

WATER DEVELOPMENT PLAN & MANAGEMENT PLAN

Introduction

The Kwoiek Creek Hydroelectric Project (the Project) is a 50 MW, run-of-river, “green power” generation project located on the lower reaches of Kwoiek Creek, a tributary to the Fraser River, approximately 14 km south of Lytton, British Columbia. The developer of the project is Kwoiek Creek Resources Limited Partnership (KCRLP), a partnership between the Kanaka Bar Indian Band (KBIB) and Innergex II Inc. (Innergex), a subsidiary of Innergex Renewable Energy Inc. (IRE). KCRLP obtained an Energy Purchase Agreement (EPA) from BC Hydro in August 2006. In March 2009, the Project received an Environmental Assessment (EA) Certificate following the completion of a provincial and federal review led by the BC Environmental Assessment Office (BCEAO). As part of the requirements for the Project, a fish rearing channel is proposed as compensation for harmful alteration, disruption or destruction (HADD) of fish habitat caused by the Project. This Water Development Plan & Management Plan is prepared in support of the attached Water Licence and Land Tenure Applications for a Fish Habitat Compensation Channel (the Channel).

Figure 1 is a map showing the general location of the Channel and the Land Tenure application boundary, which occupies an area of 20.6 ha. Shape files of the Land Tenure application boundary, as well as temporary access roads, are included in the attached cd-rom. The Channel will be located entirely on Crown land and an Integrated Land Management Bureau (ILMB) Land Tenure is required to construct the Channel and associated temporary access roads. The Land Tenure will initially be for a short-term Works Permit under the roadways policy and will eventually transfer into a long-term Licence of Occupation (per email from Matthew Simons, ILMB, dated July 21, 2009).

The Water Licence for the Channel, with the Ministry of Environment – Water Stewardship Division (MOE-WSD), will be for diverting water at a steady flow $0.2 \text{ m}^3/\text{s}$ ($17,280 \text{ m}^3/\text{d}$), for the purpose of creating habitat for fish and wildlife (i.e., Conservation & Land Improvement Use Sector). Figure 2 shows the proposed Channel alignment plan and profile, as well as the general design of typical riffle and pool sections. The Channel diverts water from Kwoiek Creek from a location downstream of the mouth of North Kwoiek Creek, and returns the water to Kwoiek Creek approximately 950 m downstream from the point of diversion.

The Water Development Plan & Management Plan for the Water Licence and Land Tenure Applications includes the Kwoiek Creek Hydroelectric Project Amended Application for an Environmental Assessment Certificate (2008), and the prescriptions identified in the Table of Commitments within the BC Environmental Assessment Certificate, as well as the Construction Environmental Management Plan (CEMP) for the Project.

Design Aspects

Rearing Channel Rationale

The Fisheries and Oceans Canada (DFO) “no net loss” policy requires habitat replacement at a 2:1 ratio to compensate for habitat loss due to a HADD. The HADD related to the Project is due to the loss of approximately $2,711 \text{ m}^2$ of instream habitat in the diversion reach and the permanent loss of approximately $6,200 \text{ m}^2$ of riparian vegetation (refer to the Draft Aquatic Environment Mitigation and Compensation Plan, February 2009, submitted in support of the BC

Environmental Assessment Certificate for the Project). At a compensation ratio of 2:1, the total instream habitat compensation requirement is 5,422 m². In discussions with DFO, a 1:1 replacement ratio will be expected for loss of riparian habitat.

Fish resource values upstream of the diversion reach, between the intake and Kwoiek Lake, are presently much more productive than within the diversion reach, primarily due to reduced stream gradients, reduced water velocities, and improved availability of substrates that are suitable for spawning and rearing. Kwoiek Creek upstream of the Project is also utilized by a substantial bull trout (blue-listed species) population as well as rainbow trout, compared to relatively few numbers of bull trout within the diversion reach.

There is the opportunity to construct rearing and off-channel habitat upstream of the intake and immediately downstream of the confluence with Kwoiek Creek and North Kwoiek Creek. In this area of the watershed, the floodplain is wider than in the diversion reach, the stream gradient is lower and there are no barriers to movement between the intake and Kwoiek Lake. Limitations to productive capacity in Kwoiek Creek include low nutrients, low temperatures, high suspended sediment load due to glacial runoff during the growth season, and poor rearing habitat availability due to high velocity and turbulent flows. Although there is plenty of pool habitat available for overwintering, low flows during winter likely restrict rearing habitat to those pools. Constructing a rearing channel complex within the left floodplain of Kwoiek Creek would benefit a much larger portion of the watershed than placing compensation works within the diversion reach, and would increase the productive capacity for both rainbow trout and bull trout. Due to the high productivity of the compensation habitat relative to the low productivity within the diversion reach, this compensation concept is expected to increase the overall productive capacity of Kwoiek Creek.

Rearing Habitat Characteristics

The rearing channel will provide habitat for juvenile bull trout and rainbow trout on a year-round basis. The channel will contain a variety of habitat features such as boulder/cobble substrates, boulder clusters, tree rootwads to provide instream cover, and low velocity deep pools with large woody cover to provide overwintering habitat. Substrates and flows will be suitable for primary and secondary production of aquatic insects to provide food for juvenile fish. The habitat characteristics for bull trout and rainbow trout rearing taken from Forbs et al. (1995) are presented in Table 1. These rearing habitat characteristics are presented to provide guidance for design and final channel treatments.

Table 1 Bull Trout and Rainbow Trout Rearing Habitat Characteristics

Rearing Habitat Characteristics	Rainbow Trout	Bull Trout
Temperature tolerance range	0 to 18 °C	0 to 24 °C
Optimum temperature for growth	<12 °C	10 to 14 °C
Recommended dissolved oxygen concentration	7.75 mg/L	7.0 mg/L
Habitat type preference	Pools	Stream margins
Depth preference	up to 1.0 m	0.3 to 1.2 m
Current velocity preference	<0.5 m/s	<0.3 m/s
Substrate	Cobble to boulder	Cobble to boulder
Cover	Cobble and fine debris	Deep water, cobble, woody debris
Primary food category	Benthic insects	Benthic invertebrates and terrestrial insect larvae
Secondary food taxa	Drift organisms	Drift organisms

Source: Forbs, B.S., P.S. Higgins, A.F. Lewis, K.L. Cooper, T.A. Watson, C.M. Gee, G.L. Ennis, and R.L. Sweeting. 1995. Literature reviews of the life history, habitat requirements and mitigation/compensation strategies for thirteen sport fish species in the Peace, Liard, and Columbia River drainages of British Columbia. Can. Manuscr. Rep. Fish. Aquat. Sce. 2321:xxiv+342 p.

Proposed Compensation Works

Figure 1 illustrates the location of the proposed rearing channel in relation to the Project and North Kwoiek Creek. Figure 2 illustrates the plan, profile, and typical sections as well as habitat treatment sketches for the rearing channel, as prepared by Focus Environmental Inc. Appendix 1 contains a set of photos of the habitat enhancement works adjacent to the Eve River on Vancouver Island, which were built under the Watershed Restoration Program to provide rearing habitat for steelhead and salmon fry and juvenile life history stages. This enhancement project is similar to the type of habitat envisioned for the Kwoiek rearing channel. Appendix 2 contains a set of photos of fish habitat compensation project experience for Focus Environmental Inc. and Innergex.

The proposed rearing channel is approximately 1,370 m in length with an average wetted width of 4 m, for a total rearing habitat area of approximately 5,500 m². The proposed rearing channel design provides the required compensation area to meet DFO's 2:1 habitat replacement ratio. The channel is designed to create a diversity of habitat types, including riffles and pools, with complexing provided by large woody debris and boulders in order to create varied water depths and hydraulic conditions that are suitable for a range of age classes of bull trout and rainbow trout. Average cross-sectional velocities will generally range between approximately 0.2 m/s for the shallow riffle habitat, 0.1 m/s for the deeper riffle habitat and 0.03 m/s for the deep pool habitat.

A steady flow of 0.2 m³/s (17,280 m³/d) will be diverted from the Kwoiek Creek mainstem into the rearing channel via a cement headworks structure including a combination of a gated intake structure with coarse trashrack and perforated pipe submerged into the substrate of the left bank of Kwoiek Creek. The intake will be located approximately 50 m downstream from the confluence with North Kwoiek Creek. The gated intake will be designed to regulate flow into the rearing channel and provide fish passage into the rearing channel through a trash rack with 0.1 m spacings. The gated headworks will allow for adjustment of the diversion flow and will be closed during winter months due to the potential for freezing, which would result in flows to the channel being cut-off. The submerged perforated pipe will provide a continuous source of water into the channel year round without the risk of freezing. The intake opening will be oriented to prevent large debris from entering and plugging up the intake. In the rearing channel, a large pool will be located approximately 10 m downstream of the intake to act as a sediment trap. Consideration is being given to constructing a series of three such pools to assist in clarifying water for the rearing channel and to provide pool habitat.

The downstream end of the rearing channel will consist of a 100 m long, low gradient (~0.5%) section joining Kwoiek Creek, to provide access for young of year and juvenile fish to enter the channel. The flow through the rearing channel and the design of the channel as it enters Kwoiek Creek will create conditions that will attract fish to the downstream entrance. There will be no barriers to upstream movement in the rearing channel, thus allowing for complete distribution of fish from both upstream and downstream entrance points.

The rearing channel will include a combination of steep (~1.5%) gradients with boulder clusters to provide turbulence and aeration, and low (~0.5%) gradients with suitable substrate to provide rearing and overwintering, as well as pool habitats.

Reservoir Information

No reservoir is required as part of the Fish Habitat Compensation Channel works.

Geotechnical Considerations

The Kwoiek Creek watershed is located within the Cantilever Range of the Southern Coast Mountains, on the eastern edge of the Coast Mountains physiographic region. The higher mountain peaks in the watershed have sharp arête forms as a result of well-developed cirque glaciation, while the lower peaks generally have more subdued and rounded glaciated summits and spur ridges. Valley sides at the Channel area are steep and U-shaped and have been incised by steep tributary creeks to the north, such as the North Kwoiek Creek located upstream of the Channel intake. These creeks generally have well-developed colluvial fans, with gentle slopes where they discharge onto the valley floor adjacent to the Channel.

The Kwoiek Creek valley is considered to be geomorphically active with ongoing slope movements leading to deposition along the lower valley slopes and valley floor. In general, valley slopes within the Kwoiek watershed are subject to rockfall, periodic debris slides or debris flows, occasional small rockslides and local snow avalanches that may material adjacent to and possibly into Kwoiek Creek and locally onto the Kwoiek Creek FSR. Project-related consequences of these hazards are primarily impacts to site access, including periodic maintenance to clean the road and potential safety considerations for workers. Snow avalanche activity may also deliver woody debris and some sediment to the Channel and floodplain of Kwoiek Creek. There is no evidence of major rock slide/avalanche activity in the valley within the Project area.

Stream bank erosion, primarily on the main channel of Kwoiek Creek occurs where stream flows impact the steep banks comprised of unconsolidated sediments, including road fills. Of particular relevance to the Channel design would be potential bank erosion at the Channel intake.

Site investigations to date at the Channel area include a ground reconnaissance and review of aerial photographs. More detailed geotechnical investigations, including test pitting, have been completed further downstream. The closest test pits to the Channel were located about 4 km downstream at the Project intake. Subsurface conditions at the Project intake location generally consisted of cobbles and boulders in a gravel and sand matrix with some roots and organics in TP 07-19 to TP 07-22. In TP 07-23 the subsurface conditions comprised sand with some silt and fine gravel to 2.6 m overlying gravel and cobbles in a sand matrix. Groundwater seepage was encountered from 1 m depth in all test pits put down at the intake location. Standing groundwater was measured at depths between 1.7 m and 3.6 m. Refer to the Kwoiek Creek Hydroelectric Project Amended Application (Focus, 2008) for more details regarding the geotechnical conditions at the Project area.

Development of the proposed Channel will not affect any significant landform or terrain features. Disturbance of surficial materials will be limited to the temporary access road spurs and

excavation along the length of the Channel. Borrow areas, if necessary, have been identified as part of the Project.

Seismic Considerations

A search carried out using the Geological Survey of Canada data base revealed a total of 309 historical seismic events within a 100 km radius from the Project site. Of these events, 5 earthquakes measured between M3.0 and M3.7 in the Richter scale. All remaining earthquakes were of magnitude less than M3.0. The details of a site-specific seismic hazard analysis carried out by the Geological Survey of Canada, Sidney, BC, is provided in the Kwoiek Creek Hydroelectric Project Amended Application (Focus, 2008). The main seismic hazard effect on the Channel includes seismically induced slope instabilities on steep ground along the FSR and above the Channel. Seismic hazard information will be taken into consideration during detailed design of the Project to ensure suitable mitigation measures (if and where required) are incorporated.

Project Related Considerations

No other Project related considerations have been identified.

Land Related Issues

Affected Lands

The Channel, including temporary access roads, will be located entirely on Crown Land. The Land Application area is 20.6 ha. The Land Tenure will initially be for a short-term Works Permit under the roadways policy and will eventually transfer into a long-term Licence of Occupation.

The access to the Channel area during construction will make use of an existing road network. Road access to Kwoiek Creek from Boston Bar is via: existing Ministry of Forest and Range (MOFR) roads (i.e., Road Permits and Forest Service Roads); existing Ministry of Transportation & Infrastructure (MOTI) roads; an existing non-status road between Keefers and Kwoiek Creek (KCRLP has applied for a Crown land tenure over this road); and, roads through private properties currently used by the public (KCRLP is in the process of negotiating access agreements with private land owners). Access from the mouth of Kwoiek Creek to the Channel will be via the existing Kwoiek Creek Forest Service Road (FSR). A Road Use Permit with the MOFR will be obtained for the Kwoiek Creek FSR. Temporary access road spurs will be built from the FSR to the Channel, as shown in Figure 1. Shape files of the temporary access roads are included in the attached cd-rom. These temporary access roads will be restored to their pre-Project condition following the construction of the Channel.

Water Related Issues

Kwoiek Creek is a Fraser River tributary, situated in the southwest portion of the Thompson-Nicola Regional District between the Stein River to the north and the Nahatlatch River to the south. It is a fourth-order stream with a mainstem length of 31.4 km, and drops from an elevation of nearly 3,000 m above sea level (ASL) at its headwaters, to around 100 m ASL at its mouth. Extensive ice fields and small glaciers occupy approximately 9% of the watershed, and feed the headwaters of Kwoiek, North Kwoiek, and Chochiwa creeks. High, consistent flows typically occur during the warmer months of May through August. The low flow period is from

November through March, with the shoulder months of September and October being more dependent on precipitation and temperature. Approximately 1.5% of the watershed is occupied by small lakes.

Water Quantity

A stream gauge was installed upstream of the Project intake between Kwoiek Lake and North Kwoiek Creek, a major tributary to Kwoiek Creek in December 2004 and has operated continuously since that time, providing over 3 years of water level records. The mean, median, and standard deviation of flows at the proposed Project intake location, based on daily and weekly flows are summarized in Table 2. Refer to the Kwoiek Creek Hydroelectric Project Amended Application (Focus, 2008) for a more detailed analysis of flows within Kwoiek Creek.

Table 2 Daily and Weekly Flow Values

Return Period	Upstream of Intake (m ³ /s)
Daily Mean	7.91
Daily Median	4.36
Daily Std. Dev.	7.82
Weekly Mean	7.82
Weekly Median	4.59
Weekly Std. Dev.	7.30

The Channel will divert water from the Kwoiek Creek at a steady flow of 0.2 m³/s (17,280 m³/d), for the purpose of creating habitat for fish and wildlife. This represents approximately 2.5 percent of the daily mean flow.

Water Quality

During construction, there is potential for increases in sediment loading due to land clearing and erosion predominantly from work near the stream bank at the inlet and outlet from the Channel, as well as along the Channel length and due to access road improvements. The potential effects due to sedimentation will be mitigated by implementing sensitive land clearing, site preparation, and erosion control measures during construction, as described in more detail in the CEMP. Where practical, removal of existing trees and disturbance to the existing soil and vegetation cover will be minimized during construction of the Channel and the temporary access roads.

In the event that mineralized rock is encountered during construction, this material will be identified and tested for acid generating potential (acid base accounting). The results of these tests will determine final treatment requirements. The CEMP will provide direction for segregation of waste rock with acid generating potential and treatment options.

Instream Requirements

Some instream work will be required at the Channel inlet, to construct the cement headworks structure, and the Channel outlet. All instream works will follow the Project requirements and instream work timing windows stipulated in the Project's CEMP, which are based on

consultation with the MOE-WSD and DFO. A Draft CEMP was submitted in support of the BC Environmental Assessment Certificate requirements.

Affected Water Users

The following water users have been identified on Kwoiek Creek:

- Kanaka Bar Indian Band, Water Licence No. C102750, issued on March 31, 2004 for domestic and irrigation purposes.
- Kwoiek Creek Resources Limited Partnership, Water Licence No. Z102749, under review, for Power – General purposes (this Water Licence is for the Project).

No significant impacts to other water users from the construction and operation of the Channel are anticipated.

Construction Activities

Construction of the Channel will require:

- maintenance of the FSR road surface, as required, and removal of danger trees and vegetation along the edge of the road right-of-way;
- clearing and grubbing of existing vegetation along the length of the Channel and the temporary access road spurs (a Licence to Cut will be obtained from the MOFR prior to cutting any trees);
- construction of short temporary access road spurs from the FSR to the Channel to allow access during construction;
- restoration of existing drainage and excavation of a trench along the length of the Channel;
- landscaping of the Channel using boulders and large woody debris to create fish habitat (refer to Figure 2); and,
- riparian planting adjacent to the Channel.

The contractor will require the following equipment and labour:

- supervisor;
- grader and operator;
- heavy equipment and operators;
- gravel trucks and drivers;
- fallers;
- tree planters; and,
- general labourers.

Wastes generated during construction will include: rock and soil associated with road construction upgrades and Channel excavation; solids and fluids associated with equipment operation; wood from clearing operations; and, domestic waste and sewage from the construction workers. All solid wastes will be collected on site and recycled or reused where possible in the landscaping of fish habitats within the Channel. Solid waste that cannot be recycled or reused will be disposed of in an approved landfill. Portable toilets will be used during construction and a contractor will be responsible for the removal and disposal of sewage.

Other liquid wastes, such as lubricants for equipment, will be collected and disposed of at an approved facility.

Safety Aspects

Downstream Consequences

There are no significant downstream safety aspects related to the construction and operation of the Channel.

Future Monitoring

The CEMP will incorporate measures related to erosion protection and monitoring of soil erosion and sedimentation into Kwoiek Creek during construction. The OEMP will outline operations monitoring requirements, such as periodic inspection of the channel integrity. No other monitoring activities are proposed for the Channel.

Related Considerations

Archaeological Assessment

An archaeological consultant will be retained to conduct an Archaeological Impact Assessment (AIA) for the Channel area that will identify and describe: (1) the nature, significance, and extent of archaeological resources in potential conflict; (2) definition of the scope and magnitude of impacts; and, (3) provide management recommendations to address identified conflicts in order to minimize or avoid potential adverse impacts to archaeological resources. Any archaeological findings will be treated in a respectful manner and reported to First Nations and the Archaeology Branch. All reasonable efforts will be made to avoid impacting known and unknown archaeological sites. In the event avoidance is not possible, KCRLP will retain a qualified archaeologist and apply for a permit to excavate and recover artifacts at sites that may be impacted by project facilities, in consultation with First Nations.

Prior to construction, KCRLP will develop an Archaeological Monitoring and Management Plan, in consultation with First Nations and the Archaeology Branch of the Ministry of Tourism, Culture and Arts, that will include the following specifications: (1) archaeological monitor(s) will be on-site during the most disruptive periods and will have the authority to suspend construction activities where they are found to be in conflict with a previously unidentified archaeological site; and, (2) mitigation measures will be undertaken in consultation with First Nations and the Archaeology Branch.

Environmental Monitors

KCRLP will retain an independent environmental monitor, to the satisfaction of the Regional Water Manager, who will be responsible for the environmental monitoring and reporting during construction.

Remaining Environmental Considerations

No other environmental considerations have been identified.

Summary and Conclusions

As part of DFO's requirements for the Kwoiek Creek Hydroelectric Project, an approximately 1,370 m long fish rearing channel (the Channel) is proposed as compensation for harmful alteration, disruption or destruction (HADD) of fish habitat caused by the Project. The Channel will have a total rearing habitat area of approximately 5,500 m².

The proposed Channel, including temporary access roads, occupies a land area of 20.6 ha and will be located entirely on Crown land. An ILMB Land Tenure for a short-term Works Permit under the roadways policy will initially be required, which will eventually transfer into a long-term Licence of Occupation.

The Water Licence for the Channel, with the MOE-WSD, will be for diverting water at a steady flow 0.2 m³/s (17,280 m³/d) from Kwoiek Creek, for the purpose of creating habitat for fish and wildlife, which represents approximately 2.5 percent of the daily mean flow in Kwoiek Creek. The Channel outlet discharges into the Kwoiek Creek approximately 950 m downstream from the point of diversion.

No reservoir is required as part of the Channel.

No significant impacts to other water users on Kwoiek Creek resulting from the construction and operation of the Channel are anticipated.

The Water Development Plan & Management Plan for the Water Licence and Land Tenure Applications includes the Kwoiek Creek Hydroelectric Project Amended Application for an Environmental Assessment Certificate (2008), and the prescriptions identified in the Table of Commitments within the BC Environmental Assessment Certificate, as well as the Construction Environmental Management Plan for the Project. The latter documents identify prescriptions for addressing geotechnical considerations, seismic considerations, water quality consideration, instream requirements, archaeological requirements, monitoring requirements and other environmental considerations related to the construction and operation of the Channel.