REEFTON POWER SCHEME: AN ARCHAEOLOGICAL ASSESSMENT

LES WRIGHT, KATHARINE WATSON AND KIRSA WEBB (UNDERGROUND OVERGROUND ARCHAEOLOGY LTD)

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UNPUBLISHED REPORT FOR THE REEFTON POWERHOUSE CHARITABLE TRUST INC.

INTRODUCTION

The Reefton Power House Restoration Committee proposes to restore parts of the town's pioneer hydro-electric scheme as a power generator and visitor attraction (Figure 1). Because the water race dates from 1887 and the original power house from 1888, an authority from the Heritage New Zealand Pouhere Taonga (HNZPT) will be required for the project. As part of that process, the Reefton Powerhouse Charitable Trust Inc ('the Trust') commissioned this archaeological assessment.

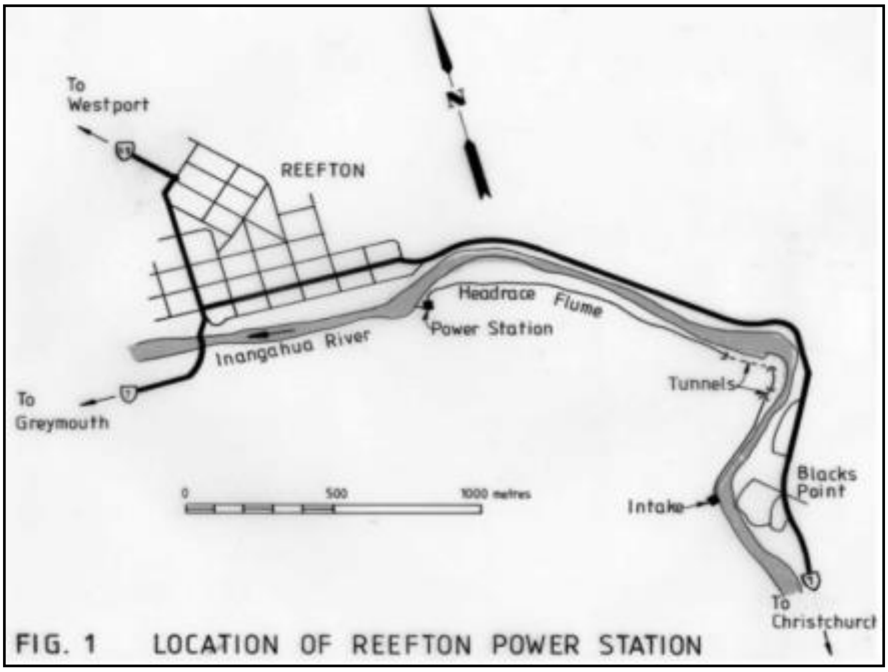

Figure 1. The location of the Reefton power station, and key features of the scheme.

Project outline

The Trust has several aims (Figure 2):

1) Reinstate the water race to supply a new power house.
2) Reconstruct the 1935 power house and plant as an area of historic interest.
3) Refurbish as much as possible of an earlier power house, believed to date from 1906, and a 1930s diesel plant.
4) Investigate the site wherever possible for remains of the original 1888 station.
5) Innovatively interpret Reefton's electricity heritage at the power houses and at points along the water race.

The full project description is attached in Appendix 1.

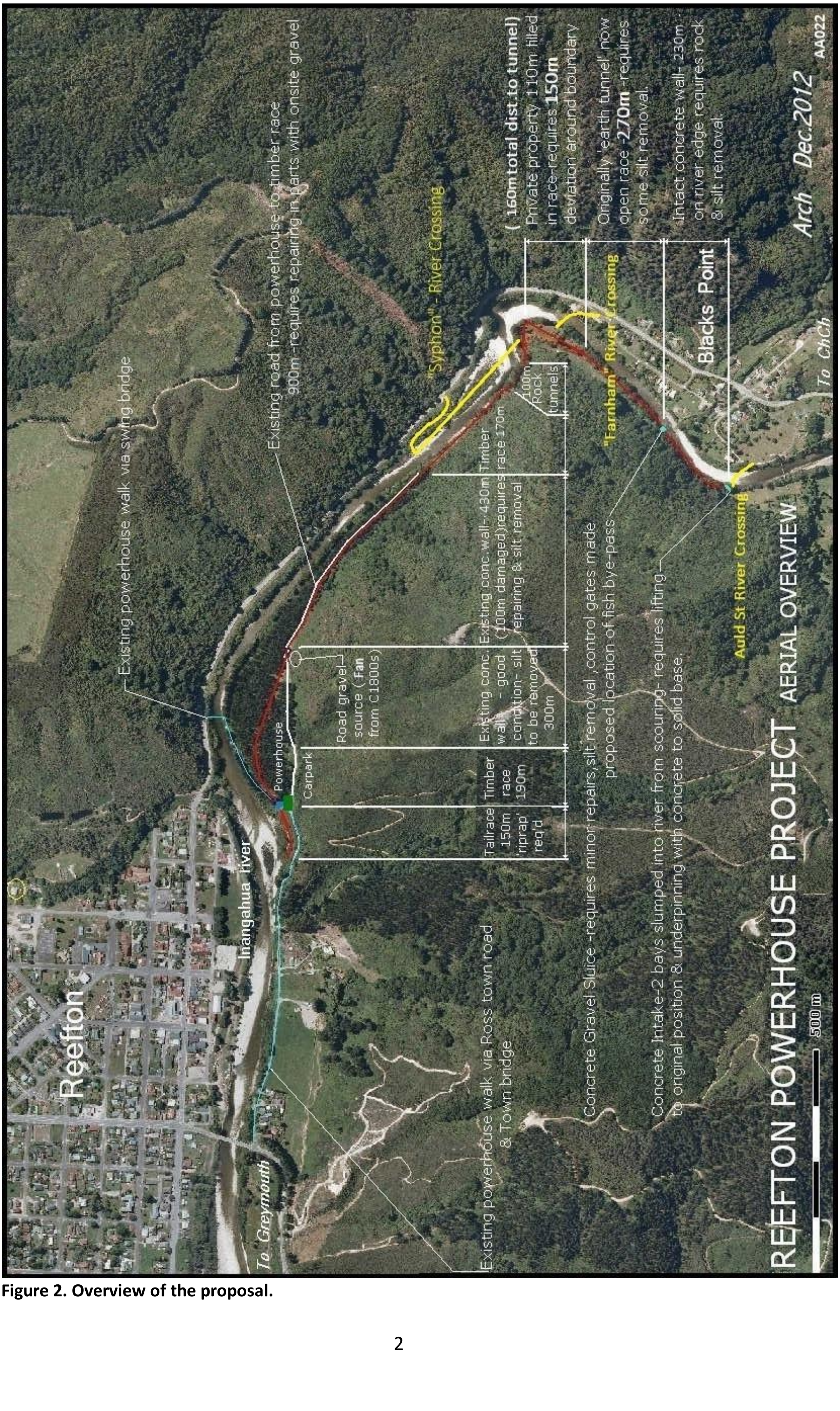

Figure 2. Overview of the proposal.

Land tenure

A land status report prepared for the applicant by The Property Group Ltd established the status of the land covered by the Reefton Powerhouse Project. A summary of land ownership follows (Figure 3).

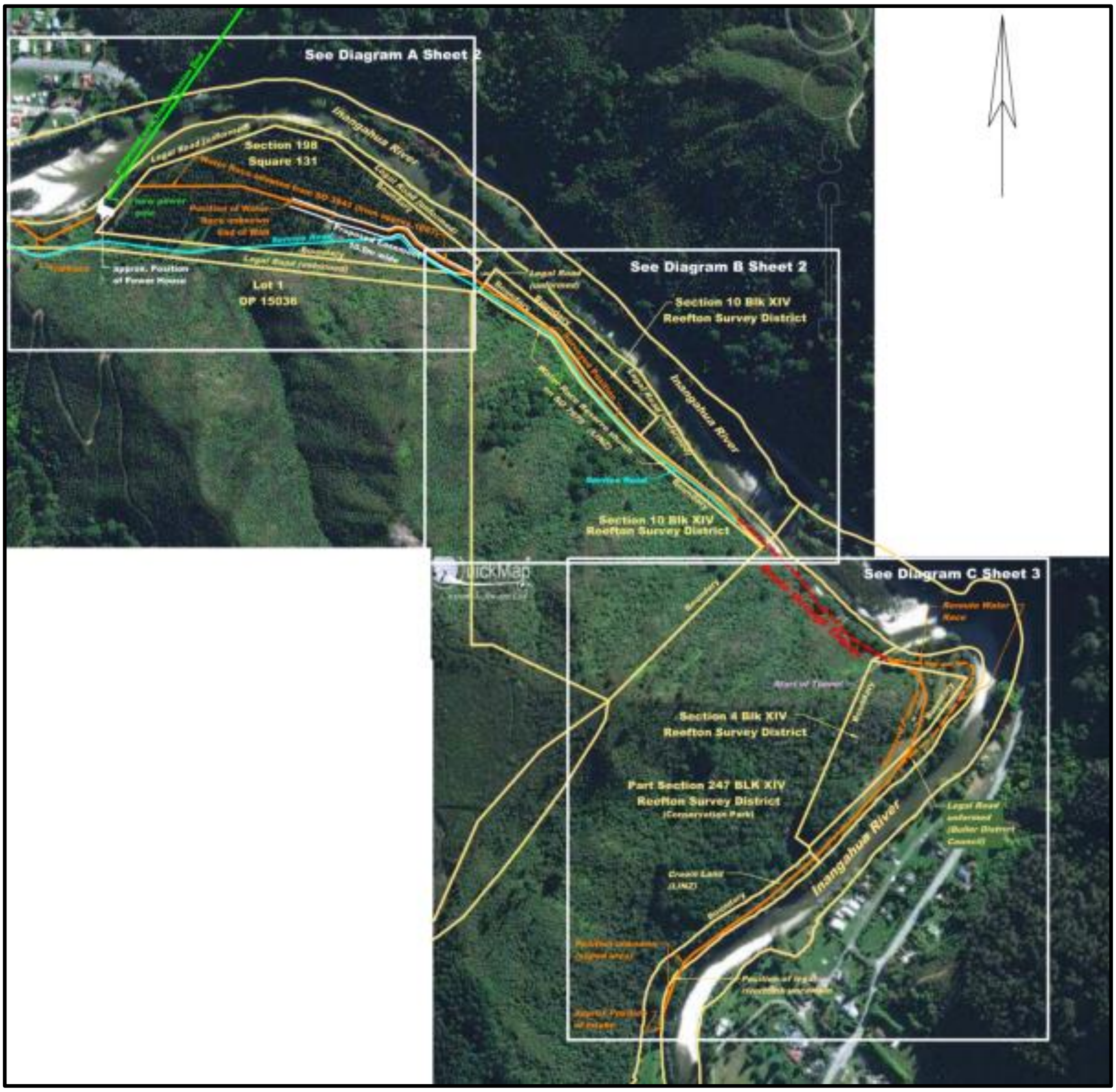

Figure 3. The scheme layout, showing the land tenure.

The intake at Blacks Point and proposed rock groyne immediately downstream are in the bed of the Inangahua River, on Crown land administered by Land Information New Zealand (LINZ).

From the intake working downstream, the water race extends along LINZ-administered land and legal road vested in the Buller District Council. The original race crossed private land (Sec 4 Block XIV, Reefton SD – J. C. Farnham), with this section of race to be abandoned and re-routed on legal road. The race then enters a tunnel that is on crown land administered by Department of Conservation (DOC) and extends along 'water race reserve' (unallocated Crown land, administered by LINZ). A short stretch of legal road is crossed, with the water race then extending down to the powerhouse site on private land (Sec 198, Sq 131, Block XIV, Reefton SD – D. Boothman-Burrell and J. James-Ashurner).

The powerhouse complex, including the tailrace, is located predominantly on legal road, with a small portion located on private land (Sec 198, Sq 131, Block XIV, Reefton SD – D. Boothman-Burrell and J. James-Ashurner).

The service road extending upstream from the site of the powerhouses is located on legal road for approximately 300 m before entering private land for a stretch of around 450 m (Sec 198, Sq 131, Block XIV, Reefton SD – D. Boothman-Burrell and J. James-Ashurner). After this it extends along legal road for a short stretch and then onto 'water race reserve' (unallocated Crown land administered by LINZ).

Status

The Reefton power house foundations were registered by the New Zealand Historic Places Trust (NZHPT) in 1990 as Historic Place No. 5002, in Category II (of local significance). The registration document does not mention the possibility of 1888 remains, nor does it describe the largely intact water race (NZHPT n.d.). While reviewing an application connected with rehabilitation of the rock tunnel Dr Matthew Schmidt, Otago/Southland regional archaeologist for the HNZPT, has told ITP-Reefton Promotions that the ranking of the Reefton power scheme should be raised to Category I (of national importance).

STATUTORY REQUIREMENTS

The Heritage New Zealand Pouhere Taonga Act 2014 provides protection for archaeological sites and is administered by Heritage New Zealand Pouhere Taonga. Under section 6 of the act an archaeological site is defined as:

"(a) any place in New Zealand, including any building or structure (or part of a building or structure), that—

(i) was associated with human activity that occurred before 1900 or is the site of the wreck of any vessel where the wreck occurred before 1900; and

(ii) provides or may provide, through investigation by archaeological methods, evidence relating to the history of New Zealand; and

(b) includes a site for which a declaration is made under section 43(1)."

Under the act, anyone who wishes to destroy, damage or modify an archaeological site requires an authority to do so. It is illegal to destroy, damage or modify an archaeological site without an authority from Heritage New Zealand Pouhere Taonga.

Summary of the timeframes associated with applying for an archaeological authority:

- Within five working days of receiving the application, Heritage New Zealand will advise whether or not the application has been accepted (this is dependent on whether or not sufficient information has been supplied with the application).
- Once accepted, Heritage New Zealand has 20 to 40 working days to process the application.
- After the authority has been granted, there is a 15 working day stand-down period before earthworks can begin.

METHODS

An archaeological survey for the restoration project was started on 12 March 2012 by Katharine Watson and Les Wright. They inspected the intake and upper part of the race, the bottom end of the rock tunnel and the portion from there to the power house foundations. Wright was already familiar with most features of the overall site, having been involved in the 1988 interpretation and subsequent oral history and archival research.

On 16 April 2012 Wright returned with Paul Thomas, a member of the Power House committee at the time, to inspect the upstream/eastern end of the rock tunnel as far as a collapse about 25m in. That followed a proposal by the Reefton Walkway Committee to clear the tunnel and have it professionally inspected with a view to using it for the walkway until it might be required for the power scheme. An NZHPT authority (2013/60) was subsequently obtained.

On 4 August 2012 Wright looked over the entire site and discussed the project with Bryan Scott of URS New Zealand Limited (Christchurch), consulting design engineer for the project, Peter Rue (graduate engineer, University of Canterbury), and restoration committee members Alan Archer, Graham Hunter (former power company employee) and Greg Topp (chairman).

Wright made further examinations of the power house sites during October and November 2012, including a visit on 29 October with former Reefton Electric Company and Grey Power Board employee and DOC industrial archaeologist Jim Staton, both of whom are also power committee members.

Most of this report was written by Wright and was subsequently edited by Watson.

PHYSICAL ENVIRONMENT

The race runs through a steep greywacke gorge of the Inangahua River, between Blacks Point and Reefton. Ground cover is the beech-podocarp forest typical of the Inangahua district. The power stations are in, on and below a river terrace on the true left side of the Inangahua River, across from Reefton. The tailrace runs along the higher riverbed on the true left of the present channel.

SITE HISTORY

Māori history

The nearest known Māori settlement was at Tiroroa Pa, approximately 30 km to the northeast of Reefton. Tiroroa, meaning ‘long view’, was named for its extensive unobstructed views of the Buller River. The defended site was reportedly occupied intermittently by Ngai Tahu prior to being abandoned c.1850 (Brailsford 1997: 197). The site was recorded in the NZAA archaeological site recording scheme in 1982 as K29/30. The site record places the site on a prominent spur on the north bank of the Buller River, but, as the site has not been visited, this has not been confirmed.

Although there is no record or tradition of Māori settlement in the immediate vicinity of Reefton, or of the proposed area of works, it is likely that Māori travelled through the region via the Inangahua River. On the Poutini Coast the rivers were the route to the interior of the South Island. Canoes were reportedly kept at all major rivers and lakes to use when gathering food in a particular area. Māori were able to travel up the Grey River nearly to Reefton, where they crossed over to the Inangahua River to more canoes for trips down to the Buller (Brailsford 1997: 197).

Establishment

An electric power scheme for Reefton was first promoted on 25 January 1883 at a public meeting in the Inangahua County Council Chambers. A provisional committee resolved to obtain estimates from the recently formed Dunedin-based New Zealand Electric Power and Light Company Limited for plant capable of running 1000 lamps of 20 candlepower each (*Inangahua Times* [*IT*] 24.1.83:2, 31.3.83:2). That company's engineer, Walter Prince, visited Reefton in March 1883 and outlined a hydro scheme, for lighting and motive purposes, to be situated in the town and driven by water from the adjacent Inangahua River. In his opinion no town in the colony was more favourably situated for hydro-electric generation (*IT* 7.3.83:2).

Even then electricity was becoming widely used. In the United States, Cleveland, Ohio had electric street lighting in 1879, the same year that the California Electric Light Company (San Francisco) sold electricity to a small number of customers (The Historical Archive website). Two years later Godalming in Surrey became the first town in the United Kingdom to install a (short-lived) public electricity supply (Godalming 2013) and in 1882 Kimberley in South Africa led the southern hemisphere with electric street lighting (Kimberley n.d.). The first permanent electric plant in New Zealand was probably at the Otago harbour works in 1877 (*Otago Daily Times* [*ODT*] 19.12.77:2), and the *West Coast Times* (*WCT*) in Hokitika (*WCT* 31.7.84:2) and Ross United gold mine (*Marlborough Express* [*ME*] 15.12.84:2) would gain electric lighting in 1884 before Reefton.

However, Walter Prince's plan for Reefton was to light up the streets and homes. While he drew plans, moves were initiated to lease land for the plant (*IT* 12.3.83:2), a preliminary survey for a water race was carried out and formation of a Reefton Electric Light Company was initiated with outside finance (*IT* 19.3.83:2). Prince then became diverted to other projects, such as a hydro power scheme that would power lights and machinery at Bullendale gold mine, Otago, in 1886 (Petchey 2006:7) so nothing more eventuated in Reefton for more than three years.

In November 1886 Prince returned to Reefton, this time to deliver three lectures and, most significantly, illuminate the town's principal hotels using an electric dynamo he had brought with him. His lectures, in the Oddfellows' Hall, also featured lighting displays and electrically driven mining models, including an aerial tramway and a 10-head stamping battery (*IT* 26.11.86:2, 29.11.86:2, 1.12.86:2). Although the demonstration dynamo was driven by the local brewery's steam engine, Prince again stressed the economic advantages of water power (*IT* 1.12.86:2, 3.12.86:2).

At a meeting in Dawson's (illuminated) Hotel there was immediate financial backing for a publicly owned company, and by early December the Reefton Electric Light and Transmission of Power Company was not only established but had commissioned a flying survey to confirm that a water race running from Blacks Point to Reefton would be sufficient to drive a power plant (*IT* 8.12.86:2, 10.12.86:2). Problems with land access along the preferred line of the race caused several changes of plan and some unnecessary surveying before the power scheme to be built was settled upon (*IT* 25.4.87:2).

Contracts for construction of the race in two sections were let in early April 1887 (*IT* 11.4.1887:2) and the work was completed in early January 1888 (*IT* 9.1.88 2). By that stage power wires had been strung across the river the Bridge Street from where an underground cable was being laid down both sides of Broadway (*IT* 18.1.88:2).

Although the generating plant had arrived from England in May 1887 (*Grey River Argus* [*GRA*] 24.5.87:2), the Christchurch-made water turbine required to drive it was not on site until April 1888 (*IT* 13.4.88:2), the lamps following a month later (*GRA* 16.5.88:2). By mid-July a short by-wash (presumably the tail race) to carry waste water clear of the machine site was the only work remaining to complete the system (*IT* 16.7.88:2).

Reefton needed something to brighten it up, literally and metaphorically. The gold industry, doing poorly at the time the power company was formed (Wright 1993:pp[1]), had improved little and the electric scheme (quite inexplicably considering it was a private enterprise) had been partly blamed in a recent editorial:

> The tightness of the local money market during the past six or nine months is shown in the unusually long list of defaulting ratepayers. The list is the heaviest that has been prepared for years past, and it is no surprise to find that the Reefton Riding is by far the largest delinquent. In addition to the heavy drain of mining companies' calls, the townspeople have had to bear the burden of the electric light undertaking, in itself a not inconsiderable extra tax …. The Collector has already issued a number of summonses.
>
> *Inangahua Times* 11.5.88:2

On the night of 31 July 1888 Prince gave the plant a preliminary trial and quickly informed the local newspapers of its success:

> It seems that the race filled sooner than was expected, and at 9 p.m. there was fully 60 heads of water flowing. This being the case it was decided to test the machinery, and the water was accordingly turned on. The turbine at once started off at a tremendous speed, and the connection with the dynamo being all in gear, the couplings were closed and away the machine went as smoothly and freely as though it had been running for months. The large arc-lamp in the machine house was then connected with the dynamo, and instantly the building was illuminated with such intense brilliancy as to be scarcely bearable. The fact was the current was far too powerful for the lamp, and would have quickly destroyed it. The success of the trial was complete in every respect, and it is needless to say Mr Prince and the spectators present were greatly delighted. After running half an hour or so the water was then turned off, and everything left in order for a public test of the plant to-day.
>
> *Inangahua Times* 1.8.88:2.

That report brought a large crowd to the riverbank on the night of 1 August 1888 to see an arc light lit across at the power station. The demonstration caused a sensation, and the local newspaper's account (IT 3.8.88) was widely reprinted around New Zealand. On 4 August there was a display of lamps in the Oddfellows' Hall accompanied by a demonstration of the arc light on Broadway:

> The night was fortunately very favourable for the display, and an immense crowd of people gathered in the street to witness the exhibition, and when, shortly before 8 p.m., the powerful light of the arc lamp burst forth, like the flash of a mighty meteor, a murmur of admiration rose from the spectators, and there was an immediate scampering of feet towards the scene of the display. As on the former occasion, the light throbbed a good deal, but at its maximum of brilliancy illuminated the town over a very wide area with its cold, cheerless, phosphorescent rays. The illumination reached far up on the mountains round the town, and gave a very sepulchral appearance to the hill-sides, the trees and stumps standing out in the strange pallid light, like so many tombstones. But if the arc- light was an attraction outside, the interior of the Oddfellow's Hall was infinitely more so. Rows of lamps were suspended down the building, encased in a variety of fantastically shaped shades of different colours, and the whole scene was one of striking splendour. It was indeed a "Hall of dazzling light".

[1] It was not possible to establish what this was a reference to.

Inangahua Times 6.8.88:2

Local demand for what Prince termed 'bottled lightning' was immediate. The work of connecting local houses and businesses to the supply started on 9 August 1888, the hardware store of Forsyth and Masters on Broadway being first connected (*IT* 10.8.88). About 150 lamps were running by mid-September (*IT* 17.9.88). However, there were soon doubts about the scheme’s true output, prompting Prince to put on another display in the Oddfellows’ Hall (which was, perhaps significantly, not wired via the underground reticulation) of 300 Thomson-Houston 16-candle lamps which would make a total of 500 lights connected with the system and enable the capacity of the dynamo to be satisfactorily tested (*IT* 18.9.88).

It was soon evident that the system would in fact power no more than 120 lamps, far short of the intended 500. With Prince absent in Auckland (negotiating a street lighting contract for that city), the system was shut down in late September, forcing consumers to revert to candles and kerosene lamps ‘with a very bad grace’ (IT 3.10.88:2).

Papers outside Reefton were quick to print articles condemning the scheme as a failure (*WCT* 29.9.88, *NZT* reprinted in *IT* 10.10.88, *Bay of Plenty Times* 5.11.88, *Timaru Herald* 11.12.88). However, a Greymouth paper came up with a defence that:

> The directors of the company had decided not to keep the plant running, fearing that in the absence of competent supervision the dynamo might be overrun and consequently injured, not that the undertaking is a failure. The defect existing is merely one of construction, and can, it is believed, be fully remedied in a few days.
>
> *Grey River Argus* 15.10.88:4

To solve the problem, the company decided to employ “a thoroughly qualified practical electrician to superintend the relaying of the wires, and to see to the perfecting of the installation generally” (IT 26.9.1888:2). It engaged another Dunedin engineer, John Joshua Horton, who had great experience with electrical installations ‘in England and the colonies’, including at the recent Melbourne Exhibition. Tests had already shown that the turbine and dynamo were up to standard, casting suspicion upon the reticulation wiring (*IT* 26.9.88, 15.10.88, *GRA* 27.9.88, *Evening Post* (*EP*) 15.10.88.).

Horton confirmed that, and on his recommendation the timber-encased underground cable along Broadway was replaced by conventional overhead wiring and the Thompson-Houston lamps favoured by Prince were replaced by Swan-Edison lamps together with appropriate switches and safety plugs (*IT* 17.10.88.). Confidence in the enterprise was re-established and the new wiring system was illuminating the town by early December 1888 (*IT* 10.12.88:2).

The system’s limitations seem to have been accepted, being far outweighed by the advantages, and electricity was a source of pride for residents of all ages:

> Dear Dot, — I live at Reefton, which is not a very large place, but is a great mining district. We have the electric light in Reefton, and it is a great convenience. It is better than gas, and nearly all the houses are lit up very brilliantly with it. Sometimes it goes out, and then it is very funny to see the business people run for their lamps. (Abridged) — Yours truly, Millie Mirfin (aged 14 years).
>
> *Otago Witness* [*OW*] 18.7.1889:34

Water race

Nearly 2 kilometres long, the race comprised mostly open ditching, 1.8m wide and 0.9m deep (*Thames Star* 27.8.88:4). The original intake structure, incorporating a bywash further downstream, was apparently timber (*IT* 3.8.1888:2). Further down was a 100 m rock tunnel, which evidently had timber fluming at each end, and the last 120m from the race ditch to the power house was also flumed (Figure 4). When a local landowner objected to a short section of deep race ditching running through her property it was covered over and became known as the earth tunnel (*Electricity in NZ* 1933 ref[2]). Where the race passed a house near the power station, the ditch was boarded over (ArchSite 2013). Walking access along the race for inspections and maintenance was mostly via the race wall; where the flume occupied a narrow side cutting below the rock tunnel there was a walkway on top of the cross timbers (Figure 4) and a narrow ledge in the hillside provided access around the tunnel itself.

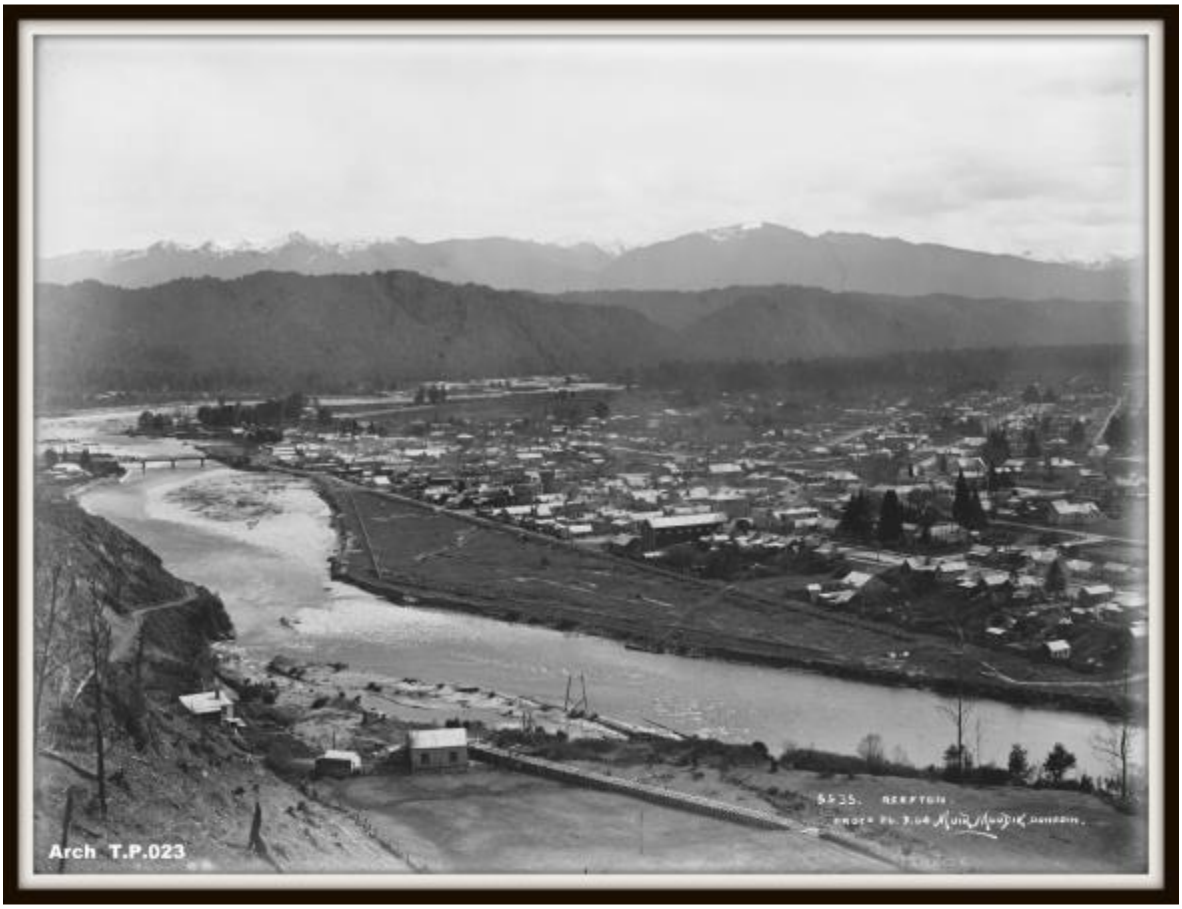

Figure 4. Reefton, with the 1888 power house and associated timber-flumed water race in the foreground. Image supplied by R. Inwood.

[2] It was not possible to establish what this was a reference to.

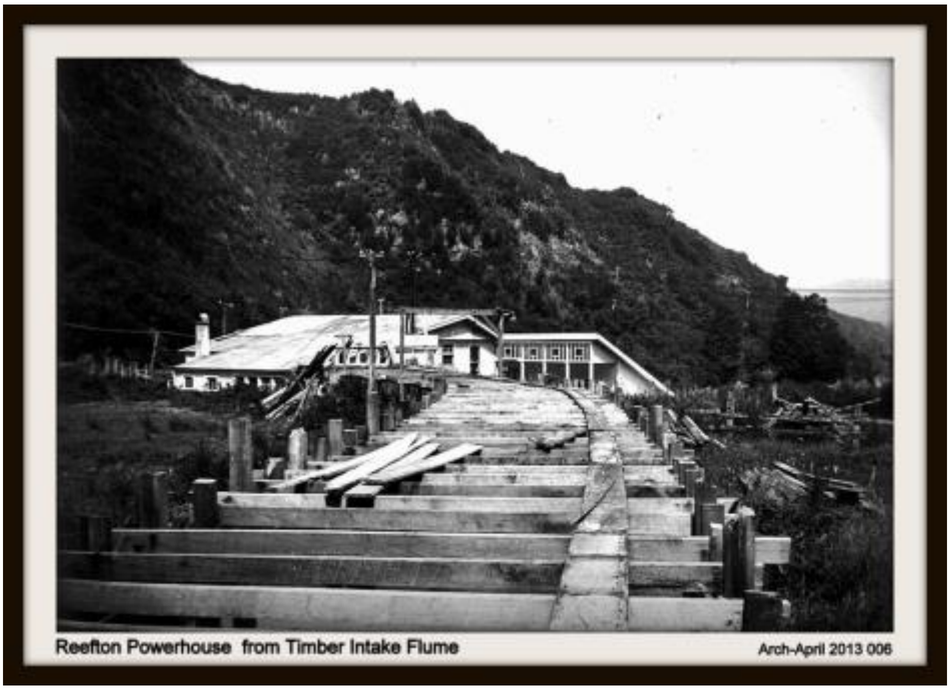

Figure 5. The timber water race, looking towards the 1938 power house, and showing a timber walkway on top of the race.

There were frequent problems with the race. Testing of the plant in July 1888 was postponed when a landslip destroyed the section of fluming below the rock tunnel (*GRA* 25.7.1888:2) and timber shrinkage in the upper section of fluming caused leakage just before the system was officially turned on (*IT* 3.8.1888:2). Landslips severed the race from time to time, sometimes to a serious extent, such as in 1892 when about 30 metres of ditching were blocked (*WCT* 31.3.92). At other times the poor condition of the race meant either low quality light (*IT* 2.3.97:2) or none at all (*IT* 21.4.97:2).

A persistent slip between the rock tunnel and the power house eventually caused a deviation to be made around the toe of the slip. Forest fires occasionally caused damage, one early in 1908 cutting off the water for a week (*Nelson Evening Mail* [*NEM*] 24.2.08:2). Fortunately, with so many races in use on the goldfield, building and maintenance skills were in good supply.

During the 1920s there was a major reconstruction of the race, causing power to be generated by steam for an extended period (Rod Alborn interview with Les Wright, 1987). The concrete intake and gravel sluice at the upper end and concrete walls downstream from the rock tunnel may have been built during that period. Getting water into the race at times of low river flow also caused difficulties, overcome by building temporary rock-and-manuka weirs across the river at the intake (Graham Hunter, pers. comm.).

A flood late in 1946 extensively damaged the water race and ended hydro generation at Reefton (*IT* 6.6.47).

First power house (1888-1906)

During its 20 years of service the original power house grew with its range of equipment. It was built at the edge of the river terrace, south of the point where the water race flume terminated. A vertical turbine, probably housed in the end of the race, had a belt drive to the generator in the adjacent power house. After passing through the turbine, water dropped into a tail race running along the foot of the terrace until it reached the river.

The turbine has been described as imported (*IT* 24.10.87:2) or built by Scott Brothers, manufacturing engineers of Christchurch (Cyclopedia 1906:256). Its make has been given as Rafel (Cyclopedia 1906:256), but no manufacturer of that name is known. It is more likely that it was a Leffel, designed and built by James Leffel and Co., Springfield, Ohio, U.S.A. Working components probably were imported directly from the makers and installed in castings by Scotts, as done elsewhere in New Zealand (*ME* 23.1.89:3). There is a story that the turbine was financed by Forsyth and Masters (Electric Journal 1933), which is possibly an indication that the company was hard-pressed financially at that stage. The turbine's quoted driving power also varied: from 120 horse-power from 60 heads of water on a fall of 24 feet or 7.2 metres (*IT* 13.4.88:2, 1.10.1888:2) to 70 horse- power (*Cyclopedia* 1906:256).

The first generator or dynamo was a Crompton bi-polar model imported by EA Ashcroft & Co of Wellington. Said to be capable of lighting 550 (probably 16-candlepower) bulbs it was believed to be the largest ever imported to New Zealand at the time (*GRA* 4.5.1887:2). With a tested output of 120 horse-power (*GRA* 24.5.87:2, 1.10.1888:2) at its normal speed of 800 rpm (*IT* 26.9.88:2) it generated 110 volts of DC current. DC was widely preferred at the time, possibly because it was easier to regulate and suffered less line loss over a short distance than the more recently developed AC.

Soon after arriving, Joshua Horton described the dynamo as one of the very best manufactured and in perfect working order, while he was also pleased with the turbine and driving system. After sorting out the reticulation problems he made some changes in the power house, moving the dynamo to avoid having to cross the driving belt and having a concrete floor laid for the machine, to secure solidity and eliminate dampness (*IT* 29.10.1888:2). A second dynamo (possibly another Crompton) to guard against breakdowns was installed the following year (*North Otago Times* [*NOT*] 26.9.89).

Complaints in 1896 over the poor quality of light and threats by several large consumers to have their supplies disconnected brought assurances from the company's directors that a new and larger turbine would be installed (*IT* 12.5.96:2) Apparently that went no further, for the following year the light was said to be "so dim that a continuance of such an inconvenience would mean the discontinuance of the Company" (*IT* 2.3.97:2). The *Inangahua Times* then proceeded with its own campaign to improve things:

> For months past the light has been wretched, and visitors to Reefton must have gone away with poor opinions of the public spirit of people who could tolerate it. The dim, cheerless lights in Broadway are a reproach to the Electric Light Company and the citizens as well, and we trust that further need for complaint will be removed by effecting immediately the necessary repairs or additions to the plant.
>
> *Inangahua Times* 9.3.1897:2

Two weeks later the paper noted a marked improvement, but whether that was due to improvement in the plant or through customers renewing their light globes more often it could not say. It was stated, however, that globes were usually kept in use far too long by consumers and were not supposed to be used for more than five weeks (*IT* 24.3.97:2).

Eventually there was a plant improvement in the form of a Flynn's Patent Dynamo (46 kw, 220 volts), ordered from Jones, Burton and Co., Liverpool, on 25 Sept 1901 (Rosanowski 1984). Capable of powering 1000 lamps (Cyclopedia 1906:256), it became the main generator although the others were retained (*GRA* 14.7.06:1).

It has been recorded that a stand-by steam plant was installed in 1901 or 1902 (Rosanowski 1984) but there is little evidence to support that. A 1904 photo gives no evidence of a steam plant in the power house building, while the 1906 *Cyclopedia* description, probably written in 1905, made no mention of steam plant and indicated the 'Rafel' turbine was still in use. Boiler records and newspaper articles (see next section) also suggest there was no steam plant in use before 1906, when the original power station seems to have been replaced.

While all or most of the generating plant from the first power house went to its successor (*GRA* 14.7.06:1), the original 1888 turbine remained in place on the truncated head race for many years (Figure 6). A tramway supplying coal to the steam plant may have been built over part of the original power house site and it was certainly covered in 1930 by floors for a workshop and a diesel plant. Subsequent erosion at the terrace edge may have taken some of the power house site as well.

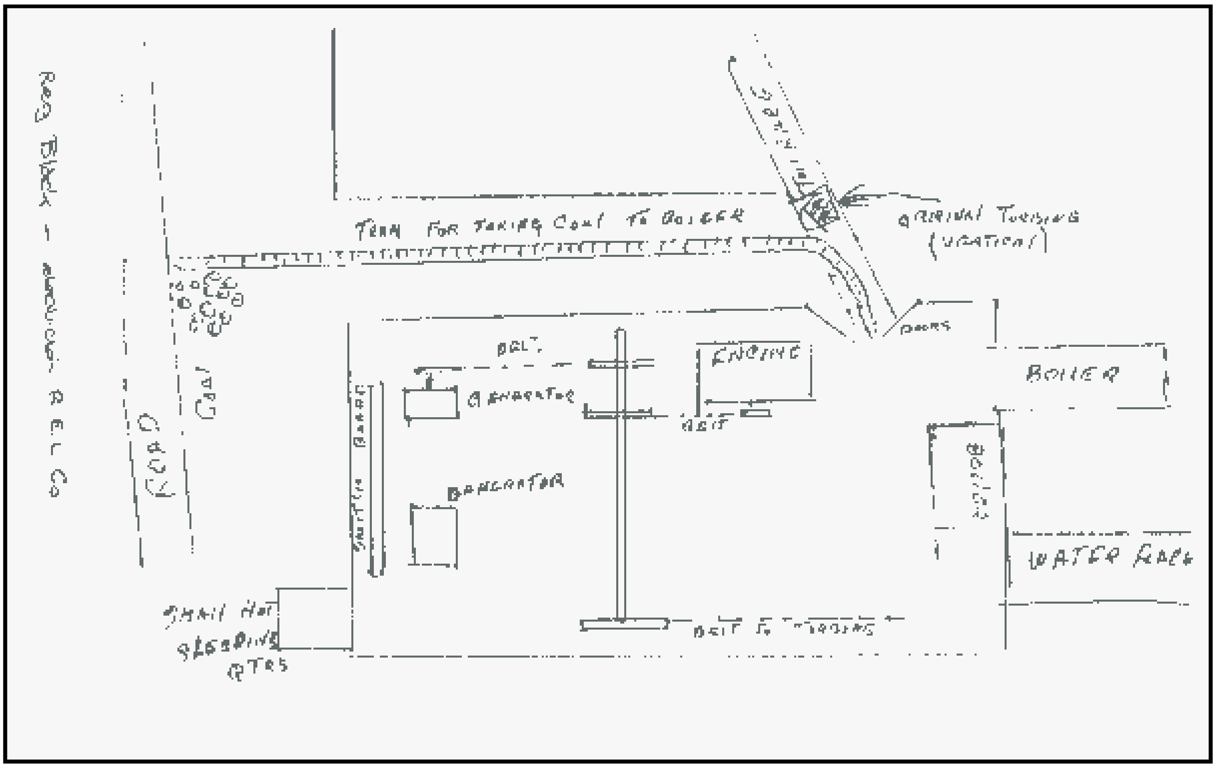

Figure 6. Reg Black's sketch plan of the power house in 1908.

Second power house (c.1906-46)

By 1906 demand had exceeded generating capacity to the point where an entirely new generating plant was required (Figure 7).[3] A concrete-lined pit was constructed behind the existing power house and water was diverted from the race via a new concrete penstock to a new British Boving 110hp horizontal turbine with an oil pressure governor (Rosanowski 1984) down in the pit. Tail water escaped via a tunnel driven through to the existing tail race below the original race terminal and turbine (Figure 6). Apparently that was all accomplished without major interruptions to the power supply.

[3] Many accounts give the date for this power house as 1908. As no newspaper accounts mention a new installation that year and it is unlikely the company would have replaced the 1906 power house within two years, the most logical explanation is that 1908 was an erroneous date, put in an article years later and subsequently repeated.

Figure 7. The 1906 power house, looking north.

To further secure the supply against river fluctuations and meet peak demands, a steam engine was installed to help the turbine along. A local reporter went to inspect the new engine and plant in July 1906:

> On entering, a spacious room some 65ft by 33ft, brilliantly lighted, forced itself on our notice. At the end by which we entered, stand the three dynamos ranged in line and all ready for instant work in case anything happens to the biggest one, that at that very moment, is sparking beneath our eyes. Each dynamo is in the best condition, everything polished to the nines, and each one looking as if it had not been long from the maker's workshop. The largest one is at work. It is a Burton and Co dynamo of 200 voltage, with a speed revolution of 650 a minute. The next to it is a Crompton, 100 voltage with a speed of 1000 revolutions a minute and the third is one by the same makers, with a voltage of 100 and 998 revolutions. These are all erected on stable concrete foundations. Then there come the driving wheels, or intermediaries. These are erected on an intermediate shaft 44ft long and 4 inches in diameter. The shaft itself was made by Mr Cederman of Hokitika, whose work is also to be seen in the wrought iron pulleys and all the work attendant on the shaft. This work has given the greatest satisfaction, and there is no doubt that it reflects credit on the foundry that turned it out. Next come the motive powers of the establishment, via a turbine, worked by water with 100 revolutions a minute, and the new engine, that beats at the rate of 120 strokes a minute, working the driving wheels on the intermediate shaft that turns at the rate of 250 revolutions a minute. The engine room is of 90 indicated horse power, and if the water at any moment goes off, another spare belt can be fixed to the intermediary shaft and full horsepower obtained. Then there is the boiler, and both engine and boiler, taken as they were, off one of the dredges, are the very best of their kind. The engine is working as sweetly as an engine can, without any vibration, and one could see that it has an enormous amount of reserve power. Especially is this latter fact forced on us when we see the mighty boiler, with the best steel platings, and capable of generating a huge amount of steam. It is neatly built in, in connection with the main shed, and a door opens on the coal house, where there is storage room for 100 tons of coal. They burn these tons of slack coal a week from the mine just outside Reefton, Blackadder's coal mine it used to be, but is now the property of the Reefton Coal Company. This coal is proving admirable steaming coal and is giving every satisfaction. Improvements have yet to be lagged, or covered over with asbestos, when it will retain the heat far better. Water for the boiler is obtained by a double acting Tangye pump, and an injector is at hand if required. Mr Wilby, the engineer, shows us the lightning mechanism, which, by simply turning a lever, arranges the lighting of the town. An indicator there also discloses the amount of power being taken. The figures on

> Saturday night was 200 amperes but at 10.30 the load goes off, and the output goes down to close on 100. Then the engine fires are banked, and the water alone does the work. The lighting power now is sufficient, were it needed, for a city, and with the reserve force of power and electricity in hand there will no fear of the light failing.
>
> *Inangahua Times* report, reprinted in the *Grey River Argus* 14.7.06:1

The article's emphasis on the steam engine and drive system suggests the turbine had been put in place earlier and received news coverage then, although that article has not been located. Awatuna (north of Hokitika) has been suggested as the source of the former gold dredge steam plant (Rosanowski 1984) and certainly the first Waimea-Stafford dredge was removed from that locality three years before (*WCT* 5.10.03:4). Boiler ON698 was still there on 13 October 1905 and moved to Reefton sometime between then and 16 November 1906 (Boiler records, J. Staton collection) so perhaps the 'new' plant had been bought some time before and kept in storage.

Coal was delivered via the Ross Town road (*Star* 15.1.1909:3) and put in a bin at the south end of the station from where a tramway carried it around the western side (apparently between the new and old power houses) to the coal shed and boilers at the north end (Figure 6).

In 1913, the boiler was the source of an early morning fire that destroyed the building and all three dynamos, but not the turbine and steam plant. There was "no insurance, whatever" (*EP* 3.4.1913). According to local folklore the fire was caused by an operator who used the hot boiler to dry some grass seed. While local shops did a brisk trade in lamps and oil the company's directors anticipated having provisional lighting in about a fortnight.

A Lawrence Scott 220 volt DC motor that had been used in the 1906 Christchurch Exhibition was converted into a generator and installed in the rebuilt power house (Rosanowski 1984). Sometime later a GEC generator - 326 amps 320 volts DC – was added (Rosanowski 1984). A sketch by Reg Black (Figure 10), company electrician during the water/steam era, shows the generators at the far end of the building from the turbine with the steam engine, intermediate shaft and belting in between, the steam engine possibly on the large plinth west of the turbine pit. The intermediate shaft would have needed to be shorter than the 44 feet (about 13m) than reported in 1906 in order to fit across the 33-foot (about 10m) wide building as shown; perhaps the reduction from three to two generators allowed that.

Steam was particularly important for a lengthy period in the 1920s while the water race was being upgraded, a great deal of coal being supplied from Alborns' mine near Merrijigs (Rod Alborn interview, 1987). There were two boilers on site between June 1918 and 1923; boiler ON731 was in use until 1929 (boiler records, J. Staton collection).

Following the conversion to diesel in 1930 (see next section) all the steam plant was removed and the GEC generator was direct-coupled to the Boving turbine (Grey Electric Power Board [GEPB] 1948 advert). The coal tramway made way for the Crossley diesel plant foundation, while the boiler room and bunker at the north end of the 1906 power house were also removed. In 1935 the new power house penstock was laid through what may have been the bunker and boiler room (shows the power house complex in 1938).

The area west of the 1906 building was (perhaps progressively) covered by a corrugated iron building with an offset gabled roof, plus a veranda for the main entrance on the central western side. Both diesels (see below) were installed there and the northern end became a workshop. Later still a weatherboard washroom and toilet were added to the south end of the building. The 1906 Boving turbine apparently remained in working order but was not used late in the life of the power scheme (Graham Hunter, pers. comm.).

Figure 8. The power house complex in 1938. Image supplied by R. Inwood.

Crossley diesel (1930-39)

In 1930 the steam plant was replaced by a 4 cylinder vertical type 110 bhp, 450 rpm Crossley OVD4 diesel engine, direct coupled to an 80 kW British Thomson Houston 2 wire, 250 volt DC generator (GEPB 1948 advert), installed by J J Niven and Co (Rosanowski 1984). Originally the engine was started by an integral compressor but later it was converted to an electric start (Graham Hunter, pers. comm.). The last marine inspection for the air receiver used with the compressor was in September 1939 (inspection records, Jim Staton collection) so the conversion may have been not long after that. A tank mounted outside the south wall of the building was the engine's radiator (Graham Hunter, pers. comm.). The Crossley did service for the last time in the winter of 1947, supplying the few remaining DC customers during post-war power cuts on the national grid (*IT* 6.6.47).

Ruston Hornsby diesel (1938-46)

In 1938 the company added a Ruston Hornsby Type VQB 52 bhp, 1000 rpm diesel direct-coupled to a Holmes 250 volt, 170 ampere 2 wire DC generator (GEPB 1948). It was installed at the south end of the workshop area, almost blocking access through the main entrance. Toward the end of the power station's life most of the electricity was generated by the diesels, partly because of problems with the water race (Graham Hunter, pers. comm.).

Third power house (1935-46)

Originally described as an extension to the 1906 power house the third power house eventually became the sole hydro generator (Graham Hunter, pers. comm.). During planning for the 'extension', the Wellington office of Boving and Co produced drawings showing an AC generator but that option was evidently rejected.

A new concrete head wall was built, incorporating a gate so flow could be directed to the penstock of either the old or new power house. In later years it was directed to the 1935 plant, probably because there was seldom enough water available to run both and there was ample diesel back-up if the hydro plant was stopped for maintenance.

Sited below the terrace, immediately north of the tail race top end, the 1935 power house contained a new 150 hp Boving Francis 425 rpm water turbine with 27 feet (8m) head, direct-coupled to a British Thomson Houston 98 kW, 2 wire, 250 volt DC generator. The cylindrical cased turbine was complete with a Boving VKA type governor (GEPB 1948). They were installed on a concrete foundation with a high concrete wall to the east with steps up to the workshop, diesel plant and 1906 plant. The new equipment and associated switching gear were housed in a timber framed weatherboard building with a west sloping corrugated iron lean-to roof and an upper-level east side veranda.

Electricity was conducted through overhead cables to the switchboard in the older building and from there to a pair of railway iron power poles on the north side of the building, the starting point for transmission across the river (Graham Hunter, pers. comm.). The last electricity generated at the station was late in 1946, before a flood extensively damaged the water race (*IT* 6.6.47).

AC/DC converter

Late in the power station's life, AC current from the national grid became available in Reefton, but could not be used because the reticulation and customers were all equipped to use DC. To meet increasing demand, an AC motor and a direct coupled DC generator were installed on the foundation plinth on the western edge of the 1906 turbine pit so AC power from the grid could be used to generate extra DC for the town. After the rest of the plant was shut down the motor and generator continued to supply the last customers waiting to have their homes rewired to the new system (Graham Hunter, pers. comm.).

Dairy company booster

There was a separate power line that ran to the dairy company, to maintain voltage for the processing plant (G. Hunter, pers. comm.).

Other buildings

There was a manager's cottage and a shed in the early days, and additions were later made to the south end of the 1906 and diesel buildings (Figure 9).

Figure 9. The tail race (foreground), power house (centre) and manager's house (right), 1888. Image supplied by R. Inwood.

Second company

There were further administrative changes over the years. The original company was superseded by the Reefton Electric Light and Power Company and in 1898 Horton resigned, to be succeeded by a Mr Bigg, assisted by B Austin (*IT* 4.4.98:2). In 1902 A. W. (Walter) Wilby took over, a debit balance was reversed and dividends were paid to shareholders (Cyclopedia 1906*:*256). The Reefton Electric Power Board, formed in 1921 to provide power to a wider area, negotiated unsuccessfully to buy the system in 1922 (Reefton Electric Power Board report for period ending 31 March, 1922).

Major hydro developments in conjunction with expansion of nation-wide power reticulation following the Second World War led to the end of generation at Reefton. The Grey Electric Power Board bought the entire scheme from the company in November 1946 (*IT* 6.6.47) and closed it down the following year when connection of the district to the national grid was completed. The Reefton Electric Light and Power Co Ltd was liquidated on 5 June 1947 (*IT* 6.6.47).

Post-closure

Equipment was advertised for sale (GEPB advert text 1948). Some was sold and the buildings served as storage sheds until they were demolished in 1961. Graham Hunter obtained some materials to build a workshop at his home along Buller Road and also bought the 1906 turbine but never moved it. A few items of equipment remained around Reefton. The Crossley diesel was sold to 'Smoky' Morris who scrapped it and the Ruston-

Hornsby went to Charlie Chandler's second sawmill at Larry's Creek (Graham Hunter, pers. comm.). Some of the concrete race walls were moved to the river as erosion protection. The rock tunnel collapsed at the entrances and later part way along. The earth tunnel was blocked at each end after farm stock was caught in it. The last traces of the timber flume at the lower end disappeared in the 1980s. The riverbed has receded to the point where it is more than a metre below the level of the intake.

The pipe for the town water supply was laid along the ledge of the probable race man's track around the outside of the rock tunnel during the second half of the 20th century.

Suspension bridges

Although probably not part of the power scheme, the two suspension bridges over the Inangahua at Blacks Point, near the intake, and upstream from Reefton, not far from the power station, were important for access. Quite similar and notable for their concrete towers, their age is not known but they can be seen in photographs from the early 20th century. In 2004 a contractor for the Buller District Council replaced the main cables and much of the timber work along with some hangers and stanchions, removed the timber bearers from the tops of the piers and put new guides for the main ropes directly on top of the piers.

Powerhouse walk

To coincide with the electricity centennial celebrations of 1986-88 the 'Bottled Lightning Powerhouse Walk' was established. Starting from the Westpower office on south Broadway it went to the power house remains via the lower Inangahua suspension footbridge, returning via Rosstown Road, passing other significant places in Reefton electrical history on the way. It was officially opened by the Minister of Energy, Bob Tizard in December 1986 (*Greymouth Evening Star* 6.12.86:5). The power house remains were interpreted on large panels and a 12-panel brochure was also produced.

PREVIOUS ARCHAEOLOGICAL WORK

The power house remains were recorded as archaeological site L30/5, Reefton Electric Light Co, in the New Zealand Archaeological Association (NZAA) recording scheme decades ago and updated in 2012 in conjunction with a report on the water race rock tunnel for the walkway committee. The adjacent Reefton water supply pipeline was also recorded as site L30/172. There are a number of recorded archaeological sites near the power house, but the only recorded sites within the footprint of the project are the power house and the water supply pipeline (Figure 10).

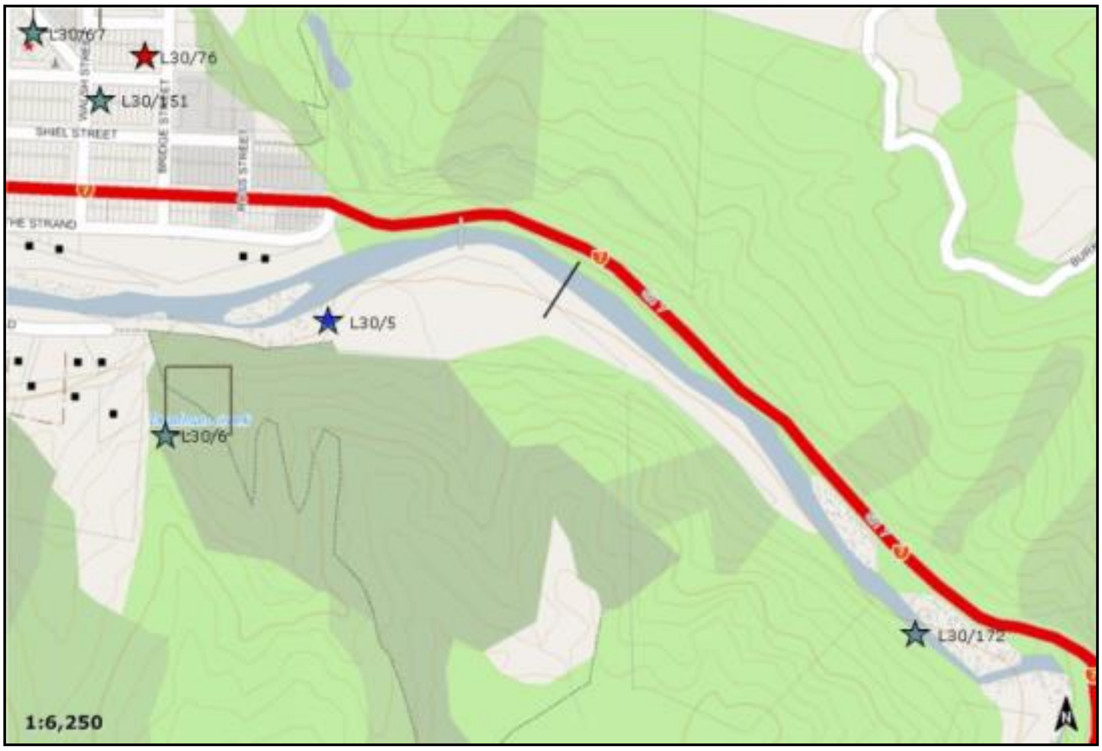

Figure 10. Recorded archaeological sites in the vicinity of the power house (L30/5). Image: ArchSite.

A blockage at the upper end of the rock tunnel was cleared for the walkway committee on 13 September 2012. Wright recorded a few remnant timbers that showed, among other things, the width of the flume entering the tunnel. He was also in attendance when the tunnel collapse was partly cleared from the outside on 2 November 2012, when a few red beech timbers of various sizes were recovered, none from their original positions. No report appears to have been written on this work.

RESEARCH RESULTS

Archaeological survey

The following features were recorded during the various archaeological surveys (Figure 3).

Access road/track

A narrow road or wide track of unknown origin, about 5 metres up the river bank, extends most of the way from the intake to the gravel sluice. It has been destroyed part of the way along by the same slip that has filled the race, but is in good order elsewhere.

Service road

A service road provided access from the powerhouse up towards the tunnel.

Water race intake

At the top end of the system is a concrete wall built into the river bank and out into the true left side of the Inangahua River (Figure 11). It incorporates apertures that allow water into the race and steps providing access from the river bank. Two of the apertures have broken away, the steel 'trash racks' that kept debris out of the race are in poor condition and the gates that controlled inflow have gone entirely, but the rest is fine. Water now enters only during floods because the riverbed has lowered by more than a metre since the scheme was abandoned.

Figure 11. The intake. Image: R. Inwood.

Concrete channel

Downstream from the intake a concrete wall and the rock of the river bank form a channel about 230m long (Figure 12). Its condition is difficult to assess, as it is almost completely full in places with shingle from the river and rock from a large hillside slip. However, it is evident that the lowered river has scoured out gravel from underneath the wall in places, effectively suspending it and no doubt adding stress. Otherwise it appears generally in fair condition at present with some cracks and slumps but few portions missing entirely.

Figure 12. The concrete channel. Image: R. Inwood.

Gravel sluice

At the downstream end of the concrete channel is a two-level rectangular concrete structure with a lower opening to the river on the outer side. It was designed to allow water to flow over the top and continue down the race while gravel was trapped in the lower section, to be periodically discharged into the river via a pair of gates. The concrete is in good condition but the control gates and mechanism have gone.

Upper ditch

Past the sluice is 230m of open earth ditch, in good condition where visible between dense blackberry and other growth (Figure 13 and Figure 14). There is some timber lining, 1.5m wide and 1.2m deep, rotten but otherwise intact. While not likely to date from the 19th century it was probably built to the same dimensions and design as the structure it replaced during the race's working life.

Figure 13. The upper ditch. Image: R. Inwood.

Figure 14. The lower ditch. Image: R. Inwood.

Earth tunnel

Apparently filled in for safety at each end and overgrown with dense blackberry and other vegetation, this tunnel has not been inspected.

Rock tunnel

Approximately 100 m long, this is mostly open and in good order. At the upper end is a temporary safety structure to protect anybody entering from falling rocks. About 25 metres in is a breach just over 10m long where the hillside has slipped; a few standing timbers immediately before it suggest this was a trouble spot historically. The rest of the tunnel is in good order with a few timbers here and there. The lower end was cleared a few years ago and seems quite stable.

Race inspector's track

A ledge around the river side of the tunnel was probably the base for a structure used to get around the tunnel while inspecting the race. It now carries has remains of a steel water pipe from the c.1950s-1990s Reefton supply system.

Side cutting

Beyond the tunnel is 120 m of side cutting that carried a timber flume with a walkway on top for the inspector (Figure 15). While the cutting is in good condition the sole remnant of the flume is a heavy timber with housings cut in at intervals, probably a sill supporting cross members.

Figure 15. The side cutting. Image: R. Inwood.

Lower concrete channel

From the end of the side cutting, impressive concrete walls about 2m high form another concrete channel, 525m long. A total of 105m of panels have been removed and dumped along the river as erosion protection. For the rest of its length the channel appears in good order with a rock bottom where exposed beneath loose slip material and detritus.

Lower ditch

Past the channel another open ditch runs for 730 m. It appears to be in good condition although filled to varying degrees with slip material. At one point there is a pronounced kink where the ditch was diverted around the toe of a large slip at some stage in its history. There and at least one other point the wall is reinforced with concrete.

Lower flume

Nothing remains above the ground of the timber flume that carried water the last 190 m from the end of the ditch to the power house penstocks. A section of flume that remained in 1985 was probably removed during tree planting a few years later. No investigation has been made for subsurface features.

Penstock headwalls

At the bottom end of the race is a Y-shaped concrete structure that could direct water into either the 1906 or 1935 penstocks. Steps are incorporated in the walls dividing the two branches. The concrete is in good condition but the control gates and lifting mechanisms have been removed, along with the 1935 penstock.

First power house

No definite remains have been identified, but historic photographs suggest some could lie under the workshop and veranda floors. Some 1888 features may have disappeared, with more than 2 metres of terrace along the western edge north of the veranda slab when the 1906 tail race tunnel collapsed. Part way down the bank south west of the veranda is an oblong foundation that may have been associated with the early power house - possibly as the base for the first pylon (although it is oriented in the wrong direction) or for a stairway down to the tail race.

Second power house

The largest and most complex feature, this comprises the concrete-lined turbine pit plus a series of other concrete floors south of the three dynamo foundations (Figure 16). Until recently the pit still contained the Boving turbine, the flywheel and a generator armature, but they have been removed for conservation work. A drainage ditch that ran into the pit, causing erosion of the ground below, has recently been diverted around the south side of the site. The tail race tunnel has largely collapsed under the workshop floor and has gone entirely to the west.

Figure 16. The power house. Image: R. Inwood.

On the south side of the turbine pit, steps lead up to another level, which was the watch room in later days. In the floor is evidence of steel posts, probably for a handrail, on the western side of the step well and possibly a wall on the east side. A low wall separates the watch room floor from the turbine pit and on the east and south sides are raised perimeter walls with timber frame remnants still in the concrete. A small fireplace is set into the southern wall, which has also been cut away at its western end to accommodate a connection with the Crossley engine room floor.

Immediately west of the turbine pit is a foundation plinth with holding down bolts for the AC/DC plant of the 1940s but no evidence of any earlier installations. Immediately west of that, a long north-south crack in the concrete possibly indicates the position of the original outer foundation wall. If so, it matches the width of 33 feet (10m) given for the main power house building in 1906.

Boiler foundations, other traces of concrete and fragments of coal around the northwest corner of the main site mark the positions of some steam plant. The concrete throughout the site is generally in good condition.

Three concrete foundation blocks at the south end of the site, adjacent to the wash room, are believed to be surviving foundations for one or more of the three dynamos described in 1906. (If the 65 foot [19.8m] power house had extended to the turbine headwall, the dynamos would have been at the opposite end, as described.)

Crossley diesel foundations

Generally in good order, the main foundations are distinguishable from the later block for the electric starter motor by their differing quality of concrete. Pipes for compressed air and cooling water are also evident. Most of the cream, charcoal and terra cotta tiles that covered the floor have been removed. Along the northern side is the imprint of a 100mm wide wall plate.

Dairy company booster

There are no obvious traces of the timber-floored structure that stood south of the watch room and east of the Crossley, but evidence of piles could lie under the weeds growing on the site.

Ruston Hornsby diesel foundation

Besides the large block for the engine and generator there are two smaller foundations for the starting compressor and a petrol motor. The bolts on the main foundation are bent, possibly as the result of taking in a vehicle to return the draught tube to the 1935 power house foundation in the 1980s.

Workshop

A concrete floor, in poor condition, defines this building, which adjoins the 1906 building on the western side. The floor appears to have been poured following construction of a post-and-rail corrugated iron clad shed, as there are imprints of posts along the northern edge and the floor has been ‘turned up’ at its northern edge to prevent ground water getting in under the wall. A rippled edge along the concrete path to the north is further evidence of the vertical corrugated iron wall it was poured against. There is no evidence of a work bench that stood along the western wall at its northern end.

Veranda

Slightly undermined on its north side by a collapse in the region of the 1906 tail race tunnel, the concrete veranda slab is otherwise in fair condition. A path runs up to it from the south side, but its continuation toward the 1935 penstock on the north side has been removed by the collapse.

Wash room

The concrete perimeter wall and floor remain in good condition but most of the floor tiles have gone. Openings for fixtures remain evident.

Unidentified concrete strips

Along the terrace west of the southern portion of the building and path is a rough quality concrete strip containing bent 30mm steel rods set into square holes that were evidently boxed with light timber when the concrete was poured. Immediately east, parallel with the concrete path along the front of the power house, is a strip of better quality concrete. Their purpose is unknown, but it has been suggested that the concrete with rods could have been associated with the earliest power house, while the better ridge could have been a footing for the picket fence that stood along the same line, although no post holes are visible in the concrete.

Third power house

Part of the floor is missing where it was broken to remove the draught tube, since returned to the site and standing upright on the adjacent floor. The rest of the concrete is in fair condition, with damage confined mainly to detail such as stair parapets. Above, the rounded base for the penstock pipe is still evident and in fair order but the concrete paths are in poor condition.

Tail race

A 150 m long channel, approximately 3 m wide and 1 m deep, leads from the 1935 power house foundations along the foot of the terrace into the Inangahua River (Figure 17). The channel appears to be in much the same place as the original but is poorly defined and there is no sign of the timber lining evident in old photographs. There is a shallow channel below the penstock headwall which we believe formed the original by-pass for the scheme.

Figure 17. Looking down the tail race from the power house. Image: R. Inwood.

Other buildings
A road and car park now occupy the sites of the manager's cottage and other buildings south of the early power house foundations. There is no evidence of these buildings on the surface and it is not known if sub-surface remains exist.

Suspension bridges
A pair of virtually identical suspension bridges give access to the water race and power house sites from Blacks Point and State Highway 7, a short distance upstream from Reefton. Their age is not known, but their distinctive concrete towers are visible in early 20th century photographs. They have been refurbished and well maintained in recent years by the Buller District Council.

ARCHAEOLOGICAL AND OTHER VALUES

The HNZPT recommend using the following criteria to assess the values of an archaeological site:

- The **condition** of the site.
- Does the site possess **contextual value**?
- Is the site **unusual, rare or unique**, or notable in any other way in comparison to other sites of its kind?
- **Information potential**.
- Does the site have any special **cultural associations** for any particular communities or groups, e.g. Maori, European, Chinese.
- **Amenity value** (e.g. educational, visual, landscape). Does the site have potential for public interpretation and education?

Values have been assessed as being low, moderate or high.

The **condition** of the remains of the Reefton power scheme varies, but the overall condition of the remains is moderate.

The **internal contextual** values of the scheme remains are moderate to high. While some elements have been destroyed – particularly earlier features by later ones – much of the scheme remains visible and legible, including an intake, gravel sluice, ditching, tunnel, timber and concrete fluming, remains of two hydro power houses with standby diesel foundations, and evidence of the tail race. The **external contextual** values of the scheme are moderate to high. Reefton, the town the scheme was built to supply electricity to, remains standing, although much of its late 19th century fabric is gone. Notably, the first shop connected to the power supply in 1888 remains standing.

The remains of the scheme are **rare**. Most other old power stations, including West Coast examples near Hokitika (working) and Murchison (complete but not working), date to the early 20th century. The scheme also derives rarity value from its early date, and the fact that it was one of the first power stations in New Zealand, and certainly the first in the country to supply power for non-industrial purposes.

The **information potential** of the remains is moderate to high. Archaeological investigation and analysis of the remains could lead to a more detailed and better understanding of the scheme's operation, particularly in relation to the 1888 building. Archaeological investigation could also find the remains of the manager's house and another building known to have stood on the site. Any domestic rubbish dumps associated with these features – or industrial rubbish dumps associated with the power station itself – could yield important information about life at the power station, and about its operation.

The scheme has **cultural associations** for the local community. Reefton is branded as 'The Town of Light' for its historical leadership in electricity generation, rather than its more obvious and probably better known quartz reef mining history.

The **amenity values** of the scheme are also high, as evidenced by the current project. The remains of the power scheme tell important stories about Reefton's pioneers and ambitions, changes through time at the site and the early generation of electricity in New Zealand. The fact that so much of the scheme remains in situ and in good condition adds to the amenity value.

Historically, the site is important as the first domestic electricity supplier in New Zealand and probably the southern hemisphere. Furthermore, it was built by a company formed expressly for the purpose, rather than by a local body or a company concerned primarily with some other industry. Kimberley in South Africa was the first town south of the equator to have electric street lighting, and other places had generating plants for lighting and industrial purposes, but Reefton's greatest distinction lay in being the first place where people had electricity in their homes. Local businesses were also lit at a time when others, even in most of the world's great cities, were still making do with gas, kerosene and candles. This 'feat' probably had little impact on the rest of the world, as generating systems were being planned in other places simultaneously, but it was reported widely in New Zealand - even if it did not warrant a headline in local papers.

Technologically, the original Reefton system was rare at the time because it employed water instead of steam for generation. Subsequent developments demonstrated the progression of generating plant that was required to meet ongoing and increasing demand as new and existing uses of electricity expanded and the limited water supply was unable to cope. So having, with Bullendale, set an example that New Zealand would largely follow, Reefton moved away from hydro toward steam and diesel, opposing the national trend.

To summarise, the Reefton power scheme sites are of high archaeological value and a nationally significant complex historically, representing an early example of the method New Zealand adopted before moving onto other means of producing electrical energy.

ASSESSMENT OF EFFECTS

In considering the effects of the proposal on the archaeological site described above, the following questions were considered:

- How much of the site will be affected and to what degree? What are the **effects on the values** of the archaeological sites?
- Will the proposal increase the **risk of future damage** to the site?
- Would a **redesign** of the proposal avoid the effects?
- What are the possible methods to **avoid, minimise and/or mitigate** the adverse effects of the proposal?

Extent of effects

Reinstating the water race and last power house will have a low effect on the sites' archaeological values. A great deal of the original fabric was replaced during the scheme's working life and the current proposal will affect only a small percentage of the remaining 19th or 20th century features.

Future damage

Rather than increase the risk of future damage to the site, the proposed work will prevent further loss to the historic fabric and plant by stabilising and maintaining it. Without this scheme, historic remains will continue to deteriorate through natural processes, vandalism and possibly land development.

Redesign

Reinstatement has been planned to minimise the effects on the historic fabric and it is not possible to envisage any redesign that would reduce the impacts outlined. The committee aims to keep the scheme's appearance as close as possible to original while meeting environmental and engineering requirements.

Avoid, minimise and/or mitigate

As noted above, the works have been planned to keep impacts on the historic fabric of the sites to a minimum, thus avoiding the loss of archaeological knowledge. The effects of the scheme on the historic fabric of the site will be minor.

All historic fabric at the site will need to be mapped and recorded (using standard archaeological techniques) prior to modification, and some earthworks should be monitored by a suitably qualified archaeologist. The work to be undertaken in conjunction with the project is outlined in the archaeological management plan accompanying this assessment, along with specific recommendations for avoiding, minimising and/or mitigating the effects.Discussion and recommendations

The Reefton Power Scheme is a significant archaeological site and the following measures will be taken to minimise the impacts of the proposed work:

- The Reefton Power House Restoration Committee should apply for a general archaeological authority to damage an archaeological site under the Heritage New Zealand Pouhere Taonga Act 2014.
- The works shall be carried out in accordance with an archaeological management plan, to be submitted with the archaeological assessment.

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APPENDIX 1: PROJECT DESCRIPTION[4]

The proposal

The proposal is to restore and rebuild Reefton's historic power scheme. The intake, water race and tailrace of the scheme are largely intact but significant repairs are required to re-instate the scheme to generate electricity. The historic 1906 and 1935 powerhouses are to be re-built, replicating the original appearance of these buildings as closely as possible. Associated with restoration of the earlier powerhouses, the applicant proposes to erect a small building that will house a modern turbine and generator. The modern plant will be the primary generator of electricity.

The physical dimensions of the river intake and water race constrain the maximum take from the Inangahua River to 3.5 cumecs. A minimum flow will be maintained in the 2 km section of river between the intake and power station tailrace, with gates at the gravel sluice used to control flows into the water race. A fish pass will also be located at the gravel sluice to enable fish to by-pass the scheme.

Based on modelling of flow data, the project is expected to generate a maximum electricity output of 154kW. Electricity generated by the scheme will be injected into the existing Westpower 11kV distribution network.

Associated with generation of electricity, it is proposed to develop and improve the existing powerhouse walk as visitor attraction. The intention is to create an interpretative walking tour that will educate residents and visitors alike as regards Reefton's electricity generation heritage. As occurs at present, the loop walk will start from the town centre, head up Broadway to the swing bridge over the Inangahua River, returning via Rosstown and the state highway bridge, with the powerhouse site being the main focus for a range of interpretative displays.

Restoration of the scheme is proposed to be undertaken so as to retain as much of the historic fabric of the original hydro scheme as possible.

Intake

Repairs are required to the existing intake structure located approximately 100m downstream of the Blacks Point swing bridge. The intake is a concrete structure extending 8.5m from the true left bank of the Inangahua River. It comprises concrete apertures that allow water into the race, with steel bars on the outer face designed to prevent debris from entering the race. Two of the apertures have broken away and the steel 'trash racks' are in poor condition and require repair.

Scouring of the riverbed periodically lowers the bed at the point of intake into the water race. The intention is to place a 40 tonne rock groyne projecting 10m from the outer edge of the water race into the river flow immediately downstream of the intake structure. It is anticipated that the groyne will cause sediment to accumulate on the upstream side to maintain the bed at the same level as the water race.

Water race and service road

The original water race is approximately 1850m long, with re-instatement to involve the following (described from the intake, working downstream to the powerhouse):

[4] Supplied by Rebecca Inwood.

- *230m of concrete canal* – the first section of race comprises a concrete wall built along the true left bank of the river. The canal is in relatively good condition but the base of the wall has been subjected to scouring and undermining and minor cracks and slumps in the concrete wall require repair. Gravel and rock debris has accumulated within the canal and will be removed. Re-construction of a 'timber roof' is proposed approximately half way along this section of the canal where a small slip has completely filled a short section (around 20m stretch) of the race. The timber roof will prevent material from falling into the canal and was a feature of the historic scheme.
- *Gravel sluice* – the sluice is in good condition but is missing the gates and control mechanisms. These will be replaced with new components copied from authentic structures elsewhere. Minor repairs to the concrete structure and removal of accumulated silt and debris is also required.
- *430m of earth tunnel* – downstream of the gravel sluice is open earth race, of which approximately 110m has been partially filled-in where it crosses private property. The 110m stretch is to be abandoned and a new section of race constructed around the freehold property on legal road. For the existing earth race, accumulated debris and growth will be cleared away and timber remnants removed to restore the original profile.
- *100m of rock tunnel* – timber fluming within the tunnel is believed to have formed part of the original scheme with remnant timber evident. The majority of the tunnel is open and stable, with the exception a short section about 25m in from the downstream entrance where a slip has resulted in collapse of the tunnel. Timber fluming will be re-instated with the slipped section to be bridged with timber flume.
- *170m of timber flume* – downstream of the tunnel is a side cutting that carried timber fluming with a walkway on top. The fluming has largely disappeared and will be replaced with a replica section.
- *730m of concrete wall/earth bank* – downstream of the timber flume is a section of concrete wall/earth bank. The race is filled to varying degrees with accumulated material. Reinstatement will require removal of overgrown vegetation and excavation of accumulated soil/gravel. Around 105m of concrete panels have been removed and will require replacing, otherwise the concrete walls appear in good condition.
- *190m of timber flume* – nothing remains of the timber flume that carried water to the powerhouse penstocks. New wooden fluming will be installed replicating the original design as closely as possible.
- *Penstock* h*eadwall* – a Y-shaped concrete structure at the bottom end of the water race directed water into either the 1908 or 1935 penstocks. The concrete is in good condition but the control gates and lifting mechanisms have been removed along with the 1935 penstock. These components will be replaced with new components replicating the original as closely as possible.

In conjunction with repair of the water race, re-instatement of the existing service road will be completed. The road was approximately 900m long and extended from the powerhouse up towards the tunnel. The road will be used to bring construction materials and to enable future servicing of the water race.

Powerhouses

The 1908 powerhouse was the largest and most complex at the site with remains including the concrete-lined turbine pit and a series of other concrete floors related to dynamo foundations, the watch room, diesel plant foundations, workshop, veranda and washroom. Part of the 1935 powerhouse floor has been damaged otherwise the foundations appear to be in reasonable condition. No remains are evident of the 1888 powerhouse but the archaeologist's report suggests that some could lie under the workshop and veranda floor of the 1908 powerhouse building.

The re-built 1908 powerhouse will be constructed over the site of the historic 1908 powerhouse, diesel plants, the workshop and the washroom using historic and new foundations. If any remnants of the 1888 powerhouse are discovered beneath the workshop floor they will be incorporated into the new building floor where practicable. The re-built 1908 powerhouse will contain interpretative displays tracing the history of the scheme.

As part of the re-construction of the 1935 powerhouse, the Trust intends resurrecting the turbine and penstock by installing a suitable generator and switchgear of this vintage to achieve an operable unit for visitor display purposes.

In conjunction with restoration of the historic powerhouses, a new building is proposed to be constructed, which will house a modern turbine, generator, switchboard and controls. The modern plant will be the primary generator of electricity for the Scheme.

Restoration of the 1908 and 1935 powerhouses will replicate the original appearance of these buildings as closely as possible. Concept plans have been provided by conservation architect Chris Cochran**.** Both the historic and modern powerhouse will have timber cladding and corrugated iron roofs, with the concept plans giving an indicative colour scheme for the buildings. The footprint of the respective buildings is summarised in Table 2 below.

	Modern Powerhouse	1908 Powerhouse	1935 Powerhouse
Ground floor area	$22m^2$	$202m^2$	$33m^2$
Maximum height	5400mm apex	4370mm apex	6840mm apex

Table 1: Powerhouse building dimensions.

Provision for parking and landscape planting around the buildings will also be undertaken.

Tailrace and spillway by-pass

The proposal is to re-instate the existing tailrace, which comprises a 150m long channel leading from the historic powerhouse site into the Inangahua River. The original channel was approximately 3m wide and 1m deep, and some excavation will be required to achieve the original dimensions.

The original by-pass for the scheme will also be re-formed and will incorporate the spillway for the modern plant.

Powerhouse track

The existing track from the Reefton swing-bridge provides walking access to the powerhouse site. It is envisaged that this will form part of the main access route for visitors to the re-instated powerhouse complex. Although the walking track is in reasonable condition, improvements to the surface will be undertaken to provide an all-weather walking track suitable for all ages and capabilities.

Interpretive displays will be erected at the Reefton swing-bridge and at the powerhouse complex, describing the history of the scheme as the first domestic electricity supply in New Zealand.

Transmission line

Electricity to the new powerhouse will be provided by means of a new 11kV transmission line spanning the Inangahua River immediately upstream of the proposed powerhouse buildings. Connection will be into the existing Westpower line and will require a new concrete pole with transformer. Power generated by the power scheme will be injected into the existing Westpower Ltd network via the same line.

Construction activities

The following is a description of the anticipated development process for the scheme and the proposed works:

Development process

Initially, the focus of the project will be re-instatement of the hydro scheme to generate electricity. The Trust anticipates that construction will be staged as funds allow, with **Stage 1** to involve re-instatement of the intake, water race, tailrace, construction of a new powerhouse for the modern generation plant and installation of the transmission line and pole for connection into the existing Westpower Ltd network.

Depending on river levels, it is envisaged that work would commence with repair of the intake structure progressing downstream with re-instatement of the water race and tailrace/spillway. Given the service road is required to transport materials to the lower reaches of the water race, it is expected that this will be completed early in the construction phase. At the same time, construction of the new powerhouse building is expected to be undertaken. It is anticipated that Stage 1 will be completed within 9 months (approximately).

Stage 2 will involve repairs to the historic powerhouse foundations, re-build of the 1908 and 1935 powerhouses, installation of refurbished historic generation plant and erection of interpretative display material. Landscape planting around the powerhouse will also be undertaken. **Stage 2** is expected to be completed within 6 months (approximately).

Intake repairs

Repairs to the intake will require temporary diversion of the river away from the intake structure to allow repairs to be undertaken in dry conditions. The temporary diversion will be undertaken during a period of low flow (expected to be over the summer months) and will involve excavation of a short section of temporary channel using a 20-30 tonne excavator. The same excavator will be used to removed damaged sections of the intake apertures. Two of the apertures will be rebuilt and all four 'trash racks' repaired to the existing pattern. Steel housing will be placed in all four apertures to accommodate new wooden gates to enable flow into the water race to be shut-off to allow future maintenance.

The anticipated volume of concrete required for repair of the intake is $20m^3$ (equating to 4-5 concrete truck trips). The full repair is expected to be completed within 6 days. Given the volume of concrete required for the repair work, it is anticipated that there will be up to 10 crossings of the river by a concrete truck and 2 crossings for the excavator.

Construction of the 40 tonne rock groyne will occur at the same time as the repairs to the intake. This will necessitate a further 8 crossings of the river (being 4 truckloads of rock) with construction of the groyne to be completed over 1 day using the same digger utilised for the intake repairs.

Access to the intake and groyne will be achieved by crossing the river via existing access off Auld Street (Blacks Point), with machinery crossing the river at a single crossing point. The total number of crossings associated with the excavator and truck movements is expected to be 20 crossings over a period of 7 days.

Water race and service road re-instatement

The water race will be extended by approximately 40m due to the deviation around the Farnham property, taking the over-all length to around 1890m.

The proposed works will be undertaken so as to retain as much of the original features as possible. Timber fluming will be constructed to replicate the original and concrete repairs will be limited to repairing missing sections of concrete wall and repairing cracks and slumps.

The following is a description of the works to be undertaken on the various sections of water race. The lengths of earth race and timber flume are approximate only, as these sections may alter slightly depending on final alignment of fluming and ground conditions encountered. This said, the footprint of the water race is expected to be roughly the same, whether earth race or timber flume.

- *230m of concrete canal* – an estimated 400m^3 of accumulated gravel and rock requires removal over this section of the race. This will be achieved by a small excavator working from within the water race. Excavated material will be placed against the base of the outer wall to protect the structure from scouring. Construction of the 20m section of 'timber roof' will involve progressive installation of timber decking, extending from the concrete wall into the adjacent bank and excavation of material from under the roof structure. Re-instatement of the canal will also require cracks and slumps in the concrete wall to be repaired. This will be undertaken at the same time as concrete repairs to the intake. Damaged sections will be boxed and concrete carted by means of hand-burrow down from the intake. Work on this section of the race is expected to be completed over 5 days with access for the excavator via Auld Street crossing at the same ford used for the intake/groyne construction.
- *Gravel sluice* – reinstatement requires installation of new wooden gates, control mechanisms, removal of accumulated silt/debris and minor concrete repairs. The gates will be built off-site and installed during re-instatement of the canal. To enable flows into the scheme to be shut-off wooden control gates will be incorporated into the gravel sluice. A fish-by pass will also be installed.
- *470m of earth race* – an existing access track will be cleared of vegetation to allow access to this section of race. The 110m (approx) stretch of race on private land will be abandoned and a new section will be constructed on legal road (around 150m long). Final design is yet to be confirmed but is expected to involve construction of an open earth trench and a short stretch of timber fluming linking to the tunnel. Re-instatement of the existing section of earth race will involve clearance of over-grown vegetation and removal of around 120m^3 of accumulated silt/soil. Excavated material will be spread adjacent to the race and access track. Sealing of the base of the earth race will be achieved by using a synthetic liner covered with compacted gravel. Approximately 200m^3 (equating to 11 loads) of gravel will be brought in for sealing of the new and existing earth race. Access for river crossings will be via the existing routes

of Syphon Track and Ford and the Farnham Ford. Should timber fluming be installed, this will be transported across in sections.

- *100m of tunnel* – the tunnel roof and walls will be supported with sets of timber framing followed by installation of wooden fluming built in-situ. Installation of fluming across the collapsed section of tunnel will require spiraling through the slip debris to create a platform for the flume. The 12m section of bridging flume will incorporate a roof that will allow debris to spill over the top. Large rock riprap will be placed at the toe of the slip to buttress the slip. Rock for this purpose will be retrieved from the riverbed in the immediate vicinity of the slip so it blends with the existing rocky outcrop. It is expected that some additional rock, sourced from retrieving large boulders along the stretch of riverbed adjacent to the canal, will be transported to the site. Any large rock recovered during the spiraling process will also be utilised as riprap. Excavated soil and debris will be backfilled behind the riprap and contoured around the timber flume. Access to the tunnels and slip site will be via the service road and/or fording of the river near Syphon Ford.
- *170m of timber flume* – all wooden fluming will be constructed off-site in 6m lengths and transported to the respective sites as required. Installation will require leveling of the narrow cutting and cut-back of the adjacent bank to allow installation of the new sections of wooden flume. Excavated material is expected to be utilised as cut and fill. Sections of flume will be brought in via the service road. Small concrete pads will be poured on-site on which the wooden flume will fasten to.
- *730m of concrete wall/earth bank* – re-instatement will involve removal of over-grown ferns, shrubs, gorse and broom and excavation of accumulated soil/gravel. It is estimated that 2200m^3 of material will require excavation and removal, with this to be achieved by a small digger working from within the race. Extracted material will be utilised as part of re-instatement of the service road and to fill depressions adjacent to the race/access road. Some repairs will be required to reinstate sections of the concrete walls of the race. This will be achieved by boxing damaged portions to allow new sections of concrete to be poured. As with the earth race, the base of the race will be sealed by using a synthetic liner covered with compacted gravel. It is anticipated that up to 538m^3 of gravel will be required for lining purposes to be bought in by 6-wheel road trucks via Rosstown.
- *190m of timber flume* – Installation will be as per the upstream sections of wooden fluming with ground levelling and removal of some pine trees required.
- *Penstock headwall* – The inlet flume will be extended to incorporate the penstock of the modern plant. The original concrete structure will be repaired and new control gates and lifting mechanisms installed, replicating the original as closely as possible

In conjunction with repair of the water race, re-instatement of the service road will be completed. The first 400m is in reasonable condition while the remaining stretch requires formation repairs and re-surfacing. Low sections of the road formation will be built-up to provide support for the water race walls. Gravel for this purpose will be sourced on-site from a gravel fan (1000m^3), along with utilisation of suitable material excavated from the water race.

The service road crosses the water race approximately 300m from the powerhouse, at which point a small wooden bridge (approximately 3m long) will be installed. Culverts will also be installed across three un-named watercourses (<1m wide).

Powerhouses

The initial focus will be on construction of the modern powerhouse to enable electricity to be re-established as quickly as possible. This will entail minor excavations over the building footprint (22m^2) to establish a foundation slab. A concrete floor will be poured and construction of the building and penstock will then follow. Once the building has been erected, the generation plant and equipment will be installed.

As regards the historic powerhouses, stabilisation of the existing powerhouse building foundations will be achieved by establishing a concrete retaining wall system ('Stone Strong' blocks). Ground at the foot of the terrace will be excavated approximately 800mm to the natural gravel bed for a foundation slab. The Stone Strong retaining wall will be erected to protect the western face of the terrace from further erosion. The retaining wall will be designed to prevent damage to the historic foundation part way down the face near the original veranda. The workshop floor (which may lie over part of the 1888 powerhouse site) and the floor of the 1908 powerhouse turbine pit will be removed so that the eroded spaces can be filled with pre-cast concrete pipes and compacted gravel. The pipes will enable water to pass under the site if required for some future development such as re-use of the turbine. Both floors will be replaced and the foundation blocks for the 1938 diesel starting equipment will be restored to their correct positions, if they have to be removed for the filling operation.

A new building for interpretive displays will be then built over the sites of the 1908 powerhouse complex using historic and new foundations. If any remnants of the 1888 powerhouse are found underneath the workshop floor they will be incorporated in the new building floor where practicable.

Re-construction of the 1935 powerhouse will require broken concrete foundations, floors, parapets and steps to be repaired and recast using the originals as patterns. A new penstock and draught tube will be installed along with turbine, generator and electrical equipment resembling the originals as closely as possible. On the upper level, the paths running to the north-western corner of the workshop will be relaid along with the adjacent portico floor and up-stands. Construction of the powerhouse buildings will then follow.

Construction access will be via Rosstown road, with storage of construction materials and parking to be provided adjacent at the powerhouse site. A number of pine trees may be removed to improve the existing turning circle and provide additional room for temporary storage of construction materials otherwise no vegetation disturbance or earthworks is envisaged. On completion of powerhouse construction, landscaping will be undertaken around the site and interpretative displays erected. No lighting is proposed at the site other than security lighting at the entrances of each of the powerhouses.

Tailrace and spillway by-pass re-instatement

Up to 170m^3 of sand/gravel is expected to be excavated from the existing tailrace and spillway channels to achieve the required profiles. Excavated material will be deposited in depressions adjacent to the channels and contoured to the surrounding ground level. Due to the low flow velocity, scouring of the channels is not anticipated. However, the last 30m of the tailrace where it enters the riverbed will be lined with rock rip to ensure the exit point does not scour. Rock riprap will also be placed along the first 20m of the modern plant spillway and at the junction of the spillway and the tailrace.

Up to 250 tonnes of rock will be required for lining purposes, with rock expected to be sourced from Echo mine and bought in by 6-wheel road trucks via Rosstown.

Excavation of a shallow channel over a short section of dry riverbed may be required from the tailrace discharge point into the active river channel. This will be assessed during works to re-instate the tailrace.

Transmission line

Construction of the new span of overhead transmission line will require installation of one new power pole. An excavator will track some 50m from the powerhouse to gain access to the pole site. A number of pine trees may require removal to allow installation of the pole and to achieve clearance beneath the line feeding to the power station. The pole and new transmission line will be installed by Westpower Ltd.