Infrastructure Development Plan for HWP

By Amanda Loeffen

Project Manager for Hurunui Water Project

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Introduction

The Infrastructure Development Plan has been prepared for the purpose of supporting the resource consent applications prepared for the Hurunui Water Project Waitohi Irrigation and Hydro Scheme. It is a strategic document that summarises the wider integration and development issues for the project. This Plan also describes the details of the proposed distribution design, even though this is not part of the current resource consent application, as the work has been completed for costing and feasibility purposes. As with much of the operational design aspects of the scheme, more details and optimisation will be conducted during the detailed engineering phase, following this first stage of consents.

1. Description of the Project

1.1 Overview

The HWP Waitohi Irrigation and Hydro Scheme is a 210 million cubic metre storage reservoir with a 105 metre dam in the upper reaches of the Waitohi catchment at Hurricane Gully. Together with run-of-river water from the Hurunui River, it can supply water to irrigate 58,500 hectares of irrigable land in the Hurunui and Waiau catchments on a reliable basis. This forms an important section of the identified 100,000 hectares of land that has been identified by the Zone Committee. The scheme will have a series of three lower dams down the length of the river for hydro generation and additional storage. These are Seven Hills (46 m), Inches Road (31 m) and Lower Gorge 1 (21 m). In addition, there will need to be a large intake canal for the South side of the river along the stretch of river below Mandamus, plus a pumped intake further up the Hurunui River below Surveyors Stream, which will be used to refill the main storage reservoir at Hurricane Gully. The scheme has the facility to supply water to the north side of the river also, through an upgrade of the existing Amuri Irrigation intake.

It is planned to build the project in two stages, with a first stage to store Waitohi catchment water in the Seven Hills and Inches Road reservoirs (11 million m^3 total live storage), with no pumping, and no hydro generation at this stage. The first stage of the main intake canal on the Hurunui River would need to be built at this stage for run-of-river supply. This would enable the irrigation of up to 6900 ha of new land. It also could supply additional reliability to existing irrigated land (5200 ha) on the north side of the river.

1.2 Stage 1

Stage 1 will irrigate 6900 hectares to the East of the main canal, and along the Waitohi River. It uses some A Block water that is not currently being used by existing irrigators, plus B Block water. Without storage it would not be reliable or feasible.

a. Stage 1 Dams

At this first stage, the addition of 11 million m^3 of storage in the Waitohi gorge at Seven Hill and Inches Road provides similar reliability to that experienced by existing irrigators (around 93%). These first stage irrigators would have the opportunity to increase reliability at Stage 2. See Tables 1 and 2. Reliability to existing irrigators could also be increased at Stage 1, subject to distribution design and sharing of A Block water.

Even at this first stage, when water is scarce, the scheme allows for an increase in the minimum flow on the Waitohi, ensuring that water will flow all year through the river, increasing fishability. In addition, the river can be used for some of the distribution,

allowing fluctuating flows of up to 3.9m^3 through the system, and providing for environmental enhancement.

Discharge over the dams will be controlled by minimum flow of 250l/s and irrigation flows of up to 3.9m^3. Mean annual floods of 50m^3 will continue to flow over the dams when the reservoirs are full, which could increase the flows further at certain times of year and particularly during winter, and the early few months of the irrigation season.

b. Stage 1 Intakes

The intake and first section of the main canal from the Hurunui River below the Mandamus is required in Stage 1 to supply run-of-river water.

We have investigated two potential intake points along this stretch of river. Initially, it was thought that the true-right bank just above the existing Amuri intake (at 305m RL) would be best because it enables supply to the north side of the river. Further work on distribution has shown that there may be an equal or better alternative further down the river at 280m RL, thus saving capital expense. A canal at RL 340m is also required to irrigate the land above the main canal. If the main canal is located at RL 280m instead of RL 305m the 340m canal would also be capable of supplying the north side The canal at 340m RL would also provide another opportunity for hydro generation as the water would drop from 340m RL to the river at 305m RL. These canals are show in the drawings in Figure A1 and A2, with the 340m RL canal currently shown in the Stage 2 design. Detailed engineering is required to optimise the distribution network design.

Table 1: Stage 1 Intakes

Intake	Intake No.(1)	Water RL (m)	Max. Flow (m^3/s)	Comment
Hurunui River (at Mandamus) (2)	1	280.0 or 305.0	3.9	Required to supply first-stage water
Waitohi River	2	280.0 or 305.0	3.9	Required to supply first-stage water

Notes: (1) Refer to attached plan 11841-10-R3 for location. (2) This may also be a point of discharge from Waitohi Storage to supply irrigation to north of Hurunui River.

Table 2: Stage 1 Dams

Dam	Crest RL (m)	Water RL (m)	Dam Height (m)	Crest Length (m)	Drawdown (m)	Live Storage Volume (MCM)	Peak Outflow (m^3/s)
Seven Hills	405	400	46	150	20	7.3	3.9
Inches Road	375	370	31	245	20	3.9	3.9

Total						**11.2**	

c. Construction

1. Main run-of-river intake from the Hurunui River (Intake 1). The take at this Stage will be 3.9 m^3/s, however parts of the construction will be undertaken for the maximum flow of 26.1 m^3/s at Stage 2.
2. Main canal from Intake 1 at RL 305m or RL 280m to supply initial 8,600 ha of land (6,900 ha of net irrigable area). This canal will continue to Washpen Stream.
3. Seven Hills and Inches Road dams and water release structures to provide 11.2 million m^3 initial in-catchment irrigation water from the Waitohi catchment.
4. Spillway for Seven Hills dam will be required to safely pass PMF (probable maximum flood) inflows; spillway for Inches Road dam will be required to safety pass PMF routed through Seven Hills dam (ie. attenuation of flood in Seven Hills reservoir will reduce peak flow).
5. Intake from Waitohi River (Intake 2) located where the main canal will cross the Waitohi River. This intake will supply the main distribution canal originating at Intake 1. The take at this Stage will be 3.9 m^3/s.

d. Operation

1. Both dams operated to meet irrigation demand. This may include full drawdown to specified levels depending on irrigation demand and natural inflows.
2. No hydro-generation included at either dam, although provision provided for its later development.

e. Hydrology

1. B-block run-of-river water is available to supply the initial 6,900 ha of net irrigable area together with any 'left over' A-block water from the existing Balmoral Scheme
2. For the purposes of hydrology, it is assumed that existing irrigators in the Waitohi catchment will become part of Stage 1. It is assumed that HWP will operate in a water users group with existing consent holders and obtain the beneficial use of consented water when not taken by that existing consent holder. It is possible that HWP will be able to increase reliability for these users, but it is not included in the model at this stage.
3. It is proposed to set a minimum environmental flow release of 250 l/s at the outlet of Inches Road Reservoir.

4. In addition, the Waitohi River below the main canal will convey up to 3.9 m^3/s for distribution which will provide a variable flow in the river from this point.
5. The Stage 1 irrigable area will have an irrigation application rate of 0.45 l/s/ha and a demand/supply ratio of 93%.

1.3 Stage 2

Stage 2 is likely to take at least two years longer until construction is complete due to the additional complication involved in detailed engineering design and much larger construction. It is intended that work will be continued in parallel with Stage 1.

a. Stage 2 Intakes

Stage 2 will involve construction of three further intakes:

1. A higher intake on the Hurunui River will also be required, located about 1.5 km below Surveyors Stream. This intake will divert water via a pump station, rising main and tunnel into the Waitohi River catchment. This intake is located on the true-right bank of the Hurunui River about 1.5 km downstream of the confluence with Surveyors Stream. The river turns 90 degrees at this point and is considered to be the most favourable location for an intake on this stretch of river. It will include a sediment pond and fish screening. The volume of water extracted can vary up to 17 m^3/s through a number of pumping stations, but the scheme will mostly rely on off-peak pumping during the night.
2. The existing Amuri Scheme intake will need upgrading to increase capacity, but will be dealt with by separate consent application.
3. At Stage 2 the total potential release for irrigation from Waitohi storage is up to 42.4 m^3/s at peak times and is too much to send down the river. Minimum flows of 250 m^3/s will continue to be released at the Lower Gorge 1 dam, plus there will be release of flushing flows at least twice a season, or as needed to reduce periphyton growth. The Lower Gorge 1 dam will allow for two intakes at two levels, from the top of the dam at 340m RL and from the bottom at 325 m RL. The top intake will serve the area above the main canal, which will be supplied only with storage water. The lower intake will supply the main canal through a connecting canal, to supplement run-of-river supply.
4. The First Stage Waitohi River intake will no longer be required, and the Waitohi storage water will all be supplied from the Lower Gorge 1 Dam. See Intake 5 on Appendix A2.

Table 3: Stage 2 Intakes

Intake	Intake No. (1)	Water RL (m)	Max. Flow (m^3/s)	Comment
Hurunui River (at Mandamus) (2)	1	280 or 305	26.1 (4)	To supply run-of-river water to the distribution system.
First Stage Waitohi River	2	n/a	n/a	The Stage 1 intake at this location will be decommissioned.
Hurunui River (at pump station)	3	383.5	17	To supply pumped water into the Waitohi catchment for irrigation storage and hydro-generation.
Hurunui River (Amuri Scheme) (3)	4	unknown	8.5	To supply run-of-river water to the existing Balmoral Scheme and Balmoral Forest.
Waitohi River at Lower Gorge Dam	5	325.0 & 340	42.4	To supply the main distribution canal and other areas from Waitohi storage.

Notes: (1) Refer to attached plan 11841-11-R4 for location. (2) This intake will also act as a discharge point for stored Waitohi water. (3) The existing Amuri Scheme intake. (4) 3.8 m^3/s to be abstracted from the mid- and lower-Hurunui River riparian area and Domett.

b. Stage 2 Dams

At Stage 2, the main reservoir at Hurricane Gully will be constructed to create the majority of the irrigation storage plus 26 MW of installed hydro generation capacity. Both the Seven Hills and Inches Road Dams will also have installed generation capacity of 4 MW each, and the fourth dam at the Lower Gorge1 location will be constructed with 3.5 MW of capacity, plus intakes for the upper and lower areas.

With the large storage and generation capacity at Hurricane Gully, Seven Hills and Inches Road dams will not be used purely for irrigation. In Stage 2, Seven Hills is used to re-regulate the Hurricane Gully release, and it fluctuates daily by up to five metres in height, and sometimes greater at weekends, only being drawn down in full demand years. Inches Road is allowed to stay full for 98% of the time, and is only used for storage in dry years, modelled at six times over the 39 year period. Lower Gorge 1 Dam would be full all the time as it is not used for irrigation storage.

Discharge over the dams will vary between that released for minimum flow (250 l/s) and peak irrigation outflow of 42 m^3/s. Mean annual floods of 50m^3 will continue to flow over the dams when the reservoirs are full, which could increase the flows further at certain times of year and particularly during winter, and the early few months of the irrigation season.

Table 4: Stage 2 Dams

Dam	Crest RL (m)	Water RL (m)	Dam Height (m)	Crest Length (m)	Drawdown (m)	Live Storage Volume (MCM)	Peak Inflow (m^3/s)	Peak Generation Outflow[(2)(4)] (m^3/s)	Peak Irrigation Outflow[(2)] (m^3/s)
Hurricane Gully	505	500	105	429	50	209.5	17[(1)]	35	42
Seven Hills	405	400	46	150	20[(3)]	7.3	42	8	42
Inches Road	375	370	31	245	20	3.9	42	8	42
Lower Gorge 1	345	340	21	71	1	0.4	42	8	42
Total						**221.1**			

Notes: (1) Not including Waitohi natural inflows. (2) The difference between peak generation and irrigation flows is to maximise generation efficiency. During peak irrigation flows, generation will be at peak and the difference will be released via a bypass. (3) Operating range for re-regulation will be up to 10 m. Full drawdown will occur in extreme dry years (5 to 10 years). (4) This is a currently estimated value and it may change, but it will not exceed peak irrigation outflow.

c. Construction

1. Completion of Hurunui River intake (Intake 1) to its full 26.1 m^3/s capacity.
2. Upgrade of existing Amuri intake at the Hurunui River to supply the existing Balmoral Scheme and Balmoral Forest to its full capacity of 8.5 m^3/s (Intake 4).
3. Upper intake on the Hurunui River, pump station, rising main, and tunnel to convey water into the Waitohi catchment (Intake 3 on plan).
4. Hurricane Gully dam, including spillways designed to safely pass PMF inflows, and water-release and hydro-generation infrastructure.
5. Hydro-generation infrastructure on the Seven Hills and Inches Road dams.
6. Lower Gorge 1 dam, including spillways design to safely pass PMF routed through upstream dams, and water-release and hydro-generation infrastructure. A high-level intake will be required at RL340m (Intake 5 on plan); a low-level intake directly from the dam outlet structure will be constructed to divert water to the main distribution canal.

d. Operation

1. The upper Hurunui River intake (Intake 3) will divert and pump a maximum of 17 m^3/s via rising main and tunnel into the Waitohi catchment.
2. Flows from the Hurricane Gully dam will be optimised for hydro-generation at a maximum flow-rate of 35 m^3/s.

3. Seven Hills Reservoir is primarily used for re-regulation to attenuate hydro-generation flows generated by supplying electricity during peak demand periods. For the purpose of this simulation it is assumed that the reservoir will be drawn down in the weekends when the electricity demand is lower and therefore the release from Hurricane Gully is lower. This will result in a drawdown of up to 10 metres in the weekends. The water level will fluctuate throughout the day depending on electricity prices. This may result in water level fluctuations of up to 5 metres within one 24 hr period. Seven Hills dam will also be used for irrigation and be drawn down in dry years. Peak inflows and outflows are presented in Table 4.
4. Inches Road dam will maintain a high reservoir level to maximise hydro-generation with normal operation being inflow = outflow but may be drawn down for irrigation in dry years.
5. Lower Gorge 1 dam will maintain a high reservoir level to maximise hydro-generation with inflow = outflow.
6. The lower Hurunui River intake (Intake 1) will divert a maximum flow of 26.1 m^3/s to the main distribution canal.
7. Waitohi intake (Intake 5) to divert a maximum flow of 42.4 m^3/s to the main distribution canal.

e. Hydrology

1. It is assumed the existing A-block users in the relevant reaches of the Hurunui and Waitohi Rivers will be part of Stage 2, therefore A-, B- and C-block run-of-river water is available to supply the total net irrigable area of 58,500 ha.
2. The Stage 2 irrigable area will have a maximum irrigation application rate of 0.6 l/s/ha (depending on soil type, evapo-transpiration etc) and a demand/supply ratio of 98%.
3. It is proposed to set a minimum environmental flow release of 250 l/s at the outlet of Lower Gorge 1 reservoir.
4. Flows in the Waitohi River would be augmented by using the river for some of the distribution.

1.4 Hydro Generation

The scheme will be optimised further for hydro generation. With energy consumption of 95 GWh and generation of 83 GWh under current assumptions, the scheme is short of energy balance with the current level of optimisation. There is a further scope for optimisation and profit improvement subject to power price predictions, particularly the relationship between peak and off-peak prices and seasonal variations. There are several months of the year when

the reservoir is full, where water could be run through the system for a profit, and there are opportunities to “add-on” further hydro stations, subject to the final distribution design. There is also the opportunity to use the water for hydro generation through this scheme, and then run it through another hydro scheme on the north side of the river, currently planned for Balmoral Forest.

The scheme currently pays for the energy consumed and optimisation will be undertaken during the next stage of resource consents.

2. The Operating Rules for the Storage Reservoirs

The HWP Waitohi Irrigation and Hydro Scheme provide four reservoirs at Stage 2:

a. Hurricane Gully –The reservoir will have a primary goal of providing storage for irrigation, but will be operated to optimise hydro generation, using the lower Seven Hills reservoir to attenuate flows by re-regulation. The mean drawdown is 8.6 metres, which is well below the maximum drawdown of 50 metres (which occurs once in six years) and the mean maximum drawdown at the end of the season is less than 20 metres. Effectively, there are five years out of six when the maximum drawdown at the end of the irrigable season is much less than this. Hydro generation for Hurricane Gully will primarily be driven by irrigation. However, at times when the reservoir is full, the scheme can be driven by hydro generation, taking advantage of the off-peak prices for pumping and on-peak prices for generation.

   Although each year is different, in general, the operation of the refill and hydro generation is as follows, as exemplified by a typical year in 1981-82 irrigation year:

   - July to mid-August – the reservoir is being refilled, so the pumps at the Hurunui intake are working to refill the lake. If the lake is not drawn down to a calculated storage volume (66 million m^3 based on current assumptions), the pumps can run outside of peak hours and still refill the reservoir by the end of the winter. One year in seven, when the live storage at the beginning of June is less than the calculated storage volume, the pumps will be operated 24 hours a day to ensure the lake is refilled.
   - Mid-August to mid-September the reservoir is already full, there is no irrigation demand, and pumping is run only for hydro generation, working off-peak for pumping and on-peak for generation.
   - Mid-September to December, the demand is mostly met by run-of-river supply. Some pumping is required to refill the lake, and there may be some pumping for hydro generation also.
   - From mid-January to April the amount of run-of-river abstraction is reduced due to low flows in the Hurunui, and there is little opportunity for pumping.
   - By May, flows have increased sufficiently in the Hurunui for pumping to resume at the higher Hurunui intake to commence reservoir refill. Irrigation demand in May is usually low. From June onwards no irrigation occurs, and flows in the Hurunui have recovered to enable the reservoir to continue filling through this period.

b. Seven Hills (46 m) –used for irrigation in stage 1 and for hydro generation and re-regulation in stage 2, plus some irrigation, but only one year in seven when the storage is required. The lake level will fluctuate according to the optimisation of power prices, so could be drawdown up to five metres in a day and up to 10 metres in a weekend under current pricing schemes.

c. Inches Road (31m) –used for irrigation in stage 1, and for hydro generation in stage 2, plus irrigation in dry years. The lake level will be held almost full all the time (except for the last few months of the irrigation season in a dry year).

d. Lower Gorge 1 – a small hydro dam of 21 metres, which will provide additional generation plus act as the main intake point for the distribution canals. It will remain stable like Inches Road and will never be drawn down for irrigation as there is relatively little storage.

3. Existing and New Recreational Activities

Please refer to the detailed report from Rob Greenaway (Hurunui Water Project Waitohi Irrigation and Hydro Scheme, Tourism and Recreation, September 2011) for details on recreation. There are four main recreational areas:

3.1 In the Hurunui River below the Pumped intake below Surveyors stream

This intake sits below the main kayaking stretch of river through Maori Gully, and it is not very accessible today. It may provide a new access point for kayakers, opening up a new stretch of river between the existing exit point at Surveyors Stream, and the new intake. This recreational facility could provide easy road access and parking for recreational users of the river.

3.2 In the Hurunui River below the Intake at Mandamus

The river along this stretch is used for angling, jet-boating, swimming and white-baiting. The higher minimum flows will allow for fish passage of salmon and trout, but it has not been fully assessed for further effects on angling. It is probable that there will be increased restrictions on times for jet-boating due to the higher flows required for this activity. Swimming may be improved due to the lower flows in summer. Whitebaiting will not be affected by the new flow regime.

3.3 In the Waitohi catchment, where the new reservoirs are formed

Recreation will change from a local and minor river fishery to various lake activities.

a. Inches Road Reservoir

At Stage 2 it is considered that Inches Road Reservoir will create a reasonable size local boating lake, close to Lake Sumner Road, and the reservoir level will be maintained high most of the time. The amenity value of this lake will depend on access for boating activities.

b. The Lower Gorge

The Lower Gorge reservoir is not as easy to access, and is long and thin, but may provide a new eel fishery due to the stable levels and the possibility of creating eel passage from the river below. Some shelving of the sides of the reservoir may be required to make the reservoir suitable as an eel habitat.

c. Hurricane Gully Reservoir

The Hurricane Gully reservoir, while it has a large potential drawdown, will be less than 10 metres drawn down for more than 70% of the time. Although it is not primarily a

recreational lake, the lake levels will generally remain high until mid or late January before being reduced for irrigation release, creating long periods of high water to provide local boating amenity. There is no practical legal access at the moment, so this will need to be established with local landowners. Recreational value will be established after initial monitoring of the local wind conditions, lakeshore quality and operation of the lake.

Table 5 : Average Monthly Lake Levels Hurricane Gully (Lake maximum level is 500m RL)

Table 5: Hurricane Gully average monthly lake levels (1972-2011)	
Month	**Lake level (m)**
January	493.4
February	487.4
March	482.2
April	481.6
May	485.9
June	490.9
July	494.2
August	496.9
September	498.3
October	498.9
November	498.7
December	497.1
Year	**492.1**

d. Downstream of Waitohi Lower Gorge

Downstream of the Waitohi Lower Gorge – the stretch of river between Medbury Bridge and Power Road often runs dry in peak summer months today, and the addition of a higher minimum flow (250 l/s) plus flushing flows will maintain fish passage year round and improve angling opportunities. Swimming is also an existing activity that could be improved with higher minimum flows. The addition of up to 3.9 m^3/s at times in Stage 1 will need to be managed from a safety viewpoint, with signposts and sensible ramping.

4. Riparian Management

4.1 Waitohi River Upstream of the areas proposed to be inundated

There are several areas of remaining high value areas above the inundated area, such as Little and Big Bush Streams (See Appendix F). It is recommended to find a way to protect these areas through either legal or physical protection from grazing, such that the native bush can re-establish. Consultation with landowners is important given that it is private freehold land, and HWP proposes to work with landowners to establish the best way to manage it.

4.2 Margins of the New Lakes

The ecological AEE recommends that shrubland or forest corridors should be established around the margins of the lakes linking the unaffected upper and lower sections of the Waitohi River. This could be established by a combination of retiring the margins from grazing and allowing riparian margins to re-establish naturally. Some native planting may be required, and could be facilitated over a number of years, with gradual introduction of small plant islands to serve as nuclei for developing indigenous growth. Weed control will need to be managed by early intervention to prevent spread of larger weeds. It is hoped to avoid spraying. Consultation with landowners will be important to establish the best results.

4.3 Downstream lower Waitohi River

Ecological advisors are recommending the establishment of new indigenous dominated ecological corridors to connect existing ones. This will primarily be achieved by retiring the riparian areas from grazing, the methodology to be discussed with individual landowners.

Riparian Management within the irrigable area is in the planning stages, with an inventory of existing wetlands already compiled by HWP. The second stage is to develop voluntary programmes to improve wetland quality for potential irrigators. HWP cannot share the map of these areas as the inventory was conducted confidentially to avoid invading personal property rights. Within the “Best Management Practises Agreement” that will be part of the Water Supply Agreement to all irrigators, there will be a section on introducing riparian management. It is expected to develop these areas in land adjacent to streams and the main river such that nitrate leaching into surface water can be minimised. This will involve a collective approach for the area and is fully cognisant of the Land and Water Quality Forum work that is being developed.

5. Irrigation of 100,000 hectares of land in the Hurunui and Waiau Zone

The Hurunui-Waiau Zone Committee has a goal to irrigate 100,000 hectares of the Hurunui-Waiau catchment. There are currently 28 kha of land already irrigated in the HW Zone, most in the Waiau catchment and north of the Hurunui River[1]:

Table 1: Summary of Irrigable Land in thousands of hectares (kha)

Waiau	k ha	Hurunui	k ha
		North side	
Existing	21.4	Existing	5.2
New potential	35.6	Dryland	13.2
in sub-zones of which:		South side	
> 75% irrigated	10	Existing	1.5
< 75% irrigated	25.6	Dryland	40.7
IRRIGABLE LAND			
TOTAL	**57.0**		**60.6**

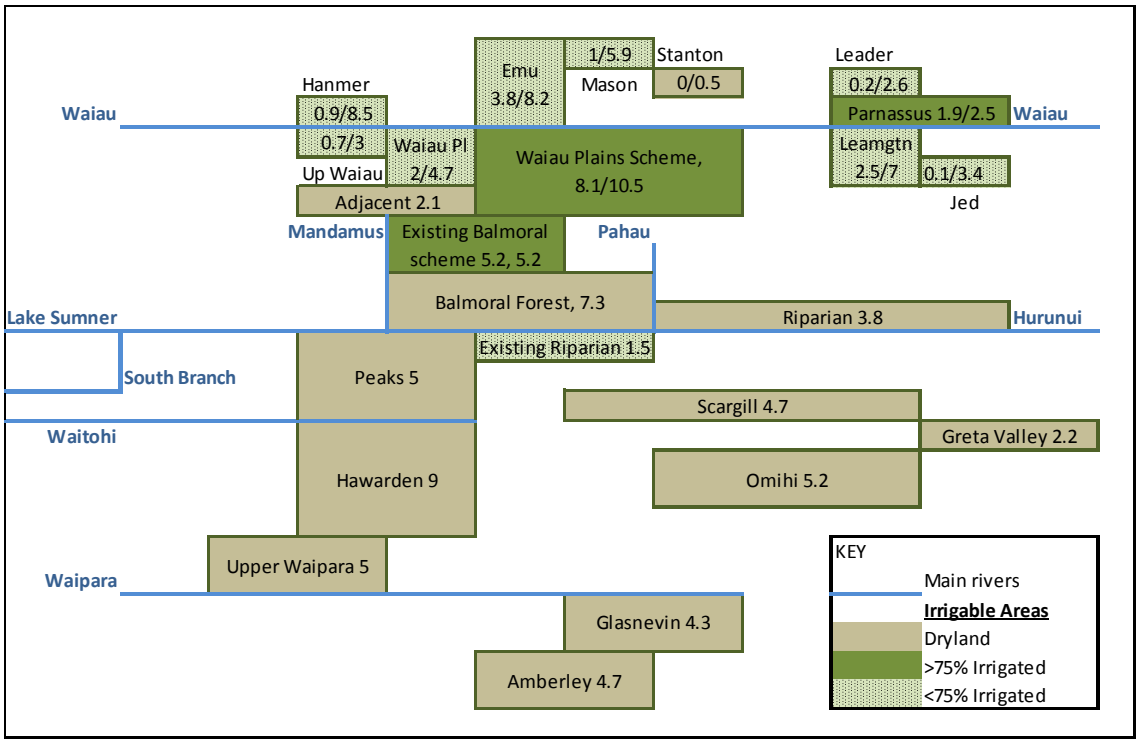
The following diagram (Figure 1) maps out in simplified form where these areas are, and how much of each area is dryland or already irrigated.

The diagram colour codes the dryland areas in brown, the areas that are already more than 75% irrigated in dark green, and the areas with only a small percentage of irrigation in dotted light green. Not surprisingly, the land between the two main rivers is more highly irrigated than anywhere else. The integrated solution will also provide for higher reliability of the existing schemes, plus allow for hydro generation (as a secondary priority behind irrigation).

The aim is to find a solution that will irrigate the areas in greatest need. Ideally, this solution should also be commercially viable, but this Plan does not address economic viability.

[1] Reference the Riley Consultants "North Canterbury Options "Report, 9 August 2010

Figure1 : Existing and Potential Irrigable areas in Hurunui and Waiau Catchments ('000 ha)



These areas are also show in a more conventional map in Figures 3 and 4.

5.1 Staging

The following graphical representation outlines a staged approach to irrigating most of the 100,000 ha in the irrigable area.

Figure 2. Potential Irrigated Land over time

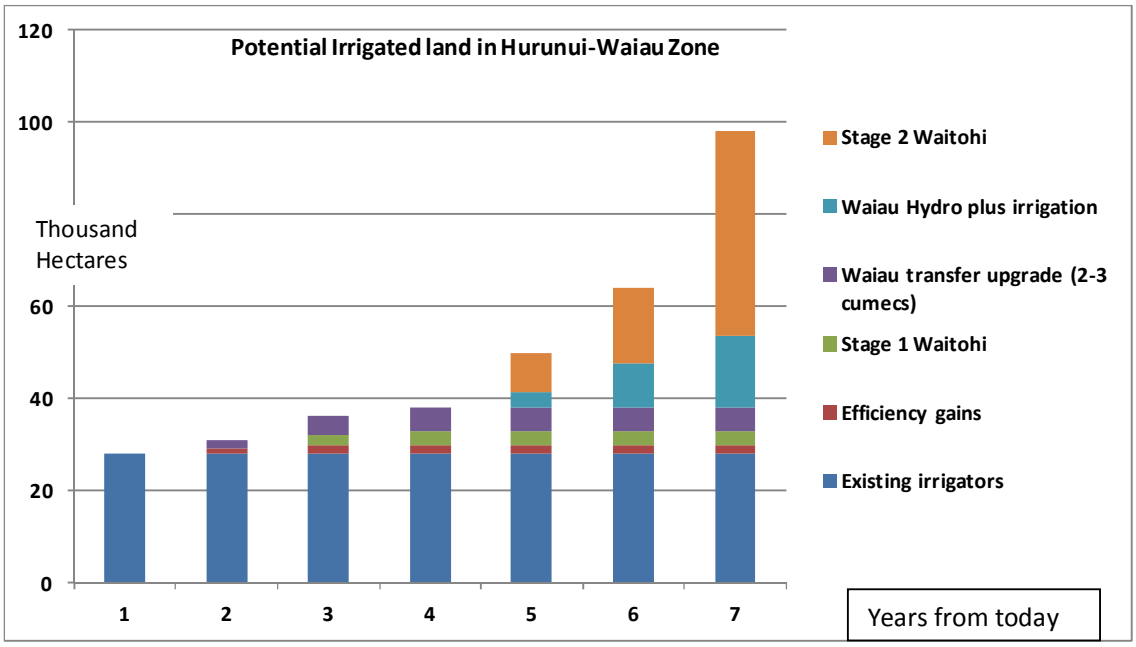


Figure 2 outlines the following schemes:

a. Existing Irrigators

Existing Irrigators – includes Balmoral irrigation Company, the Waiau Plains Scheme, plus a number of smaller irrigators along riparian zones.

b. Efficiency Gains

Efficiency gains – the Balmoral Irrigation Company estimates that reduction of current losses, plus conversion to spray, could increase the irrigable area by 2000 hectares, maintaining the existing reliability, which is approximately 93%.

c. Stage 1

Stage 1 Waitohi – using Waitohi water plus available run-of-river Hurunui water (B block plus unused A block), the HWP could irrigate an additional 6900 hectares[2] plus increase reliability for 7000 hectares (5200 on the north side plus other small consent holders).

The Waiau transfer upgrade could supply enough water to irrigate a further 5000 hectares (if some form of storage is provided, either from Waitohi storage or on farm storage)

d. Stage 2

The Waiau Hydro scheme plus Isolated hill could supply enough storage to irrigate a further 18000 hectares (either East to Parnassus or South towards Amuri) in addition to hydro generation.

Stage 2 Waitohi could irrigate a further 42,000 hectares south of the river, and in addition provide storage for improved reliability to 7000 ha of land to the north of the river plus another 9,000 hectares of new irrigation in riparian areas and on the north side.

[2] Area varies according to whether the land is north or south of river, and whether additional reliability is required

6. Integrated Strategy

HWP, Meridian, Ngai Tahu Property and Amuri Irrigation Company are working together under a Letter of Intent to find the optimal integrated strategy that will provide water for as much of the zone as possible, and at the optimal cost for all parties. This is work in progress, and it fits with the current HWP Waitohi Irrigation and Hydro Scheme, which can provide storage water for the north side as required, and also send water through both the Waitohi and the Balmoral hydro schemes.

6.1 Stage 1:

The HWP is a staged scheme, using Waitohi catchment water only in Stage 1, and enabling irrigation of up to 6900 new dryland hectares plus additional reliability for the north side of the river and existing irrigators. HWP sees three main advantages to this staging:

a. Early Water

The faster engineering stage could bring early water for some of the landowners, bringing income into the district at least two or three years earlier than a larger scheme.

b. Two Irrigation Reservoirs

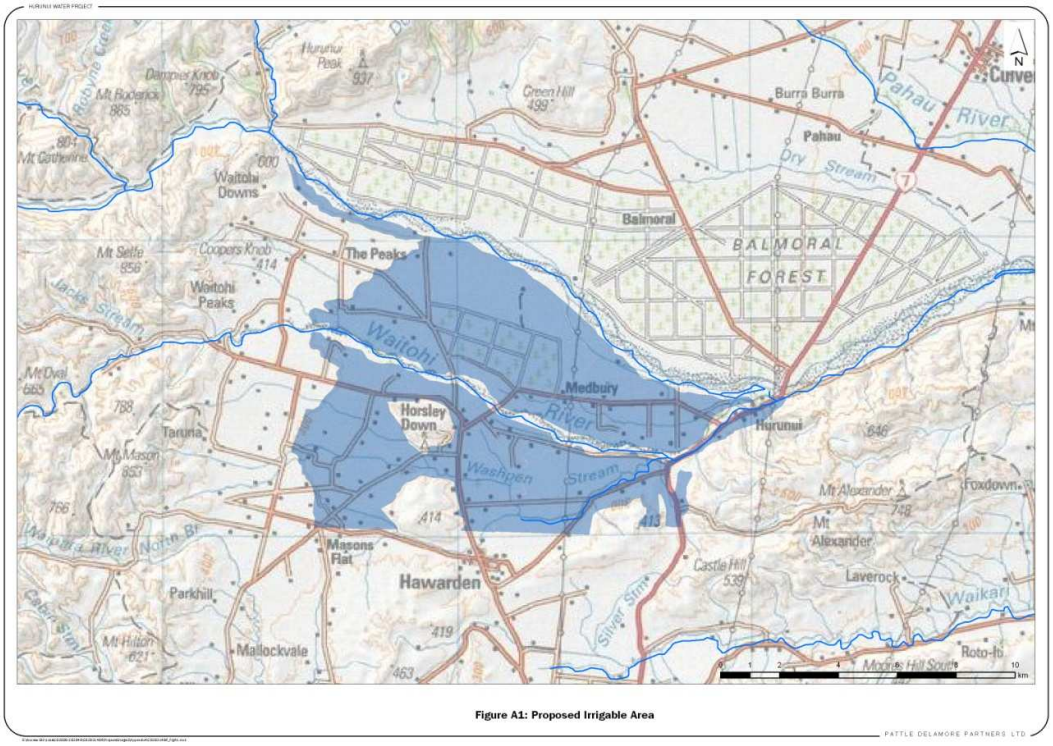
The two irrigation reservoirs are sized to utilise the optimal volume of reliable Waitohi water, and can be paid for by irrigation. This facilitates the development of profitable hydro generation at Stage 2.

c. Best Practice

The ability to demonstrate Best Practise dairy farming at the Stage 1 allows HWP to show that nitrate levels can be maintained at current levels, so facilitating further irrigation in the catchment without intensification concerns.

At Stage 1, the HWP will be developed in coordination with the efficiency gains on the north side of the river, to provide up to 6900 hectares of irrigation which could be split between the north and south side. It will also give additional reliability to the Amuri Irrigation Scheme.

Figure 3: Stage 1 Irrigation on the South Side of the River

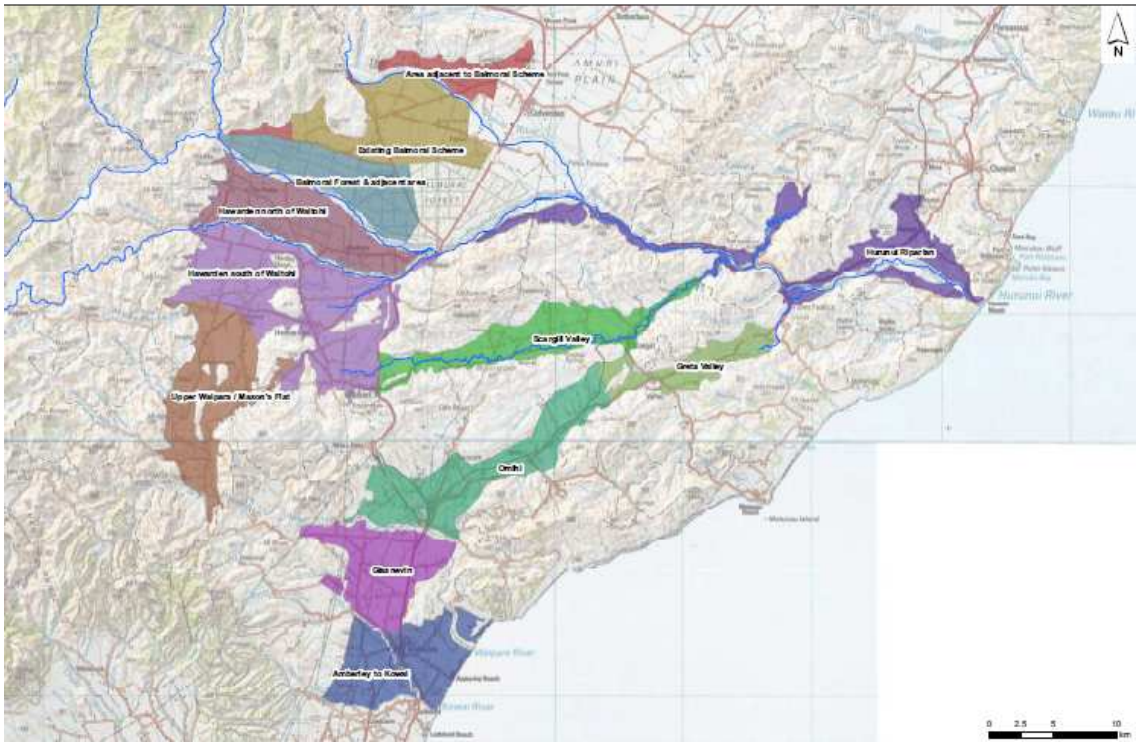


6.2 Stage 2

At Stage 2, HWP develops the main Hurricane Gully Dam and reservoir, in tandem with the pumping station on the Hurunui River. This stage is likely to require longer engineering design and construction time. This second stage could allow irrigation of a further 44,500 hectares.

Discussions with Meridian suggest that another reservoir at Isolated Hill, together with hydro generation on the Waiau would progress at the same time. This further storage of up to 45,000 million cubic metres of live storage could provide irrigation for the lower reaches of the Waiau and/or the land between the Waiau and the Hurunui River. This storage would allow for irrigation or improved reliability to more than 20,000 hectares of land.

Figure 4: Stage 2 Irrigation from the Waitohi



The combination of the six schemes and initiatives would allow for 100% irrigation of the land identified by the Zone Committee. See Appendix E for tables of data.

7. Takes and Diversions

A map showing the point of takes and diversions is attached as Appendix A. There are two main intakes planned for the Hurunui River, in addition to the existing Amuri Irrigation intake and one main intake location on the Waitohi River in Stage 2. The intake location on the Waitohi River for Stage 1 (where the Waitohi meets the main canal) will be decommissioned as part of Stage 2.

7.1 Pump Water to Storage

The intake to pump water into storage from the Hurunui will be located below Surveyors Stream, at approximately 383 RL. The structures at this location will include a sediment pond and fish gallery, and the facility to flush sediment through the pond will be provided. Approximately an additional 10% of water will flow through the pond and be discharged approximately 100 metres downstream to facilitate constant flow for fish and water health. During large floods, additional water could be flushed through the pond to eradicate build up of sediment.

7.2 Mandamus Confluence

The second intake will be below the Mandamus confluence and will be located either at 280m or and 305 RL, depending on the final distribution design. This intake and flat canal will allow up to 26.1m^3 of water to flow in either direction, thus enabling supply of water to the north side of the river. If the lower canal is located at 280m RL there will be a need to pre-build the 340m RL spur canal to supply the north side of the river prior to the stage it is required to irrigate the land above the main canal.

7.3 Intakes

At Stage 2 the intakes on the Waitohi River will be combined with the Lower Gorge hydro dam, and will provide water from storage for the higher land at 340 RL, and a lower intake into a canal at 325 RL to feed into the main distribution canal for the main scheme. A total of 42.4m^3 peak irrigation outflow will be allowed from the two intakes. Finalisation of the distribution network design will affect the sizes of these two canals.

There will also be a small weir on the Waitohi at the main canal for Stage 1, which will be decommissioned at Stage 2. It will have capacity for up to 3.9m^3.

8. Demand Analysis

A map showing the properties that will be provided with water from the scheme is attached (Appendix B). Each shareholder currently holds one ordinary share per hectare that will entitle that landowner to apply up to 0.6 l/s per hectare by spray irrigation. There is accommodation in the prospectus for less intensive farming needs to use a lower figure should farmers choose to apply less water per hectare or reduce the percentage of land irrigated.

The hydrology model is designed to allow for different soil types, and takes account of rainfall, evap-transpiration and temperature in each area. It assumes that all farmers would aim to optimise plant growth, and maintain a soil moisture balance (PAW) above 50%. It shows that the distinguishing factor to water consumption is actually the type of soil and atmospheric conditions, as well as land-use. Dairy farming conversions are most likely on flat, well-draining soils, as these are easier to manage for cattle. Crops are best grown on heavier soils, which hold more water, and do not require as much irrigation. The model predicts that lighter soils therefore need more water for irrigation, and this is reflected in the application rates, as well as the annual volume of water required.

While some landowners may need to purchase six shares per hectare, it is likely that land uses other than dairying will purchase fewer shares per hectare to reduce cost and volume of water allowance.

Early surveys at the original costs of $4-5000 per hectare to the farm gate suggested that around 30% of the land would be converted to dairy farming. However, at the new price of around $7000 per hectare excluding construction and financing costs, it is expected the percentage to increase to around 65%, as per the AIC, with the remainder in dairy support. HWP is embarking on detailed surveys with landowners to establish the true affordability of the scheme.

The prospectus already outlines the agreement that shareholders (potential irrigators) will have with HWP. All shareholders will have to agree to “Best Practise”, and will be limited on both application rate and total volume of water taken per annum. It is intended that the area will have local weather stations to monitor precipitation, evapo-transpiration, and soil moisture balance such that farmers will be directed on when and where to water. Each landowner will have the water supply metered to the farm gate, and the volumes will be monitored such that any abuse of water use will result in severe warnings and cutting of supply.

9. Distribution Design

The design of the distribution has been worked out at a high level for costing purposes. The assumptions have included main canals, with spur canals to smaller areas, and using rivers and streams as conduits where possible. It is likely that some areas could be piped, and HWP has yet to do this optimisation work as the distribution network design will be the subject of future resource consent applications. Some of the interesting points that we have found during the studies to date:

9.1 Area above 300 RL

The area above 300 RL can be supplied entirely from storage, without incurring additional pumping costs, as there is sufficient capacity to enable off-peak pumping for up to 8000 ha. The areas that are supplied by storage only, rather than from un-of-river plus storage are identified in the map shown in Appendix D3. The area coloured in orange is that supplied from storage if the canal is at 350m RL. The area could be expanded to the area in green also if the lower canal at 280m RL is selected.

9.2 North Side of River

The north side of the river can be supplied with storage at stage 1 via two potential methods, the optimal solution to be determined once HWP has more detailed contour analysis. With the 305 RL intake option, HWP would run the main canal as a two-way system, enabling supply of water to Amuri Irrigation Company (AIC) in dry periods. An alternative could be to run the 340 RL Waitohi Gorge intake spur across to the Hurunui, providing another opportunity for hydro generation, and dropping in above the Amuri intake. The main canal could then have an intake lower down at 280 RL. Average distribution prices of around $3000 per hectare are maintained even with the larger irrigable area, as HWP is able to use rivers for transport in some areas. This would affect the Waitohi, Waikari, Omihi and Waipara Rivers and would provide environmental flows during dry months.

The main distribution areas are outlined in colour in Appendices D1 and D2 . HWP has also included a high level drawing of the distribution canals showing indicative paths in Appendix D3. HWP has not consulted properly with all affected landowners to date, as the detailed engineering has yet to be completed.

The drawings also show that HWP is able to use some of the rivers for transport of water, where ecologically sensible. This helps to keep costs down and also augments some of the less healthy rivers. In addition, piping could be used in selected areas, but a significant amount of work to determine the net present value of piping will need to be undertaken,

given the significant increase in costs connected with piping. Other projects show costs can increase by 50%, and so it is a function of saving water losses and on-farm energy and reducing land impacts in order to reduce operating costs to offset the extra capital.

10. Effect on Existing Irrigators

Current irrigators are experiencing a reliability of around 93% today. Any irrigators in the Command Area that become shareholders in HWP have the facility to increase this reliability to 98% once storage has been introduced.

The model as developed by Pattle Delamore Partners (PDP) assumes that existing irrigators will become part of the scheme and effectively achieve the same reliability as all other members of the scheme.

Irrigators in Amuri Irrigation Scheme will have the option of joining the scheme at Stage 1. It is currently thought that this additional reliability will be exchanged for some of the unused A Block water, which will enable AIC to access cost effective storage, without reducing the size or reliability of the new irrigable area on the south side of the Hurunui River.

11. River Regime

The Proposed Hurunui and Waiau River Regional Plan sets a new minimum flow when storage of greater than 20 million m^3 has been provided. The "Proposed Regional Plan post storage flow regime'' sets monthly variable A-and B and C- block allocation limits for the Hurunui River. Appendix C shows the proposed flow regime as set out in the Proposed Regional Plan. This has been the starting point when considering how the flows will be managed.

12. Fish Migration

Fish migration and passage will be impeded by the larger dams, and facilitated over the Lower Gorge Dam of 21 metres for some native fish. Trap and transfer may be helpful for native fish, but it is not a guaranteed success.

Fish screens at the intake points will prevent fish from entering the pump or canal systems by using sediment ponds with tried and proven fish screening options (see Engineering Report accompanying the AEE).

It is expected that the increased minimum flows in the Hurunui River will allow for fish passage of salmon and trout, and allow for native fish including whitebait.

13. Flow Moderation

A study on the ramping of flows has been conducted as part of the hydrology report by Pattle Delamore Partners (PDP).

The ramping effects were considered under different flow conditions, considering minimum flow conditions and mean annual flood conditions for different points in the river. It is possible to see the water level changes over short periods in these ramping graphs. These effects have been scrutinised by both our recreational and ecological teams to ensure that any changes are gradual enough that they are not a health and safety hazard during these periods. It has been ascertained that a 30 minute ramping period will minimise the impact.

Operation of these intakes will be monitored and regulated to maintain safe changes in pumping and intake capacities. The infrequency of the changes could take people by surprise and so it is recommended that a sign is posted at the Waitohi Recreation Reserve to inform people of the possible change in water levels.

Figures 6 to 9 are graphs showing indicative water level time series for locations of the river downstream on the lower Hurunui intake at The Peaks and Highway 7.

Figure 6: Flow Ramping Effects at The Peaks: Minimum Flow

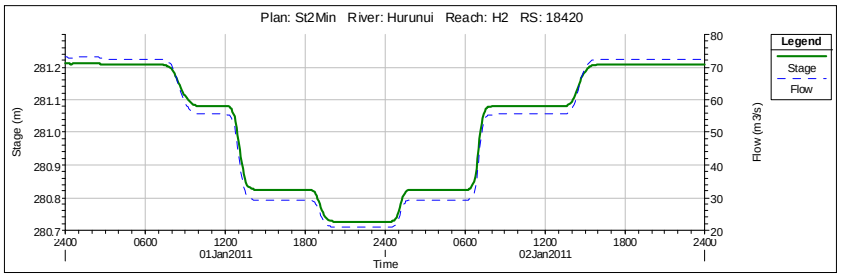


Figure 7: Flow Ramping Effects at The Peaks: Mean Annual Flood

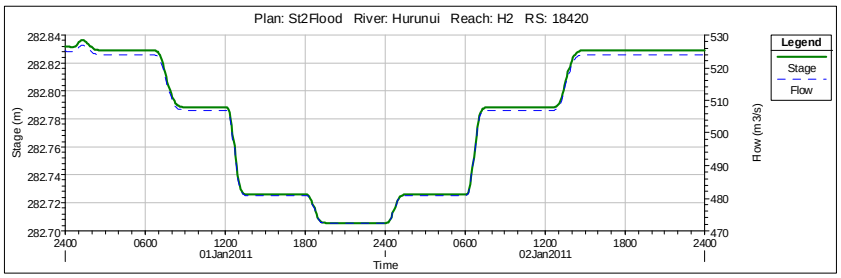


Figure 1: Flow Ramping Effects at State Highway 7: Minimum Flow

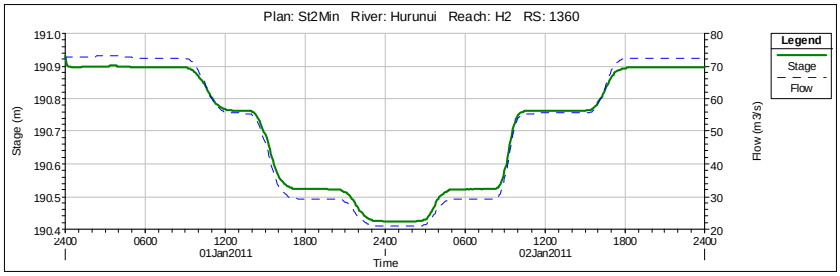
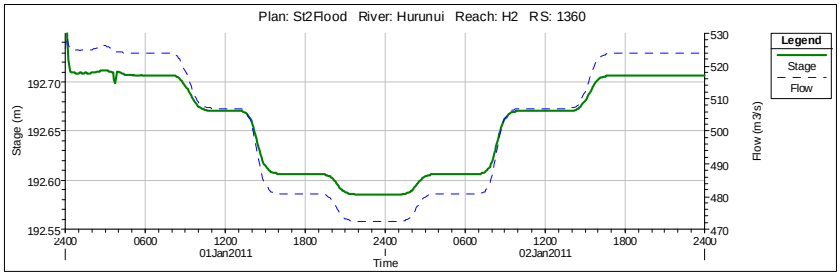


Figure 2: Flow Ramping Effects at State Highway 7: Mean Annual Flood



Final Comments

This Infrastructure Development Plan summarises the information that supports the AEE for the HWP Waitohi Irrigation and Hydro Project. The detailed engineering phase has yet to be commenced, but given the Canterbury Water Management Strategy (CWMS) targets, the work conducted by the Hurunui-Waiau Zone Committee and the momentum already captured by HWP with a project already in the consenting phase, the majority of the feasibility work has centred on how this scheme could fit with the CWMS and how it integrates with the rest of the Zone projects and goals. It is important for HWP that this scheme is a good fit with the collaborative effort, and that this change in direction is the right decision for the landowners. This Plan is an overview of the key aspects of that support work.