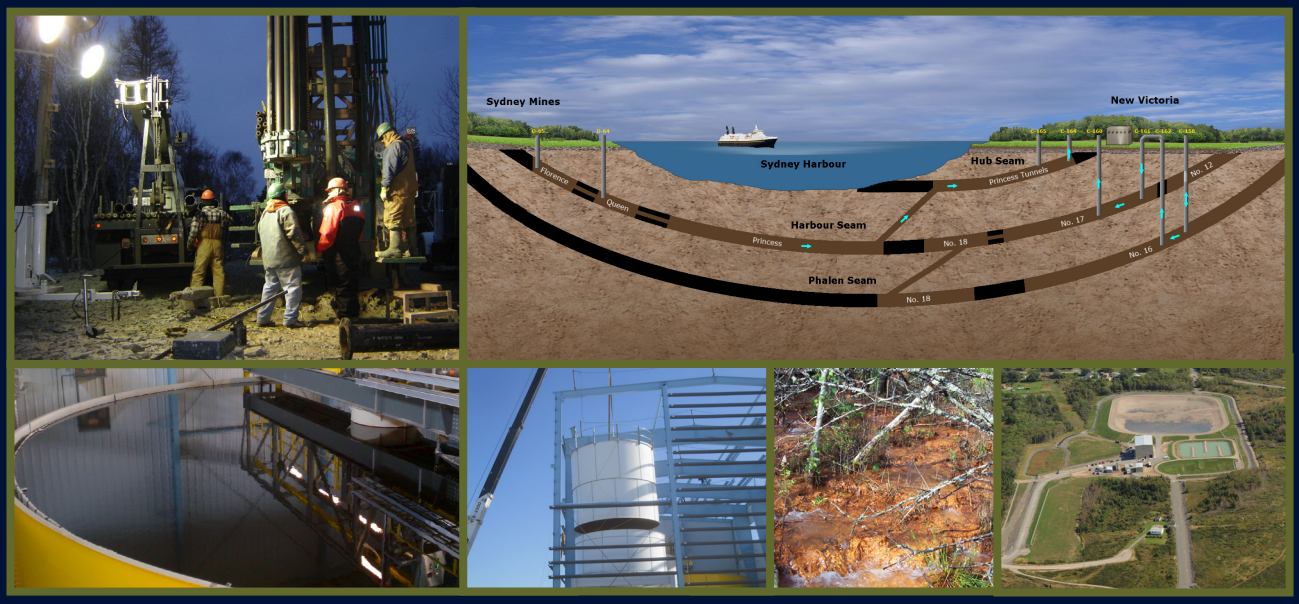
CANADIAN CONSULTING ENGINEERING AWARDS 2014

New Victoria Mine Water Treatment Plant



CBCL LIMITED

Consulting Engineers

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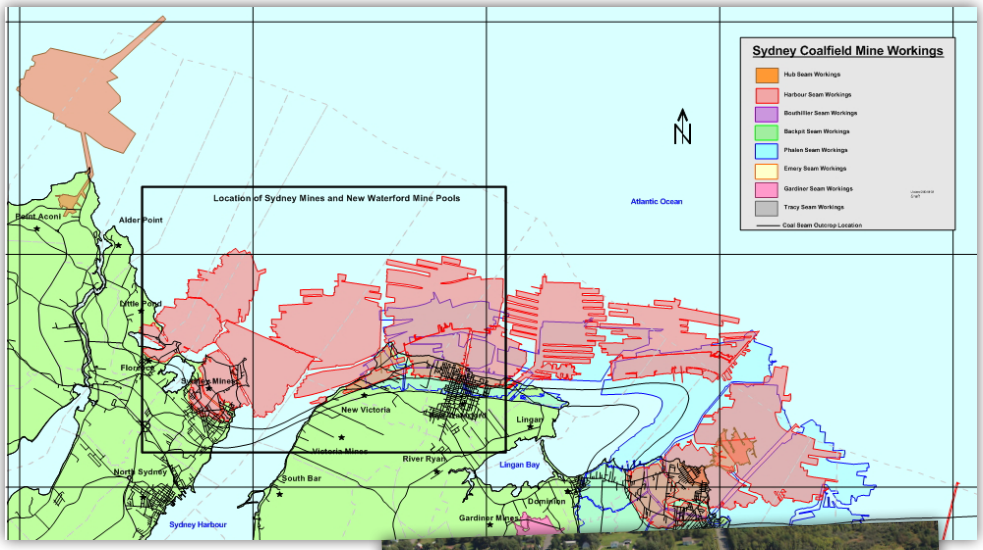
New Victoria Mine Water Treatment Plant
New Victoria, Nova Scotia

Client	Enterprise Cape Breton Corporation	Completed	Winter 2013
Sector	Environmental Remediation	Construction Cost	Approximately $13M

The project

A long legacy of coal mining in the Sydney Coalfield which ended in 2001 has left a complex and extensive network of abandoned underground workings. With the shutdown of mining operations and the end of active pumping, mines began to flood. The quality of rising water within actively flooding mines typically has low pH, high sulphate and acidity, elevated metals, (typically iron, manganese and aluminum) and often other contaminates. When poor quality mine water surfaces, contact with air promotes precipitation of dissolved metals such as iron leaving red ochre staining sometimes referred to locally as "copperous" water. In the past, acid mine drainage (AMD) and associated environmental impacts were an accepted part of mining operations. Recently however, methods to control it are better understood, many of which have been implemented in the New Victoria Mine Water Treatment Plant (NVMWTP).

If left unchecked, rising water levels would result in uncontrolled discharges of acidic mine waters, resulting in significant negative impacts to the receiving environment.



The NVMWTP is located in New Victoria, Cape Breton in the heart of the Sydney Coalfield. This "active" treatment plant is a High Density Sludge (HDS) system that utilizes hydrated lime to reduce the acidity of the mine water, raises the pH and promote precipitation of dissolved metals. The precipitated metals are collected as a solid residue and are disposed of in an on-site containment area. After active treatment, mine water is directed to a passive treatment system consisting of a settling pond and constructed wetland for final polishing before discharge into the Atlantic Ocean.


Aerial view of NVMWTP looking south
G. Langille

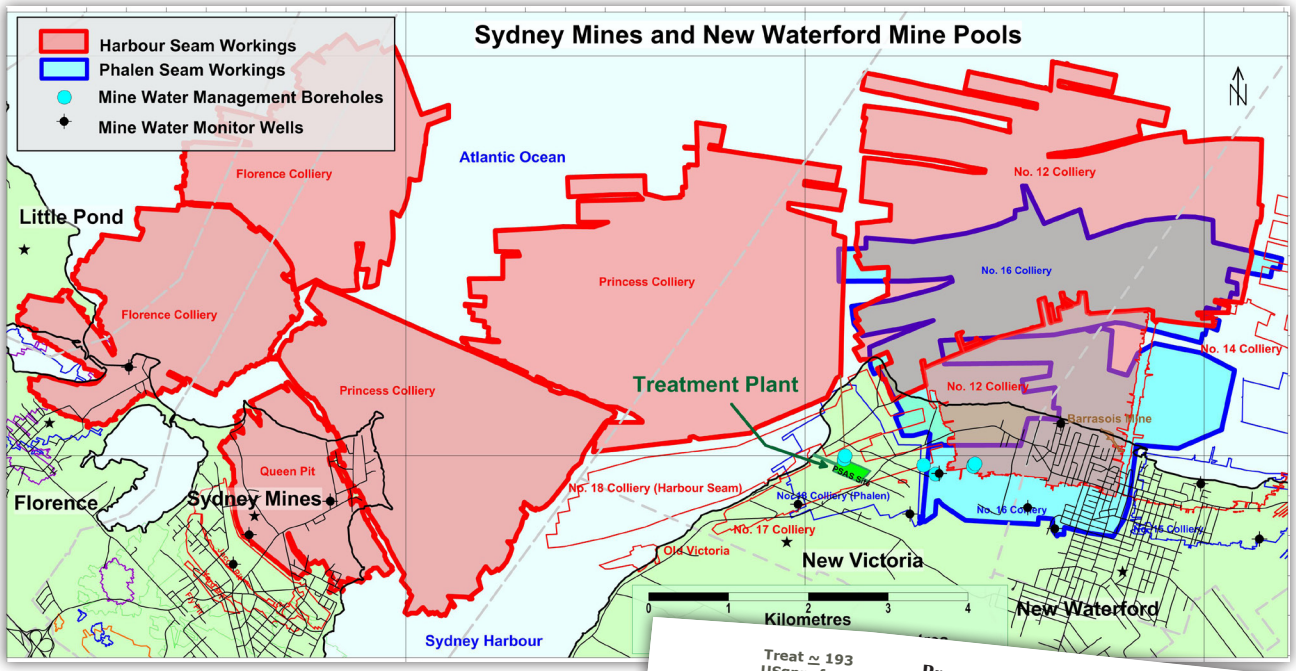
Mine water delivered to the plant is pumped from the New Waterford and Sydney Mines mine pools to control rising mine water levels. The rate of mine water rise within these hydraulic systems dictated the design, construction and

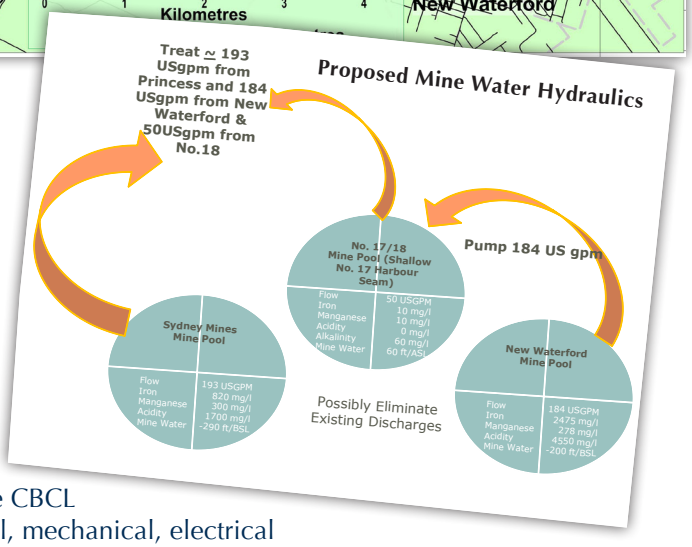
commissioning schedules for this project. If left unchecked, rising water levels would result in uncontrolled discharges of acidic mine waters, resulting in significant negative impacts to the receiving environment. Therefore it was critical that the treatment plant be fully commissioned before mine water overflow was imminent.

An innovative solution

In January 2010, Enterprise Cape Breton Corporation (ECBC) retained the services of CBCL Limited for the design and implementation of a Mine Water Treatment Scheme for the New Waterford mine pool, only.

The design team identified an innovative opportunity to treat two separate mine pools at a single plant.

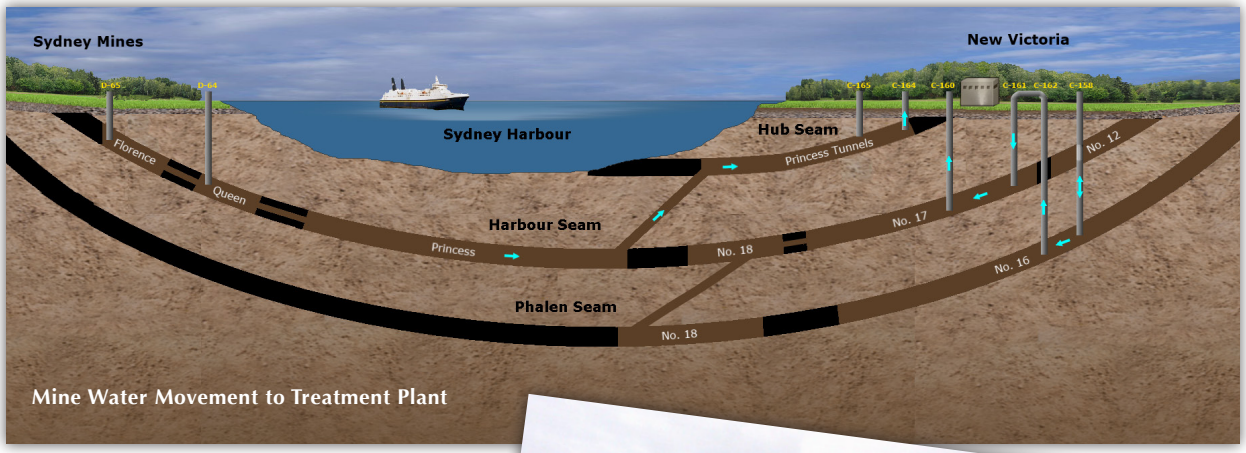




The project scope of work included identifying the following requirements:

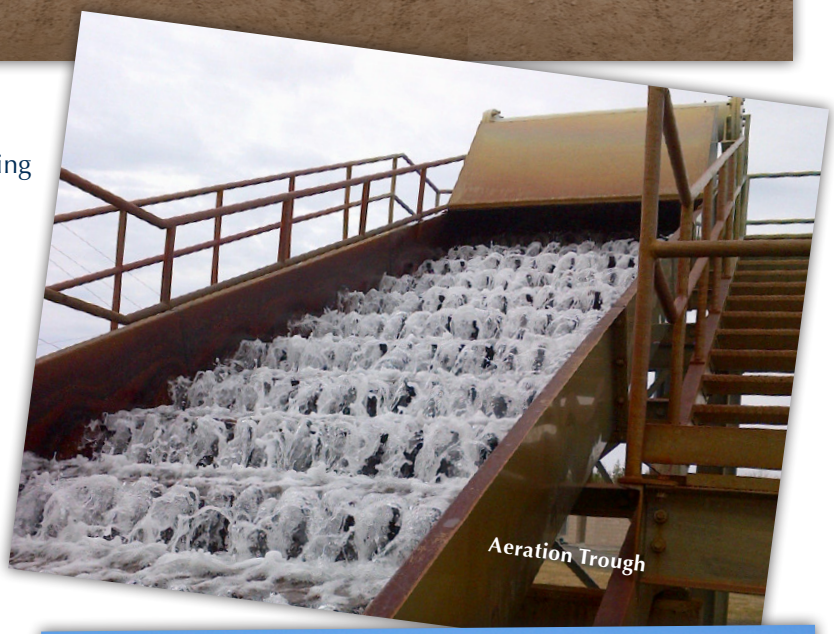
- Plant location and site infrastructure;
- Mine water pumping system;
- Processing plant components;
- Sludge processing and disposal
- Final passive treatment; and
- Integrated geothermal heating/cooling system.

In the process of refining the concept design for the New Waterford Mine pool treatment system, the CBCL project team that included geologists, chemists, civil, mechanical, electrical and process engineers identified an innovative opportunity to access the Sydney Mines mine pool water along with the New Waterford mine pool water at a single surface location. If viable, this option presented a means to treat the two separate mine pools using a single treatment plant. The significant benefits of this revised approach included:



To understand the dynamics of the individual mine pools, boreholes drilled into the old workings were used to collect mine pool water elevation and chemistry data.

- Elimination of need for a second active treatment plant for the Sydney Mines mine pool, reducing both capital and long term operating costs;
- Elimination of two existing AMD seeps from the No.17/18 mine pool in New Victoria which would have required separate passive treatment;
- Optimized treatment plant location, relative to sludge disposal;
- Management of sludge generated from one not two separate treatment facilities;
- Optimized treatment plant location for possible future passive marine discharge; and
- Opportunity to utilize artesian flow to access mine water (reducing pumping requirements).


Aeration Trough

Former Air Return Tunnel

After a comprehensive review of a total of seven potential treatment scenarios which considered numerous mine water hydraulic scenarios, three different plant locations and numerous sludge disposal options, the treatment of combined pool system with a single treatment plant located at New Victoria was selected as the most viable, economical and feasible long term solution. In addition to engineering design for this project, CBCL provided:

- CEAA Screening;
- Public consultation;
- Detailed design for three (3) construction contracts, including over 100 engineering drawings related to civil, mechanical, structural, architectural, process and electrical details;
- Contract administration and full time oversight services for the duration of each contract;
- SCADA design, programing and control system integration; and
- Client support during plant start-up and commissioning.

Sub-consultants for the project included ATKINS International, Conestoga-Rovers & Associates (CRA) and BGC Engineering.


Clarifier in Operation

Schedule

CBCL started conceptual design in January, 2010, with preliminary and detailed design completed in fall 2010/winter 2011. The civil works construction commenced in March, 2011 and was completed by December, 2011. Construction of the plant facility commenced in October, 2011 and was completed in January, 2013 with plant commissioning in January/February 2013. The first mine water was treated in February, 2013.

It was critical that the mine water treatment facility be fully operational, well before equilibrium levels were reached and uncontrolled discharge was possible.

Drill program complexity

Mine water management requires a detailed understanding of mine workings interconnections. The large body of water within one or more interconnected workings is generally referred to as a mine pool, and the movement of mine water within the pool is dependent on how the collieries are connected.

Several distinct mine pools exist in the Sydney Coalfield and two of the largest are the Sydney Mines and New Waterford Mine pool systems. The New Waterford Mine pool includes the water within the former No. 12/14 and No. 16 Collieries. The Sydney Mines mine pool includes the former Princess, Florence and Queen Pits. Together the two mine systems cover an area of approximately 50 km^2 with approximately 42 km^2 located under the Atlantic Ocean.

To understand the dynamics of the individual mine pools, boreholes drilled into the old workings were used to collect mine pool water elevation and chemistry data. The drilling programs had many challenges including drill targets based on historic mine plans, which may not reflect the actual underground conditions, and target locations were limited to ECBC owned properties. The use of large (12") casings drilled to depths up to 700 feet, aiming to hit or in some cases avoid or by-pass open workings was challenging, with the added potential of encountering pressurized gas, aquifers or artesian well conditions added to the complexity of the work.

Subsequent borehole monitoring programs, historic mine plan study and seam structure modeling provided the data needed to establish mine water inflow rates and mine pool water quality. This baseline data was critical in establishing the rate of mine water level rise, estimated timelines before equilibrium levels would be reached and the volume and quality of water requiring treatment.

Complexity of mine water hydraulics

The plant location selected in New Victoria is at the site of a former airshaft tunnel that connects to the Sydney Mines mine pool. This is a critical component of the system, because from this centrally located

site, both the New Waterford and Sydney Mines mine pools can be accessed.

The actual transmission of mine water to the treatment plant from the Sydney Mines and/or New Waterford mine pools involves complex mine water hydraulics. For the New Waterford Mine pool, water is transferred from No. 12/14 workings to the underlying No. 16 workings by a vertical interconnecting borehole. From a second borehole, No. 16 water is pumped to surface and transferred via pipe line to a third borehole where it is injected into No. 17 workings. Using No. 17 workings as a conduit, the water travels to a fourth borehole at the treatment plant site where it rises to the plant by artesian flow. The Sydney Mines mine pool water is accessed at the treatment plant site via a pumping well drilled into an on-site abandoned airshaft tunnel that connects to the Sydney Mines mine pool.

Scheduling complexity

It was critical that the mine water treatment facility be fully operational, well before equilibrium levels were reached and uncontrolled discharge was possible. Of particular concern were indications that within the New Waterford Mine pool, rising water in No.16 Colliery would reach surface before a treatment plant could be constructed. To halt the rise of water in No. 16 a borehole was drilled to hydraulically connect No. 12/14 and No. 16 Collieries in the winter of 2009. With this interconnection, water from the deeper No. 16 Phalen Seam workings rose up the borehole under head pressure and overflowed into the shallower No. 12 Harbour Seam workings. This essentially stopped the water from rising in No. 16 delaying the potential for overflow before the completion of the treatment plant construction.

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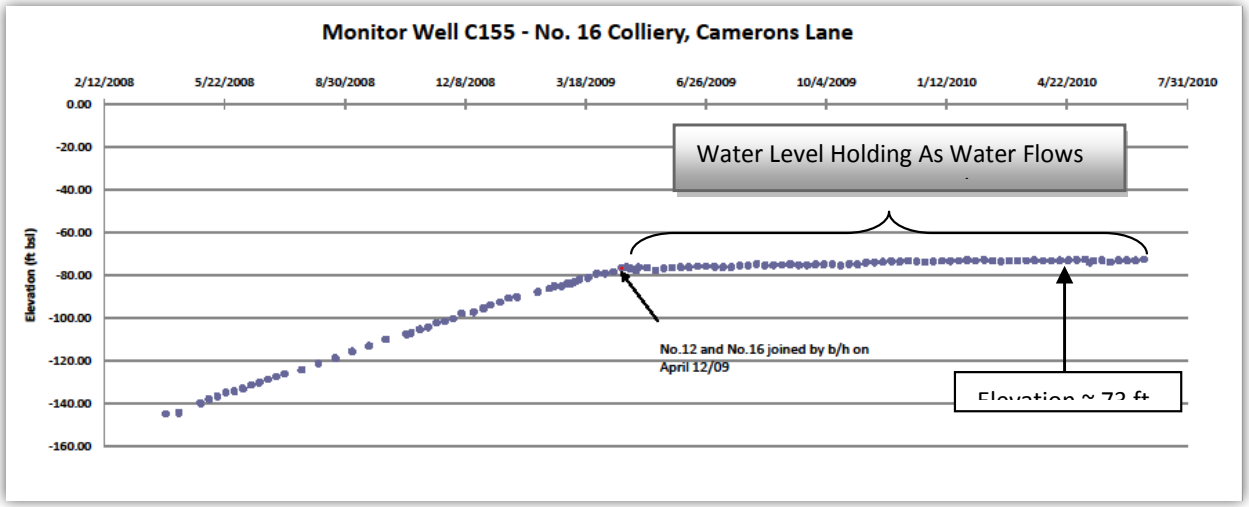
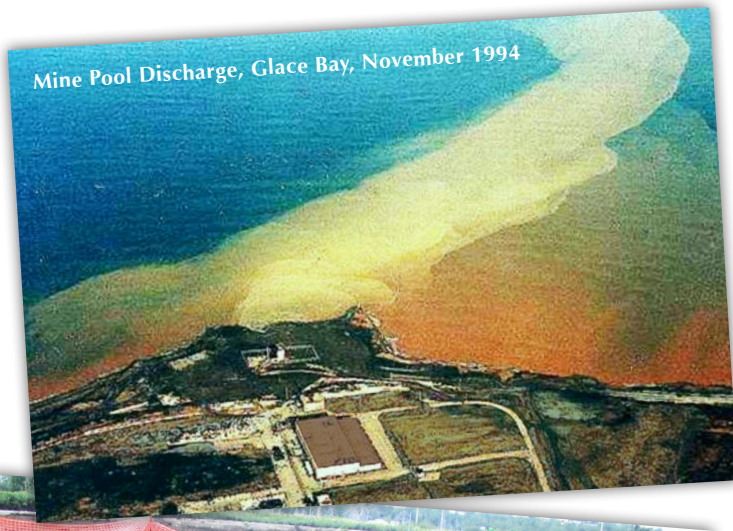


Plant design flexibility – variable flow rates and uncertain chemistry

The treatment plant was designed for two phases of operations with different flow rate ranges depending on the water make within the mine pools. Phase I was designed and constructed to treat a peak flow of 114 m^3/h (500 USgpm), with a future Phase II design flow capacity of 227 m^3/h (1,000 USgpm) should flow rates increase or mine water

quality deteriorate. In addition to variable flow rates, the treatment plant was designed for deteriorating mine water quality, and suspected poor water quality in the inaccessible submarine areas of the deep Sydney Mines pool.


Mine Pool Discharge, Glace Bay, November 1994

Social and economic benefits

Since the last operating coal mine closed in 2001, the environmental remediation and mine closure liabilities have been under the mandate of Cape Breton Development Corporation CBDC (until January, 2010) and later Enterprise Cape Breton Corporation (ECBC). The Mine Water Management Program under these organizations has been an ongoing priority and will continue under Public Works and Government Services Canada for the foreseeable future.


Remediation – Subsidence of Shallow Workings

Comprehensive and sustainable mine water management programs that include the operation of pump and treat systems like NVMWTP system addresses not only the direct impacts of AMD but also addresses the related concerns including ground subsidence, the potential infiltration and contamination of groundwater aquifers and displacement of mine gases. The social and economic impacts on both private property and public infrastructure could be catastrophic if mine water liability from historic coal mining is left uncontrolled.

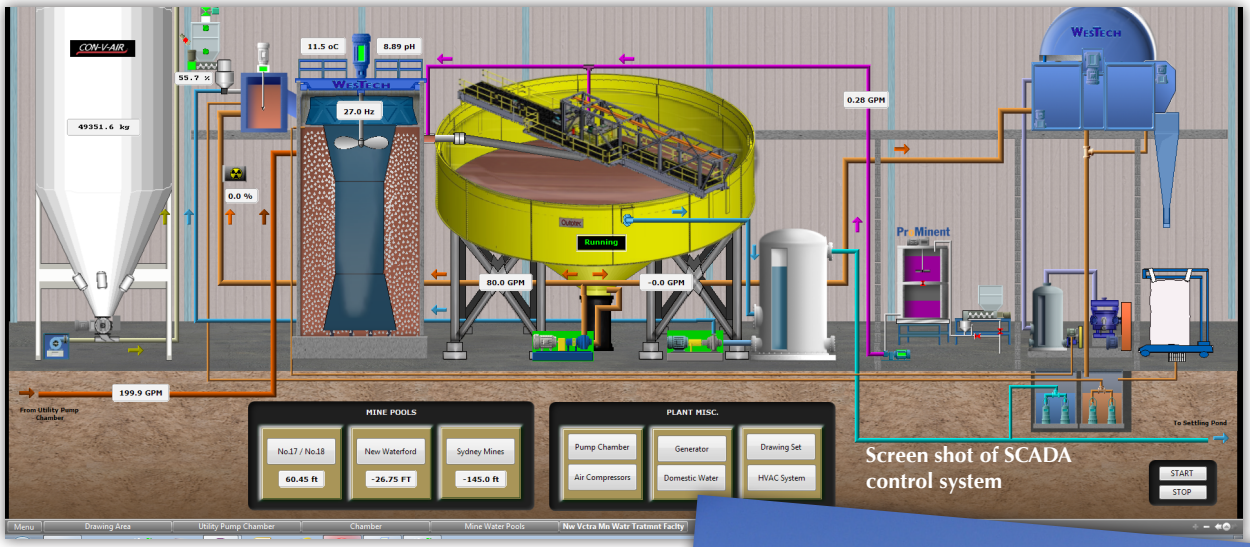
The on-going management of mine water for the foreseeable future will minimize the potential for negative environmental impacts of AMD on both fresh water and marine environments as have been witnessed in the past.

Environmental impact

The project is driven by the need to control mine water discharges to minimize potentially serious environmental impacts if mine water is left to flow untreated into the environment, including active commercial fishing zones. The full commissioning of the NVMWTP was completed before the mine water levels reached critical levels and uncontrolled discharges of AMD were realized. The on-going management of mine water for the foreseeable future will minimize the potential for negative environmental impacts of AMD on both fresh water and marine environments as have been witnessed in the past.


AMD Seep from No. 17 Colliery

The system design considered long term sustainability, concerning the selection of a costal location of the plant and incorporation of a passive treatment system for final polishing before being discharged to the marine environment. As a general rule, the estimated time frame to reach an acceptable



Screen shot of SCADA control system

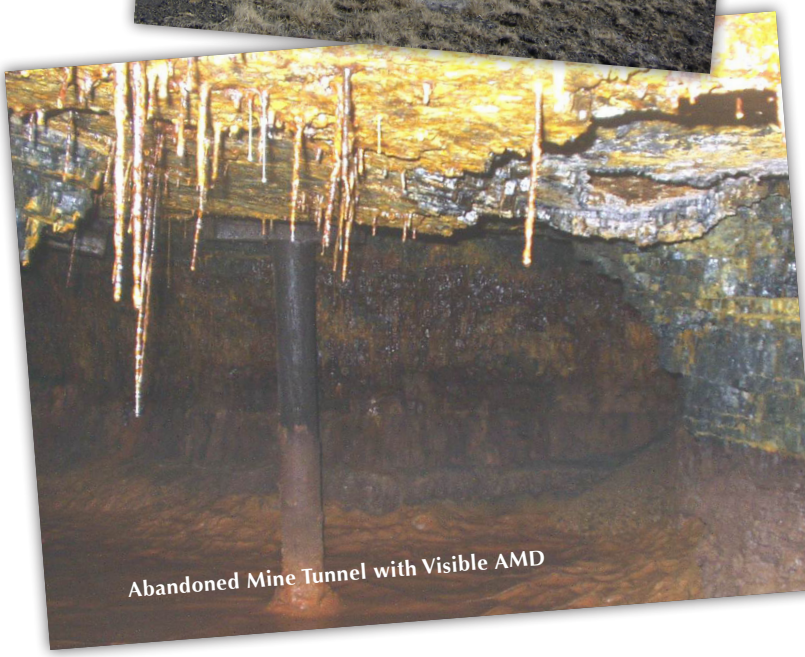
mine water quality (for direct discharge) is after four repeated flushes of the mine pool system, which could take a lifetime to achieve. But over time, the requirement for "active" treatment of mine water to achieve acceptable water quality discharge will diminish as the mine pool matures and stabilizes and then only passive treatment may be required prior to marine discharge. Until then, active treatment and the management of the Sydney Mines and New Waterford mine pools is mandatory, to avoid significant environmental impact.

The incorporation of renewable energy components in plant design fits the overall goal of sustainable management. For this reason, a geothermal heating and cooling system utilizing heat pump technology was incorporated into the facility design to take full advantage of the huge geo-thermal energy source that is the mine pool water itself. The facilities system is a closed loop design that draws or dumps heat from the mine pool water via a plate heat exchanger to provide heating and/or cooling to the plant.

The incorporation of renewable energy components in plant design fits the overall goal of sustainable management.

Meeting clients needs

In general, the most economical treatment options for mine water are passive treatment systems. However, mine water in both the New Waterford and Sydney Mines mine pools contain significantly high levels of contaminates (iron and aluminum) necessitating active treatment of this water. To ensure the most viable "active" system was designed, from both an operational and cost perspective, key plant components were fully assessed before selection (i.e. circular clarifier, filter press for sludge dewatering and use of hydrated lime for pH adjustment). The full automation of the plants operating



Abandoned Mine Tunnel with Visible AMD

The completion of construction and final commissioning of the New Victoria Mine Water Treatment Plant before mine water levels reached critical levels, met the Owner's most critical project requirement.

systems requires minimal manpower requirements; another key client requirement that was met by the CBCL design team.

The design and construction of a single treatment plant that addresses the concern associated with three mine pool systems, as opposed to the construction of two active treatment system to treat two separate systems, was an important variation of the original concept design but one that presented the Owner with benefits that included significant cost savings.

The completion of construction and final commissioning of the New Victoria Mine Water Treatment Plant before mine water reached critical levels successfully met the Owner's most critical project requirement.

Plant building under construction

New Victoria Mine Water Treatment Plant