Appendix E Feasibility Study, Crandall, 2015

FEASIBILITY STUDY:
CAP BRULÉ WWTP OUTFALL

Prepared for:

The Greater Shediac Sewerage Commission
25, ch. Cap-Brulé Rd.
Boudreau-Ouest, N.B.
E4P 6H8

Presented by:

Crandall Engineering Ltd.
1077 St. George Blvd, Suite 400
Moncton, N.B.
E1E 4C9

REGISTERED PROFESSIONAL ENGINEER
Province of New Brunswick
M7419
Christopher J. Gallant
Signature
Date
Province du Nouveau-Brunswick
INGÉNIEUR IMMATRICULÉ

FINAL REPORT

Our File No.: 14272-1
December 2, 2015

TABLE OF CONTENTS

APPENDICES

SECTION 1.0: INTRODUCTION

1.1 Background Information on Existing Wastewater System

The GSSC's Cap-Brulé aerated wastewater treatment facility is located on Cap-Brulé Road, off of Route 133, and is situated in the southeast area of New Brunswick (PID 01065655 and 01065663). This Facility includes one (1) bar screen, one (1) grit chamber, one (1) two-celled aerated lagoon utilizing subsurface diffused aerators, three (3) alternating blowers, one (1) polishing cell and one (1) UV disinfection facility.

The effluent flow rate is measured by a flow meter which sends a signal to the GSSC SCADA software system. For the year 2014, the average flow rate of the aerated lagoon was determined to be approximately 9,000 m^3/day. Under the CCME (Canadian Council of Ministers of the Environment) regulations, the facility is classified as a medium WWTP since the average flow rate is between 2,500 m^3/day and 17,500 m^3/day.

As indicated on attached Preliminary Drawing in Appendix "A", the effluent from the GSSC's Cap-Brulé lagoon is presently discharged into an un-named, man-made, open channel that eventually discharges to Lac Boudreau Ouest, which then drains to the Northumberland Strait only under low tide conditions through another small channel. Presently, effluent nutrients may be contributing to the growth of aquatic vegetation in the marshy lake and on occasion could be a source of odor during decomposition.

1.2 Review of EDO Values and WSER Requirements

When the Canadian Council of Ministers of Environment (CCME) developed its "Canada-wide Strategy for Management of Municipal Wastewater Effluent", its purpose was to replace the wide variety of basic Provincial wastewater treatment regulations with a uniform set of coordinated environmental objectives. In order to determine the effectiveness of Canada's wastewater treatment facilities (WWTFs), an Environmental Risk Assessment (ERA) Study was required to be conducted on each municipal WWTF. The objective of the ERA Study was to determine if the WWTF was effective in reducing wastewater components to a level that did not have a negative impact on the environment. It also provides CCME with an inventory of WWTFs across Canada, and information on their performance.

Environment Canada and CCME have developed a comprehensive list of "Potential Substances of Concern" in receiving waters, and have set desired maximum concentrations for many of these based on negative effects they may have on water quality or aquatic life. These values are referred to as "Environmental Quality Objectives", or "EQOs", and may be different for fresh water and salt water receiving waters. The list of Potential Substances of Concern is related to the size of the WWTF, whether "small", "medium", or "large". As noted in Section 1.1, the GSSC Cap-Brulé WWTF is classified as a "medium" facility. (The list of Potential Substances of Concern that apply to the GSSC Cap-Brulé WWTF are listed in Table 1 of the ERA Study in Appendix "B".) The ERA Study requires that the specific effluent characteristics be evaluated against the specific receiving water characteristics to assess the impact, if any, on the environment.

Basically, the effluent quality from the WWTF must be such that it does not result in the EQO value for the receiving water being exceeded. A mixing zone is permitted for the effluent to mix in the receiving water before determining if the EQO is exceeded. The upper limit of effluent concentrations required to ensure the EQO values in the receiving water are not exceeded are called the "Effluent Discharge Objectives" (EDO).

In addition to the CCME objectives, the Federal Department of Fisheries and Oceans have established Wastewater System Effluent Standards (WSER), and Provincial Environment Departments can set more stringent requirements in their Certificate of Approval to Operate, if they feel that is required. The most stringent EDO requirement is that which will be applied to the WWTF.

The full set of EDO values that were identified by the 2014 ERA Study are attached as Table 7 in Appendix "B". The values for General Chemistry and Nutrients are summarized in Table 7a, below:

Table 7a: EDOs for Substances of Potential Concern (Partial Listing)

Test Group	Substances	Downstream Conc. (mg/L)	CCME EQOs (mg/L)	Proposed EQOs (mg/L)	Proposed EDOs (mg/L)
General Chemistry /Nutrients	Fluoride	1.46	No Guideline	No Guideline	No Guideline
	Nitrate	<0.05	16.0	16.00	16.6
	Nitrate+Nitrite	<0.05	No Guideline	No Guideline	No Guideline
	TSS	5.25	No Guideline	No Guideline	25.0
	$CBOD_5$	<6	No Guideline	No Guideline	25.0
	TAN	0.58	1.7	1.70	1.74
	Un-ionized Ammonia	*0.00319*	No Guideline	No Guideline	No Guideline
	TKN	0.75	No Guideline	No Guideline	No Guideline
	TP	0.119	No Guideline	No Guideline	No Guideline
	COD	407	No Guideline	No Guideline	No Guideline
	Cyanide (total)	0.002	0.005	0.005	0.0051
	pH (units)	7.78	6.5-9.0	6.5-9.0	6.0-9.0

Therefore, as per the ERA study, if the WWTF does not exceed the EDO values listed, the WWTF does not negatively impact the receiving environment.

1.3 Summary of the GSSC ERA Study and Results

The ERA Study, conducted and submitted in 2014, resulted in the identification of Environmental Quality Objectives (EQOs) in the receiving water leading to the Northumberland Strait and the Effluent Discharge Objectives (EDOs) required in the WWTP effluent to ensure that the receiving water's EQOs were not exceeded. This work was conducted in accordance with the procedures required by the Canadian Council of Ministers of Environment (CCME) in their "Canada-wide Strategy for Management of Municipal Wastewater Effluent".

This evaluation of the CCME list of "potential substances of concern" was applied to the effluent after UV disinfection but prior to reaching the receiving water leading to the Northumberland Strait. Chemical and physical analyses were carried out on the receiving water. In addition, acute and chronic toxicity studies were conducted in order to assess possible impacts on marine life.

It was determined that a vast majority of Substances of Potential Concern are not significant with regard to the GSSC Cap-Brulé WWTP effluent discharging to the receiving water leading to the Northumberland Strait. This was based on the downstream values as there was no incoming stream to the receiving water to provide "upstream values". Lac Boudreau Ouest is essentially a tidal pond which receives water during high tides, and has outflow during low tides. Substances near the threshold EDO levels were identified for compliance monitoring. Total ammonia nitrogen was identified to be analyzed bi-weekly for monitoring purposes, but it is not included in the NB DELG's "Certificate of Approval to Operate". (This C of A is attached as Appendix "C".) All other substances were either determined to be below the lab's reporting limit, or acceptably below the threshold EDO levels; therefore, need not be monitored. Other substances which are monitored are those specifically identified in the NB DELG's "Certificate of Approval to Operate", and include $CBOD_5$ and TSS.

In Addition, acute lethality tests were identified to be analyzed quarterly since lethal samples were obtained during the ERA Study. Conditions for additional acute lethality tests were included in the latest NB DELG Certificate of Approval to Operate until the following conditions are being met:

- Three (3) Consecutive bi-weekly positive tests being obtained in the same period where previous tests have failed.
- Quarterly Positive Tests
- Annual Positive Test

If the above conditions are not obtained, it will be required to complete a separate study to better define cause of the negative results of the acute lethality tests and establish proper remedial measures.

In Section 1.2, it was noted that it is permissible to incorporate a mixing zone at the outfall discharge point before applying the EQO test. The allowable mixing zone cannot exceed 250 m from the outfall discharge. The dilution achieved within this mixing zone is a function of flow characteristics in the receiving water. The mixing zone characteristics and dilution are determined by dye tests and drogues to identify flow patterns. It is desirable to have mixing zone dilution of 100:1 or greater.

When this assessment was done in the Lac Boudreau Ouest receiving water, it was found that the mixing zone within the 250 m limit it was not acceptable, under certain circumstances, measured at maximum 4:1 mixing ratio. It was also not acceptable because there is no significant incoming source of water apart from the rising tide generated inflow from the Northumberland Strait. As a result, there is outflow effectively for only about half of the day, and dilution is greatly reduced from an already small value.

For this reason, a recommendation was made for further study of a new discharge location in order to reach an acceptable mixing zone. A receiving water characterization study was carried out by Crandall sub-consultants, NATECH Environmental Services Inc. in the Northumberland Strait which identified a suitable location approximately 350 m offshore and 925 m from the present WWTF outfall point at the UV building.

1.4 Purpose of this Study

The ERA Study resulted in several recommendations, including the need for the Commission to begin to develop a long-term strategy plan for the outfall at the GSSC WWTP in order to meet the Canadian Council of Ministers of Environment (CCME) "Strategy for Management of Municipal Wastewater Effluent". Another recommendation was to monitor Total Ammonia Nitrogen (TAN) which leaves the WWTF at a higher concentration than the EQO, although reduction through treatment is not presently required by CCME, WSER or the Province of New Brunswick.

When the NATECH Study proposed that a new outfall into the Northumberland Strait approximately 925 m in length would be required, this and the effluent TAN concentrations raised several questions from the Commission. These included:

- Can an additional treatment component be added to the WWTF to reduce the TAN to the EQO level and would this eliminate the need for the outfall?

- What are the options for the construction of the outfall and what is its cost?

- If the Commission were to install the outfall as proposed, will it still have to upgrade its facility to provide treatment for the removal of TAN?

The purpose of this Study is to address these questions and provide strategic preliminary information the Commission will require in order to make an informed decision regarding the work required to meet the new regulations. This will include:

1. Background information will be provided on the actual dilution that occurs in Lac Boudreau Ouest.

2. Provide an overview of effluent treatment standards and possible changes as they may apply to the GSSC Cap-Brulé WWTP, in particular addressing TAN.

3. Provide an overview of the possible WWTF treatment expansion options that would result in reduction of TAN.

4. Evaluate practical options for a new outfall that would meet the CCME objectives.

5. With regard to the operation of the outfall, evaluate the requirement for pumping the GSSC Cap-Brulé WWTP effluent.

6. Provide a comparison of the advantages and disadvantages of the outfall options, and make a recommendation on the most appropriate option.

7. The question of how the construction and use of the outfall is expected to impact the discharge of TAN from the GSSC Cap-Brulé WWTP will be addressed so the Commission has that information.

8. Prepare an order of magnitude cost estimate for the preferred outfall option. (This will of necessity be quite preliminary since there is at present no geotechnical information available for the subject area, so assumptions will have to be made, and soil conditions may also affect the construction method [and cost].)

9. The Study will provide the Commission with information on the approval process for the possible construction of the proposed outfall.

10. Finally, a recommendation on the course of action that should be taken will be made.

SECTION 2.0: EXISTING OUTFALL CONDITIONS

2.1 Present Mixing Characteristics of the Receiving Water

During regular operation, the UV Disinfected effluent is discharged into a 280 m long narrow channel located at the northern most part of the GSSC Facility, shown in Figure 2-1 and Figure 2-2. Where the narrow trench does not have significant flow from any other source, it is referred to as an “open pipe” with no mixing until it is discharged into the 3.7 ha shallow basin referred to as Lac Boudreau Ouest that is connected to the Northumberland Strait via a small shallow channel shown on Figure 2-3.

Figure 2-1 – WWTP Discharge

Figure 2-2 - Narrow Outfall Trench

Figure 2-3 – Outfall to Northumberland Strait

When the tide rises the water level in Lac Boudreau Ouest is lower than that in the Northumberland Strait there is effectively no outflow into the Northumberland Strait. During this time, seawater flows into the pond area, mixing with the effluent. This results in WWTF effluent being contained in Lac Boudreau Ouest until the tide cycle proceeds to the point where the water level in the Northumberland Strait is below that of the pond, again permitting outflow and "flushing" of the basin. There is no outflow from the pond until the water level either drops to the invert elevation of the outflow channel to the Strait, or the tide change is higher than the pond level, repeating the cycle.

In the 2011 NATECH Study, the effluent plume dilution rate was identified at three (3) observed distances from the point where the outfall channel enters the pond as shown in Table 2.1.

Table 2.1 – NATECH 2011 Observed Effluent Plume Dilutions

Dilution Rate (Dye : Total Volume)	Max Observed Distance from Outfall (m)
1:3	40
1:4	120
1:5	450

These factors - low dilution rates and only periodic occurrence of dilution, combined with the fact that the pond outlet is at risk of being further restricted by sand deposition - were factors in the ERA Study making the recommendation that a new location be identified for the outfall to meet regulatory requirements. It should also be noted that the maximum dispersion plume distance permitted downstream of the effluent discharge point is 250 m, so the 4:1 dilution is likely the maximum that would be accepted for application in the pond.

SECTION 3.0: DISCUSSION ON OUTFALL REQUIREMENTS

3.1 Overview of Effluent Treatment Requirements

The ERA Study conducted for the GSSC Cap-Brulé WWTP provided an overview of the development of the effluent treatment standards, based on regulatory requirements and assessment of possible impacts on receiving water quality. The basic standards that must be met are those stated in the NB DELG's "Certificate of Approval to Operate" (Appendix "C") which is issued for each treatment facility individually. The current NB DELG COA states the following treatment objectives:

- $CBOD_5$: shall not exceed 25 mg/L;
- Suspended Solids (TSS): 25 mg/L;
- E. coli: shall not exceed 200 MPN/100 mL after disinfection

In addition, the CCME ERA Study compares effluent discharge characteristics to water quality in the receiving water, and if more stringent treatment is required to protect the environment, those parameters and limits are added. From the ERA Study, a recommendation was made to monitor Total Ammonia Nitrogen (TAN) levels in the effluent because of its typical values being higher than the proposed Effluent Discharge Objective (EDO) required to in turn meet the Environmental Quality Objective (EQO) for the receiving water. TAN is a nutrient which is monitored since high values can contribute to excessive aquatic plant growth in the receiving water. That is undesirable because when those aquatic plants die, they consume dissolved oxygen from the water and can reduce oxygen values that are relied upon for fish survival. Areas where nutrient discharges are more likely to be of concern are lakes and waterways where the effluent discharges may constitute a higher percentage of total receiving water volumes. Nutrient control of discharges into marine waters is rare unless they represent a high concentration in a localized area contributing to an identified problem.

However, at present, there is no requirement for nutrient (phosphorous is the other nutrient of interest in addition to nitrogen) for the GSSC facility. In most jurisdictions, requiring reduction of nutrients is done on a location-by-location basis based on specific impacts to sensitive receiving waters. If it were deemed in the future that TAN reduction was required to meet the EQO value in the receiving water, The Commission would then be required to make changes to its treatment system to meet the requirement.

The dilution of 4:1 observed in the pond during the ERA Study characterization work is not sufficient to dilute the TAN in the WWTP effluent to meet the EQO value.

3.2 Overview of Options to Reduce TAN to Acceptable Levels

Therefore, some modification to the treatment process may be required in the event that TAN has to be controlled to meet the EQO value for the receiving water. There are two general approaches that can be considered:

- Process-specific biological treatment to reduce TAN; or,
- Installing an outfall which achieves sufficient dilution within the allowable plume to meet the EQO value.

A process-specific biological treatment process, nitrification-denitrification, could be added between the polishing cell and the UV disinfection system. It requires sequential reactors (tanks or basins) in which specific conditions are maintained to support the bacterial which carry out the nitrification conversion and then the denitrification processes. The major factor that would make this difficult to apply to the Cap-Brulé WWTP is its very large fluctuation in flow rates which would make the reactors and associated equipment (aeration system, pumps, etc.) large and not efficiently used during normal flow rate periods. Process control would also be difficult due to these large variations in flow that could wash out the microbiological population or make process parameters difficult to maintain. It typically requires close operator control to maintain the process. A preliminary cost estimate has not been prepared, but it would be very significant.

It was noted in Section 1.3 that the dilution achieved within the allowable plume can be applied before the EQO test is applied. That is, if the dilution is such that the TAN concentration is reduced to a value less than the EQO value before leaving the plume, it is acceptable. From the ERA Study, the WWTP characterization determined that the average TAN value in the effluent was 11.44 mg/L and the EQO value was 1.70 mg/L. If a new outfall location were found which achieved a dilution of 100:1 in the dispersion plume, the resulting TAN value at the boundary of the plume would be 0.114 mg/L, easily satisfying the EQO limit.

Based on this preliminary comparison of the alternative methods of meeting the desired EQO values, *it is recommended that the new outfall option be evaluated in greater detail* due to its presumed significantly lower capital and operating and maintenance costs compared to a nitrification-denitrification process. This will not only result in the EQO for TAN being met, but will also eliminate the current less than desirable effluent discharge location.

3.3 Evaluation of Effluent Discharge Locations and Mixing Characteristics

Reference has been made to the NATECH Environmental Services Inc. "Bathymetric Survey and Assessment of Potential Outfall Configurations for the Shediac Wastewater Treatment Plant, June 23, 2015". The purpose of this Study was to assess the conditions in the Northumberland Strait offshore of the Cap-Brulé WWTP including where the desired dilution is achieved. This Study report is attached as Appendix "E".

This Study concluded that the new outfall pipe would have to extend approximately 350 m offshore in order to be located so that not only is the desired dilution of 100:1 achieved but the outfall discharge would be located in a minimum of 2 m of water at low tide to offer a better degree of protection from ice during the winter than a location nearer the shore. Based on the application of CORMIX modeling software (software recommended by CCME to assess dilution of effluent in receiving waters), it determined that a single outfall discharge point would not achieve the desired dilution; multiple effluent discharge nozzles would be required.

The total length of this outfall from the Cap-Brulé WWTP UV disinfection chamber would be approximately 925 m.

The Study also cautioned that any design must consider the possible risks to the outfall in this area of the Northumberland Strait. Factors included sediment transport which could cover (or reduce cover over) the outfall pipe, and accumulation of ice pieces (ice "rafting") on the pipeline. It is anticipated that the bottom conditions would be more stable as the distance from the shore and depth of water over the outfall increase.

The NATECH Study also commented on some alternative concepts that did not extend so far into the Strait. While shorter, they did not offer the degree of dilution desired, so would require either higher levels of treatment or partial effluent retention to discharge at higher rates on falling tides only. They would also put the exposed, discharge area of the outfall at greater risk of damage from ice floes.

Recognizing the design considerations for reducing the risk of ice damage and impacts from sediment transport, it is recommended that the evaluation continue based upon the proposal for an outfall extending 350 m into the Northumberland Strait.

3.4 Evaluation of Effluent Pumping Requirements

It was noted in the previous section that multiple outlet nozzles are required at the end of the outfall to achieve the desired dilution ratio. Also the discharge rate must be sufficient to promote mixing and keep the nozzle areas clear. Previous survey work conducted in the area of the Cap-Brulé WWTP and the pond and outfall areas indicate that there is very little elevation difference between the effluent leaving the WWTP and the high tide level in the Northumberland Strait. That elevation difference is the only "energy" available to push the effluent through the outfall.

The elevation of the pipe invert leaving the Cap-Brulé WWTP UV disinfection building is +1.857 m, and allowing for 0.4 m depth of flow in the 900 mm diameter pipe at that point results in an elevation of +2.257 m; this is the “head” available at the beginning of the proposed outfall. Using an assumed high tide level of +0.5 m geodetic in the Northumberland Strait, the net elevation difference is 1.857 m. However, this normal high tide level does not take into account storm surges that can occur that could greatly reduce this available gravity head at the outfall. During such conditions, it is possible there would be insufficient head to allow flow through the outfall pipe resulting in back-ups and possible flooding at the WWTP.

Considering the friction losses in the outfall pipe from the effluent flow, the need to have a good discharge velocity at the nozzles, and risk of storm surges, there is not sufficient energy to achieve reliable flow, and it is considered unadvisable to attempt to operate an outfall by gravity flow on the basis of the low head available.

Therefore, it is advisable to pump the effluent through the proposed outfall pipeline. This will ensure that effluent is discharged at the proper rate regardless of external conditions. While a high pumping head is not required, such a pumping facility must have a high capacity to deal with the variation in flow through the WWTP.

However, due to the fact that there is high infiltration/inflow to the collection system under wet weather conditions, effluent flow rates have been observed to vary from a normal average flow rate of 104.0 L/s under dry-weather conditions to an approximate high of 450.0 L/s under extended wet weather conditions. Due to the infrequent occurrence of the extreme high flows, and the cost impact of providing pumping facilities and controls for the high flows and the resulting impact on the size of the 925 m long outfall, it is proposed to limit the pumping rate to peak dry weather flows. Flows in excess of this would by-pass to the existing effluent channel to Lac Boudreau Ouest. This concept will have to be approved by NB DELG but is felt to be a realistic approach.

Therefore, the proposed effluent pumping station and outfall would be designed for a peak flow rate of 227.2 L/s with two (2) pumps with a 3^{rd} pump on stand-by.

Crandall has prepared a preliminary design concept for such an Effluent Pumping Station (EPS) which would receive flow directly from the UV system outlet. Based on this preliminary design, the facility would include three (3) pumps, each designed for at least 50% of the peak flow capacity. Only two (2) of the three (3) pumps will be required at any time, so the third pumps will serve as a stand-by to ensure reliable operation and additional protection during high flows. The pumps will be operated through a VFD controller to ensure flow rates are within the range required for dispersion from the outfall, and to minimize the size of the wet well required. Screening and grit removal facilities are not required here due to only treated effluent being pumped. The wet well will have an overflow by-pass feature (above the anticipated storm surge level) that will function only when effluent flows exceed the pre-set maximum pumping capacity of the EPS.

Pumped flows will be measured by a flow meter installed in the discharge piping from the pumps, and any by-passed flows will be measured by a weir in the overflow structure. The EPS will have stand-by power to ensure operation of any two (2) of the pumps, controls, and building heat and lights, in the event of a power outage. Preliminary sizing of pumps would be three (3) 35hp pumps with corresponding VFD's. At this stage we estimate a 150Kw stand-by generator as back-up for the above mechanical equipment.

3.5 Design Considerations for the Outfall

The NATECH "Bathymetric Survey and Assessment of Potential Outfall Configurations for the Shediac Wastewater Treatment Plant, June 23, 2105" provided some design recommendations for the outfall that will be incorporated. These include:

- Outfall discharge being located 350 m offshore at a location where there will be a minimum of 2.0 m of water cover at low tide;
- Incorporating an effluent diffuser consisting of five (5) nozzles at 5 m spacing at the end of the outfall.

The NATECH suggestion to have the last nozzle at the end of the outfall to assist in pipe flushing will be modified. In order to ensure that the GSSC will be able to clear the outfall of the solids (minor suspended solids in the effluent, sand from the Strait, etc.) it is proposed to design it with provision for convenient swabbing, if required. This would consist of a swab launching station installed at the EPS, and a removable end cap on the outfall that would be removed by a diver and winch equipped boat. If required, this allows a positive method for cleaning the outfall. The need for swabbing the pipe can be gauged by swabbing after one year of operation to determine the amount of accumulation, and then establishing a schedule for regular swabbing. An indication of solids accumulations can also be interpreted over time by monitoring the power (amperage) drawn by pumps when operating.

It will be necessary to install the outfall pipe below the sea bed, except for the diffuser area, for protection from ice, shifting sea bottom, and boat anchors. In addition the outfall diffuser area would be marked as a "NO ANCHORAGE" area.

However, at this time it is not possible to develop an accurate cost estimate for its construction, or even to determine the construction method required, since no geotechnical information is available for the proposed outfall area. In order to develop a reasonable cost estimate it is essential that geotechnical information be obtained not only for the 575 m of outfall pipe on land, but particularly for the 350 m in the marine area. It is recommended that the GSSC authorize such geotechnical investigations so costs can be developed upon which to base a decision on the outfall proposal. A program of boreholes along the land and marine sections of the outfall is estimated to cost $50,000.00.

3.6 Comparative Advantages and Disadvantages of Options

Dredging of Existing Lac Boudreau Ouest Channel:

Advantages:	- Quick, short term; - Smaller initial capital cost.
Disadvantages:	- Not cost effective; will have to be repeated regularly; - Over a short period of time tidal activity will refill any dredged channels with the surrounding sediment/sand; - Dilution in Boudreau Ouest Lake will only achieve a theoretical maximum of 4:1 and will not guarantee the EQO values at this dilution will always be met;

- Flushing only occurs twice per day in high tide events. This leaves about half of the day with no outflow water, resulting in irregular dilution patterns;
- Anticipated difficulty of obtaining the series of environmental permits required;
- Does not eliminate the discharge of effluent to Lac Boudreau Ouest;
- Treatment for TAN is still required.

New Outfall/Forcemain Discharging to the Northumberland Strait:

Advantages:

- 100:1 dilution is achieved with five (5) diffusers, (350 m) from shore;
- The value of TAN is reduced well below the Environmental Quality Objective within the allowable mixing zone, eliminating the need for alternative treatment;
- Effluent discharge meets CCME and WSER requirements;
- Effluent is consistently discharged at a proper rate to an acceptable discharge location and will operate independent of tide cycle or storm surge;
- The Effluent Pumping Station and outfall option is less expensive than the possible future requirement for adding nitrification-denitrification to the treatment process to the Cap-Brulé WWTP;
-Based on CORMIX modeling done to date, the flow pattern from the outfall diffuser has been confirmed as suitable;
- Effluent is removed from the existing Lac Boudreau Ouest. Over a short period of time tidal flushing will remove any remaining effluent residue from the marsh in turn removing the potential for odours and excess vegetation.

Disadvantages:

- Effluent requires pumping via new lift station and outfall/force main with associated construction, operational and maintenance cost;
- There is some risk to the outfall from possible severe ice conditions.

Additional Treatment for TAN Reduction:

Advantages: - Achieves reduction in TAN concentrations to satisfy EQO limits.

Disadvantages: - Expensive system to construct since it must have capacity for full Cap-Brulé WWTP flows; anticipated to be the most expensive of the alternatives considered;
-Land area requirements are significant and may not be available;
- Increased operational requirements in terms of operator involvement, aeration and pumping costs;
- Does not eliminate the discharge of effluent to Lac Boudreau Ouest;
- Does not achieve desired CCME level of dilution of effluent so does not avoid the requirement to install a new outfall to the Northumberland Strait;
- May not be permitted by regulatory authorities without the outfall being included;

Based on these considerations, it appears that the option of installing the new outfall, even with the Effluent Pumping Station, is the preferred option. It achieves the greatest number of significant benefits of the options described. The proposed location of the Effluent Pumping Station and the Outfall pipe and diffuser is also shown on preliminary drawing, attached as Appendix “A”.

3.7 Discussion on the Impact of a New Outfall on TAN Effluent Discharges

If the new outfall achieves a dilution of 100:1 within the allowable plume limits, it will reduce the average TAN value in the effluent from 11.44 mg/L to 0.114 mg/L, easily satisfying the EQO limit of 1.70 mg/L.

Achieving this dilution, and therefore easily meeting the EQO for TAN, does not appear to be an issue. The NATECH "Bathymetric Survey and Assessment of Potential Outfall Configurations for the Shediac Wastewater Treatment Plant, June 23, 2105" states:

> "According to the model predictions, a (diffuser) length of 25 m appears sufficient to provide a dilution greater than 1 in 100 within 250 m from the outfall for a relatively low ambient current velocities (sic) of 0.2 m/s. When the current speed increases, the dilution increases significantly."

3.8 Regulatory Approval Requirements

a. The NB DELG, DFO and Coast Guard will be contacted to determine the approval requirements needed to conduct the recommended geotechnical investigations.

b. The NB DELG will be contacted to confirm if an EIA Registration is required for this work. If so, the project will be registered in accordance with the "Guide to Environmental Impact Assessment in New Brunswick, April 2012". (The Guide does state that for sewage treatment facilities "…any modification, extension, abandonment, demolition of rehabilitation of them are undertakings for the purposes of the *Environmental Impact Regulation* and must be registered…".

c. An Environmental Project Description would be completed during detailed design to determine what environmental requirements will apply to this project. At this stage, it is assumed that a Watercourse and Wetland Alteration Permit (WAWA) and Navigable Protection Act (NPA) Notice of Work Form will be required.

d. In order to identify the proper location for the outfall discharge, a Mixing Zone Field Identification Study was conducted to assess several locations in the Northumberland Strait. A location approximately 350 m from shore is recommended. The NATECH Study (attached) also determined that effluent released at the proposed location will flow east, away from the beach areas. This Report will support the various approval applications required.

SECTION 4.0: PRELIMINARY CONSTRUCTION BUDGET ANALYSIS

4.1 Preliminary Construction Budget - Outfall

Preliminary Outfall/Forcemain budget assumptions are as follows:

- An outfall/forcemain size of 450 mm HDPE pipe was selected for the peak flow of the effluent discharge; this includes an allowance for some capacity reduction due to solids accumulations between swabbing procedures;
- The length of the outfall will be 925 m from the location of the Effluent Pumping Station adjacent to the present UV Disinfection Building;
- Outfall would be directionally drilled from the GSSC facility to the proposed outfall location in the Northumberland Strait;
- Five (5) 100 mm diameter diffusers would be installed at the end of the outfall; these orifices may be fitted with “duckbill” check valves to minimize opportunities for silt, sand, or other debris to enter the outfall;
- The outfall pipeline would be installed through stable soils (assumed no rock) that will permit this method of installation (to be confirmed with geotechnical investigation); open cut installation is not the preferred procedure for several environmentally related reasons;
- Ice rafting does not go deeper than 2 m below the lowest tide;
- The outfall will be constructed with a swab launching station at the Effluent Pumping Station end and a removable cap at the diffuser end to facilitate discharge of swabbed materials and the swabs.

Based on the assumptions made above, and without the benefit of any detailed geotechnical investigations, the pre-preliminary cost estimate for the proposed outfall is **$2,000,000 to $2,200,000**. This includes allowances for engineering, contingencies and net HST. If the results of the geotechnical investigations identify less favorable soil conditions along the outfall route, this estimated cost will be impacted.

4.2 Pre-preliminary Cost Estimate - Effluent Pumping Station

Preliminary Effluent Pumping Station budget assumptions are as follows:

- The Effluent Pumping Station is recommended to have three (3) 35 hp submersible pumps each rated at 113.6 L/s (1800 USgpm); normal peak flow requirements will be handled by any two (2) of the pumps operating;
- Stand-by power would be recommended at this phase should regulations change and not permit the use of the existing outfall as an overflow;
- In order to avoid excessive on-off pumping cycles, the pumps will be controlled by a VFD (variable frequency drive) system so the pumping rate closely matches the effluent flow rate and maintains a more uniform velocity through the diffuser nozzles;
- The wet well will be kept as compact as possible because of the benefits of the VFD controlled pumping system; the wet well will include a level sensor that will send a signal to the VFD controller so that the pumping rate can be programmed to suit the effluent flow rate; the wet well will be divided into three sections so any one can be isolated for cleaning, etc., while maintaining the remaining two (2) pumps available for full pumping capacity;
- There will be a flow meter on the discharge pipe from the pumps to the outfall that will measure and totalize flow and send signals to the GSSC's WWTP SCADA system;
- A compact weatherproof structure/building will be constructed adjacent to the wet well for the discharge pipe header, electrical and control panels, and for the stand-by power unit; this structure will be built to be above the anticipated storm surge levels for the Greater Shediac area to protect the electrical and mechanical equipment and ensure the functionality of the EPS under such conditions;
- Access to the Effluent Pumping Station will be by an extension of the access road to the nearby UV Disinfection Building.

Based on the assumptions made above, and without the benefit of any detailed geotechnical investigations, the pre-preliminary cost estimate for the proposed Effluent Pumping Station is **$800,000 to $900,000**. This includes allowances for engineering, contingencies, electrical power supply, and net HST.

SECTION 5.0: SUMMARY AND RECOMMENDATIONS

5.1 Summary

- The Environmental Risk Assessment Study for the GSSC Cap-Brulé WWTP done in 2014 had identified Total Ammonia Nitrogen (TAN) as an effluent substance to be monitored since the concentration in the effluent is greater than the EDO (Effluent Discharge Objective), and does not meet the EQO (Environmental Quality Objective) in the receiving water. Under the NB DELG "Certificate of Approval to Operate", TAN is not presently required to be reduced to a specific value. It is simply tagged for monitoring in accordance with the CCME's "Strategy for Management of Municipal Wastewater Effluent".

- The ERA Study also identified that due to changes caused by long-term sandy sediment drift in the effluent discharge area, the effluent now discharges to an isolated pond which drains to the Northumberland Strait only during low tide cycles. As a result, the effluent dilution desired under the CCME Guidelines is not being achieved. A dilution of only 1 in 4 is being achieved compared to the CCME desired 1 in 100 dilution objective. This resulted in a recommendation to install a new outfall to a more suitable location in the Northumberland Strait. A NATECH Study was conducted in 2015 which identified a suitable discharge location in the Northumberland Strait approximately 350 m from shore, and 925 m from the present discharge point from the WWTP.

- The GSSC requested additional information on how closely connected the issues related to the new outfall and TAN might be, and what the impact of a change in treatment requirements requiring TAN reduction might be. Specifically, if TAN were reduced, would it eliminate the need to extend the outfall?

- The purpose of this Report is to provide the GSSC with relevant background information, to address its questions and concerns, and make a recommendation on a preferred course of action.

- A discussion on present and possible future treatment requirements was presented. It noted that nutrient (nitrogen and phosphorous) removal is typically required only in smaller receiving waters such as lakes, and is done on a case by case basis rather than across the board. Based on the Cap-Brulé WWTP effluent being such a small percentage of the volume of the Northumberland Strait in the outfall area, it is unlikely it would be singled out for nitrogen reduction. Phosphorous is more commonly the nutrient of choice to reduce to control eutrophication issues.

- Adding a process to the Cap-Brulé WWTP to reduce nitrogen is typically a biologically-based nitrification-denitrification process, and would be very expensive to implement due to the size of reactors, aeration equipment, and pumps required. Close operator control of the process is also required.

- The CCME Strategy permits identification and utilization of a dilution zone at the outfall discharge, extending for a maximum distance of 250 m. If the concentration of a substance is within the EQO at the edge of the mixing zone, it is acceptable. The NATECH Study determined that a mixing zone providing 1 to 100 dilution or better within 250 m of the discharge point exists about 350 m from shore. Discharging at the present TAN concentration into this mixing zone would result in a value at the mixing zone boundary that is only 1/14th of the EQO value, which is more than acceptable.

- A comparison of the advantages and disadvantages of these options (expanding treatment for nitrogen reduction, dredging the outlet from Lac Boudreau Ouest to permit better flushing of the pond, and the new outfall and Effluent Pumping Station) was presented. It concluded that constructing the new outfall and Effluent Pumping Station was the preferred option.

- Since the new outfall would satisfy the EQO requirements without additional treatment being implemented at the Cap-Brulé WWTP site, the new outfall option was evaluated further. It was noted that detailed geotechnical information is required along the outfall route to confirm what construction procedure is feasible, and to determine more accurately what the cost of construction would be.

- The elevation at which the effluent is discharged from the WWTP is too low to permit gravity discharge of the effluent through a new 925 m long outfall pipe. An Effluent Pumping Station (EPS) is therefore required for this. This EPS would be constructed adjacent to the existing UV Disinfection Building.

- The regulatory approvals anticipated to be required for this work were summarized.

- Although geotechnical information on the route was not available, very pre-preliminary cost estimates were prepared based on various assumptions listed, in order to provide general "order of magnitude" cost information for the GSSC.

- The pre-preliminary cost estimate for the 925 m of outfall pipe was $2,000,000 to $2,200,000, and for the Effluent Pumping Station was $800,000 to $900,000. These estimated costs included allowances for engineering, contingencies, the HST at the Commission's net rate.

- The Preliminary Drawing (Appendix A) was prepared to show the existing Cap-Brulé WWTP site, the present Lac Boudreau Ouest receiving water, and the proposed location of the Effluent Pumping Station and Outfall.

- Various related reference information was attached to the Report.

5.2 Recommendations

- Based on a comparison of alternatives to satisfy EQO limits for TAN and effluent dilution objectives, ***it is recommended that a new outfall be installed from the WWTP to a point in the Northumberland Strait where the CCME desired dilution is achieved and the outfall pipe is reasonably protected from winter ice***. This point is approximately 350 m from the shoreline and 925 m from the WWTP outlet at the UV Disinfection Building.

- ***It is recommended that this outfall be designed with a swab launching station and a removable cap at the diffuser end to discharge swabs in order to clean the outfall pipe when required***.

- If the soil conditions permit, ***it is recommended that the outfall be installed below the marsh, beach and bottom of the Strait by horizontal directional drilling***. This will protect the pipe since the only portion exposed will be the diffuser end, and will avoid disturbing wetland, beach and marine areas. (The feasibility of this can only be confirmed once suitable geotechnical information has been obtained.)

- ***It is recommended that an Effluent Pumping Station received flows from the UV disinfection system*** to pump them through the outfall into the Northumberland Strait.

- ***It is recommended that the pumps in the EPS be sized so that two (2) pumps working simultaneously will have the capacity to pump normal dry weather peak flows***. ***It is further recommended that a third pump be installed to act as a stand-by unit***, but be used in sequence with the other pumps so all wear equally for maximum life.

- In order to optimize the size of the outfall pipe and minimize the size of the EPS wet well, ***it is recommended that the pumps operate through a variable frequency drive (VFD) controller so the discharge rate can be matched to the inflow rate to the EPS wet well***.

- Because the GSSC system is susceptible to high extraneous flows during rainfall or snowmelt events, the rate of flow through the facility varies greatly. Installing an Effluent Pumping Station and Outfall sized for the worst case would be very expensive. Therefore ***it is recommended that the preliminary design concept limit the pumps to the normal peak dry weather flow, and flows in excess of that rate be by-passed to discharge to the existing effluent disposal system***. (This concept must be authorized by the NB DELG.)

- ***It is recommended that the EPS be equipped with a stand-by power supply*** to ensure continuous operation under all conditions, including power outages and storm surge.

- ***It is recommended that the EPS wet well be designed so it is not overtopped during storm surge events, and that the EPS Building be designed to have all components above anticipated storm surge levels***.

- In order to be able to refine the preliminary designs proposed here, and provide the GSSC with realistic construction cost estimates upon which to base its decision, ***it is recommended that geotechnical investigations be authorized immediately for the pipeline route and EPS site***.

- In order to be able to document the refined preliminary design of the EPS and Outfall, including preparation of preliminary design drawings and construction cost estimates, ***it is recommended that Crandall Engineering Ltd. be authorized to prepare a "Pre-design Report"*** in conjunction with the administration of the geotechnical investigations.

APPENDIX A: Crandall Engineering Ltd. Preliminary Drawings

CHEMIN CAP BRULÉ ROAD
GSSC
HEAD OFFICE
CELL #1
(AERATED)
CELL #2
(AERATED)
CELL #3
PRE TREATMENT
BUILDING
BLOWER
BUILDING
NEW EFFLUENT
LIFT STATION
NEW BORED 450mm Ø
FORCEMAIN
EXISTING OUTFALL
NEW 900mm Ø
SANITARY
SEWER
UV TREATMENT
FACILITY
5 DIFFUSERS
350m
ROUTE 133
LAC
BOUDREAU
OUEST
NORTHUMBERLAND
STRAIT
/2014

APPENDIX B: Crandall Engineering Ltd. ERA Executive Summary Report

ENVIRONMENTAL RISK ASSESSMENT REPORT
GSSC (CAP-BRULÉ) WASTEWATER TREATMENT PLANT

EXECUTIVE SUMMARY

1. **Introduction**: This Report presents the work done for and results of a 12-month study to assess the impact of the GSSC (Cap-Brulé) WWTP effluent's discharge into the receiving water leading to the Northumberland Strait. The receiving water for this facility was intended to be the Northumberland Strait when it was initially constructed. However, with time and tidal action on the dunes, the Northumberland Strait has been isolated and a small pond was created at the discharge pipe location as may be observed today (Appendix A). Therefore, the receiving water is no longer considered the Northumberland Strait but this small pond with no significant incoming source of water that is flushed by tidal activities from the Northumberland Strait. The 12-month study resulted in the identification of Environmental Quality Objectives (EQOs) in the receiving water leading to the Northumberland Strait and the Effluent Discharge Objectives (EDOs) required in the WWTP effluent to ensure that the receiving water's EQOs were not exceeded. This work was conducted in accordance with the procedures required by the Canadian Council of Ministers of Environment (CCME) in their "Canada-wide Strategy for Management of Municipal Wastewater Effluent".

2. **Facility Characterization**: In order to apply the correct analyses and frequency of testing of water quality parameters, it was necessary to determine the classification of the GSSC's WWTP under the CCME Guidelines. The GSSC (Cap-Brulé) facility is an aerated lagoon (secondary treatment level) facility which has ultraviolet disinfection of the effluent prior to discharge. Based on its average daily flow volume of 6,340 m^3/day as measured over the monitoring period, the Cap-Brulé facility is classified as a "medium WWTP". Based on this classification, the CCME Guidelines state a list of "Potential Substances of Concern" which are to be assessed. This list is included as Table 1 of this Report.

3. **Characterization of the Municipal Wastewater Effluent**: The CCME list of "potential substances of concern" was applied to the effluent after UV disinfection but prior to reaching the receiving water leading to the Strait. Chemical and physical analyses were carried out on the receiving water. In addition, acute and chronic toxicity studies were conducted in order to assess possible impacts on marine life. The CCME procedures required most analyses, including toxicity studies, to be carried out quarterly, but several general chemistry and nutrient parameters were analyzed bi-weekly. Samples were also analyzed in the receiving water leading to the Northumberland Strait downstream of the effluent discharge point in order to establish background levels as there was no incoming stream to the receiving water.

4. **Establishing Effluent Discharge Objectives (EDOs)**: EDO values of potential substances of concern in the effluent were determined as a function of the Environmental Quality Objectives (EQOs) in the receiving water leading to the Strait, the background levels of substances in the receiving water, and the amount of dilution achieved in the receiving water within the permissible effluent dilution plume. The maximum EDO is calculated as the concentration of a substance in the effluent which

EXECUTIVE SUMMARY CONTINUED

can be added to the level of this substance already in the receiving water, adequately mixed, without exceeding the receiving water's EQO concentration.

In order to determine the amount of dilution of effluent in the receiving water, detailed information on the receiving water's cross-section and flow was required. On-site dye tests indicated that a dilution of 1 to 5 was achieved within 250 m of the discharge point but only when tidal effects were included. This area is designated as the "mixing zone".

The results of the toxicity tests are also considered in setting the EDO values. Of the eight (8) acute toxicity tests conducted, all but one (1) achieved the desired result of 1 TU_a. Of the quarterly chronic toxicity tests conducted, all but one (1) achieved the desired result of 1 TU_c (its value was 6.5 TU_c, greater than the EDO).

Although these two (2) non-ideal results may be the result of non-representative samples or other issues not related to effluent quality, since there was not 100% success in the toxicity studies a recommendation for further testing in September 2014 is being made as part of this Report.

EQOs for the receiving water at the end of the mixing zone were identified from CCME documents, and are summarized in Table 6. The EDO values for all potential substances of concern were then calculated, and are presented in Table 7. Table 8 was then developed showing a side-by-side comparison of the "Proposed EQOs", "Proposed EDOs", and "Effluent Values" from the 12-month initial characterization sampling process. It is acceptable for the EDO value to be greater than the EQO value if the level in the receiving water is lower than the EQO value.

This process as summarized in Table 8 shows that the vast majority of Substances of Potential Concern are not significant with regard to the GSSC (Cap-Brulé) WWTP effluent discharging to the receiving water leading to the Northumberland Strait, based on the downstream values as there was no incoming stream to the receiving water.

5. **Selection of Substances for Compliance Monitoring**: In accordance with CCME Technical Supplement 3: Selection of Substances for Compliance Monitoring, the list of potential substances of concern was reviewed to identify those which fell under the requirements for compliance monitoring. Compliance monitoring is done to ensure that the WWTP meets its treatment objectives, and to monitor the concentrations of substances that are near the threshold EDO values to ensure protection of the receiving water.

   In order to ensure compliance with the WWTP's "Certificate of Approval to Operate", $CBOD_5$, TSS as well as un-ionized ammonia will be analyzed every two-weeks.

EXECUTIVE SUMMARY CONTINUED

Substances near the threshold EDO levels were identified for compliance monitoring. Total ammonia nitrogen will be analyzed bi-weekly. Substances with no guideline EQO were not identified for monitoring due to the lack of "true" background concentration data. All other substances were either tested to be below the lab's reporting limit, or well below the threshold EDO levels; therefore, need not be monitored.

6. **Conclusions and Recommendations**:
   a. This ERA has carried out a comprehensive program of characterizing the GSSC (Cap-Brulé) WWTP effluent and the receiving water leading to the Northumberland Strait at the effluent discharge area.

   b. Substances of Potential Concern were identified from the CCME Strategy. Based on this list, the results of effluent monitoring, and downstream receiving water sampling, Environmental Quality Objectives were established for the receiving water and Effluent Discharge Objectives were established for the WWTP effluent.

   c. It was found that an acceptable mixing zone does not exist in the receiving water. It was found that there is no significant incoming source of water, besides the tidal influence from the Northumberland Strait, to flush the pond that has been created since the initial construction of the effluent discharge pipe.

      i. *It is recommended that* further study be conducted regarding the possibility of relocating the effluent discharge pipe to a more appropriate location where an acceptable mixing zone could be achieved. This study should include a characterization of the receiving water once a potential outfall location is selected, including the identification of dilution patterns and the determination of EQOs and EDOs specific to that location.

   d. It was found that the majority of substances on the CCME's list of Substances of Potential Concern are not significant for the GSSC (Cap-Brulé) WWTP effluent.

   e. It was found that the GSSC (Cap-Brulé) WWTP is meeting the requirements of the NB Department of Environment and Local Government "Certificate of Approval to Operate".

   f. Because two (2) of the toxicity tests did not meet the desired objectives, *it is recommended that* the Rainbow Trout and *Ceriodaphnia dubia* tests be repeated in September 2014. This can be done during the additional Study work recommended above. This will provide the additional information required to determine if operational or treatment modifications are required, or if the previous test results were simply non-representative.

EXECUTIVE SUMMARY CONTINUED

g. *It is recommended that* a program of compliance monitoring be commenced:

   i. Bi-weekly testing of the effluent for $CBOD_5$, TSS, and un-ionized ammonia, in accordance with the facility's "Certificate of Approval to Operate", Dated April 30, 2013;

   ii. Bi-weekly testing of the effluent for TAN.

h. *It is recommended that* this Report be submitted to the NB Department of Environment and Local Government to fulfill the GSSC's (Cap-Brulé) obligation under the CCME "Strategy for Management of Municipal Wastewater Effluent".

Table 7: EDOs for Substances of Potential Concern

Test Group	Substances	Downstream Conc. (mg/L)	CCME EQOs (mg/L)	Proposed EQOs (mg/L)	Proposed EDOs (mg/L)
General Chemistry /Nutrients	Fluoride	1.46	No Guideline	No Guideline	No Guideline
	Nitrate	<0.05	16.0	16.00	16.6
	Nitrate+Nitrite	<0.05	No Guideline	No Guideline	No Guideline
	TSS	5.25	No Guideline	No Guideline	25.0
	$CBOD_5$	<6	No Guideline	No Guideline	25.0
	TAN	0.58	1.7	1.70	1.74
	Un-ionized Ammonia	*0.00319*	No Guideline	No Guideline	No Guideline
	TKN	0.75	No Guideline	No Guideline	No Guideline
	TP	0.119	No Guideline	No Guideline	No Guideline
	COD	407	No Guideline	No Guideline	No Guideline
	Cyanide (total)	0.002	0.005	0.005	0.0051
	pH (units)	7.78	6.5-9.0	6.5-9.0	6.0-9.0
Metals	Aluminum	0.063	0.10	0.10	0.101
	Barium	0.05	No Guideline	1.00	1.037
	Beryllium	0.015	No Guideline	No Guideline	No Guideline
	Boron	3.05	1.50	1.50	1.440
	Cadmium*	0.025	0.00037	0.025	0.025
	Chromium*	0.04	0.0015	0.04	0.04
	Cobalt	0.015	No Guideline	No Guideline	No Guideline
	Copper*	0.04	0.004	0.04	0.04
	Iron*	0.91	0.30	0.91	0.91
	Lead*	0.015	0.007	0.015	0.015
	Manganese	0.095	No Guideline	No Guideline	No Guideline
	Molybdenum	0.022	0.073	0.073	0.075
	Nickel	0.04	1.640	1.64	1.70
	Silver*	0.015	0.0001	0.0150	0.0150
	Strontium	5.56	No Guideline	No Guideline	No Guideline
	Thallium*	0.015	0.0008	0.0150	0.0150
	Tin	0.015	No Guideline	No Guideline	No Guideline
	Titanium	0.035	No Guideline	No Guideline	No Guideline
	Uranium	0.015	0.015	0.015	0.015
	Vanadium	0.04	No Guideline	No Guideline	No Guideline
	Zinc*	0.04	0.03	0.04	0.04
	Arsenic*	0.04	0.013	0.04	0.04
	Antimony	0.015	No Guideline	No Guideline	No Guideline
	Selenium*	0.04	0.001	0.040	0.040
	Mercury	<0.000025	0.001	0.001	0.001038
Pathogens	E.*coli*	49	No Guideline	No Guideline	200
	Faecal coliform	162	No Guideline	No Guideline	200

Table 7: EDOs for Substances of Potential Concern (Cont'd)

Test Group	Substances	Downstream Conc. (mg/L)	CCME EQOs (mg/L)	Proposed EQOs (mg/L)	Proposed EDOs (mg/L)
Organochlorine Pesticides	Alpha-BHC	<0.00001	No Guideline	No Guideline	No Guideline
	Endosulfan (I and II)*	<0.00001	0.000002	0.00001	0.00001
	Endrin	<0.00001	No Guideline	No Guideline	No Guideline
	Heptachlor epoxide	<0.00001	No Guideline	No Guideline	No Guideline
	Lindane (gamma-BHC)	<0.00001	0.00001	0.00001	0.00001
	Mirex	<0.00001	No Guideline	No Guideline	No Guideline
	DDT	<0.00001	No Guideline	No Guideline	No Guideline
	Methoxychlor	<0.00001	No Guideline	No Guideline	No Guideline
	Aldrin	<0.00001	No Guideline	No Guideline	No Guideline
	Dieldrin	<0.00001	No Guideline	No Guideline	No Guideline
	Heptachlor	<0.00001	No Guideline	No Guideline	No Guideline
	a-Chlordane	<0.00001	No Guideline	No Guideline	No Guideline
	g-Chlordane	<0.00001	No Guideline	No Guideline	No Guideline
	Toxaphene	0.0001*	No Guideline	No Guideline	No Guideline
Polychlorinated Biphenyls (PCBs)	Total PCBs	<0.0001	No Guideline	No Guideline	No Guideline
Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthene	<0.00001	0.0058	0.0058	0.00602
	Acenaphthylene	<0.00001	No Guideline	No Guideline	No Guideline
	Anthracene	<0.00001	0.000012	0.000012	0.00001
	Benzo(a)anthracene	<0.00001	0.000018	0.000018	0.00002
	Benzo(a)pyrene	<0.00001	0.000015	0.000015	0.00002
	Benzo(b)fluoranthene	<0.00001	No Guideline	No Guideline	No Guideline
	Benzo(g,h,i)perylene	<0.00001	No Guideline	No Guideline	No Guideline
	Benzo(k)fluoranthene	<0.00001	No Guideline	No Guideline	No Guideline
	Chrysene	<0.00001	No Guideline	No Guideline	No Guideline
	Dibenz(a,h)anthracene	<0.00001	No Guideline	No Guideline	No Guideline
	Fluoranthene	<0.000013	0.00004	0.00004	0.000041
	Fluorene	<0.00001	0.003	0.003	0.00312
	Indeno(1,2,3-cd)pyrene	<0.00001	No Guideline	No Guideline	No Guideline
	Methylnaphthalene	<0.00005	No Guideline	No Guideline	No Guideline
	Naphthalene	<0.00005	0.0011	0.0011	0.00114
	Phenanthrene	<0.000013	0.0004	0.0004	0.000415
	Pyrene	<0.00001	0.000025	0.000025	0.00003

Table 7: EDOs for Substances of Potential Concern (Cont'd)

Test Group	Substances	Downstream Conc. (mg/L)	CCME EQOs (mg/L)	Proposed EQOs (mg/L)	Proposed EDOs (mg/L)
Volatile Organic Compounds (VOCs)	Benzene	<0.0005	0.11	0.11	0.1142
	Bromodichloromethane	<0.0005	No Guideline	No Guideline	No Guideline
	Bromoform	<0.0005	No Guideline	No Guideline	No Guideline
	Carbon tetrachloride	<0.0005	0.0133	0.0133	0.0138
	Chlorobenzene	<0.0005	0.03	0.03	0.0259
	Chlorodibromomethane	<0.0005	No Guideline	No Guideline	No Guideline
	Chloroform	<0.0005	0.0018	0.0018	0.0019
	1,2-Dichlorobenzene	<0.0005	0.042	0.042	0.0436
	1,4-Dichlorobenzene	<0.0005	0.026	0.026	0.0270
	1,2-Dichloroethane	<0.0005	0.1	0.10	0.1038
	1,1-Dichloroethene	<0.0005	No Guideline	No Guideline	No Guideline
	Dichloromethane	<0.005	0.1	0.10	0.102
	Ethylbenzene	<0.0005	0.025	0.025	0.0259
	1,1,1,2-Tetrachloroethane	<0.0005	No Guideline	No Guideline	No Guideline
	1,1,2,2-Tetrachloroethane	<0.0005	No Guideline	No Guideline	No Guideline
	Tetrachloroethene	<0.0005	0.22	0.22	0.2233
	Toluene	<0.0005	0.215	0.215	0.2233
	Trichloroethene	<0.0005	0.2	0.02	0.0208
	Vinyl chloride	<0.0005	No Guideline	No Guideline	No Guideline
	m/p-Xylene	<0.0005	No Guideline	No Guideline	No Guideline
	o-Xylene	<0.0005	No Guideline	No Guideline	No Guideline
Phenolic Compounds	2,3,4,6-Tetrachlorophenol	<0.0001	0.001	0.001	0.001
	2,4,6-Trichlorophenol	<0.0001	0.018	0.018	0.0187
	2,4-Dichlorophenol	<0.0001	0.0002	0.0002	0.0002
	Pentachlorophenol	<0.0001	0.0005	0.0005	0.0005
Surfactants	Non-ionic	<0.0005	No Guideline	No Guideline	No Guideline
	Anionic	0.000075	No Guideline	No Guideline	No Guideline

* In cases where the concentration in the receiving water exceed the generic CCME EQO, CCME guidelines state that it is permissible to use the background concentration as a site-specific EQO.

Table 1: Medium Sized Facility – Potential Substances of Concern

Test Group	Substances
General Chemistry / Nutrients	Fluoride Nitrate Nitrate + Nitrite Total Ammonia Nitrogen Total Kjeldahl Nitrogen (TKN) Total Phosphorus (TP) Total Suspended Solids (TSS) Carbonaceous Biochemical Oxygen Demand ($CBOD_5$) Chemical Oxygen Demand (COD) Cyanide (total) pH Temperature
Metals	Aluminium, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, silver, strontium, thallium, tin, titanium, uranium, vanadium, zinc, arsenic, antimony, selenium and mercury
Pathogens	E. *coli* Faecal coliform
Organochlorine Pesticides	Alpha-BHC, endosulfan (I and II), endrin, heptachlor epoxide, lindane (gamma-BHC), mirex, DDT, methoxychlor, aldrin, dieldrin, heptachlor, a-chlordane and g-chlordane, toxaphene
Polychlorinated Biphenyls (PCBs)	Total PCBs
Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, methylnaphthalene, naphthalene, phenanthrene, pyrene
Volatile Organic Compounds (VOCs)	Benzene, bromodichloromethane, bromoform, carbon tetrachloride, chlorobenzene, chlorodibromomethane, chloroform, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, dichloromethane, ethylbenzene, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, tetrachloroethene, toluene, trichloroethene, vinyl chloride, m/p-xylene, o-xylene
Phenolic Compounds	2,3,4,6-tetrachlorophenol, 2,4,6-trichlorophenol, 2,4-dichlorophenol, pentachlorophenol
Surfactants	Non-ionic and anionic

APPENDIX C: GSSC Certificate of Approval to Operate

APPROVAL TO OPERATE

S-2627

Pursuant to paragraph 8(1) of the *Water Quality Regulation - Clean Environment Act*, this Approval to Operate is hereby issued to:

The Greater Shediac Sewerage Commission
for the operation of the
Wastewater Works - Cap-Brulé WWTP

Description of Source:

This Approval covers the discharge of effluent from the locations contained in the Federal Effluent Regulatory Reporting Information System for the following system.

Two-Celled Lagoon with Submerged Aerators, a Polishing Pond and a UV Disinfection System
WWC: Class II
WWT: Class II

Mailing Address:

25 Cap-Brulé Road
Boudreau-Ouest, NB
E4P 6H8

Conditions of Approval: **See attached Schedules "A" and "B" of this Approval.**

Supersedes Approval: S-2380

Valid From: **December 1, 2014**

Valid To: **November 30, 2019**

Recommended by: ______________________
Environmental Management Division

Issued by: ______________________ December 1st, 2014
For the Minister of Environment and Local Government — Date

SCHEDULE "A"

A. DEFINITIONS

1. **"Accredited"** means accreditation to ISO/IEC 17025 by the Standards Council of Canada (SCC), the Canadian Association for Laboratory Accreditation Inc. (CALA), or accreditation to ISO/IEC 17025:2005 from another body that is recognized to grant such accreditation per ISO/IEC 17011 criteria.

2. **"Acutely Lethal"** means that the effluent at 100% concentration kills, during a 96-hour period, more than 50% of the rainbow trout subjected to it.

3. **"Approval Holder"** means the name listed on the Certificate page of this Approval.

4. **"Authorization Officer"** means the Manager of the Water and Wastewater Management Section of the Department of Environment and Local Government, and includes any person designated to act on the Manager's behalf.

5. **"Average Daily Volume"** means a calculation of the sum of the daily volumes of influent or effluent and dividing that sum by the number of days in that calendar year.

6. **"CBOD"** or **"Carbonaceous Biochemical Oxygen Demanding Matter"** means the carbonaceous matter that consumes, by biochemical oxidation, oxygen dissolved in water.

7. **"Certified"** means a valid certificate of qualification that states the class of the *Operator* issued by the Atlantic Canada Water and Wastewater Voluntary Certification Program.

8. **"Deleterious Substances"** means the following substances or classes of substances: carbonaceous biochemical oxygen demanding matter, suspended solids, total chlorine, and un-ionized ammonia.

9. **"Environmental Emergency"** means a situation where there has been or will be a release, discharge, or deposit of a contaminant or contaminants to the atmosphere, soil, surface water, and/or groundwater environments of such a magnitude or duration that it could cause significant harm to the environment or put the health of the public at risk. This does not include wastewater overflows that are the result of excessive rainfall or snowmelt.

10. **"ERRIS"** or **"Effluent Regulatory Reporting Information System"** means the web based application developed by Environment Canada to facilitate the reporting of information as required under Regulations.

11. **"Final Discharge Point"** means the point, other than an *Overflow Point*, of a wastewater works beyond which the *Approval Holder* or operator no longer exercises control over the quality of the wastewater before it is deposited as effluent to the environment

12. **"Lagoon"** means a wastewater treatment facility where the average period during which wastewater is retained for treatment within the wastewater system is five days or more.

13. **"Operator"** means a person who directs, adjusts, inspects, tests or evaluates an operation or process that controls the effectiveness or efficiency of the wastewater works.

14. **"Overflow Point"** means a point of a wastewater work via which excess wastewater may be deposited in the environment and beyond which the *Approval Holder* or operator no longer exercises control over the quality of wastewater before it is deposited as effluent.

15. **"Point of Entry"** means any point where effluent is deposited in water frequented by fish via the *Final Discharge Point* or an *Overflow Point*.

16. **"Quarter"** in respect of a year, means any of the four periods of three months that begin on the first day of January, April, July and October.

17. **"Suspended Solids"** means any solid matter contained in effluent that is retained on a filter of 2.0 micrometre (µm) or smaller pore size.

18. **"Total Residual Chlorine"** means the sum of free chlorine and combined chlorine, including inorganic chloramines.

B. TERMS AND CONDITIONS

EMERGENCY REPORTING

19. **Immediately** following the discovery of an *Environmental Emergency*, a designate representing the *Approval Holder* shall notify the Canadian Coast Guard **until personal contact is made** and provide all information, such as: location in latitude and longitudes, flow, time and a brief description known about the *Environmental Emergency*.

    The telephone number for the **Canadian Coast Guard** is **1-800-565-1633**.

20. **Within five (5) days** of the time of initial notification, a copy of a Detailed Emergency Report shall be e-mailed or faxed to the Wastewater Approvals Coordinator or Engineer responsible for the regulation of the Approval Holder's wastewater works. The Detailed Emergency Report shall include, as a minimum, the following: i) a description of the problem that occurred; ii) a description of the impact that occurred; iii) a description of what was done to minimize the impact; and iv) a description of what was done to prevent recurrence of the problem.

TEMPORARY BYPASS AUTHORIZATION

21. The *Approval Holder* shall apply to the *Authorization Officer* for a temporary authorization to bypass at least one of the treatment processes normally applied to wastewater in the system. An application **must be made at least 45 days before the day** on which the bypass is required, in the form and format provided in the *ERRIS*.

EFFLUENT PERFORMANCE STANDARDS

22. The *Approval Holder* shall ensure that the average concentration of contaminants in the effluent deposited via the *Final Discharge Point* of the wastewater works does not exceed the following limiting criteria. The average must be calculated by using the applicable calculating period listed in Condition 29:

    i. *$CBOD_5$*: 25 mg of $CBOD_5$/L (average); and,
    ii. *Suspended Solids*: 25 mg/L (average).

23. For a *Lagoon*, the *Approval Holder*, in the determination of the average referred to in Condition 22 is not to take into account the result of any determination of the concentration of *Suspended Solids* in a sample of effluent referred to in Condition 29 that was taken during the month of July, August, September or October, if that result was greater than 25 mg/L.

24. The *Approval Holder* shall **immediately** apply to the *Authorization Officer*, in the form and format specified by the *ERRIS* if any samples of the effluent deposited via the *Final Discharge Point* contain a calculated concentration of un-ionized ammonia that is greater than or equal to 1.25 mg/L, expressed as nitrogen (N) at 15°C ± 1°C.

25. **By January 1st, 2016**, for systems that the *Average Daily Volume* of effluent calculated in Condition 27 is less than 5,000 m^3, the *Approval Holder* shall submit to the *Authorization Officer* an implementation plan on how the effluent deposited via the *Final Discharge Point* of the wastewater works will not exceed the average concentration of *Total Residual Chlorine* of 0.02 mg/L.

26. **By January 1st, 2015**, for systems that the *Average Daily Volume* of effluent calculated in Condition 27 is greater than or equal to 5,000 m^3, the *Approval Holder* shall ensure the average concentration of *Total Residual Chlorine* in the effluent deposited via the *Final Discharge Point* does not exceed 0.02 mg/L if chlorine, or one of its compounds, was used in the treatment of wastewater. For all other systems, where the the *Average Daily Volume* of effluent calculated in Condition 27 is less than 5,000 m^3, the *Approval Holder* shall ensure the average concentration of *Total Residual Chlorine* in the effluent deposited via the *Final Discharge Point* does not exceed 0.02 mg/L **by January 1st, 2021,** if chlorine, or one of its compounds, was used in the treatment of wastewater.

MONITORING AND SAMPLING

Pursuant to Section 17 of the *Water Quality Regulation*, this Approval is subject to the following conditions:

27. The *Approval Holder* shall, for each calendar year, calculate and record the *Average Daily Volume* of effluent deposited via the *Final Discharge Point*. The volume of effluent during each day must be determined by using monitoring equipment that provides:
    i. A continuous measure of the volume of influent or effluent or a measure of the rate of flow of the influent or effluent upon which that daily volume of effluent may be estimated; or,
    ii. A continuous measure of the volume of influent or effluent if the *Average Daily Volume* measured during the previous calendar year is greater than 2,500 m^3.

28. The *Approval Holder* shall collect monitoring samples for the following parameters in accordance with the requirements of Condition 29.
    i. The concentration of *CBOD*; and,
    ii. The concentration of *Suspended Solid*.

29. The *Approval Holder* shall collect monitoring samples at the *Final Discharge Point* of the type and at the frequency indicated below based on the *Average Daily Volume* of effluent calculated in Condition 27:

Average Daily Volume **(m^3)**	**Treatment Type**	**Type of Sample to be Taken**	**Monitoring Frequency**	**Calculating Period[1]**	**Reporting Frequency**
less than 2,500	*Lagoon*	Grab or composite	Quarterly, but at least 60 days after any other sample	Annual	Annual
	Mechanical	Grab or composite	Monthly, but at least 10 days after any other sample	Quarterly	Quarterly
greater than 2,500 but less than or equal to 17,500	*Lagoon*	Grab or Composite	Every two weeks, but at least seven days after any other sample	Quarterly	Quarterly
	Mechanical	Composite			
greater than 17,500 but less than or equal to 50,000	*Lagoon*	Grab or Composite	Weekly, but at least five days after any other sample	Monthly	Quarterly
	Mechanical	Composite			
Greater than 50,000	*Lagoon*	Grab or Composite	Three days per week, but at least one day after any other sample	Monthly	Quarterly
	Mechanical	Composite			

[1]The average must be determined for *CBOD* and *Suspended Solids*

30. The *Approval Holder* shall collect a grab sample at the *Final Discharge Point* for *Acutely Lethal* Toxicity at the frequency indicated below based on the *Average Daily Volume* of effluent calculated in Condition 27:

Average Daily Volume (m^3)	**Minimum Sampling Frequency**
less than or equal to 2,500	n/a
greater than 2,500 but less than or equal to50,000	Quarterly [1]
greater to 50,000	Monthly[2]

[1]At least 60 days after any other sample
[2]At least 21 days after any other sample

31. If a sample is determined to be *Acutely Lethal* at the system's *Final Discharge Point*, the *Approval Holder* shall **immediately** contact the *Authorization Officer*.

32. If the *Final Discharge Point* results are determined not *Acutely Lethal* in accordance to Condition 33, the *Approval Holder* may follow the reduced frequency indicated below, based on the *Average Daily Volume* of effluent calculated in Condition 27:

Average Daily Volume (m^3)	**Number of Tests Not Acutely Lethal**	**Reduced Frequency**[1]
less than or equal to 2,500	n/a	n/a
greater than 2,500 but less than or equal to50,000	4 consecutive quarters	Yearly[2]
greater than 50,000	12 consecutive months	Quarterly[3]

[1] Reduced frequency if numbers of consecutive tests of column 2 of table are passed
[2] At least 6 months after any other sample
[3] At least 60 days after any other sample

33. The *Approval Holder* shall ensure the *Acute Lethality* of the effluent be determined in accordance with Reference Method EPS 1/RM/13 or EPS 1/RM/50.

34. **Within six months** of completing the Environmental Risk Assessment, the *Approval Holder* shall submit to the *Authorization Officer* for approval, an Effluent Monitoring Plan based on the wastewater works' Environmental Risk Assessment. This Plan must include the parameters that are Effluent Discharge Objectives and a monitoring frequency for each.

35. The *Approval Holder* shall follow the monitoring requirements outlined in the approved Effluent Monitoring Plan.

36. The *Approval Holder* shall calibrate the flow monitoring equipment at least once in every calendar year and at least five months after a previous calibration.

37. The *Approval Holder* shall ensure that the monitoring equipment is capable to determine the volume or rate of flow with a margin of error of ±15%.

38. The *Approval Holder* shall ensure that all samples are collected using the methods described in the latest edition of the ISO 5667-10, Water quality - Sampling - Part 10: Guidance on sampling of waste waters.

39. The *Approval Holder* shall ensure that all parameters that are required to be analysed by this Approval, are analysed by *Accredited* laboratories whose accreditation includes the analytical method used to make the determination.

40. The *Approval Holder* shall ensure that all equipment used for monitoring parameters required by this Approval is calibrated in accordance with manufacturer's recommendations.

OVERFLOW MANAGEMENT

41. **By January 1, 2016,** the *Approval Holder* shall submit to the *Authorization Officer* for Approval a long term plan to reduce combined sewer overflows and reduce overflows from infiltration. The plan must follow, as a minimum, the *Authorization Officer's* CSO/SSO Long-Term Control Plan Guidelines.

42. **By January 1, 2016,** the *Approval Holder* shall ensure that all new lift stations are designed to prevent the release of floatable materials and that existing lift stations are retrofitted for the removal of floatable materials.

OPERATOR CERTIFICATION

43. Pursuant to Section 19 of the *Water Quality Regulation*, the Minister gives notice that the *Approval Holder* shall employ and have available the following *Certified Operators* based on the Class of the wastewater works listed on the Certificate page of this Approval:

Treatment Class	**Wastewater Treatment (WWT) *Certified Operator***	**Collection Class**	**Wastewater Collection (WWC) *Certified Operator***
I	Minimum one Class I	I	None
II	Minimum one Class II and one Class I	II	One Class I by December 31, 2016
III	Minimum one Class III and one Class II	III	One Class I by December 31, 2016
IV	Minimum one Class IV and one Class III	IV	One Class I by December 31, 2016

RECORD KEEPING

Pursuant to Section 17 of the *Water Quality Regulation*, this Approval is subject to the following conditions:

44. The *Approval Holder* shall record and retain for a period of five years the following information and make it available to the *Authorization Officer* upon request:
   a. The date of each day when wastewater effluent was not discharged via the *Final Discharge Point* (if applicable);
   b. For those days when effluent was deposited via the *Final Discharge Point:*
      i. the daily volume deposited, in m^3, if that volume is yielded by a continuous measure, or
      ii. the estimated daily volume deposited, in m^3, in any other case, and the results of the calculation and measurement used in the estimation, as outlined in Condition 27(i);
   c. For all discharges from each *Overflow Point,* including those that were directly caused by excessive rain or snow melt:
      i. the date of each day on which effluent was deposited via the *Overflow Point*,
      ii. for each of those days, the duration or estimated duration, expressed in hours, of the deposit, along with an indication of whether it is the duration or an estimated duration,
      iii. the daily volume deposited in m^3 if that volume is yielded by a continuous measure, or an estimate of the daily volume, in m^3 in any other case;
   d. For all monitoring equipment used to determine the volume or rate of flow:
      i. A description, including the type,
      ii. The manufacturer's specifications, the year of manufacture and the model number,
      iii. the date on which the equipment was calibrated and its degree of accuracy after each calibration,
      iv. The date the equipment was installed and if applicable, the date on which it ceased to be used for monitoring and on which it was replaced;
   e. For each monitoring sample determination required by Condition 29, as well as any additional sample determinations made by an *Accredited* laboratory:
      i. the results of such determinations for each of the parameters listed in Condition 28 and Condition 30 (if applicable),
      ii. a statement as to whether the sample is a grab sample or a composite sample and the date on which the sample was taken;
   f. All monitoring sample results for each parameter taken as part of the Effluent Monitoring Plan;
   g. All monitoring sample results required by Schedule "B", if applicable; and,
   h. A list identifying the *Operator(s)* and indicating the certification level of each *Operator(s).*

REPORTING

Pursuant to Section 17 of the *Water Quality Regulation*, this Approval is subject to the following conditions:

45. If the information provided in the *ERRIS* identification report changes, the *Approval Holder* shall send a notice that provides the updated information to the *Authorization Officer* no later than **45 days after the change**.

46. The *Approval Holder* shall submit electronically to the *Authorization Officer,* in the form and format specified by the *ERRIS,* a report for the previous reporting period:
    i. **within 45 days of the end of each year**, with the period starting on the first day of January each year, for a *Lagoon* with an *Average Daily Volume* of effluent less than 2,500 m^3/d;
    ii. **within 45 days of the end of each *quarter***, with the first *quarter* starting on the first day of January each year, for all other wastewater works.

    The report must summarize the following:
    a. The number of days during which effluent was deposited;
    b. The volume of effluent that was deposited, expressed in m^3;
    c. The average *CBOD* due to the quantity of *CBOD* matter in the effluent;
    d. The average concentration of *Suspended Solids* in the effluent;
    e. All test results completed as part of the approved Effluent Monitoring Plan required in Condition 35.
    f. The results of the *Acutely Lethal* toxicity tests; and,
    g. If a temporary bypass authorization was issued.

47. The *Approval Holder* shall submit to the *Authorization Officer* **within 45 days of the end of each year**:
    a. A summary of the date, location, duration including whether it is an estimated or measured duration, and estimated or calculated volume of all discharges from *Overflow Points*, including those that were directly caused by excessive rain or snow melt;
    b. A summary report of *Environmental Emergencies* that were reported through the Emergency Reporting procedure described in this Approval; and,
    c. All monitoring sample results required by Schedule "B", if applicable.

SCHEDULE "B"

A. TERMS AND CONDITIONS

DISINFECTION REQUIREMENTS

Pursuant to Sections 8(2) of the *Water Quality Regulation*, this Approval is subject to the following conditions:

1. The *Approval Holder* shall collect monitoring samples from the *Final Discharge Point* and have them analysed for *E. coli* bacteria monthly for every month that the disinfection system is in operation.

2. The *Approval Holder* shall ensure that the disinfection system is operational from **May 1st to October 31st of each year**.

3. The *Approval Holder* shall ensure that the concentration of contaminants in the effluent deposited via the *Final Discharge Point* of the wastewater works do not exceed 200 MPN/100ml of *E. coli*.

Prepared by: ______________________

Denis Chenard, EIT
Water & Wastewater Approvals Coordinator
Impact Management Branch

REGISTERED PROFESSIONAL ENGINEER
Province of New Brunswick
#M6030
Scott Lloy
Signature
2014-Dec-01
Date
Province du Nouveau-Brunswick
INGÉNIEUR IMMATRICULÉ

Reviewed by: ______________________

Scott Lloy, M. Eng., P.Eng.
Senior Water and Wastewater Engineer
Impact Management Branch

APPENDIX D: NATECH Environmental Services Inc. – Mixing Zone Field Investigation (2011)

Mixing Zone Field Investigation for the Greater Shediac Wastewater Treatment Plant

Submitted to: **Crandall Engineering Ltd.**
1077 St George Blvd., Suite 400
Moncton, New Brunswick
Canada E1E 4C9

Prepared by: **NATECH Environmental Services Inc.**
109 Patterson Cross Rd.
Harvey Station, N.B.
E6K 1L9

Date: **October 4, 2011**

NATECH

TABLE OF CONTENTS

1. INTRODUCTION

Crandall Engineering Ltd. requested that NATECH Environmental Services Inc. conduct a physical Mixing Zone Assessment at the Shediac Wastewater Treatment Plant (WWTP) in accordance with the Environmental Risk Assessment (ERA) requirements of the CCME guidelines and focused on the discharge environment within the Northumberland Strait. The objective of the investigation was to assess the mixing regime of the treated wastewater effluent from the Shediac WWTP into the receiving marine environment.

The treated effluent is discharged into a long narrow trench that empties into a wide shallow embayment. This basin is connected to the Northumberland Strait by a shallow channel.

2. METHODOLOGY

The field investigation was carried out on September 1st, 2011 from 10:00 to 18:00. The weather conditions during the investigation were sunny and warm (20°C), with light onshore wind.

2.1 Water Level

The water level in the trench was surveyed periodically relative to the top of outlet manhole during the study and converted to geodetic levels using available facility drawings. Also, a water level sensor was installed along the northern bank of the basin to monitor the tidal effects of the Northumberland Strait. Predictive tidal data from the Department of Fisheries and Oceans (DFO) were used to approximate the water level within the Northumberland Strait and interpret the effects of a tidal cycle on the receiving environment.

2.2 Bathymetry

The bathymetry within the trench, basin, and ocean were surveyed using a boat equipped with GPS and echo sounder technology. The depths were originally recorded relative to the water's surface and then converted to geodetic elevations, taking into account changes in the ocean water level.

2.3 Current Direction and Speed

The measurements were taken using drogues equipped with GPS tracking devices that drifted with the current.

2.4 Water Quality

The water quality was measured in the field on September 1, 2011 using a YSI multi-parameter water quality probe. In addition, water samples were taken, stored on ice for 24 hours, and delivered on September 2, 2011 for analysis by RPC in Fredericton. The samples were analyzed for general chemistry, trace metals and microbiology.

2.5 Effluent Flow

The effluent flow rate is monitored (MG/day) by the facility and was read off the real time digital display within the UV building. The effluent flow rate was recorded periodically during the course of the study to ensure accurate dilution rate calculations.

2.6 Mixing

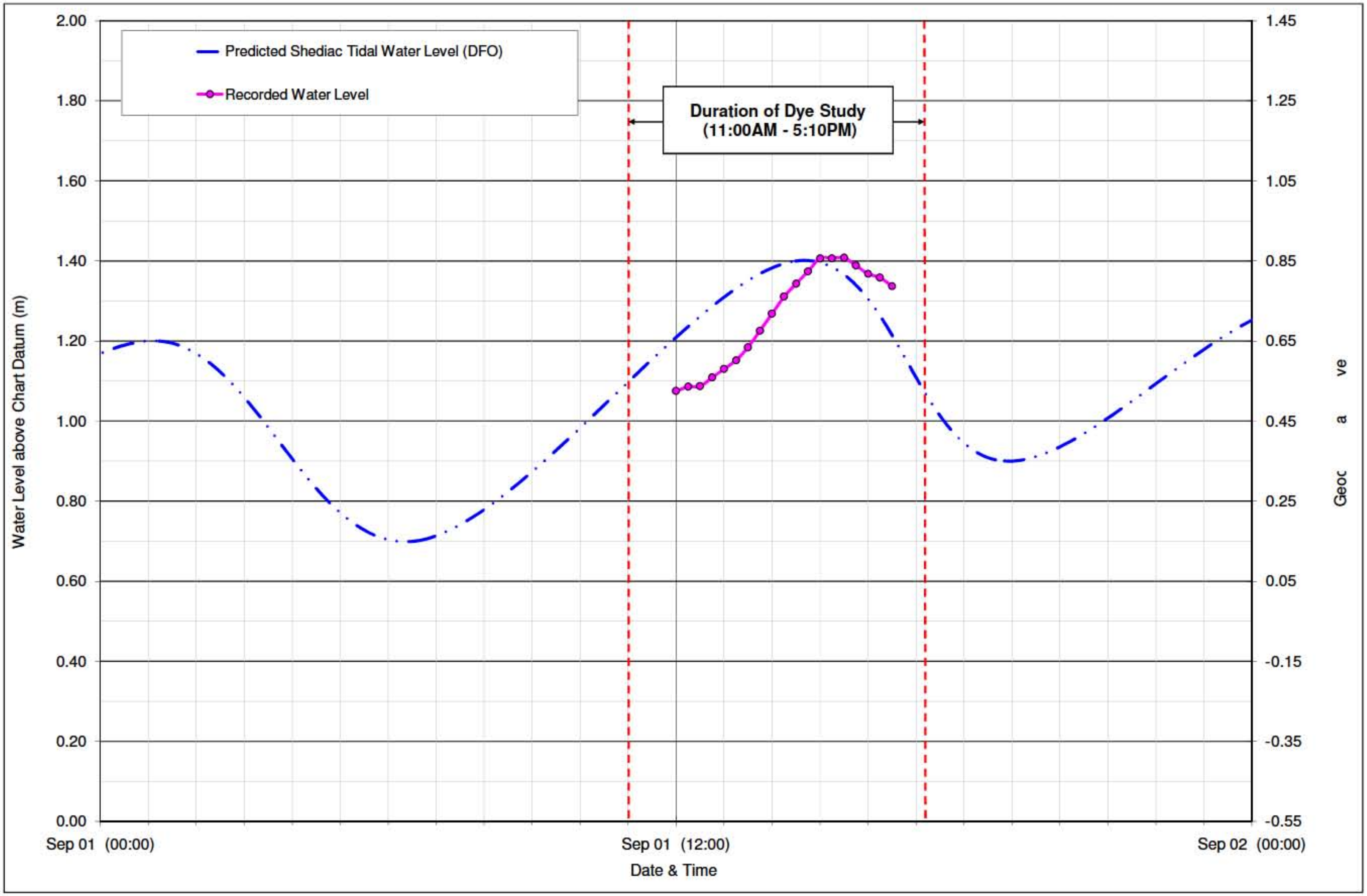
The mixing regime of the effluent in the receiving environment was measured by injecting Rhodamine WT into the effluent stream and measuring dye dilution rates in the trench and basin. Dye sensor readings along with corresponding GPS position and time were documented. Visual observations were sketched and the plume boundary shape was traced in the field using GPS tracking.

3. RESULTS

At the Shediac WWTP, after the UV disinfection, the effluent is discharged through the bank into an approximately 280m long narrow trench located just North of the UV building. The effluent then travels down the trench without mixing until it exits into a large shallow basin (approximately 3.7ha) that is connected to the ocean via a shallow sandy channel.

3.1 Measured Water Level

The study took place during the course of a small amplitude tidal cycle. The water level sensor data reveal that the basin only drains during a portion of the tidal cycle. When the water level within the basin falls below the height of the sand bar, the discharge is cut off from the ocean and becomes stagnant until the next rising tide when ocean water begins to pour into the basin. Water level measurements within the basin indicate that the minimum water level within the basin is 0.52m geodetic. Measured water levels in the basin overlaid on Department of Fisheries and Oceans (DFO) predicted tides in Shediac are shown on Figure 3-1.



MIXING ZONE FIELD INVESTIGATION - GREATER SHEDIAC WWTP **MEASURED WATER LEVEL (SEPT. 1, 2011)**	NATECH	**NATECH Environmental Services Inc.** 109 Patterson Cross Road, Harvey Station, NB, CANADA, E6K 1L9	**SCALE:** Not to scale **FILE:** CRA-11-01	**DATE:** 2011/10/03 **FIGURE:** 3-1

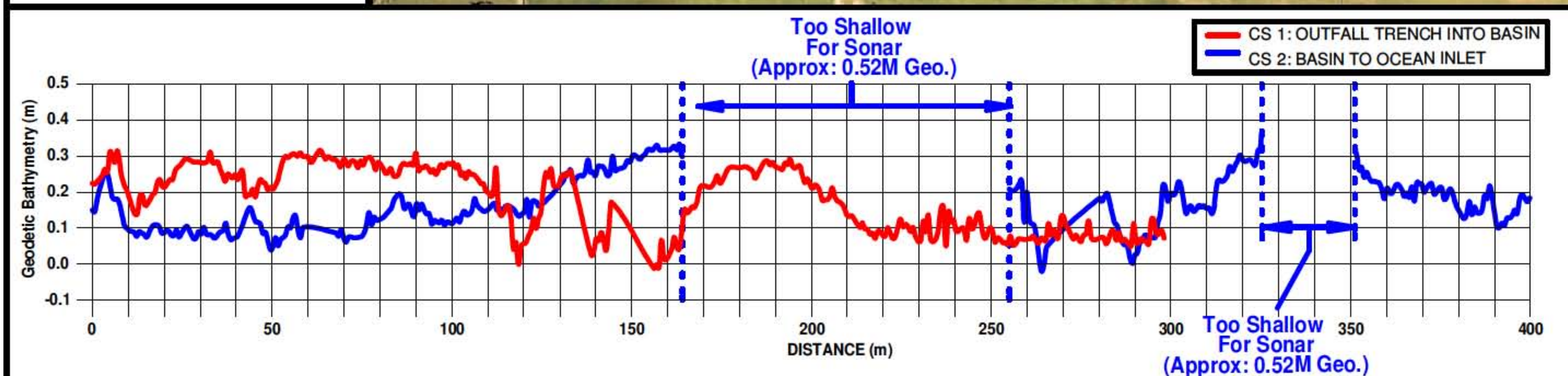
3.2 Bathymetry

Four cross sections were surveyed in order to characterize the bathymetry of the receiving environment. The cross sections were located from the trench to as far as the middle of the basin, from the basin into the ocean inlet, and two more within the ocean (see Figure 3-2 and Figure 3-3). During the survey across the shallow sandy channel from the basin into the ocean, the water level was so shallow that sonar data could not be collected. The field observations and water level sensor data indicate that the approximate average geodetic elevation of the shallow sandy channel was 0.52m. The collection of the survey data was used to produce a bathymetric geodetic elevation map found in Figure 3-4.

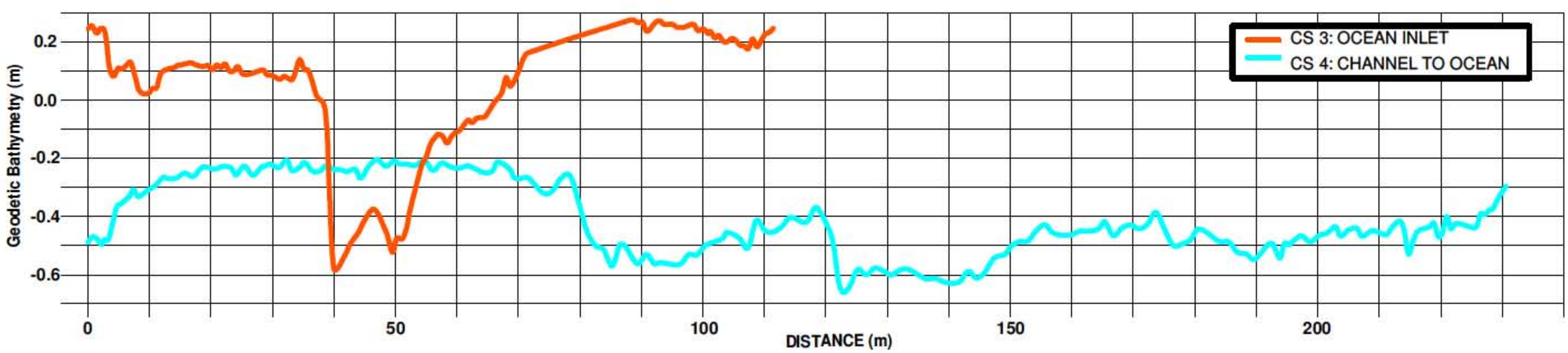
3.3 Current Direction and Speed

Figure 3-5 illustrates the current velocity and direction measurements during the study period. The current velocity was measured while the basin was filling in the early afternoon and then later while it was draining in the late afternoon.

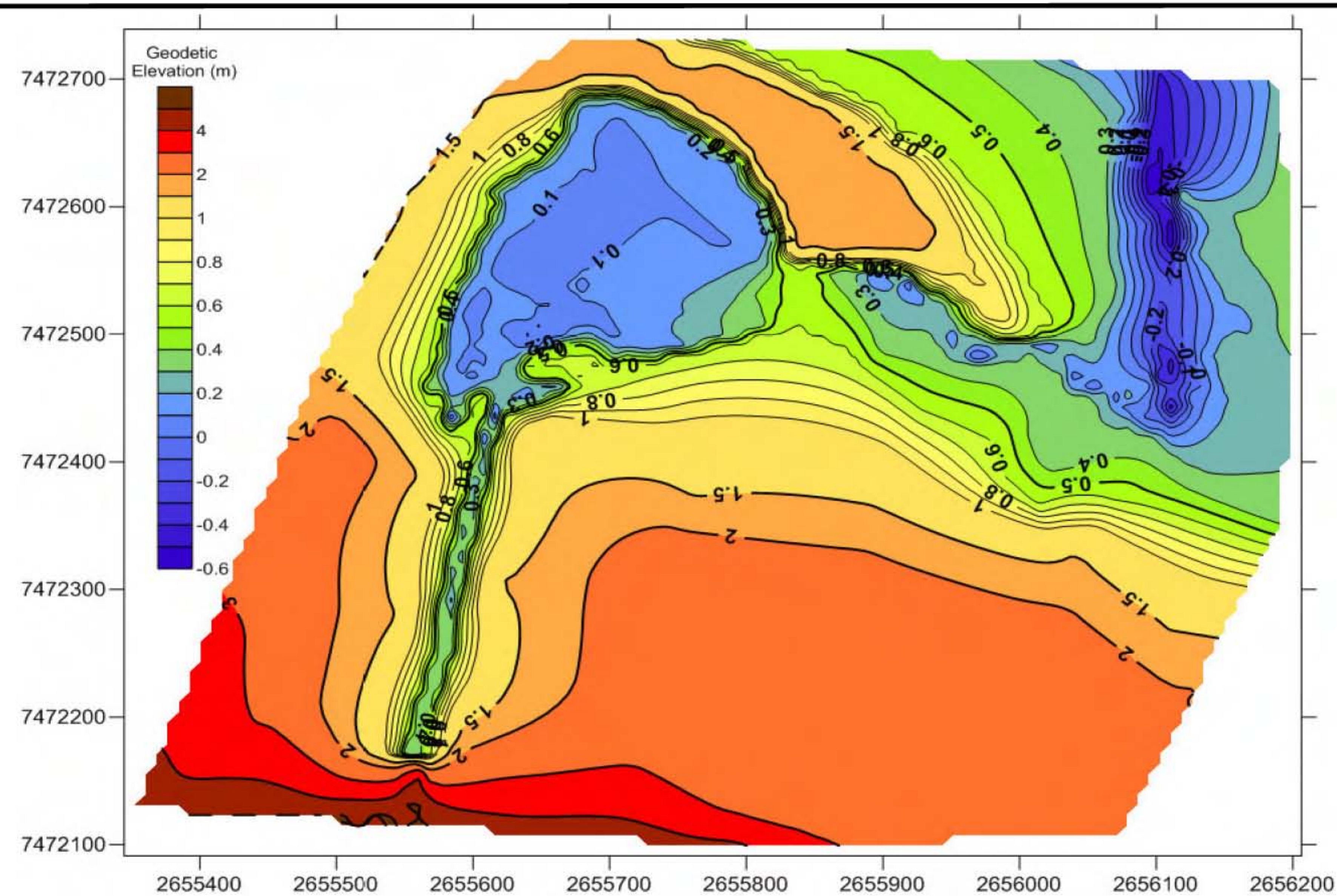
While the basin was filling, the current velocity was 0.18m/s near the ocean inlet and accelerated to 0.42m/s across the shallow sandy channel. While the basin was emptying, the current velocity was 0.24m/s in the shallow sandy channel. It slowed to 0.2m/s near the ocean inlet.



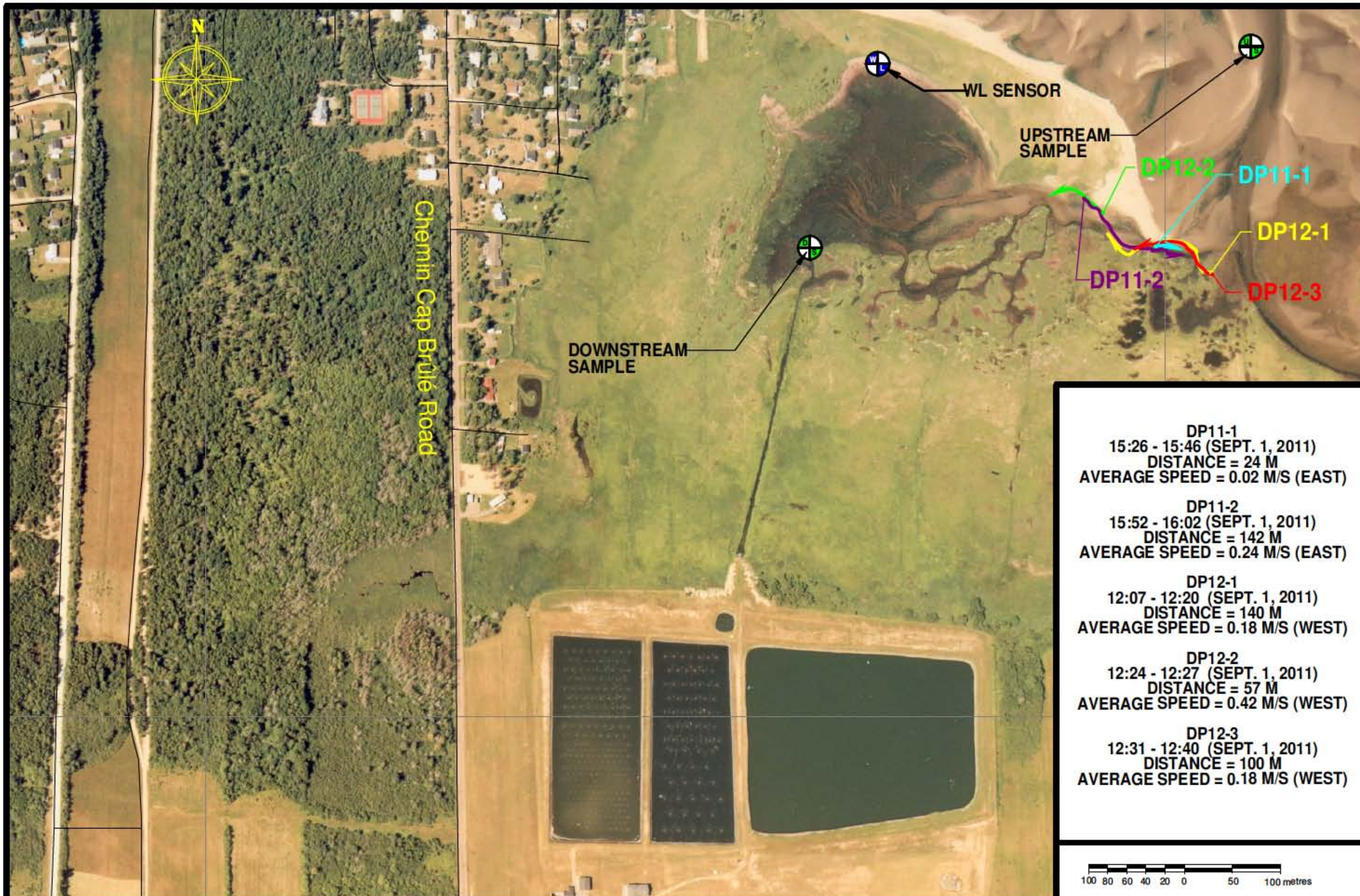
MIXING ZONE FIELD INVESTIGATION - GREATER SHEDIAC WWTP BATHYMETRY CROSS SECTIONS 1 & 2	NATECH Environmental Services Inc. 109 Patterson Cross Rd., Harvey Station, N.B. Ph: (506) 366 1080 Fax: (506) 366 1090	Date: Date: 11/10/03	Project No.: Nºdu projet CRA-11-01
		Scale: Echelle: AS SHOWN	Sheet No.: Nºde la feuille: FIGURE 3-2



MIXING ZONE FIELD INVESTIGATION - GREATER SHEDIAC WWTP BATHYMETRY CROSS SECTIONS 3 & 4	NATECH Environmental Services Inc. 109 Patterson Cross Rd., Harvey Station, N.B. Ph: (506) 366 1080 Fax: (506) 366 1090	Date: Date: 11/09/29	Project No.: Nºdu projet CRA-11-01
		Scale: Echelle: AS SHOWN	Sheet No.: Nºde la feuille: FIGURE 3-3



MXIING ZONE FIELD INVESTIGATION - GREATER SHEDIAC WWTP **BATHYMETRIC CONTOUR MAP**	**NATECH Environmental Services Inc.** 109 Patterson Cross Road, Harvey Station, NB, CANADA, E6K 1L9	**SCALE:** Not to scale	**DATE:** 2011/09/27
		FILE: CRA-11-01	**FIGURE:** 3-4



MIXING ZONE FIELD INVESTIGATION -
GREATER SHEDIAC WWTP

MEASURED CURRENT VELOCITIES

NATECH Environmental Services Inc.
109 Patterson Cross Rd., Harvey Station, N.B.
Ph: (506) 366 1080 Fax: (506) 366 1090

Date: / Date: 11/09/29	Project No.: / Nodu projet CRA-11-01
Scale: / Echelle: AS SHOWN	Sheet No.: / Node la feuille: FIGURE: 3-5

3.4 Water Quality

Table 3.1 lists the measured water quality observed in the field, and Table 3.2 contains the laboratory analysis for a wider range of parameters. Sampling locations are shown on Figure 3-5. The treated effluent was sampled downstream of the UV treatment. The high DO reading in the downstream sample is likely due to the presence of algae in the lagoon.

Table 3.1. Measured Water Quality - Shediac - September 1, 2011

Item	Upstream	Effluent	Downstream
Temperature (°C)	22.0	25.0	25.0
Conductivity (uS/cm·deg)	41.00	2.00	17.00
Dissolved Solids (calculated) (mg/L)	26.80	1.23	11.00
Salinity (mg/L)	26.40	0.99	10.00
DO (%)	116.0	109.4	170.0
DO (mg/L)	8.7	9.0	12.7
pH	8.3	8.5	8.3

Table 3.2. Shediac - Laboratory analysis for water samples (Sept. 1, 2011)

Parameter	Unit	Upstream	Effluent	Downstream
General chemistry - Measurements				
Sodium	mg/L	7930	239	2420
Potassium	mg/L	333	17.0	103.
Calcium	mg/L	345	51.2	125
Magnesium	mg/L	1050	27.0	305.
Iron	mg/L	2	0.52	0.7
Manganese	mg/L	< 0.05	0.432	0.29
Copper	mg/L	< 0.05	0.016	< 0.02
Zinc	mg/L	< 0.05	0.097	< 0.02
Ammonia (as N)	mg/L	0.13	10.2	8.9
Total Kjeldahl Nitrogen (TKN)	mg/L	0.5	27	16
pH	units	7.9	7.5	7.8
Alkalinity (as CaCO3)	mg/L	150	170	170
Chloride	mg/L	14900	440	4170
Fluoride	mg/L	1.68	0.64	0.87
Sulfate	mg/L	2600	62	620
Nitrate + Nitrite (as N)	mg/L	< 0.05	0.30	0.32
Nitrate (as N)	mg/L	< 0.05	0.19	0.21
Nitrite (as N)	mg/L	< 0.05	0.11	0.10
Cyanide - Total	mg/L	< 0.002	0.004	0.005
o-Phosphate (as P)	mg/L	0.01	3.2	1.96
Total Phosphorus (TP)	mg/L	0.035	3.39	2.34
r-Silica (as SiO2)	mg/L	< 0.1	11.4	8.6
Total Organic Carbon	mg/L	< 0.5	7.4	1.8
CBOD5	mg/L	< 6	8	< 6
Turbidity	NTU	0.8	7.9	6.9
Total Suspended Solids	mg/L	< 5	26	< 5
Conductivity	µS/cm	51800	1740	13000
General chemistry - Calculated parameters				
Bicarbonate as $CaCO_3$	mg/L	149	169	169
Carbonate as $CaCO_3$	mg/L	1.11	0.504	1.00
Hydroxide as $CaCO_3$	mg/L	0.040	0.016	0.032
Cation sum	meq/L	457	16.4	140
Anion sum	meq/L	477	17.3	134
% difference	%	-2.17	-2.80	2.13
Theoretical Conductivity	µS/cm	32900	1590	10100
Hardness (as $CaCO_3$)	mg/L	5180	239	1570
Ion Sum	mg/L	27200	969	7870
Saturation pH (5°C)	units	7.0	7.8	7.6
Langelier Index (5°C)		0.92	-0.30	0.20
Trace metals				
Aluminum	µg/L	< 50	73	40
Antimony	µg/L	< 5	0.3	< 2
Arsenic	µg/L	< 50	< 1	< 20
Barium	µg/L	< 50	226	120
Beryllium	µg/L	< 5	< 0.1	< 2
Bismuth	µg/L	< 50	< 1	< 20
Boron	µg/L	3960	178	1330
Cadmium	µg/L	< 0.5	0.43	< 0.2
Calcium	µg/L	345000	51200	125000
Chromium	µg/L	< 50	1	< 20
Cobalt	µg/L	< 5	0.3	< 2
Copper	µg/L	< 50	16	< 20
Iron	µg/L	2100	520	700
Lead	µg/L	< 5	2.2	2
Lithium	µg/L	142	6.6	44
Magnesium	µg/L	1050000	27000	305000
Manganese	µg/L	< 50	432	290
Mercury	µg/L	< 0.025	< 0.025	< 0.025
Molybdenum	µg/L	24	0.3	5
Nickel	µg/L	< 50	3	< 20
Potassium	µg/L	333000	17000	103000
Rubidium	µg/L	92	10.5	32
Selenium	µg/L	< 50	< 1	< 20
Silver	µg/L	< 5	< 0.1	< 2
Sodium	µg/L	7930000	239000	2420000
Strontium	µg/L	6500	372	2020
Tellurium	µg/L	< 5	< 0.1	< 2
Thallium	µg/L	< 5	< 0.1	< 2
Tin	µg/L	< 5	0.3	< 2
Uranium	µg/L	< 5	0.1	< 2
Vanadium	µg/L	< 50	< 1	< 20
Zinc	µg/L	< 50	97	< 20
Microbiological				
Coliforms	MPN/100mL	45	257500	74
E.Coli	MPN/100mL	22	100	49
Faecal Coliforms	MPN/100mL	22	500	74

3.5 Effluent Flow

The average effluent discharge was 73.2L/s (1.67MG/day) on September 1, 2011. The discharge was calculated from recorded data taken from the flow monitor's real time measurement display which was located within the UV Building. Effluent flow rates throughout the study were reasonably stable with a measured variation of 2L/s.

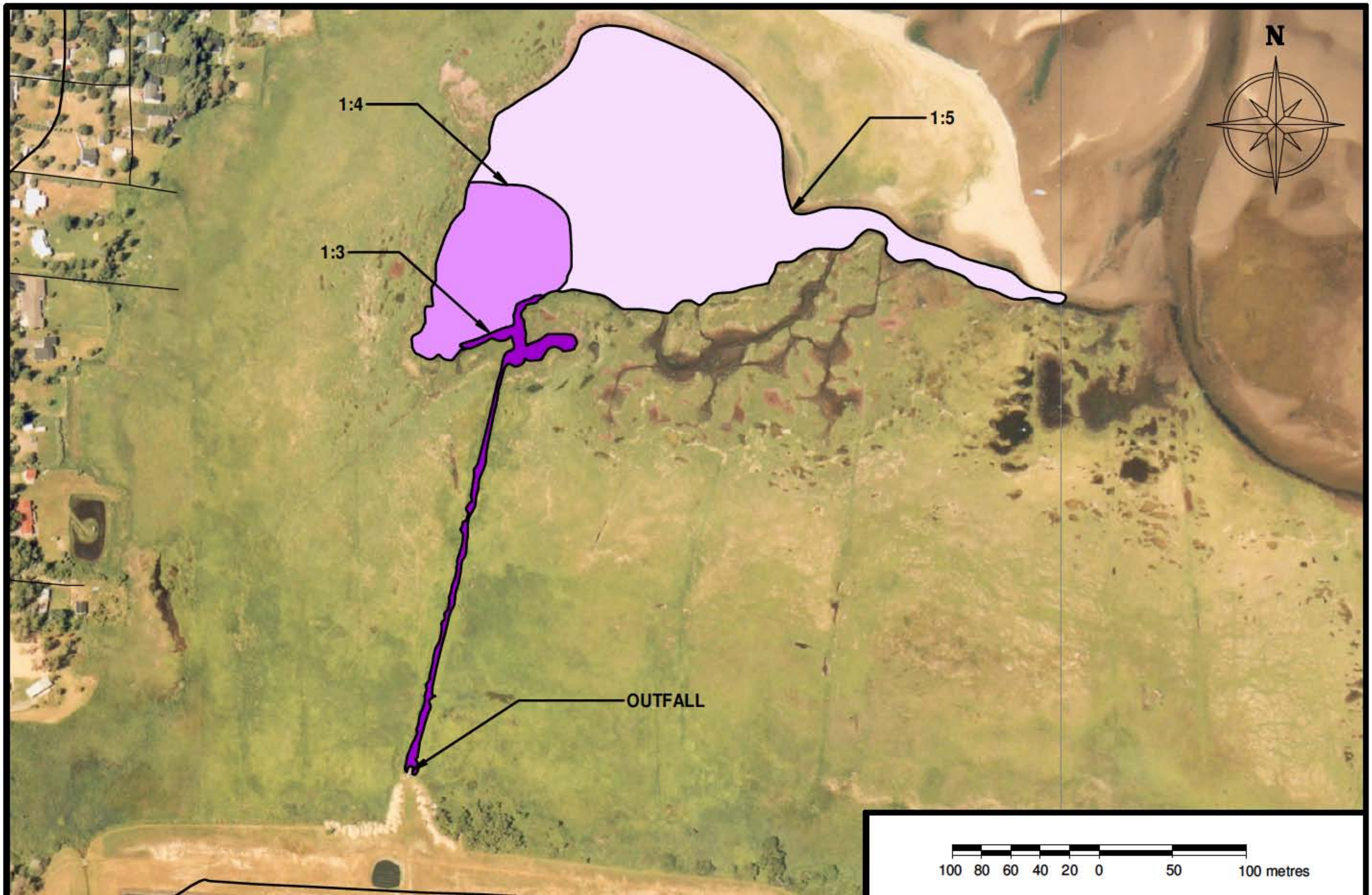
3.6 Mixing

The effluent plume, originating from the outfall located on the bank of the narrow trench, remained undiluted until entering the shallow basin. Values below one in three (1:3) dilution extended approximately 40m from the entrance of the trench into the basin. Measured plume dilutions are shown in Table 3.3 and illustrated in Figure 3-6.

Table 3.3. Observed Effluent Plume Dilutions - Shediac - September 1, 2011

Dilution Rate (Dye : Total Volume)	Max Observed Distance from Outfall (m)
1:3	40
1:4	120
1:5	450

The effluent was found to float at the surface on top of the underlaying saline layer. The volume of clean sea water that flowed into the basin during the tidal cycle studied on September 1st was calculated to be 11,400m^3. The average effluent flow rate was measured to be 73.2L/s, which corresponds to a total volume of 3,300m^3 for a 12.4 hour tidal cycle. The total volume flushing out of the basin during the tidal cycle was 14,700m^3. The volume balance for the tidal cycle on September 1st is illustrated on in Figure 3-7.

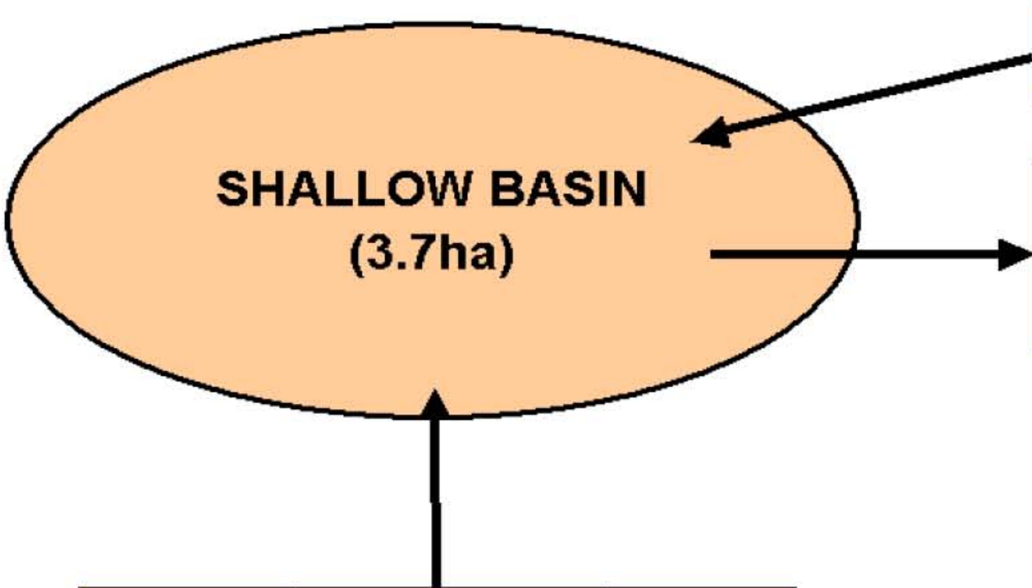


MIXING ZONE FIELD INVESTIGATION -
GREATER SHEDIAC WWTP

OBSERVED EFFLUENT PLUME
SEPT. 1, 2011 (11:00 - 17:10)

NATECH Environmental Services Inc.
109 Patterson Cross Rd., Harvey Station, N.B.
Ph: (506) 366-1080 Fax: (506) 366-1090

Date:	Date:	Project No.:	Nº du projet
11/09/29		CRA-11-01	
Scale:	Echelle:	Sheet No.:	Nº de la feuille:
AS SHOWN		FIGURE: 3-6	



Clean Ocean Water Flow	11,390	*m3 / tidal cycle*

Diluted Effluent Flow	14,656	*m3 / tidal cycle*
Diluted Effluent Concentration	22	*% Effluent*

Effluent Flow	3,266	*m3 / tidal cycle*
Effluent Concentration	100	*% Effluent*

Note: Measured flows on September 1, 2011

MIXING ZONE FIELD INVESTIGATION - GREATER SHEDIAC WWTP **EMBAYMENT FLUSHING VOLUMES ON SEPTEMBER 1, 2011**	NATECH	**NATECH Environmental Services Inc.** 109 Patterson Cross Road, Harvey Station, NB, CANADA, E6K 1L9	**SCALE:** Not to scale	**DATE:** 2011/09/27
			FILE: CRA-11-01	**FIGURE:** 3-7

APPENDIX A - SITE PHOTOS

Ditch receiving effluent

Shallow embayment at mouth of ditch

Edge of shallow embayment at low tide

Vegetation in shallow embayment

Channel at exit of shallow basin at low tide

Channel at exit of shallow embayment

Shediac Bay

End of channel draining shallow basin

APPENDIX E: NATECH Environmental Services Inc. - WWTF Outfall Study (2015)

Bathymetric Survey and Assessment of Potential Outfall Configurations for the Shediac Wastewater Treatment Plant

Submitted to: **Crandall Engineering Ltd.**
1077 St George Blvd., Suite 400
Moncton, New Brunswick
E1E 4C9

Prepared by: **NATECH Environmental Services Inc.**
2492 Route 640
Hanwell, N.B.
E3E 2C2

Date: **June 23, 2015**

NATECH

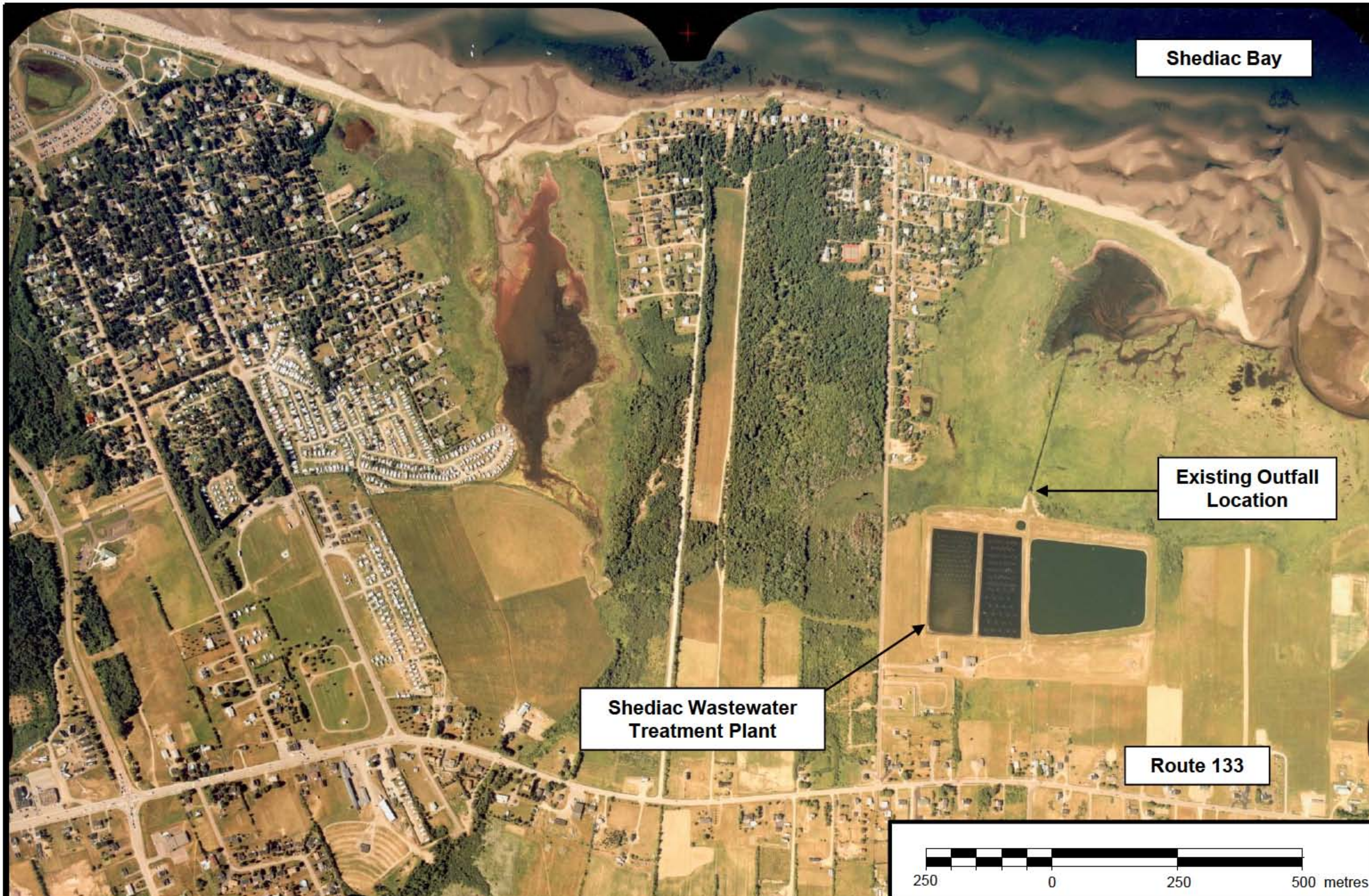
TABLE OF CONTENTS

1. INTRODUCTION

The outfall from the Shediac Wastewater Treatment Plant (WWTP) currently discharges into a ditch that flows through a tidal marsh, before reaching Shediac Bay. The nutrients in the effluent cause significant growth of aquatic vegetation in the marsh. When that vegetation dies and decomposes, it can become a source of odours. Figure 1-1 shows the existing outfall location.

Field measurements of effluent dilution in the marsh and a bathymetric survey were conducted in that area in the past (NATECH, 2011). The dilution was found to be very limited (1 in 5) at the outlet of the marsh. The marsh is shallow and is partially flushed by seawater flowing in and out with the tide. However, the flushing is limited by the bottom elevation of the narrow channel connecting the marsh to the bay and tends to only occur during a few hours around high tide. Dredging this channel may help with the flushing in the short-term, but in the long-term sandy sediment drifting along the coast will likely refill any dredged channels.

The objective of this investigation is to provide hydro-technical information to assist with the selection of suitable location for a new outfall for the Shediac WWTP. For this purpose, a bathymetric survey was carried out in the marsh and in Shediac Bay up to 500 m from the shore. Some surface ocean current velocities were measured during the course of the bathymetric survey at low tide. A mixing model (CORMIX) was run to simulate the effluent dilution for an outfall submerged into Shediac Bay, for an open-ended pipe and for various diffuser configurations.



Shediac WWTP
Location Map

Environmental Services Inc.
2492 Route 640., Hanwell, N.B., E3E 2C2
ph: (506) 455 1085, fax: (506) 455 1088

DATE: 2015/06/15	FILE: CRA-15-01
SCALE: As Shown	FIGURE: 1-1

2. METHODOLOGY

2.1 Water Level Variations

Two water level sensors were installed to continuously monitor the tidal water level variations during the bathymetric survey. One sensor was placed in the marsh near the existing outfall, and the other one at the wharf of the Yacht Club. The water levels were related to a geodetic benchmark: the slab of the small municipal building located near the beach on Pussyfoot Lane, with an elevation of 2.20 m.

2.2 Bathymetry

The bathymetry of Shediac Bay in the outfall area was surveyed using a boat equipped with GPS and echo sounder technology. The depths were originally recorded relative to the water surface and then converted to geodetic elevations, taking into account the measured tidal changes in the water level. Several manual readings were taken in the marsh because the bottom was too shallow for the echosounder to operate reliably.

2.3 Current Direction and Speed

The local ocean currents were measured at low tide using three surface drogues equipped with GPS tracking devices, that drifted with the currents.

2.4 Mixing Modeling

The CORMIX model was run, assuming a range of ocean current velocities, and various outfall configurations (open-ended pipes of various diameters, and diffusers of various lengths).

3. RESULTS

3.1 Water Level Variations

The field investigations were carried out on June 5, 2015. The weather conditions during the investigation were sunny with a light wind (18 km/hour or 0.05 m/s), blowing from the South-west.

The water level records during the survey are displayed on Figure 3-1, as well as tidal predictions for Shediac Bay from Fisheries and Oceans Canada. Only a very small water level change occurred in the marsh around high tide.

Table 3.1 shows the typical water levels expected in Shediac as listed on the local hydrographic chart. Based on the surveyed water levels, the chart datum is estimated to be at -1.2 m geodetic.

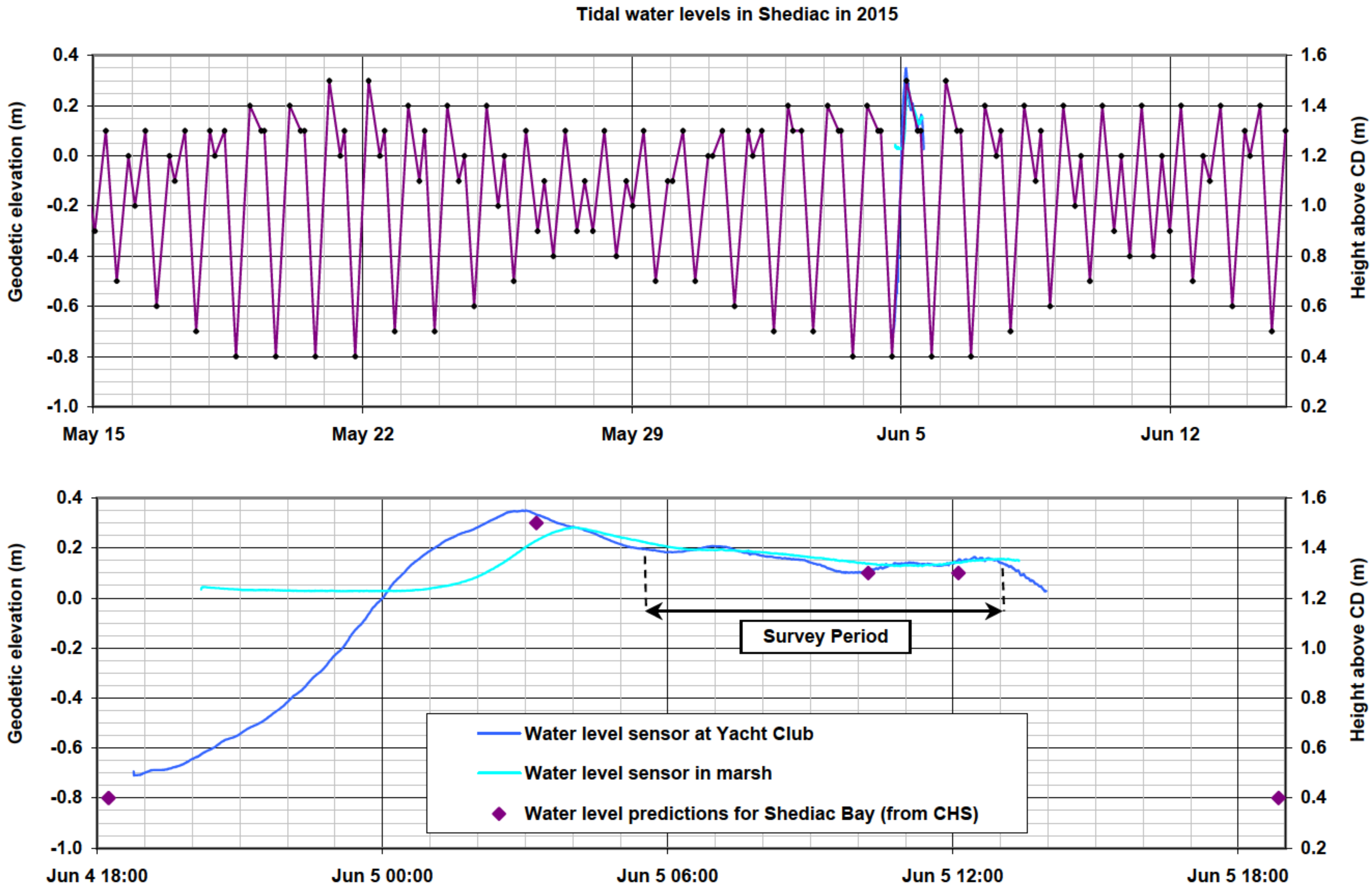
Table 3.1 Characteristics of tidal water levels in Shediac (from Nautical Chart No. 4905 relative to chart datum (CD):

Parameter	Large tides	Mean tides
Low water level (m above CD)	0.3	0.5
High water level (m above CD)	1.7	1.4
Range (m)	1.4	0.9

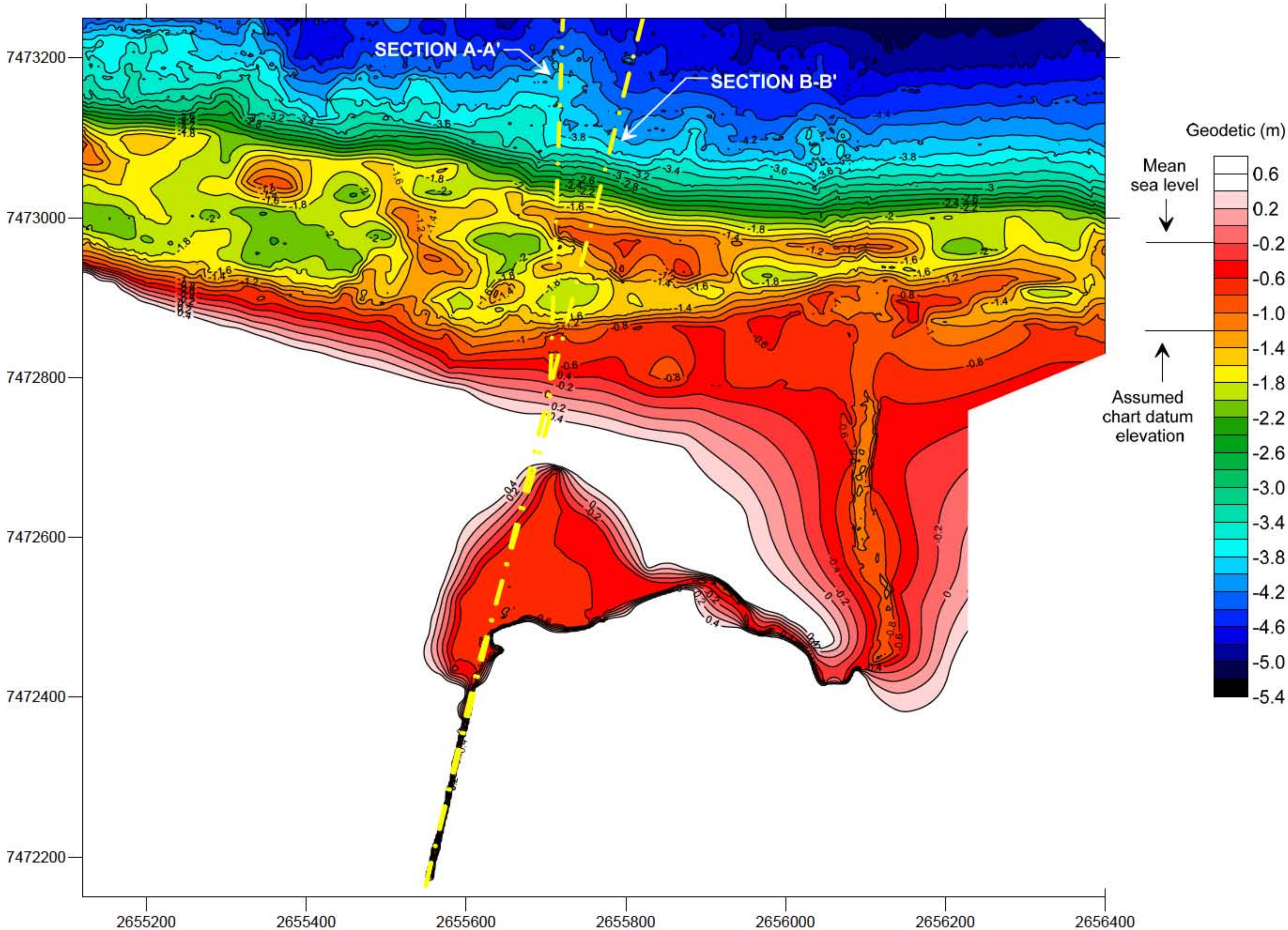
Note: the mean sea level is at 1.0 m above chart datum in Shediac. This nautical chart does not provide a conversion factor to geodetic elevations.

3.2 Bathymetry

Figure 3-2 displays the surveyed bathymetry. Cross-sections of the marsh and of Shediac Bay along potential future outfall pipeline alignments are presented on Figure 3-3.

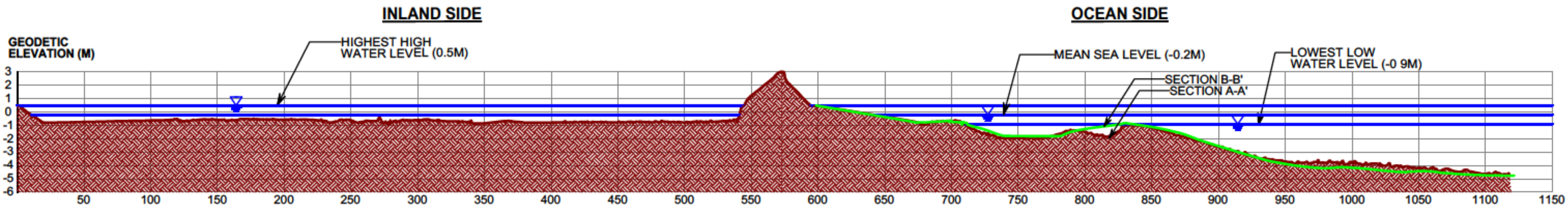


Shediac WWTP **Water Level Variations in May-June 2015**	**Environmental Services Inc.** 2492 Route 640, Hanwell, NB, E3E 2C2 Phone: (506) 455-1085 Fax: (506) 455-1088	**DATE:** 2015/6/15	**FILE:** CRA-15-01
		SCALE: As shown	**FIGURE:** 3-1

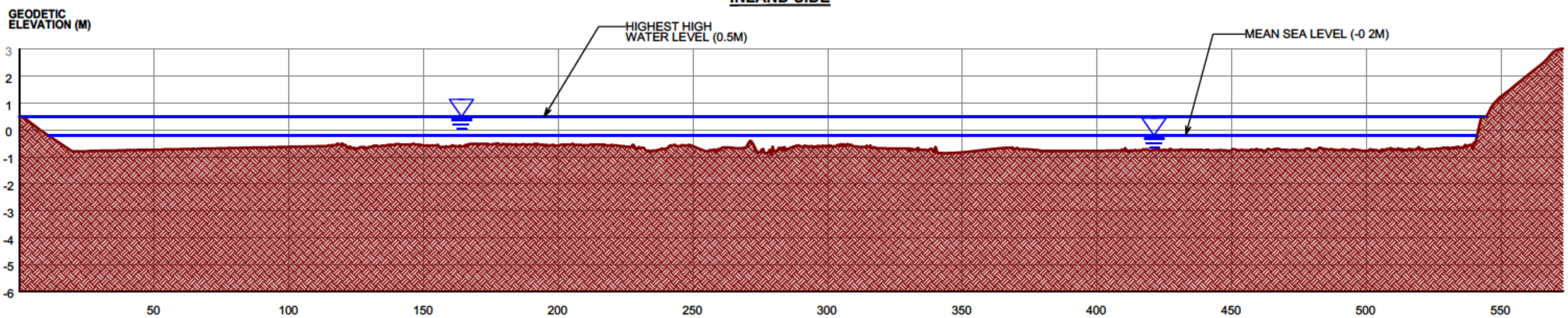


Shediac WWTP Bathymetric Survey of June 5, 2015	NATECH Environmental Services Inc. 2492 Route 640, Hanwell, NB E3E 2C2 Ph.: (506) 455-1085 Fax: (506) 455-1088	DATE: 2013/07/23 SCALE: NB Stereographic Coordinates (m)	FILE: CRA-15-01 FIGURE: 3-2

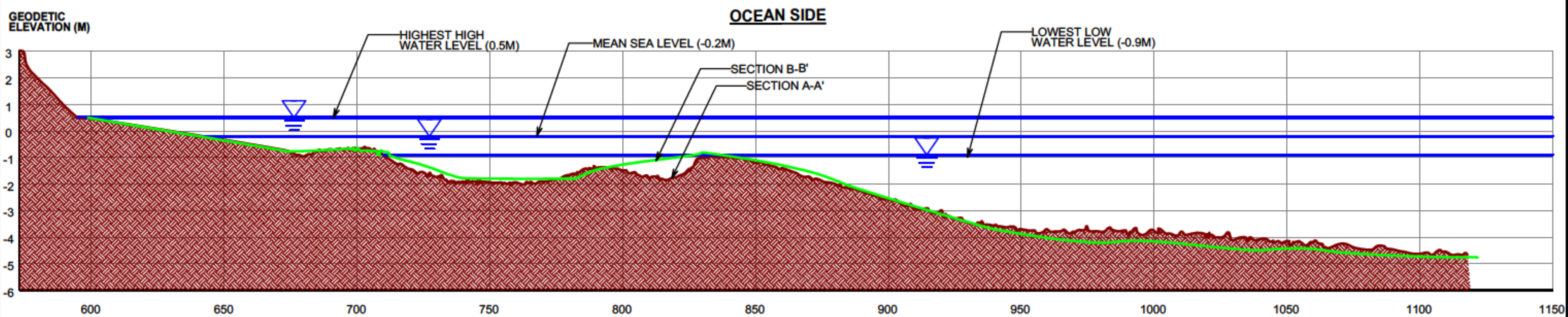
OVERVIEW



INLAND SIDE



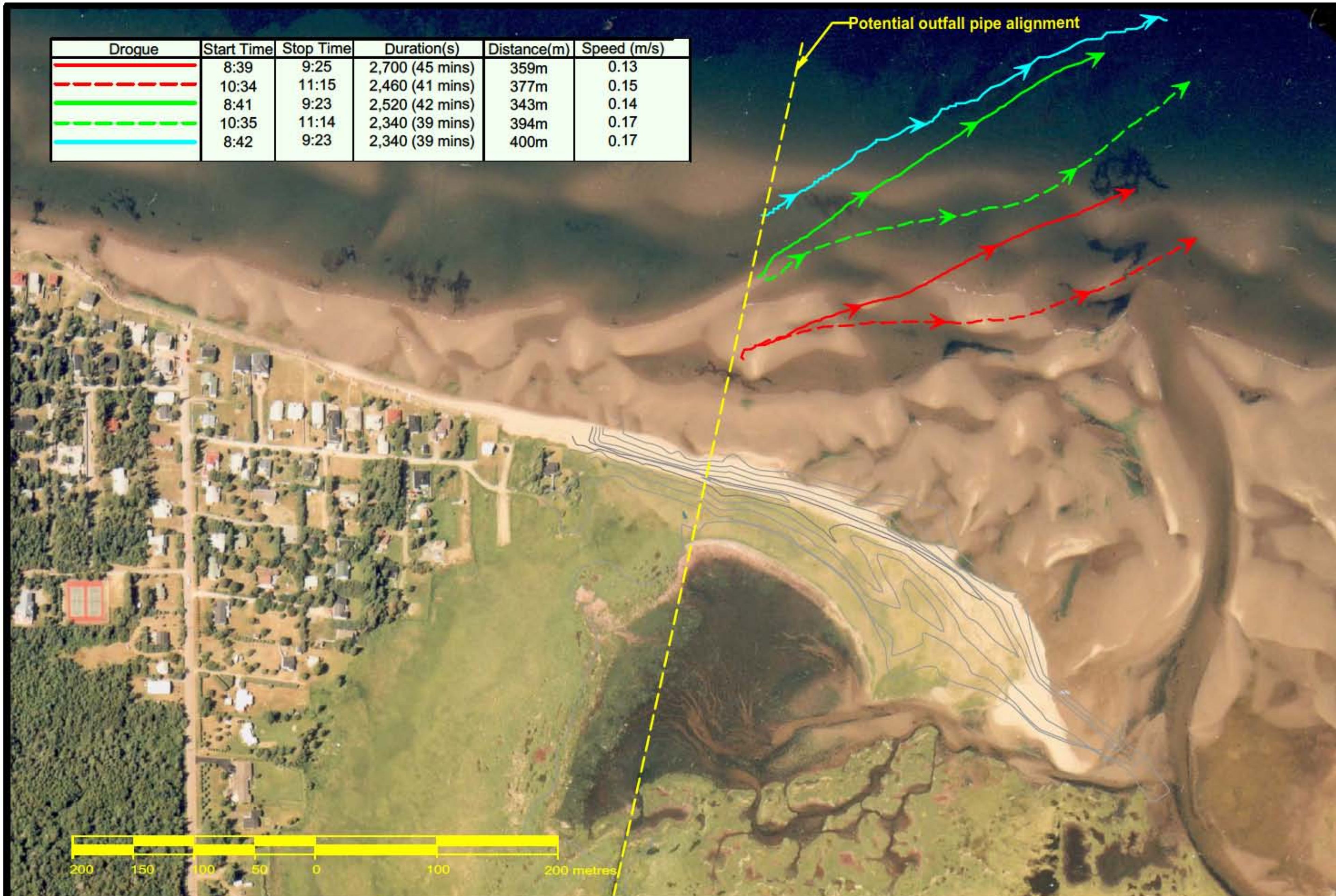
OCEAN SIDE



Shediac WWTP Cross-sections measured on June 5, 2015	NATECH Environmental Services Inc. 2492 Route 640, Hanwell, N.B., E3E 2C2 Ph: (506) 455-1085 Fax: (506) 455-1088	Date: Date: 2015/06/11	File: CRA-15-01
		Scale: Echelle: AS SHOWN	Figure: 3-3

3.3 Current Direction and Speed

Figure 3-4 illustrates the current speed and direction measured by the surface drogues. The observed velocities varied between 0.13 m/s and 0.17 m/s in North-eastern direction at low tide. The low tide level was actually as high as the high tide level on the morning of June 5 (see Figure 3-1). This choice of tides was deliberate to facilitate the bathymetric survey, but the observed velocities may not be representative of typical velocities during low water conditions given the strong mixed diurnal tidal component on that day. Minimal current speed values of 0.10 m/s are more likely to occur at low tide.



Drogue	Start Time	Stop Time	Duration(s)	Distance(m)	Speed (m/s)
	8:39	9:25	2,700 (45 mins)	359m	0.13
	10:34	11:15	2,460 (41 mins)	377m	0.15
	8:41	9:23	2,520 (42 mins)	343m	0.14
	10:35	11:14	2,340 (39 mins)	394m	0.17
	8:42	9:23	2,340 (39 mins)	400m	0.17

Shediac WWTP

Measured Current Velocities on June 5, 2015

NATECH Environmental Services Inc.
2492 Route 640, Hanwell, N.B., E3E 2C2
Ph: (506) 455-1085 Fax: (506) 455-1088

Date:	2015/06/15	File:	CRA-15-01
Scale:	AS SHOWN	Figure:	3-4

3.4 Mixing Modeling

Effluent dilution simulations were carried out with the CORMIX model. Three main design requirements were used for the simulations:

- The outfall should achieve at least a 1 in 100 dilution within 250 m of the outfall at all times, based on the New Brunswick mixing zone limits (this approach will result in the highest possible Effluent Discharge Objectives for the effluent).
- The top of the outfall structure should be deep enough (for the simulations a depth of at least two metres below the lowest low tide was assumed).
- The outfall should be beyond the shallower near-shore zone that is believed to experience significant sediment movement and ice rafting.

A depth of two metres during the lowest low tide (-3 m geodetic) is reached approximately 350 m from the shore, and at this distance the bottom contours appear relatively regular and stable, compared to the drifting sandbars observed closer to shore. During an extreme low tide the shoreline would recede up to 250 m away from the high water shoreline, and the outfall would actually be at a distance of only 100 m from the low-tide shoreline.

Current velocities ranging from 0.05 m/s to 0.15 m/s were assumed in the model. No temperature or salinity stratification was assumed to be present. The average effluent flow of 104 L/s (9,000 m^3/day) measured in 2014 was used. Initially, the outfall was assumed to be an open-ended pipe with a diameter of 0.3 m, providing an exit velocity of 1.5 m/s. With these assumptions, dilutions between 1 in 10 and 1 in 42 are predicted 250 m downstream of the outfall at low tide, depending on the ambient current velocity. The assumptions used and the results of the simulations are summarized in Table 3.2.

At this site the current speed has a greater influence on dilution than water depth. This phenomenon is due to the fact that the effluent is buoyant and tends to rise quickly without experiencing much dilution, until it spreads in a thin layer (0.1 to 0.3 m thick) at the surface of the ocean.

In order to improve the mixing regime, a range of diffuser lengths was simulated in the model. According to the model predictions, a length of 25 m appears sufficient to provide a dilution greater than 1 in 100 within 250 m from the outfall for a relatively low ambient current velocities of 0.1 m/s. When the current speed increases, the dilution increases significantly. Additional model runs were carried out to simulate various numbers of nozzles along the diffuser. At least five nozzles at a 5 m spacing along a 25 m diffuser are recommended based on the size of individual plumes of each nozzle, but beyond that number of nozzles there is little improvement predicted in the dilution at 250 m distance downstream.

The diameter of the nozzles should be small enough to provide at least a 2.0 m/s exit velocity to ensure good mixing, and also to minimize sand entering into the diffuser piping and plugging it. For example five 100 mm diameter nozzles would provide an exit velocity of 2.7 m/s for an effluent flow of 104L/s. If this can not be achieved with the head available between the lagoon level and the ocean level (also taking into consideration the head loss along the outfall pipeline), the effluent may have to be pumped into the diffuser. To avoid sediment drifting into and plugging the outfall pipe, a continuous discharge is required, and the openings or nozzles should be on top of the pipe. The last opening should be the end of the pipe, fitted with a reducer of the appropriate size. This will help flush the pipe if any sediments were to deposit inside.

Table 3.2. Summary of CORMIX model runs

AMBIENT CONDITIONS	**Unit**													
Depth below low tide	m	2.0	2.0	2.0	**3.0**	2.0	2.0	2.0	**2.5**	**3.0**	2.0	2.0	2.0	2.0
Current velocity	m/s	**0.15**	0.10	**0.05**	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
OUTFALL CONFIGURATION		**Open-ended pipe**					**Diffuser**							
Diffuser Length	m	-	-	-	-	-	**20**	**20**	**20**	**20**	25	25	**30**	**50**
Distance from shore	m	350	350	350	**400**	350	350 to 370	350 to 370	**375 to 395**	**400 to 420**	350 to 375	350 to 375	350 to 380	350 to 400
Number of nozzles		-	-	-	-	-	**11**	**21**	5	5	5	**9**	**11**	**11**
Diameter of pipe/nozzle	m	0.3	0.3	0.3	0.3	**0.2**	**0.075**	**0.050**	0.100	0.100	0.100	**0.075**	**0.075**	**0.075**
Exit velocity	m/s	1.5	1.5	1.5	1.5	3.3	2.1	2.5	2.7	2.7	2.7	2.7	2.1	2.1
RESULTS														
Dilution at 250 m	**1 in**	**42**	**21**	**10**	**23**	**27**	**87**	**88**	**105**	**121**	**101**	**101**	**111**	**155**
Plume width	m	120	170	265	175	175	185	185	185	185	185	185	185	185

Other assumptions which are the same for all runs:
Ambient density: 1022 kg/m3 (30 ppt, 15C)
Effluent density: 999 kg/m3 (0 ppt, 15C)
Effluent flow: 104 L/s (average for 2014)
Assumptions in bold differ from the default assumptions

4. DISCUSSION

Considering the preliminary review of potential physical shoreline and oceanographic conditions at this site, it is recommended that an extensive review of existing physical environmental data for this side of the Northumberland Strait be undertaken prior to final design and construction. The proposed site is exposed to the effects of winds from the north and north-west on waves and ice entering the Strait. Ice floes 0.5 m to 1.0 m thick and over 1 km long have been observed moving at 0.5 m/sec in the Strait (Prinsenberg et al., 2001). Ice ridges can form with thicknesses of several metres. Also this shore is known to experience strong littoral sediment drift. Data collected in connection with the Confederation Bridge construction may provide much of the information required. Historical anecdotal information on storm damage in the area should be reviewed.

Researching this information should help to determine how far from the shore and how deep the outfall should be located to avoid damage due to ice rafting or sediment drift. The pipe should also be buried deep enough under the sand shoals in the intertidal area to avoid disturbance of this pipeline. Breaching the natural sand dune that forms the shoreline during construction may weaken the dune. It may take several seasons before its original resistance to storms is restored.

Some alternative outfall locations were briefly considered:

❑ Using the existing marsh pond to site the diffuser and dig a channel to increase tidal flushing: this may work in the short term but the sediment drift is likely to re-fill the channel within a few years.

❑ Extending the outfall pipe Eastward through the marshland to the edge of the adjacent small brook coming from the South: this brook has a small catchment area (in the order of 10 km^2) with an estimated average flow of 200 L/s and an estimated seven-day ten-year low flow of 13 L/s, which would provide very little dilution of the effluent flow (104 L/s on average or 9,000 m^3/day). The larger marsh on the east side of the brook may experience up to 125,000 m^3/day of tidal flushing volume (assuming an area of 250,000 m^2 and an effective tidal range of 0.5 m occurring once per day, every other tidal cycle). Still this would only amount to a 1 in 15 dilution rate of the effluent flow on average over the day and the marsh would likely experience eutrophic conditions. If the effluent was discharged only during falling tides, the impact on the mash would be minimized. Tertiary treatment would likely have to be considered if an outfall in that location was to be implemented.

5. CONCLUSIONS AND RECOMMENDATIONS

The bathymetric survey and water level measurements confirmed that the marsh area between the existing outfall and the shoreline is very shallow and experiences little flushing with the tides. Significant growth of aquatic vegetation was observed to occur in the marsh. Extending the outfall in an area with better flushing is recommended. The following outfall design considerations are provided:

- ❑ It is recommended to design the outfall to achieve a 100 times dilution of the effluent within 250 m of the outfall. Based on the Strategy for the Management of Municipal Effluent (CCME, 2009), the requirements from the NB Department of Environment, the maximum mixing zone limits for a municipal WWTP in NB are a 250 m radius around the outfall pipe, or where a 1 in 100 times maximum dilution is achieved, whichever comes first. Achieving 100 times dilution in the mixing zone will enable the WWTP to have the highest possible Effluent Discharge Objectives (EDOs). If the outfall was maintained in its current location in the marsh, with a dilution in the order of 1 in 5 at the edge of the mixing zone (NATECH, 2011), the EDOs would be much stricter and costly upgrades may be required at the plant, such as additional ammonia, nitrogen, and phosphorus removal (tertiary treatment).

- ❑ Significant current-related sediment transport can be expected in Shediac Bay. This phenomenon should be considered in the design to minimize the risk to an outfall in the bay (pipe moving or plugging).

- ❑ Ice rafting can occur in the Shediac area, particularly during the spring ice break up. Thick slabs may travel in the future outfall area. An outfall pipe may have to be protected from ice rafts. For the purpose of this study, a minimum water depth of 2.0 m at low tide was assumed for the termination point of the outfall. Such depths are observed at 350 m from the shore based on the bathymetric survey results.

- ❑ The CORMIX model was used to optimise the outfall configuration if the outfall was to be extended into Shediac Bay 350 m from the shore. An open-ended pipe is predicted to only provide a dilution of 1 in 20 of the average effluent flow at 250 m from the outfall under worst-case mixing conditions (at low tide, for a current speed of 0.1 m/s). Extending the pipe into deeper water, or increasing the exit velocity by placing a reducer at the end of the pipe only appears to provide minor improvements in dilution. Therefore the use of a diffuser is recommended.

- ❑ Several diffuser configurations were tested with the CORMIX mixing model. To achieve the desired 100 times dilution at 250 m from the outfall, a 25 m long diffuser with at least five nozzles/hole is recommended. The diameter of the nozzles/holes should be small enough to provide an exit velocity of 2 to 3 m/s, to optimise the mixing and avoid the deposition of sediment inside the outfall pipe. If this cannot be achieved with the available head, the effluent may have to be pumped. To avoid sediment drifting into and plugging the outfall pipe, a continuous discharge is required, and the openings or nozzles should be on top of the pipe, possibly with short pipe extensions (provided that they can be protected against ice rafting). The last opening should be the end of the pipe, fitted with a reducer of the appropriate size. This will help flush the pipe if any sediments were to deposit inside.

- ❑ An alternative to the off-shore outfall would be an outfall closer to the existing outfall, into the channel of the adjacent brook flowing from the South. That location is more sheltered. However, dilution in that area would be limited, necessitating either an intermittent effluent discharge during falling tides only, or an improved effluent quality, produced by tertiary treatment.

6. REFERENCES

NATECH Environmental Services Inc. 2011. Mixing Zone Field Investigation for the Greater Shediac Wastewater Treatment Plant. Report dated October 4, 2011.

Prinsenberg S.J., and I.K. Peterson. 2001. Pack ice thickness and concentration measurements from the area around the Confederation Bridge (Canada) using helicopter-borne sensors. Department of Fisheries and Oceans, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada, B2Y 4A2. Report available online at: http://www.bio.gc.ca/science/research-recherche/ocean/ice-glace/documents/prins13.pdf

R J Daigle Enviro, 2011. Coastal Flooding Issues in the Maritime Provinces. Report available online at http://atlanticadaptation.ca/node/372.

APPENDIX A - SITE PHOTOGRAPHS

Shediac WWTP outfall

Marsh receiving the effluent

Beach at survey location

Shediac WWTP **Photographs taken on June 5, 2015**	NATECH **Environmental Services Inc.** **2492 Route 640., Hanwell, N.B., E3E 2C2** **ph: (506) 455 1085, fax: (506) 455 1088**	DATE: 2015/06/22	FILE: CRA-15-01
		SCALE: As Shown	FIGURE: A-1