STATE OF MAINE

DEPARTMENT OF ENVIRONMENTAL PROTECTION

BOARD OF ENVIRONMENTAL PROTECTION

	IN THE MATTER OF
NORDIC AQUAFARMS, INC.	:APPLICATIONS FOR AIR EMISSION,
Belfast and Northport	:SITE LOCATION OF DEVELOPMENT,
Waldo County, Maine	:NATURAL RESOURCES PROTECTION
	:ACT, and MAIN POLLUTANT
	:DISCHARGE ELIMINATION SYSTEM
	:(MEPDES)/WASTE DISCHARGE
A-1146-71-A-N	:LICENSE
L-28319-26-A-N	:
L-28319-TG-B-N	:
L-28319-4E-C-N	:
L-28319-L6-D-N	:
L-28319-TW-E-N	:
W-009200-6F-A-N	:
ME0002771	

Assessment of the Nordic Aquafarms Permit to Satisfy Clean Water Act Requirements

TESTIMONY/EXHIBIT:	NVC/UPSTREAM 3
TESTIMONY OF:	John A. Krueger
	Gary V. Gulezian
DATE:	December 13, 2019

Assessment of the Nordic Aquafarms Permit to Satisfy Clean Water Act Requirements
(#ME0002771, APPLICATION OF NORDIC AQUAFARMS, INC. (NAF) MPDES PERMIT)

This testimony addresses treatment and water quality issues associated with the above referenced wastewater discharge application, and suggests questions to be addressed to the applicant and to the Board of Environmental Protection/ Department of Environmental Protection. **Were the BEP/DEP to see fit to grant a permit, our goal is to assure that the best and strongest permit be provided.** There is a case to seek assurances that sufficient data will be collected in advance as well as during the operation phase to assure the success of this permit. Ultimately, this testimony requests that considerations described herein be shared with DEP staff technical permit application reviewers and with the applicant in the form of questions and, upon receipt of adequate responses from the applicant, assuming a draft permit is warranted, that appropriate conditions be added to any draft permit. The goal is to seek: (1.) a permit that sets limits on specific pollutants, at levels which ensure that water quality standards are met at the site of the discharge, (2.) a permit that requires necessary and appropriate monitoring of the effluent, as well as a comprehensive program to monitor the chemical, physical, and biological water quality of the Bay and (3.) a permit that requires implementation of a "contingency plan" to ensure that any unexpected problems are dealt with quickly and effectively. Water conservation programs, reduction of carbon footprint and pollution prevention efforts are also of value.

More specifically, while other testimony will address the poor suitability of this site and the many unique and natural resources at stake, we wish to request that the *permitting requirements not be limited to the* use of *technology* based effluent standards in this case. [1] The DEP, as the permitting authority may also utilize water quality based effluent standards. We further understand that there are several other land based aquaculture facilities being discussed in Maine at this time This provides the state with a unique opportunity to monitor existing permitted applications under the Concentrated Aquatic Animal Production (CAAP) Point Source Category and to determine what cases can be permitted under the minimum

[1] The unique suitability issues include: (1.) a lack of a sufficient deep water current at the outfall, (2.) a lack of adequate monitoring of the ocean discharge to the bay, (3.) the choice of using a “green field” site instead of a “brown field” site with historic records and **an** existing discharge pipe, (3.) availability of ground water, and (4.) poor construction site soils

regulatory Technology Based Effluent Standards and those where additional Water Quality Based Standards need to be applied. If the underlying goals and objectives of the Clean Water Act are to be met, it may require the permitting authority to exercise its discretion to develop more stringent standards, limits, and approaches, Without a standards setting process for effluents, we are concerned that the goals of the Clean Water Act may not be achieved without the use of the agency's discretionary authority.

To provide background on capacity to describe concerns with the application, here is a brief summary of pertinent credentials:

John Krueger

- BS/MS Massachusetts Institute of Technology in Chemical Engineering
- 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

Gary Gulezian

- AB Dartmouth in Biology with emphasis in aquatic biology
- SM Harvard University School of Public Health in Environmental Health Sciences
- Past Chief of Regulatory Analysis Section of the Air and Radiation Division in the United States Environmental Protection Aency's Region 5 Office for the states of Illinois, Indiana, Ohio, Michigan, Minnesota, and Wisconsin
- Past Chief of the Air Toxics and Radiation Branch of USEPA's Region 5 Office
- Past Director of USEPA's Great Lakes National Program Office

I. Discussion of Water Quality Based Effluent Discharge Limits

Specifically this testimony will address U.S. Environmental Protection Agency (EPA) and Maine MEPDES regulations under the Clean Water Act (CWA) establishing Effluent Limitations Guidelines (ELGs) and New Source Performance Standards for the Concentrated Aquatic Animal Production (CAAP) Point Source Category. Throughout this testimony references will be made of the unique suitability issues of the NAF site as reasons for requesting that additional requirements beyond the minimum technology based standards be included in the ELG. Specific references will be made to Applicability of the CAAP ELGs to System Type or Annual Production (lb) Subcategory 100,000 Flow-through and Recirculating (Subpart A) 40 CFR 451.3(a)–(d) 451.11(a)–(e) 451.12–14 and, additionally Chapter 582: Regulations Relating To Temperature and Chapter 523:Waste Discharge License Conditions.

Typically ELGs are national standards for wastewater discharges to surface waters and publicly owned treatment works (municipal sewage treatment plants) that the EPA develops for new source categories under the Clean Water Act and these standards are technology-based (i.e. they are based on the performance of treatment, control technologies, and practices). These are minimum requirements in the NPDES permit. *A permit may contain additional more stringent limits required to ensure compliance with water quality standards.*

Minimum discharge requirements are defined in Federal Regulations: 40 CFR 122.21 and 122.28, with Effluent limitations, if applicable. Requirements include: Special conditions, Standard conditions, Monitoring, record-keeping, and reporting requirements covered under Regulation: 40 CFR 122.41. *However the permitting authority has the ability to require Special conditions – in NPDES permits for CAAPs, special conditions may be included, as determined necessary*. The technology-based limitations or requirements in a CAAP permit will be based on the ELG, for pollutants covered by the ELGs. The permit writers using best professional judgment (BPJ) may develop so called BPJ limits. A water quality-based effluent limitation is designed to protect the quality of the receiving water by ensuring that state or tribal water quality standards are met. In cases where a technology-based requirement does not sufficiently protect water quality, the permit must include appropriate water quality-based limits. *Of significance is the fact that Maine has NO standards for discharge limits for nutrients for Land Based Concentrated Aquatic Animals Production Facilities.*

Data provided by NAF in its application demonstrate that the background conditions are not truly known. Additional testimonies by Upstream will identify concerns about lack of knowledge of the fauna and flora in the receiving waters and insufficient modeling of flow characteristics such as appropriate inclusion of currents, tidal variations and wind shear. Suitability of the site should also factor into discussions regarding the uniqueness of this proposed site and why this site deserves additional attention. The unique suitability issues include: (1.) a lack of a sufficiently studied deep water ocean current at the outfall, (2.) a lack of adequate modeling and monitoring of the ocean discharge to the bay, (3.) the choice of using a “green field” site instead of a “brown field” site (preferably a brown field site with historic records and an existing discharge pipe), (3.) availability of ground water, and (4.) poor construction site soils.

A lack of significant four season monitoring in the bay and a contradiction in background nitrogen levels included in the Application demonstrates the need for a better understanding of the receiving waters.

A review of a table from the Normandeau Associates water quality monitoring report which is a part of Nordic's MePDES permit application illustrates this contradiction. The data in question are included in Table 6 of the report entitled "Summary of Results of Laboratory Analyses of Water Quality Samples Collected from Discharge Locations and Dam on September 7, 2018 in Belfast Bay, Belfast, Maine" (See Permit Application Attachment 14, Table 6, reproduced in Appendix A of this testimony). The Total Nitrogen readings of concern are depth profile samples taken at high tide at discharge Station 1 (the discharge point along the original pipeline route). The depth profile data for 0.5, 4.0, 7.0, and 10 meters of depth were, respectively, 0.42, 0.78, 0.53, and 0.32 mg/l of Total Nitrogen. These Total Nitrogen numbers are potentially significant for several reasons. First of all, they are all higher than the background value of 0.17 mg/l for Total Nitrogen that the DEP supplied to Nordic Aquafarms to be used in Ransom’s water quality impact modeling (See Permit Application Attachment 12, Table 1, reproduced in Appendix B of this testimony). If the Normandeau depth profile data are a better representation of background levels than the estimate supplied by the DEP, then Ransom’s modeling projections are presumably low by 0.34 mg/l of Total Nitrogen (approximation derived by taking an average of the 4 values of the depth profile (0.51 mg/l) and subtracting 0.17 mg/l from the average). This would raise modeled projections in the vicinity of the Northport eelgrass beds (identified critical receptor site) to a level of about 0.6 mg/l Total Nitrogen. The Ransom far field modeling report states (See Permit Application Attachment 12, page 7, reproduced in Appendix B of this testimony) that "median Total Nitrogen should be less than 0.34 - 0.38 mg/l to prevent the replacement of eelgrass habitat with macroalgae growth", so a level of 0.6 mg/l would be concerning. Furthermore, the Normandeau monitored level at Station 1, while not a true median value because of the very limited data set, raises the concern that the background level itself may be high enough to impact eelgrass, even without Nordic's additional discharge. The other salient criterion cited by the Ransom report on page 7 (See Appendix B of this testimony) is "Total Nitrogen should be less than or equal to 0.45 mg/l to prevent hypoxic conditions with dissolved oxygen concentrations less than 5 mg/l". This criterion would also be exceeded by both the adjusted Ransom model projections (about 0.7 mg/l Total N) and the background levels alone (about 0.5 mg/l Total N).

One other issue raised by the Normandeau data is the possibility that the water column in the vicinity of the discharge pipe may be subject to stratification which could magnify the concentrations of contaminants by limiting mixing and dilution. Indications of stratification can be observed in the depth profile of oxygen levels contained in the Normandeau ambient monitoring study for Station 2 in the vicinity of the discharge point on August 24, 2018. (See Attachment 14 of the Permit Application, Table 2, reproduced in Appendix C of this testimony) It is not clear whether this stratification was accounted for in any way in the Ransom modeling projections of water quality.

Based on this limited set of ambient monitoring data:

1. It does not appear that Nordic/Ransom factored the Normandeau ambient water quality analyses into their modeled water quality projections.

2. 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 Nordic's discharge levels. The DEP's recommended background level for Total Nitrogen may be unrealistically low.

3. 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. We recommend that monitoring 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.

4. The presence and impacts of stratification of the water column in the vicinity of the discharge point needs to be investigated before the permit is issued and taken into account before discharge limits are set.

Concerns about the ability of the Nordic Aquafarms' 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.

Furthermore, the applicant in the permit application states,

"The information presented here is based entirely upon numerical modeling with limited knowledge of the in-situ conditions at the proposed outfall. 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 also possible that predictive error could under-estimate impacts. *Thus, it is recommended that a field data collection program be designed and implemented to provide site specific data for further analysis, and to validate the accuracy of model results" (italics added)* (See Appendix B of this testimony)

Given what little monitored data for nutrients, oxygen, and stratification have been provided in the application, and that what little data there are suggest potential current and future problems with meeting water quality objectives, we believe there is a strong case for not approving the permit until an annual cycle of monitoring and updated modeling can reasonably demonstrate that water quality objectives will be met by Nordic Aquafarm's proposed discharge plans. Without assuring through accurate modeling that water quality objectives will be met, impacts on habitats, fisheries, and recreation have the potential to be significant.

Since many of the parameters associated with the NAF effluent are experimental in nature, (unique feed, unique RAS, unique treatment, size of operation, uncertain marine water flow parameters and recirculation uncertainties, etc,) there is a need to assess and develop technology based effluent limitations, develop proper effluent water quality-based effluent limits (WQBEL), and finally determine final effluent limitations that meet technology and water quality standards and anti-backsliding requirements. WQBELs involve a site-specific evaluation of the discharge and its effect on the receiving water. A WQBEL is designed to protect the quality of the receiving water by ensuring that State water quality standards are met. Rather than provide a permit with chemical constituents limited for just the few nutrients, additional conditions/limits should be listed. Typically states may take into account the following:

- To consider unique situations, such as facilities discharging pollutants for which data are absent or limited (e. g. pheromones, viruses, trace toxics, or treatment errors that may occur for such a large size facility), which can make development of technology- or water quality-based effluent limitations (TBELs or WQBELs) more difficult or impossible
- To address foreseeable changes to discharges, such as planned changes to process, products, or raw materials that could affect discharge characteristics.
- To incorporate compliance schedules to provide the time necessary to comply with permit conditions. · To incorporate other NPDES programmatic requirements (e.g., pretreatment, sewage sludge).
- To impose additional monitoring requirements that provide the permit writer with data to evaluate the need for changes in permit limitations.
- To increase or decrease monitoring requirements, depending on monitoring results or changes in processes or products.
- To impose requirements for special studies such as ambient stream surveys, toxicity identification evaluations (TIEs) and toxicity reduction evaluations (TREs), bioaccumulation studies, sediment studies, mixing or mixing zone studies, pollutant reduction evaluations, or other such information-gathering studies.

State regulations provide a mechanism to derive water quality based effluent limits. Reference Chapter 523 Section 5. Establishing limitations, standards, and other permit conditions. [see 40 CFR 122.44]

(c.) (2) On or after the statutory deadline set forth in section 301(b)(2) (A), (C), and (E) of the CWA, any permit issued shall include effluent limitations to meet the requirements of section 301(b)(2) (A),(C), (D), (E), (F) of the CWA, whether or not applicable effluent limitations guidelines have been promulgated or approved. These permits need not incorporate the clause required by paragraph (c)(1) of this section.

(d.) (vi) *Where a State has not established a water quality criterion for a specific chemical pollutant that is present in an effluent at a concentration that causes, has the reasonable potential to cause, or contribute to an excursion above a narrative criterion within an applicable State water quality standard, the permitting authority must establish effluent limits using one or more of the following options:*

(A) Establish effluent limits using a calculated numeric water quality criterion for the pollutant which the permitting authority demonstrates will attain and maintain applicable narrative water quality criteria and will fully protect the designated use. Such a criterion may be derived using a proposed State criterion, or an explicit State policy or regulation interpreting its narrative water quality criterion, supplemented with other relevant information which may include: EPA's Water Quality Standards Handbook, October 1983, risk assessment data, exposure data, information about the pollutant from the Food and Drug Administration, and current EPA criteria documents; or

(B) Establish effluent limits on a case-by-case basis, using EPA's Water quality criteria, published under section 304(a) of the CWA, supplemented where necessary by other relevant information; or

(C) Establish effluent limitations on an indicator parameter for the pollutant of concern, provided:

Maine Chapter 523 has similar provisions for discretionary exercise of authority:

(1) The permit identifies which pollutants are intended to be controlled by the use of the effluent limitation;

(2) The fact sheet required by Chapter 522 Section 7 sets forth the basis for the limit, including a finding that compliance with the effluent limit on the indicator parameter will result in controls on the pollutant of concern which are sufficient to attain and maintain applicable water quality standards;

(3) The permit requires all effluent and ambient monitoring necessary to show that during the term of the permit the limit on the indicator

parameter continues to attain and maintain applicable water quality standards; and

(4) The permit contains a reopener clause allowing the permitting authority to modify or revoke and reissue the permit if the limits on the indicator parameter no longer attain and maintain applicable water quality standards.

(vii) When developing water quality-based effluent limits under this paragraph the permitting authority shall ensure that:

(A) The level of water quality to be achieved by limits on point sources established under this paragraph is derived from, and complies with all applicable water quality standards; and

(B) Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with the assumptions and requirements of any available wasteload allocation for the discharge prepared by the State and approved by EPA pursuant to 40 CFR 130.7.

RAS has been described as both new and mature; either way it is becoming a standard for land based CAAP applicants. It may be useful to view newer technologies that are being developed elsewhere with an emphasis to reduce water usage, limit discharge and ultimately be more consistent with demands to reduce climate change by better management of natural resources and carbon fuels Examples include: Aquamaof Aquaculture, Superior Fresh and Sustainable Blue. Since a “green field” is the chosen site for this project, prior to the issuance of a permit (referencing the consideration of alternatives provision of the Clean Water Act), the applicant should be required to explore each of these newer zero discharge technologies and explain in detail why such technologies would not be appropriate in Belfast Maine instead of applicant’s proposed, older technology.

Those CAAP facilities subject to the ELGs must develop and maintain a best management practice (BMP) plan describing how they will achieve the ELG requirements. The CAAP must certify in writing to the permitting authority that a BMP plan has been developed and make the plan available to the permitting authority upon request. The CAAP ELGs contain narrative requirements for management practices for flow through and recirculating facilities. Under these requirements, the applicant must develop and maintain a BMP plan on site that describes how you will manage the following: • Solids control • Material storage • Structural maintenance • Record-keeping • Training

Along the lines of the CAAP ELG, the NPDES permit might also contain requirements to address other considerations, such as considerations to implement requirements under the CWA Total Maximum Daily Load (TMDL) programs. A TMDL should be a calculation of the greatest amount of a pollutant that a waterbody can receive without exceeding water quality standards. It is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the state has designated. The calculation must also account for seasonal variation in water quality.

II. Need for Enforceable Concentration Based Standards

The application provides maximum daily amounts for: TSS, BOD, Total Nitrogen, Total Phosphorus, Ammonia, pH, Temperature (summer/winter), salinity. 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.

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.

III. Other regulatory issues associated specifically with CAAP

- EPA established general reporting requirements for the use of certain types of drugs (i.e., Investigational New Animal Drugs (INADs), extra label prescriptions). EPA also established general reporting requirements for failure in or damage to the structure of an aquatic animal containment system, resulting in an unanticipated material discharge of pollutants to waters of the United States. An INAD is a drug for which there is a valid exemption in effect under 512(j) of the Federal Food, Drug, and Cosmetic Act, 21 U.S.C. 360b(j). More specifically, INADs are those drugs for which FDA has authorized use on a case-by-case basis to allow a way of gathering data for the approval process. Quantities and conditions of use are specified. FDA, however, sometimes relies on the NPDES permitting process to establish limitations on pollutant discharges to prevent environmental harm. Most NPDES permits, which mention drugs and pesticides, to date have required only reporting of the use of drugs and pesticides. Reference 40 CFR 451.3(a)(1)
- Ensure proper storage of drugs, pesticides, and feed in a manner designed to prevent spills that may result in the discharge to waters of the United States. Implement procedures for properly containing, cleaning, and disposing of any spilled materials Regulation: 40 CFR 451.11(b) and 451.21(e)
- Routinely inspect production systems and wastewater treatment systems to identify and promptly repair damage. • Regularly conduct maintenance of production systems and wastewater treatment systems to ensure their proper function. Regulation: 40 CFR 451.11(c) and 451.21(f) There is little in the application to address contingency planning for spills prevention and countermeasures. The Maine permitting authority may specify in the permit what constitutes reportable damage and/or material discharge of pollutants, based on consideration of production system type, sensitivity of the receiving waters, and other relevant factors 40 CFR 451.3(b)(1)
- Train all relevant personnel in spill prevention and how to respond in the event of a spill to ensure proper clean-up and disposal of spilled materials. Train personnel on proper operation and cleaning of production and wastewater treatment systems, including feeding procedures and proper use of equipment. RAS • Train personnel on proper operation and cleaning of

production systems, including feeding procedures and equipment. Regulation: 40 CFR 451.11(e) and 451.21(h)

- Employ efficient feed management and feeding strategies that limit feed input to the minimum amount reasonably necessary to achieve production goals and sustain targeted rates of aquatic animal growth. • Minimize accumulation of uneaten feed beneath the pens through active feed monitoring and management strategies approved by your permitting authority Regulation: 40 CFR 451.21(a) Documenting efficient feed management for EPA can be accomplished by describing the following: • Feed methods used to minimize solids production. • Modifications made to feed quantities as fish production changes (e.g., size, health of fish). • Feed handling methods used to reduce generation of fine particles of feed. • Feed formulations information for each life-history stage of fish reared. Regulation: 40 CFR 451.21(a). Feed chemistry is important. As an example minimizing metabolic excretion of nitrogen from amino acids catabolized to provide metabolic energy, and minimizing nitrogen excretion in feces from indigestible protein is the top priority in feed formulation. Therefore high quality feeds for recirculating systems should have balanced amino acid profiles, e.g., profiles that meet but do not substantially exceed dietary requirements for individual essential amino acids, and contain sufficient dietary energy from carbohydrates and lipids to "spare" dietary protein for tissue synthesis.

IV. **Monitoring to Assure that Best Practices Meet Water Quality Needs**

While NAF should be applauded for its use of proven technologies such as Moving Bed Biofilm Reactor (MBBR) designs, Staff is encouraged to ask questions regarding its ability to meet desired outflow concentrations of nutrients and other parameters for CAAP applications. Newer technologies exist and are being tested around the planet. Aquamaof, Superior Fresh, and Sustainable Blue are examples.

Some use vertical hydroponics/aquaponics that run hydraulically (a water driven system rather than a pumped vertical effluent, with low energy use). There are others which use electric driven pumps to pump water up and believe that numerous small tanks are the way to go. Another option are airlift fixed media recirculating systems to provide a minimal liquid discharge to zero liquid discharge with the use of micro-algae as the primary denitrification reactor. These micro-algae systems allow the production of algae to produce a food source for fish or generate a bio-fuel. Ozone is also used for pathogen control.

Prior to the issuance of any permit, the applicant should be required to carefully evaluate these zero discharge technologies and to demonstrate why they are not preferable to the older technology proposed by applicant.

Only ten pollutants are listed in the application. For these, a maximum daily value is listed as well as the average daily concentration. The applicant should be asked What are the maximum concentrations that might exist in the effluent, under what circumstances might that occur, how will these concentrations be prevented and how will these concentrations be measured, reported, and if necessary mitigated?

The applicant should be asked to determine and demonstrate what variation in percent removal of treatment can be expected and under what circumstances? As an example, if phosphorous removal is reduced by just one percent, from 99% to 98%, the amount of phosphorous in the effluent would double. The applicant should be asked how that will be managed to prevent additional pollution. Same for a reduction to 95% or 75%, variability is not uncommon in large scale manufacturing operations.

The flow diagrams of the treatment systems provided are difficult to read. As an example, it is difficult to see, and the applicant should be asked to reveal, where in the process that the added carbon for denitrification is introduced. The applicant should be asked to provide proper information regarding the treatment in multiple tanks which can be helpful in designing response scenarios. There are multiple tanks, some with fresh water, some with seawater, and some perhaps hybrid. The applicant should be asked for additional information about how each tank will be treated, individually or as mixed which is important as the effectiveness of the treatment systems and treatment can vary with the salinity of the water and the different wastes that may be present in each. The applicant should be asked to demonstrate the treatment effectiveness of each tank.

Because the NAF application presents something that is new and different and claims to be so much more capable of removing pollutants (pollutants should also include toxics and viruses), the applicant should provide detailed, understandable, verified information about the MBBR design. Simply stating that MBBR design is used is not helpful, since MBBR designs can change significantly. Applicant should be asked:

What is the relative size of the clarifier needed after the biological tanks, important because MBBR yields to poor sludge characteristics?

- Bead filters are variations on MBBR Different manufacturers of the bio chips (film) biofilm carrier vary in the presence of phthalates or other plasticizers and may contain bisphenol A or any other aromatic compounds. Will the biofilm carrier be made from virgin polyethylene (no recycled PE), inorganic fillers, tiny amounts of monoester of glyceric acid (made from coconut fat), citric acid and soda (Na_2CO_3). Biofilms can be made with polyethylene, polypropylene, polyurethane foam, and haydite carriers
- The application suggests that there is a post-anoxic denitrification process. The influent to the denitrification reactor comes from the nitrification reactor, so the wastewater influent ammonia nitrogen has been converted to nitrate as required for denitrification. How was the 1.5 million gallons/day of Methanol derived and what forms of nitrogen can be expected in the effluent?
- What is the plan to address any washing out of the fixed film media?
- MBBR are known to encounter problems in some calcium rich wastewaters as calcium salts can precipitate on the carriers. This phenomenon, referred to as scaling, can result in clogged carriers, which sink to the bottom of the reactor - an effect that can be detrimental for the treatment process. The applicant should be asked to demonstrate how it will avoid each of these problems.
- What are the effects of oil and grease from salmon on the biofilms?
- The application states that phosphorus removal is done by precipitation of phosphate and coagulation – flocculation of particulate phosphorus using a metal salt of calcium, aluminum or iron. The applicant should be asked to address the disadvantages of chemical phosphorus removal, the cost of chemicals, and the relatively large sludge production that increases the cost of sludge treatment and the problems and cost of sludge disposal. The applicant should be asked to address how MBBR can also provide biological

phosphorus removal as an alternative to chemical treatment methods and reduce sludge production.

- The STERAPORE Hollow Fiber Membrane Bio-Reactors. while also 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. 'Sludging' refers to the filling of membrane channels with sludge solids and depends on process design (membrane module and aerator, pre-treatment). 'Ragging' (or 'braiding') is the blocking of membrane channels with particles agglomerated as long rag-like particles (Mason et al, 2010; Stefanski et al, 2011). While effective in many wastewater treatment scenarios, membrane fouling is a recurring problem that has limited further development and application of MBRs [1]. To minimize the membrane fouling problem, a MBR is either run at critical permeate flux, which optimizes the aeration intensity to remove membrane particulates, or is frequently cleaned by physical or chemical methods . Both of these procedures are time-consuming and add to the fundamental processing costs; therefore, a more effective solution would be welcomed by wastewater engineers and plant operators. Previous studies have identified sludge concentration as a key factor contributing to membrane fouling . However, subsequent studies have shown that there are several sludge characteristics in addition to concentration that impact membrane fouling, including floc size, liquid viscosity, microbial extracellular polymeric substances (EPS) and soluble microbial products (SMP). The applicant should be asked to provide detailed responses to each of the above concerns.

- Lastly, there is no discussion of other pollutant contaminants that could exist in discharges; at public hearings, the applicant said, without substantiation, that there could be no "toxic discharge". Applicant should be asked, without testing, without documentation, how it can make that statement and how it intends to verify the current treatment system will, without fail, remove any toxic contaminants in the effluent?

V. Effluent Testing to Include 40CFR part 136 defined parameters

A significant reason to seek testing for multiple chemical and biological parameters in the waste discharge (in addition to those mentioned previously) is the major unknowns associated with the fish feed. There are multiple papers that suggest that some fish feeds used for land based aquaculture have contained toxic chemicals. While the applicant suggests that there will be no toxins in the feed, there is no statement at this time about what the feed may be and applicant refuses to reveal its fish feed selection. In addition, certification standards for fish feed have not been specifically referenced to provide assurance that the feed will not have toxins present; therefore only monitoring, after the fact, can provide assurances that toxins are not entering the waste effluent as a byproduct of the fish food.

Prior to the issuance of any permit, the applicant should be asked to perform testing, or reveal the test results of others from trusted sources, to show that currently available fish food will not provide toxins to the waste stream, as assurance that the products it chooses for fish food need not not provide toxins.

Comprehensive screening analyses of waste streams are a documented process to assure a better understanding of the composition of the waste stream. There is no feed analysis and no known source of feed and there is no requirement through the MPDES application to test for feed ingredients. Effluent testing should not be limited to nutrients, but periodically tested for 40 CFR part 136 defined parameters. Refer to Lists of methods by analyte; from 40 CFR 136.3

Table IA: Biological
Table IB: Inorganics
Table IC: Non-pesticide organics
Table ID: Pesticides
Table IE: Radiological (if deep aquifer water with radon is included as input)
Table IF: Pharmaceutical
Table IG: Pesticide active ingredients
Table IH: Ambient Biological

1. Inorganics: including metals, nutrients (available and non-available), BOD, CBOD, pH, TOC, O2, sulfides, temperature, TSS.
2. Non pesticide organics (120 parameters)
3. Pesticides (70 parameters)

4. Pharmaceuticals (33 parameters)
5. Pesticide active ingredients (268 parameters)
6. Microbiology (bacteria and virus detection)
7. Pharmaceuticals and personal care contaminants as defined in method 1698 for steroids and hormones, and include pheromones unique to salmon, and 1694 pharmaceuticals

Screening at low detection limits is for wide ranges of contaminates is recommended. Examples could include ICP/ICPMS scans for metals, GC/MS scans for volatile and semivolatile organics, HPLC/HPLCMS for higher molecular weight, nonvolatile organics. The applicant should be asked if it will agree to such a permit condition and if it will agree to test currently available fish food for those parameters.

In addition to Effluent Analysis there should be testing of any untreated collected storm waters from the facility. The large area of asphalt surfaces on the site will become conduits to carry any spillage of stored materials or processed materials in storm water drainage. Drainage from the asphalt surfaces should be contained, treated, and tested before disposal into the bay.

VI. **Feed Analysis**

Research documents indicate that it is not uncommon for aquaculture fish feed to contain toxic chemicals. While applicant suggests that there will be no toxins in the feed, there is no statement at this time about what the feed may be. Also certification standards for fish feed have not been specifically referenced to provide assurance that the feed will not have toxins present, and therefore that there might be no toxins in the effluent. What goes into the feed can also go into the discharge and have effects on treatment and effluent characteristics.

How will the applicant address Investigational New Animal Drugs (INADs)? If an INAD is used will there be a complementary analytical method provided and analyses provided?

Feed analysis should not be limited to nutrients, but also include tests for

1. Inorganics: including metals, nutrients
2. Non pesticide organics
3. Pesticides

4. Pharmaceuticals
5. Pesticide active ingredients
6. Other organics

Methods for feed analysis are generally categorized to align with FDA methods.

Listed below are resources containing some of the methods used by FDA to help ensure food safety. These methods may be utilized by the food industry as well.

Bacteriological Analytical Manual (BAM)

FDA's Bacteriological Analytical Manual (The BAM) is a collection of procedures preferred by analysts in U.S. Food and Drug Administration laboratories for the detection in food and cosmetic products of pathogens (bacterial, viral, parasitic, plus yeast and mold) and of microbial toxins.

Other FDA Microbiological Methods

Additional FDA Microbiological Methods, including environmental testing methods.

Compendium of Analytical Laboratory Methods for Food and Feed Safety

The compendium contains FDA regulatory methods currently being used by the food and feed safety program, including a searchable archive of validated methods and links to other online manuals/compendia of methods. Links to the method development, validation, and implementation (MDVIP) guidelines of FDA’s Office of Foods and Veterinary Medicine (FVM), as well as a list of methods currently undergoing validation can also be found. The compendium is a new FDA resource and FDA will be adding additional methods to it.

Drug & Chemical Residues Methods

FDA's Drug & Chemical Residues Methods lists some of the procedures utilized by analysts in FDA laboratories for the detection in food and cosmetic products of drug and chemical residues including:

- Acrylamide
- Benzene
- Chloramphenicol
- Diethylene Glycol and Ethylene Glycol

- Ephedrine Alkaloids
- Fluoroquinolones
- Furan
- Malachite Green and Metabolites; Crystal Violet and Brilliant Green
- Melamine and Analogues
- Nitrofuran
- Perchlorate

Elemental Analysis Manual (EAM)

The Elemental Analysis Manual (EAM) for Food and Related Products provides a repository of the analytical methods used in FDA laboratories to examine food for toxic and nutrient elements. The manual also provides general guidance on related aspects of a laboratory analysis.

Macroanalytical Procedures Manual (MPM)

The Macroanalytical Procedures Manual contains standardized methods of macroscopic analysis which are useful in determining defects in various types of foods.

Pesticide Analytical Manual (PAM)

The Pesticide Analytical Manual (PAM) is published by FDA as a repository of the analytical methods used in FDA laboratories to examine food for pesticide residues.

CFSAN Laboratory Quality Assurance Manual

The CFSAN Laboratory Quality Assurance Manual (LQM), 3rd Edition (2009) contains the policies and instructions related to laboratory quality assurance in CFSAN. The manual is a central resource for understanding CFSAN's quality system and provides guidance on quality concepts, principles, and practices.

The applicant should be asked if it will agree to such a permit condition and if it will test the currently available fish food for the above parameters, before any draft permit is issued.

VII. TriHaloMethanes and Bromates

Another test that is recommended is the test for trihalomethanes, THM’s. When chlorine is added to water with organic material, THMs are formed. Residual chlorine molecules react with this harmless organic material to form a group of chlorinated chemical compounds, THMs. They are tasteless and odorless, but harmful and potentially toxic. The applicant should be asked how it intends to prevent the formation of THMs.

While ozone is not listed as a backup disinfectant, many treatment systems that disinfect fresh water do use ozone. Ozone reacts with bromide, which is why ozone is typically not used to disinfect seawater. Ozone reacts with bromide to produce Bromates. Bromates are toxic. The applicant should be asked how they intend to prevent the formation of Bromates. Should Ozone be introduced into the NAF process, testing of effluent should include Bromates.

VIII. **Other Chemicals Used in the Processing**

Chemicals that have been specifically listed in the permit should be tested in the effluent to detection levels that are consistent with toxicity issues for all life affected. If these are not covered in Section 3 of this testimony, the applicant should address methods of analysis that are consistent with acceptable toxicity limits for each.

Cleaners Detergents
Aqualife® Multipurpose Cleaner
Gil Save®
Clean in Place (CIP)
Gil Super CIP®
Gil Hydrox®
Disinfectants/Sanitizers
Bleach.
Virkon® Aquatic.
Zep FS Formula 12167® Chlorinated Disinfectant and Germicide.
Therapeutants
Parasite-S, Formalin-F, and Formacide-B. (Formalin).
Finquel® or Tricane-S. (Tricaine methanesulfonate).
Halamid® Aqua. (Chloramine-T). Active ingredients N-chloro, p-toluenesulfonamide and sodium salt trihydrate.
Ovadine® (PVP Iodine).
Compounds Rarely Used Only in Emergency Situations:
Praziquantel.
Potassium permanganate
Terramycin® 200. (oxytetracycline dehydrate, 44% active):
Aquaflor®. (florfenicol; 50% active).

Romet® 30/Romet® TC. (sulfadimethoxine/ormetoprim,
Waste Water Treatment
Formic Acid (85%).
Bleach. Active ingredient: sodium hypochlorite
Methanol or replacement

The applicant should be asked if such a permit condition is acceptable and if it will agree that no operation under the permit can occur until such testing is completed and the discharge tested contains concentrations below the regulated levels.

A notable exclusion in the application is the use of Sodium thiosulfate. At the November public hearing NAF discussed the use of sodium thiosulfate to negate high level of chlorine should the need exist, yet sodium thiosulfate was not listed.

IX. **Testing for Viruses and Bacteria**

There is a potential for viruses to be in the effluent. The mesh size of the membrane filters is stated as 0.4 microns. This size would capture some but certainly not all bacteria, which generally range in size between 0.2 to 10.0 microns. Viruses range in size from 0.004 to 0.1 microns in size. Viruses would not be trapped. Given the seriousness of viruses, applicant must be asked, during this permit approval process, to demonstrate with specific currently in-service examples that UV would be effective, given proposed flow volumes in the treatment process. The ability of UV disinfection deserves more attention, e.g. water color, biofilms, time, temperature and turbulence effects can have significant effects on UV success.

A 0.4 micron filter will not separate out all bacteria and certainly not viruses.

The BEP should read Upstream Watch testimonies provided by Dr. Brian Dixon and Bill Bryden regarding information regarding bacteria and viruses that should be of concern:

Viruses:

Infectious salmon anemia (ISA) or ISAv .. (v for virus) is endemic to the Atlantic.

Infectious Pancreatic Necrosis (IPN) or IPNv is endemic to Atlantic Canada and therefore probably Maine as well.

Aeromonas salmonicida is also common in the North.

X. Nitrogen Protein Profile

Another useful test is a nitrogen protein profile in the waste stream. Currently, the permit only mentions nitrogen, but not the form. Applicant should be asked to disclose the form of nitrogen it is addressing in its process and why it is not addressing other forms. There is concern that some proteins in this waste might impart either an odor or a taste that would be a concern for other marine life. Total proteins can be tested easily; however, an HPLC analysis of the nitrogen compounds could more accurately provide information about the types of nitrogen compounds in the waste. Testing could also include hormones. This way the presence or absence of pheromones could be more assured. The reason for this test is to resolve any questions about how the presence of pheromones would serve to discourage lobsters from entering waters affected by the NAF discharge or alter the behavior of migrating endangered Atlantic Salmon.

XI. Audiological Issues

Applicant should demonstrate its concern for audiological effects of RAS outfall pumps and other sound sources on marine life, fish, shellfish and mammalian, in receiving waters. Applicant should be asked to demonstrate a current baseline and to provide follow up data showing that it has prevented harm from noise to marine life.

XII. Total Nitrogen Calculations

Generally BMP suggest that CAAP's calculate feed conversion ratios by using feed and fish biomass inventory tracking systems RAS Calculation of feed conversion ratios is an essential function on all aquatic animal farms. Under Feed Management, feed is effectively the only major source of aquaculture-derived nutrients, such as nitrogen and phosphorus, and solids in flow through systems. Optimizing feed management by using high quality feeds and minimizing feed waste can reduce the nutrients and solids generated and released to the environment. Feed also represents the largest single variable cost of production and efficient use of feeds can result in cost savings. Accurate feeding systems and appropriate feeding levels are essential for productivity, economic efficiency, and protection of the environment. Relatively short hydraulic residence times and continuous discharge of water make feed management an important component in controlling the amount of nutrients and solids discharged from flow-through systems. For recirculating aquaculture systems, the loading of potential pollutants to a receiving body of water is not entirely related to feed input, but is dependent upon the effectiveness of waste capture and treatment processes within the recirculating system and on any additional effluent treatment processes used to clean the water before discharge. Minimizing waste feed will minimize the wastes that must be treated in the recirculating system and ultimately the amount of waste released to the environment. Feed management is only one factor among many in the control of potential pollution from recirculating aquaculture systems.

The calculations of nitrogen in the effluent are based upon a 1.1kg feed/kg of fish. This ratio is optimistic. Applicant should be asked to verify this with actual current data. Because the feed is not known at this time and because the composition of the feed may have a significant effect on the availability of nitrogen in the wastewater, the calculations should instead use a less efficient ratio; 2/1 is not unreasonable, unless the applicant can demonstrate the contrary. A concern is that if the nitrogen limits suggested in the permit application are based upon unattainable feed/fish ratios then higher levels of nitrogen are likely to be released. (In this case 2.0/1.1 X or nearly twice the expected Nitrogen discharge.) Prior to permit approval, the applicant should be required to show how any change in nitrogen conversion ratios would affect discharge permit limits.

XIII. **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 in a pristine location, there is reason to suggest either a scaled back application or to incorporate special conditions into a permit.

- To incorporate preventive requirements, such as requirements to install process control alarms, containment structures, good housekeeping practices, and the like.
- A chief concern with the treatment process is the need for assurances that mistakes will not cause huge releases to the pristine bay. 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 fail, how will it be emptied and what effect with emptying it have on the process and the character of the discharge?

- Regulations under Chapter 523 Water Discharge License Conditions, Section 2
- (ii) The following shall be included as information which must be reported within 24 hours under this paragraph.

  (A) Any unanticipated bypass which exceeds any effluent limitation in the permit. (See Section 2(g)).
  (B) Any upset which exceeds any effluent limitation in the permit.
  (C) Violation of a maximum daily discharge limitation for any of the pollutants listed by the Department in the permit to be reported within 24 hours. (See Section 5 (g).)

There should be written contingency plans in addition to reporting requirements. While there is a bypass option: (2) Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs (m)(3) and (m)(4) of this section. How will 7.7 million gallons/day be handled in the event of a system failure, or there is a need to clean out a tank? Considerations should be given to the use of multiple treatment systems attached to smaller tanks, so that a disruption will not be associated with huge volumes of discharge. Consideration should be given to provision of a large storage tank to contain unsuitable discharges.

XIV. **Tidal Water Thermal Discharges.**
RSA 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."

The NAF response[2] of ambient temperature ranges does not seem reasonable to those who swim in the area. The NAF assumes infinite dilution without local effects of currents, unusual tides, or wind shear. Might there be localized temperature anomalies that exceed State regulations

Clearly, at a time in modern day history where Penobscot Bay is warming faster than many other areas in our country, it is important to be able to assure that additional thermal discharge is not occurring. Without adequate current modeling and seasonal monitoring of the discharge there needs to be more assurance that thermal discharges not exceed Maine regulations. A zero discharge would solve this, but adequate models should be required as a permit pre-requirement.

[2] Temperature of the effluent is expected to be constant at 13 degrees centigrade. Ambient temperatures range from 0 centigrade to 22 centigrade (Normandeau, 1978.

APPENDIX A
Table 6 of Attachment 14 of MEPDES Submittal
Excepted from Maine Aquaculture Water Quality Summary Belfast Bay Belfast Maine Normandeau Associates

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Table 6. Summary of Results of Laboratory Analyses of Water Quality Samples Collected from Discharge Locations and Dam on September 7, 2018 in Belfast Bay, Belfast, Maine

STATION 1	Solids, Total Suspended (mg/L)	Nitrogen, Ammonia (mg/L)	Nitrogen, Nitrate/Nitrite (mg/L)	Total Nitrogen (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Phosphorus, Total (mg/L)	Chemical Oxygen Demand (mg/L)	BOD 5-day (mg/L)
9:42, High Tide (AM)								
0.5 meters	8.5	<0.024	<0.033	0.42	0.418	0.013	1100	<2.0
4.0 meters	8.8	0.024	<0.033	0.78	0.780	0.009	1000	<2.0
7.0 meters	8.6	<0.024	<0.033	0.53	0.531	0.016	1400	<2.0
10 meters	9.0	<0.024	0.046	0.32	0.321	0.015	1100	<2.0
15:08, Low Tide (PM)								
0.5 meters	7.5	<0.024	<0.033	<0.30	0.195	0.015	670	<2.0
3.0 meters	7.8	<0.024	0.034	<0.30	0.238	0.014	860	<2.0
5.0 meters	6.9	<0.024	<0.033	<0.30	0.198	0.012	660	<2.0
5.0 meters (duplicate)	9.5	<0.024	<0.033	<0.30	0.204	0.010	800	<2.0
7.0 meters	10.0	<0.024	<0.033	<0.30	0.142	0.016	750	<2.0
STATION 2	**Solids, Total Suspended (mg/L)**	**Nitrogen, Ammonia (mg/L)**	**Nitrogen, Nitrate/Nitrite (mg/L)**	**Total Nitrogen (mg/L)**	**Nitrogen, Total Kjeldahl (mg/L)**	**Phosphorus, Total (mg/L)**	**Chemical Oxtgen Demand (mg/L)**	**BOD 5-day (mg/L)**
11:35, High Tide (AM)								

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APPENDIX B
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Subject Far Field Dilution of Proposed Discharge

- 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.

APPENDIX B
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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 50[th] 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.

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

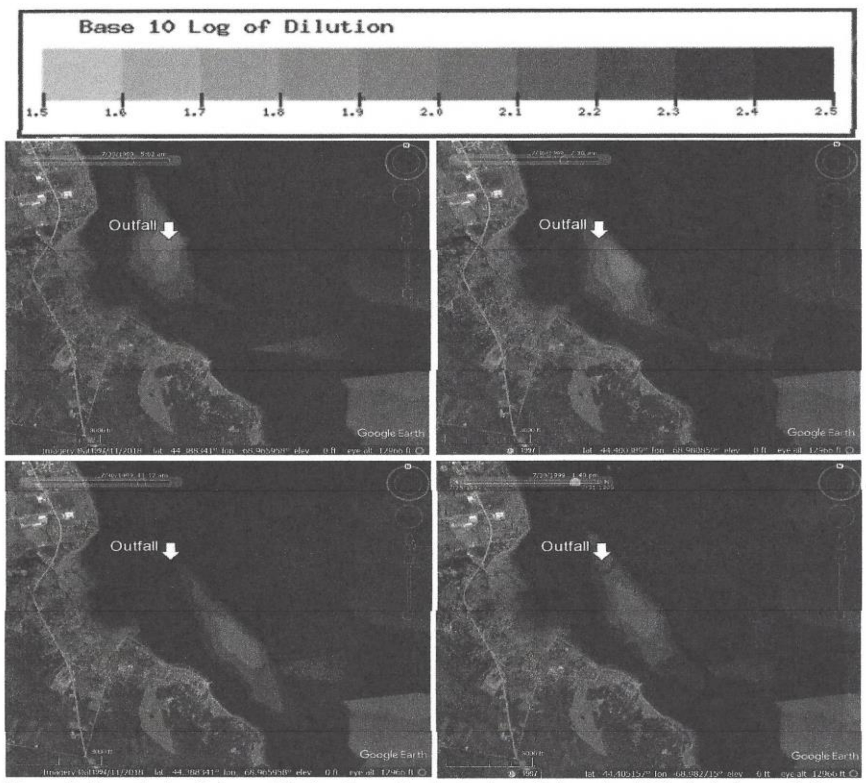

Figure 5. Snapshots of plume dilution throughout a typical tidal cycle. high slack (upper left), mid-ebb (upper right), low slack (lower left), mid-flood (lower right).

APPENDIX C

Table 2 of Attachment 14 of MEPDES Submittal

Excerpted from Maine Aquaculture Water Quality Summary Belfast Bay, Belfast Maine, Normandeau Associates.

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Table 2. Summary of Water Quality Readings Taken at Intake Locations on August 24, 2018 in Belfast Bay, Belfast, Maine

STATION 1	Temperature (°C)	Specific Conductivity (µmhos/cm)	pH (units)	DO (mg/L)	DO (%)	Turbidity (ntu)
11:35, High Tide, depth in meters						
0.5	18.73	44,301	8.11	9.42	119.6	0.00
1.0	19.26	44,192	8.10	9.49	119.5	0.00
2.0	18.01	44,511	8.09	9.49	121.3	0.00
3.0	17.70	44,712	8.08	9.23	115.9	0.00
4.0	16.71	45,597	8.00	8.96	107.8	0.00
5.0	15.18	46,999	7.96	8.81	105.6	0.00
6.0	14.02	47,412	7.86	7.89	93.5	0.00
7.0	13.31	48,235	7.86	7.87	91.4	0.00
8.0	13.00	48,385	7.84	7.26	79.8	0.00
9.0	12.87	48,450	7.83	7.25	83.6	0.00
10.0	12.25	48,532	7.77	7.00	79.8	0.00
11.0	11.84	48,649	7.73	6.63	74.6	0.00
12.0	11.48	48,819	7.75	6.51	72.9	0.00
13.0	11.46	48,815	7.76	6.37	71.3	0.00
14.0	11.41	48,835	7.76	6.15	68.8	0.00

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Table 2 (Continued) of Attachment 14 of MEPDES Submittal
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15.0	11.41	48,835	7.76	6.34	70.9	0.00
16.0	11.42	48,847	7.77	6.32	69.9	0.00
17.0	11.42	48,848	7.77	6.38	71.4	0.00
STATION 2	**Temperature** (°C)	**Specific Conductivity** (µmhos/cm)	**pH** (units)	**DO** (mg/L)	**DO** (%)	**Turbidity** (ntu)
10:00, High Tide, depth in meters						
0.5	18.26	44,366	8.10	7.64	96.3	0.00
1.0	18.17	44,401	8.13	7.56	95.1	0.00
2.0	18.00	44,440	8.15	7.77	97.7	0.00
3.0	17.85	44,538	8.15	7.86	99.0	0.00
4.0	17.49	45,028	8.13	7.66	95.3	0.00
5.0	15.10	46,832	7.96	7.28	87.1	0.00
6.0	14.76	47,255	7.98	6.72	80.1	0.00
7.0	13.51	47,659	7.88	6.06	70.6	0.00
8.0	12.92	48,748	7.87	6.10	72.0	0.00
9.0	11.91	48,639	7.78	5.64	63.7	0.00
10.0	11.52	48,810	7.77	5.58	62.2	0.00
11.0	11.51	44,818	7.77	5.23	58.6	0.00
12.0	11.47	48,812	7.78	5.41	61.4	0.00
13.0	11.47	48,849	7.79	5.60	62.8	0.00
14.0	11.43	48,855	7.78	5.56	61.3	0.00

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APPENDIX C
Table 2 (Continued) of Attachment 14 of MEPDES Submittal
Excerpted from Maine Aquaculture Water Quality Summary Belfast Bay, Belfast Maine, Normandeau Associates.

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15.0	11.43	48,867	7.78	5.49	61.0	0.00
16.0	11.43	48,812	7.79	5.38	60.3	0.00
17.0	11.43	48,880	7.79	5.48	61.4	0.00
10:21, High Tide, depth in meters						
0.5 (duplicate)	18.39	44,393	8.14	7.33	92.7	0.00
1.0 (duplicate)	18.45	44,440	8.14	7.30	92.1	0.00
2.0 (duplicate)	18.02	44,521	8.15	6.76	84.8	0.00
3.0 (duplicate)	17.91	44,590	8.14	7.07	89.1	0.00
4.0 (duplicate)	17.70	44,692	8.14	6.59	82.5	0.00
5.0 (duplicate)	15.67	46,477	8.00	6.83	82.4	0.00
6.0 (duplicate)	14.65	47,149	7.98	6.62	78.6	0.00
7.0 (duplicate)	13.31	47,767	7.87	5.82	67.4	0.00
8.0 (duplicate)	12.64	48,571	7.85	5.35	61.3	0.00
9.0 (duplicate)	12.05	48,605	7.77	5.15	58.2	0.00
10.0 (duplicate)	11.52	48,818	7.77	4.99	56.2	0.00
11.0 (duplicate)	11.48	48,801	7.79	5.27	60.5	0.00
12.0 (duplicate)	11.48	48,821	7.79	5.09	57.3	0.00
13.0 (duplicate)	11.44	48,864	7.78	5.12	57.4	0.00
14.0 (duplicate)	11.42	48,871	7.79	5.09	56.9	0.00
15.0 (duplicate)	11.42	48,881	7.79	5.17	56.2	0.00
16.0 (duplicate)	11.43	48,859	7.79	5.25	58.7	0.00
17.0 (duplicate)	11.43	48,869	7.79	5.17	57.9	0.00

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I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

________________________ December 13, 2019

Printed Name: John A. Krueger

Title:

________________________ December 13, 2019

Printed Name: Gary V. Gulezian

Title: