Reefton Hydro Project

November 21

2012

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Pre-feasibility Report

Quality Assurance Record

Document Number:
Project Reference:
File Name:

Revision Log

Rev	Date	Description		Signed	Name
00	23/11/2012	Draft Issue To Chairman of ITP Committee	Prepared		P N Rue
			Reviewed		J C Dodgshun
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			Approved		
			Prepared		
			Reviewed		
			Approved		

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1 Introduction

The Reefton Power House Committee (RPHC) has engaged Peter N Rue an Electrical Engineering Consultant to review the possible generating schemes for the Reefton Hydro Project. As part of the review the following options were reviewed:

1) Use of a modern hydro scheme.

2) Use of the original generators at original sites.

3) Use of modern generators at original sites.

4) Availability of original Direct Current (DC) and Alternating Current (AC) equipment.

5) Other forms of generating revenue.

Interviews with experts in old generating stations plant, property and equipment were undertaken to investigate the options and are the basis for this report.

This report summarises the results determined during this investigation.

2 Conclusions

The following conclusions are made:

1) A modern hydro plant could be used at the Reefton Hydro Station, but extra civil foundations and buildings would be needed or all of the 1935 building would have to be used.

2) A modern hydro plant will be easier to operate and will be able to generate $ 157,078.57 per year.

3) A 1935 plant will be harder to use and will be able to generate $85,000 per year.

4) Either the modern hydro plant or the 1935 plant should be used as the main form of generation, not both as there is not enough energy from the water.

5) Any of the 1935 original generators (DC or AC scheme) could be used with proper refurbishment, with any of the schemes likely to last ten years.

6) A 1930s era DC generator could be used as the main generator with appropriate refurbishments but:

a. They are near impossible to find

b. Would be required to place a DC motor that drives an AC generator OR

c. Placed on grid tied inverters.

7) There is a case to put a working generator in to produce power and therefore revenue.

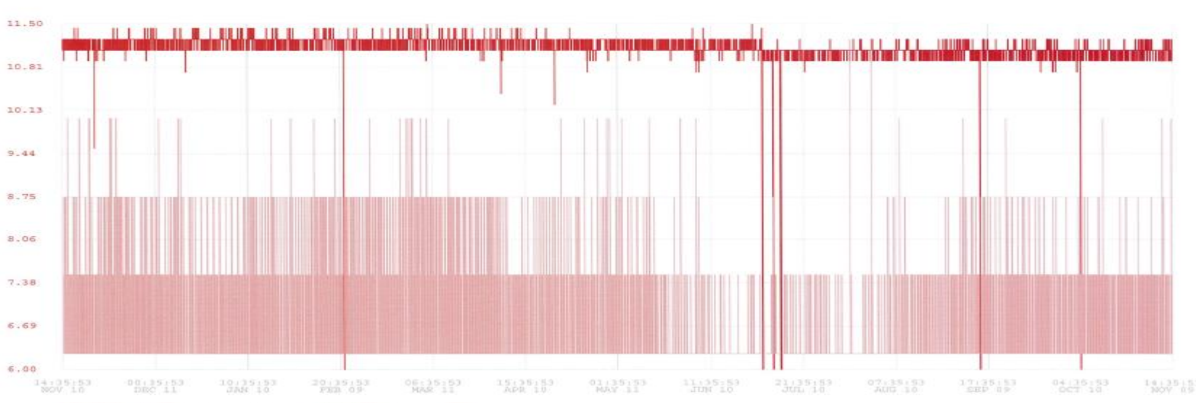
3 Recommendation

It is recommended that the modern plant be installed first because

1. It will produce more income.
2. It will be far easier to use and will be able to look after its self.
3. Will last longer at continuous use.
4. Will be more reliable.

4 Energy Demand

The proposed site of Reefton power station is located near the Reefton Township. The Reefton Township is supplied by an eleven kilovolt feeder from the Westpower owned “Reefton Substation”. The “Reefton Substation” is supplied by the National grid with the Transpower owned “Reefton Grid Exit Point (GXP) located 5 km north. It is assumed that the Reefton power station will connect onto the local eleven kilovolt Reefton feeder. The users of this feeder include local businesses and residents, drawing a typical load all year round. Other users of this feeder include local gold and coal mines and farm owners who use the power for general dairying and irrigation. As shown in the figure below which was obtained from Westpower loads drawn from the Reefton eleven kilovolt feeder remain constant throughout the year with the red lines indicating system voltage and the pink indicating reactive power drawn for inductive loads.



5 Water Demand

Apart from the requirements of the Regional Council for the powerhouse water take, there is no other commercial use of the water between intake and tail race. Hydrology Report to follow.

6 Future Demand Trends

Loading data obtained from Westpower shows that the Reefton area is expected to grow within the next 10 years. The data shown in the table below is for the Reefton Zone Substation in which the eleven kilovolt Reefton feeder which the Reefton power station will be connected to. This means there will be a demand for the power generated by the Reefton power station. Because Reefton power station will be connected to the National Grid, someone in Christchurch in theory could be using the power generated by Reefton and hence as well as paying distribution charges to Westpower, Transmission charges may also need to be paid to Transpower.

Table 5.4.3 - Zone Substation Forecast Demand

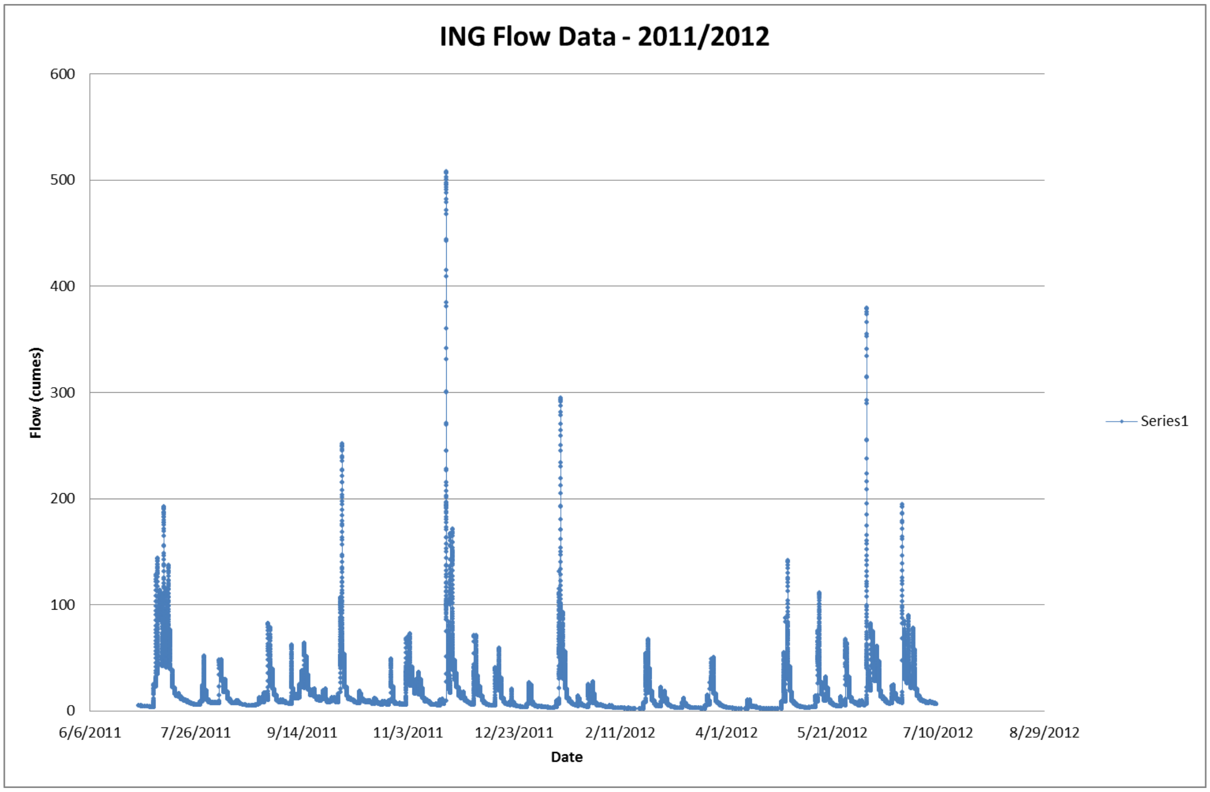
	Zone Substation	Firm Capacity (MVA)	Peak 2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Block	**Reefton**	30	9.916	9.92	10.02	10.11	10.22	10.33	10.43	10.53	10.63	10.73	10.83	10.93
Base Growth	1.0%			0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Loadwatch Growth				0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Predicted Load				**10.02**	**10.11**	**10.22**	**10.33**	**10.43**	**10.53**	**10.63**	**10.73**	**10.83**	**10.93**	**11.02**

7 Hydro Potential

River flow data of the Inangahua River is taken by Niwa at Blacks Point. The graph below shows the river flow in cubic meters per second for an entire year. River flow data for the past ten years was used for the estimation of future power that Reefton power station could deliver. This graph shows that during the summer periods the water levels are at their lowest for longer periods when compared to the rest of the year.

The data for the past ten years showed that:

Minimum Flow	**1.80 cumecs**
Maximum Flow	**510.54 cumecs**
Mean Flow	**25.16 cumecs**
Median Flow	**13.95 cumecs**
Mode Flow	**7.76 cumecs**



8 Overview of Generating Options

8.1 Introduction

Several generator options have been summarised below. Though any of the options specified can be used, each has its own pros and cons which mainly consist of historic importance, cost, availability of equipment and capableness of existing equipment.

8.2 New Modern Hydro Generator & Turbine installations

Installing a new modern hydro generator will be the easiest option. Modern hydro generators and turbines are usually designed based on the generating capacity of the river, and the available head.

Advantages	Disadvantages
1) Generator can be grid tied with less equipment when compared to DC. 2) Generator will require less maintenance than the 1935 generator. 3) Modern equipment such as SCADA technology will give the end user more control over plant operation and monitoring 4) The equipment is readily available. 5) Turbine and generator is designed specifically to the station ensuring there are no unnecessary losses.	1) Will have no historic significance. 2) Will be expensive.

8.3 1930’s era DC Generator at 1935 site

Advantages	Disadvantages
1) With respects to historic importance using a DC generator from the 1930’s era will keep with tradition. 2) If generator is found and is able to be refurbished, there is a high probability that the generator can generate power continuously for 10 years with quarterly maintenance. 3) A wider range of DC generators can be used unlike and AC generator which requires a fixed speed from the turbine making the 1935 turbine more compatible.	1) Power generated will have to be inverted from DC to AC which increases the powerhouse losses (decreases the efficiency). 2) Finding a DC generator from the 1930’s era that matches the requirements will be difficult 3) Finding DC 1930’s era related equipment such as protection relays, measurement devices, circuit breakers etc. will be difficult (near impossible) when compared to AC equipment.

8.4 1930’s era AC Generator at 1935 site

Advantages	Disadvantages
1) With respects to historic importance using an AC generator from the 1930s era will keep with tradition. 2) Generator can be grid tied with less equipment when compared with DC. 3) If generator is found and is able to be refurbished, there is a high probability that the generator can generate power continuously for 10 years with quarterly maintenance. 4) AC generators from the 1930s era will be easier to find than a DC generator. 5) AC related equipment such as protection relays, meters, circuit breakers etc. from the 1930’s era will be easier to find than their DC equivalents.	1) The speed of the existing turbine is unusual meaning a limited number of synchronous generators can be used and extra water would have to be put in to the turbine to increase its speed to match a generator.

8.5 Modern DC Generator at 1935 site

Advantages	Disadvantages
1) With respects to historic importance using a modern (i.e. less than 30 years old) DC generator will keep with tradition. 2) If generator is found and is able to be refurbished, there is a high probability that the generator can generate power	1) Power generated will have to be inverted from DC to AC which increases the powerhouse losses (decreases the efficiency).

continuously for 10 years with yearly maintenance. 3) A wider range of DC generators can be used unlike an AC generator which requires a fixed speed from the turbine making the 1935 turbine more compatible. 4) Finding modern (i.e. less than 30 years old) DC related equipment and a DC generator will be easier that finding 1930s era AC or DC equipment and generator.	2) Finding a DC generator from the 1930s era that matches the requirements will be difficult (near impossible) 3) Finding DC 1930's era related equipment such as protection relays, measurement devices, circuit breakers etc. will be difficult (near impossible) when compared with AC equipment.

8.6 Modern AC Generator at 1935 site

Advantages	Disadvantages
1) Generator can be grid tied with less equipment when compared with DC. 2) If generator is found and is able to be refurbished, there is a high probability that the generator can generate power continuously for 10 years with quarterly maintenance. 3) Finding modern (i.e. less than 30 years old) AC related equipment and an AC generator will be easier that finding 1930's era AC or DC equipment and generator.	1) Using a modern (i.e less than 30 years old) AC generator will reduce the historic significance. 2) The speed of the turbine is unusual meaning a limited number of synchronous generators can be used and extra water would have to be put in to the turbine to increase its speed to match a generator.

8.7 1910s era DC Generator at 1908 site

Getting the 1908 generator scheme working would be impractical for the following reasons:

1) Finding a 1908 DC generator would be near impossible
2) Finding 1908 DC equipment would be near impossible
3) The 1908 site has very minimal head, meaning any generation would be inefficient.

8.8 1886 DC Generator at 1888 site

Getting the 1886 generator scheme working would be impractical due to the size of the generator.

9 Generator Scheme Options

9.1 Modern Hydro as Primary Generator

This scheme would be the easiest option overall if the goal of this project were to generate revenue to ensure the sustainability of this project. This scheme would require extra civil works, building and foundations in order to generate power or it could use all of the existing 1935 structure and space. The uses of this scheme would allow maximum efficiency, more reliability and extra modern features that would not be found with an old hydro station. Once built this station can look after its self and can be started and stopped with a simple push of a button. Remote technology means the committee can simply look at their computer to see whether the station has a fault or what power is being produced. When building a new hydro scheme from scratch, a brand new scheme would be the first choice, rather than using second hand parts. Though this scheme will be capital intensive at the initial stages, due to the modern equipment there would be less maintenance expenditure in the longer term and due to greater efficiencies it can produce more power producing 150 kW at maximum river flow rather than the 98 kW that the 1935 generator could.

9.1.1 Cost of Scheme

More information is required.

9.1.2 Generating Revenue of Scheme

Based on the information provided by TURAB the modern scheme at Reefton will be able to generate $ 157,078.57 per year.

9.1.3 Cost of Operation

More information is required.

9.1.4 Maintenance Requirements

More Information required.

9.1.5 Usability

This option would be **by far** the most **simplistic scheme**. Unlike the 1935 scheme which would require an experienced operator to start and stop the scheme and an experience engineer or technician who would understand how the station would work to identify faults and major problems, the modern scheme with the modern technology will be able to look after its self. The station can also be connected to the Westpower network where the station can be monitored by the Westpower control room and by the local community members.

9.1.6 Life Expectancy of Scheme

With proper maintenance, the modern scheme would easily last up to 25 years.

9.2 1935 Site Generation

A major concern with this scheme was the fact that the equipment would not be expected to last. After speaking to three professionals, it was determined that with the right refurbishment the scheme would last at least ten years with regular maintenance.

One major threat to this project is the likely hood of finding original working equipment. After several investigations, the probability of finding original DC equipment is slim compared with the AC equipment.

After some investigation, it was found that finding original 1930ss equipment will be hard to near impossible with three locations of equipment found which are Ferrymead, Queenstown storage container and Lake Coleridge. If the equipment is not procured now, the chances of finding the equipment will be very small.

It is noted that the current foundations will have to be modified if there is a possibility that a 1930s generator can be installed. Due to the size constraints of the building, significant mechanical work will be needed to done on the generator to ensure that the generator can fit and work properly.

It is noted that more investigation with regards to the 1935 site is required before any decision is made.

9.2.1 Cost of Scheme

A rough estimate of the cost of the scheme has been determined. It is noted that more investigation is needed.

Total Building Cost	**Cost**
Design Cost	
Full Electrical & Mechanical Designs	$ 2,000.00
Material Cost	
1930's Generator	$ 5,000.00
Ferrymead equipment	$ 1,000.00
Queenstown Equipment	$ 4,000.00
Other necessary equipment	$ 5,000.00
Construction Cost	
Wiring	$ 20,000.00
Foundations	$ 10,000.00
Other	$ 5,000.00
Commissioning Cost	
Engineer to Commission station	$ 10,000.00
Total Building Costs	$ 62,000.00
Maintenance and Operation Costs	
Yearly Maintenance	$ 1,000.00

9.2.2 Generating Revenue of Scheme

Based on the assumptions made the 1935 plant at Reefton will be able to generate $ 85,000 per year. It is noted that more investigation is needed.

9.2.3 Cost of Operation

More information required.

9.2.4 Maintenance Requirements

This scheme would require quarterly bearing checks with a brief look around the operating components.

Yearly maintenance checks would be required to check electrical properties of the station including the insulation of the generator, accuracy of the meters and to ensure that the relays are still operational. This process will take 1 to 2 days and will require technical personnel with specialised equipment.

9.2.5 Usability

This scheme would require an experienced person to operate the station. This station could not simply be used by anyone in the committee. The reason being if the generator is not correctly connected to the grid the generator could easily be jarred out of the ground and would easily destroy the building. As there will be very old equipment in the building an experienced person must be near the site just in case there are faults or problems. This system does not provide remote connectivity and hence someone must be near the site to monitor the station.

9.2.6 Life Expectancy of Scheme

Though second hand and original parts will be used for the scheme with proper refurbishment and maintenance the scheme will easily be able to last up to ten years with continuous operation.

9.3 Modern Hydro in Combination with 1935 Site Generation

There is no major benefit in having a Modern Hydro scheme working in combination with the 1935 site generation due to the available water flow. Either the modern hydro or the 1935 hydro should be operating at full capacity.

10 Appendix A – Professionals Biography

11 Mr John Dodgshun

Mr John Dodgshun has had over 40 years' experience in the New Zealand's power industry. John started out in the New Zealand Electricity Department (NZED) training program gaining experience around all sectors of the Transmission and Generation network. John is currently the Engineering Manager at TWS Energy Controls Ltd where he is an expert in Australasia on Instrument Transformers. John had also been involved with the Akaroa Hydro Restoration project where John has been in charge of designing and installing the replica control equipment for the 1926 AC generator.

12 Professor Pat Bodger

Professor Pat Bodger has had over 40 years in the New Zealand Electricity industry and over 30 years as a lecture at the University of Canterbury. Pat has been involved with my projects including High Voltage Transformers, Heaters and Motors. During this time, Pat has also being involved with teaching power systems, power applications, transformers and motors.

13 Mr Ken Smart

Mr Ken Smart has had over 40 years in the New Zealand Power industry while starting his career in the NZED. Ken has been based at several power stations across New Zealand and has an excellent understanding of Generators, Motors and electrical related equipment. Recently Ken has been based at the University of Canterbury as a technician in the Machine Lab where he is responsible for the all the power equipment including motors, generators and other electrical equipment.