IPENZ ENGINEERS NEW ZEALAND
ENGINEERING HERITAGE NEW ZEALAND
April 2010
newsletter

3rd Australasian Engineering Heritage Conference

Engineering in the Development of a Region – Heritage and History
Salmond College, University of Otago, Dunedin, New Zealand
22–25 November 2009

This event was part of a cycle of Australian and New Zealand engineering heritage conferences. Approximately 120 delegates attended, from New Zealand, Australia and the United Kingdom. An excellent range of 28 papers, on engineering achievements and their effects on communities and people's lives was presented over two days of sessions.

Featured keynote addresses introduced several of the sessions. The opening address, entitled 'Does Engineering Heritage Matter?' was given by Sir Neil Cossons, formerly Chair of English Heritage.

Conference Themes, Topics and Presentations

The conference themes, topics and presentations included:

- **Agricultural Development:** irrigation; refrigeration engineering)
- **Power:** hydro-electric; gas; hydraulic
- **Transport and Communications:** bridges; railways; harbours and ports
- **Resource Extraction:** gold mining; stamper batteries; timber
- **Management and Engineering of Heritage:** sites; structures; artefacts and machinery; monitoring and analysis
- **The People:** entrepreneurs; manufacturers; engineers
- **Presentation of Engineering Heritage:** recording; archives; telling the stories; uses of modern communications technology.

The panel of invited speakers covered a wide range of interests and expertise, prompting much discussion. Speakers included:

- Sir Neil Cossons, United Kingdom, industrial archaeologist and former Chairman of English Heritage
- Paul Davies, Australia, heritage management consultant
- David Dolan, Australia, Professor of Cultural Heritage at Curtin University
- Wayne Johnson, Australia, Sydney Harbour Foreshore archaeologist
- Euan McQueen, New Zealand, geographer and New Zealand railway heritage historian Robert McWilliam, United Kingdom, editor of *ICE Biographical Dictionary of Civil Engineers, volume 3*
- Duncan Waterson, Australia, historian - settlers, agriculture, railways, politics, et al.

Conference papers can be accessed on the IPENZ Engineering Heritage website: www.ipenz.org.nz/heritage/conference/papers.cfm

Lake Benmore was part of the pre conference tour.

In the photo from left to right are: Professor Gerry Carrington IIR, Owen Graham Historic Places Trust, Rob Wilkinson IPENZ Engineering Heritage Board, Howard Healey IRHACE, and Dr Andrew Cleland Chief Executive IPENZ.

North Island PTT

Tamaki River Bridge, Panmure

Musick Point Radio Station

Stony Batter Fortress

Glenbrook Steel Mill

MOTAT

Nihotupu Dam

Kopu Swing Bridge

A and G. Price, Ltd, Thames

Thames School of Mines

Martha Open Cast Gold Mine, Waihi

Red Stag Timber at Waipa Mill

Waiotapu Thermal Area near Rotorua

Aratiatia Dam

Wairakei Geothermal Power Station

Taupo Volcanic Activity Centre

Tongariro Power Project

Raurimu Spiral

Makatote Viaduct

NIMT

Tangiwai Railway Bridge

Military Museum, Waiouru

South Rangatiki Rail Viaduct, Mangaweka

Mangaweka Power Station (site)

Tokomaru Steam Museum

Foxton Flax Museum

Steam Incorporated at Paekakariki

Wellington and Manawatu Railway (Paekakariki to

Wellington)

Museum of New Zealand

Floating crane Hikitia

Kelburn Cable Car and museum

Wrights Hill Fortress

Transpower control room

Lower Karori Dam

South Island PTT

Interislander to Picton

Transcoastal train to Christchurch

Christchurch Tramway

Lyttelton Time Ball Station

Tug boat “Lyttelton”

Christchurch Gondola

Ferrymead Heritage Park

Tranzalpine train to Greymouth

Brunner Mine and bridge

Grey River Gold Dredge

Reefton Power Station

Coaltown Museum at Westport

Denniston Incline

Menzies biplane at Hari Hari

Fox Glacier

Haast Pass

Tekapo Canal

Tekapo B Power Station

Ohau B Power Station

Lake Ruataniwha

Ohau River Bridge

Aviemore Power Station

Waitaki Power Station

Oamaru Water Race

Oamaru Opera House

Moeraki Boulders

Dunedin – 17 November

The British group's special pre-conference tour

By Rob Aspden

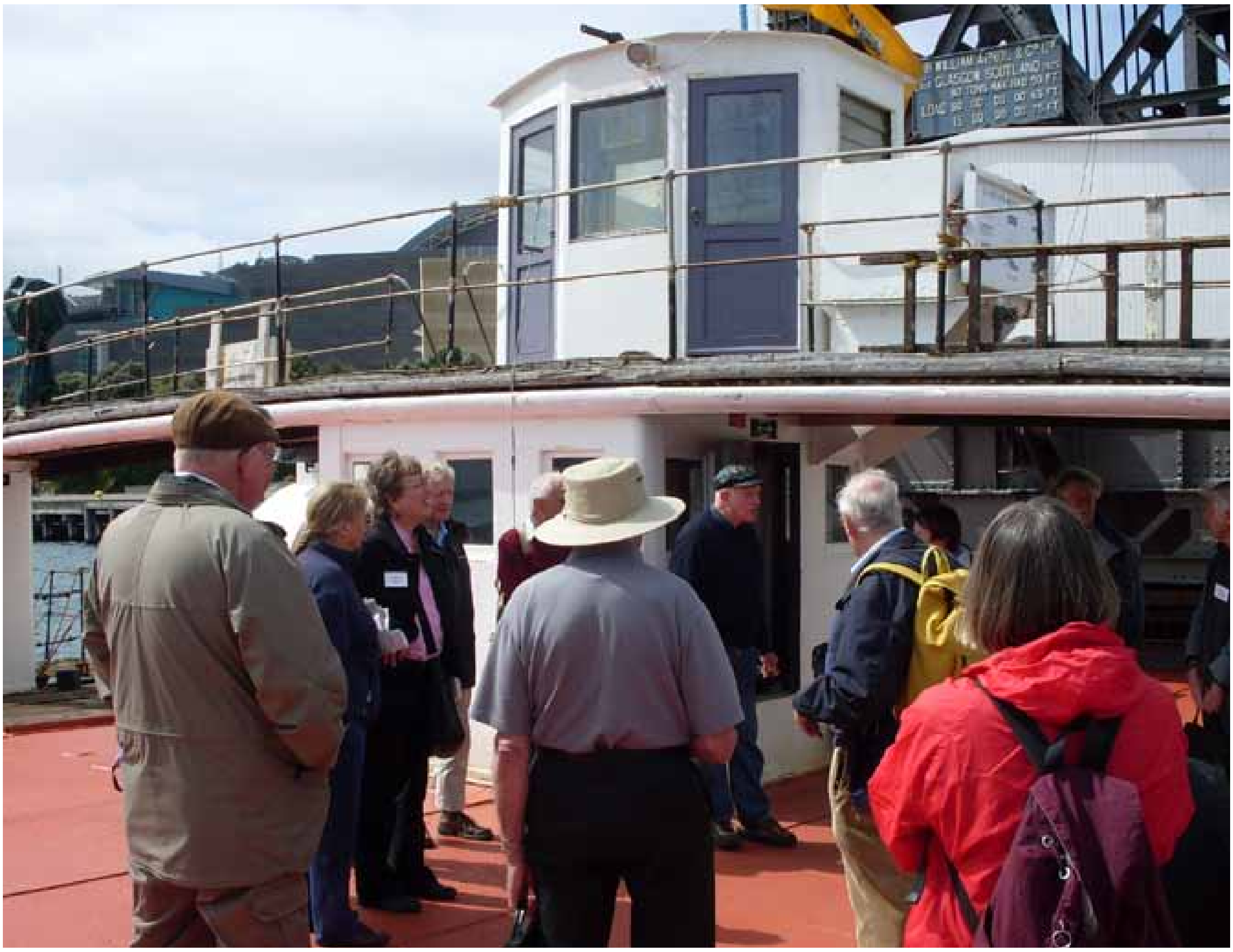
Before each Australian (or Australasian) engineering heritage conference, a group from the Newcomen Society of the Association for Industrial Archaeology in Britain use the opportunity to tour a wider area than that provided by the conference-organised pre-conference tour. This is why, prior to the Australasian conference in Dunedin we were joined by a group of 16 enthusiasts from Britain and Ireland willing to undertake a whistle-stop tour of a selection of engineering heritage sites between Auckland and Dunedin. John La Roche and I helped Paul Saulter, the leader from Britain, to organise these visits.

John La Roche greeted the visitors in Auckland when they arrived on 3 November. He hosted their time in Auckland, and then for four days through the North Island (see the details of trip below) down to Paekakariki. This was where I joined the party and took over as host.

A day in Wellington followed before crossing to the South Island. (Most of the party opted for the sometimes challenging Cook Strait crossing followed by the Transcoastal train trip to Christchurch). After a day in Christchurch, we had another four day stint across to Greymouth, down the West Coast, through the Haast Pass to the Mackenzie Country and on to Dunedin. The second panel includes the details of this trip.

It was an exhausting schedule, but one which the group seemed to enjoy. They were even ready after a day in Dunedin to join the conference organised tour around central Otago!

A copy of the detailed report Dr Fred Barker, one of the British team, produced for *IA News*, (the newsletter of the Association for Industrial Archaeology) can be provided for anyone interested. However I thought that it was worth duplicating a section of his report that dealt with a little known piece of engineering heritage - the Oamaru Water Race. (Apologies to Fred for one or two minor additions I inserted and grateful thanks to Bruce Comfort for his enthusiastic guidance.)



The pre-tour tour group visiting the Hikitia.

A surprising find – the Oamaru Water Race

On the final day of the tour we travelled down the Waitaki valley and after a brief visit to Waitaki dam proceeded next to Bortons (blink and you miss it) to meet local enthusiast Bruce Comfort at a "raceman's" cottage on the route of the former water supply to Oamaru.

Until 1880 the town obtained its water from wells, springs and an unreliable stream which ran along the main street. In 1875 it was decided, after much debate, to build a gravity-driven water race with an intake on the Waitaki River at 126 metres above sea level to feed water to a reservoir at 96 metres at Ardgowan, close to the town. The average gradient was one in 3964; the length was 47 kilometres, the width two metres and the depth one metre. There were five tunnels of combined length 2.7 kilometres and 19 timber aqueducts with a combined length of 1.4 kilometres.

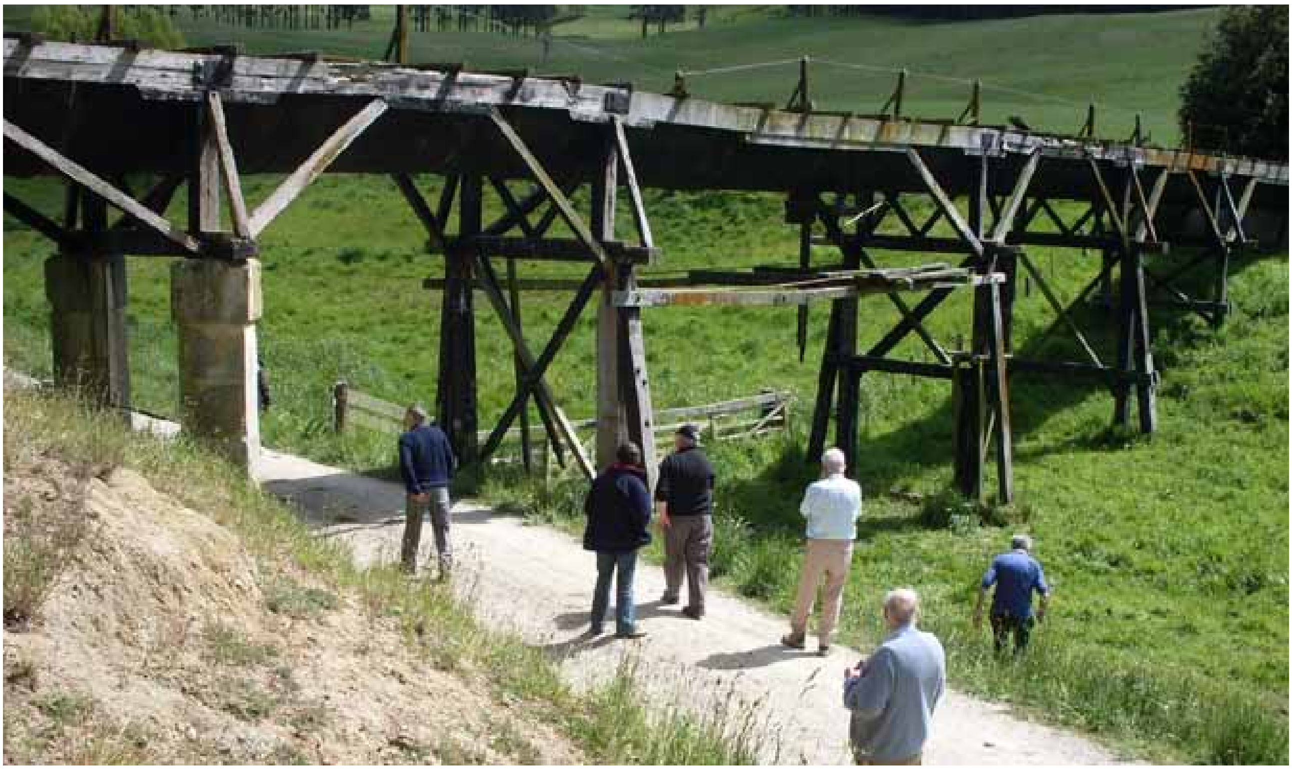
A team of about seven racemen lived in small houses along the race and mended fences and kept the banks clear. The race was emptied every Wednesday for cleaning and repair. When the race was ready in 1880 it had cost the sum of £136,000 which was a drain on public funds for 20 years, but it served the town for 103 years. The high pressure of the water from the town reservoir was used to run private and public water engines and generators, and for a time Oamaru had more electric lights than London.

Since closure of the race all the land which it crosses has reverted to private ownership. Some parts are visible from the roads and footpaths, and we were able to examine an aqueduct close up (of which the wooden trough had been replaced with steel in the 1920's) and saw one or two more from a distance.

The Bortons raceman's cottage has been restored. (For the record, the designer and latterly, construction supervisor, of this very enterprising scheme was Donald McLeod who was involved in other significant works in the South Island – refer to Furkert's *Early New Zealand Engineers*, p 217).

On reaching Oamaru we went to the Opera House, itself one of many attractive buildings. There we were shown a large collection of the original drawings for the race, which had been done in red and black ink on linen. Apart from those whose land is crossed by the race, it is largely unknown even locally, so it is to be hoped that some of its features can preserved.

Bruce was an enormously enthusiastic and knowledgeable guide and we hope that his great efforts on behalf of this remarkable piece of Victorian engineering will be fruitful.



The pre-tour tour group at one of the aqueducts on the Oamaru Water Race.

Pre-Conference Tour

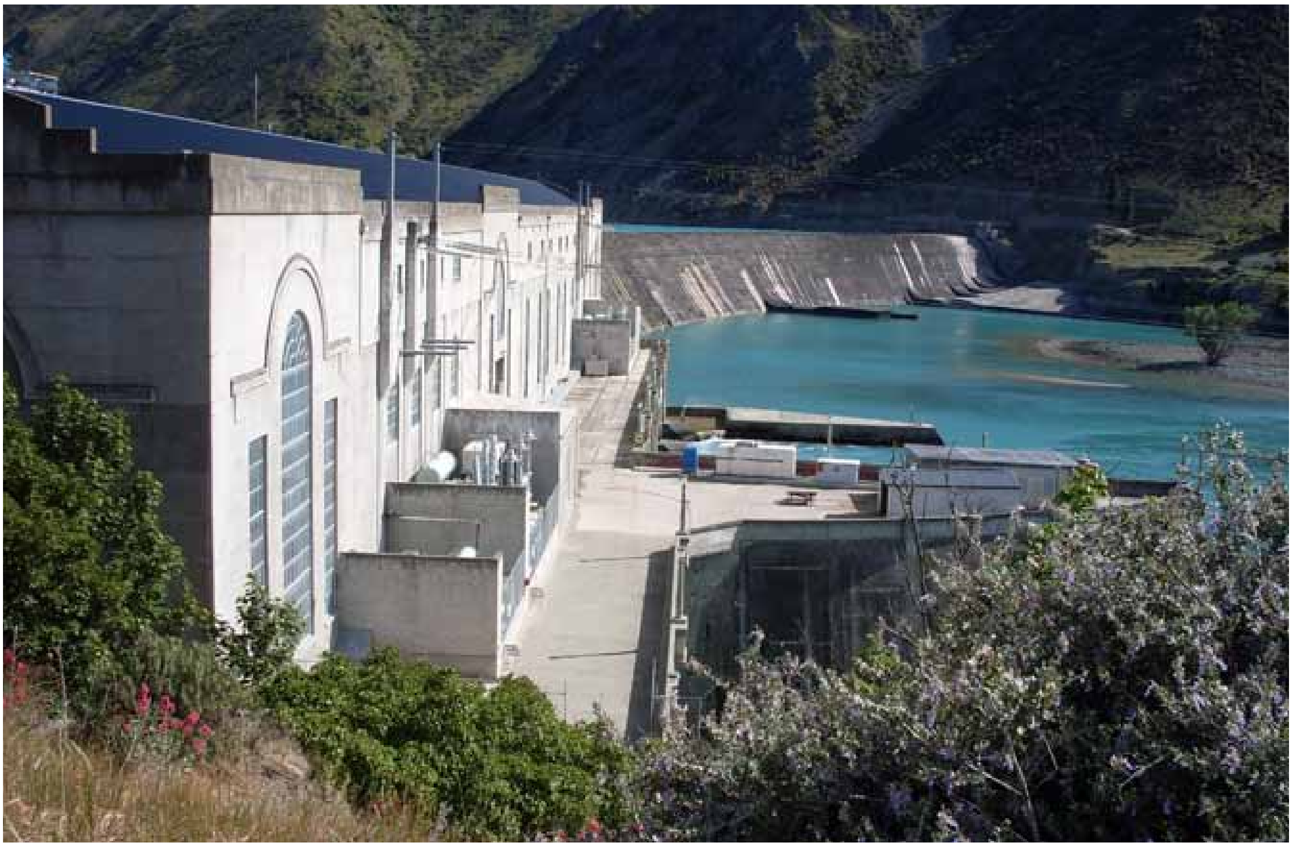
A four day tour by 46 delegates with their two guides departed Dunedin for an exploration of Otago's heritage and tourist sites, including the North Otago and Oamaru heritage and harbour areas.

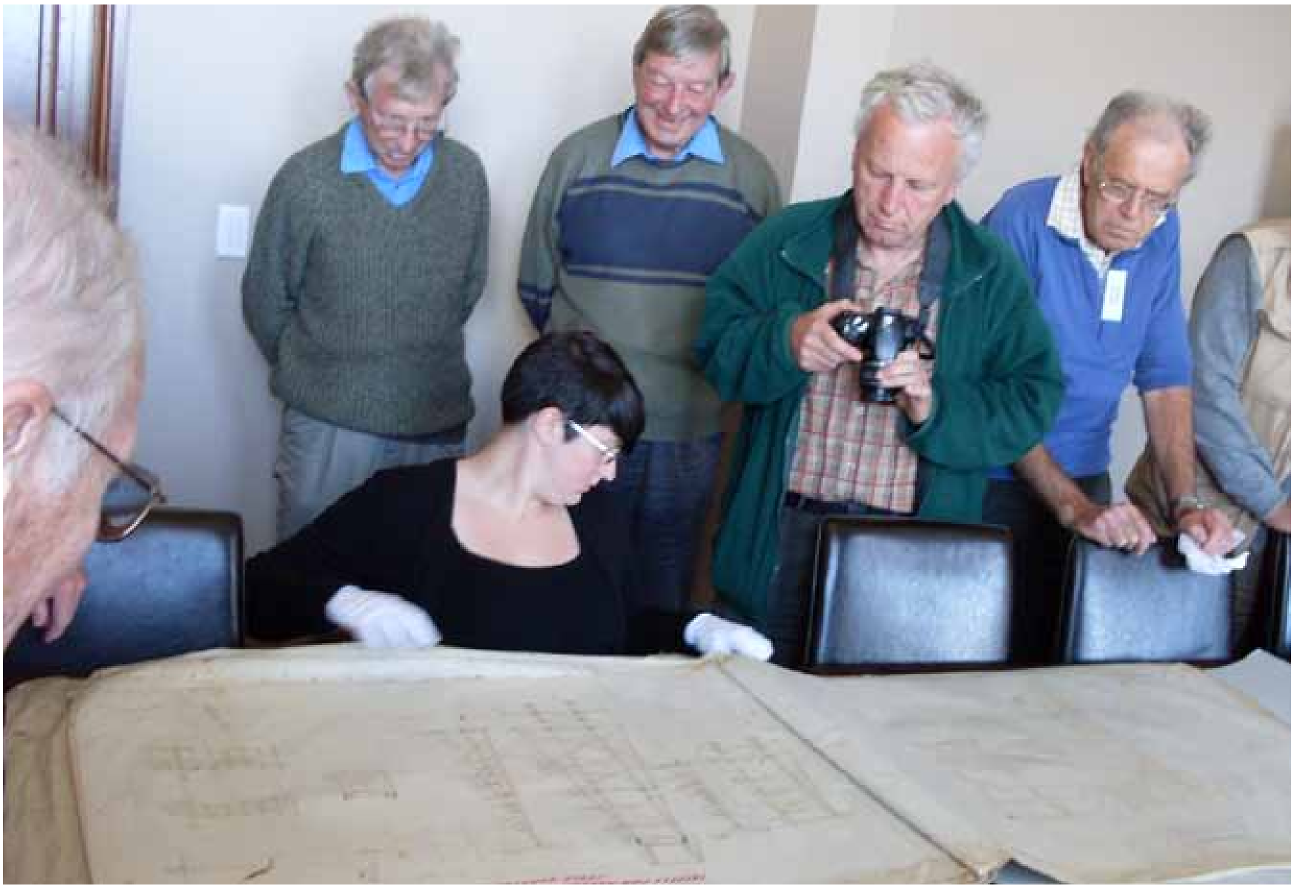
The group continued via the Waitaki valley to the Benmore hydro-electric power station and the high voltage direct current link station.

Wanaka, Queenstown and Cromwell provided visits to several heritage sites and an excursion on Lake Wakatipu's historic steamship, TSS Earnslaw.

The last day included visits to Alexandra Museum's gold dredging displays and to Hayes Engineering Works, before the final stage on the Taieri Gorge Railway train back to Dunedin.

Waitaki Construction (clockwise from above right) in 1929, 1932 and in 2009.





The pre-tour tour group at the Oamaru Opera House being shown the old drawings of the race.

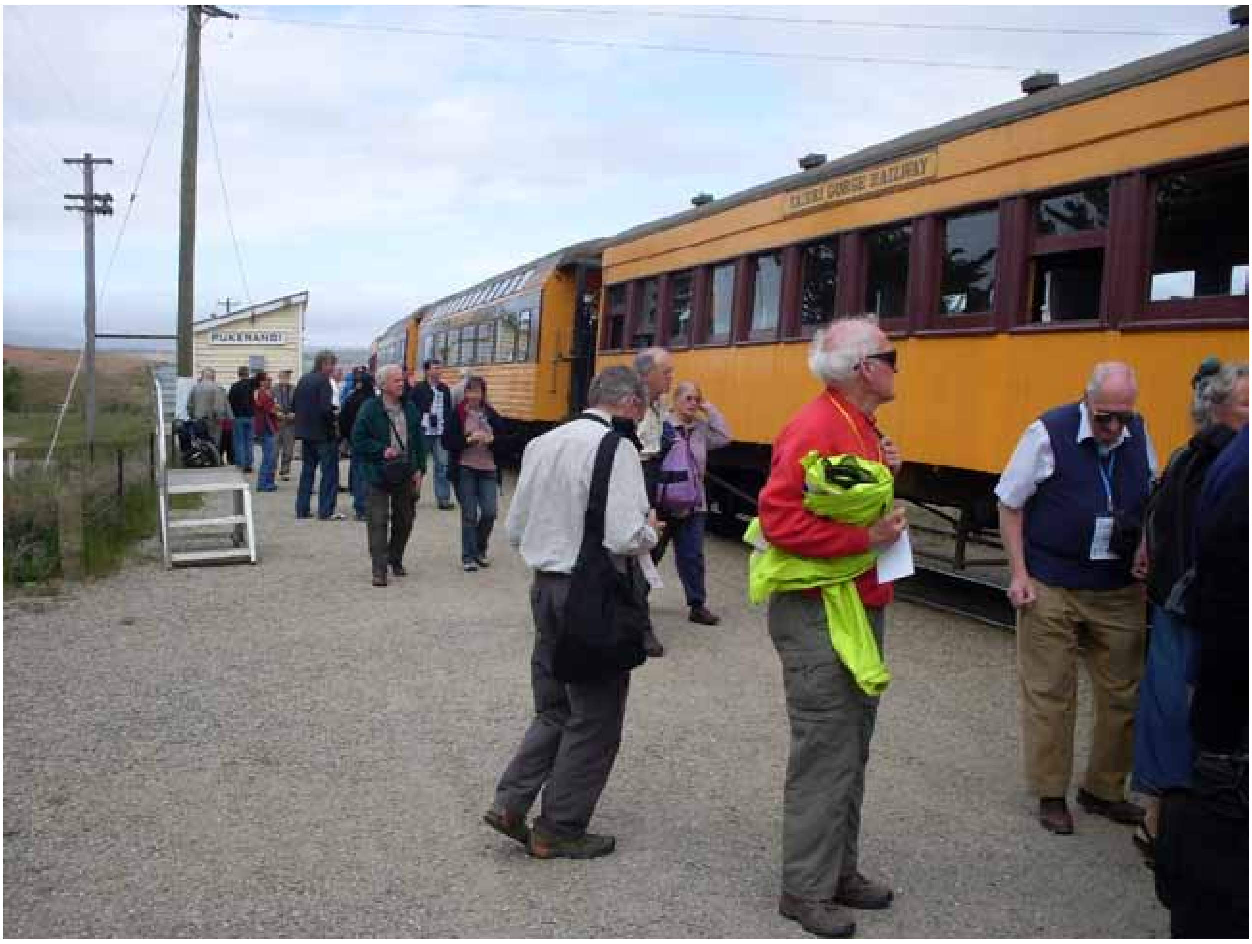
Other conference events:

- **Local tours:** Ross Creek Reservoir, Dunedin Gasworks Museum and Ocean Beach Railway. Dunedin's Engineering Heritage guided walk, Otago Peninsula, Taiaroa Head fortifications and Armstrong Disappearing Gun.
- **Exhibitions/displays:** Otago Settlers Museum, Hocken Library, Archives New Zealand and Otago Museum.
- **Public Lecture and Medal Presentation:** lecture by Sir Neil Cossons at Otago Museum - 'Preserving the Genius of Engineering'. This evening was co-hosted with the New Zealand Historic Places Trust, and included the presentation of the David Cox Memorial Awards. These recognise and encourage excellence in the restoration, conservation and continued use of buildings and structures in Otago.
- **Presentation of the John Pollard Award (IPENZ Engineering Heritage):** for best paper presentation at the conference to Owen Peake, *'The History of High Voltage Direct Current Transmission'*.
- **Presentation of the Colin Crisp Awards (Engineering Heritage Australia):** In the project division, to the Museum of Transport and Technology (MOTAT), Auckland, New Zealand, for the restoration of the Western Springs Double Woolf Compound Beam Pumping Engine. In the books and publications division, awarded to the Water Corporation of Western Australia and the National Trust of Australia (Western Australia), for *River of Steel*, a book by Richard Hartley. A Highly Commended award in the projects division was given to the Historic Houses Trust of New South Wales for the reconstruction of a water tank at the historic house "Meroogal", Nowra, New South Wales.
- **Plaque unveiling at Middlemarch:** recognising engineering of the Otago Central Railway. Unveiling of an historic panel, to be located at Totara Estate in recognition of refrigeration engineering and the development of frozen meat export from New Zealand.

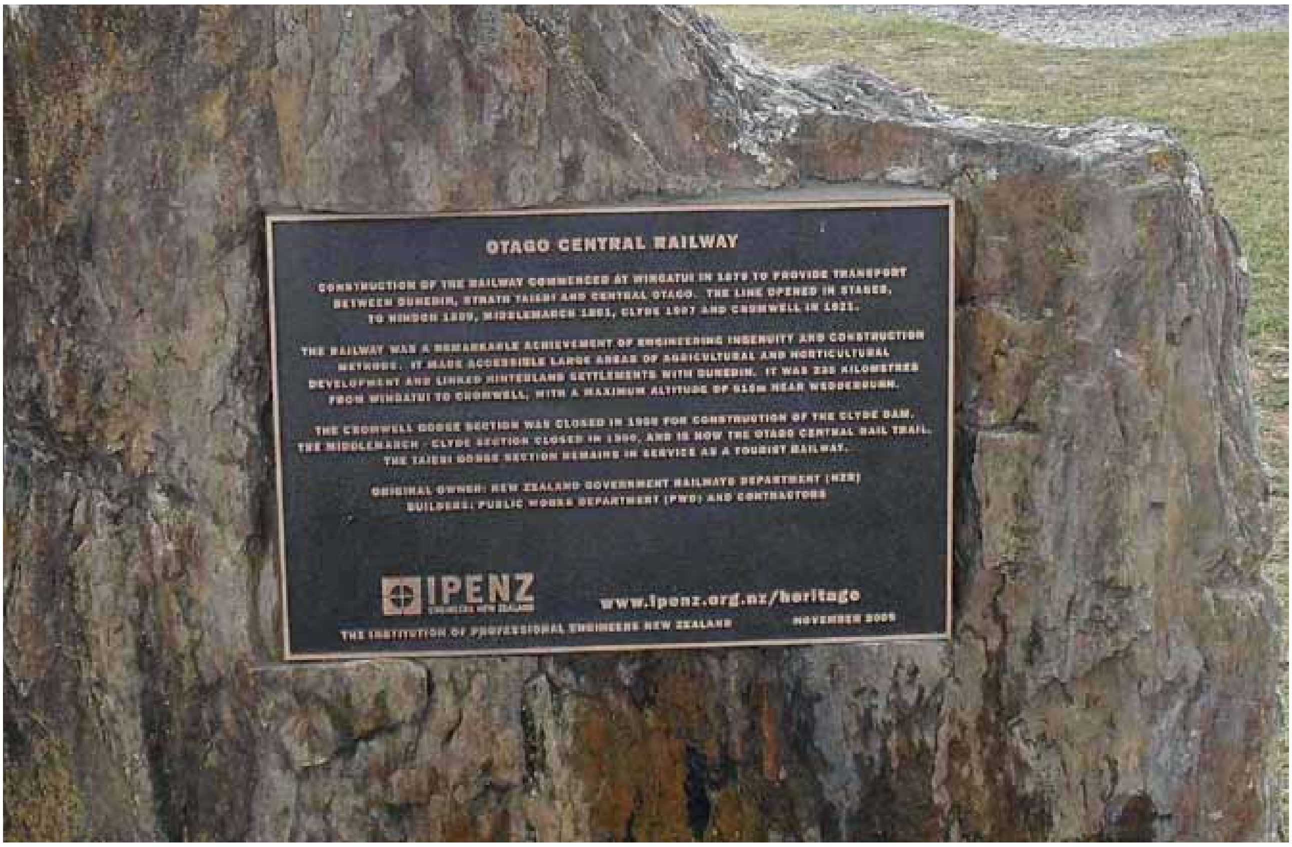
The support of many sponsors, the University of Otago History Department, IPENZ staff, the organising team and helpers in Dunedin contributed to a very successful conference.

The next engineering heritage conference will be in Hobart, Tasmania, November 2011, hosted by Engineering Heritage Australia.

www.engineersaustralia.org.au/groups/engineering-heritage/engineering-heritage_home.cfm



Above: Conference attendees enjoying the Taieri George Railway trip.
Below: The Taieri Gorge Railway plaque that was unveiled at Middlemarch.



Hauraki Gold Mining

By John La Roche

The lure of finding gold caused large migrations of people. Auckland's population between 1847 and 1848 slumped from 3,746 to 2,813 because of a gold rush to California in 1848, and people left again when there was a rush to Bathurst, Australia in 1851. The 1861 discovery of gold in Otago caused the population of Dunedin to surge from 2,000 in 1860 to 20,000 in 1864, while the population of Otago swelled to 64,000 people. Dunedin became the largest and most prosperous city in the country at that time. Gold created significant wealth not only for some of the miners, but also for nearby cities and towns.

As a country New Zealand benefitted enormously from gold discoveries. Karangahake mines and Waihi's Matha mine in particular have produced over 1400 tonnes of gold. The Matha Mine continues to produce about 2.8 tonnes of gold and about 22 tonnes of silver per year.

Fourteen of Auckland's leading businessmen concerned about the number of people leaving for the Australian goldfields in 1852, offered a reward of £500 to anyone who could find a payable goldfield between latitude 35º and 40º south (Auckland) and latitude 38º south (Rotorua). A few weeks after the reward was offered, Charles Ring, a sawmiller who had experience of prospecting in California, found gold in the banks of the Coromandel stream now known as Driving Creek. Rumour spread quickly and within a month 300 miners had arrived in Coromandel hoping to find gold.

Concerned Maori land owners promptly negotiated a payment of £600 from the Lieutenant Governor of New Zealand, Colonel R H Wynyard. The agreement was to permit access for up to 500 miners. Mining licences at 30 shillings per month were then made available. However, the alluvial gold miners were hoping to find was soon exhausted and within a few months most had left, with only 50 miners taking out licenses. Most of the Coromandel gold later discovered was contained within underground quartz reef deposits. In 1859 Provincial Surveyor, Charles Heaphy with geologists Ferdinand Hochstetter and Julius Von Haast, visited Coromandel and expressed the opinion that exploitable gold fields could be found. By April 1862, following Otago gold discoveries, there was fresh interest in Coromandel goldfields and 248 miners had returned.

In August 1867 more gold was discovered in the Kuranui stream near Thames and four months later there were 5,000 men working in the surrounding hills. One year later the population of Thames, then known as Grahamstown, had surged to 18,000 people. Initially Maori owners of the Ohinemuri area near Paeroa would not allow prospecting. But by March 1875 after careful persuasion by the Commissioner of Crown Lands, James Mackay, Ohinemuri was formally declared a goldfield. Over 900 miners soon arrived and began pegging claims around Karangahake Mountain. Like the earlier Coromandel rush, it was not long before the easy alluvial gold in the Karangahake region was worked out and the area became almost deserted until gold bearing quartz reefs were found in 1882. The problem was that the cost of machinery to crush the gold bearing rocks was beyond the financial capacity of most miners in the early gold rushes. Companies with financial resources had to be established to purchase and operate the crushers and gold extraction equipment. There was much speculative investment and many companies failed after not making the expected profits.

Gold-bearing quartz reefs in the region were formed over many millions of years after volcanic activity. When super-heated, mineralised water under pressure rises to the surface along fault lines and fissures, and gold, silver and other minerals are deposited in quartz reefs. The width of a reef can be highly variable from a few centimetres to 50 metres. A reef could extend down to 700 metres or more, although in the early years, mining below 300 metres became very expensive because of the high cost of pumping to remove water from such a depth.

William Errington, who designed the Western Springs beam pumps for Auckland's water supply in 1874, had earlier designed and supervised the installation and operation of the steam operated "Big Pump" at the Queen of Beauty mine in Thames This pump, with a 600 millimetre diameter bore, pumped water from a depth of 314 metres. The cost of the 280 tonnes of coal used per month was so great that the government was asked to pay a subsidy towards the operation. A second "Big Pump" built by A and G Price in Thames was installed in 1895 to raise 13.5 cubic metres per minute from a depth of 609 metres.

The extraction of gold mined from quartz reefs was a difficult process. Picks, shovels and explosives were used inside the mine to break up the quartz reefs, called "stopes", for removal. "Shot" holes drilled in the rock using a 25 millimetre diameter drill and hammers were required for placing the explosives. Much skill

was needed to make the drills to the correct hardness and careful tempering in an oil bath was required after sharpening. The quartz was extremely hard, but with a sharp drill and a team of three skilled men, two striking the drill with hammers, while the third turned the drill, a shot hole of up to a metre in length could be cut in a few minutes. Pneumatic drills were not available until 1896. Dynamite, used initially as an explosive, produced poisonous fumes causing headaches for the miners if the ventilation was inadequate. Gelignite used from the 1890s was better, but still required much careful handling.

Extracted ore was shovelled into hand trucks on rails within the mine, before being taken out to the crushers and stamper batteries. Prior to entering the stamper, the ore had to be crushed to less that 60 mm size. Stamper batteries were usually made up in sets of five stamps with up to 100 stamps to make up a battery. Within the set each stamp, a vertical steel rod weighing about 570 kilograms was lifted by a rotating cam and dropped through approximately 200 millimetres. Between a cast iron shoe at the end of the rod and a stationery die, the ore was crushed to a fine powder. To achieve the necessary fineness following stamping, further grinding was often needed in Berdans, cast iron bowls containing rotating grinding weights. The early process utilised amalgamating tables over which the crushed ore was washed. The plates made from Muntz metal (60 per cent copper, 40 per cent zinc) were covered with a thin film of mercury amalgam. The amalgam trapped a portion of the gold and silver from the finely crushed ore. Periodic scraping of the amalgam from the plates recovered the gold and silver, which could then be separated from the mercury in a pressurised, heated retort. The mercury could be recovered for further use, but the amalgamating process could only recover less than 50 per cent of the gold and silver from the ore. When the ore contained pyrites, extra fine grinding and roasting in a furnace was needed to remove the sulphur compounds before being passed to the amalgam plates.

Karangahake in 1889 was the world's first mining operation to use the Cassel patent, MacArthur - Forrest cyanide process, enabling 90 per cent of the gold and 50 per cent of the silver to be recovered. The gold and silver was dissolved in potassium or sodium cyanide solution percolated through the finely ground ore in large vats over several days. Precipitation of the gold and silver from the solution as a black sludge was achieved with zinc shavings. By treating the sludge with acid to remove the zinc, gold and silver were recovered. Bullion bars were made by melting the residue. Electrolytic processes were required to separate and purify the gold and silver.

Much of the cyanide-contaminated sludge ended up in the in the Ohinemuri and Waihou rivers causing loss of Maori fisheries, flooding and navigational problems. Dredging became necessary with the dredged sludge usually being deposited on the river banks. The government responded in 1895 by declaring these waterways "Sludge Canals" allowing the continuing discharge of the sludge and permitting owners with riparian rights along the rivers who suffered damage to claim compensation from the government.

Mining was a huge enterprise requiring large sums of capital expenditure and many significant engineering works. A high priority for the mining companies was to have well trained staff. They needed to keep up with the latest developments around the world and were always endeavouring to develop new and more efficient techniques. William Larnach (who built Larnach Castle) was Minister of Mines from 1885 to 1887. He persuaded the government to establish schools of mines to ensure there were well trained mine managers available. The Thames School of Mines established in 1886 was one of the first of 29 schools established throughout New Zealand at that time. Another school was established at Waihi in 1897, catering for classes of 60 students studying mining, surveying, mathematics, theoretical and practical chemistry, assaying, mineralogy and geology. By this time only six mining schools remained, but the Waihi School of Mines continued until 1947 and the Thames School continued until 1954.

Energy was required to operate pumps, stamping batteries, refining and other equipment. Water power from dams and water races was widely favoured to drive water wheels and/or Pelton wheels to power the stamping batteries and other equipment. In dry weather when there was insufficient water, wood or coal fired boilers and steam engines were necessary. Until electricity was available, dewatering pumps were usually steam powered from wood fired boilers. Shipping coal from Whangarei to Bowentown or Paeroa was difficult, and to transport coal by horse and cart over bad roads before the railway arrived in 1905 was expensive.
In 1899, pumping from 136 metres at Matha mine consumed 1,000 tonnes of firewood per month. The surrounding hills were being rapidly denuded to provide firewood and to fire the ore drying kilns.

The first petroleum oil engine was purchased in 1894 to operate a tube mill plant for grinding ore. When the railway was extended from Paeroa to Waikino and Waihi in 1905, cheaper coal became available. A well designed coal-fired power station using steam turbines coupled to a Brown-Boveri generator producing three phase 550 volt electricity was commissioned at Waihi in that year. Producer-gas engines and a coal fired plant and were installed in 1907 to drive compressors, grinding mills and generate electricity. Initially electricity was used for lighting, pumps and blowers. Low pressure Pelton wheels were also used to generate electricity for some mining operations, supplemented by steam when there was insufficient water. In 1910 the Waihi Mining Company decided to build built the first hydroelectric power station on the Waikato River, 80 kilometres away, at Horahora. Three years later it was producing electricity for the mine. The station was taken over by the government in 1919 and expanded to provide power to Auckland and later to the public in the Thames valley region.

Buildings, bridges, aqueducts, pipelines, railways, drying kilns, heavy machinery and castings were all required to service the mining industry. Local enterprises were established at Thames where Charles Judd opened a foundry in 1869 making stone crushers, berdans, liners and other machinery. Alfred Price had established A & G Price at Onehunga in 1868 and in 1871 opened a Thames branch, making stamper batteries, Pelton wheels, pumps and other machinery. By 1896 its premises had electric lighting from a Pelton wheel powered generator. Even before the Thames branch railway was completed in 1898, A & G Price was manufacturing railway engines. Both Charles Judd and A & G Price have long histories of heavy manufacturing for a wide range of industries throughout New Zealand.

References

Moore, Phil & Ritchie, Neville, *Coromandel Gold A guide to the Historic Goldfields of Coromandel Peninsular*, Dunmore Press, Palmerston North, 1996

Thornton, Geoffrey G, *New Zealand's Industrial Heritage*, A H & A W Reed, Wellington, 1982

McAra, J B, *Gold Mining and Waihi 1878 to 1952*, Martha Press Waihi, 1988

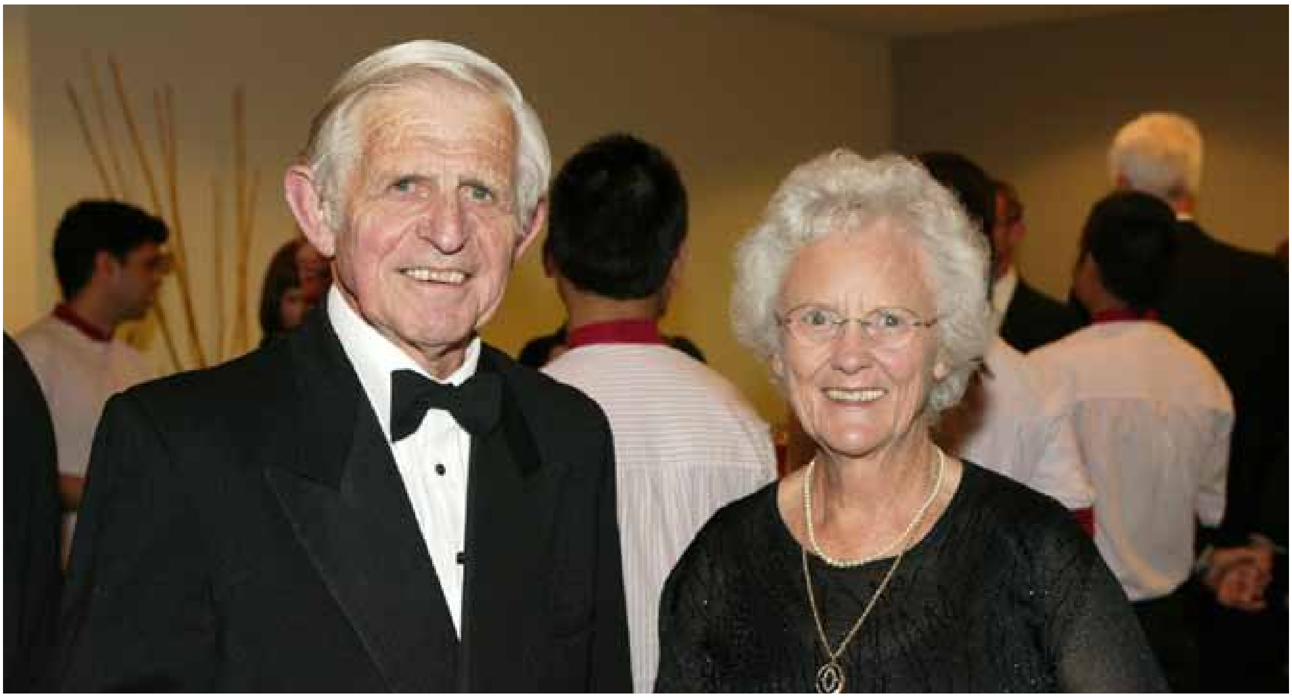
Volume 5 New Zealand's Heritage the making of a nation, Hamlyn House, Sydney, 1971

Wayte, Edward, *The Thames Miners Guide with Maps 1868 Reprinted by Caper Press*, Christchurch, 1975

Williams G J, *Economic Geology of New Zealand*, Monograph Series No 4 The Australasian Institute of Mining and Metallurgy, Victoria, 1974

Law, Garry, Abundance and Constraint, *A Short History of Water Use in New Zealand*, Mauriwi Press 2008

Mace, Tania and Ngati Maru Runanga, *Conservation Plan Thames School of Mines*, Mathews and Matthews Architects Ltd 2006.



Heritage Board member John La Roche and wife Sue at the IPENZ Fellows and Achievers dinner in Auckland.

Wairakei and Geothermal Power Stations

By John La Roche

Geothermal energy is being used to produce electricity at a number of sites in New Zealand. Wairakei Power Station with 181 megawatt maximum capacity, is one of six geothermal power stations now operating or planned in the Taupo volcanic zone. It was the world's first geothermal power station to utilise wet steam bores and was the second geothermal power station to be built in the world, being commissioned in 1958. Much has been learned in the meantime, as other stations have been built with increased efficiency and improved environmental protection. It is planned to phase out the Wairakei Power Station from 2011; it will be replaced by the Te Mihi Geothermal Power Station which will be built nearby using the Wairakei steam bores.

The first geothermal power station was built in 1913 at Larderello in Italy. New Zealand engineers had been interested in the development at Laderello since 1922 and Frederick William Furkert, as Engineer in Chief of the Public Works Department, visited it in 1926, along with other overseas hydro electric schemes. At the request of the Department of Scientific and Industrial Research in 1944, arrangements were made for a close look Lardarello power station after it had been destroyed by Germans in World War II. New Zealand engineers visited it again in 1948 after it had been rebuilt. At that time, New Zealand was facing hydro electric power shortages after two dry years, and planning for Wairakei was starting. Exploratory drilling at Wairakei started in 1950 as a joint venture between the Department of Scientific and Industrial Research, the New Zealand Electricity Department and the Ministry of Works and Development.

There were many unique problems engineers had to overcome at the Wairakei geothermal field. The high temperature geothermal water and steam comes from ground water, heated to temperatures of 200°C to 300°C by shallow reservoirs of molten rock. At Wairakei, the steam and water mixture comes from over 50 wells with an average depth of 650 metres. During the investigation stage scientists had to develop special instruments to measure temperatures of up to 300 degrees centigrade down the pressurised boreholes. Equipment and methods to measure the quantity of steam and water available from each bore also had to be developed. A major achievement was to develop special cyclonic separators to remove hot water from the water - steam mixture emerging from the geothermal bores, a problem not experienced at Larderello. Dry steam is piped away to the power station turbines, while the super-heated hot water is discharged through silencers to the atmosphere where some of it "flashes" into large clouds of steam. Special silencers also had to be developed to reduce noise from discharging bores to an acceptable level.

The deepest bore at Wairakei is 1500 metres while recent bores in other fields have been drilled to 3000 metres.

Wairakei Power Station was built close to the Waikato River to utilise the cold water for cooling. However there have been detrimental environmental effects from the discharge to the river of the geothermal liquids containing arsenic, mercury, lithium and boron. There have been ground subsidence problems associated with the withdrawal of geothermal liquids at Wairakei and elsewhere. It is now recognised that re-injecting waste geothermal water back into the ground helps to replenish the ground water and overcomes the problem of polluting surface waters.

In another development, secondary turbines use pentane, a hydrocarbon with a boiling point of 34 degrees, which is heated by the low pressure exhaust steam from higher pressure turbines.

As a result of the development of geothermal power at Wairakei, New Zealand engineers were able to offer leadership in the design of geothermal power stations in many parts of the world. A Geothermal Institute was established at the University of Auckland in 1979 to train students, many from overseas, in geothermal technology. Geothermal Energy New Zealand Ltd started with help from the Ministry of Works and Department of Scientific and Industrial Research and did a lot of work in Indonesia and round the world. The New Zealand consulting firm Kingston Reynolds Thom and Allardice, now a division of the worldwide consultants Sinclair Knight Mertz, also developed geothermal power stations in El Salvador and Indonesia.

References

Engineering to 1990, IPENZ, 1990, P22

Geothermal Power in NZ Wikipedia www.en.wikipedia.org

Wairakei Geothermal Power Station, Te Ara Encyclopaedia of NZ www.teara.govt.nz

Bolton, Richard S. *The Early History of Wairakei (with brief notes on some unforeseen outcomes*, Geothermics International Journal of Geothermal Research and its Applications, V36, No 1, March 2009.

Some Interesting Reading

Hapuawhenua Viaduct

Over the last couple of years the Tongariro/Taupo Conservancy has been working on the restoration of the historic Hapuawhenua Viaduct in Ohakune. The restoration is now practically finished, thanks to the hard work of DOC staff and volunteers from the Tongariro Natural History Society.

www.doc.govt.nz/conservation/historic/docs-heritage-work/2009/hapuawhenua-viaduct

The Tower of Hercules

The World Heritage Committee, chaired by María Jesús San Segundo, the Ambassador and Permanent Delegate of Spain to UNESCO, has inscribed a Spanish lighthouse dating back to antiquity, The Tower of Hercules in La Coruña.

www.whc.unesco.org/en/news/532/

The Vintage Aviator: Oberursel Reproduction

Locating plans or enough reference to build decent copies of WW1 aircraft is hard enough, but it's even more frustrating if the information exists but the correct engine doesn't. Sometimes it means that a more recent engine is substituted. This can be a good solution if you want to end up with an aircraft that is reliable and can be maintained without too much trouble.

www.thevintageaviator.co.nz/projects/oberursel-engine/oberursel-ur-ii-rotary-engine-build-history

Exercise your brain cells

Try the 'Feats of Engineering' puzzles on the Science Channel website.

http://science.discovery.com/puzzles/feats-engineering/feats-engineering.html

Newfoundland Fisheries Heritage

The Heritage Foundation of Newfoundland and Labrador Fisheries Heritage Preservation Program is designed preserve fishing stages, stores and structures. These places are especially vulnerable to the forces of time and nature. In the days of a declining fishing industry, it is important that they are preserved to stand as testaments to our rural way of life.

http://www.fisheriesheritage.ca/heritageFoundation.asp
http://www.shardlondonbridge.com