MCKAYS CREEK HYDRO-ELECTRIC POWER SCHEME ENHANCEMENT

FEASIBILITY AND SCOPING REPORT PREPARED FOR SCHEME RECONSENTING

Table of contents

Executive summary

The existing McKays Creek power scheme is designed and built for a maximum water flow of 5 m^3/s and generates 8GWhr/annum. Hydrology records show that a flow of up to 9 m^3/s is available and could be utilised if the scheme is upgraded to accommodate this flow. The additional investment and higher inflow will enable increased generation capacity to be installed and an additional 6GWhr/annum of electricity, from a renewable and sustainable resource, to be provided to the West Coast.

The proposed enhancements to convey the water and generate the additional electricity are described in this scoping document. All proposed enhancements lie within the footprint of the existing scheme. The key components in the McKays enhancement project include:

a) Increasing the height of the existing weir by 5cm for all but one bay so that environmental flows are able to be better controlled and measured.
b) Installing a v-notch weir below the lower bay so that environmental flows can be manually measured.
c) Undertaking minor repairs, maintenance and local improvement of the existing canal to remove debris and vegetation, smoothing the canal surface, and removing high-spots.
d) Utilising removed gravel to increase low spots on the canal bank by a maximum of 0.5m on the accessway side of the race.
e) Replacing the old inefficient (leaking) timber Coal Creek Flume with a new two or three-pipe bridge.
f) Repairing the concrete wall opposite the Greens Creek inlet where it has been undermined.
g) Repairing, refurbishing, and enlarging the 430m long McKays tunnel. If this cannot be done safely then an 800m open-cut canal will be required around the tunnel hill.
h) Building a new headpond, penstock, and power station immediately adjacent to the existing facilities.
i) Connecting the new station to the existing tailrace.

Items a, b, c, d, and f above are all minor works akin to repairs and maintenance of the existing scheme.

Items e, g, h, and i above involve more work, although they will still be within the footprint of the existing scheme.

1 Enhancement Scope of Work

1.1 Introduction

The McKays Hydro-Electric Scheme was commissioned during 1930 to service the gold mining industry south of Hokitika. With the decline in mining the scheme became an important link in the energy supply to the Hokitika township.

The scheme continues to play an important role in maintaining voltage levels to outlying areas and producing energy for domestic and industrial customers by injecting electricity into the local 11kV network.

The existing scheme has an installed capacity of 1.2MW and is built for a consented water take of 5m^3/s from McKays weir. The generation flow increases up to 6 m^3/s with the capture of local tributary flow including Greens creek.

The Kaniere River flow is regulated at the lake outlet. Hydrology analysis shows that a release of over 8m^3/s is available for generation for a significant period of time each year.

TrustPower Limited (TrustPower) proposes to enhance the existing McKays scheme to increase generating capacity of the scheme by utilising the available water at McKays weir up to a proposed consented take of 8 m^3/s. Hence the race needs to be upgraded to convey 8 m^3/s of water up to Greens Creek and 9 m^3/s from there to the power station. These proposed upgrades are described in this scoping document.

A schematic of the scheme, showing the main components, is provided in Appendix A and is further described in the following sections of this report:

Section 2	McKays weir and intake;
Section 3	McKays race enhancement, flumes, tunnel, and associated works;
Section 4	McKays headpond and tailrace;
Section 5	Power station including penstock intake and penstock;
Section 6	How this report is intended to be applied; and
Section 7	Appendices with a schematic of the McKays conveyance system and drawings illustrating the proposed enhancements.

The final scheme details will be influenced by the detailed design for the upgrade, and in particular on the extent to which the tunnel needs to be refurbished/replaced, and the most efficient configuration for the station.

2 McKays Intake Modifications

2.1 Existing weir and intake

The existing McKays weir is a 36m wide broad crested weir across the Kaniere River. A minimum flow slot is provided in the weir near the true left bank and this is rated to provide at least 250 l/s flow.

When the weir is overtopped water spills across the full weir width as shown in Figure 2.1 below. Accurate flow monitoring is not possible at higher flows due to the broad crest of the weir.

The existing intake has two gates, which can pass 5 m^3/s when about 40% open.

FIGURE 2.1 MCKAYS INTAKE WEIR

2.2 Modifications required

The existing weir and intake are able to pass the proposed 8 m^3/s design flow with minor or no modification. The two intake gates have adequate capacity to pass the additional flow by opening further.

The existing minimum flow slot is designed and rated to pass 250 l/s at low weir levels and at higher levels can pass more than this. However, no provision is currently available to facilitate flow measurement. This would become important if the minimum flow slot were to become blocked and water overtopping the weir was needed to maintain minimum flows.

It is noted that there are no records of the slot blocking since its installation. However, blockage in the future cannot be discounted and the ability to manually measure flows downstream would be advantageous.

To enable the flow downstream of the weir to be measured, and to concentrate flow so it can be measured, a minor weir modification is recommended. If the weir timbers need replacing then the weir and spilling basin top can be increased by 5cm across 33m of the 36m of the weir. The remaining 3.1m wide bay, where the minimum flow slot is located, will remain at the same height as shown in the Drawing MKY-1B-0001 provided in Appendix A.

If the weir timbers do not need replacing the 3m section could have its height reduced by 5cm as an alternative.

The flow downstream of the minimum flow slot can then be concentrated on the apron and measured at a rated v-notch weir when required.

3 McKays Race enhancement and associated works

3.1 Intake to Coal Creek Flume

3.1.1 Existing Race

The existing race, from the intake to Coal Creek flume, is constructed from natural cut to fill material. The race has an average gradient of 1 in 1200 and width of about 4m. The depth varies from 2m to 4m as shown in Figure 3.1.1 below.

FIGURE 3.1.1 [MCKAYS INTAKE TO COAL CREEK FLUME]

3.1.2 Modification to Existing Race

No structural modification is required for this race to pass the proposed 8 m^3/s flow provided the existing invert and sides are cleaned and smoothened.

3.2 Coal Creek Flume

3.2.1 Existing Flume

The Coal Creek Flume is constructed from timber and in need of significant repair and maintenance. It operates at full capacity to pass 5 m^3/s and, as shown in Figure 3.2.1 below, leaks

extensively where it crosses Coal Creek. It also provides a spill point for excess flow and regulates flow downstream in the canal.

FIGURE 3.2.1 [COAL CREEK FLUME]

3.2.2 Replacement or Modification of Existing Flume

The existing flume is not adequately sized to pass the proposed 8 m^3/s flow. If it were to be utilised the cross-section would need to be increased by approximately 60% to safely pass this flow. This increase in flow capacity is likely to overstress the existing flume supports and foundations and hence modification of the existing structure is not recommended.

Instead, it is recommended that the existing flume be replaced by a new structure that is capable of passing 8 m^3/s. TrustPower has recently (2008) replaced another timber flume in the McKays scheme with two 1.3 m diameter pipes working as a siphon.

It is proposed that a new pipe bridge across Coal Creek be constructed at the same location of, or immediately adjacent to, the existing timber flume. The pipe bridge will be constructed from two or three 1.3m diameter pipes in parallel. Detailed design will determine whether two or three pipes are utilised and whether the flumes' existing concrete foundations can be reused for the pipe bridge.

A spill facility will be retained at Coal Creek by providing an overflow at either the inlet or outlet to the new pipes.

3.3 Water Race from Coal Creek to McKays Tunnel

3.3.1 Existing Race

The existing water race crosses beneath Kaniere Road, as shown in Figure 3.3.1, about 80m downstream from Coal Creek. The concrete culvert and bridge have well over 1m freeboard under existing flow conditions.

FIGURE 3.3.1 [MCKAYS WATER RACE AT KANIERE ROAD]

The water race up to Greens Creek, including the culvert and siphon, are adequately sized for 8 m^3/s flow providing the modifications recommended below are completed.

Greens Creek, and other tributaries, add another 1 cumec to the flow in McKays Race. Hence the race downstream of Greens Creek needs to be sized to accommodate a flow of 9 m^3/s.

3.3.2 Modification to Existing Race

The culvert beneath the main road is adequately sized for the increased flow, provided the downstream restrictions (shallow portions with loose infill) are removed and the water can flow freely. An emergency overflow is currently located at Coal Creek to ensure the design levels in the culvert are not exceeded.

The enhanced scheme will replace the Coal Creek Flume with a piped crossing, which will incorporate a similar overflow structure to control race water levels in case there is a blockage downstream.

The existing race generally has adequate capacity for the increased flow providing the race invert and sides are cleaned and hydraulically smoothened. A maximum of 300mm is to be removed

from the race invert at high spots and the excavated material is to be placed on the access road embankment beside the canal. This will remove the downstream restrictions and permit free flow of the water from Coal Creek and the culvert to the siphon. If necessary the invert and sides of the canal will be hydraulically smoothened, adjacent to the culvert, by shotcrete or other suitable method.

The canal bank opposite Greens Creek junction has a concrete wall that provides erosion protection and an overflow path above it as shown on the right hand side of Figure 3.3.2 below. This wall is undermined in some places. It needs to be repaired by sequentially removing segments of the material beneath the wall and pouring a new concrete footing. The overflow channel above this should be raised to the new design level.

The race downstream from Greens creek junction, shown dewatered in the photograph below, will be smoothened and locally deepened up to 0.5m to accommodate the increased flow.

FIGURE 3.3.2 [CANAL BANK OPPOSITE GREENS CREEK JUNCTION]

3.4 McKays tunnel

3.4.1 Existing Tunnel

The existing tunnel is approximately 430m long, 2m high, and 1.8m wide. The tunnel is around 80 years old and requires regular maintenance and repair. The tunnel is supported by timber and steel sets with timber invert struts. A narrow gauge railway line runs through the tunnel to facilitate material handling. A significant refurbishment is required in the near future to ensure the structural integrity of the tunnel.

A detailed investigation of the tunnel is needed before TrustPower can confirm whether the it can be safely refurbished. If it cannot be done safely then the tunnel may need to be abandoned and an

alternative developed. Both options are considered below and the best one will be selected after detailed investigations are competed.

3.4.2 Options for refurbishment

The existing tunnel does not have adequate capacity to pass 9 m^3/s. A number of options to provide the additional capacity have been investigated. The preferred options are:

i. The tunnel be completely refurbished with an increased diameter that can pass 9 m^3/s (option A on drawing 08MKY/KWU-150 (0)).

ii. a new canal, of adequate flow capacity, is excavated around the hillside , by-passing the existing tunnel (Options C or D on Drawing 08MKY/KWU-150 (0))

If the existing tunnel can be safely refurbished it is the preferred option. The new canal section is dependent upon identifying suitable fill locations with the landowner. Hence both options need to be considered and optimum one will be selected once detailed design and safety assessments are completed.

Option B – daylighting the existing tunnel – is not considered further as the tunnel passes through a hill about 50m above the tunnel soffit. Additionally this hill is covered in primary forest that the environmental assessment indicates is of significant value.

Each of the preferred options are further described below.

3.4.3 Modification to Existing Tunnel

The existing tunnel does not have sufficient capacity to pass 9 m^3/s. Accordingly, it is proposed that the tunnel be completely refurbished with an increased diameter that can pass 9 m^3/.

The existing tunnel is nearing the end of its design life. Material handling and safety considerations indicate that an internal diameter of about 2.8m is likely to be necessary for the enlarged and refurbished tunnel. This will provide more than adequate capacity for the 9 m^3/s flow. It is estimated that approximately 1,800 cubic metres of spoil will be removed during the tunnel refurbishment and widening. This material will primarily be used by placing it on the canal embankments to remove the low spots in the downstream race and to provide earthworks material to the headpond area. Any material not suitable for earthworks will be disposed of at a location agreed with the local farmer who owns the land adjacent to the upstream tunnel portal.

3.4.4 Install approx 850m canal section to by-pass tunnel

Two viable routes have been identified where a new canal/race can be built to by-pass the tunnel. This will permit the existing tunnel and about 500m of the race upstream from it to be decommissioned when the new section is operational.

The new canal section deviates from the existing race as shown in Drawing 08MKY/KWU-150 (0). It will be excavated along most of its 850m length. The tunnel and race replaced by the new canal is a similar length to the new section.

The maximum cut depth is around 35m and geotechnical investigations will be performed during detailed design to confirm construction difficulty and determine safe side slopes on the excavation. Based on a preliminary assessment, that 45degree slopes are stable in this area, an estimated 550,000 cubic metres of earthworks will need to be removed to create the new canal.

Existing topsoil would be stockpiled prior to any filling. Subject to landowner agreement the excavated material will be placed on low-lying paddocks in Kaniere Farms, adjacent to Option C & D routes, and also used to back fill the existing race. The fill areas will be reinstated with topsoil,

grassed and fenced. Adequate drainage and cross slope will be provided for stormwater and silt control measures included if this option is selected.

3.5 McKays Tunnel to Headpond

3.5.1 Existing Water Race

The existing race, from the tunnel exit to the headpond , is constructed from natural cut to fill material. The race has an average gradient of 1 in 2000 and width of 4m. The depth varies from 2m to 4m as shown in Figure 3.5.1 below.

FIGURE 3.5.1 [MCKAYS WATER RACE FROM TUNNEL TO HEADPOND]

3.5.2 Modification to Existing Race

The existing race is almost large enough for the proposed 9 m^3/s flow. Its capacity will be enhanced by removal of vegetation and gravel/stones from the race. Locally it may be widened by up to 2m and the access road embankment height increased by up to 0.8m.

Widening will primarily occur on the cut side of the race. The cut material will be sorted and suitable inorganic material will then be placed on the access road (fill side of the canal) once vegetation has been removed. The access road will be resurfaced and batter slopes planted to control stormwater run-off. This work will provide adequate freeboard to the race when flowing at 9 m^3/s.

4 McKays Headpond and Tailrace

4.1 Storage headpond

The existing scheme does not have a headpond. Instead the race transitions to a concrete lined section of the race as it leads up to the intake gates. The race upstream of the existing gates have an operating range of just 100mm and outflows to the penstocks are controlled by two hydraulically actuated gates at the intake structure. A view of the existing race from the forebay screens looking back upstream is provided in Figure 4.1.1 below. Structures to provide spill and sluicing capability are shown on the right hand side of the photograph.

FIGURE 4.1.1 [PROPOSED HEADPOND (LEFT HAND SIDE OF PHOTO) AND EXISTING RACE]

The headpond will need to be extended to provide buffer storage and the intake to a new penstock and station.

The existing power station discharge is returned back to the Kaniere River via a long (750m) tailrace that provides flow regulation before the flow rejoins the Kaniere River. The arrangement is depicted in Drawings 08MKY/KWU-124 to 126 (rev 1) in Appendix A.

The length of the tailrace provides good flow attenuation for ramp-up and ramp-down flows.

4.2 Headpond modification for scheme enhancement

A new headpond will be formed by engineered cut to fill earthworks and will lead to the new intake and penstock created adjacent to the existing race. It will have a depth of about 2.5m and a storage capacity of about 7,600m^3. TrustPower owns the low-lying marshy land adjacent to the forebay (on

the left-hand side of Figure 4.1.1) and the headpond will be sited on this land. The spill and sediment removal facility will be retained or new facilities provided in a similar location to suit the new configuration.

4.3 Tailrace modification for scheme enhancement

The additional flow from the proposed enhancement will be routed through the existing tailrace adjacent to McKay's station. The outlet structure will be modified, or an additional outlet to the tailrace provided adjacent to the existing station. Additional scour protection will be provided as necessary. Other than maintenance work no tailrace modification is envisaged to be necessary as the existing tailrace is robust in size and over 700m long.

5 Power station and associated structures

5.1 General

The existing McKays power station includes the following components:

- penstock intake from headpond with associated screens, gates, and stoplogs:
- penstock (pipe) running underground from the intake to the powerhouse;
- powerhouse housing the turbine, generator, draft tube, and associated electrical/mechanical controls;
- transformers and switchyards; and
- tailbay area and entrance to tailrace.

It is envisaged that the existing station and penstock will remain and a new penstock and power station extension, immediately adjacent to the existing infrastructure, will convey and generate electricity from the additional flow. This will enable the existing facilities to continue generating while the new plant and equipment are installed. The enhancements required for the increased flow and generation capacity will be confirmed during detailed design.

A 'shut-down' will be planned for the final tie-in and commissioning of the new penstock and power station. The conceptual scope of the work for the enhanced scheme penstock and power station is described below.

5.2 New Penstock(s) and intake

Single or double pipe penstocks will be installed from the new headpond to the power station. The penstock intake will incorporate the following features:

- reinforced concrete structure at base of embankment founded directly onto natural ground;
- upstream coarse screens with screen cleaner;
- stoplog slot and stoplogs;
- intake gate(s); and
- transition to circular type penstock.

The relatively short length and steep gradient of the penstock favours steel as the likely fabrication material, although alternatives may be considered in detailed design.

Initially one penstock will be installed as the existing penstock will still be operational. However provision will be made for an additional penstock in the new location so that it can be installed when the existing penstock reaches the end of its design life.

The slope from the headpond to the powerhouse is steep (approximately 35 degrees) and the penstock will be provided with anchor blocks and supports founded upon competent natural ground. Vegetation will need to be cleared from the slope prior to penstock installation and erosion protection measures employed to minimise run-off prior to works commencing. Exposed slopes will be re-vegetated with low vegetation to control erosion over the longer term. Particular attention will need to be paid to the interface of fill and concrete components, with careful compaction of fill adjacent to concrete features.

5.3 Power station and ancillary equipment

It is likely that the existing powerhouse and generation equipment will be retained while it remains in good condition. Ultimately it is likely to be replaced by a new machine.

The new penstock(s) and forebay will be installed to accommodate the final configuration selected – one or two machines. The powerhouse is essentially a concrete enclosure of the turbine and generator. The new powerhouse extension will be similar or smaller than the existing McKays station and may be designed to accommodate a second new unit at a later date. The new station will be constructed adjacent to the existing powerhouse and construction would begin with erosion control works and then stripping the area of vegetation, topsoil, and other organic material followed by bulk excavation to foundation levels.

Foundations and walls would be constructed prior to installation of the inlet to the turbine and generating plant. A gantry crane would be installed as early as possible to provide adequate lifting capability.

The penstock intake and penstock would be constructed in parallel, where possible, with the powerhouse.

As the powerhouse structure, penstock, and penstock intake near completion, the turbine and generator would be installed in the powerhouse, together with ancillary equipment.

6 Applicability

This report has been prepared by TrustPower Ltd to describe the proposed McKays Hydro-electric scheme enhancement based on a preliminary design. This design is adequate to describe the key building blocks for the scheme enhancement necessary to support consent applications. The design will be further developed during detailed design.

7 Appendices

The following documents are appended to this report to provide additional information on the proposed scheme enhancement.

A McKays Creek Power Station Diagrammatic Layout Drawing No. MKY-1B-0001

APPENDIX A DRAWING MKY-1B-0001

The existing McKays Creek Schematic.