

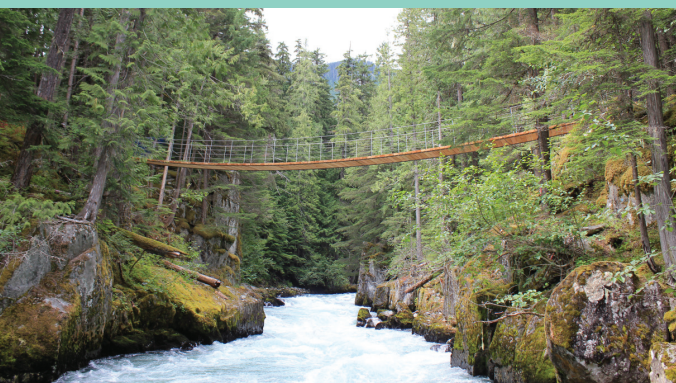
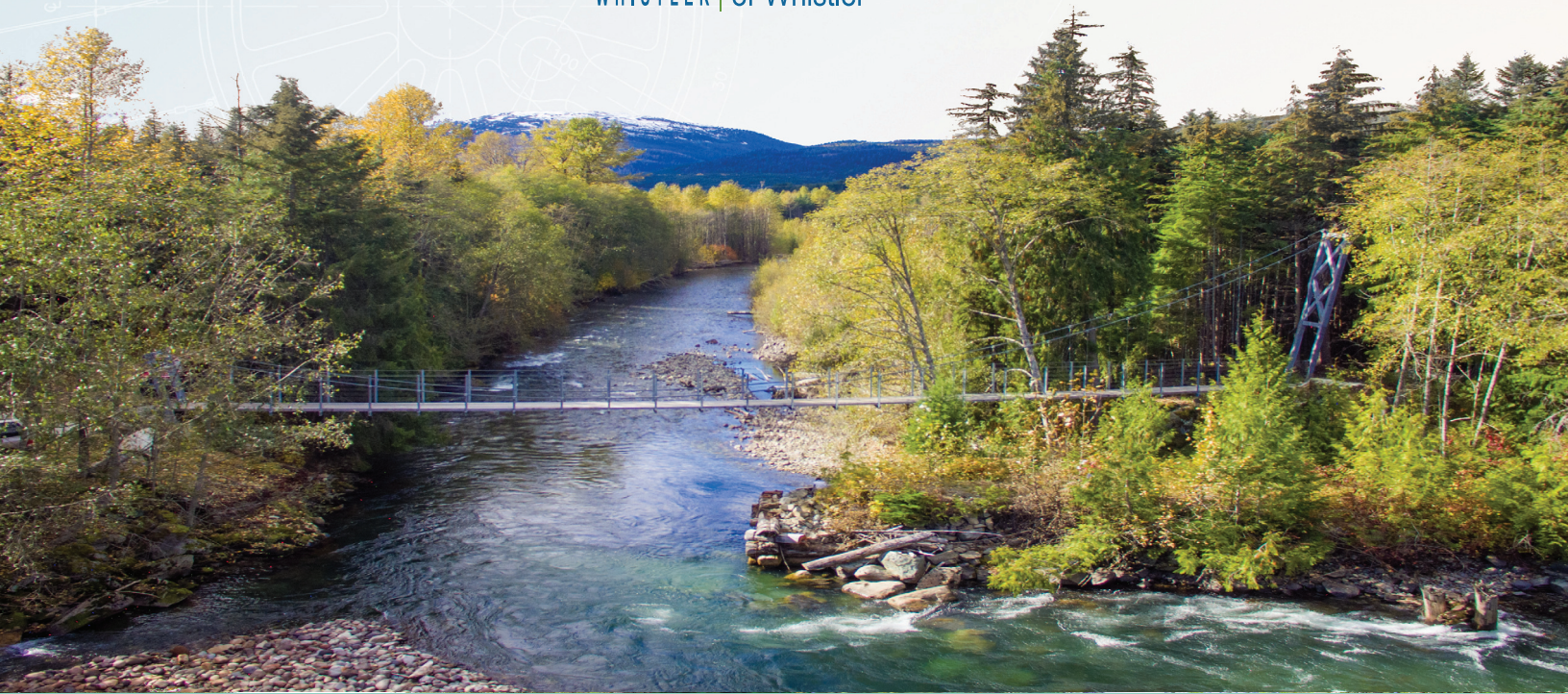


Klohn Crippen Berger

SEA TO SKY TRAIL SUSPENSION BRIDGES WHISTLER, BC



Resort Municipality
of Whistler



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KLOHN CRIPPEN BERGER



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PROJECT NAME	Sea to Sky Trail Suspension Bridges
LOCATION	Whistler, B.C.
COMPLETED BY	2016
CATEGORY OF ENTRY	B. Transportation
ENTERING FIRM	Klohn Crippen Berger Ltd.
ROLE IN THE PROJECT:	Prime Consultant
PROJECT OWNER	Resort Municipality of Whistler
PROJECT CLIENT	Resort Municipality of Whistler
SUMMARY DESCRIPTION OF PROJECT	Klohn Crippen Berger provided design and construction management services to the Resort Municipality of Whistler for two pedestrian suspension bridges over the Cheakamus River. The Sea to Sky Bridge has different height towers inclined backwards to fit the challenging constraints of the site. The Train Wreck Bridge has anchor frames shaped like locomotive wheels, as a tribute to the famous train wreck site that it leads to. The bridges link together key recreational trail segments.
NAMES OF CONTRACTORS INVOLVED	Kingston Construction Ltd. Axis Mountain Technical Inc.



Innovation

Klohn Crippen Berger (KCB) provided design and construction management services to the Resort Municipality of Whistler (RMOW) for two pedestrian suspension bridges over the Cheakamus River near Whistler, B.C. The new bridges form part of an important recreational trail network. RMOW had strict budget limits, but desired unique attractive bridges to compliment these spectacular wilderness sites.

Bridge #1, the Sea to Sky Bridge, replaces a deteriorated log stringer forestry bridge that was closed to the public due to safety concerns. The new bridge completes the final portion of the 180-kilometer long, multi-use Sea to Sky Trail between the north and south boundaries of Whistler. KCB developed a 55m long suspension bridge design for the crossing. The main cables for the bridge are anchored into bedrock using drilled-in pairs of rock anchors for each cable. The bridge deck is constructed using rough cedar planks carried by steel crossbeams and cable hangers. Additional cables are strung along the bridge to act as a railing system. Different height towers inclined backwards away from the river were designed to fit the constrained bridge site, making for an interesting and appealing structure. The efficient and elegant bridge design was built within budget during a short fall construction window.

Bridge #2, the Train Wreck Bridge, allows safe access to one of Whistler's popular attractions, a historic train derailment site featuring graffiti-covered train cars. For years, the only access to the site was by a dangerous route along CN Rail tracks. RMOW wanted a bridge to connect the site to the Sea to Sky Trail and other popular hiking and biking routes in the Cheakamus Crossing region. KCB designed a 36m long catenary cable suspension bridge with four main catenary cables. The cables connect to anchor frames at each end which are custom fabricated steel shapes, carefully designed in the form of locomotive wheels. A tension strut, designed to look like a strut between locomotive wheels, connects the anchor frames to a single 63mm diameter rock anchor, efficiently transferring the loads to the bedrock behind. Rough cedar was selected for the decking invoking railway ties. Great care was taken in every detail to create an instantly recognizable bridge design which easily distinguishes it from other bridges.

Both bridge designs are a remarkable combination of engineering efficiency and aesthetic design, and show that with a little skill and imagination, bridges can be beautiful as well as economical.



Complexity

The unique site conditions and uncommon bridge types required innovative design and construction solutions.

At the Sea to Sky Bridge site, an existing forestry road reduced the space available to construct the south bridge abutment; and bedrock for anchoring the bridge cables was irregular and unreliable. The initial bridge concept had a common suspension bridge configuration with equal height vertical towers, but the design evolved. KCB's final solution was an asymmetric suspension bridge with a shorter south tower. Both towers were inclined backwards to allow for a steeper backstay angle for the main cables, enabling them to be anchored closer to the ends of the bridge. This created room for the forestry road to remain in service and ensured that the cables could be anchored into competent bedrock.

The Train Wreck Bridge has a very remote site location which made access for regular construction equipment impossible. KCB designed the bridge abutments using light steel components to facilitate assembly without heavy equipment. The rock anchors used to secure the abutments and anchor the bridge cables were sized such that they could be installed using a mini air-track drill and air compressor that were small enough to be helicoptered to the site. The main features of the Train Wreck Bridge, the steel wheel-shaped approaches, serve as structural supports as well as architectural elements and have complex, unusual geometry. The wheels were analyzed using two structural analysis programs in order to efficiently design the thickness and dimensions of the wheel spokes and strut.





Social and/ or Economic Benefits

The Sea to Sky and Train Wreck suspension bridges bring long-term safe and convenient access for visitors and residents to some of Whistler's most important outdoor recreation assets, and contributes to the development of tourism and the economy in the community.

KCB delivered not only sound, safe and sustainable bridge designs, but designs which provided visual impact to enhance the experience of trail users. The Sea to Sky Trail Bridge's sleek design and mixed use of galvanized steel and timber components allow it to blend seamlessly into its surroundings. Meanwhile, the playful inclusion of train wheel and train track components at the Train Wreck Bridge creates a standout design which is as much of an attraction as the colorful train wreck cars that it leads to. The bridges have already become favorite destinations for many, with a marked increase in visits by school children on field trips; photographers; artists; tourists; and regular hikers, joggers and cyclists.

The beneficial effects of the project are clear: by creating access to some of the world's most picturesque wilderness locations, the project promotes exercise, health and recreation. KCB's engineering team is proud to have participated in this rewarding project that will directly benefit British Columbians for decades to come.

The new bridges form part of an important recreational trail network for the community



Environmental Benefits

Sustainability was considered in all aspects of the project, in keeping with the RMOW's sustainability objectives. The final bridges both have a very small footprints, thus minimizing the amount of tree clearing that was required at the bridge sites and adjacent paths. The trees that were felled were recycled to build the new approaches leading to the Train Wreck Bridge. Natural, renewable materials were used wherever possible, such as locally-sourced, rough-cut cedar selected for both bridge decks. Elsewhere, galvanized steel was used to ensure a long design life so as to reduce future replacement requirements.

As the bridges cross the environmentally sensitive Cheakamus River at two locations, minimizing impact on the river and its habitat was a key consideration. The abutments were set well outside of the river channel so as not to affect the river flow or cause scour of the riverbanks. Significant effort was made to eliminate the need for concrete poured in the vicinity of the river. Instead, rock anchors and built-up steel abutments were used.

Overall, the bridges contribute to, enhance and enrich the existing habitat, reminding of environmental responsibility and stewardship, and acting as an educational environment for visitors and locals.





Meeting Client's Needs

The RMOW required new bridges at key locations in order to connect important trail networks.

In order to meet the RMOW's goal to develop a world-class trail network system, the bridges needed to be visually-appealing so as to enhance the experience of the trail users. At the same time, the bridges had to be constructed within short summer construction windows and within tightly set budgets.

KCB relied entirely on our internal resources and expertise to meet the client's project objectives, forming a multidisciplinary team of in-house engineers to complete the design of the bridges. We embraced the opportunity to come up with unusual bridge designs with architectural appeal, and developed unique structures inspired by their surroundings. Our creative bridge solutions were welcomed with excitement and enthusiasm from the client, and our cooperative efforts yielded two exceptional new bridges.

Despite the uncommon designs, we did not compromise on cost or schedule. KCB developed efficient and easily constructible bridges, and adapted to unforeseen site conditions to save money where possible. For example, the south Sea to Sky Bridge abutment was originally designed with micropiles down to bedrock. During construction, shallower bedrock was located close by. KCB worked with the Contractor to develop value-engineering solutions that allowed the bridge to be founded on spread footings by shifting its position slightly, simplifying the construction and reducing the bridge cost. For the Train Wreck Bridge, KCB contacted contractors with specific expertise in remote access construction in order to come up with a cost-effective design.



SPACER R50x120# E.S.,
SEE NOTE 2



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SEA TO SKY TRAIL SUSPENSION BRIDGES WHISTLER, BC



The Sea to Sky Trail Suspension Bridges project comprises construction of two new pedestrian suspension bridges over the Cheakamus River, linking together key recreational trail segments near Whistler, BC. The bridges are the Sea to Sky Bridge and the Train Wreck Bridge.

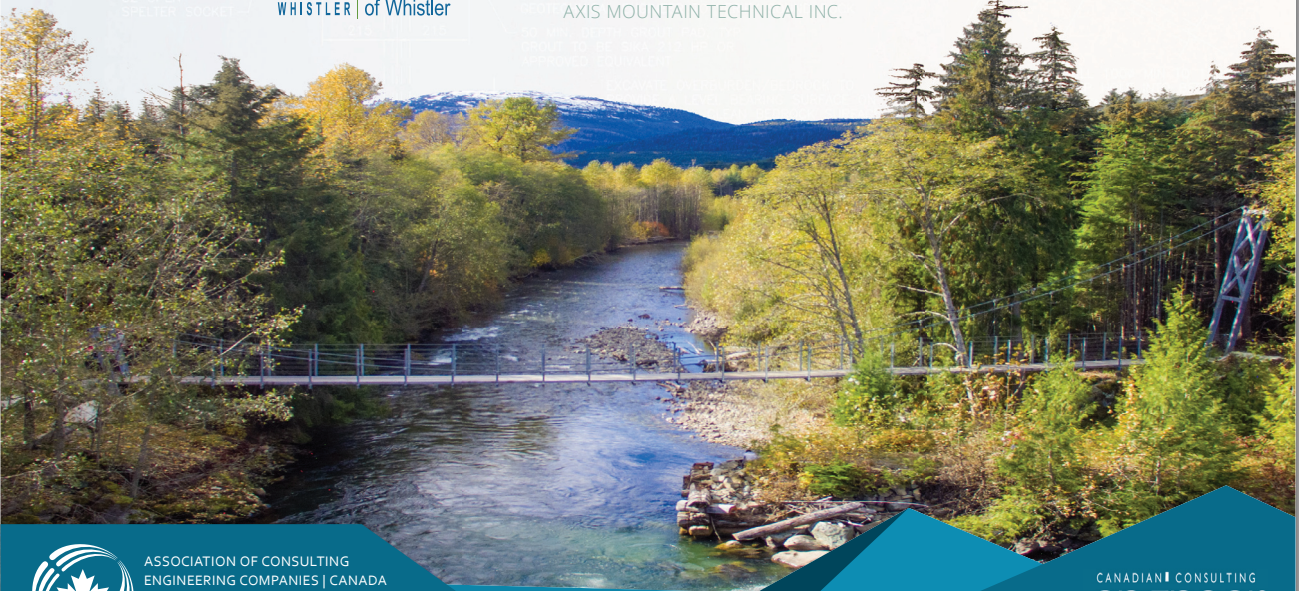
The Sea to Sky Bridge has an asymmetrical design with different height towers that are inclined backwards to allow for a steeper backstay angle, so that the bridge cables do not encroach on an existing forestry road. The Train Wreck Bridge provides safe, legal access to an old train wreck site, which is a popular landmark visited by both locals and tourists. Anchor frames for the cables at each end of the Train Wreck Bridge are designed in the form of locomotive wheels as an interesting and appealing tribute to the wreck site. Klohn Crippen Berger Ltd. provided conceptual and detailed design, and construction management services for both bridges.



CLIENT
**Resort Municipality
of Whistler**

CONTRACTORS

KINGSTON CONSTRUCTION LTD.
AXIS MOUNTAIN TECHNICAL INC.



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SEA TO SKY BRIDGE PHOTOS



The new Sea to Sky Bridge replaces the old decommissioned forestry bridge pictured beside it



The Sea to Sky Bridge features rough cedar decking and impressive galvanized steel towers

TRAIN WRECK BRIDGE PHOTOS

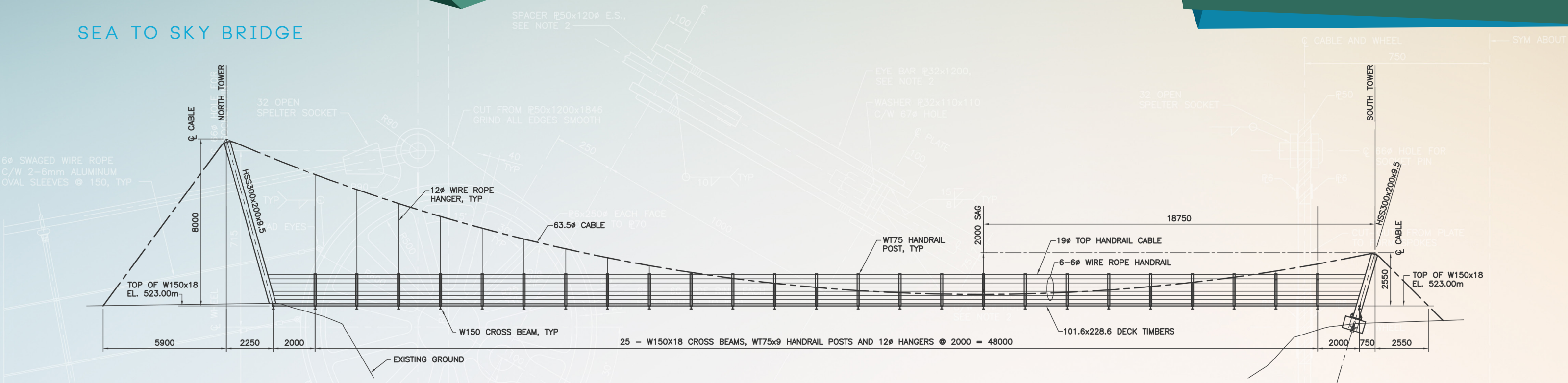


Train Wreck Bridge spanning the picturesque Cheakamus River



The completed Train Wreck Bridge is a new Whistler landmark

SEA TO SKY BRIDGE



TRAIN WRECK BRIDGE

