CANADIAN CONSULTING ENGINEERING AWARDS 2012

Eastern Wastewater Treatment Facility

CBCL LIMITED

Consulting Engineers

The Eastern Wastewater Treatment Facility (EWWTF) serves as the cornerstone for Saint John Harbour Cleanup, a major initiative by the City of Saint John, Province of New Brunswick and Government of Canada to intercept and treat raw sewage from outfalls that discharge directly to the Bay of Fundy. Located adjacent to Red Head Marsh in East Saint John, this conventional activated sludge wastewater treatment facility is the largest secondary wastewater treatment facility in Atlantic Canada.

Designed to treat an average daily wastewater flow of 35,000 cubic metres per day, with a peak daily flow of 80,000 cubic metres, the plant includes facilities that encompass preliminary treatment, screening, grit collection, sludge dewatering, primary clarification, secondary treatment, and disinfection via ultraviolet light. A 1370 millimetre diameter high density polyethylene outfall pipe extends 1400 metres from the plant into Saint John Harbour to disperse treated effluent through a diffuser. The diffuser utilizes 19 duck billed check valves to release treated effluent over a 100 metre section. The valves are ideal for marine environments as they prevent salt water intrusion as well as sediment infiltration and deposition in the outfall during low flow periods. The diffusers have the capability to self clean and lessen the occurrence of marine fouling.

CBCL Limited commenced the pre-design in 2001 to select the most viable treatment process. Preliminary design, environmental assessments and permitting began in 2004. A 3D hydrodynamic model of Saint John Harbour was developed by CBCL to predict the “near field” and “far field” effects of treated effluent on the receiving body during a rising and falling tide. Multi-discipline detailed design for a 188-drawing tender package was completed in 2005. CBCL provided civil, environmental, architectural, structural, mechanical, electrical, and instrumentation design services for the project. Construction commenced in 2009, work was completed over a period of 30 months, and commissioning and SCADA integration took place in the Fall of 2011.

The EWWTF project was completed on budget and on schedule at a cost of $48.5 million. Throughout the design process, the project team introduced the Value Engineering (VE) approach to optimize the design and provide maximum cost/benefit to the City of Saint John. VE benefits reduced capital costs, improved performance and operational flexibility, confirmed project scope and budget, identified and resolved design issues, and facilitated project team and client “buy in” to ensure we were “doing the right project”.

A fundamental challenge for the EWWTF involved construction on the site of the existing Hazen Creek Wastewater Treatment Plant and adjacent to pristine environmental features. The solution was to design and construct the new facility around the existing treatment plant while maintaining operations. Once the new facility was completed, the Hazen Creek Plant was decommissioned and demolished. The site was also located adjacent to Red Head Marsh, a provincial environmentally significant wetland that serves as prime habitat for migratory birds including the at risk species known as the *Least Bittern*. As the Bittern’s nesting period can be threatened by noise disturbance from activities such as breaking or blasting rock, non-traditional methods of rock removal were researched and employed to ensure that the wildlife and the surrounding environment were not disturbed. Fracturing and cleavage of solid rock with air pressure was chosen in sensitive areas rather than traditional blasting.

Given the environmental features of the project area and the anticipated interactions between several valued ecosystem components (VEC), socio-economic issues were strongly considered. Project activities introduced the potential to adversely affect marine water and intertidal sediment quality, fish, lobster, marine mammals, birds, Red Head Marsh, air quality, commercial and recreational fishery, public health and safety, and navigation and traffic patterns. Each VEC identified was assessed to determine whether any activities associated with the project could

result in any predicted residual effects. Several mitigative measures were put in place during site preparation, facility construction and outfall construction to minimize the adverse effects on each component investigated.

The EWWTF outfall design and construction faced marine challenges posed by varying tide levels and dynamic environments. Each day approximately 100 billion tonnes of seawater move in and out of the Bay of Fundy during tide cycles. This statistic is greater than the combined flow of the world's fresh water rivers. The tide cycle can vary in water depth as much as 8 metres every six hours.

During construction, the project team was challenged each day to adapt construction methods for extreme low and high tides and quickly changing weather conditions. The project team utilized more conventional excavation and dredging methods for low tides. During high tides, excavation was performed using dredging equipment and barges. The rising and falling tides and harsh coastal weather conditions caused moving bed and suspended sediments during dredging operations. The project team divers worked in near zero visibility subaqueous conditions during construction, outfall installation, testing, and backfilling operations.

Strong currents from the Saint John River and tidal shift introduced unique effluent discharge mixing with bi-directional receiving water flow. Coordination with the local Port Authority, Transport Canada, cruise lines, and shipping lines were paramount when working near navigation channels.

The EWWTF project provides significant benefits to the local community. In 1993, a Wastewater Strategy was completed for the City of Saint John to develop a master plan for the collection and treatment of wastewater generated within the City and addressed the collection and treatment needs for serviced and unserviced areas within the City of Saint John. With Harbour Cleanup, the City is implementing the infrastructure required to effectively collect and treat wastewater in Saint John for many years.

The EWWTF project can now treat flows that previously discharged directly to Marsh Creek and Saint John Harbour. Improvements to the wastewater collection and treatment system are ongoing to convey untreated sanitary sewer flows to the EWWTF. Dry weather raw sewage outfalls are being eliminated as a result of Harbour Cleanup initiatives. High bacterial loads are eliminated in Courtenay Bay and over the Red Head Mudflats. Treated effluent from the EWWTF is now directed more than 1 km offshore into a mixing zone, as opposed to the previous location which was directly discharged onto Red Head beach. Local residents can now safely enjoy recreation activities in this area.

As Canada's first incorporated city, Saint John is a major port of call for the cruise ship industry and is becoming a vibrant tourism destination. During design and construction of the project, approximately 120 man-years of employment, filled by local residents, were created and currently 8 full time operations staff now work at the EWWTF.

The EWWTF is the largest secondary wastewater treatment facility in Atlantic Canada. It was also the largest project that the City of Saint John had ever undertaken. Designed by CBCL Limited and associated subconsultants, the project was completed on budget, and on schedule. Subconsultants for the project included Conquest Engineering (Geotechnical), Murdock and Boyd Architects (Architectural drawing review), Lewis and Zimmerman (Value Engineering Facilitators), and Archaeo Consulting (archaeological investigation). The EWWTF provided CBCL Limited staff with personal gratification that wastewater generated in the south central peninsula and East Saint John can now be intercepted and treated at this impressive facility.

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Saint John, New Brunswick

Client	City of Saint John	**Completed**	November 2011
Sector	Municipal/Civil	**Construction Cost**	$48.5 Million

The Project

The Eastern Wastewater Treatment Facility (EWWTF) serves as the cornerstone for Saint John Harbour Cleanup, a major initiative by the City of Saint John, Province of New Brunswick and Government of Canada to intercept and treat raw sewage from outfalls that discharge directly to the Bay of Fundy. Located adjacent to Red Head Marsh in East Saint John, the facility is a conventional activated sludge wastewater treatment facility and the largest secondary wastewater treatment facility in Atlantic Canada.

Located next to Red Head Marsh in East Saint John, this conventional activated sludge wastewater treatment is the largest secondary wastewater treatment facility in Atlantic Canada.

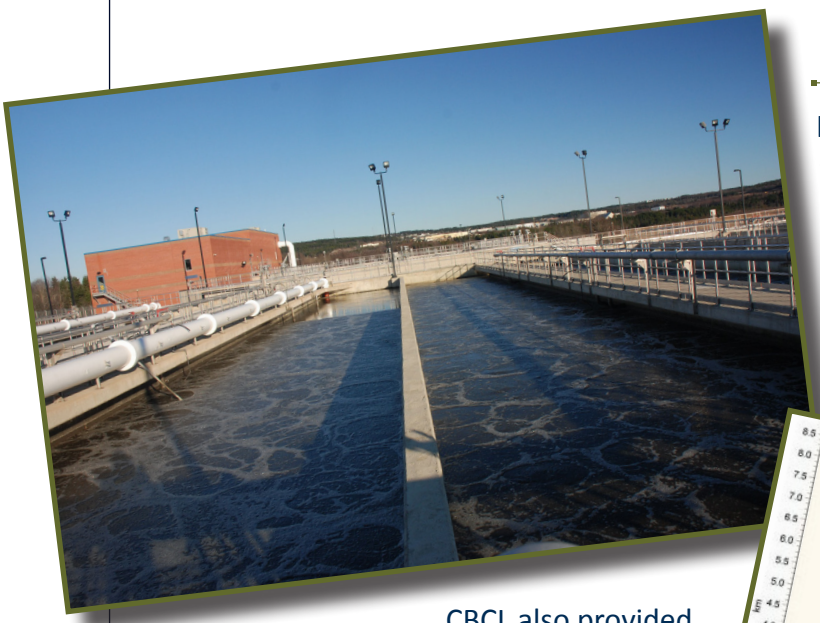
Designed to treat an average daily flow of 35,000 cubic metres and peak daily flow of 80,000 cubic metres, the plant includes facilities that encompass preliminary treatment, screening, grit collection, sludge dewatering, primary clarification, secondary treatment, and disinfection via ultraviolet light. A 1370 millimetre diameter high density polyethylene outfall pipe extends 1400 metres from the plant into Saint John Harbour to disperse treated effluent through a diffuser. The diffuser utilizes 19 duck billed check valves to release treated effluent over a 100 metre section. The valves are ideal for the marine environment as they prevent salt water intrusion and sediment infiltration and deposition in the outfall during low flow periods and the diffusers have self cleaning capabilities to lessen occurrences of marine fouling.

Scope of Services

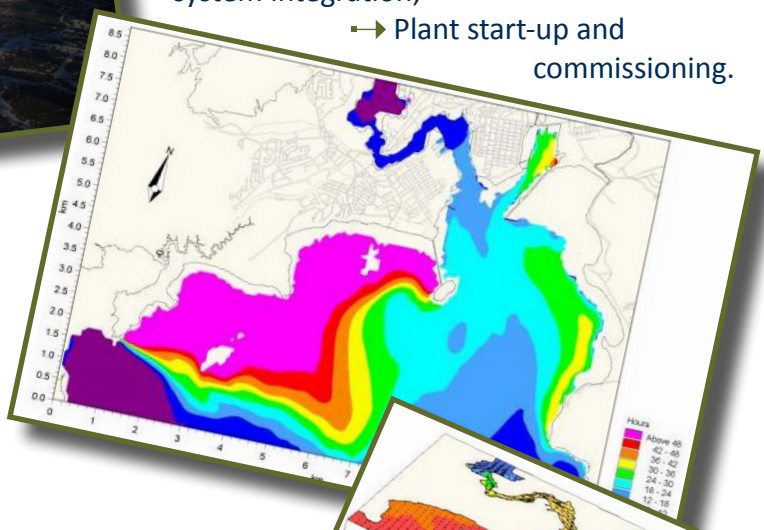
CBCL was dedicated to the project, providing multi-discipline engineering services from conceptual design through plant commissioning and operator training. More specifically CBCL provided the following services:

- Conceptual design to evaluate viable treatment alternatives and select a site;
- Preliminary design to develop the selected treatment process;
- Value Engineering Workshops to introduce cost-control mechanisms to the City of Saint John and optimize the treatment process within the given budgets;
- Environmental Assessments and Permitting through a streamlined approvals committee with joint participation from the Province of New Brunswick and the Government of Canada;
- Public consultation and stakeholder meetings;

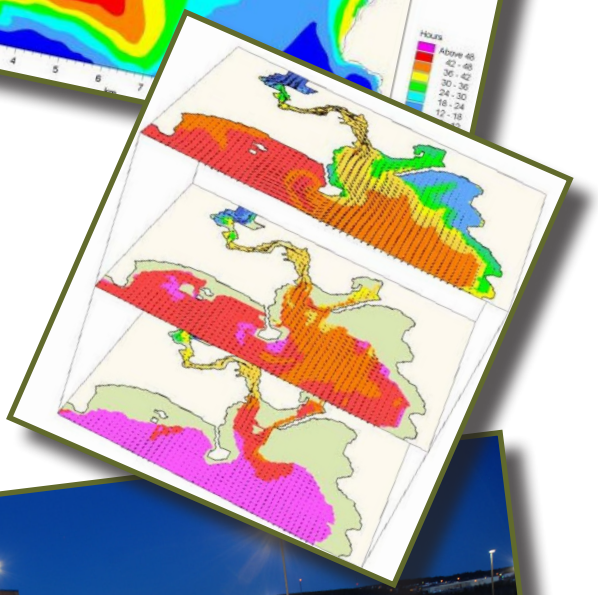
CBCL Limited commenced the pre-design in 2001, preliminary design in 2004, detailed design in 2005, and construction phase services in 2009.



- Detailed design for a 188 drawing tender package including civil, environmental, architectural, structural, process, mechanical, electrical, and instrumentation;
- Contract administration and full time resident inspection services for the duration of construction;
- SCADA design, programming and control system integration;
- Plant start-up and commissioning.



CBCL also provided specialist services for receiving water quality analysis, 3D hydrodynamic modeling of Saint John Harbour, environmental approvals and permitting, environmental management and protection plans.



Sub-consultants for the project include Conquest Engineering (Geotechnical), Murdock and Boyd Architects (architectural drawing review) and Lewis & Zimmerman Associates (Value Engineering Facilitators), and Archaeo Consulting (Archaeological Investigation).

Construction work was completed over a period of 30 months and commissioning took place in the Fall of 2011. The EWWTF project was completed on budget and on schedule at a cost of $48.5 million.

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Innovation

Innovative and integrated solutions were assembled to optimize the constructability, functionality and operational performance of the EWWTF.

Cost Control

Early in the design process, the project team introduced a formal Value Engineering (VE) approach to optimize the design and produce a project that provides maximum cost/benefit to the City of Saint John in the long term. The benefits of incorporating VE in the design process were several:

- Realized significant capital cost savings
- Improved performance and operational flexibility of the completed facilities
- Confirmed project scope and budget
- Expedited the design
- Identified design issues early in the process and set the stage for resolution of these issues, and
- Ensured understanding of the project concept by all project stakeholders and facilitated “buy in”.

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Energy Efficiency

Energy efficiency was a primary design consideration for the EWWTF project. The Aeration process of a wastewater treatment facility can consume 50% to 70% of all the power used by the facility and represents the second largest operating cost after labor. Additionally, the treatment of wastewater accounts for approximately 35% of the energy consumed by a municipality.

Designed with this in mind, the process was optimized by incorporating fine bubble diffusers, automated dissolved oxygen (DO) and pressure control, and dual point control single stage blowers controlled by variable diffusers, thus yielding an energy efficient secondary treatment process.

Design and Construction Activities

The Least Bittern, listed as threatened on Schedule 1 of the Species at Risk Act (SARA), is a migratory bird known to breed at the environmentally significant Red Head Marsh. Early in the design process, it was evident that innovative design and construction measures were necessary to avoid impacts to the Bittern, shore birds, wildlife, fish and marsh habitat. It was imperative to minimize the project footprint and efforts were made to limit clearing and grubbing activities to only those required for construction of headworks, preliminary and primary treatment and aeration facilities. The secondary clarifiers were positioned in an existing cleared green space at the site. Site vegetation clearing was performed outside the nesting period for birds. Erosion controls (silt fence, runoff collection perimeter ditches, and sediment settling ponds) were erected and maintained between the construction area and the wetland habitat of Red Head Marsh to protect the marsh and prevent silt-laden runoff from entering the marsh.

CBCL Limited was charged with researching construction noise to quantify the decibel levels for rock removal as compared to common construction noise from equipment including excavators, bulldozers, rock drills, hydraulic breakers etc.

The geotechnical investigation for the site identified solid rock excavation was required in various locations to facilitate foundation and tank construction. Hammering, ripping, or blasting solid rock on site was identified as a noise disturbance and therefore, blasting was not permitted during the nesting period for birds. The nesting period was identified as May 1 to October 1 which is considered the prime construction period. CBCL Limited was charged with researching construction noise to quantify the decibel levels for rock removal as compared to common construction noise from equipment including excavators, bulldozers, rock drills, hydraulic breakers etc. Best Management Practices (BMPs) were employed to dampen or lessen the noise and energy associated from rock removal. Non traditional methods of rock removal were utilized. Rock was fractured, broken and cleaved with the use of gas pressure in drill holes. The gas pressure developed by a proprietary propellant was used as a substitute for traditional explosives. The use of tight drill patterns with light charges and heavy mats over the area significantly reduced the blast energy, noise and potential flying debris. Blasting was focused to excavations below ground level. Therefore, the force of the blast was directed upwards more than horizontally, thereby lessening noise impacts to the wildlife in the surrounding area.

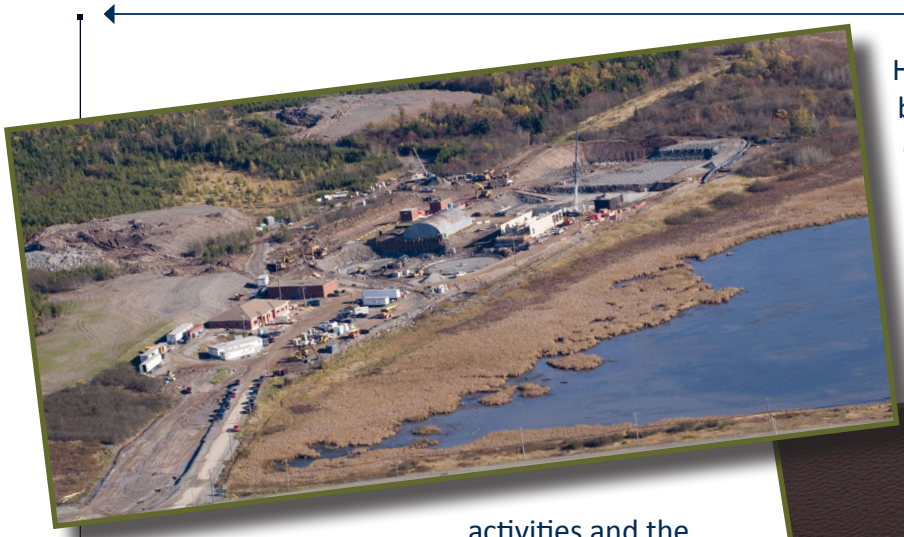
Environmental Impact

A fundamental challenge for the EWWTF involved construction on the site of the existing Hazen Creek Wastewater Treatment Plant and adjacent to Red Head Marsh, which is a provincial environmentally significant wetland. The new facility was designed and constructed around the existing treatment plant while maintaining operations. Once the new facility was completed, the Hazen Creek Plant was decommissioned and demolished.

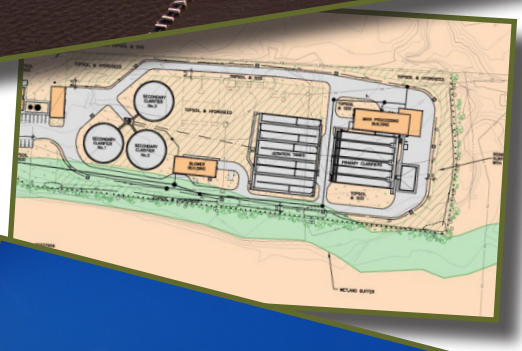
CBCL Limited performed a functional analysis of the Red Head Marsh wetland that serves as prime habitat for migratory birds including the at risk species known as the Least Bittern. The Bittern's nesting period can be threatened by noise disturbance from construction activities such as breaking or blasting solid rock.

Treated effluent is now directed more than 1 km offshore into a mixing zone, as opposed to the previous location which was directly discharged onto Red Head Beach.

The geotechnical investigation revealed that a significant amount of rock would have to be removed from the site and CBCL Limited developed an extensive environmental management plan to ensure that construction related activities did not cause detrimental effects to Saint John Harbour, Red Head Marsh, and the surrounding environment. It was paramount that fish and fish habitat, wildlife, and nesting shore birds would not be disturbed. CBCL Limited engaged local experts to perform bird surveys to ensure that no nests were present during construction. Water quality testing of Red



Head Marsh and Saint John Harbour before construction established baseline concentrations for turbidity and total suspended solids. Follow up testing occurred during construction to ensure compliance. Vegetated buffers were maintained between construction activities and the marsh. Erosion and sedimentation control devices were installed to contain and treat silt laden runoff on site. Given the environmental features of the project area and the anticipated interactions between several valued ecosystem components (VEC), socio-economic issues had to be considered. Project activities introduced the potential to adversely affect marine water and intertidal sediment quality, fish, lobster, marine mammals, birds, Red Head Marsh, air quality, commercial and recreational fishery, public health and safety, and navigation and traffic patterns. Each VEC or socio-economic issue identified was assessed in terms of whether each of the activities associated with the project would result in any predicted residual effects. Mitigative measures were put in place during site preparation, facility construction and outfall construction to minimize the adverse effect on each VEC.



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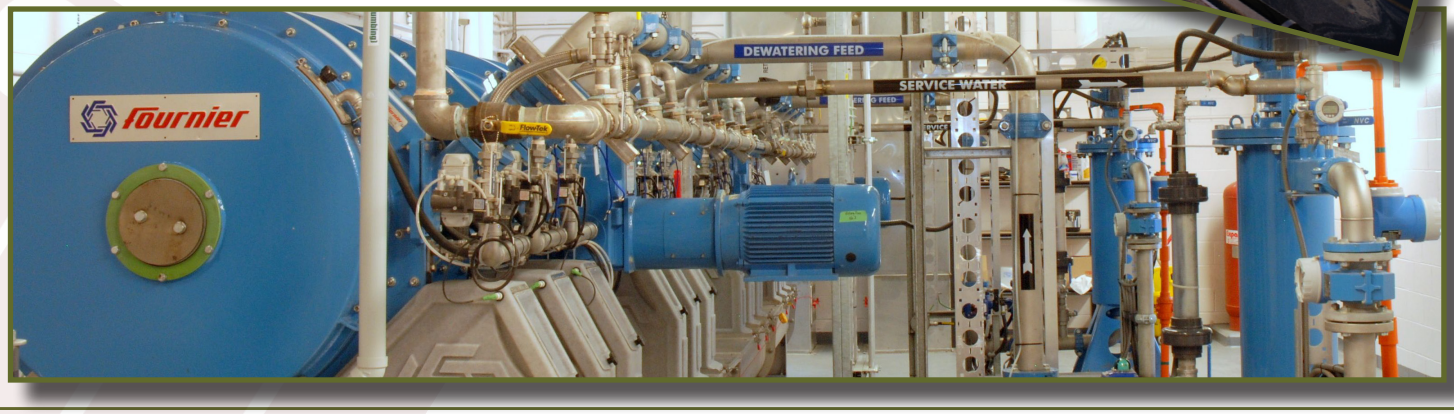

Complexity

The EWWTF outfall design and construction faced marine challenges posed by varying tide levels and dynamic environments. Each day approximately 100 billion tonnes of seawater move in and out of the Bay of Fundy during the tide cycles. This statistic is greater than the combined flow of the world's fresh water rivers. The tide cycle can vary water depth as much as 8 metres every six hours.

During construction, the project team was challenged each day to adapt construction methods for extreme low and high tides and quickly changing weather conditions. The project team utilized more conventional excavation and dredging methods for low tides.

During high tides, excavation was performed using dredging equipment and barges. The rising and falling tides and harsh coastal weather conditions caused moving bed and suspended sediments during dredging operations. The project team divers worked in near zero visibility subaqueous conditions during construction, outfall installation, testing, and backfilling operations.

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Client Expectations

CBCL Limited met the Owner's needs in this project allowing the City of Saint John to pre-select preferred process equipment and then designing the facility around the use of this pre-selected equipment. For example, the Owner selected sludge dewatering equipment similar to that used in their other facilities as staff was most familiar with the operation and maintenance of this type of equipment. Project components were considered and designed to treat odorous air. A bio-filter was constructed on-site in lieu of the use of scrubbers and chemicals to control odor. CBCL Limited also met the Owner's needs through placement of a full time resident engineer on the project site to monitor all construction activities and address any issues as they became apparent, thus preventing delays in the schedule and reducing associated costs.

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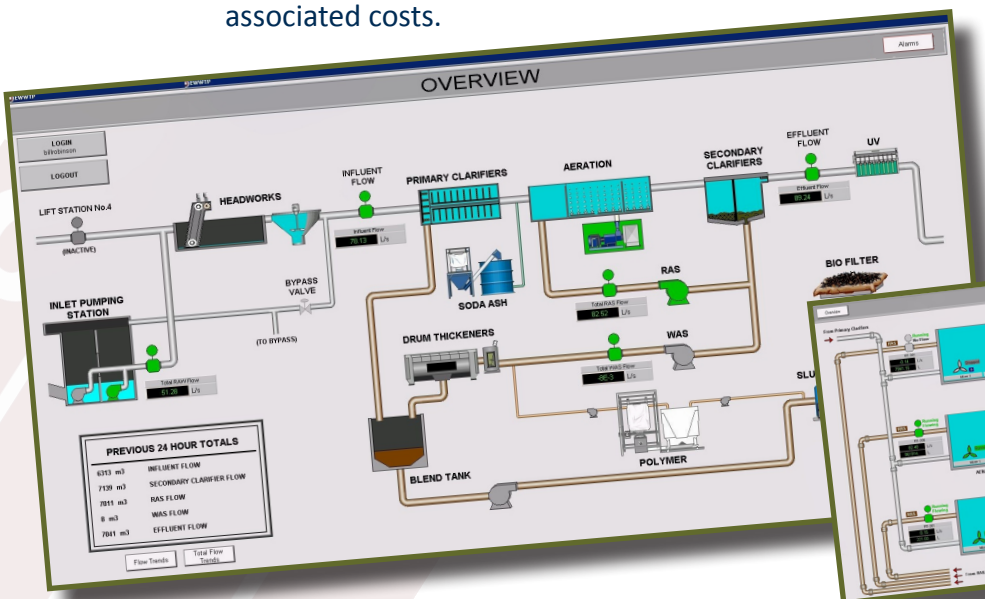
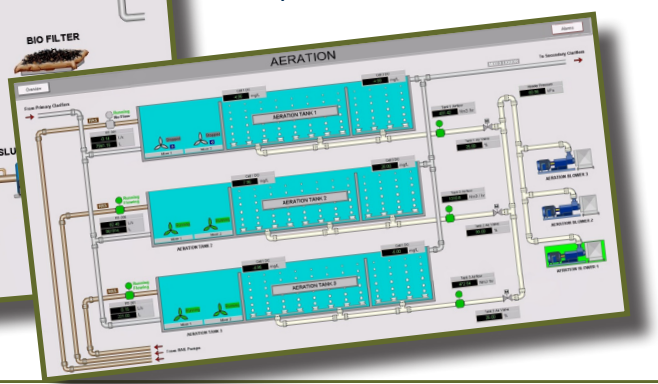


SCADA integration, commissioning and training services were provided to the Operators. Most



processes within the EWWTF are controlled automatically. The hardware associated with the plant control includes a main plant Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA) system. This permits the EWWTF operators to control, monitor and relay process information. In all cases the operator has the ability to override the automatic operation of any piece of equipment and operate it manually.

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The main plant PLC monitors all systems and directly controls the following equipment:

- Pump Stations,
- Bypass (Headworks) Flow Control,
- Primary Clarifiers,
- Primary Sludge & Scum Removal,
- Return Activated Sludge Pumping,
- Waste Activated Sludge Pumping,
- Service Water,
- Soda Ash Addition,
- Gas Detection & Plant Safety Equipment,
- Ventilation Systems Monitoring, and
- Plant Security.

Separate PLC's are provided for the following equipment processes:

- Screening,
- Grit Removal,
- Aeration Blowers,
- Odour Control,
- UV System,
- Rotary Drum Thickeners,
- Sludge Dewatering, and
- Polymer Dosing.

Social and Economic Benefits

The EWWTF project provides significant benefits to the local community. In 1993, a Wastewater Strategy was completed for the City of Saint John to develop a master plan for the collection and treatment of wastewater generated within the City.

The strategy addressed the collection and treatment needs for serviced and unserviced areas within the City of Saint John. With Harbour Cleanup, the City is implementing the infrastructure required to effectively collect and treat wastewater in Saint John for many years.

The EWWTF project can now treat flows that previously discharged directly to Marsh Creek and Saint John Harbour.

Improvements to the wastewater collection system are ongoing to convey untreated sanitary sewer flows to the EWWTF.

Dry weather raw sewage outfalls are being eliminated as a result of Harbour Cleanup initiatives.

Approximately 120 man-years of employment, filled by local residents, were created during the design and construction of the EWWTF

Treated effluent from the EWWTF is now directed more than 1 km offshore into a mixing zone, as opposed to the previous location which was directly discharged onto Red Head beach. Local residents can now safely enjoy recreation activities in this area.

Saint John, Canada's first incorporated City, is becoming a vibrant tourism destination. It is currently a major port of call for cruise ship traffic. Approximately 120 man-years of employment, filled by local residents, were created during the design and construction of the EWWTF. There are currently 8 full time operations staff now working at the EWWTF.

Public Consultation

CBCL Limited conducted public consultation throughout all stages of the project informing the community and local residents about the project and addressing any concerns. Public notices were delivered by hand and several public meetings and information sessions were held to provide details and answer questions.

Planning sessions were held with key project stakeholders and environmental interest groups including Ducks Unlimited, ACAP (Atlantic Coastal Action Program), Aboriginal consultation and Fundy Lobster Fisherman's Association to share local knowledge and integrate the EWWTF with the surrounding environment.

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Conclusion

The EWWTF is the largest secondary wastewater treatment facility in Atlantic Canada. It was also the largest project that the City of Saint John had ever undertaken. The project, designed by CBCL Limited with assistance from our sub-consultant partners, was completed on budget, and was completed on schedule. The EWWTF provided CBCL Limited staff associated with the project significant benefit in their professional development as well as personal gratification that wastewater generated in the south central peninsula and East Saint John can now be intercepted and treated at this impressive facility.