



TREE FOR LIFE AWARD  
& AWARD OF EXCELLENCE

# Box Canyon Hydroelectric Project

Knight Piésold

Below: Installation of buried penstock on a steep leg of the Box Canyon penstock.



“We appreciate how the unique engineering utilized three main and six tributary intakes to address the unique geography along the creeks and tributaries with minimal environmental impact.”  
—Jury

The 16 MW Box Canyon Hydroelectric project may have the most hydraulically complex design of any run-of-river hydroelectric project in North America, if not the world. It has nine intake structures on different creeks and tributaries, all feeding into a single, high-pressure penstock that directs water to the powerhouse containing a six-jet vertical axis Pelton turbine generating unit.

The project has three main intakes and six tributary intakes that address the unique hydrology, river morphology, and fish species distribution along McNab Creek and its tributaries. It has an 8.6-km-long water conveyance system of interconnecting pipelines and high-pressure penstocks that handles varying intake elevations and flow contributions,

requiring the addition and design of surge facilities and check valves.

The project design also takes into account the complex hydraulic transient pressures (water hammer), and provides unique ecological flow releases at each of the diversion weirs.

Knight Piésold Ltd. assisted Box Canyon Hydro Corp. in project development, from concept development through to operational monitoring

The original project concept was a 7 MW facility with a single intake on Box Canyon Creek. Knight Piésold optimized the design to the current 16 MW facility with multiple intakes, addressing complexities not typical in a single intake, run-of-river hydroelectric project.

The water conveyance system includes open channel sections, which



Right: Marty Creek main intake, showing Coanda screen and maximum diversion control weirs.



being diverted from any combination of Marty Creek and Cascara Creek.

The facility monitors water level at Box Canyon Creek and Marty Creek intakes to manage ramping rates in each creek. The three main intakes were designed to divert a portion of

The IFR at each intake is controlled by the intake design to ensure that IFR is released as priority before water can be diverted for power generation.

In single intake projects, the maximum diversion rate is often plant controlled (i.e., throttled by turbine nozzles). Due to the multiple intake design, the maximum amount of water that can enter the penstock must be limited at each intake. The Marty Creek and Cascara Creek intakes have a weir system to passively limit the maximum diversion rate.

When the project starts-up, creek flows downstream of the intakes are reduced and flows downstream of the tailrace are increased. The opposite response occurs during a shutdown. Because the intakes are connected to a single, high-pressure penstock and are at different elevations, the start-up procedure is governed by the ramping rates at each intake depending on the conditions in the penstock.

The project is operated from level control at the “master” Box Canyon Creek intake. This intake can be locked-out, if required, making the project operable from level control at the Marty Creek intake, with water

the natural stream flow to the water conveyance system. Each of the two passive intakes at Marty Creek and Cascara Creek has a weir system to passively limit the maximum diversion rate. They also have Coanda screen solutions to prevent debris and coarse sediment entrainment into the turbine flow.

**Overflow weir**

The overflow weir wall is designed to accommodate the 1:200-year peak instantaneous return period flood without structural damage to the intake structure and/or the penstock. The penstock optimization design required a balance between head loss and the pipe installation costs associated with different sizes of pipe, the resultant net head available for power generation, and the value of that energy. The steel sections of the alignment comprised of seven different pipe sizes in total, while the HDPE sections of the alignment comprised of four different pipe sizes, utilizing six different HDPE DR ratings.

The project will provide renewable energy for the BC electrical grid for the next 60 to 75 years, generating approximately 46 GWh/year. **CCE**

divert water from the tributary intake to the main intakes. Given the steep terrain, all penstock branches were installed below surface to overcome challenging construction and design conditions that were encountered at several sections of its length.

**Instream flow requirements**

The project design accounted for complex hydraulic transient pressures and provided unique ecological flow releases at each diversion weir. The project, under its Water License, must maintain minimum instream flow requirements (IFR), maximum allowable diversion rates, and maximum flow ramping rates that vary for each intake, due to differences in hydrology, river morphology, and fish species distribution.

**Box Canyon Hydroelectric Project, Howe Sound, BC**

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| <b>Award-winning firm (prime consultant):</b> | Knight Piésold (Sam Mottram, PEng.; Toby Perkins, PEng.; Benoit Otis, PEng.; Egbert Scherman, PEng.; Rob Adams, PEng.; David Levi, PEng.) |
| <b>Owner:</b>                                 | Box Canyon Hydro Corp. (Elemental Energy Inc.)  |
| <b>Project management:</b>                    | Chant Construction Company  |
| <b>Prime Contractor:</b>                      | Jacob Brothers Construction   |