal distribution of the dilution resulting from a continuous discharge during typical tidal conditions.

This memorandum expands on the previous analysis by evaluating dilution characteristics while also considering how long the diluted effluent has been present in the bay after it's discharge. Consideration of diluted effluent age in this way may help provide insight into dilution processes that occur at time scales relevant to bio-chemical processes affected by nutrients and Bio-Chemical Oxygen Demand (BOD) associated with the discharge.

A time scale of approximately two days post-discharge was evaluated as a reasonable timeframe that would be required for bio-chemical processes to become important. Particle tracking output from the modeling described in our October 2, 2018 memorandum were analyzed to evaluate dilution characteristics at this time scale.

To perform this analysis triangular elements from the ADCIRC model finite element grid were used as control volumes to estimate the average age of the diluted effluent. Within each control volume the average age of diluted effluent is estimated by determining the median age of particles found within the element. For example, an element that contains diluted effluent with a median age of two days contains as many particles that are younger than two days post-discharge as it does particles that are older than two days post-discharge. Median particle age was determined for each triangular control volume that contained at least one particle, and for each hourly snapshot in the model simulation output. Once the median age was determined, control volumes containing diluted effluent with median age ranging from 1.5-days to 2.5-days were identified for further analysis. Figure 1 shows a reproduction of Figure 5 from our October 2, 2018 memorandum showing snapshots of the dilution over the course of a typical tidal cycle, but with an additional area indicated in yellow to show where the median diluted effluent age is between 1.5-days-old and 2.5-days-old. It is noteworthy that the area defined this way tends to lag the tidally averaged centroid of the total diluted effluent area. Furthermore, the dilution in this region varies considerably from the lowest values of dilution associated with the leading edge of the region, to practically negligible values on the trailing edge of the region.

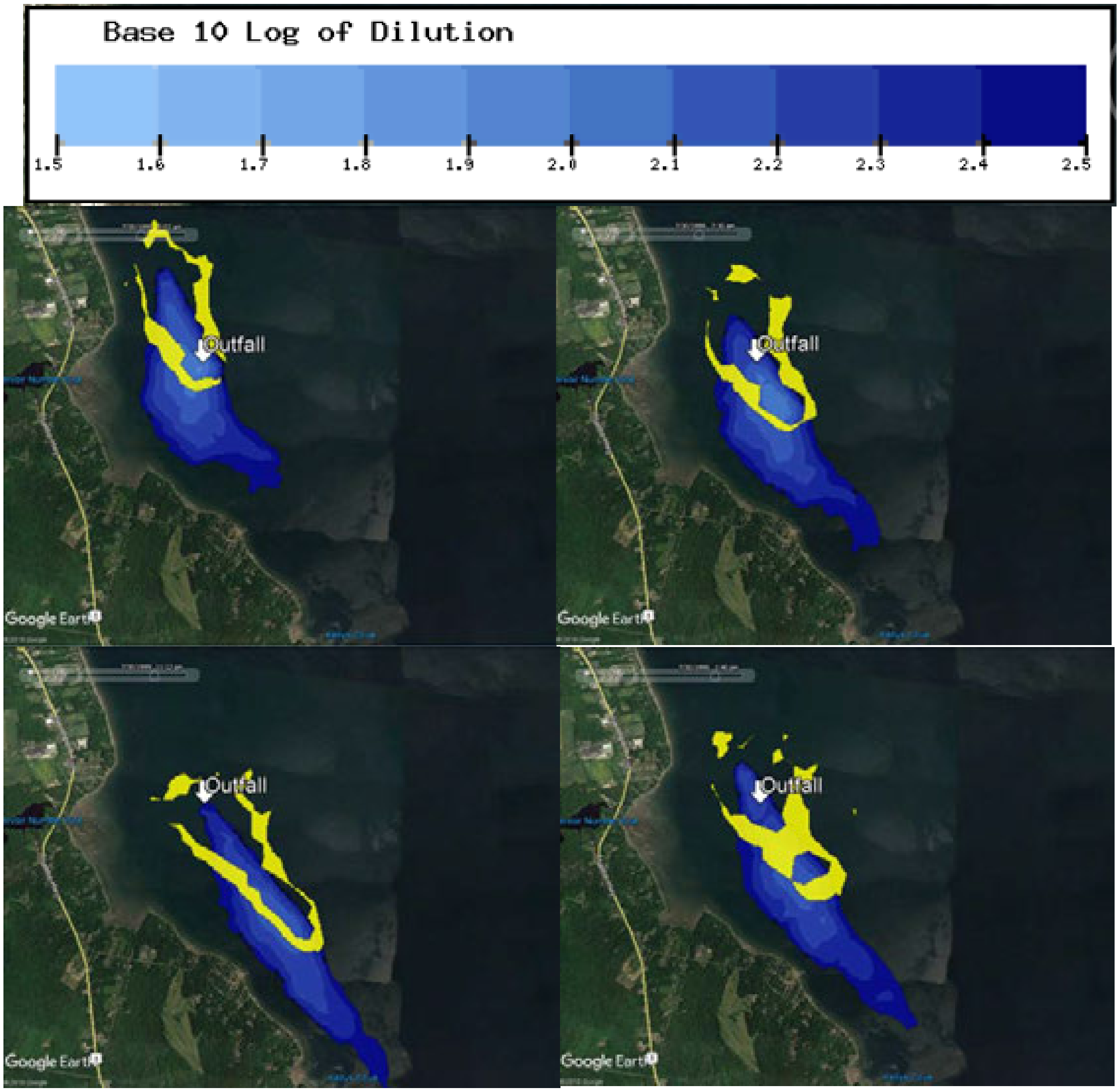


Figure 1. Snapshots of dilution throughout a typical tidal cycle. high slack (upper left), mid-ebb (upper right), low slack (lower left), mid-flood (lower right). Yellow areas show where median age of diluted effluent is between 1.5-days-old and 2.5-days-old.

In order to evaluate dilution that is associated with the 2-day-old diluted effluent, the dilution within each of the control volumes described above was calculated for each hourly output from the particle tracking simulation and then areal distribution of the dilution within the 2-day-old region was evaluated by calculating the cumulative areas at various quantiles as indicated in Figure 2. For example, the red line on Figure 2 shows a time series of the dilution that is less than the dilution in 95% of the 2-day-old area region. In other words, less than 5% of the area of the region containing diluted effluent that is between 1.5-days-old and 2.5-days-old has a dilution of about 100 (10^2) or less. Likewise, 70% of the 2-day-old area has dilution greater than about

160 ($10^{2.2}$), 50% of the 2-day-old area has dilution greater than about 300 ($10^{2.5}$), and more than 10% of the 2-day-old area has dilution greater than about 3000 ($10^{3.5}$).

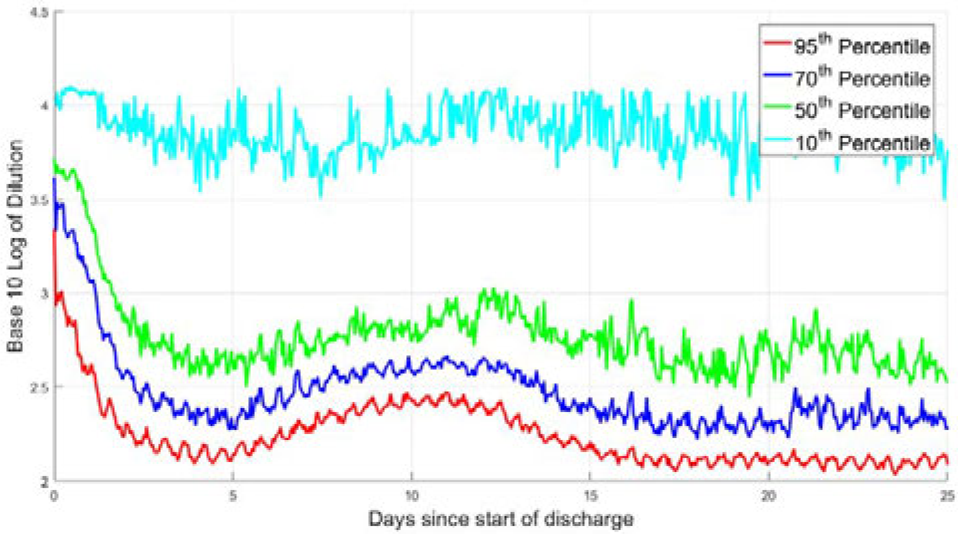


Figure 2. Time series of areal dilution distribution within region containing diluted effluent with median age between 1.5-days-old and 2.5-days-old.

2.0 ATTACHMENT 2 - ALTERNATIVES ANALYSIS

2.1 Introduction

The proposed project location in Belfast, Maine was selected by Nordic Aquafarms, LLC (Nordic) following a six-month search process. This process began with a geospatial desktop analysis, utilizing publicly available datasets, of coastal land extending from Washington D.C. to the Canadian border. This initial analysis along with Nordic's need for clean and cold fresh and salt water determined that the proposed project should be located in the State of Maine. This decision was bolstered by the comparative availability of coastal land and clean groundwater in Maine and national recognition and branding of the state as a producer of high-quality seafood.

As required under the State of Maine's Natural Resource Protection Act (NRPA), this section describes how the preferred project design presented herein will avoid and minimize impacts to protected natural resources to the maximum extent possible while remaining logistically, technically, and economically viable.

2.2 Project Need

Ocean health globally is increasingly challenged by pollution, oxygen depletion, rising sea temperatures, microplastics, ocean acidification, and demand for wild caught seafood. At the same time, there is increasing demand for healthy protein to feed a rapidly growing world population. The Food and Agriculture Organization (FAO) of the United Nations projects world population will grow by two billion within the next three decades and require a 70 percent increase in the global food supply to match the projected population growth [1].

According to the most recent outlook of world fisheries and aquaculture reported by the FAO, world aquaculture production must double in the three next decades to meet demand for sustainable protein, as wild caught fisheries have not increased substantially in the past two decades and cannot meet the projected demand in the coming decades [2].

According to the National Oceanic and Atmospheric Administration (NOAA) [3], the US is a minor aquaculture producer, ranked 16th in 2016 excluding seaweed on a global scale – but it is the leading global importer of fish and fishery products. The NOAA-National Marine Fisheries Services 2017 annual report [4] indicates the US seafood market grew by 7.4 percent, with shrimp and salmon as the highest growth products. Fifty percent of seafood imports into the US are sourced from aquaculture. In 2017, NOAA Fisheries statistics [5] indicate the US imports of fresh and frozen *salmon* were 356,385 tons valued at $3.5 billion. For comparison, US imports of fresh and frozen salmon were 329,845 tons valued at $2.5 billion in 2015 [6]. Local production of fresh seafood in the US is imperative to achieve food security, a reduced environmental footprint, and to and meet consumer demand. This belief is consistent with

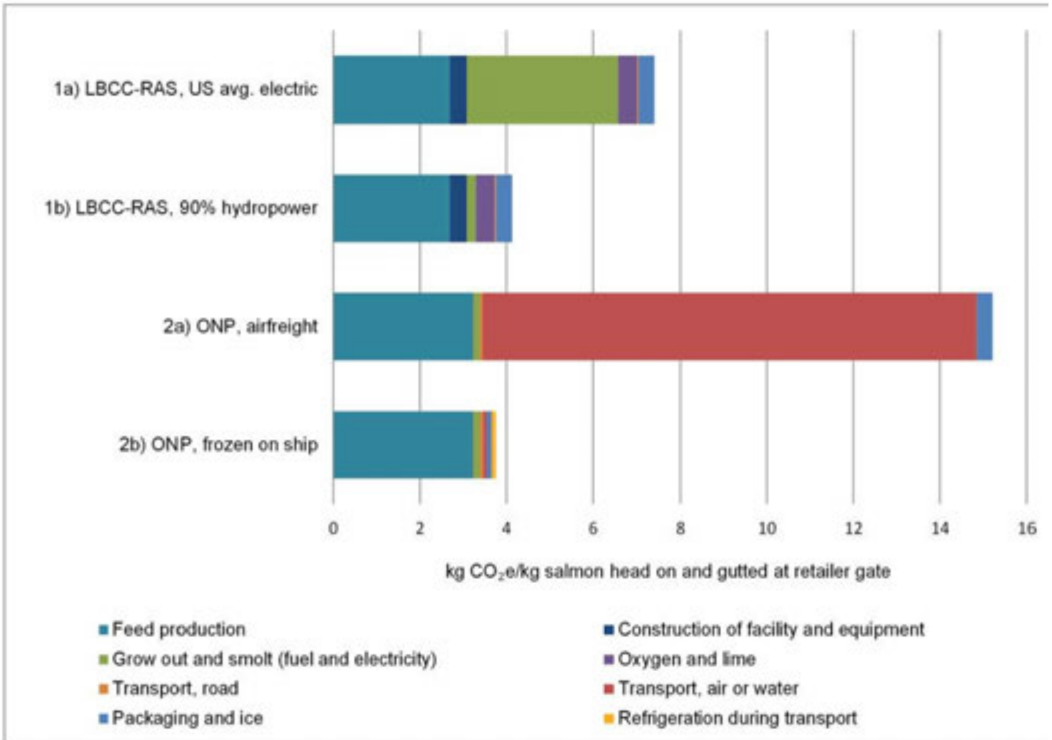
[1] FAO. 2017. The future of food and agriculture – Trends and challenges. Rome. http://www.fao.org/3/a-i6583e.pdf
[2] FAO. 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Rome. License: CC BY-NC-SA 3.0 IGO. http://www.fao.org/3/i9540en/i9540en.pdf
[3] https://www.fisheries.noaa.gov/national/aquaculture/us-aquaculture
[4] National Marine Fisheries Service (2018) Fisheries of the United States, 2017. US Department of Commerce, NOAA Current Fishery Statistics No. 2017. https://www.fisheries.noaa.gov/feature-story/fisheries-united-states-2016
[5] https://www.st.nmfs.noaa.gov/Assets/commercial/trade/Trade2017.pdf
[6] https://www.st.nmfs.noaa.gov/Assets/commercial/trade/Trade2015.pdf

findings in US-funded research [7]. Nordic is confident that "Made in the USA" seafood products (and especially "Made in Maine" seafood) have high consumer acceptance and will contribute to reducing the US seafood trade deficit. Seafood production in the US also will support consumer and regulatory desire for a full and transparent seafood traceability standard applicable to seafood products sold in the US.

In addition, production of fresh seafood at the proposed project location will contribute to lowering the carbon dioxide (CO_2) footprint associated with air freighted seafood imports, which currently dominate the US seafood consumer market. Carbon footprints of seafood products are increasingly important in sustainability assessments of seafood products, particularly with respect to eco-labels, sustainability certification, and consumer seafood sustainability guides [8]. A seafood product's carbon footprint represents the amount of greenhouse gas (GHG) emissions released during its production, transport, and any construction allocated over the lifetime of equipment/buildings calculated as carbon dioxide equivalent (CO_2e), calculated via established methodologies [9]. The proposed project in Belfast will have a significantly lower CO_2 footprint relative to the comparable footprint associated with current trans-ocean air freighted seafood imports[10]. The Nordic Belfast project is calculated to save the CO_2 equivalent of over 1.5 million barrels of oil per year compared to airfreighted alternatives. Airfreight of two pounds (≈1 kilogram) of air freighted seafood adds between 18-26 pounds (≈8-11 kilograms) of CO_2. For recirculating aquaculture system (RAS) production, the CO_2 profile is most favorable with a clean local energy mix. Maine has a favorable energy mix with less than one percent coal. An alternatives analysis of the relative CO_2 emissions as conducted by SINTEF and the Freshwater Institute is illustrated below [11]. While the economics have changed dramatically for land-based farms in recent years, the CO_2 equations remains unchanged.

[7] See e.g., Kite-Powell, H.L., Rubino, M.C. and Morehead, B., 2013. The future of US seafood supply. Aquaculture Economics & Management. 17(3):228-250.
[8] Madin, E.M. and Macreadie, P.I., 2015. Incorporating carbon footprints into seafood sustainability certification and eco-labels. Marine Policy, 57, pp.178-181
[9] Madin, E.M. and Macreadie, P.I., 2015. Incorporating carbon footprints into seafood sustainability certification and eco-labels. Marine Policy. 57:178-181.
[10] See e.g., Farmery, A.K., Gardner, C., Green, B.S., Jennings, S. and Watson, R.A., 2015. Domestic or imported? An assessment of carbon footprints and sustainability of seafood consumed in Australia. Environmental Science & Policy. 54:35-43; Ziegler, F., Winther, U., Hognes, E.S., Emanuelsson, A., Sund, V. and Ellingsen, H., 2013. The carbon footprint of Norwegian seafood products on the global seafood market. Journal of Industrial Ecology. 17(1):103-116.
[11] See e.g. Trond Rostein, Steve Summerfelt 2016. Comparative economic performance and carbon footprint of two farming models for producing Atlantic salmon (Salmo salar): Land-based closed containment system in freshwater and open net pen in seawater.

Figure 2-1: Carbon Footprint of Salmon Production by Different Methods and Power Sources



Carbon footprint for RAS-based salmon farming running (1a) on typical US electricity and (1b) on hydropower compared to Norwegian open net pen salmon farming transported (2a) by airfreight and (2b) by ship.

As part of the proposed project, Nordic has also analyzed alternatives for food production on the proposed site in terms of resource efficiency. We have specifically analyzed land and water use efficiencies with examples. This contributes an important perspective on alternative uses of the property in question.

Average land use in beef, corn, wheat, and Nordic's proposed production are compared in **Table 2-1**. The comparison is based on listed US information sources [12], against our proposed design and production data from existing facilities. Annual edible yield is used to compare types of food production. In the case of salmon, head-on-gutted yield is applied for the proposed Belfast farm. We have assumed an effective area of 35 acres in the benchmark for all products (set-backs and buffers not included). Note that figures may vary by source and location for agriculture, but the general conclusions remain the same.

[12] Various US references used to calculate land and water use:
https://farmdocdaily.illinois.edu/2018/07/international-benchmarks-for-wheat-production.html
https://foodtank.com/news/2013/12/why-meat-eats-resources/
https://www.oda.state.ok.us/food/fs-cowweight.pdf
https://farmdocdaily.illinois.edu/2018/09/exceptional-2018-corn-and-soybean-yields-and-budgeting-for-2019.html
https://water.usgs.gov/edu/activity-watercontent.php

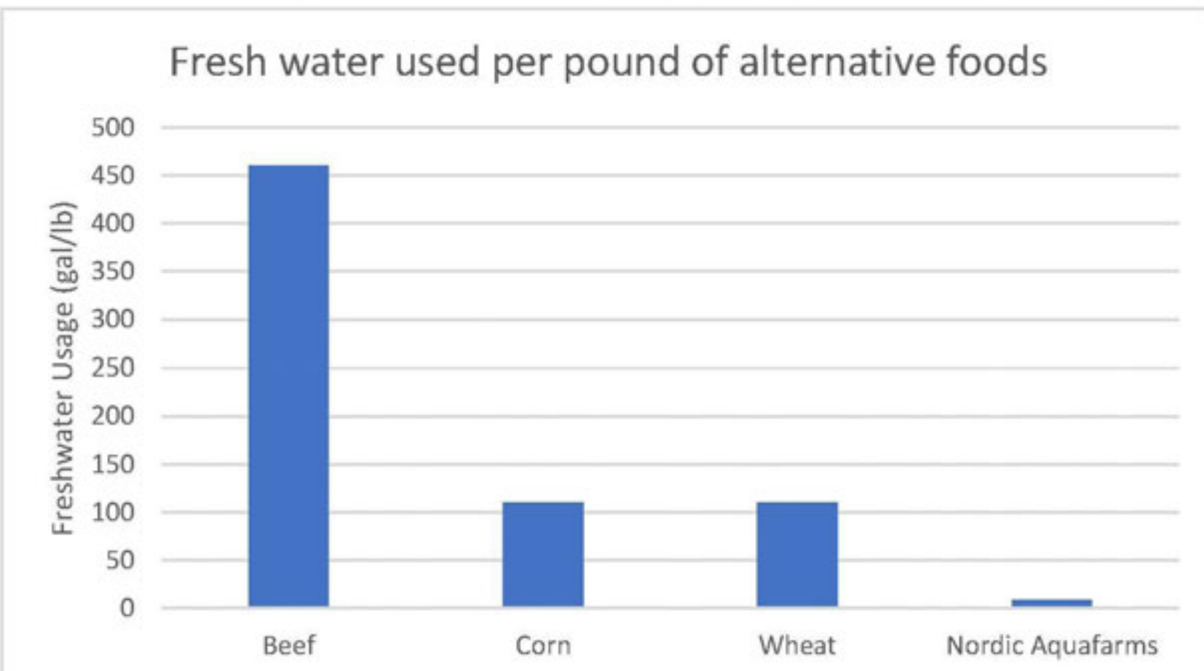
Table 2-1: Yield Footprint Comparison of Different Food Sources

Annual yield benchmark for various food production on proposed site		
Food	Food yield per acre/pounds	Total yield on 35 acres/pounds
Beef	360	12 600
Corn	12 936	452 760
Wheat	4 008	140 280
Nordic Aquafarms	1 742 857	61 000 000

The Nordic design and footprint are highly efficient in terms of food produced per acre, and more efficient than other typical agricultural products produced on land in the US. The depth of tanks, innovative approach to optimal tank volume utilization, the high edible yield from salmon, and the continuous movement of fish through the production cycle enable a high yield of quality seafood per acre facility footprint on this property.

Local water use is another important benchmark. Most foods require more water to produce than people are aware of. We have benchmarked the same foods based on US statistics noted in footnote 12 above in terms of their average water use per pound of food. The results are listed below (in gallons) in **Figure 2-2**.

Figure 2-2: Comparison of Freshwater Usage of Different Food Production Sources



The proposed Nordic facility would use 8.7 gallons of local fresh water per pound of fish. The proposed water use is significantly lower than typical RAS farms due to use of de-nitrification technologies.

The conclusion from this analysis is that Nordic's approach provides an efficient local fresh water use and yield compared to many alternatives.

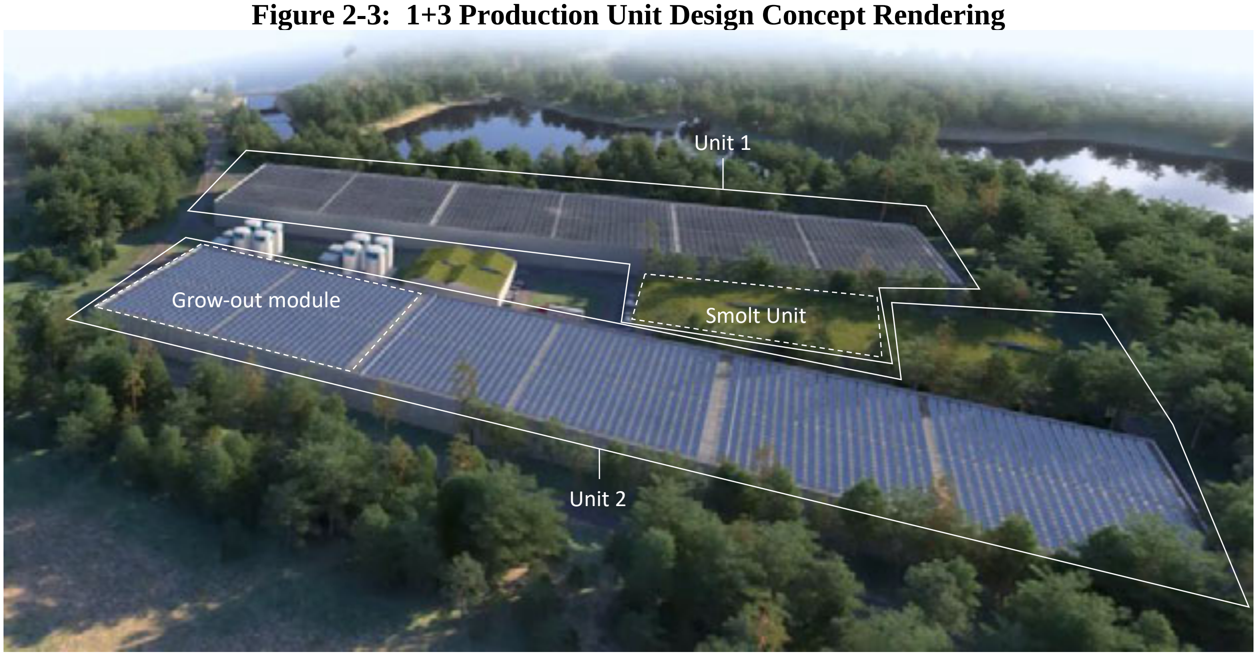
2.3 Project Purpose

The proposed project located in Belfast, Maine, is an optimum location compatible with Nordic's business, environmental, and social objectives. **The purpose of the project is to provide 33,000 metric tons of high quality and sustainable seafood to consumers in the northeastern United States**. This project is poised to become a significant new commercial driver for the mid-coast and State of Maine with local, regional and national benefits. Being at the forefront of the aquaculture industry expansion, Nordic is providing Maine with a unique position as an innovator and environmental leader in commercial fish production, propelling the iconic Maine seafood industry into the next generation and ensuring it remains a part of the Maine economy, culture and identity for generations to come.

The standardized designs Nordic has developed in Europe are based on one smolt module supporting three grow-out modules, or our two production module design (see **Figure 2-3** below for illustration of this design). Combined, these four modules comprise one production unit. The proposed Belfast project consists of two such production units, to be phased in over time. These standardized units have undergone extensive development, engineering and verification over the past two years in our European organization.

A pair of production units provides optimal scale for a long-term facility development in Belfast. This site lay-out enables the facility to grow in phases, along with new jobs, secondary business opportunities for Maine businesses, and tax benefits to Belfast.

Figure 2-3: 1+3 Production Unit Design Concept Rendering



To achieve the project purpose, the preferred alternative must meet the following goals to ensure that the project is both commercially viable and environmentally sustainable:

1. Production of 33,000 metric tons of salmon to meet approximately 7% of current US demand.

2. Reduce the carbon footprint compared to imported, fresh, farmed Atlantic salmon to 1/3 of the current footprint from the imported fish.

3. High fixed investments necessary to support infrastructure requires production of sufficient volume to achieve competitive capital expenditures per kilogram of fish. In other words, a volume of 33,000 mt is needed to justify construction and related capital costs.

4. Production cost per unit produced needs to be competitive to ensure access to market and profitability (commercial viability). In other words, a volume of 33,000 mt is needed to justify local production cost versus other suppliers in the market.

5. Provide 100+ high quality direct jobs to Belfast and mid-coast Maine; with potential for a significant indirect job impact as well.

6. Provide opportunities for development of ancillary business opportunities by utilizing 100% of the fish, for example, the facility could provide 20-25% of lobster bait for Penobscot Bay fishermen, in addition to numerous other by-product business opportunities (human supplements, specialty foods, green energy).

7. The project must make as little impact to the environment as possible while supporting the commercial considerations that make the project viable.

In order to be economically viable, the Belfast location needs an ultimate 33,000 metric tons capacity potential. Significant connecting infrastructure investments must be made in this location, including power grid connection and intake/discharge infrastructure, which costs must be offset by a corresponding required scale of production.

2.4 Site Selection Alternatives Analysis

Nordic's initial goal for the site selection was to find a location on the eastern coast of the United States that would reduce the need to air freight farm-raised salmon from Europe to the US market. The ideal location would reduce the transport and carbon footprint of the product through its proximity to the market, including cities such as Portland, Boston, New York and Philadelphia. Access to major transportation hubs would also increase the ability to bring fresh product to market with a lower environmental footprint. With Nordic's current business based in Europe, it would not be possible to meet these goals through expansion of one of these existing facilities.

2.4.1 Criteria for Assessment

Based on the initial search criteria, a desktop geospatial assessment from available public datasets identified 534 potential properties in Maine. As available geospatial datasets could not account for all variables involved, staff assessment of the generated solutions brought the list to approximately 40 locations that were further evaluated by personnel and compared to criteria presented in the decision matrix presented below and shown in the map presented in **Appendix 2-A**. Site visits were conducted on the most favorable locations, and results were narrowed further based on site evaluations and potential to acquire property rights. The pros and cons of four of the remaining locations have been compared and contrasted below. Although the specific location of these options is not being shown they are considered representative of the scenarios encountered.

1. **Availability of property.** Each site was evaluated based on the potential to acquire sufficient land for both the land-based development and supporting infrastructure. Acquisition and leasing were both considered. Based on the need for the project to have proximity to the coastline and seawater/freshwater access,

availability of tracts of land large enough to be suitable for the development became an important consideration. Locations where land could be secured, and that also had favorable water access received higher scores.

2. **Access to clean and cold seawater.** Access to clean and cold seawater is essential to our production approach for salmon. A seawater pipeline is one of the costlier pieces of infrastructure for the overall facility, so limiting the distance of the intake pipeline for the seawater supply is critical. Nordic's European facilities have a maximum run of 700 meters to seawater, so this distance was used as a baseline to score the available access of the proposed site options. 5 = existing access nearshore. 4 = no existing access but nearshore resource. 3= no existing access and farther resource. 2 = near resource but questionable water quality. 1 = far away and poor quality. 0 = deal breaker, too far away or potential water quality issues. Achieving consistently cold water is a function of **depth**, with deeper water being colder and more consistent in temperature, along with having more consistent water quality parameters and less biologic activity. A limiting factor would be the overall **cleanliness** of the waterbody (bay, etc.) as a whole. Nearby pre-existing pipelines were viewed as a negative because of the potential risks.

3. **Attractive workplace location.** Land-based farms need to draw on a mix of skilled and highly educated labor and lower-skilled labor. Proximity to a town and/or city where Nordic could engage the local work force and also attract high-level talent from beyond Maine is necessary to achieve a world-class operation. Towns with an attractive place to work and live were rated more highly than rural areas more than 50 miles from a cosmopolitan town center.

4. **Buildable lot size.** The six-module layout requires a minimum of 50 acres to accommodate the size of the buildings and the associated process piping and infrastructure for the facility. Properties greater than 30 acres were initially considered, and as due diligence and design considerations progressed, the 50-acre minimum became apparent given set-back and fire code requirements in relevant property areas.

5. **Available road and utility infrastructure.** Transportation of fresh product relies on good roads, and the facility needs to be located in an area with reliable transportation in all seasons, including winter weather and tourist traffic. Location on paved US Highways were rated more favorably than local or secondary roads. In addition, the facility requires 3-phase power. Proximity to required 3-phase power was rated highly, and increased distance from a 3-phase power connect was rated poorly. Distances greater than 6 miles from 3-phase power are infeasible. Sufficient capacity was also a key consideration. Proximity to city sewer for domestic waste was also important.

6. **Effluent impacts to local waterbody.** This criterium was applied to evaluate whether the effluent from the facility could have an impact on the surrounding marine environment. Confined water bodies, such as estuaries with limited circulation, Maine protected water bodies (SA waters), and similar features were scored negatively. SA waters were given a buffer, and areas within SA waters were scored with a 0. In addition, waters that were already impaired were scored negatively, as existing bacteria and/or contamination have the potential to affect the health and quality of the fish.

7. **Construction impact to natural resources.** Online resources were evaluated to look at mapped wetlands, vernal pools, and species of special concern. Sites such as Belfast where no vernal pools were mapped were scored more highly than sites with state-mapped natural resources.

8. **Lack of adverse pre-existing environmental conditions.** Sites with known environmental impacts were scored lower than sites that didn't have impacts. In addition to the potential cost of environmental clean-up, historic impacts have the potential to affect the water supply for the facility and pose unknown risks, and therefore were scored negatively.

9. **Ground conditions favorable to construction.** Topography, geotechnically suitable soils, and degree of land preparation needed for construction were all considered when ranking suitable sites. Flat lands with firm soils were considered most favorable. Elevation change from seawater was also scored as part of this evaluation, with limited elevation change being most favorable, while future sea rise was also considered.

10. **Access to Abundant Freshwater Resource.** Sites were evaluated based on their potential to provide fresh water. Areas with potential for production wells and/or other sources of water that could be used for fish production were scored highly. Sites with limited water supply options where scored poorly. If clean fresh water without contamination could not be obtained, the site received a 0 for this criterion.

Table 2-2 summarizes the scoring for the four remaining locations following application of the review criteria discussed above and extensive site visits.

Table 2-2: Site Selection Decision Matrix

	Belfast	**Alternative Mid-Coast Site**	**Alternative Northern Site**	**Alternative Southern Site**
Access to clean and cold seawater	4	4	4	5
Access to abundant clean and cold freshwater	5	2	3	0
Potential for effluent impact to local waterbody	4	4	4	5
Lack of adverse pre-existing environmental conditions	5	5	5	3
Buildable lot size	5	4	4	4
Favorable road and utility infrastructure	4	2	2	3
Attractive workplace location	5	2	3	3
Probable Acquisition of Property	5	3	3	4
Ground conditions favorable to construction	4	4	5	4
Anticipated Construction Impacts	4	3	3	4
Score (out of 50)	**45**	**33**	**36**	**35**

It was evident from Nordic's assessment that the proposed location in Belfast, Maine scored high on all assessment criteria and clearly stood out as the preferred location for Nordic's proposed project.

2.5 Project Layout Alternatives Analysis

Nordic carefully considered whether the project purpose could be met by changing the project size, scope, configuration or density at the Belfast site in order to avoid or minimize the impact to natural resources. Four site layout alternatives were considered for upland portions of the project. Five routing alternatives were considered for the intake and outfall pipes. A discussion of these alternatives is presented below.

2.5.1 Description of Upland Site Layout Alternatives

Changes in the layout of necessary infrastructure has evolved over time due to constraints encountered with the original 39-acre site. For each alternative a discussion is provided regarding technical and logistical feasibility, cost, and potential environmental impacts. As discussed more thoroughly below, the preferred alternative is the only practicable alternative.

The following four upland site layout options were considered for project development in the order in which they are presented:

Option 1: 6 Modules on 39 Acres

The initial project design for the Site entailed the construction of the two production module layout on 39 acres of land owned by the Belfast Water District (BWD), excluding the 250-foot buffer zone along the Little River and Lower Reservoir, and land owned by an abutter (Cassida). This design placed infrastructure, including grow-out modules, smolt units, fish processing facility and utilities, on the majority of the Cassida parcel and western portions of the BWD parcel. The eastern portion of the site would be improved with the intake and wastewater treatment plant while the existing BWD office building would be renovated and converted into a visitor center. A conceptual site plan is presented on **Appendix 2-B.**

Option 2: 3 Modules on 39 Acres

Following a revision to the local zoning requirements and redesign to address setbacks and cleared area requirements in conjunction with buffering, a revised facility design was explored, comprising just one production unit situated on 39 acres of land owned by the BWD, excluding the 250-foot buffer zone along the Little River and Lower Reservoir, and Cassida land. The design placed the majority of infrastructure, including grow-out modules, smolt units, fish processing facility and wastewater treatment plant on flatter, upgradient portions of the two properties. The eastern portion of the site would be improved with the intake water treatment plant and office space, while the existing BWD office building would be renovated and converted into a visitor center. A conceptual site plan is presented on **Appendix 2-C.**

Option 3: 6 Modules on 54 Acres

Following the acquisition of rights to additional land owned by Goldenrod Properties, LLC ("Goldenrod"), the two production unit design could be placed on 54 acres of land owned by the BWD, excluding the 250-foot buffer zone along the Little River and Lower Reservoir, but including portions of the Cassida and Goldenrod properties. This design placed infrastructure, including grow-out modules, smolt units, fish processing facility and utilities, on the majority of the Cassida parcel, the Goldenrod parcel and western portions of the BWD parcel. The eastern portion of the site would be improved with the intake and wastewater treatment plant while the existing BWD office building would be renovated and converted into a visitor center. A conceptual site plan is presented on **Appendix 2-D.**

Option 4: 5 Modules on 54 Acres

In an attempt to reduce the development footprint, a design for five modules was explored on 54 acres of land owned by the BWD, excluding the 250-foot buffer zone along the Little River and Lower Reservoir, but including portions of the Cassida and Goldenrod properties was developed. This design places infrastructure, including grow-out modules, smolt units, fish processing facility and utilities, on the majority of the Goldenrod parcel and western portions of the Cassida and BWD parcels. The eastern portion of the site would be improved with the intake and wastewater treatment plant while the existing BWD office building would be renovated and converted into a visitor center. A conceptual site plan is presented on **Appendix 2-E.**

2.5.2 Criteria for Assessment of Upland Layout Alternatives

The evolutionary process of site layout design was evaluated using the following criteria:

Regulatory Requirements

Regulatory requirement criteria refer to the ability to obtain rights to property for development, compliance with City of Belfast ordinances, fire codes, and all Maine Department of Environmental Protection (MEDEP) requirements. Applicable City of Belfast ordinances influencing site layout include property line setbacks and fire codes. The three setback requirements include a 40-foot property line setback for all development, a 50-foot property line setback for all development excluding utilities, and a 75-foot property line setback at Route 1. The applicable fire codes require fire truck access to all sides of the buildings, and a 100-foot buffer is provided to meet the “open yard” concept for fire protection. Taken together, these requirements allow Nordic to preserve an uncut property line setback (which buffers the project from neighbors) followed by an additional open yard for fire protection.

Environmental Impacts

MEDEP requirements include wetland delineations completed on all properties considered for development. This natural resource identification work included the assessment of vernal pool presence, NRPA jurisdictional streams, and coordination with the Maine Department of Inland Fisheries and Wildlife to identify essential and significant wildlife habitats and endangered, threatened or special concern species that could be impacted by the project. Specific analysis criteria include impacts and proximity to wetlands, streams and all other natural resources protected by the NRPA. The functional assessment of these features was also considered.

Construction /Engineering/Operational Feasibility

The degree of difficulty and technical feasibility of construction and engineering is a necessary consideration for all development. The facility must be constructed in a way that allows for geotechnical, structural and operational feasibility for Nordic’s RAS designs, appropriate access to buildings, and stormwater control and treatment. Aspects considered include existing site geology and topography in relation to land preparation and regrading, and utility corridor design for the network of water distribution pipes. Nordic’s proprietary RAS design has a fixed building size for grow-out modules and smolt units. These proprietary designs are key to the function and competitiveness of the aquaculture facility in the marketplace. The site layout is further constrained by key operational features such as a process piping network that connects smolt, grow modules, and processing.

<u>Financial Feasibility</u>

Chapter 310 of the MEDEP rules, 06-096 CMR § 310(3)(R), defines "practicable" as "[a]vailable and feasible considering cost, existing technology and logistics based on the overall purpose of the project. This criterion includes budget estimates of construction and operation costs per unit produced based on investor expectations and seafood industry metrics. These cost considerations are further assessed relative to the anticipated market value of the product and how well these metrics meet Nordic's business model.

2.5.3 Site Layout Analyses

<u>Option 1: Two Production Units on 39 Acres</u>

Regulatory requirements

Due to the fixed size of the layout and the shape of the property originally available through agreements with the BWD and Cassida, by the exclusion of the 250-foot shoreland zone, infrastructure cannot be arranged in a manner that satisfies all applicable City of Belfast building and fire ordinances. The conceptual layout shows the placement of all buildings and infrastructure within the property boundaries. Reducing the buildable area through the insertion of setbacks causes the presented arrangement to be out of compliance.

Because appropriate setback requirements cannot be met with Nordic Aquafarm's proposed two production module layout on 39 acres, Option 1 is not viable.

Environmental Impacts

Due to the maximized development of the property for the placement of infrastructure, the environmental impacts to on-site natural resources would be significant. Expanding the construction design to consider grading and stormwater control and current infrastructure and design needs, the facility would be anticipated to impact all protected habitat and natural resources located on the central and western portions of the site. In addition, due to the necessary building and infrastructure, it would have significant impacts to the eastern stream and associated wetlands.

Construction / Engineering/Operational Feasibility

Based on the maximization of the layout on the given property, additional construction requirements and costs would be incurred. These would include a grading plan that results in a need for retaining walls along the boundaries abutting the shoreland zone. Due to the narrow 39-acre lot shape, the two production unit layout cannot fit within the property boundaries and include necessary supporting utilities and process piping. This layout on 39 acres would not provide space for fish processing or an office building.

Option 1 is not feasible from the perspective of site engineering or operations, as critical site functions do not fit.

Financial Feasibility

The two production unit layout is financially feasible.

<u>Option 2: One Production Unit on 39 Acres</u>

Regulatory Requirements

Due to the fixed size of two production unit layout and the shape of the property originally available through agreements with the BWD and Cassida, by the exclusion of the 250-foot shoreland zone, production modules and infrastructure cannot be arranged in a manner that satisfies all applicable building and fire ordinances. In addition, this alternative cannot use Nordic's two production module design layout. The conceptual layout shows the placement of site buildings and infrastructure within the property boundaries; however, when applicable zoning requirements and setbacks are applied, the presented arrangement of buildings is out of compliance.

Option 2 is not viable because it does not allow for Nordic to use their two production module design layout, nor does it meet appropriate setback requirements.

Environmental Impacts

Due to the centralized development of the property and the need for supporting infrastructure, the environmental impacts to on-site natural resources would be significant. Expanding the construction design to consider grading and stormwater control and current infrastructure and design needs, the facility would be anticipated to impact all protected habitat and natural resources located on the central and western portions of the site.

Option 2 would have significant environmental impacts.

Construction /Engineering/Operational Feasibility

The site layout is constrained by the shape of the 39-acre lot. The narrow and elongated shape of the main portion of the site only allows one production unit. Facility operations are hindered by lack of centralized processing and utilities. Site grading results in a need for retaining walls along the boundaries abutting the shoreland zone.

Option 2 is infeasible because engineering that meets operational requirements is not possible.

Financial Feasibility

The one production unit layout is not financially viable and does not warrant the construction of the facility. The construction costs and production cost per unit produced would result in a facility that would operate at a loss for years. In addition, the commercial production, jobs, and byproducts available to market would all be cut in half.

Option 3: Two Production Units on 54 Acres: PREFERRED ALTERNATIVE

Regulatory Requirements

Acquisition of rights to the Goldenrod parcel provided a site shape which allows for compliance with applicable regulatory requirements. All applicable City of Belfast zoning and fire code requirements can be met.

Two production units can be configured to meet regulatory requirements.

Environmental Impacts

Due to the density of development in the center of the property in order to comply with regulatory requirements and other considerations discussed herein, the environmental impacts to on-site natural resources will be centralized. Expanding the construction design to consider grading and stormwater control and current infrastructure and design needs, the facility will limit impact to protected natural resources located on the central and western portions of the site, as shown on **Table 2-5** and **Table 2-6**.

Table 2-5: Impacts to Wetland Resources by the Option 3 Design

Wetland ID	[1]Temporary Impacts (SF)	Permanent Impacts (SF)	Impact Total (SF)	Impact Characterization
W1	0	115,674	115,674	Direct, Fill
W2	0	24,612	24,612	Direct, Fill
W3	0	5,057	5,057	Direct, Fill
W4	0	692	692	Direct, Fill
W5	0	18,672	18,672	Direct, Fill
W6	1,766	3,120	4,886	Direct, Fill
[2]W11	2,611	0	2,611	Direct, Excavation
W13	0	556	556	Direct, Fill
W15	0	708	708	Direct, Fill
W16	1,245	0	1,245	Direct, Excavation
Totals	5,622	169,091	174,713	

1. All temporary impacts are restored in place
2. W11 consists of 2,125 square feet (SF) of temporary impact to Salt Marsh and 486 SF of temporary impact to Cobble Beach

Table 2-6: Direct Impacts to Stream Resources by the Project

Stream ID	[1]Temporary Impacts (L.Ft.)	Permanent Impacts (L.Ft.)	Impact Total (L.Ft.)	Impact Characterization
S3	0	635	635	Direct, Fill
S5	0	459	459	Direct, Fill
S6	0	86	86	Direct, Fill
S9	145	0	145	Temporary Culvert
Totals	145	1,180	1,325	

1. All temporary impacts are restored in place.

This alternative preserves the eastern intermittent stream and wetlands, including restoration and a deed restricted 75- foot wetland buffer. The additional lot size allows for improved stormwater control and treatment, and incorporation of additional site buffers.

Construction/Engineering/Operational Feasibility

Development of the site for construction of this alternative will require the same amount of infrastructure as Option 1, but with additional land available, bank stability issues are reduced, stormwater treatment areas are expanded, and final grading can be achieved with fewer retaining walls. In addition, the acquisition of additional land facilitated a shorter sewer line connection to the north where the Mathews Brothers facility has a connection on Perkins Road. Retaining walls along the shoreland zone would no longer be needed for this option. Buffers and setbacks would be met and expanded on by this option. This option allows for buffers of 100+ feet from most property lines, which results in a 350+ foot setback from the Lower Reservoir. The enhanced buffers provide larger wildlife corridors, enhanced resource protection, and a more pleasing visual setting for the site development.

Financial Feasibility

The two production unit layout is financially viable from a business perspective and warrants the construction of the facility.

<u>Option 4: 5-Module Design on 54 Acres</u>

Regulatory requirements

Acquisition of rights to the Goldenrod parcel provided a site shape which allows for compliance with applicable regulatory requirements. City of Belfast zoning and fire code requirements can be achieved.

The 5-module design on 54 acres meets regulatory requirements.

Environmental Impacts

Due to the density of development in the center of the property in order to comply with regulatory requirements and other considerations discussed herein, the environmental impacts to on-site natural resources would be similar to those of Option 3, with the exception of Stream 6.

Construction /Engineering/Operational Feasibility

Development of the site would require the same amount of infrastructure as Options 1 and 3 (the preferred alternative) but would marginally decrease bank stability issues and expand stormwater treatment areas. This option would also allow for final grading to be achieved with fewer retaining walls. Option 4 would result in only 66% utilization of the second smolt module, as it would be supporting two rather than three grow-out modules. This option does not operationally support Nordic's proprietary design and results in inefficient site operations.

Financial Feasibility

The 5-module production design would not be financially viable from a business perspective and does not warrant the construction of the facility. All commercial evaluation criteria will not be met in this alternative, specifically:

1. The lay-out differs from Nordic's proprietary design concept for production units. It would leave unused smolt capacity in the facility and result in other

process inefficiencies. Redesign of Nordic's production units would be a costly and time-consuming activity.

2. This alternative does not meet the project production goals. Volumes are reduced to 27,400 mt and 5.5% of market respectively.

3. High fixed investments in supporting infrastructure are not supported by sufficient volume to achieve competitive capital expenditure per kilogram of fish.

4. Production cost per unit produced increases.

5. This alternative would produce approximately 83 jobs, thus the goal of 100 jobs is not met.

6. Byproducts volume is reduced by 17%.

2.5.4 Comparative Analysis of Site Layout Alternatives

Table 2-7: Weighted Scoring of Site Layout Alternatives

Decision Criteria	Weighting Factor	Layout Alternatives			
		6 Modules on 39 Acres	3 Modules on 39 Acres	6 Modules on 54 Acres	5 Modules on 54 Acres
Legal Requirements	4				
Title, Right and Interest		4	4	4	4
Building Code Setbacks		0	0	4	4
Fire Code Setbacks		0	0	4	4
Environmental Impact	3				
Wetlands		2	3	1	2
Streams		2	3	1	2
Forest		2	3	1	2
Engineering Feasibility	1				
Land Preparation		4	4	3	3
Piping Layout		4	4	4	3
Operational Flow		3	4	4	2
Financial Feasibility	4				
Capital Investment		4	1	4	2
Operational Costs		4	1	4	2
Business Model		4	1	4	1
Totals		**93**	**67**	**116**	**94**

Although Options 1 and 2 receive a score, they are not possible given regulatory limitations on the site.

<u>Selection of the Preferred Site Layout</u>

As outlined in **Table 2-7**, the Option 3 is the preferred alternative. There are no practicable alternatives. Options 1 and 4 are not feasible due to technical, logistical or financial constraints, while Options 1 and 2 do not legally meet applicable requirements.

2.6 Pipeline Route Selection

Similar to Sections 2.4 and 2.5 above, this section addresses whether the project purpose can be met by changing the size, scope, configuration or density of the activity, thereby avoiding or minimizing the impact to natural resources. In this section, the review is related to the siting of the project seawater intake and discharge pipes and is independent of the analysis of the remainder of the site.

Since the inception of the project, several options for pipe routing have been considered as a result of challenges and opportunities related to constructability; engineering design; potential environmental impacts; and other regulatory concerns. In all cases, the pipe layouts include a combination of both buried and surface pipe as described in more detail below, as well as a system of intake structures raised approximately 10 feet above the seabed, and a series of duck-billed diffusers for discharge. These elements are common for all options as they will be utilized to maintain acceptable flows for the intake and assist in maximizing diffusion of the discharge.

For each layout alternative a discussion is provided regarding technical and logistical feasibility, cost, and potential environmental impacts. As discussed more thoroughly below, the preferred layout alternative is the only practicable option.

2.6.1 Description of Site Layout Alternatives

Each of the proposed pipeline alternatives propose a seawater intake structure at a depth of 55 feet (-55 feet NAVD88), approximately 7,000 feet east of the Little River Bridge and Belfast Water District Facility. A pair of parallel intake pipes connecting the intake to shore would be anchored on the seafloor, spanning from the intake structures to a depth of approximately 25 feet (measured from mean lower low water (MLLW), where the pipes would transition underground. In approximately the same location as the transition to underground, a multi-port diffuser at the end of the discharge pipe would be placed to discharge treated wastewater from the facility.

The following intake/outfall routing options were considered:

<u>Option 1: Little River</u>

Description

As shown on **Appendix 2-F,** Option 1 proposes a seawater intake structure at a depth of 55 feet (-55 feet NAVD88), approximately 7,000 feet east of the Little River Bridge and Belfast Water District Facility. A pair of parallel intake pipes connecting the intake to shore would be anchored on the seafloor, spanning from the intake structures to a depth of approximately 25 feet (measured from MLLW, where the pipes would transition underground. Both the intake and discharge pipes would be laid in a common trench following the Little River channel, under the US Route 1 bridge, and to the shoreline in the vicinity of the Belfast Water District building. The pipes would extend from the bank of the Little River to the north to a proposed pump station connected with the facility's Water Treatment and Wastewater Treatment Plant. Due to wide tidal ranges and limitations on suction capacity of pumping operations, the pumps must be set near a high tide level or at an approximate elevation of 8 feet NAVD88. Ground surface elevation in the location of the proposed pump station is approximately 35 feet NAVD88.

Regulatory Requirements

Once the intake/outfall lines leave the project site it would follow the Little River, which is the line between the City of Belfast and the Town of Northport. Rights within this option would involve numerous property owners because this route is the longest of the alternatives considered. This option would require an extensive submerged lands lease with the Maine Bureau of Parks and Lands. Furthermore, multiple approvals would be required for crossing under the US Route 1 bridge, which would include blasting activities to remove bedrock.

Environmental Impacts

As the longest of the pipeline routes evaluated, Option 1 would have the most significant environmental impacts, including impacts to coastal wetlands, and sensitive river and bank ecosystems. Benthic and other studies of the intertidal and subtidal area suggest that bivalves and other sea life may be more abundant in the area where the Little River discharges than areas immediately to the north. Approximately 1,800 linear feet (estimated 27,000 square feet) of area within the intertidal and Little River channel and bank would be temporarily disturbed during pipeline installation of this option. Permanent impacts to the intertidal zone at the mouth of the Little River would be minimal, as the trench would be backfilled with native material. Impacts to the channel and bank of the Little River may be more substantial, as armoring would be required for slope and channel stabilization. Placement of armoring material may impose a negative impact on wildlife habitat.

Above the mean high-water line, approximately 250 linear feet (estimated 3,750 square feet) of vegetated area would be impacted. The upland portion of the pipeline route would require clearing during construction and long-term maintenance to prevent root growth from affecting intake and discharge pipes.

<u>Construction Considerations/Engineering</u>

Bridge Considerations

Little River Bridge plays a critical role in the region's transportation needs. Along this corridor, US Route 1 is part of the National Highway System (NHS), which means the Federal Highway Administration (FHWA) has determined it is important to the nation's economy, defense, and mobility. The bridge also functions as a key crossing for emergency responders to serve those in the surrounding communities. According to Maine Department of Transportation (Maine DOT) records, the current Average Annual Daily Traffic (AADT) over this bridge is 8,040. For this reason, proper protection of the bridge integrity at all phases of construction is paramount.

The bridge was constructed in 1944 and was rehabilitated in 1987 to incorporate a new wearing surface and curb/guardrail system. The channel consists of clean bedrock noted to be badly weathered and loose where exposed on the edges. The river bottom now contains various-sized stones and blocks of granite randomly scattered along the channel above the bedrock. The banks near the bridge have been carefully armored with heavy riprap. Construction of this alternative has a high risk of impact to the Little River Bridge and construction of a bypass would be infeasible.

Trenching Procedures

Option 1 would require approximately 3,600 linear feet of trenching, including below MLLW, through the intertidal zone, along the Little River channel, and upland. Review of NRCS Web Soil Surveys indicates soils in this area to be primarily Boothbay silt loam with an estimated depth to restrictive feature of greater than 80 inches. Excavation within the Little River channel is anticipated to require bedrock removal because bedrock is visible.

Water depth beneath the bridge varies due to tidal effects, from only inches deep during low tide to approximately 13 feet deep during high tide. The minimum depth is affected by seasonal changes. Clearance between bedrock and the low chord of the bridge is approximately 20 feet. For blasting in this area, drilling would be limited to low tide because of the low clearance. Access for the drill rig would be by barge (grounded out during low tide) or by a rock causeway in the channel starting from the northwest side of the bridge, currently owned by the Belfast Water District. A crane set up near the water district building could also be used to set the drill rig in the river during low tide and remove the drill before the tide begins to fill back in. However, the overhead power lines running along the upstream side of the bridge would be an obstacle and hazard for cranes operating in this location. Because drilling operations in this area could only commence during low tide, the trenching operation would be very time consuming.

Assuming bedrock is encountered, blasting would likely be required to achieve necessary depths. Overburden soils would be removed by excavator, and depending on the depth and extent of bedrock, the edges of the trench would be line drilled to establish the trench section. Line drilling entails predrilling closely spaced vertical holes into the bedrock to just below the bottom of trench elevation with a track-mounted hydraulic drill. Once the edges of trench have been predrilled, the boreholes would be drilled within the trench, loaded with explosives, and detonated in a linear progression to break up the rock within the trench. The blast material would then be removed by excavator and hauled offsite. Overburden soils would likely be stored onsite for use as backfill.

Challenges and Risks

Primary challenges and risks for Option 1 include environmental impacts, habitat loss, channel and bank stability, impacts to nearby structures and property, specifically the bridge crossing the Little River and the dam impounding the Belfast reservoir, general blasting and heavy construction risks, and property owner concerns.

Excavating a trench beneath the bridge may cause vibration-related damage to the river channel. Blasting could cause cracks to propagate from the trench toward the abutments weakening the bedrock beneath the concrete leveling slabs. Blasting and trenching in the vicinity of the dam may also pose a risk to the structural and hydraulic integrity of the impoundment. A detailed analysis of this risk would be required if Option 1 were pursued.

The banks of the Little River in this area have slumped. Vibrations due to blasting may cause further instability and slumping of the banks. Construction activities beneath the bridge would likely restrict the hydraulic opening, which could lead to increased water depth and velocity. This could also adversely affect the riverbanks and channel bottom.

Engineering analysis indicates the trench would need to be approximately 15 feet wide to facilitate the three intake and discharge pipes. If centered in the channel, this only provides a buffer of approximately 15 feet between the existing abutments and the blasting zone. Potential damage to the granite blocks and concrete stem walls of the abutments is a concern. Currently the substructure has a condition rating of 6/10 with minor deterioration noted. Vibration may cause shifting of the granite blocks and cracking of the nearly 75-year old concrete stem walls. Since the superstructure is rigidly connected to the substructure at the north end, the vibrations experienced by the substructure would be amplified as they are transferred to the superstructure. Similar to the concrete stem walls, the concrete superstructure is nearly 75 years old. The superstructure and deck have condition ratings of 5/10 with minor section loss noted. Further damage is possible due to blasting-related vibrations.

According to the Maine DOT Public Map Viewer, the bridge has an inventory load rating factor of 0.78 and an operating load rating factor of 1.01. Rating factors less than 1.0 indicate the structure does not satisfy the current American Association of State Highway and Transportation Officials (AASHTO) standards. Damage or section loss from blasting directly adjacent to the bridge would likely cause these rating factors to reduce.

Soil stability where Option 1 crosses the mean high-water line is a challenge due to the steepness of the slope and the composition of the soil. Boothbay silt loam is considered highly erodible at slopes greater than 15%. Steep, unstable soils, in combination with the general vulnerability of coastal vegetation creates a substantial challenge to environmentally responsible construction.

Financial Feasibility

Due to the challenges and risks described above, this option entails significant costs. Significant resources would be required to mitigate these risks and these costs would reflect a greatly increased investment over other, lower risk alternatives. Furthermore, the longer route when compared to the preferred alternative, would be more time consuming and costly for installation.

<u>Option 2: Eckrote Property</u>

Description

As shown on **Appendix 2-F,** Option 2 from the Eckrote property includes three potential pipeline routes. In each case, intake and discharge pipes would be laid in a common trench to the shoreline. The pipes would extend from the shoreline perpendicular to Route 1, under Route 1, and to a proposed pump station associated with the facility Water Treatment and Wastewater Treatment Plant, approximately 100 feet west of Route 1. Due to wide tidal ranges and limitations on suction capacity of pumping operations, the pumps must be set at an elevation of approximately 8 feet NAVD88. Ground surface elevation in the location of the proposed pump station is approximately 35 feet NAVD88.

One route, the straight route, would head slightly northeast across the intertidal area and out to the discharge and intake points. A second route, with a slight curve (the preferred alternative), heads generally east from the Eckrote high tide line. The third route heads east and slightly south before turning more northerly to the discharge location. Each of these routes is evaluated further below.

Regulatory Requirements

Option 2 crosses one parcel of land with a single owner. Nordic has an option to obtain an easement to cross the Eckrote's property. The route across the Eckrote's complies with local requirements and will include the natural resource protections.

The straight route crosses intertidal outside of the Eckrote's parcel, while the curved route and the southern route both stay within the intertidal in front of Eckrote's parcel. The intertidal portion of the curved route is within the City of Belfast as is the discharge point and the curved route requires a smaller submerged land lease than the southern route.

Environmental Impacts

The Option 2 alignments are associated with environmental impacts; however, each of the possible alignments from the Eckrote parcel reduce impacts in comparison to Option 1. The curved route (the preferred alternative) is shorter than the southern route, further reducing the potential impacts to the benthic community and ocean environment during and after construction.

Approximately 500 linear feet (estimated 7,500 square feet) of intertidal zone would be temporarily disturbed during pipeline installation. Permanent impacts would be minimal, as the trench would be backfilled with native material.

Above the mean high-water line, approximately 325 linear feet (estimated 4,875 square feet) of vegetated area would be permanently impacted, including crossing of an unnamed stream. The orientation of the Option 2 pipe layout is nearly perpendicular to the stream, minimizing impacts. This portion of the pipeline would require clearing during construction and maintenance to prevent root growth from affecting intake and discharge pipes.

Construction Considerations/Engineering

Trenching Procedures

Option 2 would require approximately 2,800 linear feet of trenching, including below MLLW, through the intertidal zone, and upland. Trench depths would vary from very shallow at the transition from pipe laid on the seafloor to underground pipe to approximately 30 feet deep at the upland pump station. Based on current data, typical trench depths are expected to be approximately 9 feet to provide a minimum of 5 feet of pipe cover. Review of NRCS Web Soil Surveys indicates soils in this area to be primarily Boothbay silt loam with an estimated depth to restrictive feature of greater than 80 inches. Given the necessary depth of excavation and nearby exposed bedrock, it is likely that bedrock will be encountered and some removal by blasting may be required.

Assuming that bedrock is encountered, blasting would be required to achieve necessary depths. Overburden soils would be removed by excavator, and depending on the depth and extent of bedrock, the edges of the trench would be line drilled to establish the trench section. Line drilling entails predrilling closely spaced vertical holes into the bedrock to just below the bottom of trench elevation with a track-mounted hydraulic drill. Once the edges of trench have been predrilled, the boreholes would be drilled within the trench, loaded with explosives, and detonated in a linear progression to break up the rock within the trench. The blast material would then be removed by excavator and hauled offsite. Overburden soils would likely be stored onsite for use as backfill.

Challenges and Risks

Primary challenges and risks for Option 2 include the stream crossing, soil stability and revegetation, crossing Route 1 at a depth of greater than 25 feet and general blasting and heavy construction. Further discussion of each challenge, probable approach, and associated risks is provided below.

The stream crossing can be accomplished with minimal impacts using standard construction methods and best management practices for erosion and sedimentation control. Trench depths in this area will be approximately nine 9 feet. Stream banks in this area are a combination of exposed beach and vegetation with slopes up to 16%. Permanent impacts to the stream quality and channel stability are not anticipated for this option.

Maximum slopes in the direction of the pipeline are approximately 16%, and vegetation and stabilization following construction are not expected to be concerns. However, the combination of increasing trench depth and Boothbay silt loam soil characteristics, which is considered highly erodible at slopes greater than 15%, may pose a challenge to excavation stability. Use of engineered shoring and excavation protection systems will likely be required to minimize potential erosion and stability risks during excavation.

Crossing Route 1 has been carefully planned. Open excavation in this area would be accompanied by the abovementioned possibility of encountering bedrock, the risk of unstable soils in a deep excavation, and the logistical challenge of keeping Route 1 open during the crossing. Interruption of traffic on Route 1 will require a short-term detour that is planned for, as shown in **Appendix 2-F,** and additional site impacts, including temporary impacts to Stream 9, will occur as part of the detour. The established construction approach mitigates these risks and is feasible.

Financial Feasibility

Option 2 is the shortest route, as well as the route requiring the least risk mitigation procedures; therefore, it provides the most cost effective and lowest risk option for the project. Cost impacts including potential ledge removal, wetland restoration, and Route 1 temporary re-alignment are all relatively predictable costs and are within acceptable cost and risk. The curved Option 2 alternative is the preferred alternative.

<u>Option 3: Tozier Road</u>

Description

Option 3 is a pipeline that extends from the shoreline to the northwest along an existing drainage way to Tozier Road, west along Tozier Road to the intersection with Route 1, across Route 1, and south-southwest to a proposed pump station associated with the facility Water Treatment and Wastewater Treatment Plant approximately 100 feet west of Route 1. The last 600 feet of pipeline would be installed along the edge of the southbound lane of Route 1. Due to wide tidal ranges and limitations on suction capacity of pumping operations, the pumps must be set at an elevation of approximately 8 feet NAVD88. Ground surface elevation in the location of the proposed pump station is approximately 35 feet NAVD88.

A conceptual plan and profile for Option 3 is shown in **Appendix 2-F**. The figure shows the proposed alignment and profile of the intake and discharge piping in relation to local topography, bathymetry, land use, and infrastructure elements.

Regulatory Requirements

Option 3 entails multiple property owners at least one of whom was not interested in allowing use of their land for the project. The many owners potentially complicate the planning and construction process. Furthermore, construction between lots 34 and 35 on City of Belfast Tax Map 29 would likely eliminate all buffering vegetation between residences. Option 3 also requires a pump station in the residential neighborhood, which is not compliant with City regulations. Permission from the City of Belfast would be required for crossing and use of US Route 1 for installation of portions of the pipeline.

Option 3 does not meet regulatory requirements.

Environmental Impacts

The Option 3 alignment comes with environmental impacts, particularly above the mean high-water mark. Approximately 300 linear feet (estimated 4,500 square feet) of intertidal zone would be temporarily disturbed during pipeline installation. Permanent impacts to the intertidal zone would likely be minimal, as the trench would be backfilled with native material.

Above the mean high-water line, approximately 1,400 linear feet (estimated 21,000 square feet) of vegetated area would be permanently impacted, including approximately 300 feet (estimated

4,500 square feet) along which the pipeline would be within or near the banks of an existing drainage way with side slopes of approximately 20%. The existing drainage way is currently vegetated with trees. Option 3 also would require excavation and restoration of a coastal bluff with a slope of approximately 33%. The upland portion of the pipeline would require clearing during construction and long-term maintenance to prevent root growth from affecting intake and discharge pipes.

<u>Construction Considerations/Engineering</u>

Trenching Procedures

Option 3 would require approximately 3,600 linear feet of trenching, including below MLLW, through the intertidal zone, and upland. Current analysis indicates that a trench approximately 15 feet wide is required to accommodate seawater intake and discharge piping. Trench depths would vary from very shallow at the transition from pipe laid on the seafloor to underground pipe to approximately 30 feet deep at the upland pump station, with a maximum depth of nearly 40 at the intersection of Tozier Road and Route 1. Review of NRCS Web Soil Surveys indicates soils in this area to be primarily Boothbay silt loam and Swanville silt loam with an estimated depth to restrictive feature of greater than 80 inches. Given the necessary depth of excavation and nearby exposed bedrock, it is likely that bedrock will be encountered, and significant quantities of rock will require removal by blasting. However, further geotechnical investigation is required to confirm presence and depth of bedrock.

Assuming bedrock is encountered, blasting would likely be required to achieve necessary depths. Overburden soils would be removed by excavator, and, depending on the depth and extent of bedrock, the edges of the trench would be line drilled to establish the trench section. Line drilling entails predrilling closely spaced vertical holes into the bedrock to just below the bottom of trench elevation with a track-mounted hydraulic drill. Once the edges of trench have been predrilled, the boreholes would be drilled within the trench, loaded with explosives, and detonated in a linear progression to break up the rock within the trench. The blast material would then be removed by excavator and hauled offsite. Overburden soils would likely be stored onsite for use as backfill.

Challenges and Risks

Primary challenges and risks for Option 3 include soil stability and revegetation, crossing Route 1 at a depth of up to 40 feet, impacts to nearby structures and property, access to property for construction and maintenance, general blasting and heavy construction risks, property owner concerns, and changes in pipeline direction. Further discussion of each challenge, probable approach, and initial risk estimation is provided below.

Soil stability where Option 3 crosses the mean high-water line is a challenge due to the steepness of the bluff and the composition of the soil. Boothbay and Swanville silt loams are considered highly erodible at slopes greater than 15%. Steep, unstable soils, in combination with the general vulnerability of coastal vegetation creates a substantial challenge to environmentally responsible construction.

The crossing of Route 1 proposed as part of Option 3 introduces a significant logistical and construction challenge. Due to the alignment, approximately 100 linear feet of trench is required to make the crossing over the course of a roughly 70-degree sweep, at an intersection. Traffic control for Route 1, access for Tozier Road, which is a dead end, and excavation stability in a deep trench would complicate and extend the duration of pipeline construction. Furthermore, the sweep precludes the use of directional boring as an alternative method intended to minimize impacts to Route 1.

As noted on the attached figure, Option 3 positions the centerline of the trench less than 30 feet from a residential structure and within 65 feet of three additional structures. At the depths required for installation of this alignment, protection of the structure at Tax Map 29, Lot 34 would be a significant consideration.

This route is considered infeasible with regard to construction/engineering feasibility.

Financial Feasibility

Option 3 represents the costliest option for the pipe installation. The route is significantly longer than Option 2, and most of the route is located in ledge, requiring significant rock removal. Additionally, because of the length and elevation changes in the pipe, a pump station along Tozier Road would be required, adding additional costs. This option is impracticable.

2.6.2 Summary of Pipeline Options

Option 1 would involve numerous property owners, a lengthy pipeline and pipeline construction process that has significant environmental impact to the Little River and associated infrastructure and the intertidal area, and substantial cost and uncertainty.

Option 3 has significant impacts to coastal wetlands, including sensitive coastal bluff ecosystems, extensive slope stabilization measures, potential impacts to transportation infrastructure and nearby structures, numerous property owners, construction within a drainage way and loss of vegetation, deep excavation and pipe alignment at the crossing of Route 1. Lack of engineering feasibility and at least one property owner who refused access for the project make this alternative impracticable. Additionally, this option would pose significant financial burdens on the project both during installation and operation.

Option 2 achieves the purpose of transporting seawater to the proposed facility site and discharging treated water from the proposed facility in the lowest risk, fewest impacts to natural resources, and least costly method. Based on environmental, engineering, constructability analysis conducted to date, Option 2 is the preferred option. Within Option 2, the curved route is the preferred alternative for its logistical and technical advantages.