File AAP.42595.01.01
Applicant: Glenview Estate Ltd

6/10/21

INFORMATION REQUESTED UNDER S92(1)
Glenview Estate Hydroelectric power station at Knight Rd, Kokopu.

Dear Alisha,
This letter and attached reports aim to satisfy your S92(1) request for further information on the proposed hydro power project.
The following is in the order of your request.

1. Accompanying this letter is an assessment of environmental effects from Ecoprojects Consulting Collaborative, the freshwater ecologists being Terry Kennedy and Bernadine Kiro.
2. A clear site plan showing the location of all the schemes components is on page 14. This plan has been forwarded to all the iwi, hapu, Marae addresses supplied to me by yourselves as well as other tangatawhenua who have shown interest together with my Hapu Consultation documents.
3. Accompanying this letter is a prefeasibility study by John N Duder F Eng. NZ, CP Eng. At the back of the study is various maps and plans that include cross sections of the whole scheme and individual components.
4. Accompanying this letter is my Hapu Consultation documents that includes a full description of a travelling debris screen fitted with eel baskets. Of note is that travelling screens have been examined in Niwas Fish Screening for Canterbury – good practice guidelines. They state that travelling screens have a good performance record and with total prevention and entry. Travelling screens get their highest rating for proven technology and of note that this has been widely validated.
5. An assessment of policy D 1. 1 has been undertaken by Terry Kennedy and Bernadine Kiro and is included in the ecological assessment. With the conclusions in their assessment that a minimum flow of 200 litres per second down the river is the point

at which there are no adverse effects to the river, an elver fish passage and a travelling screen fitted with fish baskets all combine to create a sustainable hydroelectricity power generation scheme that does not trigger any environmental effects listed in D .1. 1.

6. With the previous paragraphs conclusion D .1 .2. Is not required however consultation with tangatawhenua has been ongoing. Accompanying this letter is Hapu Consultation documents that have been circulated to all local Maori groups and to Te Tiriti O Waitangi and Te Taitokerau Maori District Maori Council Kaunihera Maori O Taitokerau.
7. Mr Milan Ruka has sent me his Whatitiri Resource Management Plan which he says is registered at the Northland Regional Council. Relevant to this application is page 16 paragraph titled Energy – Hydro Generation and page 17. They accompany this letter. Generally, a summary would be that it supports sustainable renewable energy as long as it does not compromise the environment and in particular the lifecycle of eels.
8. The accompanying Hapu Consultation documents outline the applicants family history in the area and its association with the Wairua River. Feedback from tangatawhenua have illustrated that they are unaware of the ecology in the river next to Glenview Estate. Their ecological concerns as outlined in your letter focuses on eels whilst the applicant who has concerns about the eels also has concerns about kakahi (freshwater mussels) and freshwater crabs. This sustainable project rather than creating adverse effects to the environment actually will enhance the water quality especially in summer when stagnant waters come down river suffocating eels and other fish life. It will provide a haven for our freshwater mussels and native crab which are both listed by Doc as threatened etc.
9. The in river structures will have a nil adverse effect on eels travelling up and down river with the ecoproject team studying, editing and endorsing the Hapu Consultation documents and including them in their ecological assessment. The concrete weir and sluice sections maximum height above sea level will be 81.5 metres. The original pre Hikurangi swamp blasting height was 82. Currently elvers climb over 10 metres vertical to inverted shear rock

walls. A low weir with a gradual slope designed in accordance with Niwas Fish Passage Guidelines will be no problem.

10. Mr Milan Ruka has compared this sustainable scheme with Northpowers Wairua Falls power station. The true part of his comparison is that we intend generating power from the same river. Nothing else is the same. It is obvious from tangatawhenua consultation to date that there are many environmental issues surrounding the Wairua Falls power station. Our freshwater ecologists wanted to check that we were not creating the same issues as them however they were denied access. The big differences is that our scheme has an elver fish bypass stream which requires zero human involvement. Elvers upstream passage is not hindered whereas at the Wairua falls elvers have to be transported in vehicles to safety. If those involved are sick or do not turn up for any reason then the elvers passage is stalled. Secondly migrating adults travelling down river will be prevented from entering our pipes safely as opposed to the Wairua falls where tangatawhenua remain upset at the continued mortality rate. Thirdly our scheme enhances water quality (temperature, debris removal and oxygenating), as opposed to the Wairua falls where the summer water is stored in their 1.8 km canal gaining temperature and losing oxygen. Finally, our head pond and tail race will be carefully designed to provide habitat for eels, mussels, crabs and their ecosystems.

11. ESCP. Accompanying this letter is a map marking the areas of excavation. We envisage construction will take two full summers mainly so there is sufficient times of low river flow to build the weir and excavate the head pond. The rest of the earthworks can be done in a variety of river levels. Before any works can start detailed expensive geotechnical surveys must be done and those results may alter excavation quantity.

12. ESCP. Weir. The head rock about 40 and travelling out to 50 metres back from the waterfall edge will need to be cleaned and have anchor hole drilled into it to secure concrete parts of weir. A very small volume of rock extracted. The rock is solid basalt with zero silt or clay.

13. ESCP. Headpond. A headpond will be excavated up river of the weir. The edge of the pond will site the debris and eel screen,

and pipe intake structure. This structure needs to be foundered on solid rock which will be confirmed in a geotechnical investigation. Worst case scenario 12,000 cubic metres of silt will be excavated. This silt will be used as compacted fill covering the pipeline.

14. ESCP. Pipeline excavation. Assuming the weir and river height is at 81.5 metres above sea level (asl) then the pipeline will be 5.5 metres lower. With ground level at about 83 asl and the basalt rock at 80 asl, the approximate volumes to be excavated are 12,000 cubic metres of solid basalt rock and 7,500 cubic metres of dirt. The 7500 cubic metres of dirt will be kept handy to be returned to the trench covering pipes together with the silt from the head pond. The 12,000 of solid rock will be drilled, blasted, processed and removed. Spalls will be used as armour rock in headpond and tailrace. Riprap and Gabon sold. Fine grades used in Trench as a levelling compound and base for powerhouse and tailrace.
15. ESCP. Powerhouse. Maximum of 1500 cubic metres of allochthon.
16. ESCP. Fish passage. Very little excavation required, say 50 cubic metres.
17. ESCP. Tailrace. 35,275 cubic metres of clay, silt and allochthon. This will fill the existing drain and area inland between tailrace and hill. When finished that area will be mostly planted in native trees.
18. Your 17/3/2021 letter S92(1) request for further information requests an actual sediment and erosion control plan. This seems a little premature in this project as a lot of geotechnical work is still required and detailed working plans will take at least 12 months to prepare. When contracts are tendered for an ESCP to be designed in accordance with Auckland Council's guideline document "Erosion and Sediment Control Guide for Land Disturbing Activities can be made a condition as will be the Regional Council approving that plan.
19. This is a very easy site to work as a site visit by yourselves would prove.

Please do not hesitate to contact me should you not be able to find all the details that you require.

Yours Faithfully
Neil Lewis. Director Glenview Estate Limited.

EEL SCREEN

Travelling Screen

The eel screen to be used in this project is commonly called a travelling screen.

The purpose of the screen is to filter debris and fish from entering our hydro power generation station. Debris must not enter the penstocks as it will be forced into the turbines and cause blockages and damage.
Fish must not enter as the propellers in the turbines would kill them.

In our situation the only fish requiring protection from the turbines are eels. Their lifecycle involves them migrating down the river in the autumn as the first part of their journey to spawn and die in the South Pacific Ocean. These eels are fully mature fat and full of eggs.Their migration seems to be triggered by the first autumn rains. They use the rivers current to get them to the Sea.

Although in this project only a proportion of the rivers flow will go through our penstocks especially in autumn floods which have been flowing at 200 to 270 cubic metres per second (we take maximum of 24 cubic metres per second), should migrating eel choose to swim into our debris screen then they will likely get stuck as the rivers current is travelling faster than they can swim. Water pressure then will hold them against the screen. In other hydro dams and screen very high mortality occurs to these trapped eels when the debris is mechanically removed often with devices similar to excavators with steel rake fingers.

We plan to have a zero eel mortality.
To do this we will be having a travelling screen with built in eel baskets.
A travelling screen is a screen which mechanically rotates by having sprockets top and bottom on both sides of it. Around the left and right sprockets is an endless chain that has horizontal bars welded between them at 10 ml spacing. Below every 75 bars will be a steel basket perforated with slots so that when the screen is rotated a large weight of water is not lifted.
The screen will operate and rotate when required. In floods and high debris times it will be continually rotating. In normal river flows every hour , and in normal flows when the water pressure is greater on the up river side of the screen as compared to the penstock side it will also rotate. It can be manually started from I phone and timings adjusted also remotely. Should debris jam

the screen auto alterts are sent to operator and screen reverses before going forward again.

Niwa Fish Passage Guidelines

Most of New Zealand,s in river/ stream structures come under the directions of Niwa,s Fish Passage Guidelines (NFPG)

NFPG 1.2 states the design of water intakes, diversions and pump screens outside of its scope.

NFPG 1.2. State that the guidelines recognise the need for ongoing design development of fish passage solutions to ensure the best outcome for our freshwater ecosystems. There is a need for innovative solutions...

NFPG page103
Intentionally screened barriers (eg water intakes) should generally exclude all fish.

NFPG 8.4
The need for novel solutions and innovative approaches

Our travelling screen is to be designed to specifically catch and lift out of harms way, eels. As an eel which has been held against the screen by water pressure is lifted out of the water and released it will fall into an eel tray. When the eel basket / tray is next to an eel passage a jet/ plug of water will flush the eel into the eel passage. From there the eel will make its own way to an exit below the weir.

Niwa Fish Screening for Canterbury – Good Practice Guidelines

3.1.1
Screens should try to be parallel or diagonal to river flows.

3.1.3
Travelling Screens

Page 13, figure 5 . Shows a design and workings of travelling screens.

Please be aware that these best practice guidelines were produced 10 April 2007. In the last 15 years there has been dramatic improvements in the technology of these screens and the latest are infinitely better than what is seen in figure 5.

Niwa state that travelling screens have a good performance record and with total prevention and entry.
There are many of these travelling screens world wide with many manufacturers. In North America they have good results in screening 0.7 to 21 cubic metres per second. In North America and other countries many are fitted with fish baskets.
The only disadvantage with travelling screens is their cost. There are nil in New Zealand. On this note a screens cost will be over $500,000

4.3.3
Summaries Table 7.
In table 7 all different sorts of screens are compared along side each other.
The travelling screen gets the highest rating of good for in canal and diversions.
The travelling screen gets the highest rating for fish exclusion and effectiveness.
The travelling screen gets the highest rating for proven technology. Of note is that the proven technology has been widely validated.

These screens can be seen working on the following sites
www evoqua.com
www internationalwaterscreens.com

Tangatawhenua and Hapu consultant paper.

Hydro electricity power generation project.

Glenview Estate Ltd is proposing to build a run of river hydro electricity power generation power station on its farm at 512 Knight Road, Kokopu.
The scheme will comprise of a weir and sluice gate situated about 50 metres up river from the Purua waterfall on the Wairua river. This will create a head pond that will maintain an even draw off river height.
Immediately up river of the weir will be a screened intake structure which passes water into pipes which travel about 300 metres to a power house where the electricity is generated. From the power house all the water is returned to the main river about another 170 metres away.

This run of river scheme is very different from traditional power projects as it has no ability to dam the river for water storage and no long power canals to hold and stagnate waters. It only uses available water with the rest flowing over the weir and waterfall.

Previous Hydro Electricity Generation studies on Purua rapids.

1. 1978. Tonkin and Taylor study found the West Bank to have a 2890 kw potential
2. 1983 and 2003 by North Auckland electric power board
3. 2007 by Northpower
4. 2020 published by govt as Northlands best potential site.

Eco Scheme
Glenview motivation for progressing current scheme.

Glenview is owned by the Lewis family's who have been farming on Knight Road since freeholding the original part from the Government in the 1980's. Neil Lewis's family has a very long association within the area with his great grandfather being New Zealand's first Maori surveyor who surveyed most of our area, and his grandfather who farmed here and was building the Wairua falls power station when the First World War broke.

Whilst not being Tangatawhenua the Lewis's have lived beside the Wairua for the majority of their lives and have witnessed its degradation and have were upset at some of the previous proposed schemes by outside companies.

The opportunity for an ecologically sustainable scheme beckons. It is sad to see all the renewable energy flowing to waste whilst having to use electricity generated from diesel and coal, and knowing that the energy derived from fossil fuels are destroying our planet.

As well as boundering the waterfall the Lewis's farm bounders two very long section of rocky rapids. Those rapids once supported colonies of native fresh water mussels (kakahi). The colonies could be easily found as on the rocky river banks were large heaps of shells broken by birds dropping them from height. 30 to 35 years ago our children could hunt for these mussels in the river. Today those rocky rapids are covered with a horrible algae slim that has choked out the ecosystems.

As a part of an ecosystem where birds picked , dropped , broke open and then eat these freshwater mussels, the debris left in those broken shells were cleaned up by our freshwater crab , in fact New Zealand's only freshwater crab. They could be found by day under rotting timber and at night foraging on the mussel leftovers.
These crabs (halicarcinus lacustris) are a very small and invertebrate growing only to about 10 mm wide with a 'H' shaped groove on its back. They are generally small and weak with poor eye sight. They are food for fish and eels so they forage at night.
These crabs have a DOC classification of ' at risk and naturally uncommon being biologically scarce '.

As the rivers water quality has declined the mussels disappeared from the river rapids
Facts about freshwater mussels known to Maori as Kakahi. These mussels have been identified as hyridella menziesi a bivalve mussel which grows to 50 to 90 mm and can live for 60 to 70 years.. They are filter feeders which do an awesome job of filtering 1 litre of sediment laiden water per hour. A colony of a million mussels wold filter 24 million litres of water per day, every day.
The mussels lifecycle involves the males releasing sperm into the water in the summer time. The females inhale the sperm as it passes them to fertilise its eggs. Once the eggs are fertilised the female attracts native fish to them and releases the eggs (glochidia) onto the fishes gills, skin and fins. The eggs

parasitically live off the fish for about two weeks before being dropped off onto a new site to grow. The eggs can only last 2 to 3 days in the female mussels waiting for a host fish. After that they die.

The real problem with the river in respect of the mussels lifecycle is that there is huge amounts of sediment choking the native fish and the up river summer stagnation has the effect on the water of reducing the dissolved oxygen levels so that the native fish can not survive. No fish no mussels. 20 years ago there were no small young mussels only old ones which can not breed because there are no fish. This phenomenon is known as debt extinction.
Adding to the loss of the mussels will be the loss of these rare crabs which use the mussels as food.

Kakahi was a valued Maori food and medicine and its juices used as milk for motherless infants.

Over many years Neil Lewis has tried to champion the mussel cause. Letters were distributed to all the Knight Road residents, DOC informed of the mussels life status , combined meetings at council with NRC and District deputy majors councillors and dept heads. Everyone nodded and agreed but did nothing.

The next step taken was to seed a farm water drain which runs clear water through summers with mussels. The drain was home for tiny mosquito fish in floods when the river becomes filthy and smelly. Things went well for a few years until heavy rains brought heavy sediment from Knight Road down the drains and then a bad summer drought completely dried up the drain.

Lately successive summer droughts have highlighted the dangers of the effects of global warming on our rivers ecosystems. Most ecologists, climate researchers have agreed on the need to do what we can to prevent global warming. The government has New Zealand in a climate emergency. Reducing our use of fossil fuels is one of the keys.
In the last few summers there has been little rainfall which seems to have resulted in the swamps canals and drains stagnating. The odd small weather event has had the effect of flushing the stagnant water down to our rocks, rapids and pools. When combined with the fact that the water flows over basalt rocks that are too hot to walk on at times causing water temperatures up to 20 degrees , the slime and algae forms into long floating masses.

The concerns created from the waste of clean renewable energy, the degradation of the rivers waters , the loss of habitats for essential freshwater native fish, the potential extinction of our freshwater mussels in this part of our river, the loss of habitat and ecosystem for our rare freshwater crabs have resulted in the idea of a power scheme that combines the changing of wasted energy into renewable energy and reoxygenating the tailrace and a part of the river so that there is an oxygenated habitat that the native fish and eels can thrive and recolonisation of our fresh water mussels can be successful . Hopefully a home can be made for our native crabs and or the cleaner oxygenated waters may make their previous home liveable again.

The aim is that everything done will be in a sustainable way so that rather than causing adverse effects to any part of the river or its ecology , the effects will be positive enhancement .
The water used will be filtered of algae, weed and rubbish and that filtered debris will be composted and returned to farm soils. The water travelling through the pipes and penstocks will have a lower temperature than had it travelled over the hot basalt rocks in summer. Air will be added to the water in the turbines and draft tube which will effectively raise the dissolved oxygen 2 to 3 parts per million so that native fish can thrive.
Migrating eels will be prevented from entering the penstocks and elvers will have their own fish bypass so that the system does not rely on human intervention to get them up river of the power station.

Establishing the tailrace lined with basalt rock, rock groins, logs and stumps and fed with filtered and oxygenated water that leads into a large existing scour pool will provide a home for native fish and eels to thrive in, for mussels to grow in and which in turn will filter sediment from the water. The tailrace edges will be planted in trees to provide further cooling for the water. The lands between the tailrace and the river will be retired from pasture and planted in native trees.

Hopefully this habitat will suit the native crabs.

Prefeasibility Study

John N Duder, F Eng NZ, CP Eng who is one of New Zealand's most experienced hydro engineers has completed as prefeasibility study on a run of river hydro scheme. This has resulted in a conclusion that there is a potentially feasible scheme which could generate 3.0 MW of power per hour when generating at peak.

Initial Tangatawhenua Consultation

The first research of this project, before any pen was put to paper and before any consultants were employed, was finding and talking to Tangatawhenua who hold the traditional authority over the Wairua river next to our farm.

It became clear that Tangatawhenua from the Korokota Marae hold that authority over both the Wairua and Mangakahia rivers. Their Marae is situated beside the Wairua river and close to the Wairua Falls and power station.
Early talks about 4 years ago informed those members of a possible scheme and importantly found the key ecological issues for the proposed scheme. . Their experiences in dealing with eel recovery, water, silt and sacred burial sites at the Wairua falls power station has been very helpful in planning this current scheme.
As a result of these talks non negotiable issues have been highlighted

1. The health of the rivers eel travelling down rivers and elvers travelling up river.
2. The control of silt.
3. A zero water take
4. The possibilities of sacred burial sites in rock caves.

As ideas and rough plans were initiated communication with tangatawhenua continued, not as consultation about any exact plans but more as a heads up that something was happening and again an opportunity to gain more knowledge of eel behaviour and things to be aware of.

Again being respectful of Korokota Marae 's Tangatawhenua kaitiaki role of the Wairua this consultation paper will have been fist sent to those members.

Statutory Consultation

National Policy Statements are prepared by central government and covers matters of national significance including renewable hydro electricity power generation.

Regional Policy Statements and regional plans give effect to National Policy Statements and provides rules and identifies issues related to the development use, and protection of resources . Renewable hydro electricity power generation is virtually a permitted activity after having passed all but less than minor environmental effects and has had Tangatawhenua consultation.

The Resource Management Act requires councils to pre notify Tangatawhenua through iwi authorities on all plans.

The Resource Management Act requires Councils to recognise and give effect to iwi and hapu management plans when preparing all of their plans and statements.

As the result of the above it is sort of deemed that iwi and hapu have been consulted about the provisions for Regionally significant infrastructure and renewable energy. Tangatawhenua consultation focuses on the effects on Tangatawhenua and their taonga

Generally National Policy Statements and all the other descending in significance Statements, plans, and management strategies all note the significance of renewable hydro electricity generation, its importance to communities and its need to be located in the place of the resource.

The Whatitiri Resource Management Plan forwarded to me by Mr Milan Ruka is a hapu management plan written to ensure Mana Whenua Ki Whatitiri are a participant in both Council planning , resource consent applications , and environmental management.

The mission statement is to revitalise the health and wellbeing of our environment and our people.

Page 16 of the Whatitiri resource management plan Energy- Hydro Generation.

4.5. Issues.

(a) Tuna lifecycle has suffered greatly from impassable infrastructure and high mortality rates as a result ....

(b) ....no economic benefit..

(c) .....no accesss...

(d) Access to traditional sites on the Wairua river blocked...

(e). Lack of monitoring of consent compliance..

4.6. Objectives.

(a). To maintain, protect and enhance where possible our waterways ,their habitats and our taonga species from inappropriate power generation schemes.
(b). To create an awesome income stream from renewable hydro energy for our hapu that is environmentally sustainable and does not compromise aquatic life.

4.7. Policies
(a). The Whatitiri RMU will promote the philosophy of kaitiakitanga of natural resources and the environment to be maintained through use of sustainable renewable energy.
(b) Locally produced renewable energy that is of an appropriate scale and uses appropriate technology is supported by the Whatitiri RMU
(c). Whatitiri RMU will work to grow the capacity of Mana Whenua in regard to micro energy production and will seek opportunities for employment and training utilising natural resources within our rohe
(d). Whatitiri RMU will endeavour to improve relationships with existing energy generators.....

Summary of Policies
All national, regional, district policy statements and plans together with the Whatitiri RMU policies support the production of renewable energy especially when there is an absence of harmful environmental effects.

Scheme in Detail.
Bear in mind that the scheme fine points including detailed geotechnical work are yet to be designed and engineered as the cost is too great without resource consent.
A maximum of 24 cubic metres per second of water will be diverted.
All water diverted will be returned to the main river about 480 metres downstream from the diversion.

1. Weir.
   The intention is to build a low concrete weir across the rocks about 50 metres up river of the waterfall. The weir will not be at right angles to the banks. Instead it will be on an angle so that the far right side is a lot

closer to the waterfall edge. It's purpose will be to maintain a full pipeline to suit the large range of turbine flow conditions while also providing a constant residual flow over the waterfall. In a longitudinal profile the weir will have a maximum elevation of 81.5 metres above sea level (asl) .

The waterfall has been altered from its natural height already. In about 1922 it was drilled and blasted by the Hikurangi drainage board as the first part of draining the Hikurangi swamp. Currently two channels on both banks carry most of the water except in floods when the whole thing is covered. The original height across the front edge of the waterfall is at 82 asl. This was a natural weir and 0.5 metre higher than the weir we propose to build.

This waterfall and the Wairua falls and power station down river are complete natural obstacles for all but climbing fish. Nevertheless the weir has been designed in accordance with the recommendations of section 4.3 of the NIWA Fish Passage Guidelines.

The concrete mass will have a hydraulically efficient ogee shaped crest which replicates the natural shape of water falling over a crest and recommended by Niwa FPG (page 65 , upstream weir face) 150 to 200 mm rocks will be embedded into the concrete to help elver travel up river once they have scaled the vertical sides of the waterfall.

On the eastern side of the weir which is the closest to the waterfall a notch will release a continual 200 litres per second environmental flow. That being said in times of high flow ,large volumes will flow over the weir and notch. Similarly in very low flows all the rivers water will flow over the weir.

Built into the weir on the left bank will be flood sluice gates which have the purpose of opening in high flows and floods so that the scheme does not cause any up river flooding. These gates may well be in the form of a deflatable rubber dam .

2. Head Pond.

Up river of the weir on the left bank about 12000 cubic metres of earth will be excavated. This will be taken from Glenview lands who have a riparian boundary with the river. The effect will be to enlarge the existing pond. In this area a large concrete intake structure anchored in rock will be built. Water for electricity generation will flow through this structure and into pipes leading to a power house about 300 metres away.

In front of the intake structure will be a floating debris screen. This is designed to deflect large floating debris away from the intake structure and towards the weir and waterfall.
Attached to the intake will be a debris and eel screen.
The walls of the new part of the head pond will be lined with basalt rocks. The sides and bottom will include logs and stump to create a fish habitat.

3. Eel and Debris Screen

The eel screen to be used in this project is commonly called a travelling screen.
The purpose of the screen is to stop debris and fish from entering our hydro power generation station. Debris must not enter the penstocks as it will be forced into the turbines and cause damage and blockages. Similarly fish will be killed by the turbines propellers.

In our situation the only fish requiring protection from the turbines are eels. Their life cycle involves them migrating down the river in the autumn as the first part of their journey to spawn and die in the South Pacific Ocean. These eels are fully mature , fat and full of eggs. Their migration seems to be triggered by the first autumn rains. Being average swimmers they use the rivers current to get them to the sea.

Although in this project only a proportion of the rivers flow will go through our penstocks especially in the autumn floods which have been flowing at 200 to 300 cubic metres of water per second (we take a maximum of 24 metres per second) should migrating eels choose to swim into out debris screen, as the rivers current and the current into our pipes are travelling at a faster speed than they can swim water pressure will then hold them against the screen. In other hydro dams and schemes very high mortality occurs to these trapped eels when the debris is mechanically removed often with devices similar to excavators with steel rake fingers.

We plan to have zero eel mortality.

To do this we will have a travelling screen with built in eel baskets. It will mechanically rotate by having sprockets top and bottom on both sides.

Around left and right sprockets is an endless chain that has horizontal bars welded between them at 10 mm spacing. Below about every 75 bars will be stainless steel baskets perforated with slots so that when the screens are lifted a large weight of water is not lifted. The screen will rotate when required on pressure sensors and switches that tell the difference in water pressure either sides of the screen. In normal flows it will operate every hour but in floods and high debris times it will go continuous. It will be able to be operated manually from a cell phone. Should debris jam the screen it will reverse before going forward again. Any jams will sent auto alerts to management.

Niwa Fish Passage Guidelines state that there is a need for novel solutions and innovative approaches to fish screens (NFPG 8.4) and that intentionally screened barriers (eg water intakes) generally should exclude all fish (NFPG. Page 103)

Our travelling screen is to be designed to specifically catch eels trapped against the screen by water pressure and lift them out of harms way. When an eel which has been held against the screen is lifted out of the water and the holding pressure is released they will fall into an eel basket / tray and lifted up next to an eel passage. A jet / plug of water will flush the eel into an eel passage pipe which will ale the eel back to the river just below the weir.

Our eel screen complies with Niwa Fish Screening for Canterbury- good practice guidelines.

3.1.1. Screens should try to be parallel or diagonal to river flows

3.1.2. Travelling screens. Page 13, figure 5 shows a design and workings of a travelling screen. This was produced on 10 April 2007. And since then these screens are infinitely better.

Niwa state that travelling screens have a good performance record and with **total prevention and entry.**
There are many of these screens worldwide and many manufacturers. There are many in North America and other countries fitted with fish baskets Screening trout and salmons.

The only disadvantage of travelling screens is their cost. There is nil in NZ.

4.3.3. Niwa has done a comparison table with all different types of screens Summaries Table 7.
The travelling screen gets their highest rating of good for in canal and diversions
The travelling screen gets the highest rating for fish exclusion and effectiveness
The travelling screen gets the highest rating for proven technology.
Of note is that proven technology has been widely validated.
These screens can be seen working on the following websites
Www evoqua.com
Www internationalwaterscreens.com

4. The Pipeline
The pipes will be sized to carry an estimated maximum flow of 24 cubic metres of water per second. The pipes will be buried at about 5 metres below the current ground level. The trench will have the top and bottom soils dug out and stockpiled to be eventually used to cover the pipes. The basalt will be drilled and blasted. Spalls will be used to line the tail race and head pond. The fines will be compacted around the pipes and gabions sized rocks sold. The approximate 12,000 cubic metres of fill from the head pond digging will also be distributed along the trench as fill. The backfilled trench will be regressed and returned to pasture.

5. The Power Station
This will be a concrete sub structure housing two Kaplan turbine and generators. Detailed geotechnical will determine the exact powerhouse position.
The two 1.5 megawatt Kaplan turbines are fed water from two penstock pipes with a maximum volume at 12 cubic metres per second each.
As an initiative to enhance the water quality air will be introduced into the low pressure vortexes in the turbines and around the walls of the

draft the tubes with the intention of raising the waters dissolved oxygen levels 2 to 3 mgs per litre of water in the tail race.
A tee and valve will be added to the base of one penstock as a future proofing for further reoxygenation of low flows.

6. Tailrace
   A trapezoidal channel will be excavated from the powerhouse to the river scour pool about 170 to 200 metres away. The channel sides will be armoured with basalt spalls and the channel floor will have position designed rock groins in accordance with fishery recommendations.
   The tailrace will return the waters to he main river in a scour pool that currently receives water from rapids. It pass through a 20 metre wide DOC strip without effecting any trees.

   Between the tailrace the rivers rocky rapids will be a fish passage. It will be dug in the shaded area at the base on the existing bank and trees, have deeper resting pools and lined with rocks and spalls in accordance with the Niwa Fish Passage Guidelines. A small continual flow of water will come from the rapids through the fish passage and into the tailraceup by the powerhouse. To further help elvers exit the tail race mussel ropes will be n place.
   The water level at the tailrace end of the passage will be about 63 asl and rise about 3 metres to 66 asl at the river meaning that the fish passage can be easily made to be a bubbling aerated stream.

Stage 2 of Project.

Stage 1 will have a T fitting in the penstock in the powerhouse. Attached to this is a shut off valve.
Stage 2 will see a very small crossflow turbine attached to the valve. It's purpose will be to use low flow waters that are basically stagnant. The crossflow has a large central void which can be charged with air. The energy generated will be used to continuously run the eel and debris screen (the stagnant water is very weedy and slimed) and some sort of air blower pump. The objective will be to raise the dissolved oxygen levels to 8 – 9 parts per million. 4 parts per million is sufficient for fish life and 9 is at the very top of the oxygenation scale. Currently summer low flows have next to zero oxygen.

Transmission

A 33 kv transmission line will run from the power station to Stratton road , across two private properties to the intersection of Malone road and Kokopu roads
and there on to Northpowers Poroti sub station on Mangakahia road.

Sustainable Renewable Energy for Local Communities

Glenview has been in negotiations with Platinum Power for several years and have a verbal agreement in principle for Platinum Power to construct the transmission lines as well as purchase the energy as a electricity retail company.
Platinum Power has a strong relationship with Maori communities and a desire to provide Marae and their whenua affordable power and incentives that also support local Marae or whanau.
Currently Platinum Power has a signed memorandum of understanding with Taitokerau District Council kaunihera Maori o Taiokerau which ensures that the power rates proposed onto the Top Energy network customers are a fair and reasonable rate which remonstrated the commitment of Platinum Energy Ltd to Te Tiriti O Waitangi and Taitokerau Maori District Maori Council Kaunihera Maori o Taitokerau.
This agreement was signed on 30.4.2021. By Platinum directors and Rahiri Dargaville for the Taitokerau District Maori Council.

Platinum Powers agreement is based around the use of Ngawha geothermal power.
Should this project go ahead we envisage Platinum Power using Glenview electricity in the same ways to our local communities.

Further Wairua River Restoration.

Dove tailed into this project is another. About 400 metres up river of the power project is 1 – 2 kilometres of the abandoned Wairua River riverbed and dry diversion channels. These lie dry in all but floods and was named as a flood overflow channel by the Hikurangi drainage board.
The history behind this dry river bed is: the riverbed is all basalt rock that arrived in the form of Northlands longest lava flow out of Mirowhakatiki. That was 1 to 3 million years ago and was what blocked the Wairua valley and created the Hikurangi swamp.
These diversions of the then named Wairua rapids (later called the Mangere rapids and now the Purua rapids) were first surveyed in 1879, however the first large scale drainage scheme was not started until 1919 by the Lands and Survey Department.
The Basalt lava flow that formed the Purua waterfall and the upstream shallow rock bottomed river was seen as a plug to the swamp.
First to be drilled and blasted in 1922 was the waterfall. Next was the up river basalt rapids. The scheme was to excavate a series of diversions, 13 in total, and widen, deepen and straighten a river channel 2 miles 15 chain long. The channel dimensions being 120 feet surface width, 50 feet bottom width and being 20 feet deep. In doing this work 287,000 cubic yards of rock and 116,000 yards of clay were excavated.
The result of the excavations is a new river summer water level of 13 feet (3.96 metres) at the rapids and 9 feet (2.75 metres) at the start of the swamp.
The land between both channels was heaped with the soil and rock that was removed from the new channel. It is now cloaked in self sown trees.

Unfortunately the new channel being very straight has no rock features to tumble, fold back and oxygenate low summer flows.

What beckons is a new designed riverbed in the dry bed to take the summer stagnant low flows whilst not constricting winter floods
The rock bottom needs to be deepened by 2 to 3 metres . Deep holes for cooling the water need to be blasted. Huge 100 year old trees already exist to shade the holes.
Rock groins and inverting rapids need to be designed to maximise oxygenation of the low flow waters.
Shallow edges planted in raupo and oxygenating reeds need to be designed and planted to provide habitat for eels and other native fish.
The new riverbed needs to be seeded with freshwater mussels to help filter sediment and provide food for fish.

A very low weir needs to be built across to new channel to direct the summer low flows down the rebuilt natural riverbed.

Summary

All policies , statements and plans encourage renewable hydro electricity power generation provided there is no adverse environmental effects.

In this project improving water quality so that the freshwater mussels and native crabs ecosystems may survive and thrive is a motivating reason for the project together with the benefits of renewable energy for our planet.

Neil Lewis and an independent ecologist can find no adverse effects to the environment.
Should adverse effects be found that can not be mitigated all parts of this project will be canned.

We reject that this project is the same as Northpowers. We will not comment on their environmental issues and 100 year old systems.

For eels travelling up river, a fish passage will allow them to swim and climb without human intervention.
Migrating eels will be prevented from entering the penstocks though a rotating travelling screen fitted with eel baskets.
Water leaving the draft tubes will be cooler than had it travelled over hot basalt rocks, it will have more oxygen in it , and be free of weed and debris.
This enhanced water will provide a better habitat for eels, other native fish, fresh water mussels and our fresh water crabs.
These crabs and mussels are food for eels.

Dovetailed into the project is two other initiatives to oxygenate the waters, restoration the river and provide more habitat for eels, fish, crabs , mussels, and their ecosystems.

With regard to the big picture of global warning and its disastrous extreme weather effects it is up to everyone to do there best. This scheme is the Lewis's best effort to do what they can.
Major adverse effects to the river and its ecology will be the result of climate change in the future. We are now in a climate emergency and have a small window to stop using fossil fuels. Preventing renewable energy projects is the same as causing major adverse effects.

Conclusion

Sometime in the future there will be a site visit day when it would be good to have representatives from all interested hapu in attendance.
Hapu or individuals who need questions answered or may prefer their own site visit should email Neil at lewslot@xtra.co.nz

RC Application: – APP042595.01.01
Applicant: Glenview Estate Ltd.

Attention: Alisha Vivian
Consents Officer
Northland Regional Council » Te Kaunihera ā rohe o Te Taitokerau

30 September 2021

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emissions trading scheme administrator

Proposed Purua Rapids Hydroelectric Scheme - Assessment of Ecological Effects

***Figure 1*: The Falls.** The unnamed waterfall in the section of the Wairua River affected by the proposed hydroelectric scheme (sometimes described as Purua Falls).

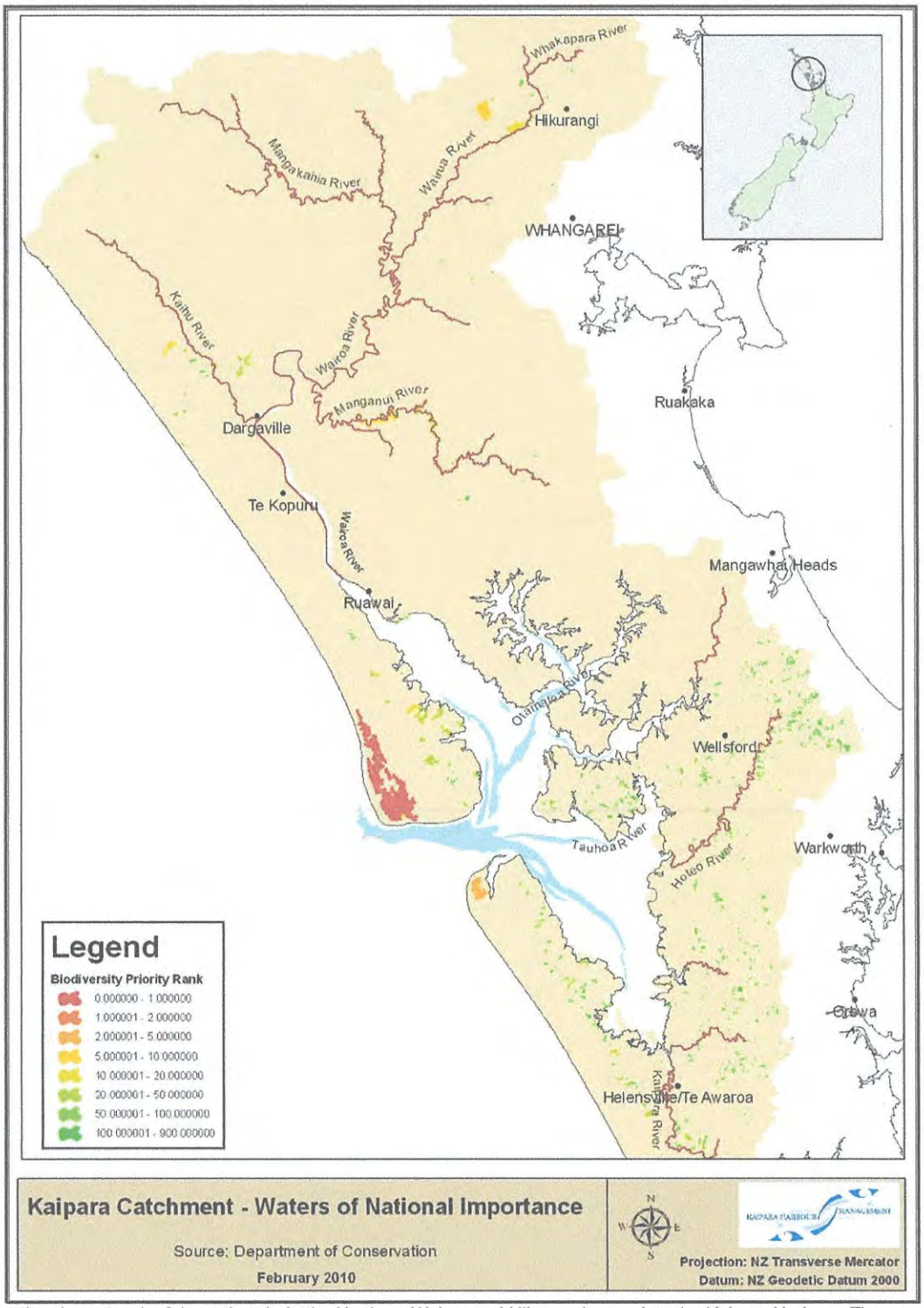


Figure 2: Showing the network of rivers that drain the Northern Wairoa and Hikurangi areas into the Kaipara Harbour. The proposed hydroelectric scheme is a little southwest of Hikurangi on the Wairua River.

Figure 3: Showing the affected section of the Wairua River encompassed by the proposed Purua Falls hydroelectric scheme. On the eastern side of the river, the schemes water intake is around the top of the photo and the outlet back into the river is near the bottom of the photo. The river is shown in high flow following a substantial rainfall event.

Introduction

Glenview Estate Ltd is proposing to build a run of river hydroelectricity power generation power station on its farm at 512 Knight Road, Kokopu. Neil Lewis, on behalf of Glenview Estate Ltd, approached Ecoprojects Consulting Collaborative in April 2021 to provide an ecological assessment, as requested by the Northland Regional Council (NRC) detailing the effects of a proposed hydroelectric plant on the Wairua River.

Ecoprojects agreed to provide the following services relating to request S92 (1) from NRC in response to **Resource Consent Application – APP042595.01.01** requiring:

(1) An updated Assessment of Environmental Effects on the impact of the river diversion and associated structures on flora and fauna within the portion of the river affected by the proposal.

(4) An assessment of Policy D.1.1 to establish the effects of the activity on tangata whenua and their toanga.

"D.1.1 When an analysis of effects on tangāta whenua and their taonga is required A resource consent application must include in its assessment of environmental effects an analysis of the effects of an activity on tangāta whenua and their taonga112 if one or more of the following is likely:

1) adverse effects on mahinga kai113 or access to mahinga kai114, or

2) any damage, destruction or loss of access to wāhi tapu, sites of customary value and other ancestral sites and taonga with which Māori have a special relationship115, or

3) adverse effects on indigenous biodiversity in the beds of waterbodies or the coastal marine area where it impacts on the ability of tangāta whenua to carry out cultural and traditional activities116 , or

4) the use of genetic engineering and the release of genetically modified organisms to the environment, or

5) adverse effects on tāiapure, mataitai or Māori non-commercial fisheries, 117 or

6) adverse effects on protected customary rights, 118 or

7) adverse effects on sites and areas of significance to tangāta whenua mapped in the Regional Plan (refer I Maps | Ngā mahere matawhenua)."

NRC noted the key concern to tangata whenua would be the adverse effects on tuna (eels) which are both mahinga kai and a toanga and access to mahinga kai sites upriver.

An initial assessment of the affected area was carried out by Terry Kennedy and Bernadine Kiro (ecologists). They held a follow up meeting and preliminary consultation with members of the iwi shortly after.

The river was of moderate flow at the time and was representative of its normal condition for the time of year, being between major weather events.

Testing of water quality was carried out utilizing the SHMAK system (NIWA's Stream Health Monitoring Assessment Kit). Counts of river fauna species were carried out on two separate occasions.

This report draws also on the Waitangi document "Northland Rural Rivers Environmental Management, Pollution and Kaitiakitanga since 1991" WAI 1040 #A60, for historical perspectives regarding the potential effects of further activity on the health of the river system.

Ecological assessment of the affected portion of the Wairua River

The Wairua River flows through the drained Hikurangi Swamp catchment from the Whakapara River over a basalt floored plane heavily populated with dairy farms, cropping areas and beef farms.

The river is rich with nutrients and nitrates carried into the river by groundwater flows and as a result an overabundance of in-stream flora is apparent along the section observed.

There are two large waterfalls on the lower section of the Wairua River that form an impassable barrier to diadromous fish species.

The presence of eels (*Anguilla australis; Anguilla dieffenbachia*) above the falls indicates the ability of elvers to bypass the falls by climbing overland.

A NIWA ecological survey carried out in 1999 (NRC00203/1) dated February 2000, details the populations and taxa of the river above and below the falls at the time and will not be reproduced herein. The conclusions of this report and gathered anecdotal evidence demonstrate that native fish species have not managed to overcome the obstacles and make the journey upstream.

Our initial assessment and subsequent on-site observations confirm this is still the case.

The water tested was carrying no sediment and was of excellent clarity but the pH 4.5 taken during the day was tending toward acidic and had a high nutrient content.

Retesting two weeks later following a rainfall event showed a pH of 4 indicating an upstream discharge of acidic material.

River topography of the affected section.

The section of the Wairua River adjoining Glenview, although anthropologically altered during the swamp drainage is geologically an ideal base for a healthy and energetic freshwater ecosystem. There are varied geological features each presenting changes in the flow patterns.

There are narrow channels interspersed with rapids and scour holes above and below the falls plus boulder fields in the flat areas of the riverbed.

Positive effects of existing topography:

The Rapids

- Support oxygenation.
- Vary the flow rates.
- Allow the river water to absorb minerals from the rock bed.

The Waterfall

- Drives oxygen into the pool below.
- Creates vortices and backflow energizing the pool.
- Increases turbidity, mobilizes, and transports sediment.

The Deep Pools

- Cool and stratify water into temperature zones.
- Provide rest areas for migrating fish and eels.
- Hold large quantities of water modifying microclimatic conditions.

Adverse effects of existing topography:

The flood remediation canals that have been excavated above the affected area have a detrimental effect on the water passing through the project section of the river.

The canal structures

- Reduce the capacity of the river to deposit sediment.
- Reduce the capacity of the river to accumulate oxygen.
- Expose the river water to sunlight over extended distances.
- Reduce the ability of the river to accumulate energy normally gained by the meandering action.
- Reduce the ability of the river to cleanse itself of nitrates.
- Reduce the ability of the river to maintain a positive temperature gradient.

Water temperature:
The positive temperature gradient for a healthy functioning waterway progresses downward toward 4 degrees Celsius.
The negative gradient is upward toward 9 degrees Celsius.

At this upper level the river sheds its oxygen and overheats.
A habitat for pathogens algae and eutrophic flora is created.
The Wairua's central vortex collapses. See central vortex in ***Figure 4*** below.

Water temperatures in the Wairua River regularly exceed the 9 degrees maxim and over summer can reach up to 20 degrees.

Figure 4: Showing the vortex that when functioning:

- Centralizes current flow.
- Guides and supports fish migration.
- Carries the Wairua (life force) upstream.

The scour holes

There are two major scour holes in the section of the river being addressed.

The 9m deep scour hole below the falls was deepened during the Hikurangi drainage works by blasting through the basalt bedrock. It penetrates the allochthon clay substrate.

There are strong back flow currents below the falls that draw floating material downward before ejecting it downstream. This presents a dangerous situation for recreational users of the river.

The depth of this pool aids greatly in cooling and enhancing the quality of the water collecting there by creating a stratum of temperature.

Scouring of the riverbanks in this section is minimal as the riversides are mainly basalt cliffs.

The downstream scour hole forms a large pool around 100m further downstream (the pool designated for the water discharge from the scheme) - ***Figure 9***. It is deep and wide and stabilizes the velocity of flow within a circular current.

The flow into this pool is regulated by the section of shallow rapids *(**Figure 7**)*. The river deposits silt here and water clarity at the surface improves.

The material at the bottom of this pool is likely to be toxic. A pH of 4.5 was recorded there.

It is anticipated that this pool would receive the outflow from the hydroelectric mechanism.

Being the point of water discharge from the tailrace channel, this pool is the southernmost point in the river that is directly affected by the proposed hydroelectric power scheme.

Riverside environs

Along portions of both sides of the river, there is a riparian strip of Crown Land (around 20m wide) that is administered by the Department of Conservation (DoC). Along the parts of the river where there is a break in the continuity of this 20m strip of Crown land, landowner's rights extend to the edge of the river. Within the area of the proposed hydroelectric scheme this variability is mapped (***Figure 8***).

The riparian plantings, together with natural regeneration within this zone includes both native forest species (much of which is mature) and exotic willows.

This vegetation provides shade along some of the narrower parts of the river. The vegetation is generally thinner around the pools and the wider portions of the river, resulting in minimal shading and therefore less cooling of the flow.

Grasses and semi aquatic weed species are established close to the water edges.

Observed avian species include Pukekos, Kingfishers, Shags, Parakeets, Tuis and Fantails.

Riverside activities affecting the river ecology

During its passage through the Hikurangi farmlands, the Wairua River collects surface water containing silt runoff from croplands and dairy farms, together with ground water containing nutrients and organic residues.

The nutrient content of the stream water sampled was high to the point of being toxic. Measurements have been recorded showing excess e.coli, coliforms, phosphorus and nitrates present.

Extensive cropping on neighbouring properties leaves large areas of bare earth exposed to rainfall at various times of the year. Silt from these areas is regularly mobilized during periods of high rainfall.

During flood events drainage pumps in the upper catchment deposit large amounts of biomass and faecal matter into the river

The water velocity in the canal system regularly purges silt from the upper regions of the catchment, transporting it to accumulation areas where it is deposited together with piles of decomposing vegetation.

There is an existing hydroelectric facility about 15 km distant in the lower river, that draws water and channels it along a 1.7-kilometre canal that bypasses the original river course to a hydroelectric generator above the lower falls.

Glenview Estate activities with regard to contamination

Cowshed effluent from the Lewis property is well managed with no apparent surface flow into the waterway.

The wintering pad is well set back from the river and is well constructed to contain waste. It appears that no leachate is entering the system through effluent drainage.

Portions of the river that include the nominally 20m wide DoC administered riparian strip are fenced to exclude cattle from the riverside.

Below the Falls

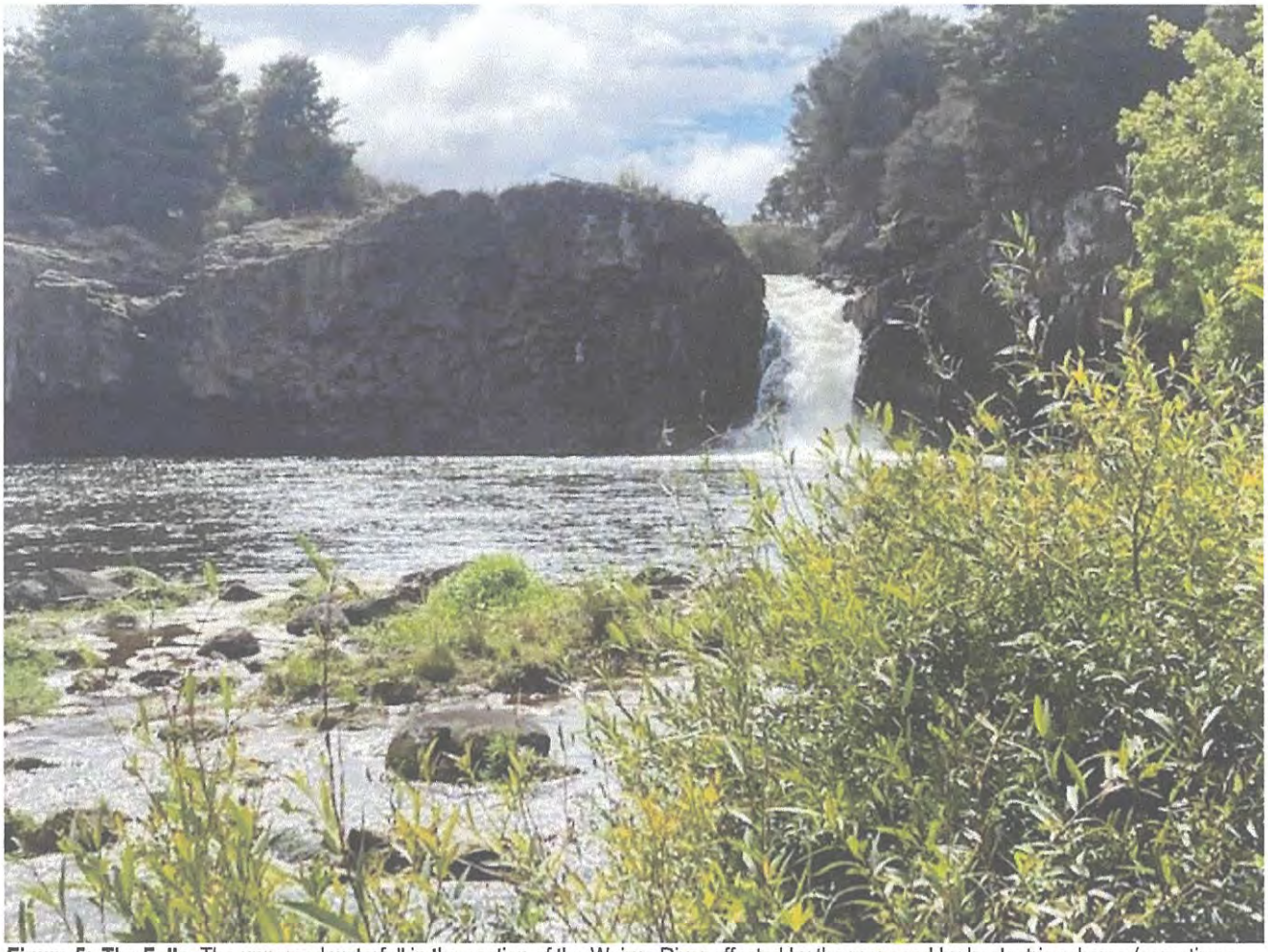


Figure 5: **The Falls.** The unnamed waterfall in the section of the Wairua River affected by the proposed hydroelectric scheme (sometimes described as Purua Falls). During median annual flows the falls channel water over a 5m drop into a 9m deep scour hole / pool below. The channel at the right of the rock formation was blasted during the drainage works for the Hikurangi Swamp. During flood events the flow can increase dramatically, covering the entire rock wall and transporting vast amounts of sediment downstream.

Figure 6: Another view of the wide, deep pool below the falls.

After a period of warming over sunlit rapids, the river water plunges over the falls into the pool below, where it is cooled and circulated through a downward vortex to the bottom of the pool. The water in this pool is highly dynamic and it is regarded as a dangerous section to enter.

This pool is approximately 9 metres deep from surface to base, enabling stratification of water temperatures from cool at the bottom to warm at the surface.

As a large portion of the river is shallow, these deeper "cooling chambers" are important to the health of the river.

As the pool is of fixed depth with defined basalt banks and a shallow outlet, the pool level remains constant.

Figure 7: The Rapids between the two wide pools.

Rapids are stretches within a river where the riverbed has a relatively steep gradient, resulting in an increase in velocity and turbulence.

The rapids between the two wide pools perform several physical functions in this section of the river:

- Regulation of flow velocity.
- Aeration – the turbulent rolling and tumbling action of the rapids draws oxygen into the water resulting in improved water quality.
- In the area of the rapids, the river is shallower and allows deposition of gravel and rocks, with some rocks exposed above the rivers flow surface.
- Provides habitat for fish and invertebrates.

This area may experience increased water temperature during periods of low flow. The sun warmed rocks, many of which are exposed, have the effect of raising water temperatures, sometimes to critical levels.

Temperature gradients

A healthy river system has a positive temperature gradient wherein the flowing action over the river topography lowers temperatures toward an optimum of 4 degrees Celsius. A negative temperature gradient, increasing toward 9 degrees Celsius and higher, indicates a deterioration in river quality. *(Schauberger: The Secret Nature of Water, 1942).*

The physical requirements for a positive temperature gradient are present here. However, the contamination levels render such habitat enhancing effects ineffectual.

Aquatic flora

The shallow areas observed contained thick mats of Periphyton covering the boulder substrate. (Periphyton is a complex mixture of algae, cyanobacteria, heterotrophic microbes, and detritus that is attached to submerged surfaces in most aquatic ecosystems - Wikipedia). The long filaments of green algae were abundant across the river profile and brown mat coverage of the submerged boulders was thick. This is indicative of a sustained period of low flow, high nutrient content of the water and high temperatures.

Areas of still water alongside the wider pools tend to accumulate large quantities of Alligator weed (*Alternanthera philoxeroides*) and other aquatic vegetation that decompose during dry spells, further reducing water quality.

The pools contained clusters of introduced Oxygen Weed (*Lagarosiphon major*).

Aquatic fauna

This section of the Wairua River is not accessible to diadromous native fish or introduced trout.

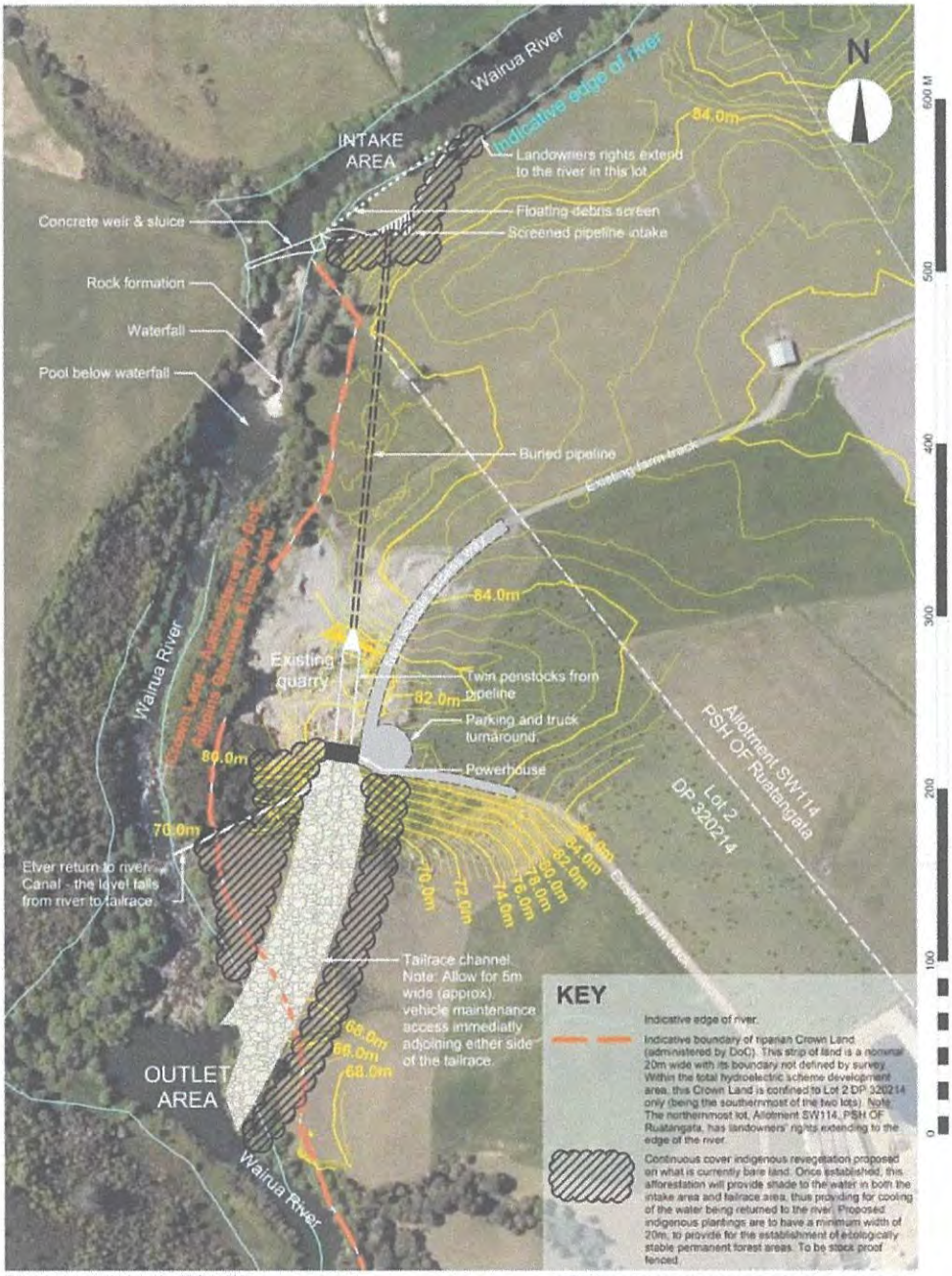
Observations indicated that Mosquito larvae, Water Fleas and New Zealand mud snails (*Potamopyrgus antipodarum*) are thriving in the nutrient rich environment.

An abundance of aquatic vegetation supports snails and insect larvae.

A small number of Elvers that would have been hand released have been observed in the channel.

Clusters of Mosquito fish (*Gambusi affinis*) inhabit the fringes of the large pools and appear to have sufficient prey to establish colonies. The absence of predatory native fish and introduced trout plus the abundant cover of Periphyton filaments enable the populations of Gambusi to thrive.

The proposed hydroelectric installation



Scheme layout second revision 09 Sept 2021
Scheme layout traced from Drg # 20/2/3 (J N Duder FIPENZ CP Eng) May 2021 Revision
Aerial scale photo extracted from WDC GIS Map Viewer
Scale approx. 1:2000 @ A3 1:1000 @ A1
Existing site contours from Boundary Hunters.
Proposed contours not shown.

NOTE: The underlying scaled aerial photo for this conceptual plan has been included to provide an easily understood context for the drawing detail overlaid. The drawing overlay is on a "best overall fit basis". Thus, the photo will be a little out of alignment in places.

Consultant:
ecoprojects consulting collaborative
landscape architecture, ecology
ph: 0274 738 216 (Hedley Evans)

09 Sept 2021

Applicant: Glenview Estate Ltd

PROPOSED PURUA RAPIDS HYDROELECTRIC SCHEME - CONCEPT (provisional)

Figure 8:

*Other than the proposed hydroelectric scheme layout shown in **Figure 8** and the general descriptions that follow, refer to the engineer's report submitted with the application for further engineering detail. **Appendix 3** to this report **"Explanatory background detail regarding the proposed Purua Rapids hydroelectric scheme"** also provides further detail related to the project.*

The weir (& sluice)

In consultation with the project engineer the following measures have been incorporated in the weir design to maintain and improve the capacity of the river to sustain aquatic life and to enhance water quality.

The proposed weir is to be designed incorporating a fish ladder and an eel bypass. Elvers will have their own fish bypass so that the system does not rely on human intervention to get them upriver of the power scheme.

The weir incorporates a sluice which is a device for controlling or stopping the flow of water.
When a sluice is lowered, water may spill over the top, in which case the gate operates as a weir. The sluice will be mechanically driven up or down.

The sluice section of the weir is to be automatically height adjusted to maintain above minimal flow rates in the river during dry spells and to allow reduction of impediment to water flow during flood events.

A weir field would be constructed behind the wall to maintain a habitat and minimize temperature increases.

The variable depth weir field would consist of boulder placements, large log insertions 9 (refer to ***Appendix 2***) and excavated pools.

A rock base with differing depths would be laid to provide invertebrate habitat.

A channel is be created on the side opposite the intake to attract eels and fish to a passage over the weir.

There is to be minimal loss of vegetation during construction of the weir abutments.

With regard to fish passage, how does the weir work?
Although the proposed concrete weir structure is to be a fixed structure on solid rock, the weir height is engineered to be automatically adjusting in flood conditions. The weir has been designed in accordance with the recommendations of section 4.3 of the NIWA Fish Passage Guidelines including water flow, gradient and size of rocks etc.

Regarding the upstream passage of elva, when they meet the sheer basalt walls at the waterfall (around 8-10 metres high) they are managing to climb these walls). After reaching the top, they will encounter the newly constructed weir. This will provide a diffused flow of water over a gentle gradient with embedded 150 mm grade gabion rocks.

The weir will provide a zero obstacle to elvas. No other fish will be able to climb it.

Maintaining minimum flow in the river

Maintaining a minimum flow of 200 litres per second water down the river as proposed in the Consent application is the point at which there are no adverse effects.

In summer when the river flow drops and just before it becomes impossible to operate the hydroelectric scheme, the scheme will be turned off. The river will then flow unimpeded in its natural state.

The intake

The alteration to river flow to serve the power generation system begins at the weir that holds the headwater reserves needed.

The weir will raise water levels behind it high enough to enter the intake pipes of the electricity generation system.

The water passes through the intake screen where it is filtered and transported to the penstocks. The intake screen also excludes rubbish.

Larger materials such as logs, and floating biomass are diverted over the falls.

Logs are returned to the river as an integral component of the river ecosystem *(Refer to **Appendix 2**).*

Aquatic detritus will be mechanically removed at the screen and deposited in a facility to be created on the Glenview Estate, for composting and integration into farm soils.

The eel screen complies with NIWA Fish Screening for Canterbury - good practice guidelines, thereby preventing any eels from entering the penstocks and ensuring that the screen design is 'fit for the job'. Little mechanical baskets will transport migrating eels over the system and return them unharmed to the river.

The discharge

Neil Lewis has undertaken to install a series of steps to return water to the river in a much-improved state following energy extraction at the turbines. These steps include:

- Mechanical insertion of oxygen into the spent water flow.
- Passage through a flow form channel to re-establish the Vortex (refer to ***Figure 4***).
- Cooling of the water through the buried intake pipes.
- Establishing a fish ladder for elver passage.
- Strategic placement of the outlet into the discharge pool.

Establishing a tailrace lined with basalt rock, rock groins, logs and stumps and with filtered and oxygenated water that leads into a large existing scour pool will maintain and improve the capacity of the freshwater ecosystem to sustain aquatic life and to enhance water quality. The tailrace edges will be planted in indigenous trees to provide further ecosystem enhancement including shading and therefore cooling of the water. The lands between the tailrace and the river will be retired from pasture and established in indigenous forest.

Figure 9: **Around** 100m downstream from the 9m deep scour hole below the falls, this scour hole forms a large pool. Screened, oxygenated water from the hydroelectric scheme would be discharged into this pool.

The water intake & outlet areas are to be formed across two areas of riparian land that are almost entirely devoid of indigenous vegetation

Refer to ***Figure 8***, "Proposed Purua Rapids Hydroelectric Scheme – Concept (provisional)" for the conceptual layout of the hydroelectric scheme intake and outlet areas. Both of the riparian areas that the intake and outlet areas will traverse, are currently almost entirely devoid of indigenous vegetation (refer to the four photos that follow immediately below ***(Figures 10 -13)***.

Figure 10: Looking North towards the river. Terry Kennedy (ecologist) to the left & Neil Lewis (landowner) to the right. Near the river edge, intake area excavation is to be carried out in a manner that will direct river water flow to the "screened pipeline intake" (refer to ***Figure 8*** for the layout). It is proposed that excavation for the intake area is located between the two tall Kanukas' on the river's edge (the larger tree being at the top left of the photo & the other being to the right a little further along the riverbank).

Figure 11: Looking South towards the river edge, across land where the tailrace is to be formed. It is proposed that the tailrace is located between the Totara just to the left of centre of this photo and the tall Kanuka Kanuka to the right. ***Figures 12 & 13*** are closer views of these two trees. The tailrace discharges to the river at that point (the "outlet area").

Figure 12: Close up view of the Totara ientified in ***Figure 11***. The proposed location of the tailrace outlet is to the right of this tree. As shown in this photo, other vegetation established in this riparian area is predominantly Willow.

Figure 13: Close up view of the Kanuka referred to in ***Figure 11***. The proposed location of the tailrace outlet to this scour hole / pond in the river, is to the left of this tree. As shown in this photo, other vegetation established in this riparian area is predominantly Willow.

Although every reasonable effort will be made to retain them, none of the isolated indigenous specimens identified in the above four photos are of significant ecological value.

Extensive indigenous riparian revegetation

Based on best practice principles, extensive indigenous revegetation is proposed within selected areas of the project site (the total hydroelectric scheme site extending for a length of around 650m along the river - refer to ***Figure 8***). The objective is to enhance the extent and therefore ecological value of the zone of indigenous vegetation adjoining the river edge. The indigenous revegetation is proposed to assist in providing a near continuous cover over selected areas of riparian pastureland some of which has intermittent indigenous specimens & clusters established. The proposed areas of afforestation once established, will provide shade to the water in both the intake and tailrace areas, including the tailrace outlet to the scour hole / pond on the river (Refer to ***Figures 9 & 13***). Such shading will contribute to cooling of the water being returned to the river.

Proposed indigenous revegetation zones are to have a minimum width of 20m, to provide for the establishment of ecologically stable permanent forest areas. In cooperation with the Department of

Conservation, gaps in the existing 20m zone of riparian vegetation on Crown land managed by DoC, could be infill planted. The balance of farmed land between the tailrace and the nearby 20m DoC managed zone of riparian vegetation, would also be retired and established in indigenous vegetation.

All revegetation areas are to be stockproof fenced and will significantly enhance the overall ecological values of the riverside area adjoining the hydroelectric power scheme.

It is noted that in the project engineer's engineering prefeasibility report (21 May 2021 revision) that the envisaged scheme should have no significant effect on the 20m strip of DoC managed riparian Crown Land, with minimal loss of riverbank vegetation at the river weir abutments, pipeline intake area and the tailrace outlet. The stand of mature totara which screens the southern boundary of the quarry should not be significantly impacted by power station construction.

Ecologist to be closely involved with the weir field and tailrace construction

The project ecologist is to be closely involved with the construction of both the weir field (where the river water flow is altered and starts to back up) and the tailrace (being the diverted water exit).

Ongoing ecological monitoring as the scheme proceeds

As the scheme proceeds, ongoing monitoring for changes in the river ecology will be maintained.

Concerns of tangata whenua

The Tangata Whenua administering Kaitiaki over the Wairua River are Ngati Hau.
General concerns on the degraded state of the river are constantly raised in all discussions with Tangata Whenua.

The concerns of the river kaitiaki groups have been well documented in *"WAI 1040 #A60 Northland Rural Rivers Environmental Management, Pollution and Kaitiakitanga Since 1991."*

Interviews with members of the iwi residing in the lower regions of the Wairua indicate their concerns are current and are major.

"The quality of the water arriving in our rohe has deteriorated dramatically over the last 4-5 years. "

"Swimming holes have been too toxic to enter, and children have contracted skin rashes and eye problems after bathing. "

"Pools that have been used recreationally for generations are now off limits."

Mahinga kai, although there are still eels present in large numbers during migration periods, the existing dam and hydro station at Wairua Falls has interrupted their migratory patterns and manual intervention has become necessary to facilitate their breeding cycle.

The efforts of tangata whenua and other environmental groups to address the ongoing deterioration of the Wairua River are acknowledged in this report. The authors tautoko the work carried out by the kaitiaki of the Kaipara region.

Discussions with members of Ngati Hau have so far revealed a wealth of local knowledge and multi-generational, anecdotal evidence on the behavior patterns of the eels and other river fauna.

The applicant has expressed a desire to seek ongoing advice from local kaitiaki when designing passages for elvers and migrating mature eels.

Fish passages.

Discussions with the applicant indicate that much thought, research and planning has gone into the design and implementation of eel and fish access to the upper reaches of the Wairua catchment.

Although at present there are no diadromous or native fish species present in the river above the lower dam, the possibility of future corrections to the river ecology and restored access of migrating species to the upper Wairua regions has been a significant consideration in the design process

The weir is to be constructed incorporating recommendations published by NIWA (Doc. 2018019HN) Fish Passage Guidelines.

The tailrace design would also serve as:

- a water quality enhancement unit,
- a fish ladder and an oxygenation system utilising riffles and rock placements to replicate instream conditions.

Future proofing

Although the Wairua River is currently in a highly degraded state, it is not envisioned that this will always be the case. The expectation is that one day the river will be cleaned up, with its health & vitality having

been gradually restored to an optimal state. The scheme as proposed will make a significant contribution to cleaning up the river.

The weir and tailrace outlet planning process needs to ensure that any future efforts by council to restore the Wairua River to its optimum ecological status are not impeded by the physical structures or the operations of the proposed hydroelectric facility.

Conclusions

High levels of contamination and engineered flood controls in the Wairua River system have over time, lowered the life sustaining capacity of its waters.

The proposed maximum extraction rate of 24 cubic metres per second during times of moderate to high flow rates from a total river flow of up to 300 cubic metres in a flood type situation, is unlikely to have a substantial effect on the ecology of the river in its current ecological state.

A reduction of flow over the section affected will result in less than minor eco-system degradation in either quantity or quality within the affected area or further downstream.

Glenview Estate CEO Neil Lewis has taken an innovative approach to the construction of a facility that would produce energy without further compromising the ecological integrity of the Wairua River and the applicant undertakes to construct a sustainable facility that will not impede any future efforts to restore the river to its optimum health.

Ecoprojects Consulting Collaborative, **Hokianga**
Per: Terry Kennedy
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This document has been internally reviewed (and commented on / discussed) with input during preparation by:
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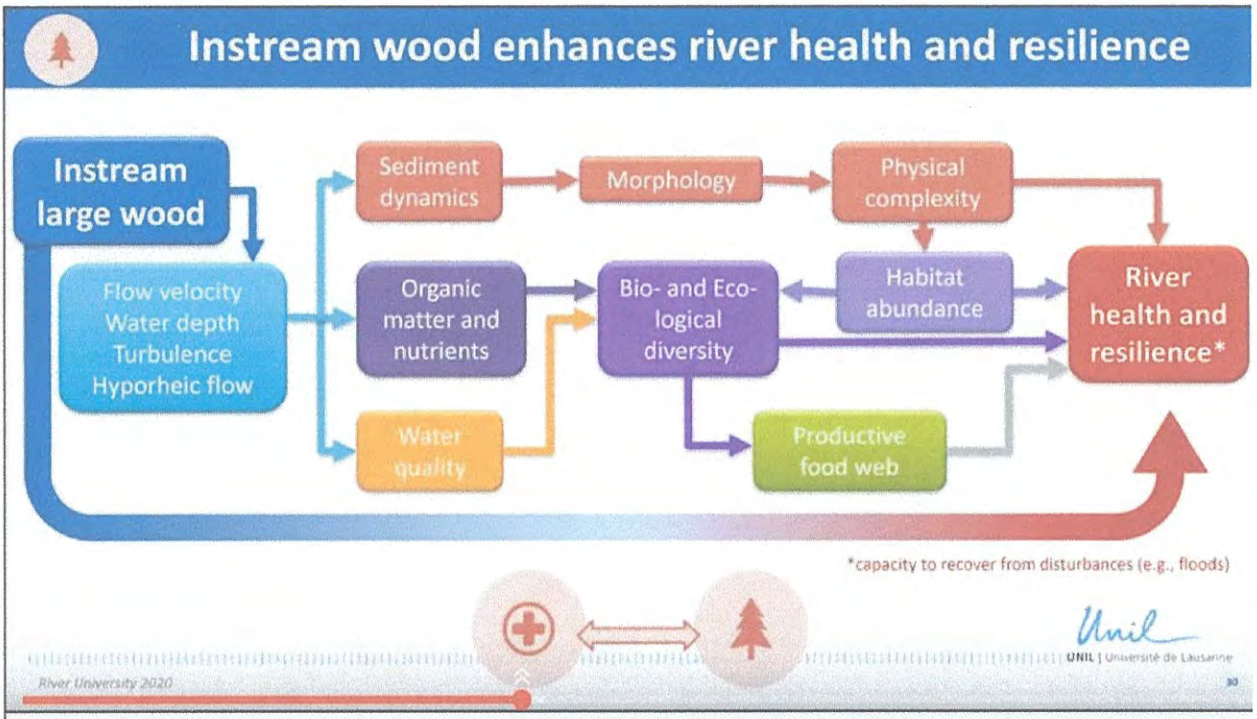
APPENDICES:

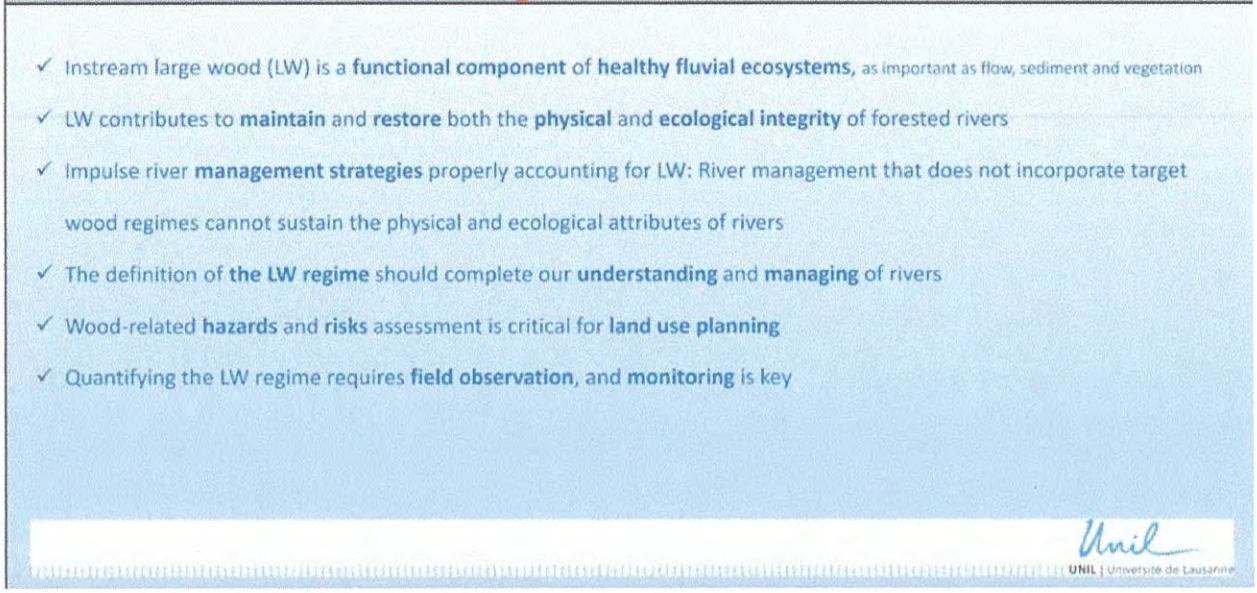
Appendix 1: Area affected by the hydro scheme currently documented as being prone to flooding
Appendix 2: In support of returning large logs to the river. (River Restoration on Ptolemaic River 1992)
Appendix 3: Explanatory background detail regarding the proposed Purua Rapids hydroelectric scheme

Appendix 1: Area affected by the hydro scheme currently documented as being prone to flooding.

The hydro scheme as proposed is being engineered withstand such flooding.

Appendix 2: In support of returning large logs to the river. (River Restoration on Ptolemaic River 1992)





Appendix 3: Explanatory background detail regarding the proposed Purua Rapids hydroelectric scheme.

These appended notes were prepared by Neil Lewis as a consultation paper and have subsequently been edited by the project team for inclusion in this report.

Introduction

Glenview Estate Ltd is proposing to build a run of river hydroelectricity power generation power station on its farm at 512 Knight Road, Kokopu.

The scheme will be comprised of a weir and sluice gate situated about 50m upriver from the Purua waterfall on the Wairua River. This will create a head pond that will maintain an even draw off river height.

Immediately upriver from the weir will be a screened intake structure which passes water into pipes which travel about 300 metres to a powerhouse where the electricity is generated. From the powerhouse, all the water is returned to the main river about another 170 metres away.

This run of river scheme is very different from traditional hydro power projects as it has no ability to dam the river for water storage and has no long power canals to hold and stagnate waters. It only uses available water with the rest flowing over the weir and waterfall.

Previous Hydroelectricity generation studies

1978. Tonkin and Taylor study found the West Bank to have a 2890 kw potential
1983 and 2003 by North Auckland electric power board
2007 by Northpower
2020 published by govt as Northlands best potential site.

Eco scheme

Glenview motivation for progressing the current scheme. Glenview is owned by the Lewis families who have been farming on Knight Road since freeholding the original part from the Government in the 1980's.

Neil Lewis's family has a very long association within the area with his great grandfather being New Zealand's first Maori surveyor who surveyed most of their area, and his grandfather who farmed there and was building the Wairua falls power station when the First World War broke.

Whilst not being tangata whenua, the Lewis's have lived beside the Wairua for most of their lives and have witnessed its degradation and have been upset at some of the previous proposed schemes by outside companies.

The opportunity for an ecologically sustainable scheme beckons. It is sad to see all the renewable energy flowing to waste, whilst having to use electricity generated from diesel and coal.

As well as bounding the waterfall, the Lewis's farm bounds two very long sections of rocky rapids. Those rapids once supported colonies of native freshwater mussels (kakahi). The colonies could be easily found, as on the rocky riverbanks were large heaps of shells broken by birds dropping them from height. 30 to 35 years ago children could hunt for these mussels in the river. Today those rocky rapids are covered with an algal slime that has choked out the ecosystems.

As a part of an ecosystem where birds picked up, dropped, broke open and then ate these freshwater mussels, the debris left in those broken shells was cleaned up by the freshwater crab, in fact New Zealand's only freshwater crab.

They could be found by day under rotting timber and at night foraging on the mussel leftovers.

These crabs (*Halicarcinus lacustris*) are a very small and invertebrate, growing only to about 10 mm wide with a 'H' shaped groove on its back. They are generally small and weak with poor eyesight. They are food for fish and eels, so they forage at night.

These crabs have a DoC classification of 'at risk and are naturally uncommon being biologically scarce '.

As the rivers water quality has declined the mussels disappeared from the river rapids.

Facts about freshwater mussels known to Maori as Kakahi.

These mussels have been identified as *Hyridella menziesi,* a bivalve mussel which grows to 50 to 90 mm and can live for 60 to 70 years.. They are filter feeders which do an awesome job of filtering 1 litre of sediment laiden water per hour. A colony of a million mussels would filter 24 million litres of water per day, every day.

The mussels lifecycle involves the males releasing sperm into the water in the summer time. The females inhale the sperm as it passes them to fertilise its eggs. Once the eggs are fertilised the female attracts native fish to them and releases the eggs (glochidia) onto the fish's gills, skin and fins. The eggs parasitically live off the fish for about two weeks before being dropped off onto a new site to grow. The eggs can only last 2 to 3 days in the female mussels waiting for a host fish. After that they die.

The real problem with the river in respect of the mussels lifecycle is that there are huge quantities of sediment choking the native fish and the upriver summer stagnation has the effect on the water of reducing the dissolved oxygen levels so that the native fish cannot survive. No fish - no mussels. 20 years ago, there were no small young mussels, only old ones which cannot breed because there are no fish. This phenomenon is known as debt extinction.

Adding to the loss of the mussels will be the loss of these rare crabs which use the mussels as food.

Kakahi was a valued Maori food and medicine and its juices used as milk for motherless infants.

Over many years Neil Lewis has tried to champion the mussel cause. Letters were distributed to all the Knight Road residents, DoC were informed of the mussels life status, and combined meetings were held at council with NRC plus District deputy mayors, councillors and department heads. Everyone nodded and agreed but did nothing.

Neil's next step was to seed with mussels, a farm water drain which runs clear water through summers. The drain was home for tiny mosquito fish in floods when the river becomes filthy and smelly. Things went well for a few years until heavy rains brought heavy sediment from Knight Road down the drains and then a bad summer drought completely dried up the drain.

Lately successive summer droughts have highlighted the dangers of the effects of global warming on our rivers' ecosystems. Most ecologists, climate researchers have agreed on the need to do what we can to prevent global warming. The government has New Zealand in a climate emergency. Reducing our use of fossil fuels is one of the keys.

In the last few summers there has been little rainfall which seems to have resulted in the swamps canals and drains stagnating. The odd small weather event has had the effect of flushing the stagnant water down to the rocks, rapids and pools. When combined with the fact that the water flows over basalt rocks that are too hot to walk on at times causing water temperatures up to 20 degrees, the slime and algae forms into long floating masses.

The concerns created from the waste of clean renewable energy, the degradation of the rivers waters, the loss of habitats for essential freshwater native fish, the potential extinction of freshwater mussels in this part of the river, the loss of habitat and ecosystem for rare freshwater crabs, have resulted in the idea of a power scheme that combines the changing of wasted energy into renewable energy and reoxygenating the tailrace and a part of the river so that there is an oxygenated habitat the native fish can thrive in and recolonisation of our fresh water mussels can be successful . Hopefully a home can be made for the native crabs and the cleaner oxygenated waters make their previous home liveable again.

The aim is that everything done will be in a sustainable way so that rather than causing adverse effects to any part of the river or its ecology, the effects will be positive enhancement.

The water used will be filtered of algae, weed and rubbish and that filtered organic debris will be composted and returned to farm soils. The water travelling through the pipes and penstocks will have a lower temperature than had it travelled over the hot basalt rocks in summer. Air will be added to the water in the turbines and draft tube which will effectively raise the dissolved oxygen 2 to 3 mgs per litre of water so that native fish can thrive.

Migrating eels will be prevented from entering the penstocks and elvers will have their own fish bypass so that the system does not rely on human intervention to get them upriver of the power scheme.

Establishing a tailrace lined with basalt rock, rock groins, logs and stumps and with filtered and oxygenated water that leads into a large existing scour pool, will provide a home for native fish to thrive in, for mussels to grow in and which in turn will filter sediment from the water. Eels will also thrive in this habitat. The tailrace edges will be planted in trees to provide further cooling for the water. The lands between the tailrace and the river will be retired from pasture and planted in native trees, thereby extending the existing riparian ecosystem.

Hopefully this habitat will suit the native crabs.

Prefeasibility study

John N Duder, F Eng NZ, CP Eng who is one of New Zealand's most experienced hydro engineers has completed a prefeasibility study on a run of river hydro scheme. This has resulted in a conclusion that there is a potentially feasible scheme which could generate 3.0 MW of power when generating at peak.

Initial tangata whenua consultation

The first research of this project, before any pen was put to paper and before any consultants were employed, was finding and talking to tangata whenua who hold the traditional authority over the Wairua River next to the Lewis's farm.

It became clear that tangata whenua from the Korokota Marae hold that authority over both the Wairua and Mangakahia rivers. Their Marae is situated beside the Wairua River and close to the Wairua Falls and power station.

Early talks around 4 years ago informed those members of a possible scheme and importantly found the key ecological issues for the proposed scheme. Their experiences in dealing with eel recovery, water, silt and sacred burial sites at the Wairua falls power station have been very helpful in planning this current scheme.

As a result of these talks, non-negotiable issues have been highlighted

1. The health of the river's eel travelling downriver and elvers travelling upriver.
2. The control of silt.
3. A zero water take
4. The possibilities of sacred burial sites in rock caves.

As ideas and rough plans were initiated communication with tangata whenua continued, not as consultation about any exact plans, but more as a heads up that something was happening and again an opportunity to gain more knowledge of eel behaviour and things to be aware of.

Again, being respectful of Korokota Marae 's Tangata whenua kaitiaki role of the Wairua, this consultation paper will have been fist sent to those members.

Statutory consultation

National Policy Statements are prepared by central government and cover matters of national significance including renewable hydroelectricity power generation.

Regional Policy Statements and regional plans give effect to National Policy Statements and provide rules and identify issues related to the development use, and protection of resources. Renewable hydroelectricity power generation is virtually a permitted activity after having passed all but less than minor environmental effects and has had tangata whenua consultation.

The Resource Management Act requires councils to pre notify tangata whenua through iwi authorities on all plans.

The Resource Management Act requires Councils to recognise and give effect to iwi and hapu management plans when preparing all their plans and statements.

As the result of the above it is more or less deemed that iwi and hapu have been consulted about the provisions for Regionally significant infrastructure and renewable energy. Tangata whenua consultation focuses on the effects on tangata whenua and their taonga.

Generally National Policy Statements and all the other descending in significance statements, plans, and management strategies all note the significance of renewable hydro electricity generation, its importance to communities and its need to be located in the place of the resource.

The Whatitir Resource Management Plan forwarded to Neil Lewis by Mr Milan Ruka is a hapu management plan written to ensure Mana Whenua Ki Whatitiri are a participant in both Council planning, resource consent applications and environmental management.

The mission statement is to revitalise the health and wellbeing of our environment and our people.

Page 16 of the Whatitiri resource management plan; Energy - Hydro Generation.

4.5. Issues
(a) Tuna lifecycle has suffered greatly from impassable infrastructure and high mortality rates as a result ....
(b) ....no economic benefit...
(c) .....no access...
(d) Access to traditional sites on the Wairua River blocked...
(e) Lack of monitoring of consent compliance...

4.6. Objectives
(a) To maintain, protect and enhance where possible our waterways, their habitats and our taonga species from inappropriate power generation schemes.
(b) To create an awesome income stream from renewable hydro energy for our hapu that is environmentally sustainable and does not compromise aquatic life.

4.7. Policies
(a) The Whatitiri RMU will promote the philosophy of kaitiakitanga of natural resources and the environment to be maintained through use of sustainable renewable energy.
(b) Locally produced renewable energy that is of an appropriate scale and uses appropriate technology, is supported by the Whatitiri RMU
(c) Whatitiri RMU will work to grow the capacity of Mana Whenua regarding micro energy production and will seek opportunities for employment and training utilising natural resources within our rohe.
(d) Whatitiri RMU will endeavour to improve relationships with existing energy generators.....

Scheme in detail

Bear in mind that the scheme details are yet to be designed and engineered as the cost is too great without resource consent.

1. Weir
   The intention is to build a low concrete weir across the rocks about 50 metres upriver of the waterfall. The weir will not be at right angles to the banks. Instead, it will be on an angle so that the far-right side is a lot closer to the waterfall edge. Its purpose will be to maintain a full pipeline to suit the large range of turbine flow conditions while also providing a constant residual flow over the waterfall. In a longitudinal profile the weir will have a maximum elevation of 81.5 metres above sea level (asl).

The waterfall has been altered from its natural height already. In about 1922 it was drilled and blasted by the Hikurangi drainage board as the first part of draining the Hikurangi swamp. Currently two channels on both banks carry most of the water except in floods when the whole area is covered. The original height across the front edge of the waterfall is at 82 asl. This was a natural weir and 0.5m higher than the proposed construction.

This waterfall, the Wairua Falls and power station downriver are complete natural obstacles to all but climbing fish. Nevertheless, the weir has been designed in accordance with the recommendations of section 4.3 of the NIWA Fish Passage Guidelines.

The concrete mass will have a hydraulically efficient ogee shaped crest which replicates the natural shape of water falling over a crest and recommended by NIWA FPG (page 65 , upstream weir face) 150 to 200 mm rocks will be embedded into the concrete to help elver travel up river once they have scaled the vertical sides of the waterfall.

On the eastern side of the weir, which is the closest to the waterfall, a notch will release a continual 200 litres per second environmental flow. In times of high flow, large volumes will flow over the weir and notch. Similarly in very low flows all the rivers water will flow over the weir.

Built into the weir on the left bank will be flood sluice gates that have the purpose of opening in high flows and floods so that the scheme does not cause any upriver flooding. These gates may well be in the form of a deflatable rubber dam.

2. Head pond

Upriver of the weir on the left bank about 12,000m^3 of earth will be excavated. This will be taken from Glenview lands that have a riparian boundary with the river. The effect will be to enlarge the existing pond. In this area a large concrete intake structure anchored in rock will be built. Water for electricity generation will flow through this structure and into pipes leading to a powerhouse about 300m away.

In front of the intake structure will be a floating debris screen. This is designed to deflect large floating debris away from the intake structure and towards the weir and waterfall.

Attached to the intake will be a debris and eel screen.

3. Debris and eel screen

The eel screen to be used in this project is commonly called a travelling screen. The purpose of the screen is to stop debris and fish from entering the hydro power generation station. Debris must not enter the penstocks as it will be forced into the turbines and cause damage and blockages. Similarly, fish would be killed by the turbines' propellers.

With this scheme, the only fish requiring protection from the turbines are eels. Their life cycle involves them migrating down the river in the autumn as the first part of their journey to spawn and die in the South Pacific Ocean. These eels are fully mature, fat, and full of eggs. Their migration seems to be triggered by the first autumn rains. Being average swimmers, they use the rivers current to get them to the sea.

Although in this project only a proportion of the rivers flow will go through the penstocks, especially in the autumn floods which have been flowing at 200 to 300 cubic metres of water per second (a maximum of 24 metres per second will be taken), should migrating eels choose to swim into the debris screen, as the rivers current and the current into the pipes are travelling at a faster speed than they can swim, water pressure will then hold them against the screen. In other hydro dams and schemes, very high mortality occurs to these trapped eels when the debris is mechanically removed, often with devices similar to excavators with steel rake fingers.

Zero eel mortality is planned.

This will be achieved through a travelling screen with built in eel baskets. It will mechanically rotate by having sprockets top and bottom on both sides. Around left and right sprockets is an endless chain that has horizontal bars welded between them at 10 mm spacing. Below about every 75 bars will be stainless steel baskets perforated with slots so that when the screens are lifted a large weight of water is not lifted. The screen will rotate when required on pressure sensors and switches that tell the difference in water pressure either side of the screen. In normal flows it will operate every hour but in floods and high debris times it will go continuously. It will be able to be operated manually from a cell phone. Should debris jam the screen it will reverse before going forward again. Any jams will send auto alerts to management.

NIWA Fish Passage Guidelines state that there is a need for novel solutions and innovative approaches to fish screens (NFPG 8.4) and that intentionally screened barriers (e.g., water intakes) generally should exclude all fish (NFPG. Page 103).

The travelling screen is to be designed to specifically catch eels trapped against the screen by water pressure and lift them out of harm's way. When an eel which has been held against the screen is lifted out of the water and the holding pressure is released, they will fall into an eel basket / tray and be lifted up next to an eel passage. A jet / plug of water will flush the eel into an eel passage pipe which will deliver the eel back to the river just below the weir.

The eel screen complies with NIWA Fish Screening for Canterbury - good practice guidelines.

3.1.1. Screens should try to be parallel or diagonal to river flows.

3.1.2. Travelling screens. Page 13, figure 5 shows a design and workings of a travelling screen. This was produced on 10 April 2007. And since then these screens are infinitely better.

NIWA state that travelling screens have a good performance record and with total prevention of fish entry.

There are many of these screens worldwide and many manufacturers. There are many in North America and other countries fitted with fish baskets screening trout and salmon.

The only disadvantage of travelling screens is their cost. There are nil in NZ.

1.3.3. NIWA has done a comparison table with all different types of screens Summaries Table 7.
The travelling screen gets their highest rating of good for in canal and diversions.
The travelling screen gets the highest rating for fish exclusion and effectiveness.
The travelling screen gets the highest rating for proven technology. Of note is that the proven technology has been widely validated.
These screens can be seen working on the following websites
Www evoqua.com
Www internationalwaterscreens.com

4. Pipeline

The pipes will be sized to carry an estimated maximum flow of 24m^3 of water per second. The pipes will be buried at about 5m below the current ground level. The trench will have the top and bottom soils dug out and stockpiled to be eventually used to cover the pipes. The basalt will be drilled and blasted. Spalls will be used to line the tail race and head pond. The fines will be compacted around the pipes and gabion sized rocks sold. The approximate 12,000m^3 of fill from the head pond digging will also be distributed along the trench as fill. The backfilled trench will be re-grassed and returned to pasture.

5. Power station

This will be a concrete sub structure housing two Kaplan turbines and generators. Detailed geotechnical investigation will determine the exact powerhouse position.

The two 1.5 megawatt Kaplan turbines are fed water from two penstock pipes with a maximum volume at 12 cubic metres per second each.

As an initiative to enhance the water quality air will be introduced into the low-pressure vortexes in the turbines and around the walls of the draft tubes with the intention of raising the waters dissolved oxygen levels 2 to 3 mgs per litre of water in the tail race.

A tee and valve will be added to the base of one penstock as future proofing for further reoxygenation of low flows.

6. Tailrace

A trapezoidal channel will be excavated from the powerhouse to the river scour pool about 170 to 200 metres away. The channel sides will be armoured with basalt spalls and the channel floor will have position designed rock groins in accordance with fishery recommendations.

The tailrace will return the waters to the main river into a scour pool that currently receives water from rapids. It passes through a 20m wide DoC strip without affecting any trees.

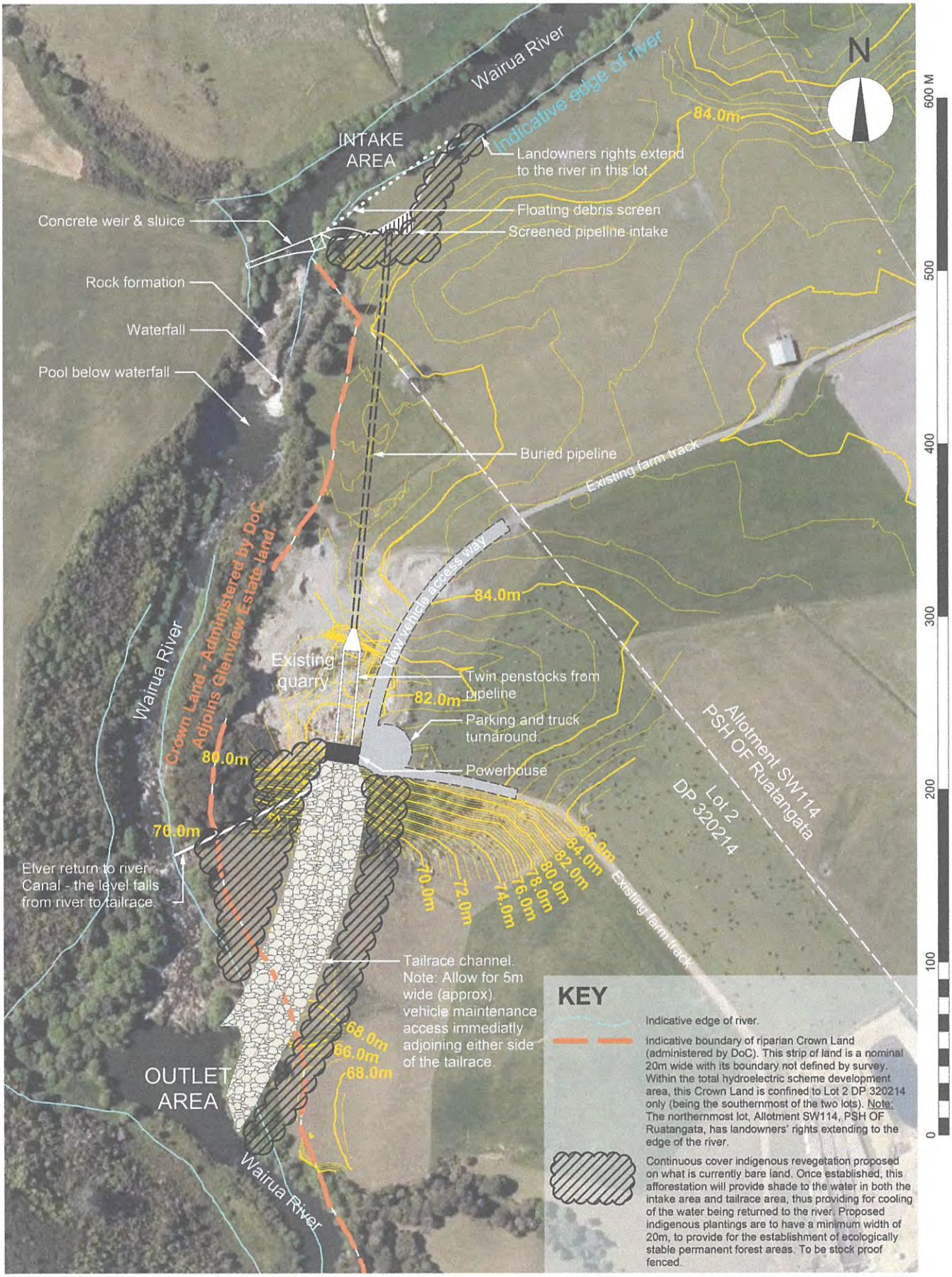
Between the tailrace and the rivers rocky rapids will be a fish passage. It will be dug in the shaded area at the base on the existing bank and trees, have deeper resting pools and be lined with rocks and spalls in accordance with the NIWA Fish Passage Guidelines. A small continual flow of water will come from the rapids through the fish passage and into the tailrace up by the powerhouse. To further help elvers exit the tail race, mussel ropes will be in place.

The water level at the tailrace end of the fish passage will be about 63 asl and rise about 3m to 66 asl at the river, meaning that the fish passage can be easily made to be a bubbling aerated stream.

Schemes geology

The Wairua River has a 567 square kilometre catchment with its waters draining from the Hikurangi swamp and following the edge between weathered basalt clay hills and the lava flows from Mirowhakataki, which are now overlaid with soils.

The Purua waterfall is where the river crosses the approximately 4-million-year-old lava flow. Below the lava flow is the blue green mucky mud called allochthon which was pushed into Northland from the sea floor as part of the Tangihua complex.



Scheme layout second revision 09 Sept 2021
Scheme layout traced from Drg # 20/2/3 (J N Duder FIPENZ CP Eng) May 2021 Revision
Aerial scale photo extracted from WDC GIS Map Viewer
Scale approx. 1:2000 @ A3 1:1000 @ A1
Existing site contours from Boundary Hunters.
Proposed contours not shown.

NOTE: The underlying scaled aerial photo for this conceptual plan has been included to provide an easily understood context for the drawing detail overlaid. The drawing overlay is on a "best overall fit basis". Thus, the photo will be a little out of alignment in places.

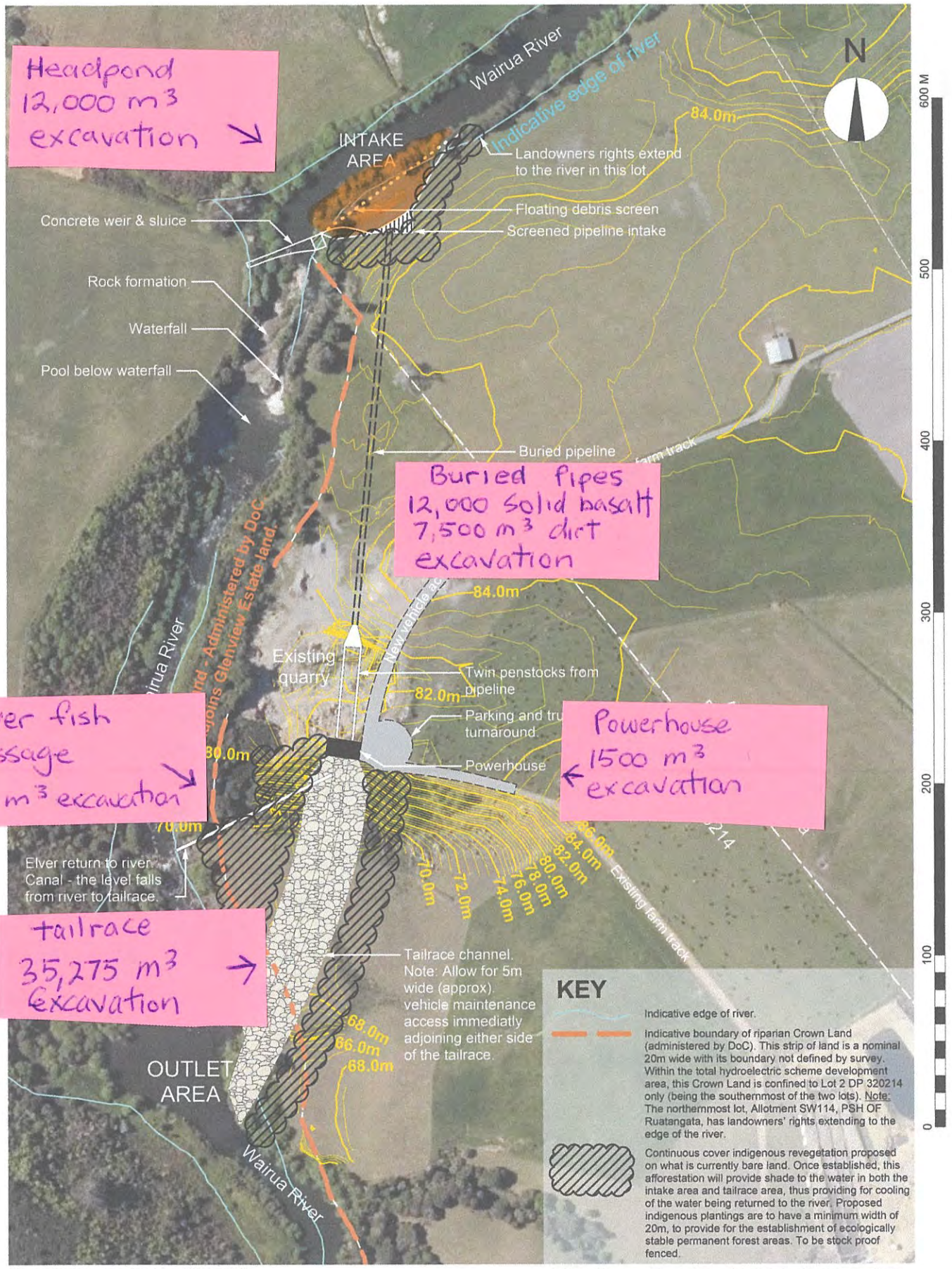
Consultant:
ecoprojects consulting collaborative
landscape architecture, ecology
ph: 0274 738 216 (Hedley Evans)

09 Sept 2021

Applicant: Glenview Estate Ltd

PROPOSED PURUA RAPIDS HYDROELECTRIC SCHEME - CONCEPT (provisional)

Excavation Plan.



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09 Sept 2021

Applicant: Glenview Estate Ltd

PROPOSED PURUA RAPIDS HYDROELECTRIC SCHEME - CONCEPT (provisional)

Whatitiri Resource Management Plan

P.O. Box 98 Whangarei 0148

Poroti Springs

Ko Whatitiri te maunga
E tu nei i te āo i te pō
Ko Waipao te awa i rukuhia,
i inumia e ōku mātua tupuna
Ko Maungarongo te marae
Hei tangi ki te hunga mate
Hei mihi ki te hunga ora
Ko Te Uriroroi
Ko Te Parawhau
Ko Te Māhurehure ki Whatitiri ngā hapū
Ko Ngāpuhi-Nui-Tonu te iwi

Whatitiri is the mountain which stands by night and day
Waipao is the babbling brook where my ancestors dived and drank
Maungarongo is the Marae lamenting the dead, greeting the living
Te Uriroroi, Te Parawhau, and Te Māhurehure ki Whatitiri are the hapū
The people of Ngāpuhi are the people

e) NRC in collaboration with Mana Whenua ki Whatitiri will have an integrated catchment management planning and implementation programme that includes all water bodies in our rohe.
f) Activities potentially affecting waterbodies will be managed on an integrated catchment basis.
g) All aquifers will be protected from contamination and over allocation.
h) All puna and repo will be protected from inappropriate use and development.

4.4 Methods

a) Councils and Mana Whenua ki Whatitiri will together jointly develop integrated catchment management strategies including mechanisms for allocating water and monitoring for all waterbodies in our rohe.
b) Whatitiri RMU will take positive action to enhance waterbodies.
c) Whatitiri RMU will advocate for the enhancement of all our waterbodies and will work with any party promoting or implementing positive actions to improve water quality. Whatitiri RMU request statutory authorities to:

- promote and provide incentives for the rehabilitation, enhancement and protection of waterbodies and margins;
- ensure no repo of any size is used for sewage systems. We do not object to the use of appropriately sited man-made wetlands;
- prohibit drainage of naturally wet areas or wetlands including draining nearby land;
- chemical pesticides, fertilisers or contaminants are not used where they can potentially affect any waterbody;
- no liquid waste (e.g. stormwater, sewage and farm effluent) will be discharged into a waterbody;
- unrestricted stock access to waterbodies is prevented and nitrogen caps are imposed on farms;
- consents for works stipulate regular cultural health monitoring. Where data shows that there is an adverse effect on water quality then activities must cease;
- riparian margins are as wide as possible and planted in locally sourced indigenous plants;
- when structures are placed in waterbodies provision is made for indigenous migratory species;
- NRC will provide free riparian management plans for farms.

Energy - Hydro Generation

Water in motion is a renewable energy. The abundance of moving water and headwaters in our catchment has been exploited by native forest logging and following the

development of the Wairua Power Station in 1917. Other heads of water in our rohe have also been tapped to supply energy for small-scale power generation.

4.5 Issues

a) Tuna lifecycle has suffered greatly from impassable infrastructure and high mortality rates as a result of generation and pump turbines.
b) Mana Whenua ki Whatitiri have not shared any of the economic benefits derived from energy generation on our waterways, in our rohe.
c) Mana Whenua ki Whatitiri are not granted access to existing energy generation structures and the participation we seek as the kaitiaki of customary tuna has been met with resistance by the infrastructure owners.
d) Access to traditional sites on the Wairua River is hampered or blocked by current energy generation infrastructure.
e) There has been a lack of monitoring of consent compliance, fish passage and mortality rates of tuna in relation to existing hydro-energy infrastructure.

4.6 Objectives

a) To maintain, protect and enhance, where possible, our waterways, their habitats and our taonga species from inappropriate power generation schemes.
b) To create an income stream from renewable hydro-energy for our hapū, that is environmentally sustainable and does not compromise aquatic life.

4.7 Policies

a) Whatitiri RMU will promote the philosophy of kaitiakitanga of natural resources and the environment to be maintained through use of sustainable renewable energy.
b) Locally produced renewable energy that is of an appropriate scale and uses appropriate technology while protecting and maintaining our water resource and habitats is supported by Whatitiri RMU.
c) Whatitiri RMU will work to grow the capacity of Mana Whenua in regard to micro energy production and will seek opportunities for employment and training utilising natural resources within our rohe.
d) Whatitiri RMU will endeavor to improve relationships with existing energy generators within our rohe in order to protect and enhance our water resource and habitats.

4.8 Methods

a) Whatitiri RMU will investigate and develop strategies for hapū led renewable energy generation opportunities in our rohe to provide for the social, environmental and economic benefit of Mana Whenua ki Whatitiri and the wider community.

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Ref JND/21/2
Original draft Nov 2019
Revised 21 May 2021

GLENVIEW ESTATE LTD - PURUA RAPIDS HYDROELECTRIC SCHEME REVISED REPORT ON ENGINEERING PREFEASIBILITY STUDY

1.0 Introduction

This revised engineering prefeasibility study of the hydroelectric potential of the Wairua River at Purua Rapids is in response to an initial request from Neil Lewis to the writer in March 2019. The study has been updated to reflect a piped conduit from the river head works to the power station rather than a canal as proposed initially.

The purpose of the study and the report is to examine the engineering feasibility of the scheme as proposed by Mr Lewis, and to consider how the power generation would accord with the Northland distribution system and to identify key environmental and ecological issues.

The study outcomes should form the basis of deriving costs estimates for development and construction, along with scenarios for evaluating the economics and benefits of power and energy generation and thence consideration of sources of finance and to address issues of approvals, consents and credits.

The report includes a series of drawings and photographs together with two appendices covering hydrology with an outline of generated output and basic engineering geology. Preliminary comment is included on environmental issues, principally fishery and ecology through the rapids and waterfall, including those of particular relevance to local iwi.

2.0 Scheme Description

The Wairua River drains a central area of mid Northland flowing southwards through the Hikurangi swamp area and then dropping over a series of basalt sheets before joining the Mangakahia River to become the Northern Wairoa flowing past Dargaville to the Kaipara harbour. The Purua Rapids are some 4.5km downstream of the Pipiwai Rd bridge and some 15 km upstream from the Wairua Falls and Northpower's adjoining 5 MW power station. The overall location is shown in the accompanying Figure 1. The site includes a basalt quarry operated by Mr Lewis.

The scheme concept comprises a river weir and pipeline offtake structure on the left (east) riverbank at the head of the Purua Rapids. A 300m pipeline excavated into basalt rock would run from the intake structure to a powerhouse situated near the southern edge of the quarry.

Power station turbine discharge from two nominal 1.5MW Kaplan turbines would run through an excavated trapezoidal tailrace channel to return to the Wairua River some 200m downstream.

The scheme aims to make optimum use of the fall in the waterfall and series of rapids over some 500m, without impacting significantly on either the flow regime or the local environment with due regard for the passage of eels.

The general layout of the scheme is shown in plan on Drawing 3, and in profile on Drawing 4 in expanded vertical scale.

3.0 Background

The Purua Rapids have been the subject of previous studies of hydroelectric potential, starting with the NZERDC Study of Hydroelectric Potential in Northland, July 1978 (Ref 1) by Tonkin & Taylor, Consulting Engineers. That study envisaged a right (west) bank scheme with a generating capacity of 2890kW at 50% plant capacity factor.

Subsequent studies by King and Griffin for North Auckland Electric Power Board in 1983 and 1991 and by SKM in 2003 did not proceed to development.

In 2007 Northpower commissioned a study of a right bank scheme from Tonkin & Taylor Ltd with Hydro Tasmania. That scheme included a gated dam structure at the head of the rapids and did not proceed on account of concerns about upstream land inundation raised by local landowners.

4.0 Data Sources and Usage

4.1 Engineering Geology

The local basalt of the Kerikeri lithology, probably Pliocene to Pleistocene in age (Ref 2 and 3) forms the series of Purua Rapids and is exposed in the riverbed and the local quarry managed by Mr Lewis – refer Drawing 2. The basalts are overlain by 2 to 3m of weathered basalt and other soils and interspersed with clay materials, and underlain by older material probably allochthon.

A series of bore holes along the pipeline route and test pits in the area of the tailrace along with quarry exposures give initial indications of material likely to be encountered (Appendix C). The tailrace channel will be excavated in underlying basalt rock debris from the rapids and some softer materials. The quarry is evidently sited near the southern edge of the main basalt sheet. Further geotechnical investigation will be required as necessary for detailed design of scheme components, as noted in Appendix C.

4.2 Hydrology

The Wairua River has been gauged at Pipiwai Road bridge since the 1960s. Flow duration statistics from 21.3.1960 to 11.3.2015 as provided by Northland Regional Council are plotted in Appendix A on Figure A2, together with a 'capacity factor' curve, which relates to the theoretical percentage availability (i.e. area under the curve) for a given intercepted flow.

Ref 1. NZ Energy Research and Development Councils Report No 36, July 1978
Ref 2. Geology of the Whangarei Area – S.W. Edbrooke & F.J. Brook, G.N.S. Science 2009, including NZ Geological Map 1:250,000 scale Sheet 2
Ref 3. Out of the Ocean, into the Fire Bruce W. Hayward 2017

The long term annual mean flow has been assessed as 18.5m^3/s, about equivalent to the 50% capacity factor in theory, assuming all flow up to that figure be utilised. However, that issue is reviewed in light of required residual flow at the headworks and the limitations of low flow usage by the turbines, as examined in Appendix A.

Of relevance to design of headworks and to tailrace levels will be the water level, frequency and size of flood flows. Peak flow data derived for earlier examination of hydro potential (Ref 1) indicates a 1:100-year return peak flow of around 360 m^3/s at Purua Rapids from the 567 km2 Wairua catchment and now confirmed by frequency analyses provided by the Regional Council. Recent flood peaks have been of the order of 250m^3/s (refer Appendix A), with water level rises of the order of 2.5m at the head of the rapids.

4.3 Topographical Surveys

The general site of the Purua Rapids was surveyed along the right (west) riverbank by Beazley Burgess in 2010 for Northpower. In March 2019 the left (east) bank of the river was surveyed for Neil Lewis by Boundary Hunter's Brian Smith. That recent survey forms the basis of the following details of scheme components and the assessment of generating head for the proposed scheme, as shown on Drawings 2 and 4, and confirmed by LIDAR. Additional survey will be required for determining details of the river weir and pipe intake and the power station locations.

4.4 Environment

The length of Purua Rapids comprising the proposed hydroelectric scheme is mainly in reserve (DOC) and under mature vegetation – refer Drawing 2. The envisaged scheme should have no significant effect on the reserve area and minimal loss of riverbank vegetation at the river weir abutments, pipeline intake area and the tailrace outlet. The stand of mature totara which screens the southern boundary of the quarry should not be significantly impacted by power station construction (see photographs).

It is noted that the main river channel above and through the head of the rapids was historically lowered by blasting in order to improve flows from the Hikurangi swamp area. Modification to the rapids' head would comprise a concrete weir on rock across the river and provisionally a discharge control structure at the start of the left side local deepening, so as to optimise the water level at the pipeline intake structure while maintaining the flood capacity through the head of the rapids.

Upstream of that point, the incised river channel is effectively flat for 500m to the scour pool at the foot of the next rapids upstream and may provide moderate storage to benefit peak generation at lower river flows.

The passage of fish species and juveniles (elvers, inanga) upstream through the rapids will be regulated by the Wairua Falls downstream and the waterfall within the Purua rapids (see photo). The upstream passage of elvers that are likely to congregate at the power station outfall will be facilitated by formation at the head of the tail race of an elver pass. An elver ladder formed from mussel ropes will lead to a roughened channel with a regular flow leading to the bottom of the rapids section below the waterfall.

A 200l/sec flow would be maintained over the waterfall and through the rapids from a release at the concrete weir. The weir will be designed in general accordance with NIWA fish passage guidelines.

Design of the pipeline intake screens will recognise the impacts on downstream passage of adult eels, with a recovery system to remove them from the screens and return them to the head of the rapids.

Given the poor quality of the Wairua River at lower flows the opportunity will be taken to improve the water quality by aeration of the discharge from the turbines by introducing air into the draft tubes below the turbines. It is envisaged that aeration will be designed to raise the dissolved oxygen levels in the water by 2 to 3 mg/litre.

5.0 Proposed Scheme Component Structures

5.1 River Headworks and Pipeline Intake

Drawing 5 indicates a weir some 2.5m above the average levels of the rock. Provision will be made for a lower-level sluice in the weir against the left (east) abutment if required. The intention will be to maintain a full pipeline to suit the range of turbine flow conditions while providing a constant residual flow downstream of the falls.

As shown on the attached conceptual Drawing 21/2/5, the mass concrete weir will have a hydraulically efficient ogee shaped crest which replicates the natural nappe shape of discharge over a vertical structure.

In longitudinal profile the weir crest will have a maximum elevation of 81.5 RL. Generally, the weir will be in accordance with the recommendations in Section 4.3 of NIWA Fish Passage Guidelines e.g. rocks embedded in the concrete to facilitate elver passage upstream once they have ascended the sides of the water fall. A minimum flow of 200 l/sec would be released through a notch at the right-hand end of the weir crest, or by a lower-level release when head water levels are below the weir crest.

A floating debris boom across the entrance to the pipeline intake would encourage larger debris to continue on downstream over the weir during floods. The pipeline intake structure would be of reinforced concrete and fitted with control gates, screens for smaller debris and stoplog slots for closing off the structure and pipeline. Debris on the intake screens will be controlled by mechanical raking along with an adult eel collection facility.

In recognising the significance of adult eel migration, the intake screening system will incorporate an eel collection system comprising a series of baskets on ascending chains. The eels will be tipped into a flushing gutter and thence returned to the head of the rapids below the weir structure.

5.2 The Pipeline

The pipeline will be sized to carry an estimated maximum flow of $24m^3/s$ to two turbines over a range of flows and appropriate water levels from the river. Excavation for the pipeline would be an extension of quarry blasting operations. As indicated on Drawing 3, a nominal diameter of 2.8m would be subject to final optimisation balancing costs against energy losses.

The trench for the pipeline is likely to be partly in the material underlying the basalt sheet and hence the pipeline will be initially buried at least up to the level of the bottom of the basalt in order to preserve the stability of the basalt sheet.

The trench will have the top and bottom soils dug out and stockpiled and eventually returned to the trench to cover pipes. The basalt sheet will be drilled and blasted. The top spalls will be taken and used as armour rock in the tail race and headpond. The quarry run will be processed. Fine aggregate will be compacted around the pipes in the trench. The gabion-sized rock will be sold. The approximate 12,000 cubic metres of excavation from the headpond will be distributed along the trench as fill. The backfilled trench area will be regrassed and turned to pasture.

At the end of the single pipeline a bifurcation structure would lead twin penstocks to the power station turbines as indicated on Drawing 6.

5.3 The Power Station Structure

The power station and penstocks would be located within the quarry near the toe of the ridge which lies along the southern edge of the quarry as shown on Drawing 3.

A concrete substructure would house two Kaplan turbo generators and associated electrical equipment as shown on Drawing 6. From preliminary test excavations it is envisaged that the substructure would be founded on either underlying basalt or indurated mudstone. Detail design of foundations and floor levels would follow geotechnical investigations and be suited to the final selection of turbines, generators and associated electrical equipment including the transformers.

A relatively light weight weather-proof structure would include a gantry system with hoist for normal maintenance and a roof with panels to allow mobile crane access for major equipment.

5.4 Access

Extension of roading through the Glenview Estate property would lead to the power station and the river intake and weir area, as shown on Drawing 3.

5.5 Tailrace

As shown on attached Drawing 6, the trapezoidal channel would be excavated to a profile in accordance with the subsoil conditions, to outfall in the Wairua River some 200m downstream. Flood levels are being ascertained to allow for potential backwater effects on the turbines. Rock armouring of the channel sides and base could be supplemented by occasional rock groins in accordance with fishery recommendations.

An elver pass as described in 4.4 above would be formed at the start of the tailrace on the right bank to assist elvers to return to the river. The land between the tailrace and the river would be retired from farming and planted in natives.

5.6 Turbines, Generators and Electrical Equipment

Attached in Drawing 6 is a schematic layout of the power station provisionally comprising two 1.5 MW Kaplan turbines and associated electrical installations as provided by Vortex Hydro. Two turbines are provisionally preferred over a single machine from considerations of overall economics of powerhouse and penstock construction, and generator efficiencies at low flows; however further considerations would be given to these options in the feasibility study.

Given the poor quality of the Wairua River at lower flows the opportunity will be taken to improve the quality by aeration of the discharge from the turbines by introducing air into the draft tubes below the turbines to raise the dissolved oxygen levels in the water by 2 to 3mg per litre.

5.7 Transmission

As indicated on Figure 1.0 a 33kV transmission line would run from the power station to Stratton Road then across private property to the intersection of Malone Road and Kokopu Road and thence to Northpower's Poroti substation on Mangakahia Road. Details of transmission line routes and affected properties are under discussion.

5.8 Outline Development Programme

Figure 2.0 shows an indicative timeline for feasibility study and economic viability, design and consents, construction and commissioning and overall project management. This minimal programme envisages two summer construction seasons, with commissioning and ideally first generation aimed at the second winter. Key decision points would arise with the granting of approvals and consents and then at the completion of the feasibility study and economic assessment.

6.0 Risks, Conclusions and Recommendations

6.1 Hazards and Risks

There are a number of issues which would receive particular attention in the feasibility and detailed design stages with the intention of identifying potential fatal flaws and at least controlling if not eliminating them including:

- Residual flows downstream of the falls in the rapids reach, and hence the availability of low generation flows will need to be established once seepage contributions have been identified.
- Softer materials associated with and underlying the basalt sheets will influence the design of all excavations and structures particularly the pipeline and its intake and the substructure of the powerhouse, in terms of foundation stability, bearing pressures and seismic factors.
- The proposed transmission line route to Northpower's Poroti substation would be refined in terms of crossing some private properties, and then running along public roads.
- Cost estimates and potential economic viability will form a critical part of the feasibility study.
- Consent application and conditions will address the requirements of regulatory authorities, and local stakeholders including tangata whenua.
- Construction processes and costs have yet to be discussed with potential contractors and suppliers.
- Financing arrangements.

6.2 Conclusions

The study has identified a potentially feasible scheme for hydroelectric development along the left bank of the Purua Rapids on the Wairua River, comprising a river weir and pipeline intake structure at the head of the rapids, a pipeline excavated largely through basalt rock, and a nominal 3.0MW power station and tailrace channel back to the river. A minimal project timeline envisages first generation within two years of start of construction subject to financing, approvals and consents and no adverse construction issues.

Reference to hydrological data from Northland Regional Council has enabled an estimate of average annual energy to be generated from the scheme and confirmation of flood frequencies. Further geotechnical studies are in hand to identify the extent of the local basalts and softer associated materials of significance for excavations and foundations. Environmental and ecological issues are under active discussion.

6.3 Recommendations

It is proposed that the project proceed to a feasibility study focusing on:

- Confirming consent issues and conditions with the relevant authorities and stake holders.
- Additional engineering geology and geotechnical engineering analyses.
- Developing estimates of construction cost and electrical generation revenue.
- Finalise transmission of electrical energy via Northpower's substation.

Satisfactory outcomes of these key factors would contribute to a more detailed study and report covering engineering feasibility, environmental issues and economic viability.

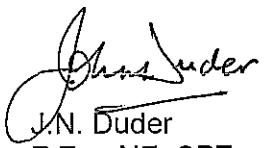
7.0 Acknowledgements

The assistance of Northland Regional Council, Boundary Hunter surveyors, Brian Leyland Consultant, WSP OPUS, Maskell Productions and Vortex Hydro in the preparation of this prefeasibility report is acknowledged.

8.0 Limitations

The structures and capacities outlined in this report are provisional and conceptual, and subject to geotechnical analysis, topographical survey and more detailed design. The details provided by Vortex Hydro are reproduced with their permission without prior commitment by them or the client.

This report has been prepared for the benefit of Glenview Estate Ltd with respect to our particular brief and it may not be relied upon in other contexts or for any other purpose without my prior review and agreement.



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F Eng NZ; CPEng

(See attachments Page 8)

ATTACHMENTS:

Figures: 21/2/1 Wairua River catchment and location of proposed hydroelectric scheme
21/2/2 Outline development programme

Photographs – 3 sheets

Appendix A, Hydrology Review and Energy Estimation
Appendix B, Initial Review of Engineering Geology

Drawings:
21/2/ - 1. Proposed Transmission Line to Poroti Substation
2. Aerial Photo Plan & Contour Survey of Purua Rapids
3. Plan of Pipeline to Power Station and Pipe Detail
4. Profile of Pipeline Power Station and Tailrace
5. Plan and Profiles of River Weir and Pipe Intake
6. Power Station with Tail Race Cross Section

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WAIRUA RIVER CATCHMENT
Bay of Islands
Cape Bre
Keriker
Russell
Paihia
Opua
Waitangi
Haruru
Pakaraka
Moerewa
Kawakawa
Kawiti
Pokapu
Motatau
Maromaku
Towai
Kaimamaku
Opuawhanga
Waiotu
Hikurangi
Wilsonville
Tanekaha
Oakura
Whangarei Harbour
Whangamumu Harbour
Whangamumu Point
Parekura Bay
Manawaora
Taupan Bay
Whangaruru North
Whangaruru South
Whangaruru Bay
Motukehua I (Nops I)
Pararaunui Point
Motutara Island (Henry Island)
Danger Rock
Moanarua Island
Okaoka Rock
Motukauri Island
Helena Bay
Okupe Beach
Home Point
Okaroma Point
Waiotaua Bay
Ngaiotonga
Tutaemaiai
Walkare
Walkare Inlet
Oromahoe
Pukatawa
Waitangi River
Waiomio
Kerikeri Inlet
Waikare Inlet
Whangaruru Harbour
Motukiekie I
Moturua Island
Urupukapuka Island
Waewaetorea Island
Okahu Island (Red Head Island)
Te Nunuhe Rock (Whale Rock)
Motutara Rock (Twins Rock)
Karlparipa Point
Waiwiri Island
Net Rock
Motukoreri Island
Motukumara Rock
Rawhiti
Pukehuka
Whangamumu
Motuarohia Island (Roberton Island)
Te Rawhiti Inlet
Albert Channel
Tapeka Point
Scoria Flat
Brampton Shoal
Wairoa Bay
Oneroa Bay
Matauwaora Bay
Purua Bay
Motumaire Island
Waitangi
Te Pahi Islands
Poraenui Point
Black Rocks
Tareha Pt
Whale Bay
Rangihoua Bay
Howe Point
Kapiro
Walpapa Stm
Kerikeri Inlet
Kerikeri
Moturua Island
Onewhero Bay
Waiomio
Pukatawa
Waitangi River
Haruru
Palhia
Opua
Okiato
Orongo Bay
Parua Bay
Frenchmans Swamp
Waikare Inlet
Waiomio Channel
Oromahoe
Pukatawa
Otao
Whangae
Kawakawa
Hupara
Pakaraka
Tauraroa
Karetu
Moerewa
Kawakawa
Lake Owhareiti
Stream
Gloria
Kawiti
Orauta
Waitarakeke
Tuhipa
Lake Kaiwai
Pokapu
Waiomio
Kawakawa Stream
Waiomio Stream
Owaka Stream
Tupehanga Stream
Waiomio Stream
Waiotu
Walkare
Walkare River
Paukatauri Stream
Punaruku
Whangaruru South
Oakura
Te Rangi
Punaruku Stream
Mokau
Whangaruru Bay
Motukehua I (Nops I)
Parenuata Hill
Hut
Hurupi
Helena Bay
Okupe Beach
Ruapekapeka
Tapuhi
Tapuhi River
Tapuhi Stm
Pokere
Opahi
Hawera Stream
Talkirau
Motatau
Akerama
Towai
Maromaku
Waiotu River
Kaimamaku
Opuawhanga
Matawaia
Pukaka
Marlow
Waiotu
Whakapara
Whakapara River
Olonga
Kirikiritoki Stream
Marua
Waro
Wilsonville
Hikurangi
Tanekaha
Ripenui
Pipiwai
Pipiwai Stream
Moengawahine
Moengawahine Stream
Aponga
Purua
Otakairangi
Apotu
Kauri
Wairua River
Matarau
Hunlangata West
Ngararatunua
Three Mile Bush
Kamo
Glenbervie
Whareora
Tahera
Waiarohi River
Tarakeke R
Tarynavon
Kiripaka
Kaingaroa
Mangakahia River
Mangere
Mangere Stream
Gumtown
Maketown
Kensington
WHANGAREI
Parahaki
Titoki
Poroti
Wairua River
Whirinaki
Whirinaki River
Hikurangi Stream
Hanenga Stm
Mangakahia River
Parakao
Otaika Valley
Maunu
Raumaiahere
Sherwood Rise
Waikaraka
Owhiwa
Whatitiri
Waiotama I
Maungaru
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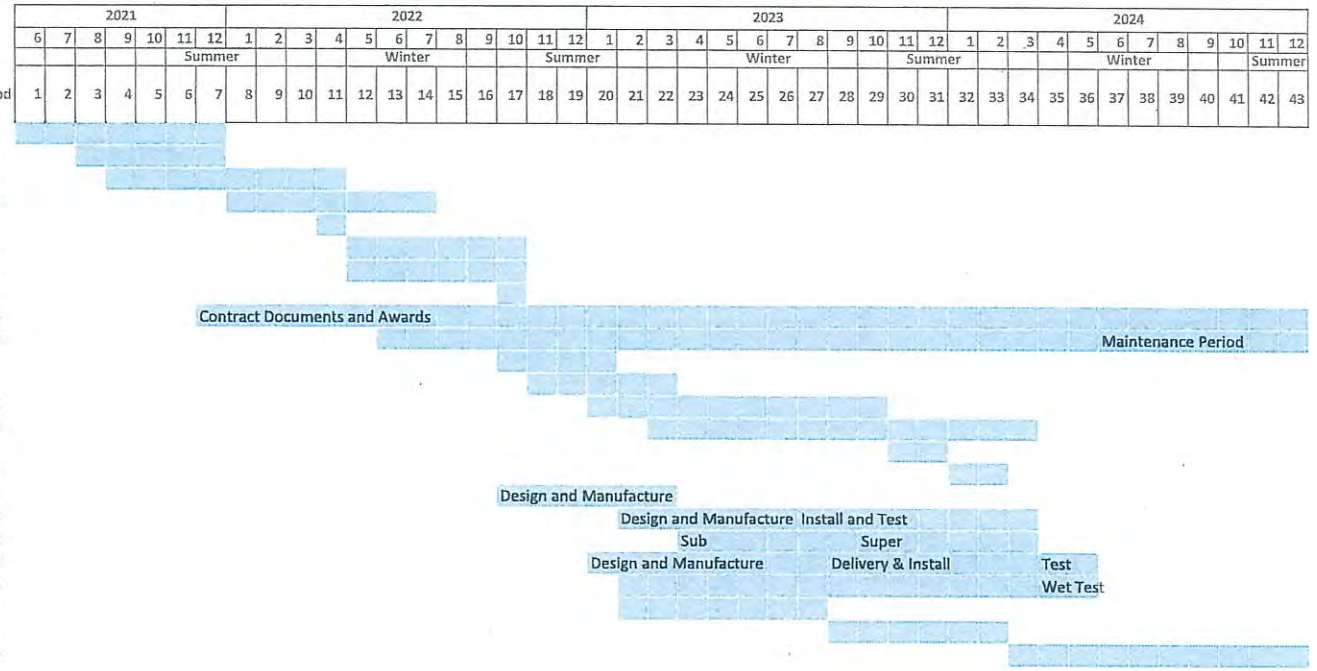
PURUA RAPIDS HYDRO SCHEME
PREFEASIBILITY REPORT - GLENVIEW ESTATE
LOCATION & CATCHMENT: FIGURE 21/2/1

Glenview Estate Ltd

PARUA RAPIDS HYDRO SCHEME
INDICATIVE PROGRAMME OF PROJECT DEVELOPMENT

ACTIVITY	PERIOD	PLAN START (Period)	Period
Resource Consents & Feaibility Study		1	7
Geotechnical Investigations, Survey and Reportings		3	5
Preliminary Design and Report, Consent Issues and Cost Estimates		4	8
Economic Viability and Financing		8	7
First Decision to Proceed		11	1
Detailed Design		12	6
Establish Project Management		12	6
Second Decision to Proceed		17	1
Set up Contract(s) and Project Management		7	54
Construction		13	39
	Preliminary Site Works, Access, Power etc	17	4
	River Weir and Diversion	18	5
	Pipeline Excavation and Headpond	20	10
	Pipeline Intake	22	13
	River Debris/Boom	30	2
	River into Pipe	32	2
	Penstock and Bifurcation Structure	17	6
	Intake Gates, screens etc	20	15
	Powerhouse – sub/super structure	23	12
	Turbines and Generators	20	17
	Electrical Works, Final wet tests	21	16
	Tailrace Excavation	21	7
	Transmission Line	28	6
Commissioning and Generation		34	30



PURUA RAPIDS HYDRO SCHEME
PREFEASIBILITY REPORT - GLENVIEW ESTATE
INDICATIVE DEVELOPMENT PROGRAM.
FIGURE 21/2/2

Aligment of proposed weir

Wairua River –Purua Rapids , Proposed Intake Location

Proposed pipeline route

Rock pile from previous channel deepening

DOC Reserve between river and proposed pipe route

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PURUA RAPID HYDRO STUDY

PHOTO SHEET 1 OF 3.

MAY 2021 J N DUDER

Head of Rapids looking NW towards proposed intake site

Pipeline route.

View northwards from powerhouse location.

Penstock intake site on right

Tailrace route looking south,

power-house site in foreground

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PURUA RAPID HYDRO STUDY

PHOTO SHEET 2 OF 3.

MAY 2021 J N DUDER

Waterfall and Rapids from west bank

Quarry Operation , looking south toward proposed power-station location

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PURUA RAPID HYDRO STUDY

PHOTO SHEET 3 OF 3.

MAY 2021 J N DUDER

Appendix A, Hydrology Review and Energy Estimation
Appendix B, Initial Review of Engineering Geology

Purua Rapids Hydroelectric Scheme – Glenview Estate **Appendix A**

Hydrology Review and Energy Estimation

A1 Introduction

Evaluation of the hydroelectric potential of a given site requires definition of available head (as surveyed) and a flow record of reasonable duration, preferably from an established river gauge. The Wairua River at Purua has been gauged at the Pipiwai Road bridge since 1960. Northland Regional Council have provided monthly mean flows and flood peaks including frequency analyses. Summation of the monthly mean flows give flow duration statistics to allow estimation of percentage flow availability and hence average annual energy generation. Flood data are relevant to the design of any river works and potential limitations on scheme operation.

A2 Flood flows in Wairua River

The attached figure A1 shows a series of three flood peaks of about 260m^3/s at the Purua gauge in 2014. A similar flood on 17 July 2020 confirmed a high-water level at the head of the rapids. Peak flow data derived from earlier examination of hydro potential (Reference 1) indicates a 1:100 year (1% ARI) peak flow of around 360m^3/s. That value is confirmed by up-to-date flood frequency analyses by the Regional Council using four statistical distributions for flood peaks since 21 March 1960.

A weir structure is intended in the river channel as noted in the main report, hence the establishment of extreme flood levels at the intake site and upstream is relevant primarily to effects of the weir and on the pipeline intake area on the left bank of the Wairua River. Development of a stage/discharge relationship at the head of the rapids addresses the flood capacity of the weir and the protection of the pipe intake in flood conditions, together with effects on upstream properties.

A3 Flow duration statistics

The monthly mean flows at the Purua gauge from March 1960 to April 2019 are summed in Figure A2 showing the percentage of time a given flow is equalled or exceeded. The area under the curve for a given flow provides a measure of flow availability and hence theoretical energy generation for a given installed turbine capacity and its associated maximum diverted flow.

A4 Flow availability and estimation of energy

The flow duration data given in Figure A2 provides the basis for estimating average annual energy with recognition of limitations in turbine operation at low flows. The preliminary concept design comprises two Kaplan turbines with variable flow capacity each taking up to 12m^3/s and either turbine not operating below about 2.4m^3/s

The Vortex Group have provided details of a 2/1.5MW installation with a maximum flow of 12 m^3/s for each turbine producing 1500kW from a net head of 14m. Reference to Figure A2 shows that a maximum diverted flow of 24m^3/s has a modified capacity factor of 42.5%.

A provisional indication of average annual energy can be estimated at approximately 10,000,000 kWh/yr based on the data presented in Figure A3 by courtesy of Vortex.

J.N. Duder
21 May 2021

(See page 2, Appendix A, for Figures)

APPENDIX A

Figures:

Figure A1 Flood peaks 2014 at Purua
Figure A2 Flow duration curve
Figure A3 Kaplan Turbine: Flow, Efficiency and Power

Wairua at PuruaFlow

Flow

Bookmark this site for future use

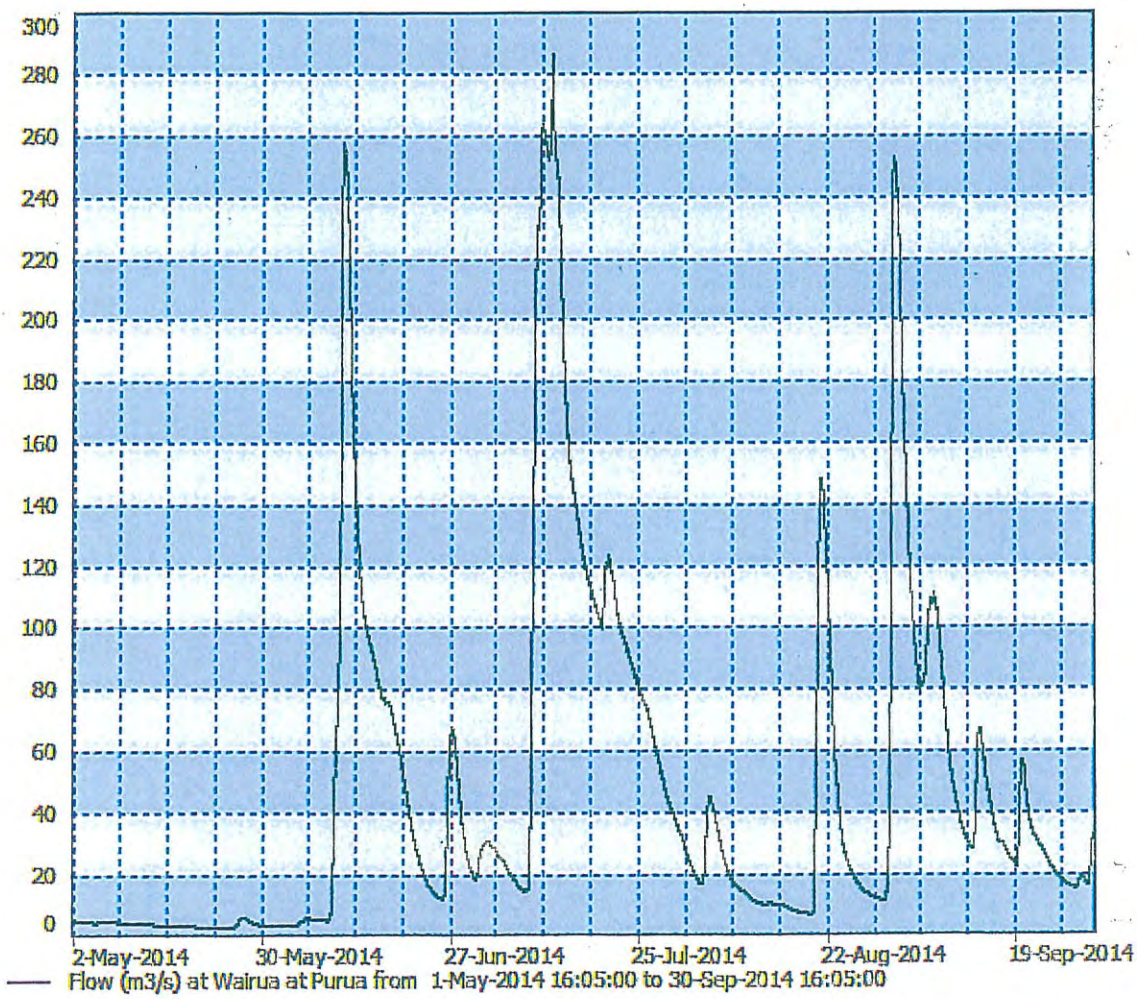
From

1 May 2014 16:05

To

30 Sep 2014 16:0

Note - similar peak flow on 15 July 2020



Download CSV Download XML

Quick View Last 24hrs and Last 30 Days

FIG A1

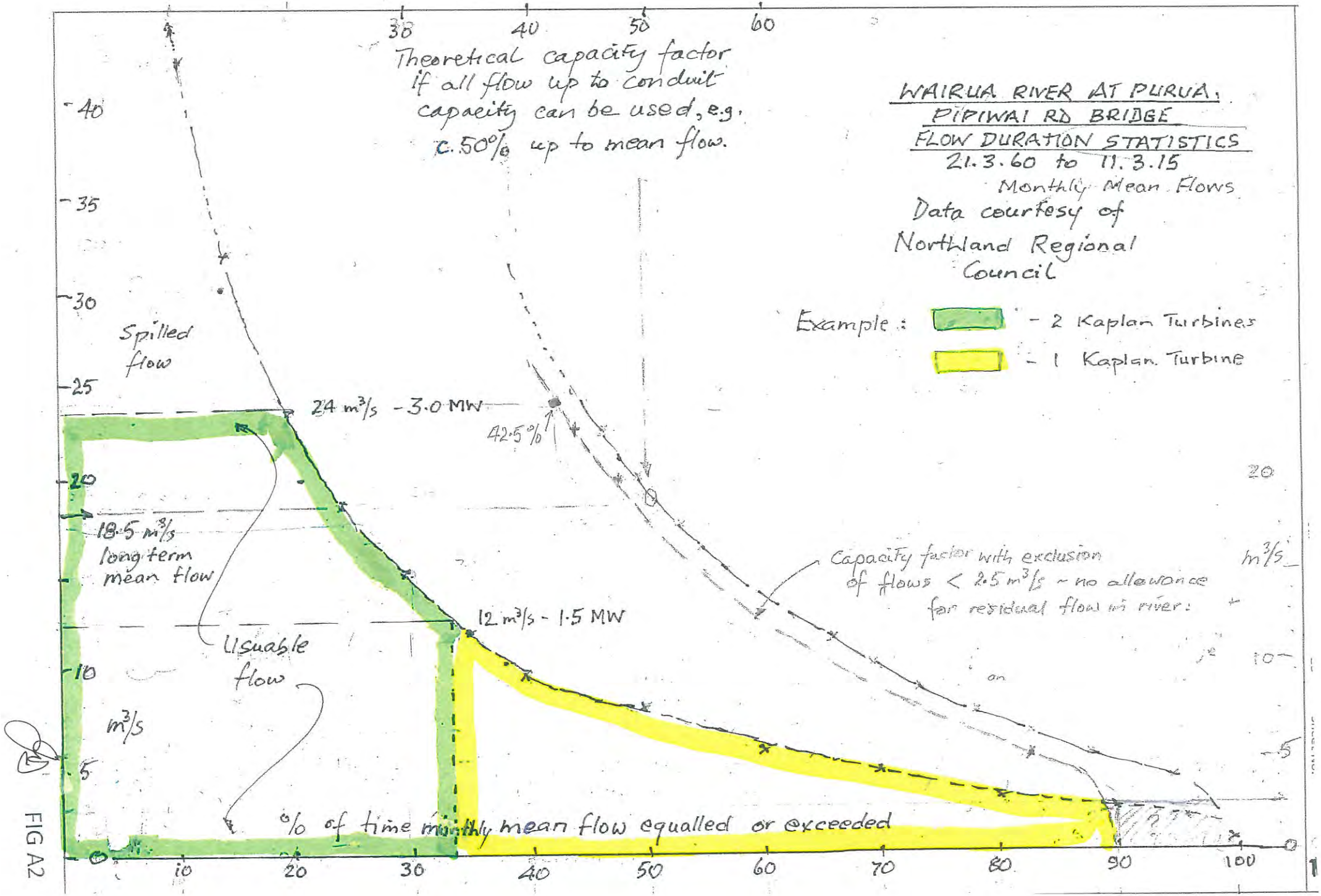
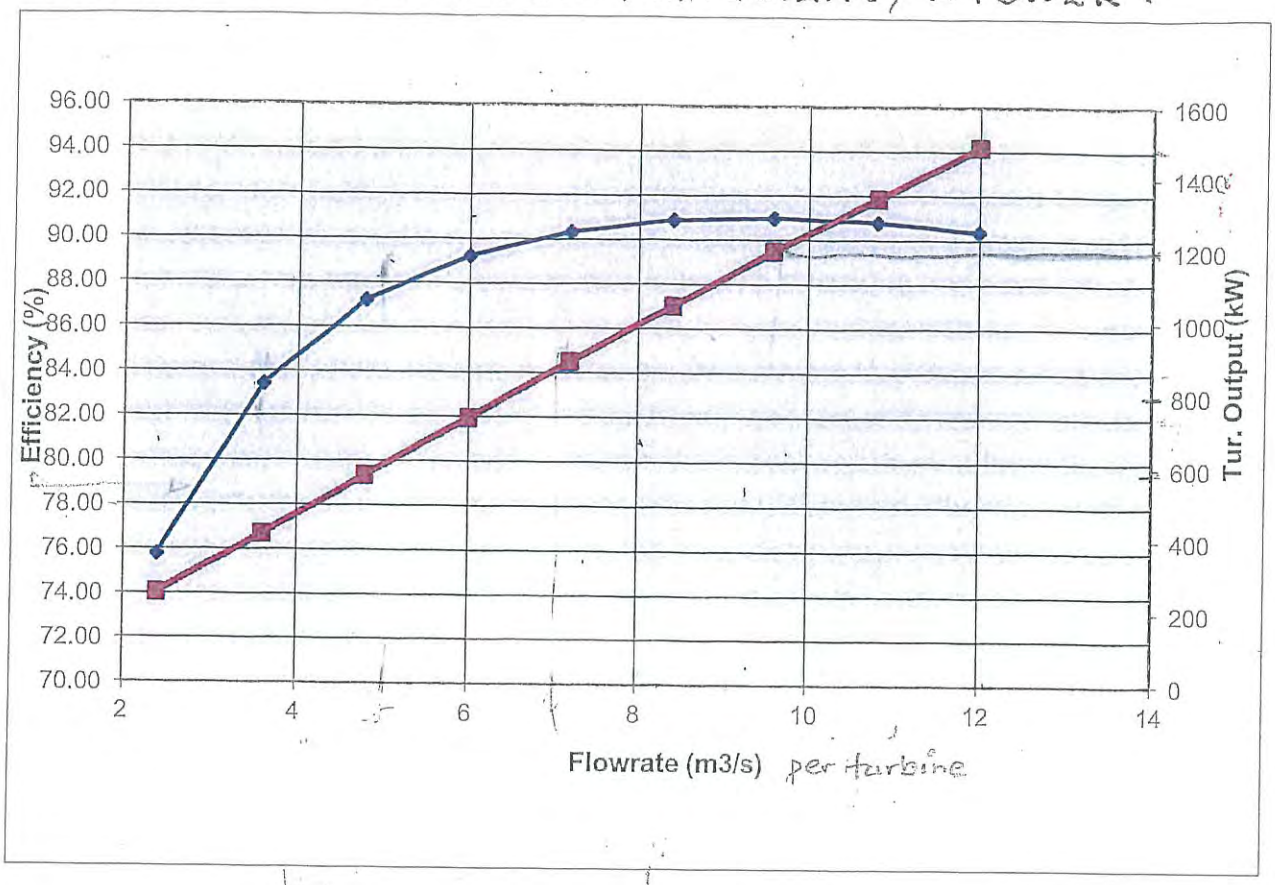

WAIRUA RIVER AT PURUA:
PIPIWAI RD BRIDGE
FLOW DURATION STATISTICS
21.3.60 to 11.3.15
Monthly Mean Flows
Data courtesy of
Northland Regional
Council
Example: - 2 Kaplan Turbines
- 1 Kaplan Turbine
Theoretical capacity factor if all flow up to conduit capacity can be used, e.g. c. 50% up to mean flow.
Spilled flow
24 m³/s - 3.0 MW
42.5%
18.5 m³/s long term mean flow
12 m³/s - 1.5 MW
Usuable flow
Capacity factor with exclusion of flows < 2.5 m³/s - no allowance for residual flow in river:
m³/s
% of time monthly mean flow equalled or exceeded
40
35
30
25
20
10
5
0
10
20
30
40
50
60
70
80
90
100

FIG A2

Vortex Group

KAPLAN TURBINE : FLOW, EFFECIENCY & POWER.



Hn(m)	Q(m3/s)	eta(%)	P(kW)
14	2.4	75.79	250
14	3.6	83.45	412
14	4.8	87.23	574
14	6	89.25	735
14	7.2	90.34	892
14	8.4	90.89	1047
14	9.6	91.00	1199
14	10.8	90.82	1346
14	12	90.38	1488

FIG. A3

Purua Rapids Hydroelectric Scheme - Glenview Estate **Appendix B**

Preliminary Report on Engineering Geology

1.0 Introduction

The scheme site is characterised by the Wairua River exposing the Mirowhakatiri basalts in a waterfall and series of rapids. The basalts are also exposed nearby in a quarry near the southern edge of the basalt flow. The proposed scheme envisages a weir and intake above the waterfall, a pipeline excavated through the basalt as far as the quarry a power station and a tailrace channel excavated through alluvial material back to the river.

The site geology is summarised at small scale in the attached Figure B1 enlarged from Sheet 2, NZ Geological Survey at 1:250,000 scale. The basalt sheet overlies older possibly allochthon material as exposed in the quarry floor and in turn may be underlain by older basalt. NZGS Sheet 2 describes the allochthon deposits as 'undifferentiated mélange, mostly Mangakahia complex' of limited stability. Refer also Reference 3, Hayward 2017.

The basalt sheet appears to be of variable thickness as evident from the exposures in the quarry, the results of a test boreholes, and exposures along the rapids. There is local deepening of the riverbed immediately upstream to a water depth of at least 4.0m, and to a 9.0m depth in the scour pool below the main waterfall, which are inferred to be below the bottom of the upper sheet.

2.0 Engineering Geology

The geotechnical engineering implications are foreseen in preliminary terms as follows – refer to the prefeasibility report.

2.1 River Works

Local trimming of the exposed basalt at the head of the rapids is proposed for foundations for a low concrete weir and provisionally a flow control structure in the existing artificial low flow channel along the left bank.

2.2 Pipeline Intake

Formation of an intake to the pipeline would be nominally to a depth of some 5.5m below the normal generating water level at the headworks, i.e. RL81.5 – 5.5 = 76.0m. However, this may be below the bottom of the basalt at the intake structure in underlying material yet to be investigated and likewise along the pipeline.

2.3 Pipeline Route

The top of the basalt sheet would appear to be at about RL80.0 as evident from a local test pit, a series of shallow bore holes, the water course exposure halfway along the pipeline route and the quarry exposures. However, some variability is to be expected, which could be examined by initial excavation of the pipeline route and mapping of the eastern riverbank.

2.4 Penstocks to Power Station

From initial inspections, the quarry floor is a softer dark grey clay or silt; possibly allochthon, with charcoal inclusions caused by the basalt flow. That material would need detailed analysis in terms of foundation bearing capacity for the penstocks including the bifurcation structure and the power station.

2.5 Powerhouse

The location has yet to be finalised in the general area of the quarry at the southern edge of the basalt sheet and clear of the existing silt ponds which are understood to be formed in the 'alluvial' material along the tailrace route.

2.6 Tailrace

Excavation is likely to be through a combination of rock debris from the rapids and possibly some softer material, with attention to side slope stability and erodibility requiring protection by locally sourced basalt rockfill.

3.0 Recommendations

A key requirement for advancement of the project will be the development of a reliable geological model and definition of geotechnical parameters, entailing the following phased approach.

Phase 1: Initial geotechnical investigation

Development of a project scale geological map would provide the basis for identifying potential geotechnical issues building on the present series of test pits and bore holes. A limited programme of in situ and laboratory testing of bulk samples is likely to be appropriate.

Phase 2: Detailed geotechnic investigations

Detailed geotechnical investigations will be required at the key structures i.e. river weir and control structure, pipeline intake, penstocks and power station. In situ testing will be needed to evaluate ground strength, ground water level and permeability with additional lab testing on recovered materials.

A detailed report covering the investigations, test results and conclusions will be required to inform the feasibility study and detailed design of component structures.

4.0 Acknowledgements

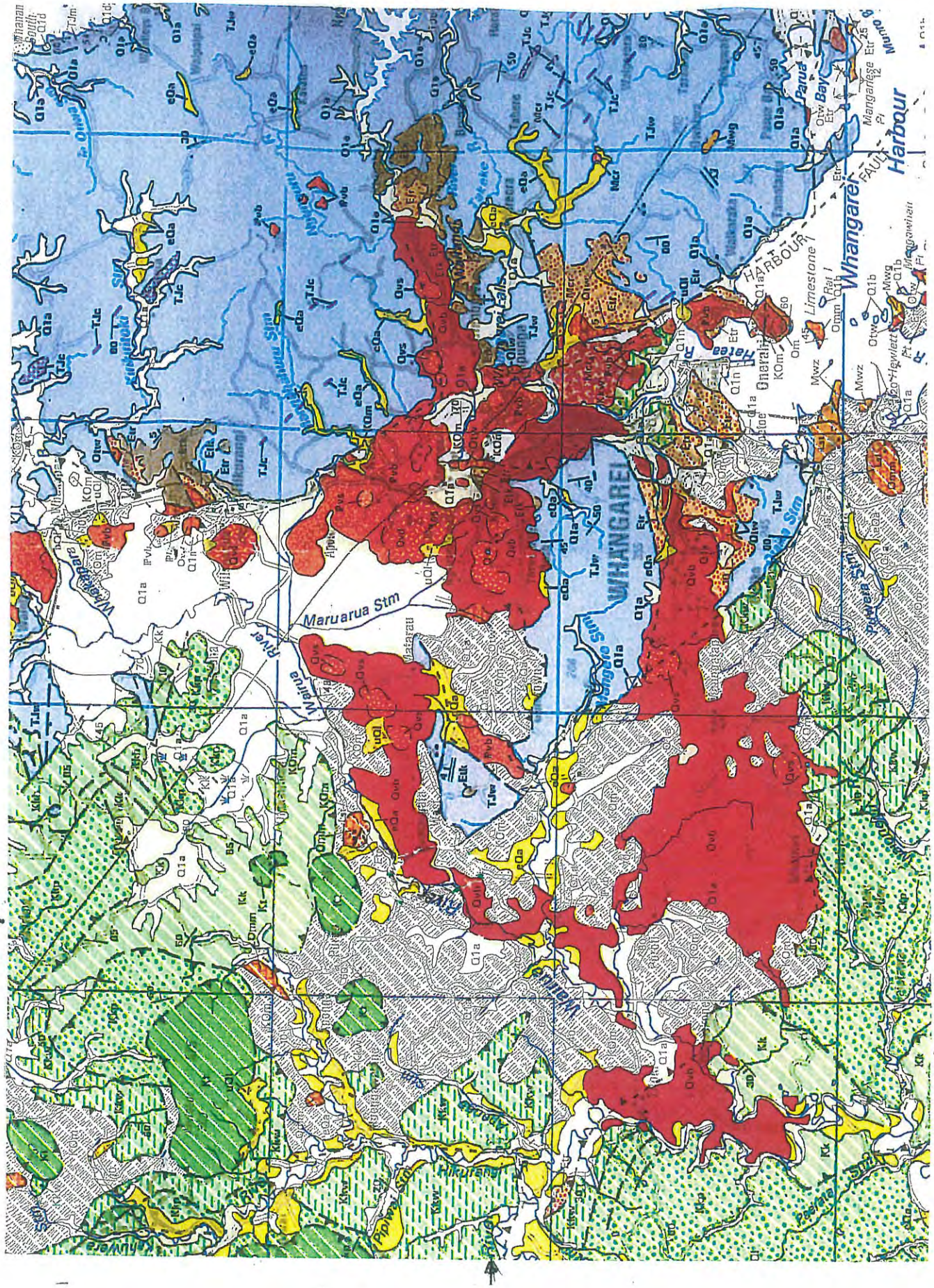
Neil Lewis's advice from quarry operations, bore holes and trial pits is acknowledged, as are preliminary comments from WSP OPUS Whangarei office, and the information obtained from Bruce W. Hayward's book 'Out of the Ocean, into the Fire'.

J.N. Duder
21 May 2021

Attachment: B1 Extract of geological map from NZGS Sheet 2 1:250,000 scale

Drawings:

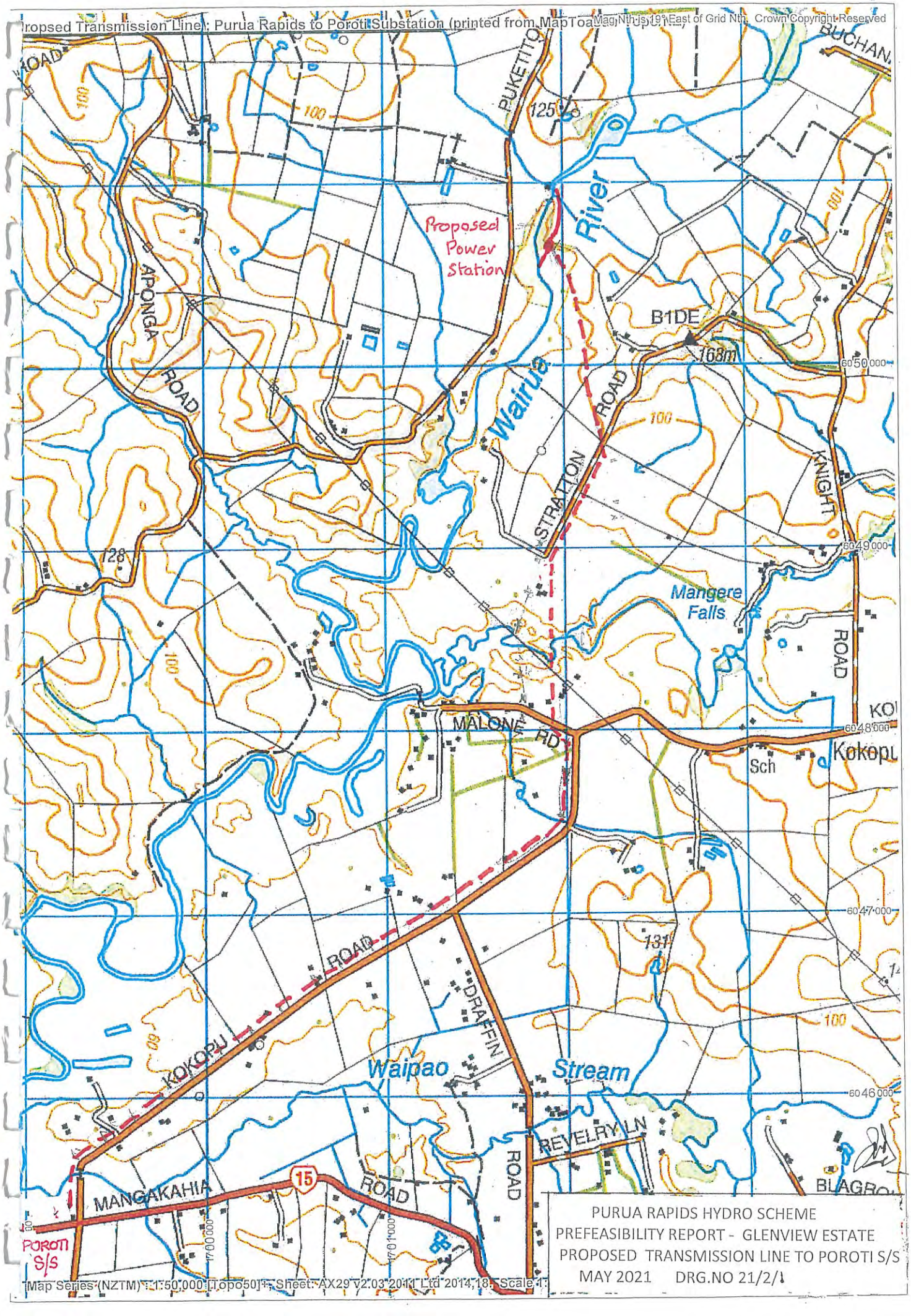
21/2/ - 1. Proposed Transmission Line to Poroti Substation
2. Aerial Photo Plan & Contour Survey of Purua Rapids
3. Plan of Pipeline to Power Station and Pipe Detail
4. Profile of Pipeline Power Station and Tailrace
5. Plan and Profiles of River Weir and Pipe Intake
6. Power Station with Tail Race Cross Section



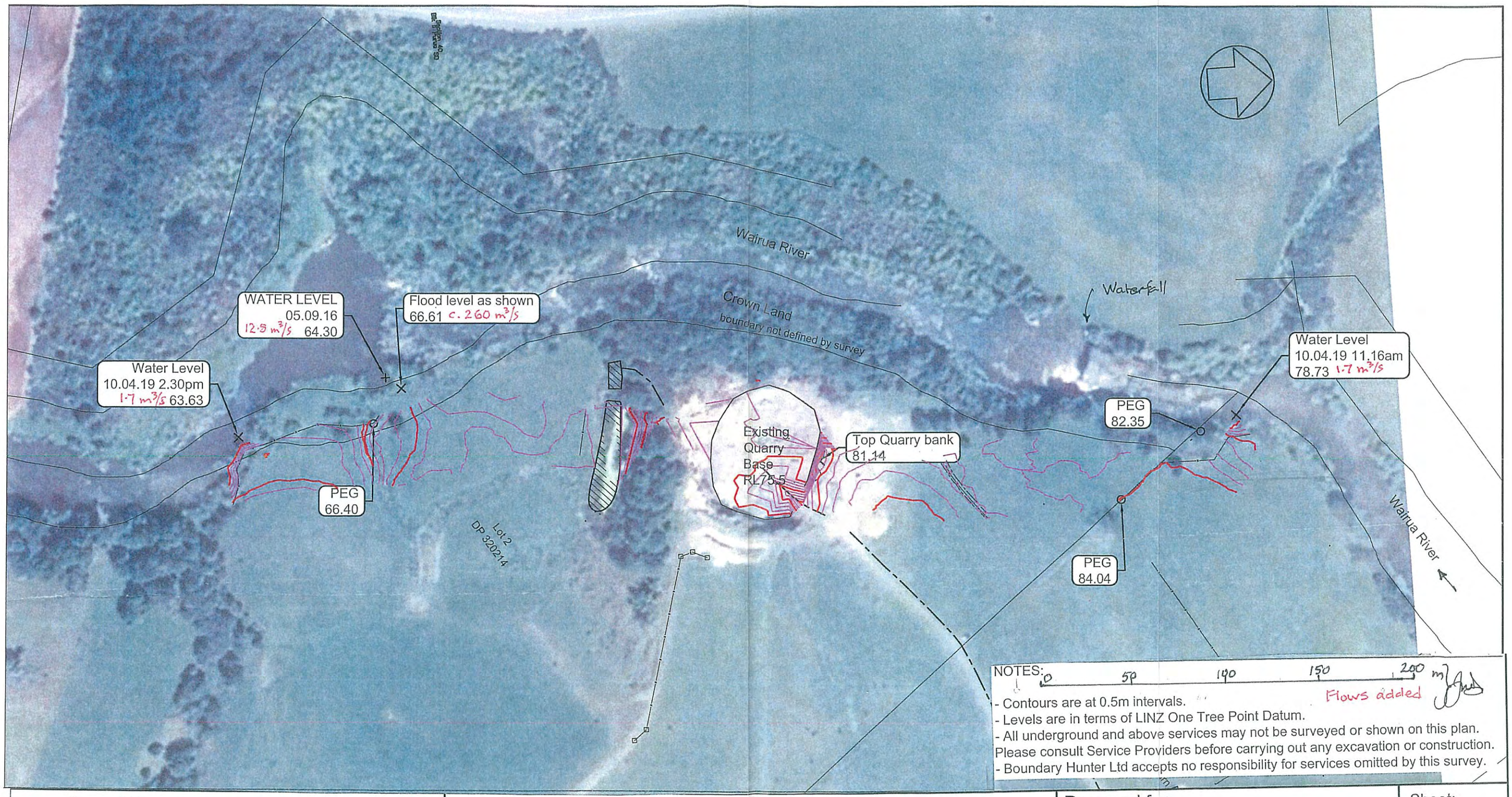
Enlargement from ;Regional geology of Whangarei Area
S.W Edbrooke &F.J. Brook
GNS Science 2009
Enlarged Scale 1:125,000

KEY Red - Basalt
Grey - Allochthon
Purua Rapids →

FIG B1



PURUA RAPIDS HYDRO SCHEME
PREFEASIBILITY REPORT - GLENVIEW ESTATE
PROPOSED TRANSMISSION LINE TO POROTI S/S
MAY 2021 DRG.NO 21/2/1



Surveyed & Drawn by:

BOUNDARY HUNTER LTD

Ph. 09 435 5387

Email. bruce@boundaryhunter.co.nz

Purua Rapids Scheme
Knight Rd, Kokopu
Existing Contour Survey

Prepared for:
Glenview Estate

Sheet: 1 of 3

Surveyed: HS	Checked. B Smith	
Date: May 2019	Scale: 1:2000 @ A3	Ref: 7465

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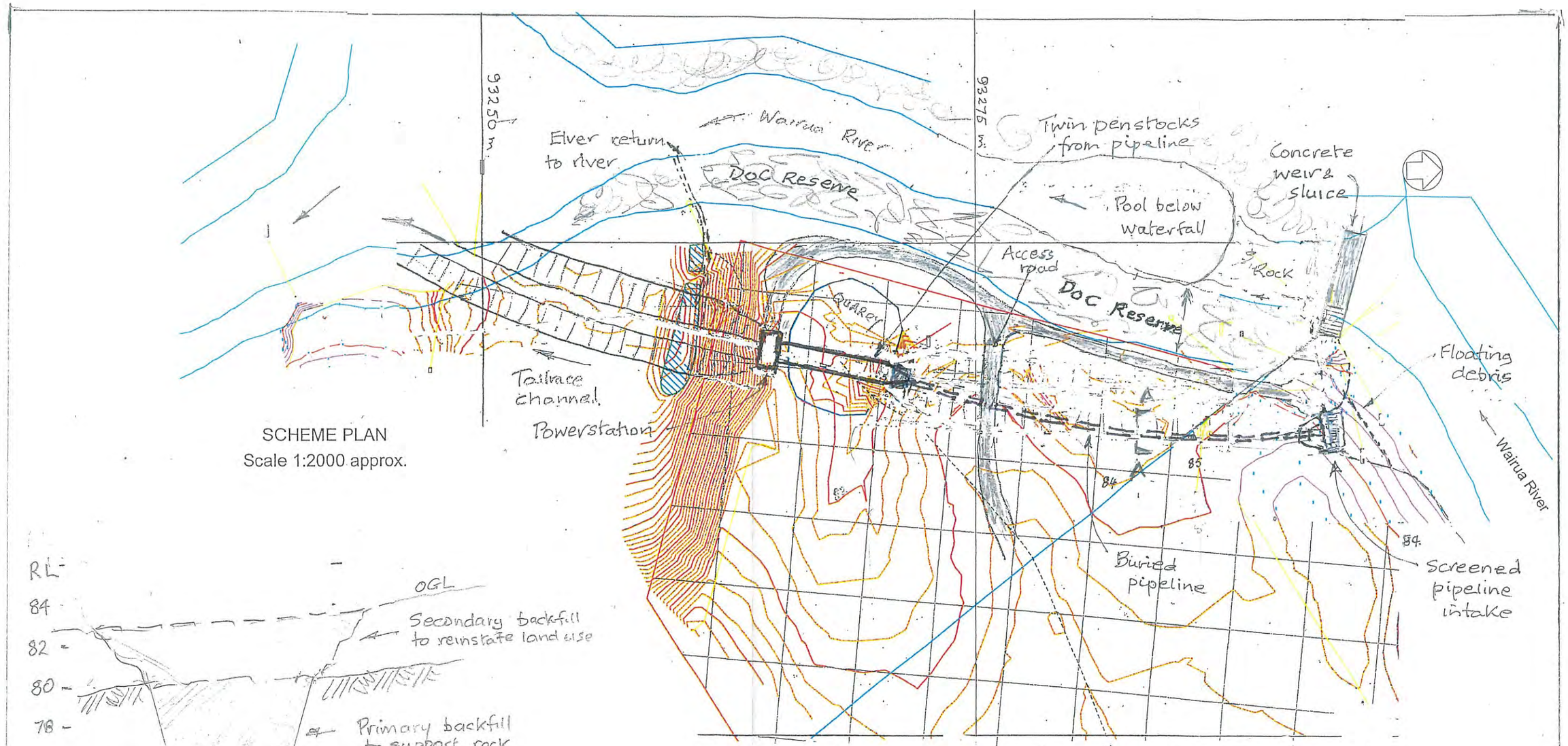
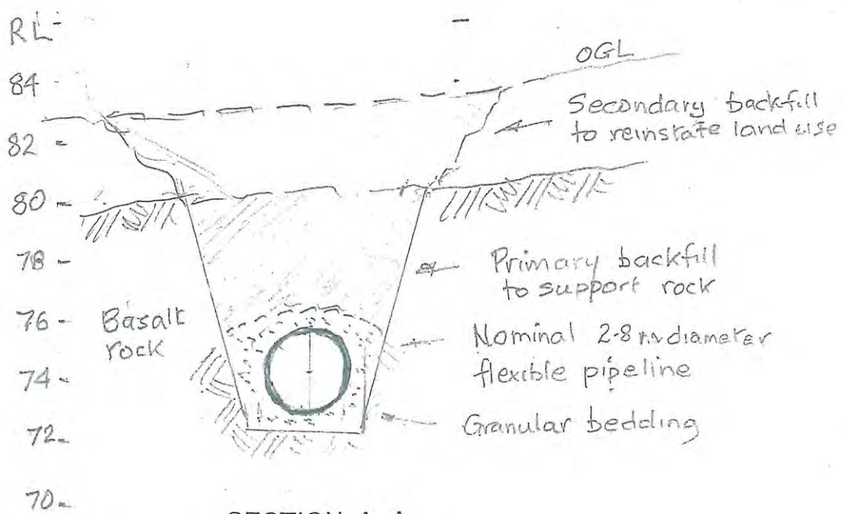
PURUA RAPIDS HYDROELECTRIC SCHEME -
PREFEASIBILITY REPORT FOR GLENVIEW ESTATE LTD-
AERIAL PHOTOPLAN & CONTOUR SURVEY OF PURUA RAPIDS

J N DUDER FIPENZ CPEng 41 A Church St Devonport 0624

Scales : As Shown MAY 2021 DRAWING NO. 21/2/2



SCHEME PLAN
Scale 1:2000 approx.



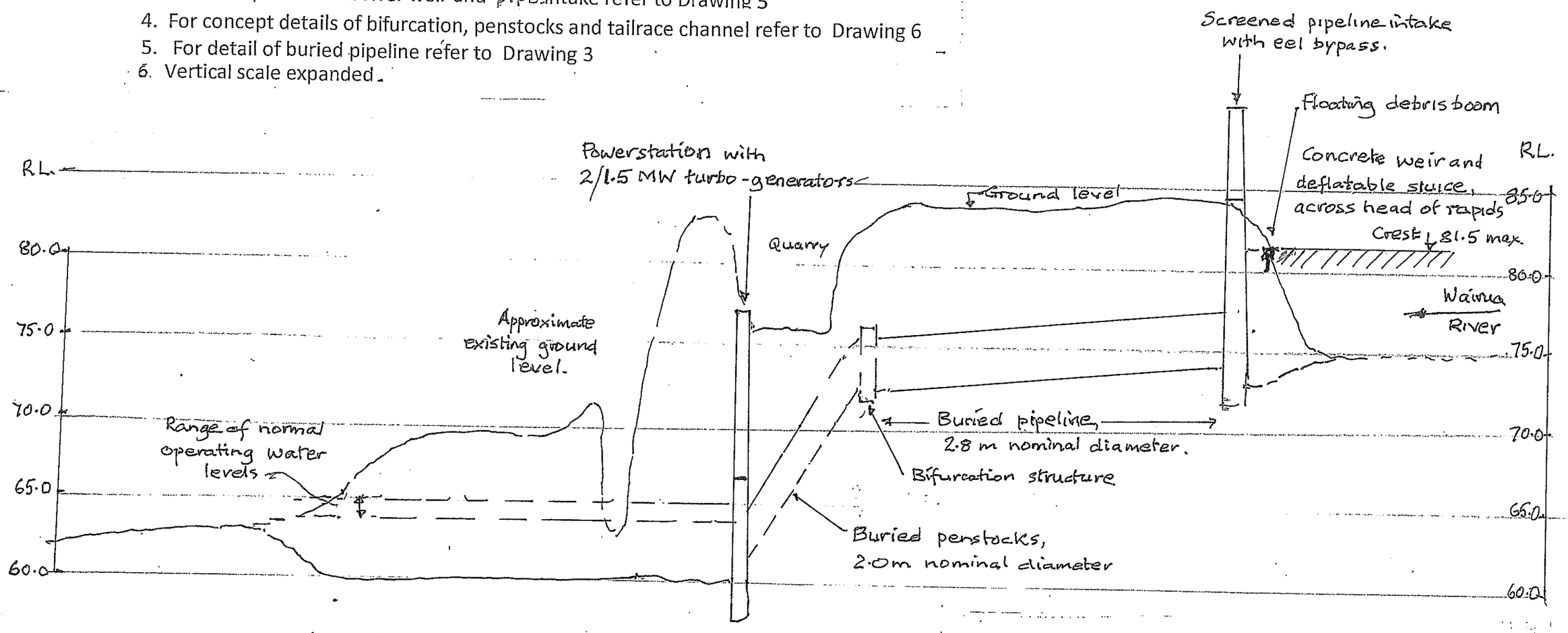
SECTION A--A
Typical detail of buried pipeline
Scale 1:200

NOTES. 1. Contours from Boundary Hunter's surveys for Glenview Estate Ltd , Ref 7465 May 2019.
2. Levels are in terms of One Tree Hill [Whangarei Harbour] datum. Contours are at 0.5 m intervals.
3. For indicative details of scheme components refer to Drawings 21/2/--
-/4 -Profile of Pipe , Penstocks ,Powerstation & Tailrace.
-/5 Plan & profiles of River Weir & Pipe Intake
-/6 Plan & Sections of Powerstation & Tailrace

PURUA RAPIDS HYDROELECTRIC SCHEME –
PREFEASIBILITY REPORT FOR GLENVIEW ESTATE LTD-
SCHEME PLAN & DETAIL OF BURIED PIPELINE

J N DUDER FIPENZ CPEng 41 A Church St Devonport 0624
Scales As Shown MAY 2021 DRAWING NO 21/2/3

NOTES 1. For Scheme Plan refer Drawing 3
2. Ground levels taken from Boundary Hunter's Topographical Survey May 2019
3. For concept details of river weir and pipe intake refer to Drawing 5
4. For concept details of bifurcation, penstocks and tailrace channel refer to Drawing 6
5. For detail of buried pipeline refer to Drawing 3
6. Vertical scale expanded.



m 0 50 100 150 200 250 300

HORIZONTAL SCALE 1:2000 APPROX

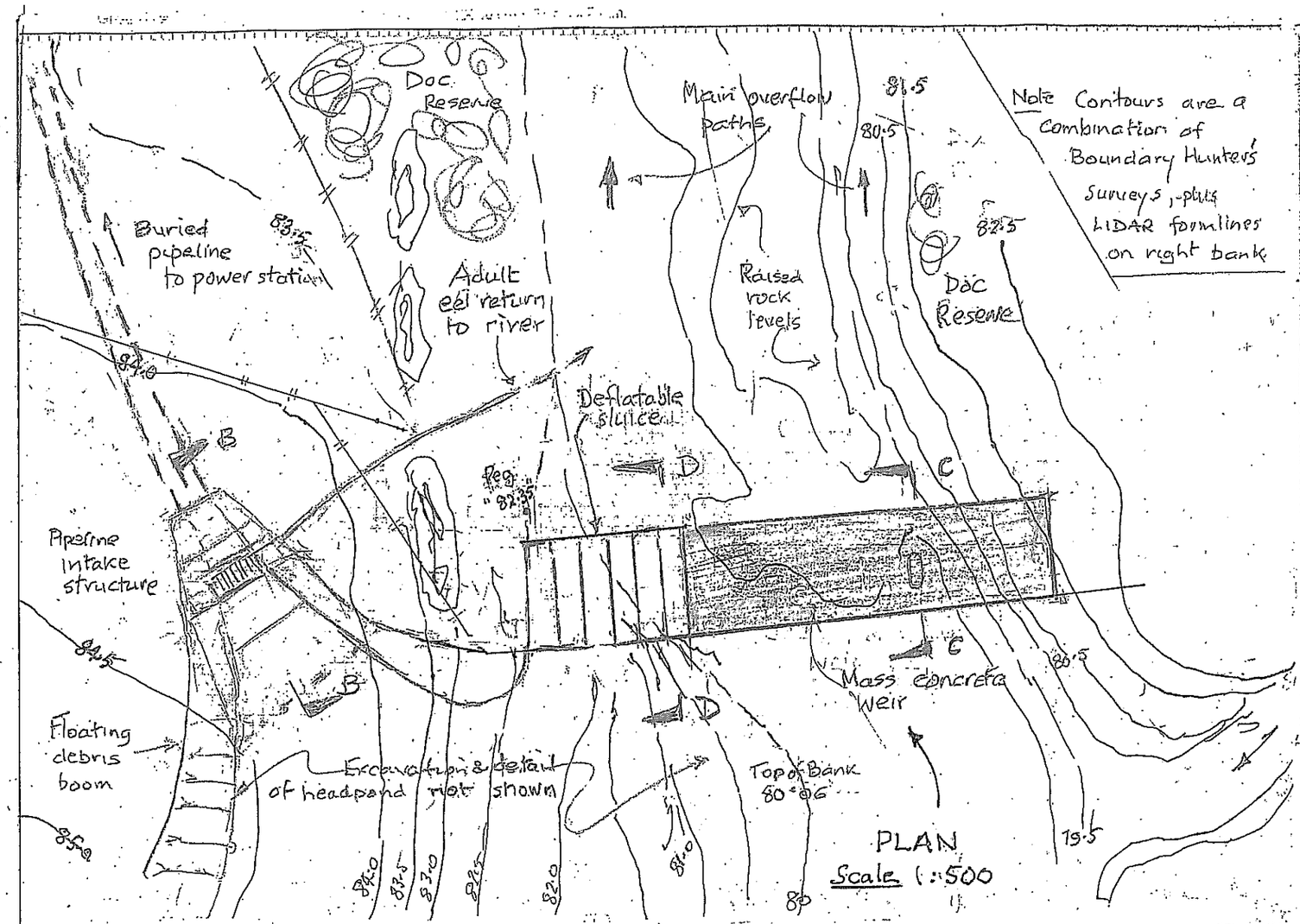
PRELIMINARY ESTIMATE OF NET GENERATING HEAD

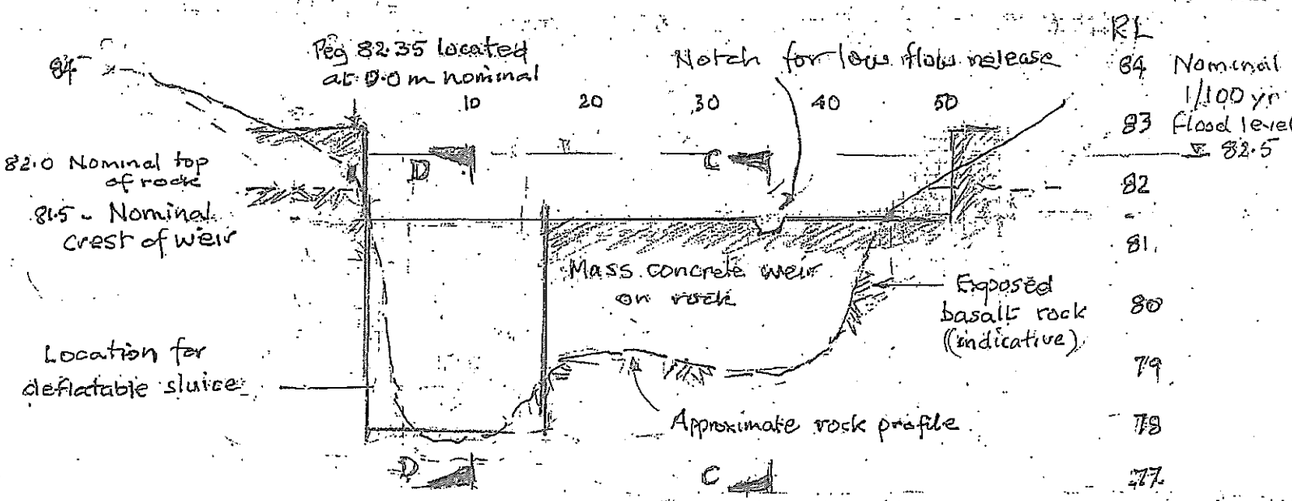
Diverted Flow m3/s	River Intake level	Tailrace outlet level	Nominal allowance for overall losses -metres	Net head m.
24.0	81.5	64.5	3.0	14.0
2.0	81.5	64.0	2.5	15.0

PURUA RAPIDS HYDROELECTRIC SCHEME –
PREFEASIBILITY REPORT FOR GLENVIEW ESTATE LTD-
PROFILE OF PIPE, ,PENSTOCKS , POWERSTATION & TAILRACE

J N DUDER FIPENZ CPEng 41 A Church St Devonport 0624

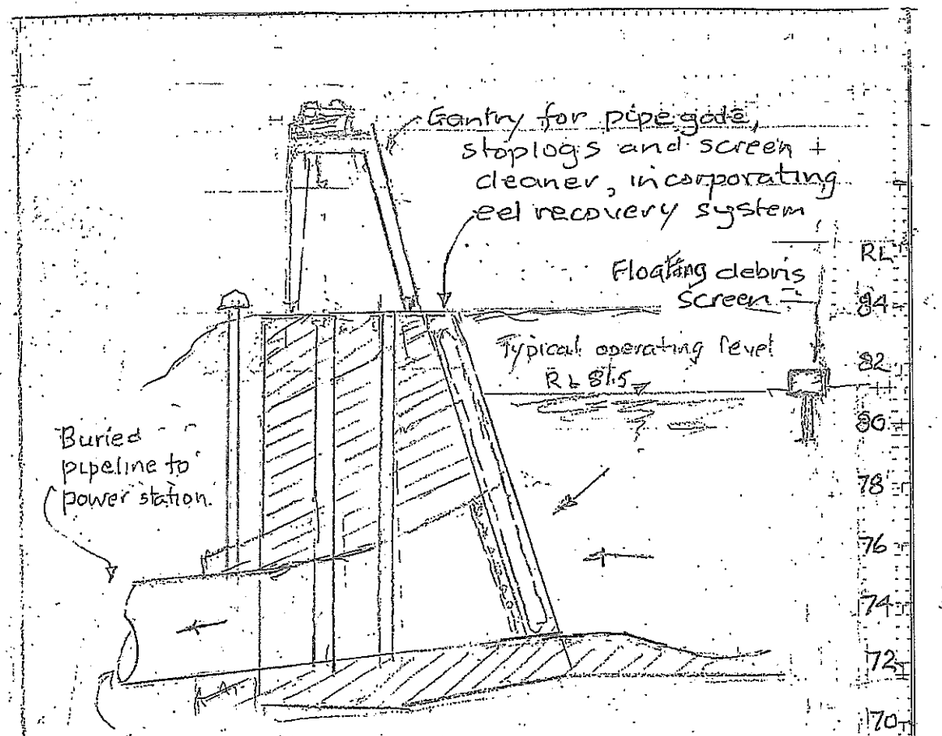
Scales : As Shown MAY 2021 DRAWING NO 21/2/4





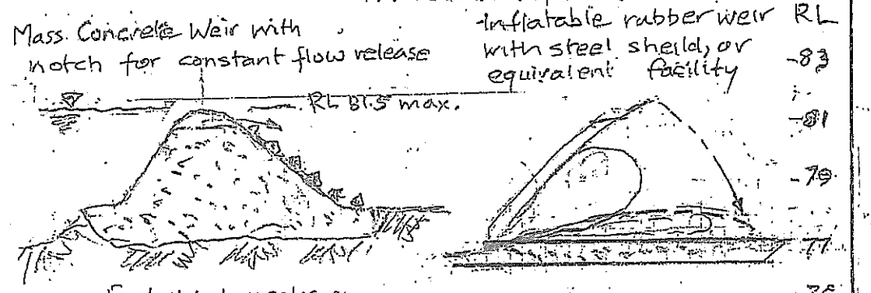
PROFILE ALONG WEIR ON SECTION A-A

Scales Horizontal 1:500 Vertical 1:100



Scale 1:200 at A3

PROFILE OF PIPE INTAKE ON SECTION B-B



SECTIONS C-C & D-D

Scale 1; 200 at A3

Indicative outline only; proprietary details to be determined in detail design.

PURUA RAPIDS HYDROELECTRIC SCHEME

PREFEASIBILITY REPORT FOR GLENVIEW ESTATE LTD.

PLAN & PROFILES OF RIVER WEIR & PIPE INTAKE

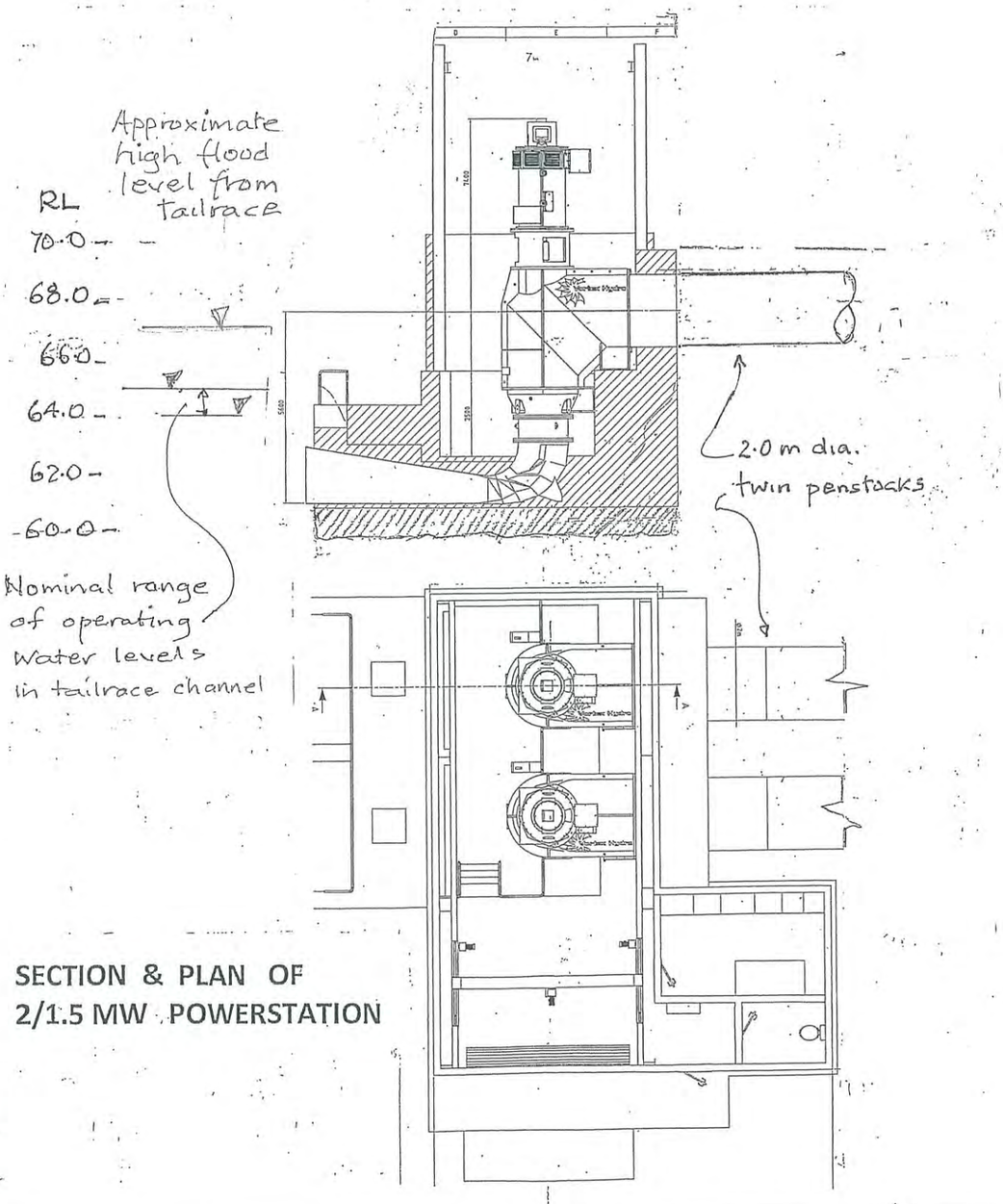
J N Duder FIPENZ CPEng 41 A Church St Devonport 0624

Scales As Shown MAY 2021 DRAWING NO 21/2/5

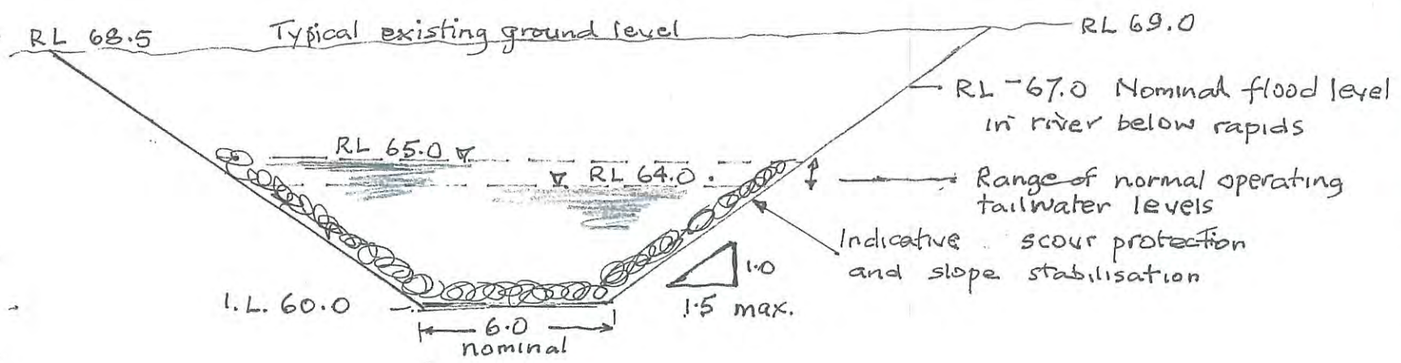
NOTES.

1.For location and layouts of penstock and power-station refer to Drawings 3 and 4

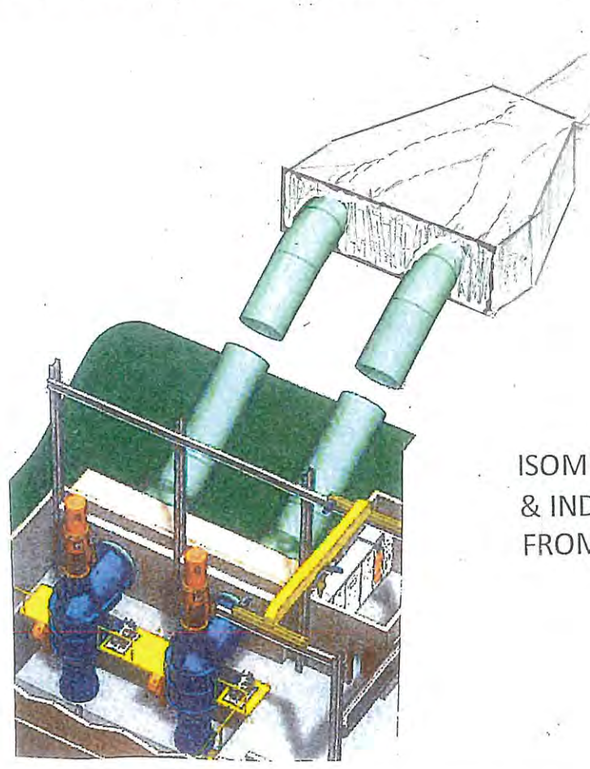
2.Powerstation details taken from Vortex Hydro with acknowledgements .



SECTION & PLAN OF 2/1.5 MW POWERSTATION



TAILRACE IN VARIABLE ROCK & ALLUVIUM



ISOMETRIC OF POWER STATION & INDICATIVE BIFURCATION FROM PIPELINE TO PENSTOCKS

PURUA RAPIDS HYDROELECTRIC SCHEME – PREFEASIBILITY REPORT FOR GLENVIEW ESTATE LTD.

PLAN & SECTIONS OF POWERSTATION & TAILRACE

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Scales As Shown MAY 2021 DRAWING NO 21/2/6