To: **Belfast Planning Board**

From: Upstream Watch Consultants

RE: **Response to Ms Olver October 10, 2020 Report:**
Nordic Aqua Farms Waste Water Discharge Review

Date: **October 15, 2020**

Upstream Watch has a number of concerns with Ms Olver's review of Nordic Aquafarms' wastewater discharge captured in a memorandum dated October 10, 2020 and entitled, "Nordic Aquafarms Wastewater Discharge Review". To begin with, many of the concerns that Upstream has had with the Nordic application have been focused on Chemical and Biological Engineering, Oceanography and technologies that we believe likely go beyond Ms Olver's experience as a Civil Engineer. Examples of important technological issues that are on the public record but have not been addressed by this current report include chemical and temperature dispersion modeling, ambient background monitoring, output and by-pass monitoring, data verification and biological response. In summary, it appears that Ms Olver has simply repeated the DEP permit conditions and has failed to respond to specific questions that Upstream's consultants have brought before the DEP. Both DEP and the Belfast Planning Board have asked questions of Nordic on these concerns, but have received no or inadequate responses. Since the DEP has also failed to directly respond to Upstream technical concerns, the Belfast Planning Board is in the uncomfortable position of needing an objective reasoned response, not a repeat of potentially politically motivated responses dictated by the applicant.

1. Allowable Nitrogen Concentration in the Effluent

Let's begin with the allowable Nitrogen concentration in the effluent discharge. "Anti-degradation" of the SB classification is one of only two specific standards that currently exist in Maine that might allow the Nordic Aquafarm, (NAF) application to meet the requirements of the Clean Water Act. "Anti-degradation" assures that the bay's state marine and estuarine waters SB classification, 38 M.R.S. §464(4)(F), not be allowed to degrade more than 20% of the assimilative capacity remaining in the bay. In this case, this means that nitrogen levels should not be higher than the default anti-degradation licensing criteria threshold, nor higher than the threshold needed to protect Eelgrass in Northport. Excess algae growth can be associated with high nitrogen. Using Nordic's own dilution numbers provided under oath both in permit application and at public hearings, DEP staff calculated that the maximum allowable concentration of Nitrogen in the effluent would be 12 mg/l, not the 23 mg/l that NAF has in its application. It was not until DEP staff had performed its own calculations and announced that the permit application's nitrogen levels are almost 2 times the size allowable under existing standards that Nordic wished to take back its modeled dilution projections. Instead Nordic wished to insert new dilution numbers at significantly higher values. Nordic's own models show that values were not the steady state values. Nordic hand-picked dilution values from a logarithmic graph that represented higher dilutions reached before the effluent had a chance to equilibrate, and coincidentally came very close to their 23 mg/l application. Understanding this dilution factor is critical to this conversation.

Attached, as Appendix A, is a more comprehensive explanation, but for the sake of simplicity, Nordic has provided a model of how the dilution of the effluent for 50% of the area being protected will vary with time. For the default licensing criteria, the steady state dilution factor from Nordic's models was 300:1 dilution and for the eelgrass protection, Nordic's models predicted a 1000:1 dilution. Nordic's model has only considered tides to move the effluent. Initially, the dilution factor is very high because the effluent has not increased the background concentration. Imagine the difference in adding the first drop of red dye to clear water and the addition of subsequent drops; the dye takes longer to diffuse evenly in an already polluted environment. As the effluent spreads into the bay, the rate of dilution will settle to a lower value. Eventually the dilution factor reaches a steady state, only oscillating with the tides, weather, and seasons. The steady state long term dilution ratio submitted in writing and verbally, both under oath was 300:1 for the default licensing criteria and 1000:1 for eelgrass. Using these dilution ratios, the maximum allowable nitrogen in the effluent was 12 mg/l, approximately ½ the 23 mg/l in the application. When it became apparent that Nordic would fail to meet this anti-degradation standard, Nordic offered and the DEP accepted the use of a higher dilution for both, a dilution that represented early non-steady state dilution numbers. Using a new dilution of 530:1, which is a dilution number from an early non steady state portion of the model, Nordic requested a new effluent maximum of 21 mg/l for the default standard. For the eelgrass, a dilution value of 1500:1 was chosen that just matched this same 21 mg/l concentration limit; again a dilution was cherry-picked to closely met the nitrogen concentration requested in their application.

Using the models properly and as intended, the real steady state number maximum concentration is 12 mg/l; Nordic will be in violation by a factor of 2, suggesting that the nitrogen discharge is twice as large as the bay can allow and keep its SB classification. DEP accepted Nordic's new number which Nordic provided to DEP by a telephone call, after the record had closed. There was no opportunity for cross-examination or rebuttal testimony that would have exposed the errors in Nordic's numbers and made a record of this "outside the record" activity. There was no cross-examination or rebuttal testimony as there would have been were the record not closed. DEP just "did it". This is one of the many reasons Upstream Watch urges the Belfast Panning Board to look carefully at what has been presented and NOT to rely on the DEP. Ms Olver was not in the position to do anything but review what was presented by the DEP. She probably just assumed DEP was doing its job. Upstream appreciates the opportunity to set the record straight.

If we assume the permit is issued with NAF's new dilution factor (the one selected to match the maximum allowable discharge). What is the likelihood that at 7.7 million gallons a day discharge, the nitrogen concentration would never exceed a level that is set at the maximum allowable amount? Any error would put the nitrogen concentration over the regulatory recommended limit. Add to this concern the minimal requirements for monitoring the nitrogen in the outfall.

Ms Olver did not address this dilution factor. It is also important for the planning board to recognize in her table why Whole Oceans was allowed higher nitrogen discharge levels. Buckport is classified as a SC. SC is the least stringent state classification for marine and estuarine waters and allows for more degradation. There are dangers in allowing for more and more degradation of the Bay. Because Belfast already discharges nitrogen, and Northport discharges nitrogen, does not address the concern about adding significantly more nitrogen and further degradation of the bay.

2. Temperature

Temperature is the one other DEP standard applicable to this waste water permit[1]. This regulatory standard sets the maximum increase in temperature for an effluent into a water body to be 1.5 degrees F in the summer. Using Nordic models that predict a 10:1 mixing zone dilution, the DEP found that the temperature increase would be 1.4 degrees F, passing the regulatory standard by only 0.1 degree F. The DEP at Nordic's request used the NOAA recreational surface temperature of 50 degree F for June. If the water temperature below the surface was just 2 degrees less, 48 degrees F, the temperature increase would be 1.64 degrees, a clear violation! Nordic's discharge will be at a depth of 35 feet where the water will be colder that at the surface but Nordic omitted that data and calculation in their model. Appendix B offers this calculation.

There is insufficient data to verify that the state Tidal Water Thermal Discharge Standard can be met. NAF is using unverified models. The NAF discharge temperature must be verified with additional data collected over several seasons and take into account anomalies in the currents and wind, and sub-circulations within the bay. The need for verified data is supported by testimony by Dr. Pettigrew and Dr. Aveni-Deforge. Additional data should be collected, before predicting effects of the effluent on the bay. Models are approximations and need to be verified with data.

Given what little monitored data for nutrients, oxygen, and stratification have been provided in the application, and that what little data there is to verify potential currents and dispersion, Upstream Watch believes that a permit should not be provided until an annual cycle of monitoring and updated modeling can reasonably demonstrate that water quality objectives will be met by NAF's proposed discharge plans. After the fact model verification is too late. The project will have been built and the violations made permanent. Verified pre-construction modeling is crucial to ensure that water quality objectives will be met, otherwise impacts on habitats, fisheries, and recreation have the potential to be significant.

Ms Olver did not address this temperature issue.

3. Dye Testing

There is concern about the appropriate time to require the permittee to conduct a dye study to more accurately determine the mixing characteristics of the treated effluent discharge from the facility with the receiving water. Performing a dye test after the fact is not consistent with the need to more accurately verify the near and far field dispersion models. Existing models suggest NAF just barely, and likely does not, satisfy both the DEP temperature and anti-degradation standards. The draft permit does not specify consequences or contingencies for the applicant (NAF) if the dye test that they conduct indicates that their model was wrong or their discharge

[1] MRSA Chapter 582:REGULATIONS RELATING TO TEMPERATURE

does not, after all, meet permit requirements. Upstream Watch has provided significantly more information about the inadequacy of the existing models with the understanding that a dye test should be only part of the verification process of the models. Most importantly this needs to take place BEFORE a permit is granted. Additional data would include temperature and current information that is gathered by sensors deployed at different locations and depths in greater Belfast Bay and also near the proposed discharge site.

What if the first dye test does not verify the near and far field models? Since a significant concern for the far field dilution consists of secondary circulation patterns and currents not limited to tides, where will the dye tests be performed? Upstream has consistently requested that the dye test be designed AND implemented prior to the permit being approved. To perform a dye test after the facility has already been constructed is too late. For the record, Upstream only suggested a dye test prior to granting a permit.

Prior to permitting, the applicant must undertake and verify additional, scientifically rigorous, Penobscot Bay circulation modeling that confidently predicts effluent movement and levels to determine the least environmentally damaging alternative for discharge. Current models provided by NAF fail to provide data to verify their accuracy and fail to take into account secondary circulation, wind shear, stratification, and other anomalies associated with the Bay. Not only that, but the NAF work contradict 35 years of data gathered by Dr Pettigrew who has made Gulf of Maine currents his life's work.

Among our stated concerns on the record are that:

1) The CORMIX and ADCIRC models are not the appropriate tools to use for the determination of mixing factors at and near the site of discharge because of their inability to fully take into account the complexity of the site with respect to the effects of winds, current speeds and direction differentiated by depth, the local tidal regime, and the local finer scale shoreline configuration.
2) Onsite monitoring data are insufficient to characterize local site specific conditions with respect to water column temperature, density, current speeds and direction, and background levels of pollutants of interest. This information, which needs to be collected over multiple seasons and at strategically identified locations, is necessary to properly provide input to and validate models. Failure to have local, site specific data reduces the utility, reliability and accuracy of models, greatly increasing the uncertainty of their results. This renders a modeling exercise, like the one that has been conducted by NAF, wholly unsuitable for the purpose of determining dilution factors which will be used for setting precise discharge concentrations, especially when the model is predicting impacts that are on the cusp of or exceed the State's relevant benchmark standards.

NAF's current data is based on models that for far-field are only 2 Dimensional and that do not take into account wind shear, secondary circulation, or currents in the bay. Verification of the models is based on very limited old data and at anomaly sites near a large methane pock area. Dr. Pettigrew provides data to suggest that NAF has even falsely predicted the direction of the effluent plume. Pettigrew and Aveni-Deforge both testified that there is need for a yearlong study; this statement is also <u>supported by NAF's own scientists</u>, (see testimonies of Dill and refer to Ramboll recommendations).

Ms Olver did not address the need to verify critical models with real time data prior to permitting.

4. Problems with a Monthly Average Water Quality-Based Mass Limitation For Total Nitrogen

A monthly average does not address the possibility of large concentrations of nitrogen that could exist for significant periods of time. We wish to be assured that the concentration values are enforceable. The proposed monitoring program provided by NAF is not sufficient either in what will be monitored nor the frequency. Providing an enforceable concentration based standard provides assurances that large slugs of contaminants cannot be released, and provides additional assurances any spills or contingency failures can be observed and monitored. As an example, NAF has provided at hearings the nitrogen concentration levels in the discharge of its Sashimi Royal facility. The nitrogen discharge concentrations varied by factors of 3, day to day.

5. Problems With A Requirement To Conduct Seasonal (May – October) Ambient Water Quality Monitoring At Five (5) Stations In Belfast Bay

The proposed permit provides no enforceable consequence to findings from this monitoring; it is after the fact (construction).

6. **Ambient Water Quality Monitoring**

Action needs to be taken to more fully characterize background levels of Total Nitrogen in the vicinity of the discharge point, in both time and space, before discharge limits can be safely established. Background levels determine a baseline to be used to assure degradation does not occur. In order to accomplish that, monitoring must be performed at multiple depths at the discharge point and at multiple locations in the bay (with locations supported by flow modeling) over the course of a year, to determine an appropriate background, as a precondition before the permit is issued.

As part of that monitoring, the presence and impacts of stratification of the water column in the vicinity of the discharge point needs to be investigated before any permit is issued and taken into account before discharge limits are set.

A review of a table from the Normandeau Associates water quality monitoring report, which is a part of NAF's MEPDES permit application, illustrates several contradictions and should raise a red flag of concern to regulators. Normandeau Associates is a NAF subcontractor.

Based on this limited set of ambient monitoring data, which is the only site-specific ambient monitoring for nutrients and oxygen levels data included in the MEPDES application, the following can be observed:

- The Normandeau ambient monitoring recorded dissolved oxygen levels below the 85% saturation criterion contained in the SB classification standard. These levels are occurring in the absence of NAF’s discharge, which would only exacerbate the oxygen deficiency.
- Levels of Total Nitrogen monitored by Normandeau for some depth profiles exceed guideline levels for the protection of eelgrass beds, which would constitute an adverse impact to marine life and habitat in the receiving waters. These levels are occurring in the absence of NAF’s discharge, which would only exacerbate the problem.

- It does not appear that the NAF water quality modeling factored the Normandeau ambient water quality analyses into their modeled water quality projections, resulting in likely under predictions of ambient levels.
- Some of the Normandeau ambient monitoring at the discharge location indicates elevated background levels of Total Nitrogen which, if representative of longer term values, could damage local eelgrass beds and contribute to low oxygen levels, especially when combined with NAF's discharge levels. The DEP's recommended background level for Total Nitrogen to be used in NAF's modeling may be unrealistically low.

Concerns about the ability of the NAF modeling to accurately predict conditions in the near and far field are also expressed in the Upstream Watch testimonies filed by both Dr. Neal Pettigrew and Dr. Kyle Aveni-Deforge. Both identified the need for additional baseline monitoring and more accurate predictive modeling, prior to the issuance of any permit.

Ms Olver did not address the need to verify models with additional real time data.

7. Membrane Bioreactors

Ms Olver discusses in very general terms the STERAPORE Hollow Fiber Membrane Bio-Reactors. While these are highly acknowledged as effective and state of the art, the applicant should provide assurances and to prove that these too will not be subject to failures that might endanger the discharge waters. While most scientific articles about MBR systems suggest membrane surface fouling as being the main operational limitation for the technology, it is widely recognized by practitioners that clogging phenomena – possibly related to inefficient pre-treatment – are at least as important. It is also recognized that clogging takes different forms. Nordic has at the last minute changed the filter size from 0.4 um to 0.04 um or 40 nm. Ms Olver makes no notice of this and the potential consequences. This is a significant change. While this smaller pore size will reduce but not entirely eliminate virus transfer, it will significantly increase the likelihood of clogging of the filters, potentially increasing the likelihood for by-passing the system and increasing temperatures of the effluent as water is "forced" through the system. We can find no examples of successful filtering at this size filter in any comparable facility. Nordic, by changing the effluent concentration from 23 mg/l (which they claimed as best available) to the newly enlightened DEP number of 21 mg/l, is now anticipating an 8% improvement in their technology. What changes in the system are being made to accomplish this improvement?
An improved technology should be either a zero or a closed loop discharge system. These systems are considered state of the art and the new frontier internationally.

8. **How to Respond to the Event of an Unpredicted Outflow Contamination**

Given the size of this facility and lack of data to support how a large facility such as this can operate at the chosen location, there is reason to suggest either a scaled back application or to incorporate special conditions into a permit.

A chief concern with the treatment process is the need for assurances that mistakes will not cause huge releases to the bay. The applicant should be asked for a detailed explanation of how errors in continuous flows will be contained before contaminant laden effluent is released to the bay. If needed, will containment structures be provided to bypass discharge to the bay? The applicant should be asked where containment structures are located on its plans on file as part of its application, or if such containment is not provided on the plans, where will/can it be located, how large will it be and how will it function with the other plan components. For example, if the storage facility is full and there is additional need, what is the plan? If the storage facility fails, how will it be emptied and what effect would emptying it have on the process and the character of the discharge?

Ms Olver did not address by-pass or contingency plans.

9. **Effluent Limitations And Monitoring Requirements**

There is no daily maximum for the concentration of total Nitrogen or any potential pollutants. We still do not know what is in the fish feed. Monthly and even weekly averages allow the possibility of concentrations greater than 21 mg/l of nitrogen to exist for extended periods of time, meaning that harmful slugs of nitrogen could be discharged.

The procedures for monitoring disease are insufficient. Methods, diseases, detection limits are not provided in sufficient detail. The permittee must comply with Maine Department of Inland Fisheries and Wildlife (MDIFW) (freshwater facilities) and Maine Department of Marine Resources (MEDMR) (salmon & marine facilities) fish health laws (12 MRS, § 6071 and 12 MRS, §§10051, 10105, 12507 and 12509, as amended). The cited laws include requirements for notification to the appropriate agency within 24-hours of pathogen detection. In addition to the requirements of the MDIFW and MEDMR rules, the permittee shall notify the DEP in writing within 24 hours following pathogen detection, with information on the disease/pathogen, necessary control measures, and the contact information for the veterinarian(s) involved . Maine IFW rules define authority, licensure of eggs and importation etc, but they do not cover testing for diseases. Many of the concerns expressed by Upstream on disease are not addressed. As an example 12 MRS 10105 “For dead fish or wildlife, dispose of that fish or wildlife in any manner considered appropriate by the commissioner.” This is too vague. This threat may be real, and in “our” Bay. What is the plan? Should Nordic be allowed to wait for a fish kill, several phone calls to DEP, and a debate between DEP and the Nordic staff, before acting to protect the Bay? The likely scenario, as seen with other violators such as Cooke Aquaculture, is a fine and continued violation. Is this a risk that Belfast is willing to take with a place where its residents gain their livelihood and recreate?

No monitoring plan is provided for virus and bacterial contamination in the discharge. Detailed sampling criteria, enforceable limits, and analytical protocols need to be developed.

There is a need for enforceable concentration based standards. Enforceable means if a violation occurs there is an automatic shut-down until the problem is resolved. The application provides maximum daily amounts for: TSS, BOD, Total Nitrogen, Total Phosphorus, Ammonia, pH, Temperature (summer/winter), salinity and also average daily values, and finally concentrations. We wish to be assured that the concentration values are enforceable. One example would be the slug-like discharge of the total daily amount of nitrogen in a small percentage of the discharge. Large concentration discharges may produce much larger impacts on the resources. Discharge limitations in NAF's MEPDES permit need to reflect its level of production to assure the minimization of pollutant discharges.

The proposed discharge limitations contained in NAF's MEPDES permit application are based on full production at the facility (Phase 2 levels). During its first years of operation (Phase 1), the facility will be operating at approximately 50% capacity and discharge limits should be adjusted accordingly. Otherwise, there is no incentive for NAF to operate its controls at their designed efficiency levels. and pollution is the inevitable result.

Discharge limits need to reflect both the concentration of effluents and the volume of effluents at that concentration, with maximum total weight of daily discharge amounts with the corresponding maximum concentrations allowed. A monitoring program needs to be developed with a high frequency of concentrations and volume reporting.

Ms Olver did not address the need for adequate chemical or microbiological testing methods or frequencies of testing.

Final Comment

Upstream Watch urges the Belfast Panning Board to look carefully at what has been presented, and to realize that all State agencies, including the DEP, can be under pressure to give a permit. When the DEP writes, “where a discharge will result in lowering the existing water quality of any waterbody, the Department has made the finding, following opportunity for public participation, that this action is necessary to achieve important economic or social benefits to the state”, it is clear that the DEP is under pressure to push through this permit, and outside factors that are not within its jurisdiction are influencing its decisions. There has been no public opportunity to discuss lowering the water quality standards for Belfast Bay in favor of economic factors.

Upstream Watch Consultants

John Krueger Qualifications:

● Past Director of Licensing & Enforcement and Past Director of Field Services at Maine DEP

● Retired Director of the DHS Health and Environmental Testing Laboratory (HETL)

● Retired Consultant for the Association of Public Health Laboratories, with numerous publications on Biomonitoring, Laboratory Data Interoperability.

● Retired Consultant for EPA Emergency Response Laboratory Network, through Computer Science Corporation

● BS and MS Massachusetts Institute of Technology in Chemical Engineering

Gary Gulezian Qualifications:

● Past Director of USEPA's Great Lakes National Program Office

● Past Chief of the Air Toxics and Radiation Branch of USEPA's Region 5 Office

● Past Chief of Regulatory Analysis Section of the Air and Radiation Division in the United States Environmental Protection Agency's Region 5 Office for the states of Illinois, Indiana, Ohio, Michigan, Minnesota, and Wisconsin

● SM Harvard University School of Public Health in Environmental Health Sciences

● AB Dartmouth in Biology with emphasis in aquatic biology

Kyle Aveni-Deforge, PhD Qualifications:

● Chief Scientist, Ecological Monitoring and Analysis LLC 2015-present

● Lead Environmental Scientist ,Stable Rd. Beach Restoration Foundation 2009 – 2015

● Environmental Scientist Oceanit Labs, Honolulu, HI 2012 - 2014

● Post-Doctoral Fellow Hawaii Institute of Marine Biology, Kaneohe, HI 2007-2010

● Ph.D. Ecology and Evolutionary Biology University of South Carolina, Columbia, SC 2007

● BA Biology Swarthmore College, Swarthmore, PA 1999

Appendix A
Responses to the DEP Procedure Order in Response to the Dilution Factor used to predict Anti-Degradation.

Upstream Watch believes that the incorrectly modeled and incorrect dilution factors were applied when calculating the anti-degradation licensing criteria. NAF provided under oath in writing and in public hearings that a 300:1 dilution factor is supported by modelling and should be used for far field dilution calculations. Using the dilution factors provided under oath by Nordic, a 300:1 dilution factor should be used for far field dilution. Based on the licensing criteria analysis to date, the proposed discharge concentration of 23 mg/L would not meet the default anti-degradation licensing criteria threshold of 12 mg/L at full flow. This is because, in the proposed discharge value of 23 mg/L would consume 38% of the remaining assimilative capacity of the receiving water. According to the state's anti-degradation policy, and the staff's historical practice and best professional experience and judgment, this would be considered a lowering of water quality and the applicant would only be able to meet the standard if it established and the Department made the findings required by 38 M.R.S. §464(4)(F)(5).

In this proceeding, the applicant utilized a hydrodynamic model referred to as the ADvanced CIRculation (ADCIRC) model to estimate the far-field dilution factors for the proposed discharge to Belfast Bay. The ADCIRC model was originally developed for coastal flood hazard studies in the larger Penobscot Bay and has many of the dynamic physical attributes of the bay already built into the model. The applicant evaluated a particle tracking output from the model to evaluate the far field dilution factor in close proximity to the proposed discharge over 4 tide cycles and determined that a far-field dilution factor for assessing impacts to dissolved oxygen is 300:1. For potential impacts to the closest eelgrass bed located 4 kilometers (2.5 miles) to the southwest of the proposed discharge along the southern shore of Northport as mapped by the Department, the dilution factor of 1,000:1 was based on the Department's best professional judgment.

The Department utilizes two total nitrogen (TN) threshold values to address aquatic life use of Maine's marine waters:

• 0.45 mg/L for protection of dissolved oxygen, when eelgrass has not been historically mapped within close proximity to the discharge in question, the so called default value environmental response indicator.

• 0.32 mg/L for protection of eelgrass, when historically mapped as present within close proximity to the discharge in question;

Using these numbers, the recommended nitrogen values should be calculated as follows:

Default Value Environmental Response Indicator

Given:

Critical water quality threshold - 0.45 mg/L

Background concentration – 0.25 mg/l

Applicant's proposed discharge concentration of total nitrogen – 23 mg/L

Far field factor: 300:1 (calculated by the applicant)

Finding: Proposed effluent limitation 0.45 mg/L – 0.25 mg/L = 0.20 mg/l (remaining assimilative capacity) (0.20 mg/L) (0.2) = 0.040 mg/L (20% of the remaining assimilative capacity) (300)(0.040 mg/L) = 12 mg/L (7.7 MGD)(8.34 lbs/gal)(12 mg/L) = 770 lbs/day. (This is the figure that Department staff believes, based upon its review and analysis to date, is the limit that would avoid the need to make supported findings pursuant to 38 M.R.S. §464(4)(F)(5).

Eelgrass as the Environmental Response Indicator

Given: Critical water quality threshold - 0.32 mg/L

Background concentration – 0.25 mg/l

Applicant's proposed discharge concentration – 23 mg/L

Dilution factor: 1,000:1 (at location of the Northport eelgrass bed, DEP station PB02)

Finding: Proposed effluent limitation 0.32 mg/L – 0.25 mg/L = 0.07 mg/l (remaining assimilative capacity) (0.07 mg/L) (0.2) = 0.014 mg/L (20% of the remaining assimilative capacity) (1,000)(0.014 mg/L) = 14 mg/L (7.7 MGD)(8.34 lbs/gal)(14 mg/L) = 899 lbs/day. (This is the figure that is the limit that would avoid the need to make supported findings pursuant to 38 M.R.S. §464(4)(F)(5).

Based on this licensing criteria the proposed discharge concentration of 23 mg/L would not meet the default anti-degradation licensing criteria threshold of 14 mg/L at full flow. This is because the proposed discharge value of 23 mg/L would consume 33% of the remaining assimilative capacity of the receiving water. . According to the state's anti-degradation policy, and the historical practice and best professional experience and judgment, this would be considered a lowering of water quality and the applicant would only be able to meet the standard if it established and the Department made the findings required by 38 M.R.S. §464(4)(F)(5). Therefore, if a permit were to be granted, and absent supported findings contemplated by 38 M.R.S. §464(4)(F)(5), the most stringent discharge concentration that would protect both dissolved oxygen and eelgrass as the environmental response indicators would be 12 mg/L based on the dissolved oxygen analysis at a full flow of 7.7 MGD. DEP staff determined that

DEP staff seem to have accepted the need to reinterpret what has been provided multiple times under oath that supports a dilution of 300:1 for the 50% area. It was only after it was determined that a 300:1 dilution is not sufficient to address the assimilation/anti-degradation standard did a new interpretation of what the steady state equilibrium dilution would be for 50% of the affected area.

Until 300:1 was found to be insufficient dilution to meet regulatory standards, professional review of dilution data determined that the dilution value was the value at the tail end of the curve, the point where equilibrium and a steady state takes place. It is the long term dilution that we seek to determine, not an arbitrary time at 5 days, or 10 days, or a fortnight. Indeed the way Upstream has viewed this figure is precisely that, what is the steady state dilution that the model is predicting? The curve is clearly approaching a 300:1 (the 2.5 value on a logarithmic chart) as the number of days increase. This is the way NAF originally characterized the dilution data for

50% of the area under consideration, and this is what Upstream believes is a reasonable way to interpret this data.

1. The 300:1 dilution value is already conservative in that it represents a 50% of the area occurrence. This is still a sizable portion of the area to exceed a standard. Allowing a 50% of the area to reach a more stable equilibrium of 300:1 is already allowing a less conservative interpretation of the likely long term dilution. There is reason to be concerned about the effect on assimilation and anti-degradation of the remaining 50% area that will see less dilution than the predicted 300:1.
2. The point of using these models of different percentages of the areas with predicted dilution is to view what the longer-term equilibrium value will be. The 25-day model for the different area percentage to reach equilibrium suggests that the lower dilutions tend to be reaching equilibrium (or a more steady state) at less than 50%. The 70% line (meaning 30% of the area will have a dilution less 160:1) is clearly showing a leveling out by 25 days.
3. To arbitrarily pick a fortnight of time that includes a tidal variation (high and low tides and tidal wave interference) before equilibrium is being reached in Figure 2 is cherry picking of data in an attempt to provide a desired result. Indeed, the way that Dill and others have originally referenced their Exhibit 23 was the statistical way to predict a steady state longer term dilution for a certain location over time. It is the end time that we seek, not the times of tidal oscillations before equilibrium is modeled. Depicted below as Exhibit 1 is a markup of Dill's Figure 2. Here, the approximate asymptotes of the data for each of the represented % areas are penciled in. The asymptote line represents the predicted end point of the final dilution value beyond the 25.45 days when the dilution has reached a more steady state equilibrium. Nordic has now suggested to use instead a cherry picked portion of the graph with a higher dilution than the steady state longer value.

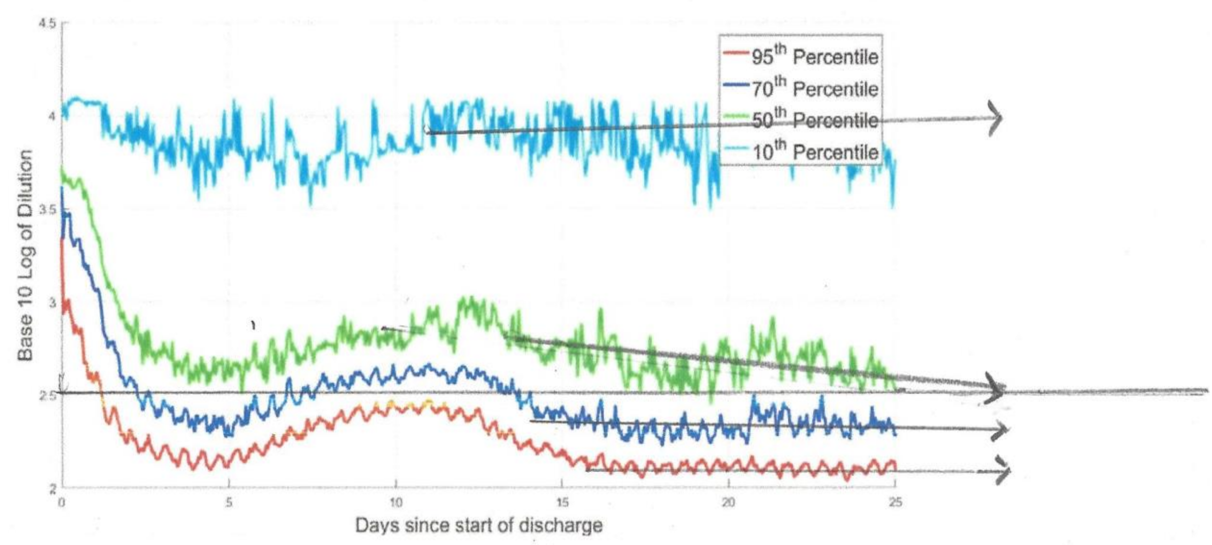

Exhibit 1 Asymptotic steady state predictions of time series areal dilution at the environmentally sensitive region containing diluted effluent with the median age of 1.5 – 2.5 days old. The $10^{2.5}$ line represents ~300:1 dilution for the Green 50th percentile.

4. Nordic testimony includes multiple references suggesting that collection of data would be needed to verify models. Upstream has provided under oath information suggesting that there is conflicting information regarding background nitrogen levels (as the application includes conflicting data on background levels), stratification (as Normandeau data suggests that stratification of oxygen demonstrates that the water column is not consistent top to bottom as a 2 Dimensional, 2 D, model suggests), and most importantly data to support that wind, wind direction, secondary circulation patterns, and current movements need validation. Also noted is that a 2 D model (ADCIRC) is insufficient to protect eelgrass and public swimming areas. The DEP have used a lower background concentration than that provided by Normandeau which is a significant advantage to Nordic's ability to meet the assimilation standard. Assuming no stratification also provides a significant advantage to Nordic to meet this assimilation standard.

5. During the testimony of DEP staff during deliberations, it was suggested that Dr. Neal Pettigrew supported the use of dye testing after the construction to model the effluent of 7.7 million gallons/day. Dr. Pettigrew did NOT suggest that this would be sufficient by itself. Dr Pettigrew is a UMO Professor of Physical Oceanography with an impressive knowledge of the ocean currents in Penobscot Bay. He has stated for the record that he believes that wind/wind direction, secondary circulation patterns, and even the predicted current pattern provided used in the 2 D model provided by Nordic need to be verified with data taken from the actual proposed discharge area. DEP staff have suggested that wind would only provide additional dilution. There is cause to believe that depending upon wind speeds and direction that there may be times when indeed less dilution will take place at the eelgrass location. This can only be verified by collection of data. The onus should be on the applicant to provide this evidence that a 2 D model is sufficient for dilution characterization.

Conclusion

The 300:1 dilution entered as a professional interpretation of the steady state equilibrium of the expected dilution of 50% of the area is a reasonable and predictable dilution from the ADCIRC models. To include variations in the dilution reached before steady state equilibrium is not reasonable. If one cannot accept the model, then the model needs to be verified by collecting real data from the specific areas being modeled. One needs to either accept the reasonable steady state dilution predicted by the model or collect data to verify that a different model characterization is warranted. Nordic has had ample time to perform this data collection, and even their own consultants have recommended under oath that additional data should be collected. Nordic could be collecting the data now. This data should also include additional testing of nitrogen and oxygen to confirm background levels and degree of stratification.

Additional Concerns with the Nordic Dilution Discussion

In an email dated May 18, 2020 from Nathan Dill to Elizabeth Ransom, Mr. Dill makes the case that both the 300 to 1 and 530 to 1 dilution factors are incorrect because the actual area of assimilation is all of Belfast Bay. Mr. Dill has estimated that the total area of nutrient assimilation will be much larger than he initially calculated, and that this much greater dilution means that the sensitive receptors located near the outfall pipe will not be threatened by Nordic Aquafarm's proposed nutrient discharge. There are two major problems with this line of reasoning:

1) Averaging the nutrient concentrations over the entire Belfast Bay artificially dilutes the pollution released at the outfall site. While this entire area may interact with *some* nutrients, the tidal excursion that drives the far-field dilution model suggests that most of the discharge will remain in a narrow body of water between Islesboro, Belfast and Northport.

2) Discrete receptors do not interact with the spatially averaged water column of the Belfast Bay, they interact with water column at their specific location. The characteristics of the water that passes an individual point changes throughout the tidal cycle, and because of their nearshore and shallow water position with a lot of locally driven hydrodynamics. The (1.5 to 2.5 day old) nitrate released from the facility will interact with these receptors at much lower dilutions than are calculated at the bay scale.

Negative effects of nutrient discharge and accumulation in the water near the discharge pipe are likely to be typical of coastal eutrophication, including increased growth rates for phytoplankton, macroalgae and epiphytes, as well as increased organic matter in the sediments and biological oxygen demand. These may lead, directly or indirectly, to seagrass die-off.

Although Ransom Consulting calculates a much higher dilution factor in the tidal prism of Belfast Bay, this is incorrect for assessing biological responses. The concentration of nutrients in the water column near the sensitive receptors will not be changed. There is still a high chance of exceeding the thresholds for concern for maintaining habitat for submerged aquatic vegetation.

APPENDIX B TEMPERATURE

Tidal Water Thermal Discharges.
MRSA Chapter 582:REGULATIONS RELATING TO TEMPERATURE

"No discharge of pollutants shall cause the monthly mean of the daily maximum ambient temperatures in any tidal body of water, as measured outside the mixing zone, to be raised more than 4 degrees Fahrenheit, nor more than 1.5 degrees Fahrenheit from June 1 to September 1. In no event shall any discharge cause the temperature of any tidal waters to exceed 85 degrees Fahrenheit at any point outside a mixing zone established by the Board."

Department staff have reviewed and analyzed the applicant's proposal from the standpoint of applicable temperature criteria and note the following: The DEP considering a worst-case scenario for the applicant's proposed discharge at the full flow of 7.7 MGD contemplated by the application as follows: The DEP used the highest discharge temperature 18°C (64.4°F). (The temperature of 18°C is the highest discharge temperature identified by the applicant in its application.) Using the mean of the daily maximum ambient temperature – non summer 1.3°C (34.3°F), in the month of March. (Ambient temperatures are coldest in the month of March.) The DEP used the mean daily maximum ambient temperature - summer 10°C (50.0°F) in the month of June.

The DEP calculations used measurements for the water temperature in Belfast, Maine provided by the daily satellite readings provided by the NOAA. The temperatures given are the sea surface temperature (SST) which is most relevant to **recreational users**. These are surface temperatures. For June, the DEP calculated that the temperature increase would be 1.4 degrees F, 0.1 degree less than the standard. What if instead of using the surface temperature as Nordic has requested the DEP to use, a temperature below the surface, closer to the temperature 35 feet below the surface where the pipe is? Using lower temperatures from below the surface has the effect of increasing the delta T. As an example, if the June mean temperature used in the calculation was just 48 degrees instead of 50 degrees F, the calculated Delta T would be:

((64.4F)(7.7 mgd)+ (48F) (69.3mgd))/77mdg =49.64 F The Delta T is 49.64F-48F = 1.64 Degrees. This would be a violation. **Using a temperature at the point of discharge of just 2 degrees less than the surface temperature would now create a temperature increase that is 0.14 degree F above the regulatory limit.**

If the modelling dilution factor varied by 10% with a 9:1 dilution factor instead of a 10:1 dilution factor (8 parts ambient and 1 part effluent) the delta T would calculate as follows:

((64.4F)(7.7 mgd)+(50F)(61.6))/69.3mgd = 51.59F The Delta T is 51.59F-50 F=1.69 Degree. **Using a mixing zone with a 10% less dilution factor would be a 0.19 degree F increase over the regulatory limit and a violation.**

The point is that the applicant needs to verify temperatures with collected data at the actual discharge point. Also the CORMIX near field model used to predict the near field dilution needs to be verified with real time data collected over varying conditions.

Global sea temperatures are increasing and our region is increasing at a faster rate than others. This is additional reason to take into account the temperature rise in our shallow bay as a result of the effluent discharge temperature. To put the effluent temperature rise into context: The average amount of heat transferred to the bay every day from this discharge would be the equivalent of the heat produced by burning 10,000 gallons of gasoline a day or the electric energy consumed by 10,000 homes a day. Waiting until the facility is built and finished and running to test and monitor the temperature increase is too late.