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Category C: Water Resources

Coquitlam UV Disinfection Project

Water Treatment Facilities - Coquitlam, BC

Owner / Client: metro vancouver

Submitted by: Ausenco

Ausenco

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Project title: Coquitlam UV Disinfection project – Water Treatment Facilities

Location of project: Coquitlam, British Columbia

Component being submitted: Entire project; UV Disinfection Facility and associated works

Category of entry: C. Water Resources

Project owner/client: Metro Vancouver

Other consultants involved:

- CDM Smith – UV Process Specialists
- Clemson Engineering Hydraulics – Physical Hydraulic Modeling
- CJP Architects Ltd. (now Kasian) – Building Architecture
- DMG Landscape Architects (now PMG Landscape Architects) – Landscaping
- Design
- Golder Associates – Geotechnical and Environmental Services
- Advicas – Project Architectural and Structural Costing and LEED Consulting

Contractors involved:

- Kenaidan Contracting Ltd. – General Contractor
- Trojan Technologies – UV Reactor Supplier
- Ozonia North America LLC — Ozone Reactor Supplier

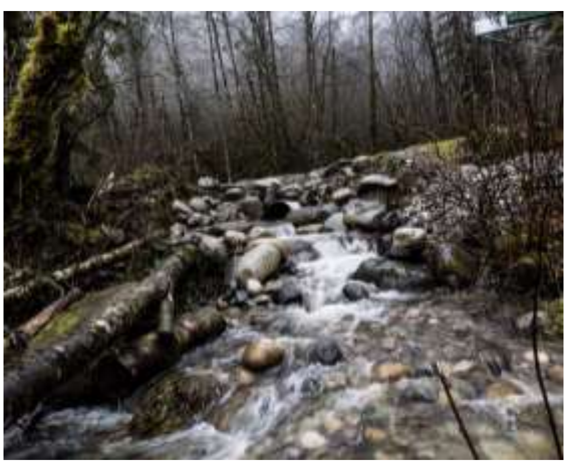
Executive summary

Operated by Metro Vancouver (MV), the Coquitlam Water Treatment Plant (WTP) provides approximately 370 million litres of potable water on an average day — approximately one third of the total water supply delivered in the Metro Vancouver region.

Constructed on a compact site in an environmentally sensitive watershed, this innovative UV Disinfection Facility services one third of MV's water needs.

The existing Coquitlam water disinfection process provided ozonation and chlorination, as well as soda ash for corrosion control. However, to comply with the new requirements under revisions to *Health Canada's Guidelines for Canadian Drinking Water Quality*, further improvements were required for rapid and effective inactivation of chlorine-resistant microorganisms such as *Giardia* and *Cryptosporidium.*

To address these new requirements, the existing water treatment facilities were upgraded and an ultraviolet (UV) disinfection plant was added. The plant is located within the Coquitlam watershed, on an environmentally sensitive site. Construction activities and the finished facility were managed and designed to protect the extensive wildlife present as well as terrestrial and aquatic systems, while reflecting the goals outlined in Metro Vancouver's Sustainable Region Initiative (SRI).



Designed to protect the environmentally sensitive area.

Working closely with MV, the Ausenco team developed the conceptual design for the facility, implementing a range of innovative approaches to allow the facility to be located on the tightly constrained site. The team also provided preliminary and detailed engineering and design; construction management; and commissioning management services.

The project was completed under the $110 million budget and on schedule, helping MV continue to provide a reliable source of safe, high-quality drinking water to the region while minimizing impact on the environment.

Ausenco

Project background

Home to over 2.3 million people, Metro Vancouver is responsible for delivering a variety of services and policy leadership for its members, which comprise 22 municipalities, one electoral area and one treaty First Nation.

Among these services is the provision of potable (drinking) water to members as well as associated planning and regulatory responsibilities.

Coquitlam Lake

The existing Coquitlam WTP treats water from Coquitlam Lake, one of the region's three water supply sources. The plant has an ultimate peak hour summer-rated capacity of 1,200 million litres per day (ML/day) or 317 million gallons per day (MGD) and is a gravity-fed, unfiltered system with a treatment process train that includes ozonation, chlorination and soda ash corrosion control systems. To comply with the new requirements under Health Canada's Guidelines for Canadian Drinking Water Quality, further improvements were required to provide rapid and effective inactivation of chlorine-resistant microorganisms such as Giardia and Cryptosporidium. UV light is highly effective at treating these microorganisms and provides no disinfection by-products.

Located in the remote and environmentally sensitive Coquitlam watershed, the size and shape of the new facilities were limited by the physical constraints of the site which included existing watermains and treatment buildings, as well as natural features of the site. In keeping with MV's stated Sustainable Region Initiative which places sustainability at the center of its operating and planning philosophy, the design and construction planning had to minimize environmental impacts to plants, animals and all terrestrial and aquatic systems in the watershed.

An Ausenco-led team was selected by MV in 2008 to provide engineering services for the project implementation. Working closely with MV, the team developed the conceptual design for the facility, implementing an innovative vertically-oriented UV design to reduce building footprint, environmental impact, capital costs and long-term operating costs.

Mission Statement

The SUV team in partnership with Metro Vancouver, do hereby affirm that we will:

Deliver a world class facility for the Coquitlam UV Disinfection Drinking Water Project that is:

Safe, efficient, reliable, maintainable, timely, cost-effective, and operator friendly.

This shall be done in support of Metro Vancouver's principle to protect and care for the community, and enhance its health and environmental well-being.

This objective will be achieved through dedicated, collaborative, innovative, excellence and world-class teamwork, together with absolute integrity, mutual respect and an enthusiasm for the project.

We will always deal fairly, honestly and ethically with each other, which will result in a unique and sustainable facility where people want to work, for today and into the future, in order to supply the region with superior quality drinking water.

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Project Highlights

Innovation

The existing Coquitlam WTP treats water from Coquitlam Lake, one of Metro Vancouver's three water supply sources. The plant is designed for an ultimate peak hour summer-rated capacity of 1,200 million litres per day (ML/day) or 317 million gallons per day (MGD) and is a gravity-fed, unfiltered system with a treatment process train that includes ozonation, chlorination and soda ash corrosion control systems.

To comply with the new requirements under Health Canada's Guidelines for Canadian Drinking Water Quality, further improvements were required to provide rapid and effective inactivation of chlorine-resistant microorganisms such as Giardia and Cryptosporidium.

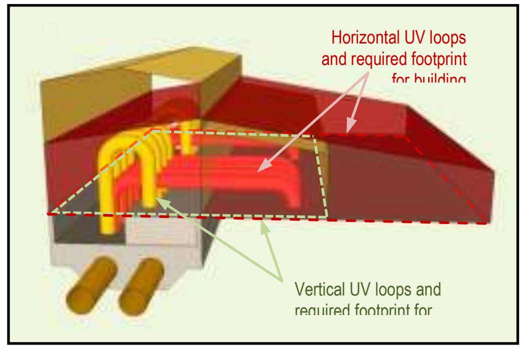
Key innovative features that contributed to the success of this project include the following:

- **Constrained Site and the Vertical Loop Approach**

  The site was tightly constrained by the existing 3-meter and 2-meter-diameter water supply lines and the Coquitlam river to the East, the steep mountainous terrain to the West and North, and the existing Chlorination and Corrosion Control (CCC) building to the South. The CCC needed to remain fully functional during and after construction of the new UV disinfection facility.

  The initial conceptual work was based on a conventional configuration with the UV equipment in a series of horizontal piping runs, resulting in a very large plant footprint.

  To reduce the project and building footprint, the Ausenco team developed a configuration with vertically-oriented UV reactors and Vertical Pipe Loops (VPLs). This resulted in a building width over 13 meters smaller than the original 28-meter-wide design for the typical horizontal configuration.



The innovative UV vertical loop design allowed the building footprint to be considerably smaller than a traditional horizontal design, significantly reducing earthworks and impact on the environment.

This layout, which is believed to be America's largest vertical pipe loop (VPL) UV design (1,200 ML/d), meant that the new facility could fit into the available space with significantly reduced earthworks and environmental impacts, while providing better maintenance access along with substantial cost savings.

- **Procurement Approach**

  An early procurement contracting approach (separate purchase contracts, subsequently assigned over to the general contractor) for the UV equipment and other core equipment allowed MV to explore alternate UV technologies and consider emerging developments that could provide superior operational, environmental, social and/or financial benefits to MV without impacting the project schedule.

  This approach resulted in the team selecting a new hybrid style of UV reactor by Trojan™ (Torrent) that combines the low maintenance aspects of a medium pressure design with the low energy demand of conventional low pressure high output units.The key project objectives

Complexity

The most complex elements of the project involved two related considerations:

- **Minimization of hydraulic losses within the facility**

  During the early stages of the design, the MV Policy and Planning group requested that very strict hydraulic grade line parameters be followed to ensure that MV could minimize hydraulic losses and thus preserve maximum flexibility for future improvements to their downstream distribution system. The Ausenco team used hydraulic modelling to determine that upsizing some of the

Hydraulic modelling of the UV system

project piping and fittings could maintain the reserve hydraulic potential of the system. This worked in conjunction with the VPL configuration to provide the most cost effective solution for MV.

- **Validation of water flow characteristics through the UV reactors**

  Extensive physical hydraulic modeling was also used to optimize the layout of the VPL design. This meant that in addition to reducing the building footprint and maintaining the strict hydraulic grade-line limitations the team could minimize the depth of excavation and the height of the building for the new facility. This was achieved by reducing the length of straight pipe upstream and downstream of the UV reactors below typical industry guidelines by the inclusion of turning vanes in the piping as well as a flow straightening grid in each reactor. This further assisted in decreased overall construction costs, reduced environmental impact and reduced long term operating costs for the new facility.

The 3m-diameter (120") butterfly valve which was installed in the intake pipe is the largest valve in the MV system.

Vertical pipe loops

Social and/or Economic Benefits

The project benefits include:

- **Public Health**

  The upgraded system provides a multi-barrier, sequential ozone-UV-chlorine disinfection strategy, relying on: ozone disinfection for 4-log virus inactivation; ozone oxidation for improved UV transmittance (clarity) of the raw water and DBP precursor reduction; UV disinfection for 3-log Cryptosporidium and Giardia inactivation; and chlorine disinfection to maintain a secondary chlorine residual in the distribution system. As a multi-barrier system, ozone also provides 3-log Giardia inactivation, and chlorine provides additional virus inactivation.

- **Capital Cost Optimization**

  The system design incorporating VPL's for the UV equipment allowed significant cost savings in terms of the building footprint and site preparation in the order of 5% of the project cost. Other capital cost savings were found through the use of onsite spoil disposal, as well as reusing existing topsoil and wood waste for example.

- **Operating Cost Optimization**

  The selected hybrid style UV reactors require lower ongoing maintenance due to their medium pressure design compared to the higher maintenance costs associated with conventional UV reactors. In addition, the selected system features 40% energy consumption reduction compared to low pressure high output conventional UV reactors.

Environmental Benefits

The project has recognized its sensitive environmental setting and Metro Vancouver's Sustainable Region Initiative goals in many ways including:

- The new UV WTP building is designed to meet LEED Silver requirements (currently pending certification);
- During the pre-construction phase, a comprehensive trapping program was conducted to relocate wildlife such as frogs, snails, shrews, salamanders and screech owls as well as fish and other aquatic life from the construction area;
- Tree removal was minimized by using existing cleared areas within the watershed and reusing top soil and woody debris on-site for restoration and landscaping;

Green roofs

- The project's environmental plan included creation of additional salmon habitat and a hydroponic heating system that uses water to heat or cool the building as opposed to conventional heating and using the discharge water to maintain constant water flow in summer months through the areas streams and ponds;
- EcoSmart™ concrete was used to reduce carbon dioxide emissions;
- Electrical vehicle charging stations for smaller utility vehicles were installed;
- Recycled building materials were used where possible;
- Green roofs populated with indigenous plant species, and permeable pavement to minimize run-off were utilized;
- Indigenous plants were used as part of landscaping and non-native species were removed;
- A large retaining wall was faced with a sculpted rock-like finish and natural colours to blend in with the environment.

Meeting Client’s Needs

The client’s main objectives were achieved as follows:

- **Enhance the Coquitlam water treatment facility to comply with the new drinking water quality guidelines from Health Canada**

  The upgraded system provides a multi-barrier, sequential ozone-UV-chlorine disinfection strategy, relying on: ozone disinfection for 4-log virus inactivation; ozone oxidation for improved UV transmittance (clarity) of the raw water and DBP precursor reduction; UV disinfection for 3-log Cryptosporidium and Giardia inactivation; and chlorine disinfection to maintain a secondary chlorine residual in the distribution system.

- **Provide ultimate design capacity of 1,200 ML/day of water (peak hour summer-rated capacity) and provide flexibility to meet further regulatory changes**

  The new facility’s capacity meets the required ultimate peak hour summer flow of 1,200 ML/day. Use of this design basis also provides significant additional capacity through the rest of the year. The new facility provides flexibility to accommodate future regulatory changes and demand growth by providing sequential disinfection for multi-barrier protection (ozone, UV and chlorination) and disinfection by-product reduction. The design also allows for a future capacity expansion by installing space for two additional UV treatment loops.

- **Complete the project on budget and on schedule, while minimizing disruption of operations of the existing facility.**

  The facility was substantially completed on schedule, under budget and successfully went through a 30 day compulsory test in January and February 2014 meeting all test parameters. Disruption to existing operations was limited to a number of prearranged shut downs (for tie-ins to existing trunk mains and electrical power supply), all of which were completed within their allotted schedules.