Appendix G

Mixing Zone Study Proposal

Oak Bay Salmon Hatchery
Oak Haven
Charlotte County
Province of New Brunswick

November 14, 2017

Prepared for:
Kelly Cove Salmon Ltd.
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November 14, 2017

SIMCorp File # SW2017-094

Mr. Mitchell Dickie
Kelly Cove Salmon Ltd.
93 Oak Haven Road
Oak Haven, NB
E3L 3S7

Dear Mr. Dickie,

Reference: **Oak Bay Salmon Hatchery - Mixing Zone Study Proposal**

Please find enclosed a Mixing Zone Study proposal in accordance with the Canadian Council of Ministers of the Environment (CCME) guidelines for the Oak Bay Salmon Hatchery located in Oak Haven, New Brunswick. Given the conditional timelines of Phase 1b, it is important to note that an approval or further guidance to the proposed methodology prior to commencing the works is required by the Environmental Assessment Section of the New Brunswick Department of Environment and Local Government no later than **Monday, December 4th of 2017**.

If you have any questions or comments on the above-noted proposal, please do not hesitate to contact our office at (506) 467-9014.

Sincerely,

Janelle Arsenault

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cc: Jake Elliott, KCS
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INTRODUCTION

The Canada-wide Strategy for the Management of Municipal Wastewater Effluent series (CCME, 2008a; CCME, 2008b; CCME, 2009) assembled by the Canadian Council of Ministers of the Environment (CCME) includes a minimum set of National Performance Standards (NPSs) and outlines the process to develop Effluent Discharge Objectives (EDOs) based on Environmental Quality Objectives (EQOs). The EQOs and monitoring requirements have already been established, as shown in Table 1, by the New Brunswick Department of Environment and Local Government (NBDELG) for wastewater facilities discharging into an estuarine or marine environment (NBDELG, 2013) for Total Nitrogen (TN) and Total Phosphorus (TP). However, an allocated mixing zone has yet to be established following CCME guidelines as indicated by NBDELG, item #47 from the latest Technical Review Committee (TRC) Response Letter #3 dated July 31, 2017, as followed: "*… to more accurately determine the potential zone of influence of the effluent within Oak Bay, a mixing zone study is required to be conducted that follows the CCME guidelines. The study sampling should be undertaken at a point within the current cycle when the biomass and feed offered is in the upper end rather than when little to no feed was offered as has been done during the 2015 study.*"

Table 1. NBDELG Regulatory Thresholds for Wastewater Facilities discharging into Estuary / Marine environments (NBDELG, 2013).

Trophic Status	Estuary / Marine		
	Total Phosphorus[2] (µg/L)	**Total Nitrogen[2] (µg/L)**	**Secchi Disk (metre)**
Oligotrophic	≤ 10	≤ 260	> 6.0
Mesotrophic	11 – 20	260 – 350	6.0 – 3.0
Meso-Eutrophic	21 – 34	350 – 500	-
Regulatory Threshold			
Eutrophic	35 – 100	> 500	3.0 – 1.5
Hypertrophic	> 100	-	≤ 1.5

According to CCME (2008a), a mixing zone is defined as "the area contiguous with a point source (effluent discharge site) where the discharge mixes with ambient water and where concentrations of some substances may not comply with water quality guidelines or objectives.". For the purpose of TN and TP discharged from the Oak Bay facility into the receiving Oak Bay estuary, an allocated mixing zone would permit EQOs to be exceeded within the allowable zone of impact as long as the Oak Bay facility abides by the EQOs set by NBDELG at the edge of the mixing zone as per the EMP (NBDELG, 2013) and Approval to Operate (ATO I-9921).

The development of a mixing zone in an estuarine or marine environment, in comparison to a stream or river, can however be challenging due to various factors which include, but are not limited to, fluctuations in current speed and direction (e.g., tides), freshwater fluxes (e.g., spring thaw), and water depth. Hydraulic modeling and / or tracer studies can assist in understanding the dynamics and boundaries of the mixing zone from a single discharge point in estuarine and marine environments (CCME, 2008a) which is consistent with those established for the municipalities of St. Stephen, New Brunswick (Dillon, 2014) and Campbellton, New Brunswick

(NATECH, 2014). As such, the purpose of this proposal is to outline a series of small-scale studies which will have an overall end goal of delineating the mixing zone of the Oak Bay facility for annual Level I monitoring of TN and TP.

METHODOLOGY

Hydraulic and / or tracer studies generally incorporate various components to achieve their conclusive results, and as such, this proposal will be divided into phases with its associated timelines of completion.

Phase 1: Description of the (a) Physical and (b) Oceanographic Environment

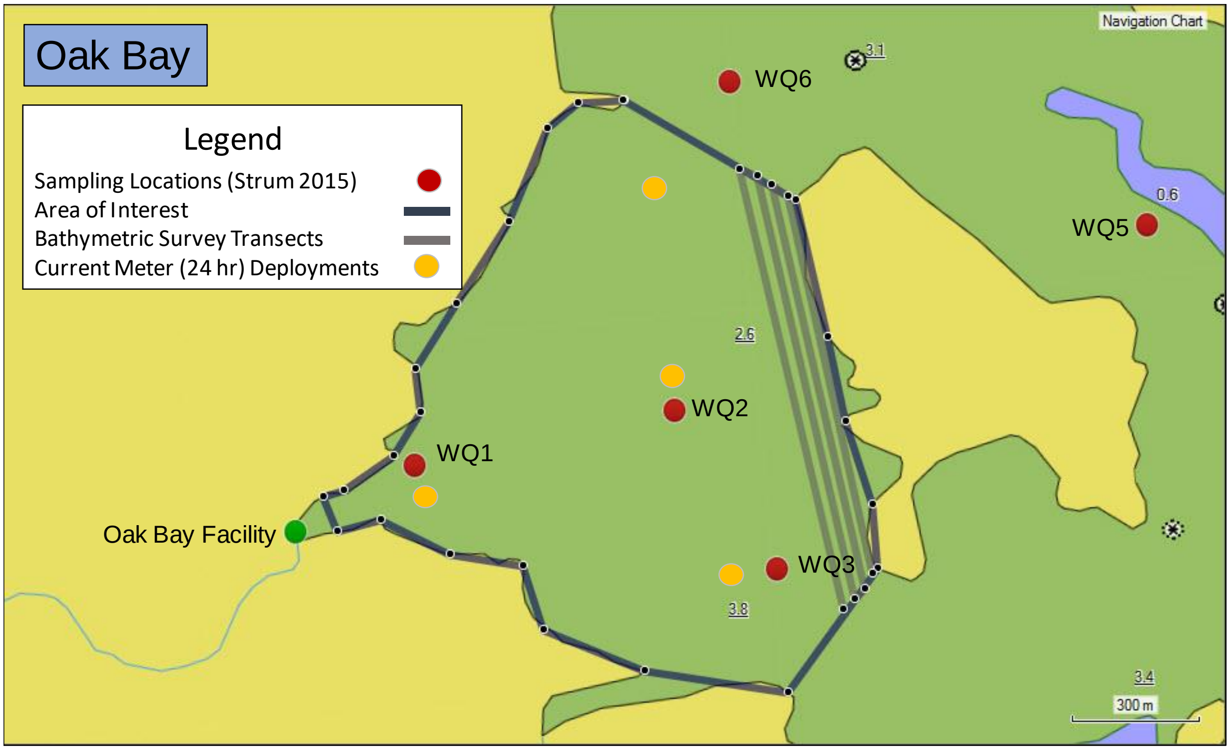
In order to better understand the hydrodynamics of the receiving body of water from the Oak Bay facility, it is important to describe, in greater detail, the physical and oceanographic conditions of the surrounding environment.

The collection of detailed bathymetric data at high tide would allow for more accurate model output predictions (described in further details below in Phase 2). The grey lines depicted in Figure 1 represent an example of the transects to be followed, which would run across the entire highlighted area of interest, for the collection of bathymetric data. The data would be collected with the use of a Dual Frequency Transducer, mounted onto a custom-build towfish, and the data later corrected for tidal variability in an underwater three-dimensional mapping software. Weather, wind and wave conditions are taken into consideration when selecting dates for the surveys as light winds and low wave height are necessary for accurate measurements. As the bathymetric survey is conducted on board a vessel, the data would be collected in the center of the area of interest starting from the mid-flood tide, or as access allows, and the outer edges would be collected near the high tide. This portion of Phase 1, titled Phase 1a, if approved by the client and the TRC, can be completed at any time; however, it would be beneficial to complete by December of 2017.

Based on communications with experts, on-site observations, and preliminary drone surveys, the presence of a natural barrier, south of station WQ3 along the southern border of the area of interest, appears to limit the flow of water into the delineated area of interest. Therefore, it is believed that the predominant water flow, as the tide rises, enters the area of interest from the north. As the tide retreats, it appears that the predominant water flow exits from the north while a small channel forms in the mud flats and exits to the south. The collection of current speed and direction data with the use of a current meter strategically placed at multiple locations (Fig. 1) for two (2) full tidal cycles (24 hours) would provide a better understanding of water movements during the rising and falling tides within the area of interest. The data would also allow for a more accurate model prediction (described in further details below in Phase 2). This portion of Phase 1, titled Phase 1b, if approved by the client and the TRC, should be completed near the time of highest loading (e.g., September) to mimic modeling parameters and conditions as much as possible, and avoid any annual cycles (e.g., spring thaw), which may alter the results. However, considering the high priority status of this project, data collection for Phase 1b could be completed in December of 2017, if the TRC deems it necessary.

Figure 1. Proposed Short-Term Physical and Oceanographic Data Collection Surveys

Note: Bathymetric survey transects would cover the entire area of interest. A few examples only are shown on the figure below.



Phase 2: Predictive Modeling of Total Nitrogen (TN) and Total Phosphorus (TP)

For consistency purposes, regulators generally set default limits, as deemed fit, to account for the compounding effects of environmental conditions (e.g., sampling frequency, sampling times, etc.). The ATO I-9921 specifies that sampling at the Oak Bay facility for TN and TP is required on the ebb (outgoing) tide. Additionally, model predictions should be run for the time of highest loading (S. Robinson, personal communication, October 31, 2017) incorporating average input parameters as well as worse-case input parameters. As such, all model predictions will be run during the ebb (outgoing) tide at peak loading (e.g., September) to obtain the most accurate estimates. The data collected during Phase 1 in addition to other necessary model input variables (e.g., effluent flow, effluent concentrations, etc.) would be assembled from previous production cycles to run the numerical model(s) for the prediction of TN and TP within the area of interest. Phase 2, if approved by the client and the TRC, in addition to having all relevant and necessary information available, could be completed by April of 2018.

Phase 3: Dilution and Validation Assessment (a) Pilot-Project (b) Ground-Truthing

In order to utilize the predictive model outputs from Phase 2 with certainty and confidence, it is important to conduct field studies for validation and comparative purposes with observed data. Based on communications with an expert (S. Robinson, personal communication, October 31, 2017) from the St. Andrews Biological Station, a time-lapsed dilution study with the use of powdered milk as the dilution agent can provide relatively important information in regards to the spatial and temporal dilution patterns of a particular area of interest (to note, Rhodamine, a fluorone dye, is considered to be a toxic substance and therefore not considered for this project). Taking into consideration the shallow depths within the area of interest and assuming TN and TP only mix within the top 1-meter depth of the water column due to a relatively dynamic surficial environment (e.g., tide and wind), the area of coverage by the plume would be multiplied by one (1) meter for volume to calculate dilution estimates.

Prior to the Ground-truthing study (described in further details below in Phase 3b), a pilot study should be conducted for verification of the proposed methodology. The Pilot-project would include releasing a known amount of powdered milk, where the effluent falls, one (1) hour after the high tide, on the ebb (outgoing) tide, and conducting a photographic time-lapse with a drone to follow the plume. This portion of Phase 3, titled Phase 3a, if approved by the client and the TRC, could be completed in June of 2018 in conjunction with the first set of regulatory sampling for the Oak Bay facility and beyond external influences from annual cycles (e.g., spring thaw). Dilution factors calculated from the plume could then be compared to predictive model outputs, specific to the conditions present at the time of sampling, and regulatory sample results. Based on the successes and failures of the Pilot-project, modifications may be required for the ground-truthing study.

Once Phase 3a is complete, modifications would be made, if needed, prior to Phase 3b, the Ground-truthing study. Phase 3b would essentially involve the same procedures as Phase 3a, with modifications if needed, and conducted during the time of highest loading from the Oak Bay facility. Phase 3b, if approved by the client and the TRC, should be completed near the time of highest loading to mimic modeling parameters and conditions as much as possible, and would therefore be projected for September of 2018.

Phase 4: Reporting

If approved by the client and the TRC, logistical planning and preparation for the various phases could begin immediately. The last component, Phase 3b which is scheduled to be conducted in September of 2018, would complete the data collection phases of the Mixing Zone study. Given the possible vast amount of data collected throughout the entire Mixing Zone study, the preparation of a final report is predicted to take some time. As such, a final mixing-zone report, to serve as an addendum to the complete Environmental Impact Assessment report, would be completed and submitted by the end of December of 2018.

SUMMARIZED TIMELINES

Table 2. Projected Timelines

Phases	Timelines
1a. Description of the Physical Environment 1b. Description of the Oceanographic Environment	December 2017 December 2017
2. Predictive Modeling of TN and TP	January – April 2018
3a. Dilution and Validation Assessment: Pilot-Project 3b. Dilution and Validation Assessment: Ground-Truthing	June 2018 September 2018
4. Reporting	December 2018

It is important to note that the projected timelines are subject to change based on the approval response time of the mixing zone study proposal by the Environmental Assessment Section of the New Brunswick Department of Environment and Local Government. Delays in the approval of the mixing zone study proposal may lead to Phase 1b pushed to September 2018 which subsequently would push Phase 2 to October – December 2018 and Phase 4 to March 2019.

REFERENCES

Approval to Operate (ATO) I-9921. Issued November 6, 2017. Kelly Cove Salmon Ltd. for the operation of the Oak Bay Salmon Hatchery. Department of Environment and Local Government.

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Dillon Consulting Limited (Dillon). 2014. CCME Municipal Wastewater Effluent Characterization and Environmental Risk Assessment (Draft). File No. 11-5027. 229 p.

NATECH Environmental Services Inc. (NATECH). 2014. Environmental Risk Assessment for the City of Campbellton Wastewater Treatment Plant, in accordance with the Canada-wide Strategy for Municipal Wastewater Effluent. 52 p.

New Brunswick Department of Environment and Local Government (NBDELG). 2013. Environmental Management Program for Land Based Finfish Aquaculture in New Brunswick. Version 1.0. 37 p.

Robinson, S. (2017, October 31). Contacted via telephone by J. Arsenault.