KANIERE HYDRO-ELECTRIC POWER SCHEME

WARDS ROAD ENHANCEMENT

FEASIBILITY AND SCOPING REPORT FOR SCHEME RECONSENTING

Table of contents

Executive summary

The main source of water for both Kaniere Forks and McKays Creek power schemes is Lake Kaniere, with flows being augmented from local tributary pick-up. Flow out of Lake Kaniere is controlled by a gate to the Kaniere Forks race, and by another two gates that manage the water released to the Kaniere River and that is later available to McKays Creek power station.

The Kaniere race is approximately 9 km long, and the race and associated power station in 2009 marked a centenary of operation. The race has a consented take of 1.0 m^3/s, and the power station generates a maximum of 0.43 MW, and on average produces 3.5 GWh annually. The Kaniere race has several overflow features to limit race flows to the consented 1 m3/s.

The existing discharge from the Kaniere Forks station - approximately 7 km from Lake Kaniere - is below the intake for the McKays Creek power scheme. Hence the water currently used in Kaniere Forks station is lost from generation in McKay's scheme.

Hydrology records show that an average flow of about 7 m^3/s is available, and could be utilised, if the Kaniere race and scheme is upgraded to accommodate this flow. The enhancement involves increasing the consented Kaniere Forks race capacity from 1 m^3/s to 8 m^3/s and installing a new station upstream of McKay's weir, near Wards Road, so that the water can be utilised in both schemes.

The enhancements needed to convey the water and generate the additional electricity for will require the following work to be completed:

a) Modifying the existing intake so that the three existing gates send water to the new Kaniere-Wards road race.
b) Installation of a residual flow bypass to ensure residual flow is maintained.
c) Installing a new tunnel and culvert, sized for a flow of 8 m^3/s, under Kaniere road and extending to the start of the Kaniere Race.
d) Replacing the existing 1 m^3/s race with a new 8 m^3/s race following essentially the alignment shown on the attached drawings.
e) Building a new penstock, power station and tailrace immediately downstream of Wards Road.

The enhancement scope is described in this report and the attached drawings.

1 Enhancement scope of work

1.1 Introduction

The Kaniere Lake Water Race was constructed in 1874 from Lake Kaniere to the Hokitika area. The race originally had many side branches to supply water to the miners. In 1907 the branch from Lake Kaniere to Kaniere Forks Power station, including over 4.5km of tunnels, was installed.

The original Kaniere Forks Power station began generating power on 8th September 1909 and currently generates around 3.5GWhr/annum. Much of the existing scheme is very old and in need of continuous maintenance.

Kaniere river flow is regulated at the lake outlet under the existing consent. Hydrology analysis show that an 8m^3/s water release is available for generation for a significant period of time each year; with a mean flow of around 7m^3/s. Currently just 1 m^3/s is diverted down the Kaniere Race for generation at Kaniere Forks power station. The balance of flow passes down the Kaniere river until it reaches McKays Creek Weir, where the consented take of 5 m^3/s is diverted to McKays Creek Power Station. The remaining flow is spilt at McKays weir and lost from generation. The water used in Kaniere Forks station cannot be used for further generation in the McKays scheme as it re-enters the river downstream of the intake weir.

The enhancement is to increase water utilisation of the combined Kaniere/McKays scheme by increasing the size of the Kaniere Race to 8 m^3/s capacity, as far as Wards Road, about 3km down from the lake. A new hydro-electric power station will be installed adjacent to Wards Road and the water used to generate about 10 GWhr/annum of electricity. The water from this station can then be captured at McKays weir enabling an additional 6 GWhr of generation from an enhanced McKays scheme.

In total an additional 16 GWhr/annum of renewable electricity can be generated from the same water being discharged from Lake Kaniere – 10 GWhr/annum is from the Kaniere Enhancement and 6 GWhr is from the McKays enhancement. If the existing Kaniere Forks scheme is decommissioned (-3.5GWhr/annum) then the net additional electricity generation, from the enhanced Kaniere and McKays schemes, is 12.5 GWhr/annum.

A description of the existing scheme and modifications needed for the Kaniere enhancement are presented in the following sections of this report.

Section 2	Kaniere Lake weir and intake
Section 3	Water race from Lake Kaniere to penstock near Wards Road
Section 4	Power station including penstock intake and penstock
Section 5	Tailrace to river
Section 6	Presents how this report is intended to be applied.
Section 7	Contains appendices with drawings illustrating the existing scheme and proposed enhancements.

Chainage distances in this document relate to the original race starting at chainage 000m. The existing race chainage is identical to the new race chainage up to 480m. From there on the chainage marks in the drawings (Appendix A) are for the new route, which is about 400m shorter than the existing race up to Wards Road. Table references to the old race are still in the old race chainage, as some sections of this are not on the new route.

The final scheme details will be influenced by the detailed design for the upgrade, and in particular on the race position within the designated corridor plus penstock location. The enhancements

required for McKays scheme are addressed in the feasibility and scoping report for McKays Creek hydro-electric power scheme enhancement".

1.2 Scheme operating philosophy

The scheme flow regime and operating philosophy is addressed in the report "Kaniere Forks & McKays creek Power Stations Re-consenting: Hydrological Study", L Palmer 2010. The new race is sized to cater for a maximum design flow of 8 m^3/s and overflow structures will be provided along its length to ensure this flow is not exceeded.

2 Kaniere Lake weir and intake

2.1 Existing weir and intake

The Lake Kaniere spill weir, shown in Figure 2.1.2, has a rounded concrete crest 26.5m in length and an 11m section made up of stop logs. The top of the weir is relatively uneven but functional. The intake channel and gates are located just past the posts seen below.

FIGURE 2.1.1 [LAKE KANIERE SPILL WEIR WITH STOP-LOGS]

The lake level is normally lower over the winter months, which coincides with the low inflows and higher managed flow release for generation. The maximum level recorded (local datum) is 1.71m in January 2002and the lowest level of -0.13m was measured on 30 April to 1 May 2003. The top of the concrete weir seen in the picture above is about 1.01m local datum or 133.1m (Lyttelton 1937 Datum).

Outflows from the lake are controlled by three gates to the true right of the Lake Kaniere spill weir. Two of these gates currently control the Kaniere River flow down to McKay's intake. The other gate controls the flow into the Kaniere Race. Figure 2.1.2 shows the general arrangement of these gates.

FIGURE 2.1.2 [CONTROL GATES TO KANIERE RIVER/MCKAYS CREEK (CENTRE) AND TO THE KANIERE FORKS RACE (RIGHT)]

2.2 Modifications required

The enhancements will require modification of the gate configuration shown in Figure 2.1.2. Two gates, the same size as the existing gates, are needed to divert the 8 m^3/s to the enhanced Kaniere Race. The residual flow to the Kaniere River can be passed by either another gate or an engineered bypass.

The gate configuration and junction with the tunnel on the opposite side of Kaniere road will be determined during detailed design. However it is envisaged that the work will be carried out within a corridor about 10m either side of the existing gates and downstream channel. The existing Armco culvert under Kaniere road will be replaced by a larger one that joins into the tunnel opposite the intake gates. A fish screen will be provided at the intake to stop fish entering the conveyance system.

The existing Lake Kaniere spill weir, although functional, should be repaired where necessary and the top levelled to 133.1m (Lyttleton datum).

The lake junction with the existing channel, upstream of the gates, will need maintenance dredging with an excavator to remove the bank of sediment built-up between the lake and the channel.

3 Kaniere Race enhancement and associated works

3.1 Enhancement Modifications - intake to chainage 530

3.1.1 Existing water race (race)

The existing conveyance system extends 60m underground, through a culvert and tunnel, from the intake to the race start chainage 000m. From the start of the open race to approx chainage 530m it follows contours along the true right bank of the Kaniere river. The bank of the river is quite steep (up to 45 degrees) for some of the first 530m and the race and access is formed by typically cutting the race 2m into the uphill portion and filling onto the river side for the access track. Existing cut slopes, up to 6m high in places, appear stable at a 2V:1H slope.

Parts of the track, near chainage 300m, are on level ground further from the river. Figure 3.1.1 shows a typical section of the track looking upstream towards Lake Kaniere.

FIGURE 3.1.1 [TYPICAL EXISTING TRACK NEAR CHAINAGE 230M]

The existing clearing for the track is between 6m and 10m over this length, although the cut and fill slopes have 80 year old regenerated growth in places leaving a race/access width of about 5m.

The key components of the existing race, along this section, are summarised in Table 3.1.1.

TABLE 3.1.1 [KEY COMPONENTS OF THE EXISTING RACE FROM LAKE KANIERE TO CHAINAGE 530m]

Start	End	Length	Description
0	20	20	Armco culvert
20	89	69	No.1 Tunnel with manhole. Boxed and Earth
0	111	111	Boxed race flume - silver and red pine
111	172	61	Open cut race
172	282	110	No.1 Boxed Flume
282	600	318	Open cut race
600	616	16	No.2 boxed flume (Hatchery Flume)

3.1.2 Modification required

A new race/channel, sized to convey 8m^3/s, will be constructed along the same alignment as the existing 1m^3/s race and access track. The alignment is constrained by the river on the true left and steep bush-clad hill on the true right. The structures listed in Table 3.1.1 will be replaced by the new race/channel.

This 530m length of the water race represents the most difficult part of the enhancement as the construction corridor is constrained in location and needs to be as narrow as practicable. A very tight 15m race/access construction corridor is nominated throughout most of this section. The first 70m of the existing culvert and tunnel will be replaced, by cut and cover, with structures of increased capacity. The new culvert and tunnel will be backfill and reinstated to minimise the impact on this area. The accessway will be above the new structures in a 10m wide construction corridor. Temporary road diversions will be needed when the culvert is replaced.

The new race will typically have a bottom width of 4m and gradient of 1 in 1000. Water depth will be about 1.5m and 0.5m to 1m of freeboard will be provided. Three or four emergency spillways will be provided along the 2.9km race length and one of these is likely to be located around Chainage 250m.

The existing race crosses three or four small streams which are not captured but typically flumed over or conveyed under the race by culverts. The new race will apply the same philosophy to stream capture – the existing streams conveyed under/over the race will not be captured.

Drawing No. 10KNF/RUG-110 shows the existing and proposed race along this length plus typical cross-sections. The new race has a top width about 7m, and a 3m wide access track will be provided between the race and the river. This access track will have a gravel surface and be designed for multiple use (water race maintenance, pedestrian and mountain bike recreational use). The overall race construction width varies along its length as the cross-slope changes.

Wherever practicable the earthworks will extend away from the river and into the hillside. This will be done to minimise potential river-bank instability, ensure run-off from the site into the river is minimised, and maintain the vegetation between the track and the river wherever possible.

3.2 New Race Chainage 480m to 1100m

3.2.1 Existing race

The existing race alignment is crossed twice by 11kV transmission lines at approximate chainage 480m and 560m. The race is briefly underground as it crosses a high spot before resurfacing after

chainage 600m. Figure 3.3.1 shows a typical view of the water race looking upstream from chainage 530m.

FIGURE 3.3.1 [EXISTING RACE LOOKING UPSTREAM FROM APPROX CH 530]

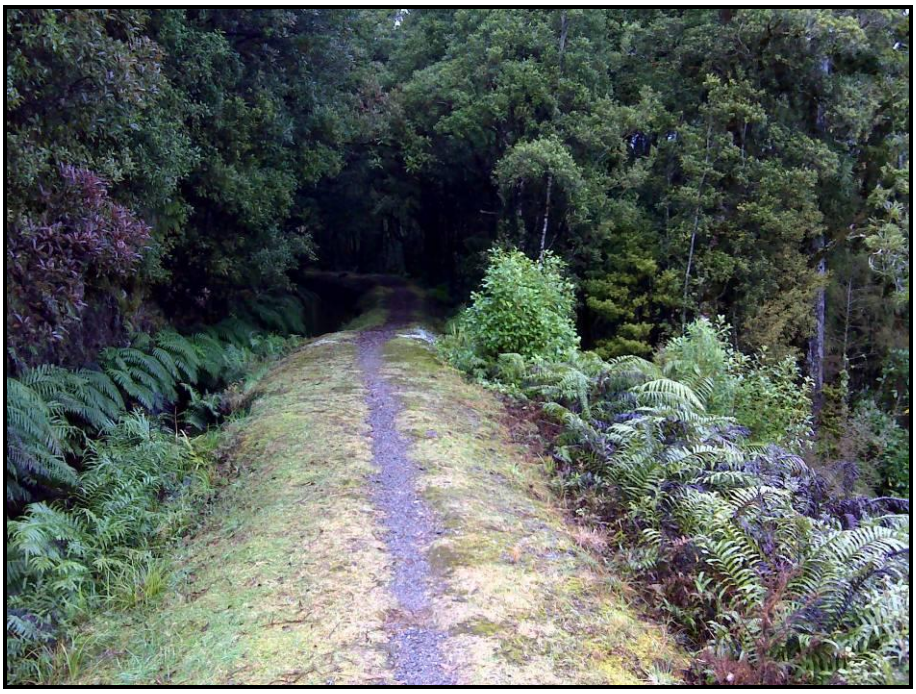


Table 3.1 lists the key components of the existing race in this area. There is one short section of tunnel (No. 2 tunnel) that has up to 8m overburden on top of it.

TABLE 3.3.1 [KEY COMPONENTS OF THE EXISTING RACE FROM EXISTING RACE CHAINAGE 600 TO CHAINAGE 1226]

Start	End	Length	Description
600	616	16	No.2 boxed flume (Hatchery Flume)
616	638	22	Open cut race
638	679	41	No.2 tunnel
679	761	82	Timbered open race
761	1226	465	Open cut race

The 11kV transmission lines traverse parallel to the race, but are often on slightly higher ground. Vegetation has been cut right back along a 25m wide width (12.5m either side of the pylons) for the full length of the pylons.

Figure 3.3.2 shows the view up the hill towards the power pylons near chainage 600.

FIGURE 3.3.2 [VIEW FROM EXISTING RACE TOWARDS CHAINAGE 600M WHERE 11KV TRANSMISSION LINES CROSS]

3.2.2 Modifications Required

It was originally proposed that the larger 8 m^3/s water race and accessway would replace the existing structures along the same alignment. The existing race traverses relatively flat land with low-lying secondary growth while following the most viable route. It also minimises the earthworks volume and impact compared to following the transmission lines.

However, after discussion with the terrestrial ecologist, the proposed route is now located along the existing 25m wide 11kV transmission line. This corridor has already been cleared and the new race will be installed within this 25m width. The existing race, which is up to 6m deep in places, would be a safety hazard if left exposed. It will be backfilled to original ground level and natural growth allowed to regenerate.

The water race and accessway dimensions are as described in Section 3.2, but a wider construction corridor is required as the route is less constrained. The new race will be up to 8m deep in places and the additional width will be needed to accommodate cut slope batters.

From chainage 900 to 1030 the race will follow the old race alignment. A small stream will be conveyed under the race by culverts to maintain existing waterways. The race will be locally

widened up to 30m at this area, in a low-lying area, to provide buffer storage, and an emergency spillway provided into the existing stream.

3.3 New Race Chainage 1030 to 1990

3.3.1 Existing race

From existing race chainage 1230m to 1990m the existing race follows contours around three low spurs. The 11kV transmission line, with 25m wide clearing, takes a more direct route from chainage 1230 and rejoins the race at chainage 1990 as shown on drawing 10KNF/RUG-114 in Appendix A. The ground height at each 11kV pylon has been taken and the maximum is 133.9 – about 4m above the existing race elevation.

Table 3.4.1 lists the key components of the existing race in this area.

TABLE 3.4.1 [KEY COMPONENTS OF THE EXISTING RACE FROM CHAINAGE 1226 TO CHAINAGE 2077]

Start	End	Length	Description
1226	1301	75	No.3 Flume (long flume)
1301	1585	284	Open cut race - some timber
1585	2077	492	Open cut race with some timber, No.1 and No.2 spill plus flume over race

3.3.2 Modification to existing race

It is proposed that the existing race be left intact along this area. It is generally less than 2m deep and significant parts of it are timber lined. The access path along the race will be retained so that recreational users can walk or cycle the old race.

A new section of race and access track, constructed for a water flow of 8 m^3/s, will follow the cleared 11kV transmission corridor.

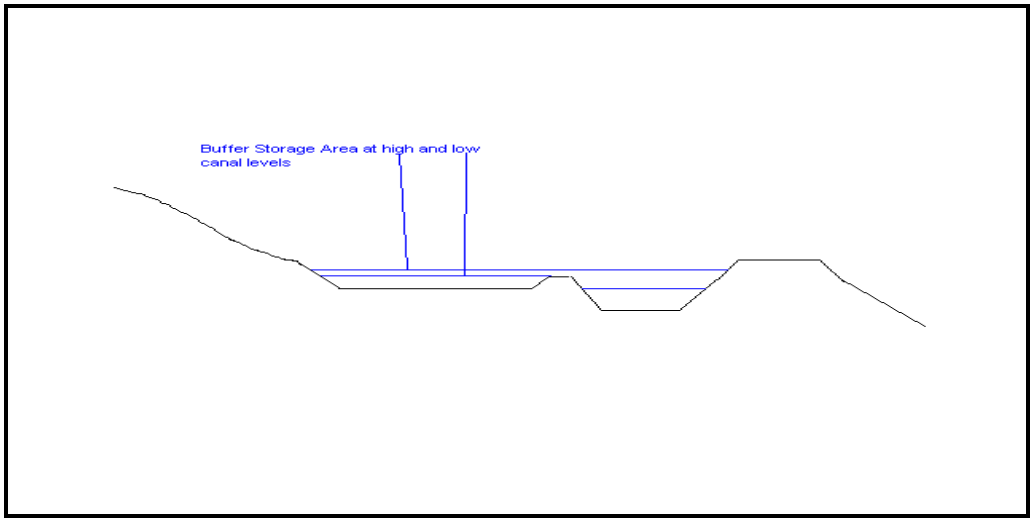
3.3.3 Installation of new race

A new 4 to 5m wide race formed in the existing 11kV cleared corridor between Chainage 1230 and 1990. Figure 3.4.1 shows the view of the corridor that the new race section will follow. The race invert varies between 1 and 4.5m below the existing ground level so will be mostly in cut. Excavated material will be used to form the access alongside the race and any excess will be spread at disposal areas within the construction corridor, Wards Road temporary works area, and approved off-site disposal areas. A typical cross section of the existing and new race is shown in Section B on Drawing No. 10KNF/FUG-11 (located in Appendix A of this document).

FIGURE 3.4.1 [VIEW OF 11KV TRANSMISSION CORRIDOR FROM CHAINAGE 1850 BACK TOWARDS CHAINAGE 1230]

At chainage 1600 the race may be widened over the low-lying area and excess fill used to provide a buffer storage area. This area will be designed so that the earthworks avoid the large Rimu trees on the true left. These buffer storage areas enable flows and levels to be regulated during start-up and shut-down of generation. They can be configured to provide still water at lower race levels if this is desired from an ecological perspective as shown schematically below in Figure 3.4.2.

FIGURE 3.4.2 [BUFFER STORAGE SCHEMATIC THAT ALSO PROVIDES STILL WATER AT LOW RACE LEVELS]



3.4 Existing Race Chainage 1990 (new race chainage 1600) to Wards Road and penstock intake

3.4.1 Existing race

From existing race chainage 1990 (new race chainage 1600) as shown on drawing 10KNF/RUG-112) the existing timbered race follows contours about 20m above the Kaniere river. The race is generally in cut, but in some areas the race is flumed at ground level as shown below in Figure 3.5.1.

FIGURE 3.5.1 [EXISTING RACE WITH FLUME SECTION NEAR CHAINAGE 2600M]

The land around the race is less steep along this portion and it slopes steadily uphill to the 25m wide transmission line clearing that traverses the terrace about 8m above the race. Table 3.5.1 lists the key components of the existing race in this area.

TABLE 3.5.1 [KEY COMPONENTS OF THE EXISTING RACE FROM CHAINAGE 1990 TO START OF PENSTOCK]

Start	End	Length	Description
2077	2243	166	Open cut race with No. 3 spillway
2243	2312	69	Tunnel No. 3 (Scotties)
2312	2434	122	Boxed and Open cut race
2434	2465	31	No.4 Boxed Flume
2465	2598	133	Open cut Race
Start	**End**	**Length**	**Description**
2598	2626	28	No.5 Boxed Flume
2626	2905	279	Open Cut Race
2905	2924	19	No.4 Tunnel
2924	3454	530	Open cut Race with Wards Road bridge, No.4 spill and screens, flume and bywash

3.4.2 Modification work required

The transmission line route is between 6m and 8m above the race for a significant part of the length (about 300m), which makes routing higher capacity race along this area difficult due to the earthworks volumes required. The most practical route is therefore to follow the existing race alignment over these 300m and replace it with a larger race sized for 8 m^3/s.

The physical work involved will be removing the existing race, cutting the new race into the same alignment and using the fill material to form the access way.

At new race chainage 1900 the slopes downhill of the existing race become steeper and the already-cleared transmission alignment is within 5m of the existing race. The new race will change to the transmission line alignment as shown on drawing 10KNF/RUG-112 up to Wards Road.

3.4.3 Construction access and excess spoil disposal

The existing 11kV transmission line corridor follows relatively even contour adjacent to the race route. A 25m wide corridor has been cleared beneath the lines along the transmission route.

Temporary construction access, from Wards Road to chainage 2320m, is planned along the 11kV transmission corridor subject to agreement with Westpower. The transmission corridor, shown in drawings 112 & 113, will be used as accessway for equipment and materials to the central race area without disrupting the works.

Excess spoil from the race construction will be placed within this transmission line corridor, at a nominal thickness of 1.2m, to provide free draining construction access to the works area. At the completion of construction this access can be either retained (for use by the lines company) or re-vegetated with low-growing ground cover, whichever is preferred.

4 Penstock, powerhouse and associated structures

4.1 General

The new Kaniere (Wards Road) power station will require the following components:

- penstock intake from the race with associated screens, gates and stop logs;
- 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;
- tailbay area and entrance to tailrace.

The conceptual scope of the work for the enhanced scheme penstock, power station and associated structures is described below.

4.2 Penstock from race to power station

At Wards Road there are two penstock options for the enhanced scheme. Each option will involve either one 1.8 m diameter penstock or two approx 1.3 m diameter penstocks.

Option 1 penstock route starts from the lake side of Wards Road and traverses 320m under the road and down to the new Wards Road power station. Most of the penstock route, except the road crossing, is likely to be above ground. The penstock will need to traverse over the small gully on the north side of Wards road, and run down the north side of it, so that this water course with its vegetation is maintained. Option 2 penstock starts about 250 downstream from Wards road adjacent to an old slip that runs 120m from the race down the hill to the new power station. If the second penstock option is selected then the existing race will be replaced by a larger race/channel, from Wards Road to the penstock offtake, sized for the 8 m^3/s flow.

Foundations and anchor blocks for the penstocks will be reinforced concrete. The penstock material is yet to be selected, but is likely to be either high density polyethylene (HDPE), glass reinforced plastic (GRP), concrete or steel.

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4.3 Power station and ancillary equipment

The powerhouse will be located as shown on drawing 10KNF/RUG-113 at an existing ground elevation of about 105m. The penstock alignment, station location, tailrace and temporary works areas have been sited close to the hill to minimise impact on the Wards Road wetland identified by Boffa Miskell's ecologist.

The reinforced concrete building with steel roof, within a 40m by 40m (approx.) compound, will be similar in size to the existing Deepstream powerhouse shown in Figure 3.6.1 below. The water will enter the powerhouse, from the penstocks, at one end and flow through the turbine before exiting towards the river through an open tailrace. The turbine will most likely be installed in a pit within the powerhouse.

The main electrical and control equipment (generator, exciter, governor, controller/plc, switchgear and support utilities) will be sited within the powerhouse. The transformer will be located just outside the powerhouse, within the fenced compound. Parking and turning circles will be provided for up to 4 vehicles for routine operations and maintenance works. The station will not be normally manned and operations will be controlled from TrustPower's operations centre in Mt Maunganui. West Coast Operations staff will be able to monitor station performance from the Kumara Station.

The temporary works area will be used to store materials and equipment for the duration of the project. It will be filled to about the same level as Ward's Road and drainage provided it to the wetland area. Silt control measures will be employed to ensure run-off to the wetland is not contaminated.

On completion of the project only the permanent works will be fenced (power station and surrounds, tailrace) and the temporary works area will be restored by either natural regeneration or replanting. Advice will be taken from terrestrial ecologists on the preferred method of reinstatement.

FIGURE 3.6.1 [TYPICAL POWERHOUSE SIZE AND CONFIGURATION]

5 Tailrace

5.1 Tailrace alignment and elevation

The 150m long tailrace is an open channel that transfers water from the powerhouse to the Kaniere river. The first section of the tailrace will be fenced as it is about 9m deep where it exits the station. The invert level of the tailrace will be about 95m and the water discharge to the river at the existing river level (approx. 96m). The tailrace and discharge water level will be designed to ensure any excess energy is dissipated before the water enters the river.

5.2 Tailrace construction

The tailrace near the station will be rectangular in cross-section and have reinforced concrete base and sides. The sides will be designed as retaining walls. The tailrace cross-section will transition into a trapezoidal earth channel with a wider cross-section as it nears the river. Armouring may be provided, using locally sourced rock, if required to maintain slope stability and protection from scouring.

6 Applicability

This report has been prepared by TrustPower Ltd to describe the proposed Kaniere Forks (Wards Road Enhancement) 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 drawings provide additional information on the existing scheme and proposed scheme enhancement.

Kaniere Forks Hydro Scheme – 8 Cumec Enhancement. Reference Plan 10KNF/RUG-100

Kaniere Forks Hydro Scheme – 8 Cumec Enhancement.Drawing No. 10KNF/RUG-110

Kaniere Forks Hydro Scheme – 8 Cumec Enhancement.Drawing No. 10KNF/RUG-111

Kaniere Forks Hydro Scheme – 8 Cumec Enhancement.Drawing No. 10KNF/RUG-112

Kaniere Forks Hydro Scheme – 8 Cumec Enhancement.Drawing No. 10KNF/RUG-113