TRETHEWAY CREEK PROJECT

TRANSFORMING CHALLENGES INTO OPPORTUNITIES

CANADIAN CONSULTING ENGINEERING AWARDS – 2017
Natural Resources, Mining, Industry & Energy Category

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Summary

The construction of the Tretheway Creek run-of-river facility in B.C. was a challenge, with more than 4 km of penstock buried in rugged terrain, marked by a total drop half the height of the CN tower. Owner, Innergex, signed an EPC contract with contractor Jim Dent Construction for the civil works, who in turn partnered with BBA to provide state-of-the-art solutions customizing cost-effective and environmental design. The facility is now providing much needed clean energy.

Summary

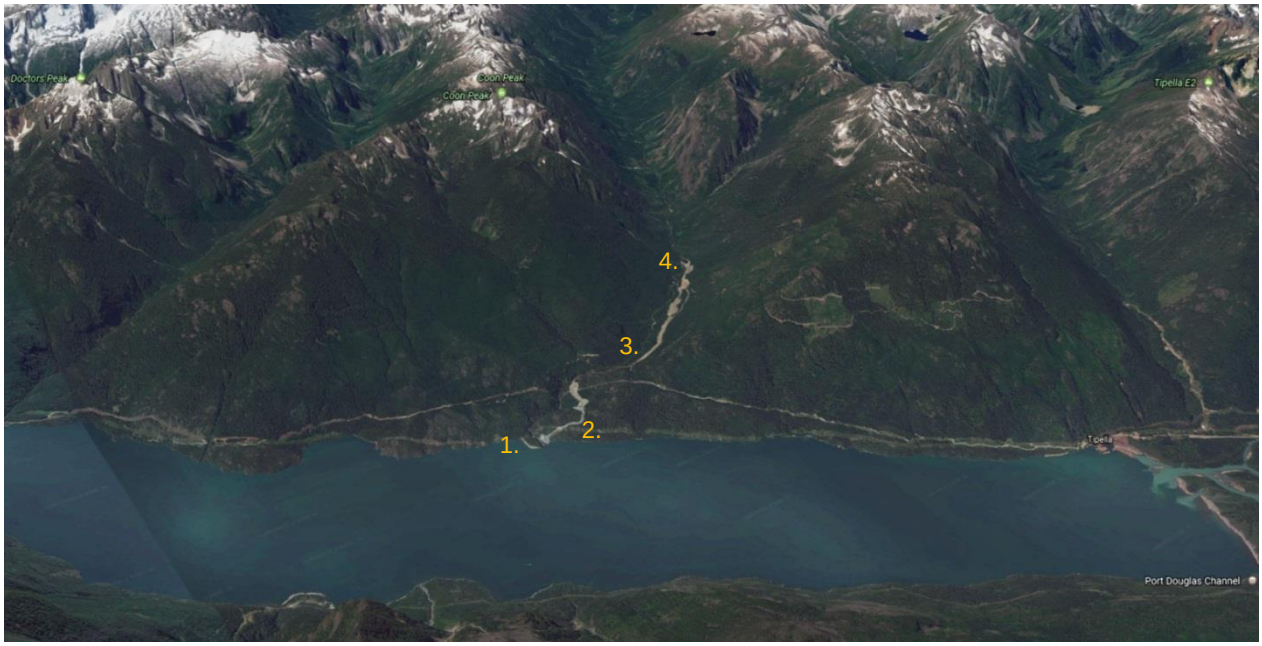

Image credit : Google Earth

1. Powerhouse

3. Buried penstock (4.4 km)

2. Above-ground penstock (250 m)

4. Intake and weir

Innovation

Innovation

The Tretheway Creek facility took two years to build (2013-2015). It is owned by Innergex Renewable Inc., an independent renewable power producer that obtained a 40-year power purchase agreement from BC Hydro. The contract was awarded as part of the 2008 Clean Power Call Request for Proposals, which helps B.C. meet its growing demand for emission-free energy.

The Tretheway facility includes a powerhouse, 4.6 km of penstock and a diversion weir and intake. Its two Pelton turbines have a rated discharge of 11.4 m^3/s under 263 m of head.

The powerhouse is in a rock excavation at the bottom of a steep slope (approx. 200 m high), just off Harrison Lake. This location was chosen so the run-of-river plant could discharge water back into Tretheway Creek, but there were many challenges. The powerhouse was built on a small ledge (approx. 20 X 50 m) excavated into the rock slope, where all the plant components had to be located. Adding to the complexity, the alluvial river delta, adjacent to the powerhouse, was exposed to seasonal lake levels that inundated the foreshore and was accessible only by the lake's barge. On the high side, the intake and its weir were to sit 263 m higher up to ensure an excellent water flow transfer.

BBA had to work closely with the contractor and the client to overcome numerous challenges.

Construction of the intake and weir

Powerhouse

The bottom of the cliff was excavated to “push the powerhouse into the rock”. This provided enough land surface for construction activities and machinery. All machinery and equipment were brought to the site on a large barge, since the construction cost of an access route was prohibitive.

The excavated material was reused as backfill to elevate the area around the powerhouse and provide access and laydown above the lake’s seasonal and flood levels.

The first 200 m penstock section was installed on a steep slope. It is connected to a powerhouse built on a small ledge excavated into the rock.

Penstock

A gantry rail car system had to be used to install the first 200 m section of the penstock on a slope too steep to effectively install below ground penstock.

The excavation of the underground penstock route in a rugged terrain uncovered unforeseen soil factors and challenges. BBA worked closely with the contractor to optimize construction while minimizing costs of the selected route.

Design and construction provided the necessary protection against erosion and land subsidence to ensure the long-term stability of the structure. BBA performed early stage mapping of streams and potential landslides along the 4.6 km penstock route.

The steep rugged terrain where the facility was constructed presented numerous challenges.

Complexity

Complexity

The pipe was routed in the rugged site to avoid natural terrain hazards, and optimize excavation costs and the project's footprint.

A total of 47 bends and deflections were required along the 4.6 km penstock in order to fit the mountainous topography. Each deflection had a set of loads that had to be restrained accordingly.

Soil restraint was used to eliminate the expensive concrete anchor blocks on the buried section of the penstock (4.4 km). Only a small section of the penstock (the last 250 m connected to the powerhouse) could not be buried due to the steepness of the terrain. BBA's cost-effective design helped reduce the quantity of concrete required for the project. For example, various key factors (thrust forces, thermal loads, gravity) were studied and expansion joints were used and located to significantly reduce the thermal loads and use the weight of the pipe to balance some of the thrust forces.

The installation of post-tension anchors reduced the required amount of concrete while providing the penstock with the necessary protection against seismic conditions.

The intake diverts water flow from the Tretheway Creek. It was built on a competent rock foundation, but voids in the rock foundation were discovered during construction. Drilling and a pressure grouting program were implemented to mitigate seepage and uplifting. A water pool was incorporated in front of the intake to help downstream fish migration.

A total of 47 penstock bends, like this one, were required to fit the mountainous topography. On the far left: the power line connecting the facility to the BC Hydro network.

Social and/or Economic Benefits

Social and/or economic benefits

The run-of-river facility was built on Crown land and within the traditional territories of the Douglas and Sts'ailes First Nations. Innergex consulted with both First Nations communities as key partners on the project[1], and executed Impact Benefit Agreements providing various benefits, including royalties and contract opportunities, during project construction and operation.

"This facility shows what can be achieved when First Nations, industry and government work together to develop clean-energy resources in First Nations' traditional territories," noted Laurie Throness, former Chilliwack-Hope MLA, present at the Tretheway site opening in July 2016.

- The Douglas and Sts'ailes will indirectly profit from revenues generated by the new facility through the revenue-sharing agreement they signed with the B.C. government in 2015. A total of 32 First Nations have signed 41 similar clean-energy revenue-sharing agreements with the province[2].
- The site employed over 100 workers during its peak construction period. First Nations people represented 15% of employment during construction. More than 40% of construction camp and catering service workers were from the First Nations[3].

The site was expected to generate revenues of just under $8.7 million in its first year of operation[4] by selling its clean electricity to the BC Hydro utility.

The Tretheway facility will provide much needed clean energy in the province, as demand for electricity is expected to increase by up to 40% over the next 20 years, due to a forecasted population growth of one million[5].

Tretheway Creek is located within the traditional territories of the Douglas and Sts'ailes First Nations. The two communities benefited from the project and were key partners.

[1] "Innergex celebrates the commissioning of the Tretheway Creek Hydroelectric Facility", Innergex.com website, published July 6, 2016. http://www.innergex.com/en/news/innergex-celebrates-the-commissioning-of-the-tretheway-creek-hydroelectric-facility/
[2] "Tretheway Creek Hydro Project generating clean power", *Canadian Mining & Energy*.
[3] "Tretheway Creek Hydro Project comes online", *Agassiz-Harrison Observer*, July 21, 2016.
[4] "Innergex Renewable Energy commissions 21.2-MW Tretheway Creek Hydroelectric facility", Hydroworld.com, 11/10/2015. http://www.hydroworld.com/articles/2015/11/innergex-renewable-energy-commissions-21-2-mw-tretheway-creek-hydroelectric-facility.html
[5] "A Growing Population and Economy", BC Gov. News website, https://news.gov.bc.ca/stories/growing-demand-for-electricity

Environmental Benefits

Environmental benefits

The Tretheway site produces an average of 81 GWh of renewable emissions-free electricity annually, which is enough to power at least 7,300 households each year, but its green engineering is also remarkable.

Burying 4.4 km of penstock

The hundreds of metres^3 of aggregate and soil used to fill the trenches came from the excavation and areas adjacent to the penstock route. The buried penstock will be significantly less visible in just a couple of years, even to regular hikers enjoying the surrounding pines, oaks and cedars of this forest area.

The numerous streams of run-off waters were carefully mapped before development. These small streams carry a large volume of rain water in times of heavy rain. The penstock was built perpendicular to these streams and along the natural terrain to avoid any water course interference. Drains above ground ensure the streams regained their natural course.

The buried penstock was designed and built to become significantly less visible in just a couple of years.

Preserving fish habitat

The selected intake (Coanda style) allows fish to migrate downstream without entrainment, and the weir is equipped with a fish ladder to enable upstream fish movement. The water diverted into the penstock is returned to the Tretheway Creek before reaching Harrison Lake; thus water returns on its natural route without affecting the ecological surroundings.

The various seasons of ecological habitats were considered before construction. For example, water works were conducted during low-flow seasons to avoid any unexpected migration of sediment into the water bed.

The selected intake (Coanda style) allows fish to migrate downstream without entrainment.

Meeting Client's Needs

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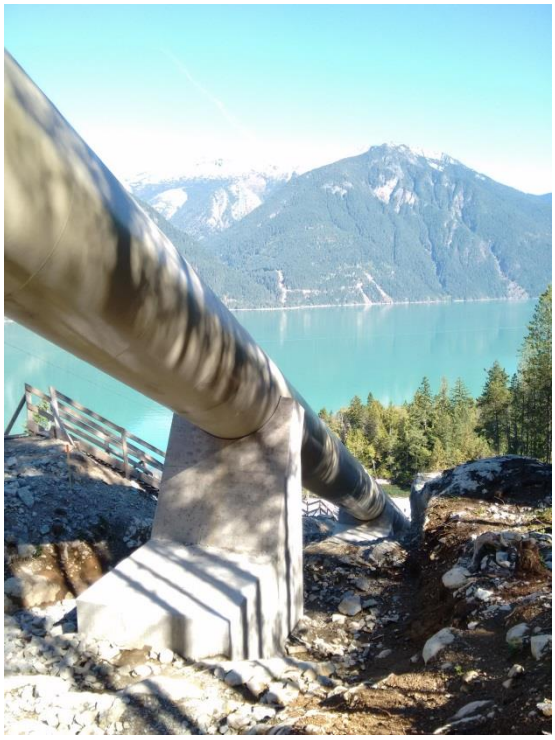
The Innergex project is a great example of how green engineering can be smart... while generating savings.



The installation of post-tension anchors reduced the required amount of concrete, which in turn reduced costs.

The 'one-size-fits-all rule' did not apply here, as soil composition, terrain drop and exposure to elements changed along the penstock path. The peculiarities of each section were studied, and the material and design were adapted accordingly. All elements were optimized, and the interlocking effects of each section were carefully considered. This customizing not only ensured that installations suited the variety of terrain conditions, it also helped decrease costs, accelerated construction and limited risks for workers.

The project was completed in October 2015, on time and approximately $8 million under budget.

The project was publically praised by B.C. Energy Minister Bill Bennett, who personally visited the site in 2016 with representatives from Innergex, BC Hydro and the Douglas and Sts'ailes First Nations. "The Tretheway Creek Hydroelectric Project is the kind of private-sector renewable-energy project that is a big part of BC's clean and diversified energy supply," said Mr. Bennett when the plant was first powered in July 2016.

Innergex is now selling the clean electricity generated by the Tretheway Creek facility to BC Hydro through a 138 kV transmission line linking the project to the point of interconnection at BC Hydro's Upper Harrison Terminal. The independent renewable power producer has a 40-year contract with the utility.

The facility 138 kV switchyard. The plant will produce enough energy to power at least 7,300 households each year.

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About BBA

For over 35 years, BBA has been offering a wide range of consulting engineering and project management services, from project definition to commissioning. The firm's expertise is recognized in the fields of energy, mining and metals, and oil, gas and biofuels. BBA relies on a team of seasoned experts to transform complex problems into practical, innovative and sustainable solutions.

BBA is supported by a network of offices across Canada to better serve its clients and carry out mandates at the local, national and international levels.

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