

# Lower Kicking Horse River

## Preliminary Design Report

Golden, British Columbia



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## Table of Contents

Introduction .....	1
Background .....	4
Hydrology .....	4
Preliminary Design .....	8
Phase I .....	8
North Bank Layback .....	9
Possible Future-Phase II Improvements .....	11
Fish Passage .....	11
Fish Habitat .....	12
Recreation and Economic Benefits .....	13
Similar Projects and Ice Concerns .....	13
Gunnison, Colorado .....	14
Permitting .....	15
Preliminary Cost Estimate .....	17
Conclusion .....	17
Recommendations .....	18
Bibliography .....	20
Appendix 1: <i>Design Drawings</i> .....	21
Appendix 2: <i>Lower Kicking Horse River Fisheries Assessment</i> by Carolla Environmental	22
Appendix 3: <i>Overview Fisheries Assessment of the Kicking Horse River through Golden, B.C.</i> by Carolla Environmental .....	23
Appendix 4: Section 9 Permit Application .....	24
Appendix 5: Cost Estimate .....	25

## Introduction

The Town of Golden, B.C. (Town) retained Recreation Engineering and Planning (REP) to complete a project assessment for the Kicking Horse Whitewater Park and Habitat Improvements project (Project). That report was completed in September of 2006. Subsequently, Golden Area Initiatives retained REP to complete Preliminary Design for the Project. This report and attached drawings complete the contract for Preliminary Design.

Habitat improvement structures have proven to create additional in-stream habitat and fish passage opportunities that enhance and facilitate healthy ecosystems. The structures create riffle-pool-glide sequences that are known to provide a diverse range of habitat for spawning, holding, and migrating fish. The complexity and diversity created by the proposed structures offers a variety of habitats available for all native species. The structures contain riffles upstream of the drop structures that provide spawning habitat. The pools below the structures provide deep winter habitat and refuge areas. The random boulders placed in the pools below the structure provide channel complexity, diversity, and refuge zones for migrating fish. The glide area downstream of the structures provide valuable feeding and holding areas that have proven to be good fishing “holes” for recreational fisherman.

## SECTION 1

### Introduction, Background, and Hydrology

Whitewater kayaking is one of the fastest growing outdoor sports in the country, and whitewater parks are an emerging way to provide river-related recreation near population centers. Diverse communities ranging in population and geographic characteristics are turning to their rivers as a source of recreation, education, and local pride. Whitewater parks attract citizens of all ages and socio-economic status. Whitewater parks across the country have provided towns with a number of benefits including new recreational opportunities, economic stimulus, enhanced aquatic habitat, and environmental education opportunities.

The Project area is located on the Kicking Horse River from the location of the college in Golden to approximately 1 Kilometer upstream of the confluence with the Columbia River shown in Figure 1.

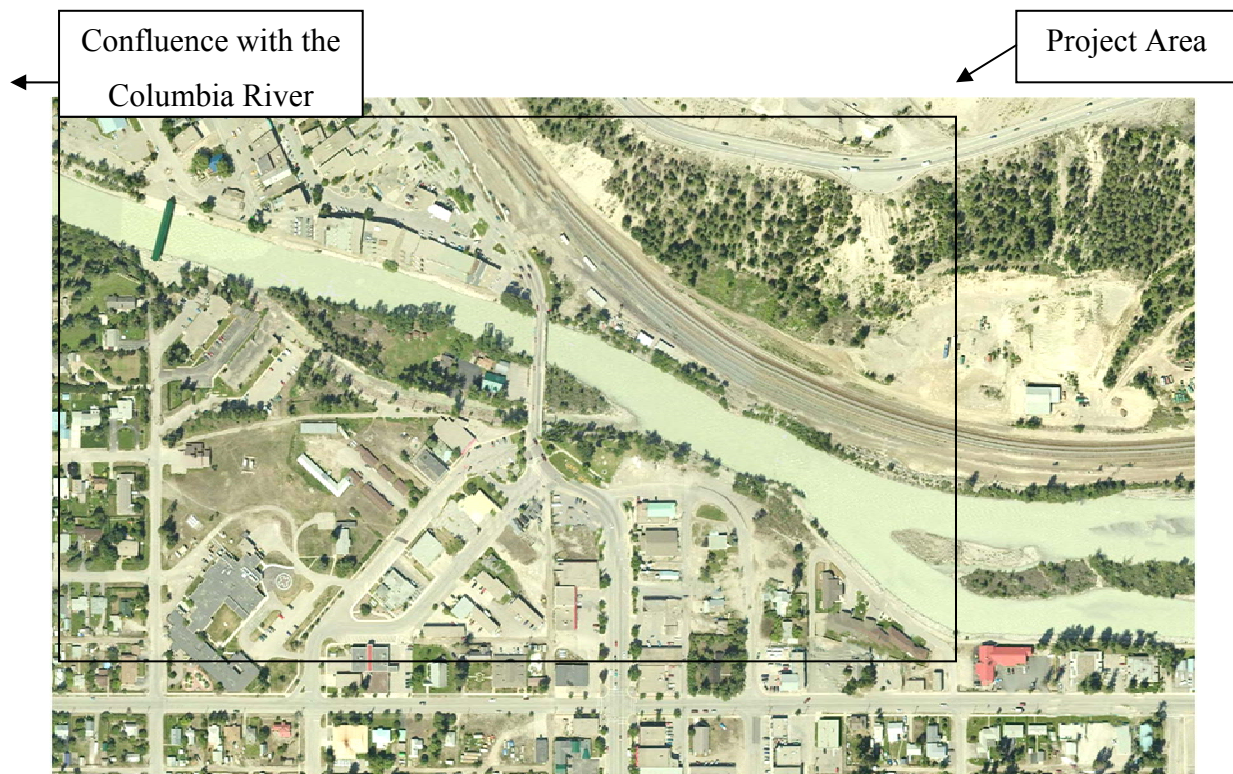


Figure 1: Vicinity Aerial Photograph

Within the Project area there are two bridges: The Highway 95 bridge shown in Figure 2 and the covered pedestrian footbridge near 8<sup>th</sup> Avenue South shown in Figure 3.



Figure 2: Highway 95 Bridge



Figure 3: Covered Pedestrian Footbridge near 8<sup>th</sup> Ave. S

## **Background**

Golden, British Columbia is located within the center of Kicking Horse Country and surrounded by six of Canada's majestic National Parks. The Kicking Horse River near Golden is a valuable amenity for the community. It offers valuable fishing opportunities in addition to recreational floating, whitewater rafting, and kayaking opportunities. Currently, multiple whitewater rafting companies operate trips on the river and provide economic stimulation for the Town.

In recent years, the Town has experienced increased flood and ice flow risk. Specifically, two ice flows occurred in January 2005 and December 2005 that caused emergency maintenance and damage to riparian vegetation (Carolla Environmental, 11/07). To combat the problem, the Town has proposed removing gravel from the Lower Kicking Horse River (Carolla Environmental, 11/07). Dialogue continues as to what should be done to mitigate the potential for future damage.

REP's design work includes recognition of the potential flooding and ice flow problems. The design incorporates specific measures to mitigate the potential for flooding. The instream structures will facilitate the transport of ice and debris through the area while providing recreational and habitat enhancements that will stimulate economic growth in the community.

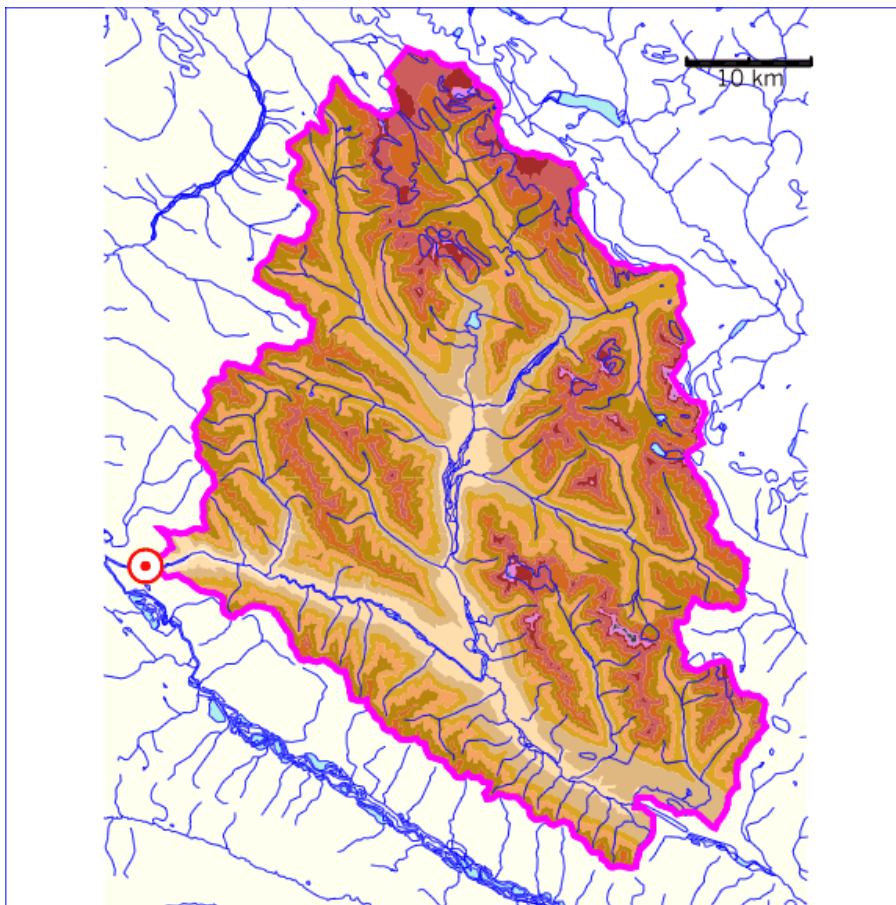
## **Hydrology**

The Kicking Horse River flows generally west through Golden, British Columbia before its confluence with the Columbia River. The river is characterized by a high mountain catchment draining the Rocky Mountains with elevations up to 3250 meters above sea level and multiple waterfalls. The lower catchment is characterized as an alluvial floodplain with significant deposition, prior to its confluence with the Columbia River. The river has a relatively high sediment load.

Environment Canada maintains a hydrometric station on the Kicking Horse in Golden labeled Station #08NA006. The statistics and topography for the station are shown in Figure 4.

### Hydrometric Station: KICKING HORSE RIVER AT GOLDEN (#08NA006)

Lat. (deg)	Long. (deg)	Period of Record	Station Status	Basin Area (km <sup>2</sup> )	Elevation (m)
51.3	-116.968	1/1/1912-present	Active	1850	N/A



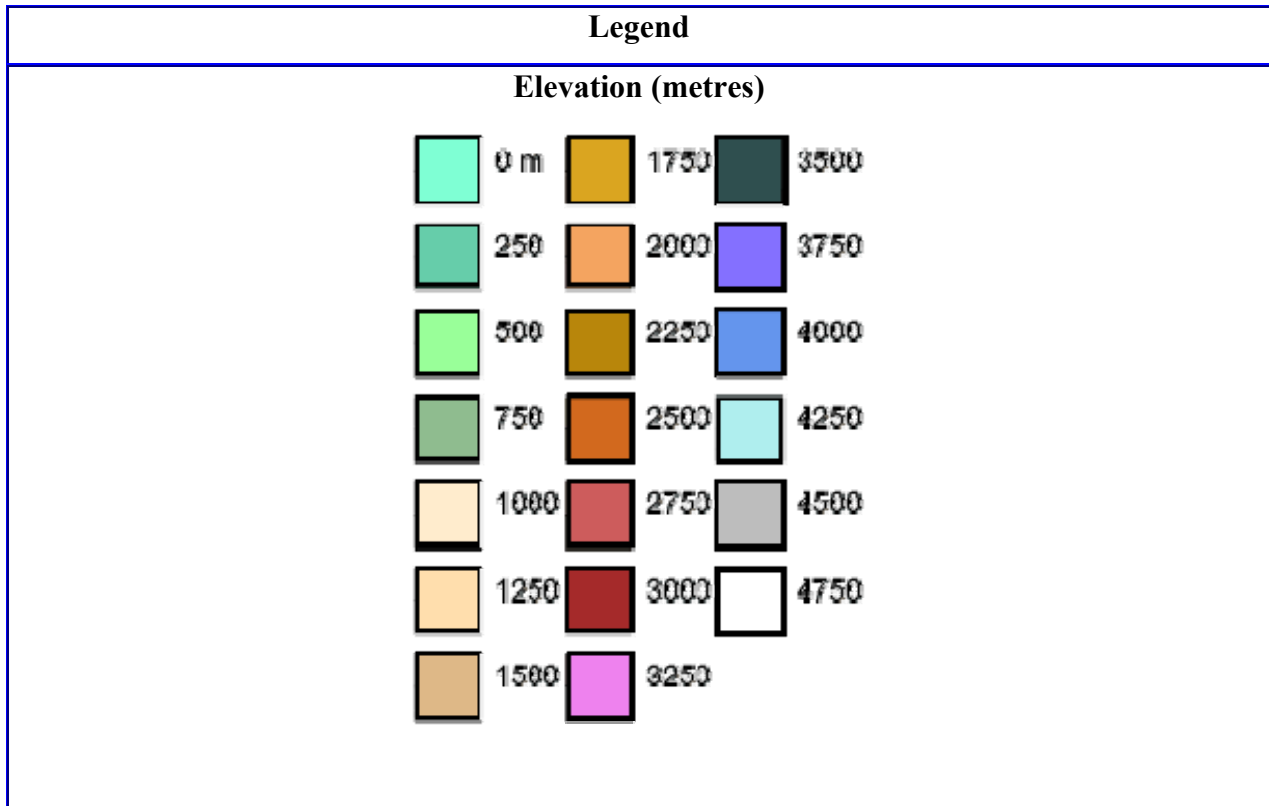


Figure 4: Hydrometric Parameters and Topography for the Kicking Horse River in Golden, B.C.  
(from Environment Canada [www.wsc.ec.gc.ca](http://www.wsc.ec.gc.ca))

The Kicking Horse River has a mean basin elevation of 2,062 meters with a basin area of 1850 square kilometers. There are no known impoundment structures and the river follows a natural flow regime which is characterized by seasonal snowmelt runoff from approximately April through August as shown in Figure 5.



## KICKING HORSE RIVER AT GOLDEN (08NA006)

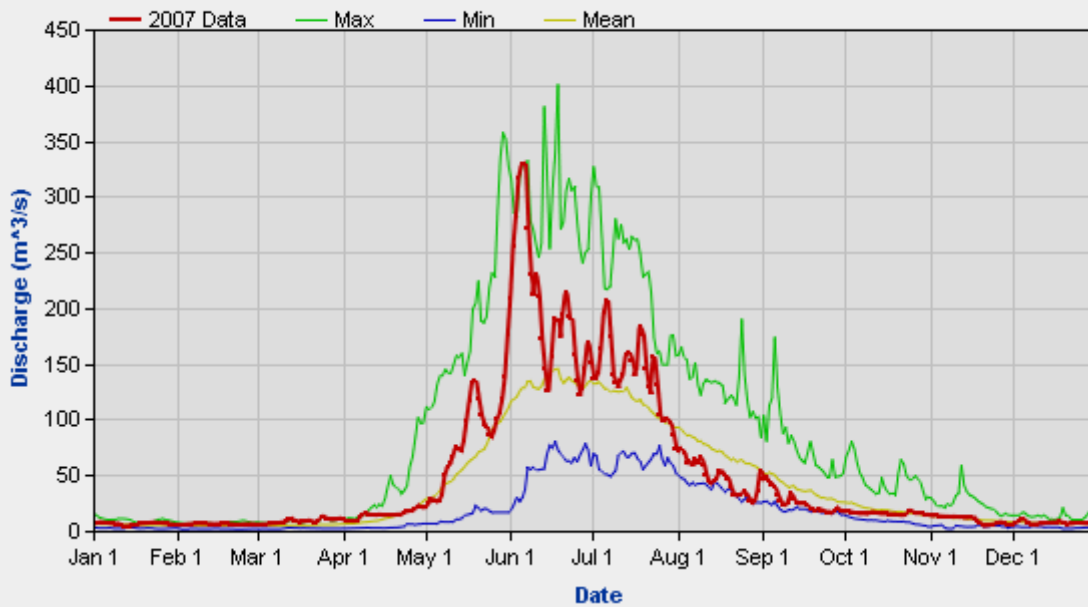
Graph:

08NA006

Daily

Refresh

### Daily Discharge for KICKING HORSE RIVER AT GOLDEN (08NA006)



**Figure 5: Kicking Horse River at Golden, B.C. Daily Mean hydrograph  
Statistics corresponding to 44 years of data recorded from 1911 to  
2007.\***

Figure 5: Kicking Horse River at Golden, B.C. Daily Mean Hydrograph

## **Preliminary Design**

Based on projected funding opportunities, the project has been split into two phases. Phase I includes improvements from the Highway 95 Bridge downstream to the covered footbridge. Possible Future-Phase II Improvements includes improvements from the Highway 95 Bridge upstream. The design drawings are attached in Appendix 1.

### **Phase I**

Phase I improvements include the addition of four offset deflectors (labeled as Structures #3-#6 on page 2 of the attached design drawings) downstream of the Highway 95 bridge. The deflectors are designed to add habitat value through channel complexity, variability, a low flow pilot channel, and deep thalweg pools for overwinter habitat. In addition, the deflectors add recreational opportunities including eddies, runs, and pools for beginner to intermediate boaters.

Phase I includes a U-structure (labeled as Structure #7 on page 2 of the attached design drawings) just upstream of the covered footbridge. U-structures have been used in many types of rivers to provide riffle, plunge pool, run habitat, and whitewater opportunities.

# SECTION 2

## Preliminary Design

Random boulders are placed throughout the reach to provide diversity, habitat areas, eddies for re-circulating boaters, and channel complexity.

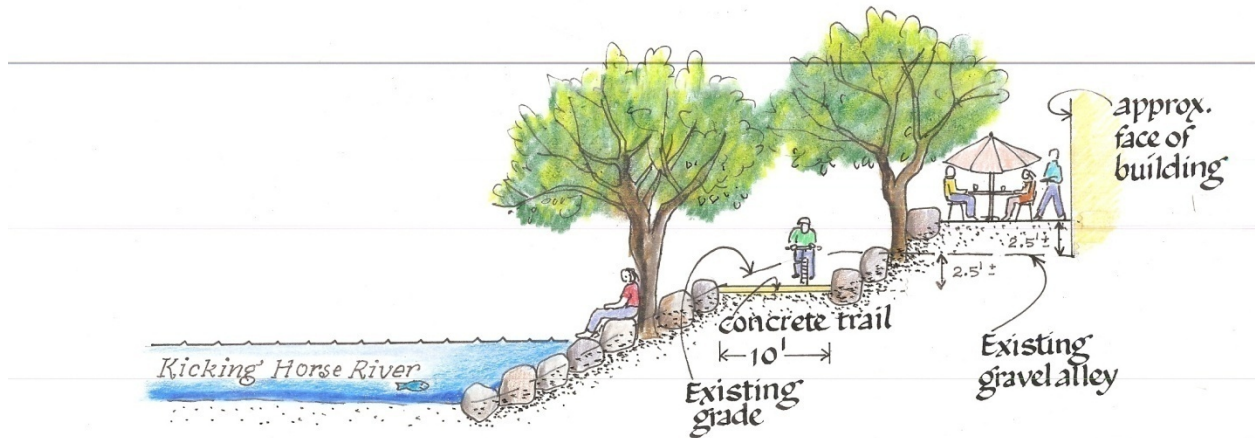
### **North Bank Layback**

Based on stakeholder feedback, REP has incorporated flood and ice flow mitigation within the design. Specifically, the river right bank will be laid back to provide additional conveyance for flood and ice flow mitigation. REP recommends the layback geometry be hydraulically modeled to confirm protection from the 200-year flood. The bank is currently constructed at an approximately 2:1 slope with boulder riprap armoring as shown in Figure 6.



**Figure 6: North Bank existing conditions**

The proposed design improvements include laying back the slope of the bank and constructing a 10-foot wide concrete trail, boulder seating, access locations, and plaza areas to bring the public to the river and create a valuable greenway and recreational site (as shown in Figure 7). The 10-foot wide concrete trail would begin near the existing highway 95 bridge and continue to the covered bridge along the north bank (river right). The concrete trail would continue to be available for minimal deliveries, maintenance, and emergency access. Specific access points would be terraced to allow the public access to the water in designated locations. The contractor would install planting pockets at select locations to enhance the riparian habitat. The improvements are designed to increase flood and ice flow conveyance, enhance riparian habitat, and provide a valuable recreational amenity for the public.



### Typical Cross Section Looking Downstream

Golden, B.C.

Figure 7: Typical Cross Section for the North Bank (river right as looking downstream)

## **Possible Future-Phase II Improvements**

Phase II improvements include the addition of a u-structure upstream of the Highway 95 bridge (labeled as Structure #2 on page 2 of the attached design drawings), multiple random boulders, and detached wave stimulators near the upstream end of the project area (labeled as Structure #1 on page 2 of the attached design drawings).

The u-structure in Phase II will be similar in design to Structure #7 in Phase I with riffle, plunge pool, run habitat, and whitewater opportunities. See the Phase I description above for more information.

In addition, random boulder would be placed throughout the reach to provide diversity, habitat areas, eddies for re-circulating boaters, and channel complexity.

The detached wave stimulators are a state-of-the-art design technique employed by REP to create instream habitat and a whitewater amenity. The stimulators include construction of two wings which are not connected in the center portion of the river. The wings are designed to channel flows to the center of the stream and consolidate the flow. Two independent structures, or “plates” are constructed in the middle third of the channel to create whitewater features at low and high flows. Each structure acts as a velocity barrier to slow flow, increase riffle and pool habitat, and create eddies on both sides of the river for fish migration, holding, and feeding. Whitewater play features are created at both high and low flows for recreational value.

## **Fish Passage**

Random boulders, offset deflectors, and detached wave stimulators have been used in multiple projects to create valuable instream amenities while ensuring that portions of the river are

untouched and open for fish passage. Random boulders assist in fish passage by creating velocity barriers and refuge zones. Offset deflectors and detached wave stimulators create deep thalweg pools and runs used by fish for passage. In addition, the eddies created by these features create velocity barriers and refuge zones.

U-structures have been used in multiple stream types and configurations to create recreational features while allowing for fish passage of native species. The structures include roughened boulders on the wings to provide interstitial space and refuge zones for fish negotiating the structure. Grout is not used in these areas to allow for interstitial space and refuge zones to form. These wings are commonly constructed at an approximately 15:1 slope which creates velocities conducive to fish passage for a variety of species.

## **Fish Habitat**

The *Lower Kicking Horse River Fisheries Assessment* completed by Carolla Environmental Consulting in November 2007 provided an “assessment of the lower Kicking Horse River, specifically to address the gaps in information in the DFO submission to remove gravel material from the Lower Kicking Horse River” (See appendix 2). Carolla Environmental also completed the *Overview Fisheries Assessment of the Kicking Horse River through Golden, B.C.* in March 2004 (See Appendix 3). These studies provide additional information about the existing habitat characteristics and spawning areas within the project area. According to Caroline Heim (verbal correspondence 2-10-09), the studies will be helpful during Section 9 permitting but they do not provide a comprehensive analysis and further analysis will be necessary to ensure there is no impact to existing habitat and spawning areas.

## **Recreation and Economic Benefits**

The recreation and economic benefits associated with whitewater and habitat improvements have been well documented. Our success has been closely tied to the success of our parks. REP's parks have had a dramatic effect economically, recreationally, and aesthetically upon the Cities and Towns in which they reside. Our \$170,000 whitewater park in Golden, Colorado has had an estimated 1.7 to 2 million dollar *per year* impact on the local economy. Similar estimates have been made for our parks in Breckenridge and Vail, Colorado. Another project, a two channel whitewater park on the Truckee River at Wingfield Island in Reno, Nevada, has transformed a neglected and denuded section of downtown into a revitalized urban greenway with walking paths, shaded riverside seating, and picnic areas all surrounded by world-class whitewater that has already hosted major national competitions.

## **Similar Projects and Ice Concerns**

Golden experienced a 100-year ice event on January 8, 2005. The event was created from the release of an ice dam in the upper canyon carrying 16-inch ice blocks down the river through Golden. The flows overtopped the adjacent dikes created for flood protection and encroached upon the bordering streets. The event has raised additional concerns about the impact of the structures on ice flow events and the resulting damage to property.

REP has completed multiple projects in waterways that are impacted by icing. All REP structures are designed to withstand the hydraulic forces associated with ice flows while facilitating the transport and movement of debris including ice and woody material. The u-structures, detached wave stimulators and offset deflectors are designed to be self maintaining and clear from obstructions that may cause flooding and safety concerns. These features create

a thalweg pilot channel, and a similar technique that was used during the January 8, 2005 to relieve ice flow pressure (Doyle, 2006).

### **Gunnison, Colorado**

REP designed and performed construction observations for river improvements on the Gunnison River in the City of Gunnison, Colorado. One of the primary concerns with the project was potential ice and debris flows that are common during the winter season. The ice flows have caused significant flooding in the past and significant concern about failure of an upstream bridge. Figure 8 shows the improvements during icing conditions.







**Figure 8: Gunnison Colorado Instream Improvements during icing**

The river maintains a higher velocity, higher turbulence low flow pilot channel that effectively moves ice and debris without buildup. In addition, the wings funnel the low flow to the center of the channel to further facilitate the movement of debris. The project has been operating effectively since 1999.

## **Permitting**

REP conducted a preliminary investigation of the permitting requirements associated with the improvements. The findings suggest that any ‘changes in and about a stream’ are subject to notification under the Water Act Section 9. A copy of the permit application is attached in Appendix 4. Any approval will be in accordance with Part 7 of the Water Regulation and include written authorization after review from agencies that may include:

1. Ecosystem Branch
2. Fisheries and Oceans Canada (DFO)

It is possible that the permit will be approved under Water Act Section 9 without consultation from the aforementioned agencies but it is unlikely at this location because of the presence of Kokanee Salmon.

The Water Act Section 9 permitting process will take a minimum of six months depending on additional requests and studies.

All work must be performed within the allowed “Work Window” which is determined by the Ministry for the Environment (MFE) for the Kootenay Region ([http://www.env.gov.bc.ca/wsd/regions/kor/wateract/terms\\_conditions.html](http://www.env.gov.bc.ca/wsd/regions/kor/wateract/terms_conditions.html)). REP recommends contacting the MFE for additional information.

The MFE has also produced a User’s Guide for ‘changes in and about a stream’ that can be found at [http://www.env.gov.bc.ca/wsd/water\\_rights/cabinet/working\\_around\\_water.pdf](http://www.env.gov.bc.ca/wsd/water_rights/cabinet/working_around_water.pdf).

In addition to the requirements suggested above from the MFE, additional regional and local permits may be required. Based on conversation with the Town staff, a riparian area development permit may be required if the work is not deemed institutional. Town staff will assist the design and permitting consultants to determine the nature of the work and determine if the riparian area development permit is required. If required, this permit should be submitted at the completion of final design.

## **Preliminary Cost Estimate**

The preliminary cost estimate is shown in Appendix 5. The cost estimate includes all mobilization, water control, instream work, bank terracing, and the trail between the Highway 95 Bridge and the covered bridge. Possible future Phase II Improvement items are included on the cost estimate but no associated costs are included.

## **Conclusion**

The Town retained REP to complete a project assessment for the Project in September of 2006. Subsequently, Golden Area Initiatives retained REP to complete Preliminary Design for the Project. This report contains the preliminary design drawings and associated report that complete the deliverables for the project.

The Town endeavors to achieve multiple objectives through implementation of the proposed design. The structures create additional in-stream habitat and fish passage opportunities. Instream structures across North America have provided towns with a number of benefits including new recreational opportunities, economic stimulus, enhanced aquatic habitat, and environmental education opportunities. All REP structures are designed to withstand the hydraulic forces associated with ice

# SECTION 3

## Conclusion and Recommendations

flows while facilitating the transport and movement of debris including ice and woody material.

Based on projected funding opportunities, the project has been split into two phases. Phase I includes improvements from the Highway 95 Bridge downstream to the covered footbridge. Possible Future-Phase II Improvements include improvements from the Highway 95 Bridge upstream.

Phase I improvements include the addition of four offset deflectors downstream of the Highway 95 bridge, a U-structure just upstream of the covered footbridge, and random boulders placed throughout the reach. Phase II improvements include the addition of a u-structure upstream of the Highway 95 Bridge, multiple random boulders, and detached wave stimulators near the upstream end of the project area.

The river right bank will be laid back to provide additional conveyance for flood and ice flow mitigation, in addition to a 10-foot wide concrete trail, boulder seating, access locations, and plaza areas to bring the public to the river.

REP's parks have had a dramatic effect upon the Cities and Towns in which they reside. Parks in Golden, Breckenridge, and Vail, Colorado have each had up to 1.7 to 2 million dollar *per year* impact on the local economy.

## **Recommendations**

1. Retain a recognized fish habitat consultant, such as Carolla Environmental, to provide necessary studies and recommendations to streamline the permitting process and work closely with REP to ensure there is no net negative impact to the habitat. Carolla Environmental has been involved with other projects in the area, has collected data that is directly relevant to this project, and has worked with permitting agencies on other in-

stream projects on the Kicking Horse River. Reporting by the habitat consultant should provide mitigation techniques and recommendations to streamline the permitting process.

2. Create a riparian planting strategy that moves or replaces impacted vegetation, and enhances existing vegetation.
3. Initiate conversations with adjacent landowners on the north bank (river right as looking downstream) regarding the proposed bank layback, trail, and dike configurations.
4. Begin stockpiling 3-foot diameter, and greater, boulders near the project site recognizing the appropriate permitting requirements.
5. Complete hydraulic modeling of the project site to determine impacts to the floodplain and the proposed river right layback.
6. Pursue funding opportunities for later stages of the project including hydraulic analysis, permit completion, final design, and construction.

## Bibliography

Carolla Environmental Consulting. *Lower Kicking Horse River Fisheries Assessment Prepared for the Town of Golden, B.C.* November 2007.

Doyle, P.F. *Predicting Ice Runs on the Kicking Horse River in Golden.* Technical Memo. January 2006.

## SECTION 4

### Bibliography

## **Appendix 1: *Design Drawings***

# SECTION 5

## Appendices

Recreation Engineering and Planning  
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**Appendix 2: *Lower Kicking Horse River Fisheries Assessment* by Carolla  
Environmental**



**Appendix 3: *Overview Fisheries Assessment of the Kicking Horse River through Golden, B.C.* by Carolla Environmental**

## **Appendix 4: Section 9 Permit Application**

# Appendix 5: Cost Estimate