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Cover Images:

Front – Hydro Tasmania's Gordon Dam on Lake Gordon, Sept 2012.
Photo courtesy Hydro Tasmania

Back – Melbourne's Spotswood Sewage Pumping Station viewed from the Westgate Bridge in May 1985
Photo M. Doring.

This is a quarterly magazine covering stories and news items about engineering and industrial heritage in Australia and elsewhere. It is published online as a downloadable PDF document for readers to view on screen or print their own copies. EA members and non-members on the EHA emailing lists will receive emails notifying them of new issues with a link to the relevant Engineers Australia website page.

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Editorial – Water, Water Everywhere!

This issue of the magazine is mainly about Water. Things in water, things on water, things done with water, things made with water, and ways to use water. Water is stored, enjoyed, pumped, piped, used to make electricity, carries sewage, floats boats, and is the last resting place for a sunken submarine. Lake Burley Griffin in Canberra is an ornamental lake, enjoyed for boating and picnicking and just for the pleasure of looking at it, but it serves other, more prosaic purposes in environment protection and flood control.

Submarine AE2 played an heroic part in the Gallipoli Campaign in WW1, and it is now being explored, inside and out, with ROVs [remotely operated (underwater) vehicles], where it lies on the bottom of the Marmora Sea. Steam Tug Forceful, which worked the Port of Brisbane, is 90 years old but still going strong, and is a floating feature of the Queensland Maritime Museum, having retired from pushing big ships around in 1970.

There are two stories about turning the energy from water into electricity – one is set in the northern NSW Municipality of Mullumbimby, which decided to make its own electricity in the 1920s – one is about the Centenary of Hydro Tasmania, which happened in 2014. Two water supply schemes feature, one in Hong Kong, dating back to the 1880s, and Perth's first water supply scheme in WA, which was officially opened in 1891. And the last, but in no way least water story, is an account of the great Melbourne Sewerage Scheme, centred on the wonderful Spotswood Pumping Station, which brought health and salubrious air to Marvellous Melbourne when it opened in 1896-98.

In addition to water stories, Miles Pierce wrote us a review of the new book *The Innovators*, by Walter Isaacson, about the history of computing, from Charles Babbage in the 1820s to the times of the Internet. And some housekeeping items include: a "Call for Abstracts", opening on 30th March, for the 18th Australian Engineering Heritage Conference, to be held in Newcastle NSW next December; a notice about the now available revised Engineering Heritage and Conservation Guidelines of Engineering Heritage Australia; and a note about the Engineers Australia web pages commemorating WW1.

Water engineering and water engineers have been with us for millennia. Think of the men in Egypt who learnt to harness the Nile floods to irrigate their crops and feed the population. Stone-built fish traps were being built in rivers and along the coasts of Australia by Aboriginal people, probably even longer ago than the floods of the Nile were being controlled. Engineers in the hot and arid regions of Persia developed Qanats around 500BC. These were a sophisticated system of wells and tunnels used for collecting, moving and distributing mainly underground water, without evaporation losses, for use in irrigation and town supplies. At the same time the Chinese were building dams on streams and rivers and diverting the water into canals for irrigation. The canals got bigger and longer until they could be used with ships and barges to transport goods. Then it became necessary to find some means of changing levels, and locks were invented.

Around 300 BC the Romans built the first of many aqueducts, through tunnels and across valleys, to bring clean water to cities in many parts of their Empire. They were building canals too, and the first canals in Britain were built by the Romans, mainly for irrigation or drainage. The first navigation canals in Britain were built (or dug) in the 16th Century, and they rapidly became the principal means to move goods around the country. Pumps that could move water uphill became practical when steam engines were invented in the 18th Century, and the steam engines opened up a wealth of new ways to use water. In eastern Australia in the 19th Century, coastal steam ships, and paddle steamers on the major rivers, took the place of canals, until steam locos on railways penetrated the inland. Burning coal produced the steam to make 90% of our electricity (when that was invented – or discovered) but early on, in the few regions of Australia with abundant water, it was used directly to produce electricity – as in Tasmania and Mullumbimby.

I have spent a significant part of my life in places where we had to supply our own power and water, and both were scarce and became a very much discussed part of life. On one farm, we pumped water, with a big old Ronaldson Tippet engine with a huge flywheel, two miles from the river to four huge tanks in a tall stand near the house. At our next farm, we used Tilley kerosene lamps for light and the water came from a deep well in alluvial gravels, and was again pumped a mile or so to the house and dairy. Then we had another farm, on the Murray arm of the Hume Weir – one of the great storage dams, where I could swim for hours among the dead trees that had been standing in water there since 1930 – when there wasn't a drought. There was no power or piped water there either. We used Hurricane lamps and a tiny tank of water from the shed roof. Dad was fascinated by water and electricity, and he took us to see the construction works happening on the Eildon Dam, and the Hydro-electric construction works at Kiewa, and Australia's famous Snowy Hydro-electric Scheme when it was just getting underway.

When finally, many years later, I got to live in Rome for a time, I was gob-smacked – first by the abundance of water everywhere – next by the profligate way it was thrown around, in fountains in every square, and running taps in every street, and lastly by the incredibly inefficient way it was distributed to the customers. It was as if they still expected everyone to cart their water from the nearest street fountain in wooden buckets – as they had in the Middle Ages. They weren't much more efficient with the electricity supply either! However someone suggested I read H.V. Morton's *The Waters of Rome* – and I did (I found it in a secondhand bookshop near the Vatican) and all was forgiven.

Does all this explain my interest in ways of using water? I don't know, but it probably explains why I have collected many water stories. Expect quite a few more in future issues.

The Editor

Newcastle on Hunter was our first colonial settlement outside Sydney and quickly grew into being one of the major wealth generators in Australia. It was the origin of the first Australian exports and is now the largest tonnage export port in the country. It is an ideal city to contemplate the ways in which engineering has contributed and continues to contribute to the economic and social development of Australia since its founding as a convict settlement in 1788. Newcastle built its early success on technology imported mainly from Britain – early technology transfer will be a significant theme of the conference.

The conference venue is the Newcastle Museum which is the site of some significant engineering heritage exhibits, such as the fish-belly rail with established 1826 provenance (from Australia's first commercial coal mine and railway), and the world's only working rope-driven gantry crane (made by Craven Bros, England, in 1885).

To introduce the varied themes proposed for the conference, a pre-conference tour will start at Sydney's Central Station, include a descent on the world's steepest cable railway, take in parts of the World Heritage Great North Road and visit many other sites of outstanding engineering heritage value. They include Aboriginal works, 19th and 21st century coal mines, a Fresnel solar array power booster for a power station, and a medley of 19th century timber truss bridges. The tour ends in Newcastle for the conference reception.

Call for abstracts – opens 30th March 2015 : The conference will cover a wide range of topics. Papers are invited about subjects of engineering heritage interest and particularly those which relate to the chosen themes.

Primary theme : International Technology Transfer during the Industrial Revolution

Newcastle built its industrial success on technologies imported mainly from Britain. This theme will explore how new and developing countries, such as Australia and New Zealand, adopted and adapted from European countries the engineering technologies that fuelled the Industrial Revolution.

Secondary themes :

Filling in the Gaps – Papers will be accepted that substantially expand our understanding of engineering technologies or individual works of engineering that may have been described at previous engineering heritage conferences.

Exploring the Heritage of New or Unusual Works of Engineering – Had enough of celebrating the heritage of dams, bridges and railways? Can we address the heritage of some of our newer disciples of engineering – say in fields such as computing, medical and space technologies, or industrial engineering?

World War I – 2015 is the centenary of Gallipoli, the battle of WWI which is said to have brought Australia together as a nation. Newcastle is the site of some of the most significant WWI memorabilia in the country and papers relating to the engineering contribution to the war effort will be welcome.

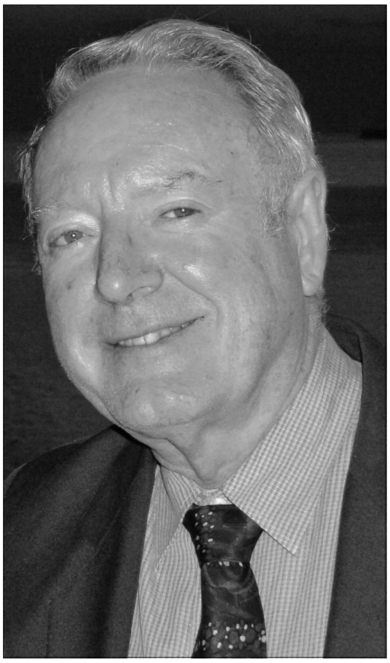
Key Dates :

- Call for abstracts open – 30 March 2015
- Abstract reviews completed – 1 June 2015
- Conference registration opens – 1 May 2015
- Standard registration closes – 1 November 2015
- Pre conference tour – 3 to 7 December 2015
- Abstract submission deadline – 20 April 2015
- Abstract acceptance notification – 8 June 2015
- Early bird registration closes – 1 October 2015
- Late/onsite registration closes – 7 December 2015
- Conference – 7 to 9 December 2015

For more information, go to : https://www.engineersaustralia.org.au/heritage-2015/

The organising committee is sure that those attending the 2015 Engineering Heritage Conference will enjoy the conference, and the historic city of Newcastle. They look forward to meeting you in December 2015.

From the Chair – What is Heritage?



Keith Baker, Chair, EHA.

While recently enjoying a meal with friends, the subject arose of the redevelopment of the public housing complex on Northbourne Avenue, the main transport route into Canberra City from the North. This has become a matter of controversy in Canberra, with the ACT Government wanting to increase the density along the corridor of the proposed light rail line and at the same time modernise the appearance of the main entrance to Canberra from the North. The public housing was built around 50 years ago, was at the time innovative architecture for relocating government staff from Melbourne, and is highly valued by the Institute of Architects, the National Trust and the ACT Heritage Council. A counter view is held by many residents of Canberra that the flats are a rundown eyesore.

My dinner companion was clearly of the view that they weren't heritage and should be demolished, regardless of the heritage protection placed on them by the Heritage Council. Without getting into debate about what should be done with them regarding heritage listing and future use, I felt compelled to argue that they had heritage significance, since heritage does not rely necessarily on age and beauty. It is a common fate of industrial heritage to be condemned on these grounds, so I thought it was worthwhile quoting here the ACT Heritage Council's website on the matter:

However, heritage need not always be old. While history or age is one criterion under which a place or object might be recognised and registered under the Act, there are many other criteria for which a place or object might be recognised as having heritage significance. This includes social, aesthetic, archaeological and architectural significance, which might encompass places and objects which demonstrate technical or creative achievement, certain design qualities, value by the community or a cultural group, is a rare or unique example of its type, or might have a special association with a prominent person or group. Basically, heritage is anything from the (recent or distant) past that we want to keep for current and future generations.
http://www.environment.act.gov.au/heritage/heritage-in-the-act

In assessing the heritage significance of engineering and industrial works, Engineering Heritage Australia uses very similar criteria to those applied by federal, state and territory heritage councils, with just a couple of exceptions. Firstly we are primarily interested in engineering significance rather than architectural, although many architectural works rely on engineering and vice versa. And only some heritage councils are concerned with movable objects, many of which embody important engineering innovation.

Public Housing Flats in Northbourne Avenue, Canberra. Source unknown.

Part of what EHA has done since its inception in the late 1970s is to identify important engineering works, assess their significance and celebrate their value with their owners and the community at a local or national level. EHA continues with its engineering heritage recognition program, which now also recognises international significance, where the works in question are of international interest or rarity, have involved significant collaboration with other countries, or where Australian engineering innovation has been world leading. The most recent of these was the Humphrey Pump at Cobdogla in the South Australian Riverland (which I wrote about in this magazine after visiting it a year ago), recognised for its international rarity as the only remaining example in the world of this most unusual design still capable of operation.

But EHA is not just involved in heritage recognition, important as that is. Many of our members are directly involved in heritage conservation projects, either as volunteers or as specialist engineering professionals. This may involve endeavouring to rescue works that are under threat, educating our fellow engineers and the public about the importance of heritage, working on machinery restoration and operation, or advising on the safe and economic conservation of structures.

Keith Baker, Chair, EHA.

Lake Burley Griffin on the Molonglo River, Canberra.
Discussing its Heritage Significance

An aerial view of Lake Burley Griffin and the Scrivener Dam. Image courtesy of the National Capital Authority

In an earlier edition of my chair's column I wrote about bridges across Lake Burley Griffin, a part of modern Canberra which has been recognised by EHA for its national engineering heritage significance. It is over 50 years since the lake was "inaugurated" by Sir Robert Menzies, which makes it about the same age as the (notorious?) Northbourne flats. But judging by the crowds along its shores for events each year like Floriade and for the recent Enlighten festival, it is more universally popular.

Two views of Lake Burley Griffin and the EA plaque, photographed by Keith Baker in August 2005.

In 2001 when the Lake Burley Griffin Scheme was recognised by EHA, the 37 year old water feature may not have been an obvious candidate for a National Engineering Landmark award, but this was based on some serious background research and analysis. In the mid 1990s, with funding from the Australian Heritage Commission (AHC), Engineers Australia and the Australian Committee on Large Dams undertook the first nation-wide survey of heritage dams, resulting in the selection of the 26 dams considered most worthy of nomination for listing on the Register of the National Estate. This thematic survey was followed by a 1999 report to the AHC, and an engineering heritage conference paper presented by dams engineers Bruce Cole from Tasmania and Tony Moulds from Western Australia and heritage consultant Lenore Coltheart, in which Scrivener Dam, which forms Lake Burley Griffin, was rated number 5 in Australia for its heritage values.

The Scrivener Dam, Canberra. From a photo by Scott George.

Scrivener Dam was subsequently nominated to the Register of the National Estate, and based on this work and other documents by the National Capital Development Commission, the Lake Burley Griffin Scheme was proposed by Canberra Division of EA as a National Engineering Landmark. This was recognised in 2001 as part of the Centenary of Federation celebrations. The lake, formed by Scrivener Dam and bridged at Commonwealth and Kings Avenues, was plaqued as a major engineering contribution to the Australian seat of government and an outstanding aesthetic setting for national buildings and public social and recreational activities.

The nomination prepared by Byrne Kenny listed a range of significant features including:

- Technological/scientific value as a highly effective application of engineering science which demonstrates measures appropriate to flood control and environment protection land uses for artificial lakes, in addition to being a major public demonstration of high quality engineering solutions to aesthetic and land use needs;
- Historical value as a key feature of the national capital plan adopted soon after federation, and associated with a range of historical figures; and
- Social value as a focus for public events, recreation and tourism.

The full nomination with supporting papers can be viewed where it is archived at:
https://www.engineersaustralia.org.au/portal/system/files/engineering-heritage-australia/nomination-title/Lake_Burley_Griffin_Nomination.pdf

Information about the heritage significance of almost 200 engineering works around Australia can be found on EHA's searchable database which is being progressively updated, see: https://www.engineersaustralia.org.au/heritage/search

Keith Baker

Engineers Australia & World War I

Engineers' stores near ANZAC Cove, 1915

Engineers Australia has established web pages devoted to engineers and engineering in WW1. EA says: *The importance of the contribution made by the engineering profession to WW1 cannot be overstated. This is clearly evidenced by the number of Engineers Australia's founding members, Past Presidents, and Honorary Fellows such as Sir John Butters, Sir Henry Barraclough and Sir John Monash, who served with distinction during World War I.*

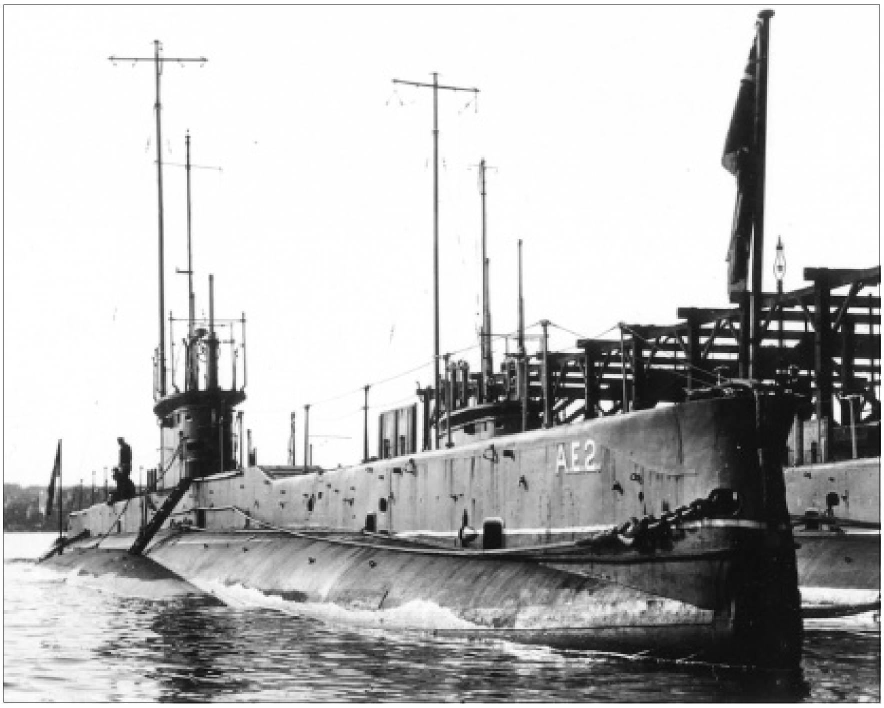
Find lots of information about what is happening and will happen to commemorate the engineering profession's contribution to the war effort at :
https://www.engineersaustralia.org.au/engineering-and-world-war-1

The Exploration of Submarine HMAS AE2

Introduction

AE1 and *AE2* were two E Class British submarines, built in England for the Royal Australian Navy and launched in June 1913. *AE2* was commissioned in February 1914, under the command of Lieutenant Commander Henry Hugh Gordon Dacre Stoker, RN. She had a crew of 35 officers and men some of whom belonged to the Royal Navy and some to the RAN. *AE1* and *AE2* sailed for Australia almost immediately, on 2nd March, under the escort of an RN cruiser as far as Colombo, then *HMS Yarmouth* to Singapore, where the cruiser *HMAS Sydney* took over escort duty to Sydney. It was a long, hot, uncomfortable, and almost calamitous voyage, particularly for *AE2*, which lost a propeller blade en route twice. But she and her crew survived OK and were ready for service when WW1 broke out in August 1914, under three months after their arrival at Garden Island in Sydney.

AE1 and *AE2* joined the naval and military force *assigned to capture the German colonies in New Guinea. Stoker and his crew took part in the seizure of New Britain, culminating in the capture and surrender of Rabaul on 13 September 1914 and the general surrender of the New Guinea territories on 22 September 1914.*[1] Only a few days before this, on patrol between New Britain and New Ireland, *AE1* disappeared with all hands. A search was made, lasting several days, but no trace of *AE1* was found.



AE2, and AE1 behind her, docked at Garden Island, Sydney Harbour, soon after they arrived in Australia from England. Photo RAN

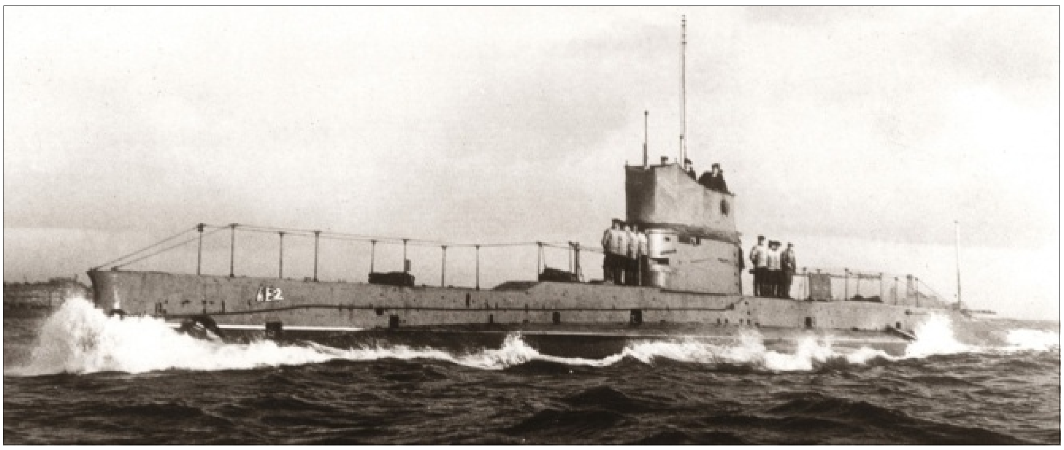
Following a short deployment to Fiji, *AE2* returned to Sydney to be prepared to join the second convoy of transport ships assembling near Albany for departure to Suez, which it did on 31st December 1914. It must have seemed very peculiar to Stoker and his crew, to so soon be enacting a reprisal of their acutely uncomfortable journey to the antipodes, and they must have been very relieved to be soon operating in the cooler Aegean Sea and in support of the Dardanelles campaign.

Stoker's idea, approved by the C-in-C of the Eastern Mediterranean Fleet, was *to attempt to force a passage through the 35 mile long, heavily fortified Dardanelles Strait and enter the Sea of Marmora*,[2] and thus to prevent enemy shipping from supporting Turkish troops on Gallipoli. *AE2* entered the Strait on 25th April 2015.

On the morning of 30th April, somewhere in the sea of Marmora, *AE2* was sighted by an enemy torpedo boat but after having great problems in diving, she was hit and holed in three places.

Stoker ordered all hands on deck and scuttled the ship. He reported: *The boat sank in a few minutes in about 55 fathoms, in approximate position 4 degrees north of Kara Burnu Point at 10:45 am. All hands were picked up by the torpedo boat and no lives lost.*[3] Stoker and his crew spent the rest of the war in a Turkish prison camp, and *AE2* was thought to have been lost forever.

The Editor



AE2 with her crew on board, shortly after commissioning. Photo RAN

1 See http://www.navy.gov.au/hmas-ae2
2 ibid.
3 ibid.

The Exploration of Submarine HMAS AE2

An Account by Archaeologist Tim Smith, Executive Director of Heritage Victoria.

AE2 is one of 57 completed E-type British submarines that served as the backbone of the British submarine force during the First World War. She played a critical role in the Dardanelles offensive by making the first successful penetration of the Turk Bogazlari (Dardanelles Strait) during the opening hours of the ground offensive (25 April 1915).

Although subsequently caught on the surface by Ottoman gunboats, damaged and forced to scuttle (30th April 1915), *AE2* led the first Australian forces into battle, opened up the ensuing Allied submarine campaign and interrupted the flow of supplies and troops to the Çanakkale War [Gallipoli Campaign]. Her successful wireless message to the Allied Commander in Chief considering evacuation on the day after the awful landing at Anzac Koyu (Anzac Cove) may have had a seminal role in the decision to keep the troops ashore, leading to the prolonged eight - month campaign.

The remains of the Australian submarine *AE2* were located in 1998 by Turkish businessman, diver and renowned explorer, Mr. Selçuk Kolay. With the support of an Australian archaeological team headed by Dr Mark Spencer and professional Australian Government Maritime Archaeologist, Mr Tim Smith, the site was confirmed to be *AE2* in September 1998.

In terms of non-disturbance archaeological examinations of submarine wreck sites, Project Silent Anzac is one of the most sophisticated projects underway internationally. The documentation of the physical fabric, both external and internal, the environmental modelling, corrosion assessment and protection activities, installation of site warning systems (surface buoy and tracking), and the extensive educational programs, makes it an exemplar of best practice scientific approaches to the management of a complex submarine site anywhere in the world today.

A number of comparable British E-class submarines have been located by divers, or through remote sensing surveys since the 1998 discovery of the Australian *AE2* site. Inspection of many of these sites has been varied, often the capture of stills and video being the outcome, in lieu of management reports and scientific analysis and documentation and site data. But they provide useful comparative data to *AE2* in terms of E-class hull survival, site formation processes in a range of underwater environments, and unfortunately, in some cases, insights into the dangers of un-regulated site management and protection. Some sister E-class wrecks have, at times, been subject to uncontrolled diver visitation and recovery of internal artefacts.

There has been an international focus particularly on the examination of Great War underwater archaeological sites with the Centenary of the First World War and UNESCO's advocacy of seminal projects like the *AE2* and Project Silent Anzac. Projects like *AE2* were also welcomed in their adherence to and advancement of UNESCO's Convention on the Protection of Underwater Cultural Heritage 2001 principle. The joint Turkish-Australian Project Silent Anzac seeks to preserve the *AE2* submarine as part of the Military heritage of Turkey, Australia and the world, now and into the future.

The 2014 archaeological investigations were developed over a number of years and intended to expand on the scientific data obtained during the last major documentation of the *AE2* site in 2007. Applications were appropriately made to the Government of the Republic of Turkey to obtain requisite archaeological and other approvals, with a formal application report documenting the intended project aims, methodology to be deployed, and the safeguards to be put in place to obtain scientific data and safeguard the site's heritage values. Since its discovery in 1998 and the first archaeological interrogation and significance assessment by the initial *AE2* volunteer team, all archaeological work has sought to build on our knowledge of the *AE2* and to ensure appropriate strategies are in place to protect it. The site project work has been associated with several Government and private workshops to debate long-term management of the site (Istanbul 2002, 2004 and 2008) that identified leaving the wreck in situ in its 1915 battle context, resting in 74 metres of water within the Turkish Sea of Marmora, Turkey.

A major archaeological project was conducted at the site in 2007, headed up by the newly formed *AE2 Commemorative Foundation Ltd*, involving the initial project team and elements of the Submarine Institute of Australia (SIA). The 2007 project completed an extensive assessment of the external condition and an exploratory investigation of the internal spaces of the *AE2* submarine through a Turkish Government approved Maritime Archaeological Assessment (MAA) program. Following the production of the MAA Report and development of an options paper, a joint Australian/Turkish workshop was held in Istanbul in April 2008 that determined that an additional archaeological survey be conducted to determine the condition of the interior spaces, the presence of relics, and to prolong the retention of the site by site protective measures including installation of a cathodic protection system. All activities at the *AE2* submarine site are subject to archaeological permit approval of the Government of the Republic of Turkey.

The Project Silent Anzac 2015 archaeological activities were directed by the author, Director Maritime Archaeology for the project, a professional maritime archaeologist and current Executive Director of Heritage Victoria (Victorian Government), who has been leading the archaeological interventions at *AE2* since its discovery in 1998. The objective of the internal archaeological survey was to collect a comprehensive internal archaeological and environmental record of the interior of the submarine. The 2014 expedition was designed as a non-disturbance archaeological exercise. The purpose of the internal examination of the hull was to identify its condition, historic layout, to document key features, and to assess the existence, condition and spatial extent of any observable archaeological relics. As stated, the internal exploration of the *AE2* hull is proposed by:

1. Initial static drop camera inserted through the conning tower opening;
2. Insertion of a larger drop camera and instrumentation probe once the hatch has been opened, followed by;
3. An internal "swim through" ROV [remotely operated (underwater) vehicle] survey through the hull. The ROV has the unique ability of penetrating areas of hull that will never be reached by the human eye.

The multi-disciplinary expedition was completed over 10 days in June 2014 and the findings are shortly to be presented at an international conference at the Naval Museum in Istanbul, Turkey immediately prior to Anzac Day 2015. The project team succeeded in inserting a variety of instruments into the pristine interior of *AE2* and documented the complex nature of the conning tower, helms, the control room, periscopes, main and auxiliary electrical switchboards, the officers quarters with wonderfully preserved timber cabinetry, the forward single torpedo room, and the amidships twin beam torpedo tube area.

Throughout the interior, the level of preservation of fixtures, fittings and moveable objects was spectacular. The ongoing assessment of the machinery, gauges, instrumentation, and interpretation of former uses of a broad range of specialised equipment has enabled a unique insight to be gained on the technology employed in this 1913-era British submarine type. Importantly, the investigation of the interior spaces has enabled a unique opportunity to tell the story of the brave Australian and British crew who worked *AE2*, their battle to save the craft in its final hours when stricken by Ottoman gunboat Sultan Hissar, and to turn back the pages of time by 100 years and view again the spaces where this important naval history took place.

A comprehensive environmental assessment of the exterior and interior of *AE2* has been undertaken to better understand the long-term corrosion and decay processes at hand. The installation of the world-largest cathodic protection system at the site and surface marker buoy will ensure that *AE2* and its amazing engineering heritage will be preserved for study well into the future. The work could not have been completed without the high-tech engineering solutions delivered by Defence Science and Technology Organisation (DSTO) researchers at Port Melbourne, including their manufacture of high-definition underwater camera systems and environmental data capturing instrumentation.

Details of the engineering insights gained will be the subject of an additional story following the formal presentation of the findings in April. The fuller story of *AE2* and the volunteer *AE2* Commemorative Foundation's involvement in its care, protection and management can be found at: http://ae2.org.au/ and http://www.navy.gov.au/hmas-ae2 .

Maritime Archaeologist Tim Smith,
Executive Director of Heritage Victoria

On the 28th August 2014, the ABC Catalyst programme broadcast AE2 – The Silent ANZAC, a story about the June 2014 expedition.
This can be viewed online as a video, downloaded in mp4 format or read as a transcript. Find it at :
http://www.abc.net.au/catalyst/stories/4075917.htm
from the Editor.

Photo – Tim Smith in Turkey, being interviewed in 2014 by Anja Taylor of the ABC Catalyst programme.

Mullumbimby NSW Hydro-Electricity Scheme

A local council's answer to the need for electricity in a country town.

In the September 2014 issue of this magazine, we published a story about the enterprising Mr Brown, who built a hydro-electric scheme near Batlow in southern NSW in the early 1930s, firstly to service his own timber mill, but soon to provide electricity for the town and its fruit cannery as well. Mullumbimby in northern NSW had a similar need for electricity, but went about it in a different manner and about 10 years earlier than Batlow's Mr Brown. Failing any State Government interest, the Mullumbimby Scheme became a Municipal Council initiative.

Many of the services we take for granted today, in even the remotest areas, were virtually non-existent outside the major cities and big provincial towns of Australia at the beginning of the Twentieth Century. Fresh clean water on tap, sewers to carry the waste away, gas stoves and electric power and lighting could only be dreamed about in most country towns. In Mullumbimby, the government is said to have shown interest in developing a town water supply in 1909 – but this came to nothing. By 1916 the concept of combining a water supply for the town with a hydro-electricity scheme had taken hold. Several surveys were made, but a detailed report contained cost estimates which seemed prohibitive at the time, and the project was shelved.

Jim Brokenshire, in his book *The Brunswick – Another River and its People* tells us: *Serious consideration was given to the proposal over a number of years after that, but it was not until December 1922, that a poll of ratepayers in the Municipality decided by 77 votes to 51, that the proposal should proceed. At the same poll, a suggestion that the project should be passed over to private enterprise was defeated and approval was given for a municipal loan application to provide finance.*

Council were obviously seriously concerned to do this job properly, because the consulting engineer they engaged was the *ne plus ultra* of hydro-electricity experts in Australia. Mr. William Corin, MInstCE, MIEE, MAmerIEE, MIE(Aust), was born in England in 1867 and received his engineering education at University College, London. He worked as a civil engineer at first, but had changed to electrical engineering by 1891, when he joined the London Metropolitan Electric Supply Company.

He migrated to Launceston in Tasmania in 1895, and was appointed City Electrician, just in time to take part in the opening of the Duck Reach Power Station and to control its operation for its first few years. Hydro-electricity became an abiding interest, and he made the preliminary surveys for the Great Lakes Hydro Schemes before moving on to Melbourne and then, in 1907, to become the Chief Electrical Engineer to the NSW Department of Public Works.

Duck Reach Power Station in Tasmania c1900 – this was William Corin's first place of employment in Australia, starting in 1895. Photo G. Dineen

He continued his involvement with hydro-electricity design as the adviser on such schemes to several governments, in Australia and elsewhere. In 1913 he travelled abroad to study new developments in electrical engineering and from 1915 produced a series of reports on Snowy River hydro schemes, culminating in cost estimates of £2 million in 1920. No doubt the lack of action on his ideas led him to resign from the public service in 1923 and set up a consulting practice. It appears one of his first consulting ventures, in December 1923, was the contract to design the Mullumbimby Hydro Scheme.

Corin's previous site explorations and discussions with Council led to a design with a weir built on the Wilson River near Wilson's Creek, at an elevation of about 380 feet above sea level, a water race from the weir running roughly 1000 feet east along a hillside to a tunnel where it plunged about 350 feet under the hill to pop out on the other side, where another short, widened, race formed a pipehead reservoir. From the pipehead, a wood stave pipeline carried the water down to the power station 270 feet below and 1700 feet beyond.

Preliminary work started on the project about July 1924, when Mr Corin engaged a foreman for the weir construction to be done by day labour, and *Four men commenced operations to secure a solid foundation for the concrete dam.*[1] Also, *Surveys on Wilson's Creek for the weir race and tunnel and on the Northern side of Laverty's Gap for the pipe line and Power Station are being carried out by Mr. W. I. Muntz, resident Supervising Engineer for the hydraulic works.*[2] Mr W.I. Muntz was the (civil) engineer to the Byron Shire Council, and was appointed supervising engineer of the hydro scheme.

1 The Richmond River Express , etc. – 18th July 1924

2 Mullumbimby Star – 31 July 1924

At the same time Mr Corin was advertising *for a suitable auxiliary generating set, which can be set to work as soon as available without awaiting the completion of the hydro-electric plant.*[3] It was a long time before this auxiliary (diesel) generating set put in an appearance. They were looking for a second hand machine, but eventually settled on a new 220 h.p. *Mirrlees* diesel from W.J. Spencer & Co.Ltd. of Sydney, direct coupled to a Brush alternator. *The auxiliary set is being put in as a guarantee to the Byron Shire Council, that in case of a drought there will be a continuity of the service, as this set is capable of supplying all the power required.*[4]

The Mullumbimby Hydro-electric Scheme weir on Wilson's Creek. Photo - G. Estcourt.

By November 1924 cement for the weir was on site, a stone crusher was starting work, the sand was being carted to the site, and the works foreman had arrived. In February 1925 there was a setback, when heavy rains washed away timbers at the weir – but the concrete was OK, and the timbers were found and returned.

The weir was completed in May 1925. *Some 230* [cubic] *yards of excavation had to be removed before suitable rock was struck. The weir is 198 feet on the crest, and 26 feet high at the deepest point. It is 4 feet wide at the bottom and 3 feet on the top. The weir is of the arched type, reinforced. In the weir 480 cubic yards of concrete were used......*[5]

The contribution of Mr J. Davidson, Contractor, made it a truly local project. Davidson, an ex Mayor of Mullumbimby, and a former enthusiastic supporter of the hydro-electricity proposals, was engaged to cut a water race from weir to tunnel, and on the other side of the tunnel, to form a concrete-lined shorter race and pipe-head reservoir.

The local paper noted that:

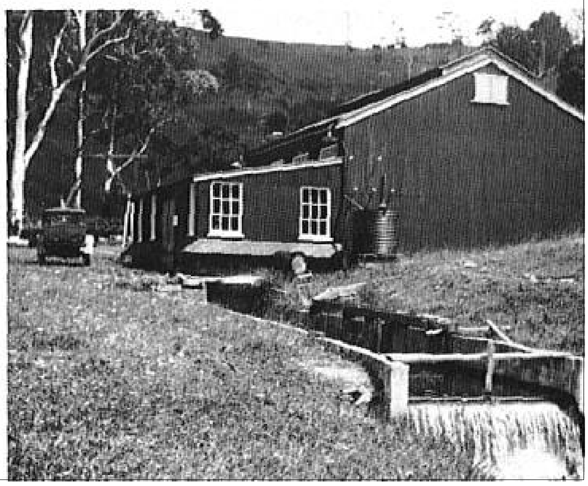
The races were cut by ex-Mayor Davidson and it is a matter of satisfaction to know that part of the work was thus confided to one who had given so much attention and interest to the scheme in its early stages.[6]

Jim Brokenshire, in his book, reproduces a photo of ex-Mayor Davidson hard at work himself, with mattock in hand. The tunnellers were a different local crew. The same newspaper article pays tribute as: *The greatest credit is due to Mr. Glock and his associates, Messrs Costigan and Braunschied, in driving the tunnel. This was a gruelling piece of work, but Mr. Glock 's persistency and courage carried him and his colleagues through.*

Brokenshire notes: *Gangs working from each end of the hydro tunnel met under the hill on October 29, 1925, and shook hands.*[7] The tunnel was about 400 feet long and cut through very hard rock.

Three c1925 (tunnel) or later images of the weir, tunnel & power station, copied from Jim Brokenshire's 1988 book.

Note the trolley rails going into the tunnel, the small original size of the power station, and the tailrace emerging from the power station.



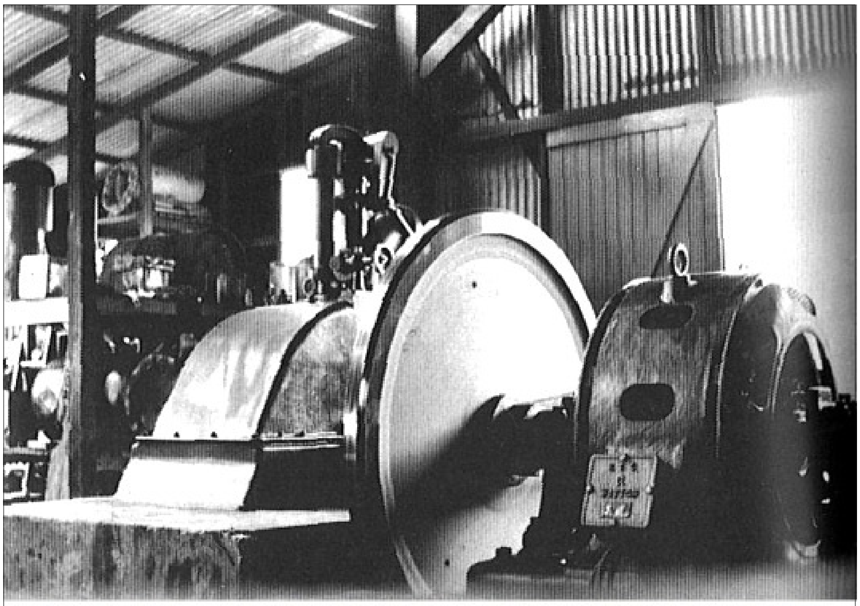
3 Ibid – 7 Aug 1924.

4 Northern Star, Lismore – 11 Nov 1924

5 Ibid – 18 July 1925

6 Mullumbimby Star – 11th March 1926

7 Jim Brokenshire, *The Brunswick – Another River and its People*



One of the first two hydro generating units installed in the power station in 1925. Another image from Jim Brokenshire's book.

In the meantime, the pipeline was almost installed, the power station built, the machinery installed and the poles and wires were almost ready to go.

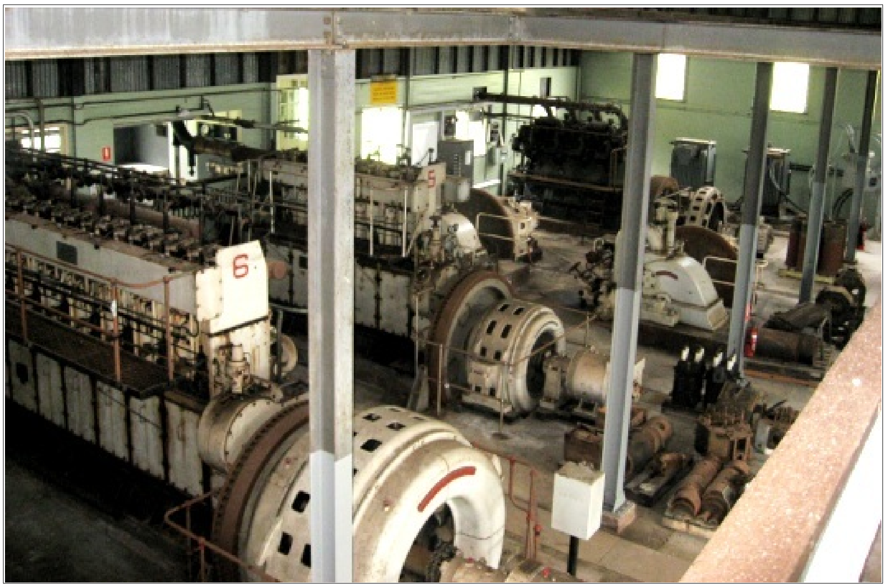
The pipeline/penstock was an unusual design, which narrowed as it descended the hill. The wood stave pipes were made by the Australian Wood Pipe Company, and ordered in three sizes, with the largest, 17 inches at the top, 16 inches in the middle and 15 inches at the bottom. *Outside the power house a breeches piece divides it* [the penstock] *into two 11 inch branches, one to each turbine.*[8]

The two turbines were the Pelton Wheel type, made by Boving & Co of the UK and were close coupled to British General Electric alternators, each developing 140kW.

The Hydro PS Switchboard Photo - G. Estcourt.

A recent photo of the two original GEC alternators with exciters. The two turbines are partially hidden behind the big flywheels. G. Estcourt.

This shadow board & its spanners are included in the list of movable heritage items – part of the Power Station listing on the NSW Heritage Register. Photo - G. Estcourt



Diesel Engines 5 & 6 with alternators are later additions. The two original turbines are visible beyond generators 5 & 6 to the right. In the back corner, the diesel engine & generator are probably the original Mirrlees engine with its Brush alternator. Photo - Gary Estcourt

8 Mullumbimby Star – 11th March 1926

Coates & Co. of Melbourne were the agents for the wood stave pipes, Boving turbines, BGE alternators and BGE Switchboard, while W.J. Spencer & Co. Ltd were the agents for the back-up 220 h.p. Mirrlees diesel engine and its Brush alternator. The tail race for the spent water from the Boving turbines, served a dual purpose as a cooling pond for the diesel back-up system.[9]

Examining the site for the future Power Station weir in 1924 - from Brokenshire p.76.
Could the gentleman on the left be design Engineer William Corin?

Another image from Jim Brokenshire's book, showing Mr Davidson, ex-Mayor of Mullumbimby and an original supporter of the hydro scheme, at work excavating for the pipehead reservoir.

The official opening of the Hydro-electricity Works took place on Saturday 6th March 1926, but Mr Corin had promised that Mullumbimby would be lit up in time for Christmas 1925 – and it was. I like the following account of the illuminations in the Mullumbimby Star of 24th December:

Mullumbimby Illuminated — A Momentous Occasion. Electric Light Switched On.

Great excitement prevailed at 4.30 yesterday afternoon, when Electric light from the Mullumbimby Hydro Electricity light works, was first switched on in the streets of Mullumbimby. The occasion, despite the fact that it did not mark the official switching on ceremony, will go down in history as a Red Letter Day for the town. .... The main street was crowded at the time the lights were switched on. The Mayor, who has had an exceedingly worrying time of late, in connection with the scheme, shed an aura of brightness all his own, and the illumination of the lights was of but secondary importance, to the transformation of his face, as one by one the lights were switched on and off at will. There had been certain carping individuals who had forecasted that there never would be light from the scheme, but after yesterday's successful tests, their tongues should be silenced. The town was brilliantly lit last night, and even in the afternoon the illuminations rivalled those of King Sol himself. It is expected that the town will be thronged to-night, and. the prospect of viewing Mullumbimby, illuminated by electricity on Christmas Eve should prove sufficiently alluring to drag the most confirmed recluse out of doors. Mullumbimby Council has certainly provided one of the most pleasant Christmas gifts, to both business people and public alike, in making light available for the most festive night of the year. The town will be lit from 7.30 p.m. to 1 a.m. on Christmas morning.

Recent photographs of (left to right) the water race, tunnel entrance and the power station – all by Gary Estcourt.

9 ibid.

The municipality was extremely proud of its new light and power scheme, which operated largely automatically, with minimal supervision – as: *The turbines are provided with very delicate governors which hold the speed constant at night and reduce the water when on account of the load being switched off by householders and motor users, only a small amount being required for the street lighting and the few lamps that are left. When motors are switched on in the morning the governor is on the alert and provides more water. On the switchboard is a corresponding electric regulator which holds the pressure constant in accordance with the load. No attendance is required beyond a visit once a day as the bearings are all self-oiling.*[10]

The minimal attendance needed was just one advantage of such a scheme, which operated with great economy for a number of years, and presumably paid back the £25,000+ borrowed to build it. However, there was no stopping the growth of power consumption and the number of connections, and by 1934, the hydro scheme was augmented by another alternator with a much larger Mirrlees engine. Interconnection with other parts of the region happened in 1938, and as the system was augmented again and again with more diesel driven alternators, the importance of the hydro scheme declined until it was said to be finally shut down in the 1960s.

The whole power station was decommissioned in 1990 – removed from the active list – as were a number of smaller power stations (and some big ones like Wangi) around the same time. Extraordinarily, most of the original hydro equipment was, and still is, intact and restorable to working order. Its survival has been assured by its recent listing on the State Heritage Register. The Statement of Significance in the Register notes that Mullumbimby was the fourth hydro-electric power station built in NSW. It is not only associated with the early development of hydro-electricity in NSW but is an exemplar of the change from small successful and profitable rural and municipal electricity supplies, gradually growing until they became part of the much wider electricity grids represented by the regional County Councils. The Heritage Register lists the weir, water races, tunnel, pipeline (with the wood stave pipes replaced by cast-iron), the original powerhouse, and all its contents, including plant and machinery from every stage of its life, and a catalogue of the smaller, movable items which represent the everyday work of the power station employees.

Mullumbimby Hydro-electric Power Station is thought to be the only early regional NSW power station to have survived with all its structures, plant and equipment intact. As such it is capable of becoming a wonderful illustration of the technology of electricity manufacture, from the distant past to the recent past.

From the Editor

The view from pipehead down to the power station Photo - Gary Estcourt.

Editor's Notes:

The photographs by Gary Estcourt are reproduced courtesy of the Heritage Division, Office of Environment & Heritage, NSW. The Mullumbimby Hydro Scheme is listed on the NSW Heritage Register at:

http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=5060490

The numerical information in this story relates to a time long before metrics were adopted in this country, so it seemed redundant to provide translations in the text. For those too young to remember the days of Imperial measurements:

1 inch = 25.4 millimetres; 1 foot = 0.3048 metres; 1 cubic yard = 0.765 cubic metres;

1 h.p.(horse power) = 0.746 kW (kilowatts); £1 (1 pound) = $2 – but add a multiplier to allow for the inflation rate over time.

For those unfamiliar with the name Mirrlees, this must be one of the oldest continuing engineering companies in Britain, suffering the most frequent changes of name since 1840, when the firm was founded to manufacture sugar processing machinery. In 1897 the firm made its first Diesel engine (and the third in the world), an engine which still exists in the Anson Engine Museum (see http://www.enginemuseum.org/mrindex.html under Mirrlees Blackstone).

Also see Grace's Guide at http://www.gracesguide.co.uk/Mirrlees.

Although the weir was originally intended to provide a water supply to the town of Mullumbimby as well as to the hydro plant, this didn't happen for many years. *Work began on the scheme on May 13, 1938, and the town reservoir was built in the same year. The supply scheme was estimated to cost £1000, with supply restricted to the township, although water was taken to some farms close to the pipeline. Supply was commenced in 1939, with full sandbed filtration and chemical purification. Tests showed the water to be equal in quality to the best in the State.*[11]

10 ibid.

11 Jim Brokenshire, *The Brunswick – Another River and its People.*

Engineering Heritage of Hong Kong
The Tai Tam Waterworks Heritage Trail

In November 2014 Brian McGrath, of Queensland Engineering Heritage, spent eleven days as a tourist in Hong Kong. He took the opportunity while there to check out some items and places which are interesting from an engineering heritage perspective. This account of his exploration of the Tai Tam Waterworks Heritage Trail is the first of a series which will be published in later issues of this magazine. *Editor*


The Tai Tam Tuk Reservoir Dam, with the Tai Tam Road passing over its 12 spillways Photo: Brian McGrath

Construction of the Tai Tam Reservoirs commenced in 1883 to provide a water impoundment to supply drinking water to Hong Kong. In 2009, some 41 historic waterworks structures within the Tai Tam group of reservoirs and five other pre-war historic reservoirs (Pok Fu Lam, Wong Nai Ghung, Kowloon, Shing Mun and Aberdeen reservoirs) were declared as Monuments to ensure that they would be protected and preserved.

The Tai Tam Waterworks Heritage Trail covers 21 of these historic structures. The trail is 5 km long. It is on the southeastern end of Hong Kong Island; the eastern end of the trail is accessible by bus along Tai Tam Road from Stanley.


One of 4 masonry bridges along the western shore of the reservoir, bridging major inflowing streams. Photo: Brian McGrath

The structure at the most easterly and downstream end of the reservoir system is the Tai Tam Tuk Reservoir Dam. It was constructed between 1912 and 1917 and is a masonry-faced concrete gravity dam. The busy Tai Tam road from Stanley to Chai Wan and Shek Ho passes over the twelve large spillways. The road deck is supported by arch structures on half-round granite columns.

At the western end of the Heritage Trail is the upstream limit of the reservoir system, featuring the Tai Tam Upper Reservoir Dam, constructed between 1883 and 1888. It is a granite-faced concrete structure 30.5m high, 121.9m long and 18.3m wide at its base. Nearby is a series of quite beautiful masonry bridges and aqueducts, valve and recorder houses.

In the upper reaches of Tai Tam, further storage dams, the Tai Tam Byewash Reservoir Dam and the Tai Tam Intermediate Reservoir Dam were constructed in the early 1900s, again concrete gravity structures with masonry facing.


Spillway & valve house, Tai Tam Intermediate Reservoir Dam. B. McGrath

Altogether one may see some 21 historic structures on the Tai Tam Waterworks Trail. The reservoir complex is still in use for the purpose for which it was designed, ie. providing drinking water storage for Hong Kong residents. An information sign at the start of the Trail states *the existing historic waterworks facilities are distinguished by their exquisite architecture and detail, a testimony to the imagination and ingenuity of early Hong Kong engineers.*

This reservoir system is well worth a visit, but note that one must return to the bus stop at the eastern end (it is not a "return circuit") and that the Trail is a steady climb from the mid-point to the Tai Tam Upper Reservoir Dam. The walk to that Dam and back takes at least 2 hours. There are a number of rest spots, including barbeque facilities, along the Trail.

B. L. McGrath, PSM

[For more notes & images see: http://www.hongkongextras.com/_tai-tam-waterworks_heritage_trail.html – Ed.]

Hydro Tasmania – Celebrating 100 Years

Part of an article first published in WEA Magazine in August 2014

Hydro Tasmania's Gordon Dam on Lake Gordon in the south-west of Tasmania – September 2012. Photo © Peter Mathew, courtesy Hydro Tasmania.

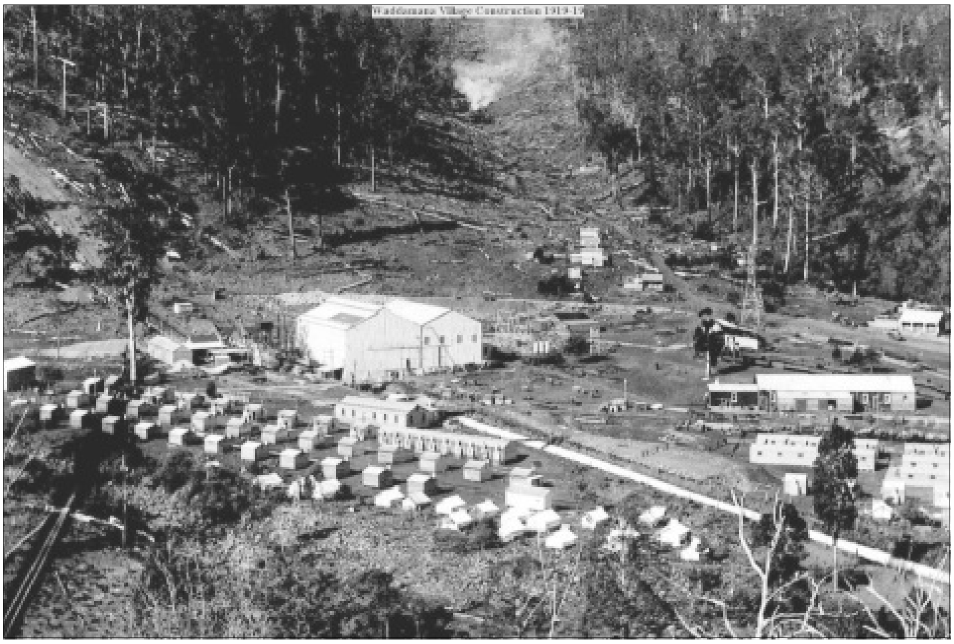
One hundred years is enough time to shape a nation. It's also been enough time for Tasmania's only hydroelectric power business to discover success and earn a solid reputation as a global leader in renewable energy. Success hasn't come easy for Hydro Tasmania, and the journey has had its share of trials and tribulations, but the Hydro – as it's affectionately known – has risen above adversity to succeed in its field. Like any bold venture, the journey is far from over. But 100 years is a milestone that warrants applause, and Hydro Tasmania is taking the time to reflect and celebrate the people that built the business.

Any organisation that has survived a century has a story to tell, and Hydro Tasmania is no exception. Starting out as the Hydro Electric Department in 1914, the company was created by the Tasmanian government to harness the state's potential in hydro power. The first power station at Waddamana opened in 1916, producing enough electricity to power about 250-300 homes, and by the 1920s, hydroelectric power was widely available in Tasmanian farms and factories. Construction continued strong until the onset of the Great Depression and the Second World War, but work continued, and a wave of new power stations were commissioned in the 1960s.

The 1970s sparked a change for Hydro Tasmania, with the flooding of Lake Pedder in 1972 putting the business in the midst of a bitter environmental dispute. Subsequent proposals to construct the Franklin Dam, though later quashed, also divided the state and led to one of the most significant environmental campaigns in Australian history. The controversy was a cornerstone that marked the end of the dam-building age in Tasmania, but it also prompted Hydro Tasmania to step up its commitment to environmental planning and invest in other forms of renewable energy such as wind and hybrid power.

Tarraleah Power Station soon after opening in 1938. HEC Collection.

The Faces of Hydro Tasmania



While Hydro Tasmania's historic timeline speaks for itself, there is much to be said about the tenacity of workers in its pioneering stages. Not only was construction difficult, but it was also common for workers to stay on the job six days a week for up to two months at a time, living in rustic and isolated tents in bitterly cold conditions.

Left: Waddamana construction village (said to be 1919, but this image looks to be before the P.S. was built – perhaps 1914). Hydro Tasmania

Below: A concrete batching plant c1926 – used for building the Shannon Power Station. Hydro Tasmania

Leading up to the centenary celebrations in October, Hydro Tasmania is appealing to the community to share their stories of its early days. Fascinating stories have come out of the woodwork – from childhood memories of building forts and billycarts on work sites, to tales of everyday life in bushland communities around the dams and power stations being built. Their stories are many and various, and they haven't gone unnoticed by Hydro Tasmania CEO Steve Davy, who credits the company's success to the workers who poured their efforts into building Tasmania's hydro power scheme.

Payday at Butlers Gorge – 1948. Hydro Tasmania

"Much has been written about our history, the achievements and the conflicts, but the constant through the past 100 years has been the role played by the men and women who gave so much to make the business what it is today," Davy said. "The centenary event program is our way of saying thanks to them and to the Tasmanian community."

Measuring the Success

From what started as a small but bold project in 1914, Hydro Tasmania now operates 30 hydroelectric and two diesel power stations, in addition to being the part owner of three wind farms. It also employs around 1000 staff, has more than $5 billion in assets and has grown to become Australia's largest producer of renewable energy.

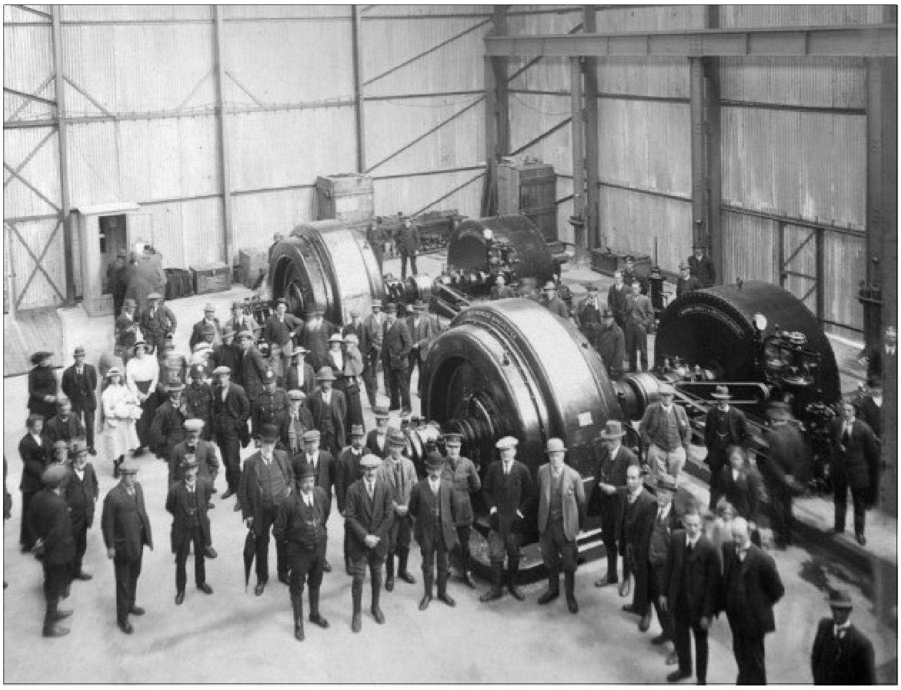
by Louise Wallace
with permission, Engineers Media

The Hydro after 100 Years

From the Editor.

The preceding text is less than half of the original article as published in WEA (Water Engineering Australia) Magazine in August 2014. Hydro Tasmania was celebrating not just its historical achievements, but also the way it has grown and changed recently to become a leader in sustainability and innovation. Their emphasis has turned to projects like mini hydro power stations, which use stored water in more sustainable ways. Their wind farms, on King Island and mainland Tasmania take advantage of Roaring Forties locations to supplement diesel and hydro generation. Solar power is used in integrated systems with wind and diesel on the islands.

So what has this to do with engineering heritage? Well let's say these innovations will be the heritage of the future.



Official opening of Waddamana Power Station, 6th May 1916. Hydro Tasmania

1914	The Tasmanian government sets up the Hydro Electric Department (The Hydro) to construct the State Government's first power station, with John Butters as Chief Engineer and General Manager.
1916	Waddamana A Power Station officially opened.
1931	Shannon Power Station commissioned. Lake St Clair substation commissioned.
1934	Work commenced at the eastern end of the Tarraleah Canal.
1938	Tarraleah Scheme commissioned.
1944	Waddamana B Power Station commissioned alongside Waddamana A.
1949	Clark Dam at Butler's Gorge completed.
1964	Poatina Power Station commissioned.
1966	Tods Corner Power Station commissioned.
1967	Rowallan Dam was completed.
1969	Devils Gate Power Station commissioned.
1971	Bell Bay Power Station commissioned.
1972	Lake Pedder was flooded.
1974	Gordon Dam completed. Bell Bay Power Station expanded.
1977	Gordon Power Station commissioned.
1982	The Hydro's first female apprentice hired.
1983	Plans for the Franklin Dam axed.
1986	Currie Power Station commissioned on King Island.
1991	Crotty Dam commissioned – feeds John Butters Power Station.
1992	John Butters Power Station commissioned
1998	The Hydro commissioned its first wind farm, Huxley Hill.
2002	Parangana mini hydro power station commissioned.
2004	Bluff Point Wind Farm completed.
2007	Studland Bay Wind Farm completed. Hydro Tasmania Consulting opens office in India.
2009	Hydro Tasmania purchased Momentum Energy.
2012	The Hydro signs joint agreement for Musselroe Wind Farm.
2014	Musselroe Wind Farm officially opened. Hydro Tasmania wins national innovation award for its King Island Renewable Energy Integration Project.

The WEA article had a brief timeline for Hydro Tasmania. An expanded (but still by no means complete) version of this is at left.

Somewhere in the Hydro Tasmania website is a list (see the box below) titled :

ENERGY IN TASMANIA

with a list of power stations and associated organisations. The list did not include the diesel and solar power stations on the islands.

HYDRO : Bastyan - Butlers Gorge - Catagunya - Cethana - Cluny - Crotty - Devils Gate - Fisher - Gordon - Huntsman - John Butters - Lake Echo - Lemonthyme - Liapootah - Mackintosh - Meadowbank - Paloona - Parangana - Poatina - Reece - Repulse - Rowallan - Tarraleah - Tods Corner - Trevallyn - Tribute - Tungatinah - Wayatinah - Wilmot

WIND FARMS : Huxley Hill - Musselroe - Woolnorth

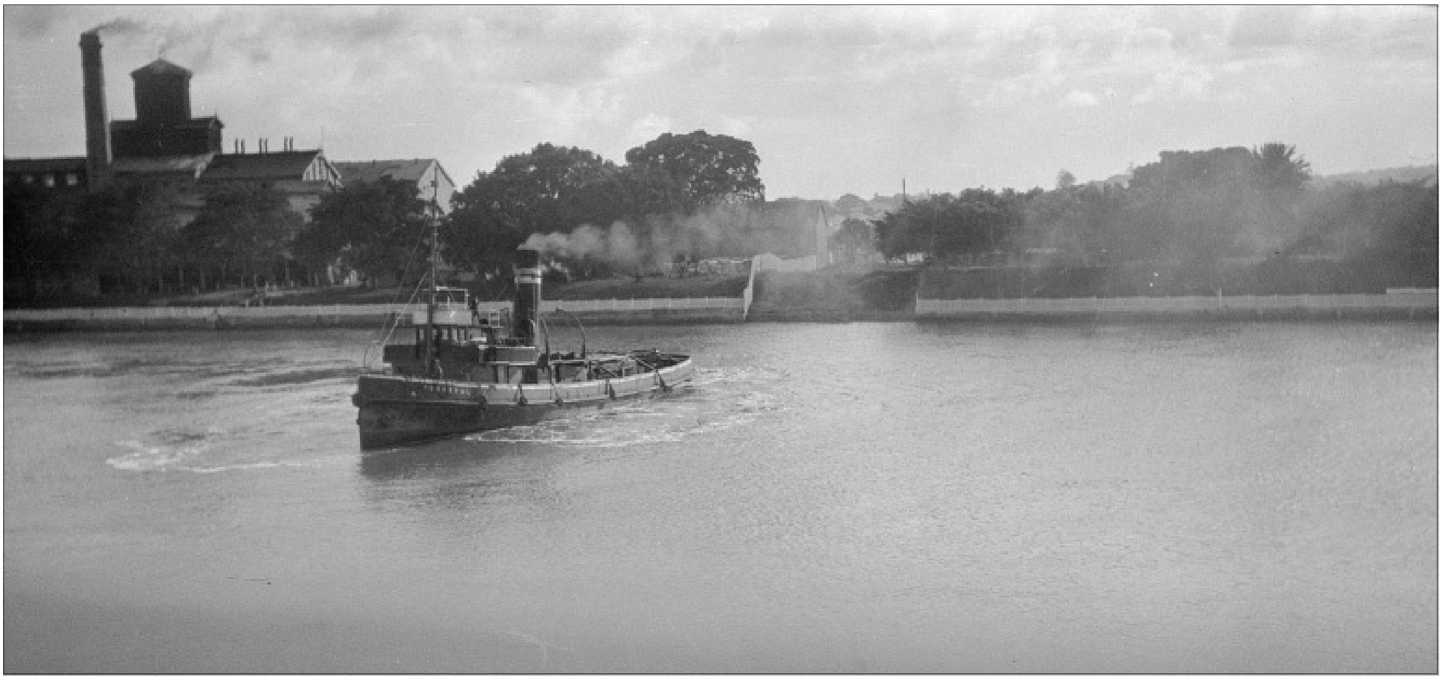
GAS : Tamar Valley - Bell Bay

MISCELLANEOUS : Basslink

COMPANIES : Hydro Tasmania - Aurora Energy - TasNetworks - Alinta - Roaring 40s - Powerco

HISTORICAL : Duck Reach - Lake Margaret - Moorina - Waddamana - Waddamana B - Transend Networks

A New/Old Image of Historic Tugboat "Forceful".

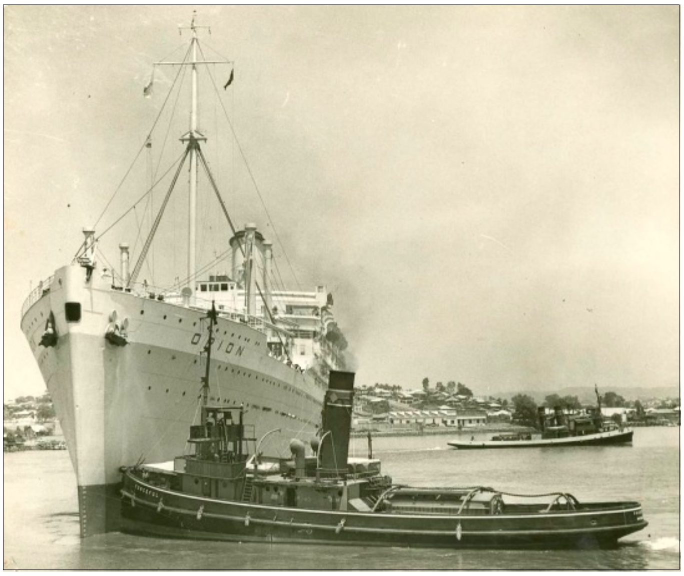


Queensland Steam Tug "Forceful" at work on the Brisbane River, January 1929 — Photo – Joan M. Ferguson

For some years before she died in 1996, my mother, Joan Haughton (née Ferguson), spent much time and anguish searching for an album of photographs she had taken when she was a schoolgirl. She wanted to tell me who all the people in the photographs were, before it was too late and she was no longer with us. She never did find that album, much to my huge regret – particularly when I was immersed in recording her life and family and friends. Some years later, by a quirk of fate, we found the album. It had been "borrowed" c1980 by a person who assumed property rights for the organisation he was employed by. We managed to retrieve it eventually, but by then it really was too late to identify many of the subjects.

However, one of the photographs piqued my curiosity – the subject was fairly obviously a tugboat, but she was not on any watercourse or landscape I was familiar with. By blowing the photo up it was possible to read her name – *Forceful* – what a great name for a tug! A bit of Google research turned up her home port, the Brisbane River, and a fascinating history.

But what was my mother, a Melbourne schoolgirl when she took this photo, doing in Brisbane? I have her 1929 diary, and near the end of the school holidays in January, Joan sailed from Melbourne with her father (on a business trip) on the coastal cargo steamer SS Ormiston headed for Brisbane. They arrived on January 21st in the early morning, and I assume Tug *Forceful* was there to greet them. She writes: *Woke at 5.30 am, looked out of cabin and found we were sailing up the Brisbane River. Berthed about 6.15? Breakfast on ship and then up the City . . . .* Not bad for the photo's provenance! Now perhaps a reader in Queensland can identify the factory in the background of the photo?



Steam Tug "Forceful" turning RMS "Orion" in the Brisbane River – c1950s.
Photo George Jackman – from the John Oxley Library.

Forceful is an ocean-going steam tugboat built for the Queensland Tug Company by Alexander Stephen and Sons Ltd in Govan, Scotland. She was launched on November 20th 1925 and arrived in Brisbane, Qld on March 7th 1926. She spent most of her career working in the Brisbane River, but in February 1942 she was commissioned into the RAN as HMAS *Forceful*, and sailed first to Fremantle and then in October '42 to Darwin.

She was *engaged in harbour work around Darwin, towed lighters to Merauke in Dutch New Guinea and, on occasions, acted as a rescue vessel for aircraft and crews returning from bombing missions.* In late 1943 she towed a landing ship back home to Brisbane, was paid off, and returned to her owners. She received two Battle Honours for her Navy service – *Darwin 1942-43* & *Pacific 1943*.

Forceful retired in 1970, and started an honourable third career as an operating museum ship for the Qld Maritime Museum. Now 90 years old, she is undergoing a refit at present, preparing to return to service at the Museum. What a life !

For lots more information – Google Tugboat Forceful.

I looked for another photo of "Forceful" and discovered this most appropriate one at left. Joan Haughton (née Ferguson) travelled to Europe via the Cape of Good Hope on the Orion in 1956, in the middle of the Suez crisis.

Building Melbourne's Sewerage System

From Stinking Smellbourne to Marvellous Melbourne

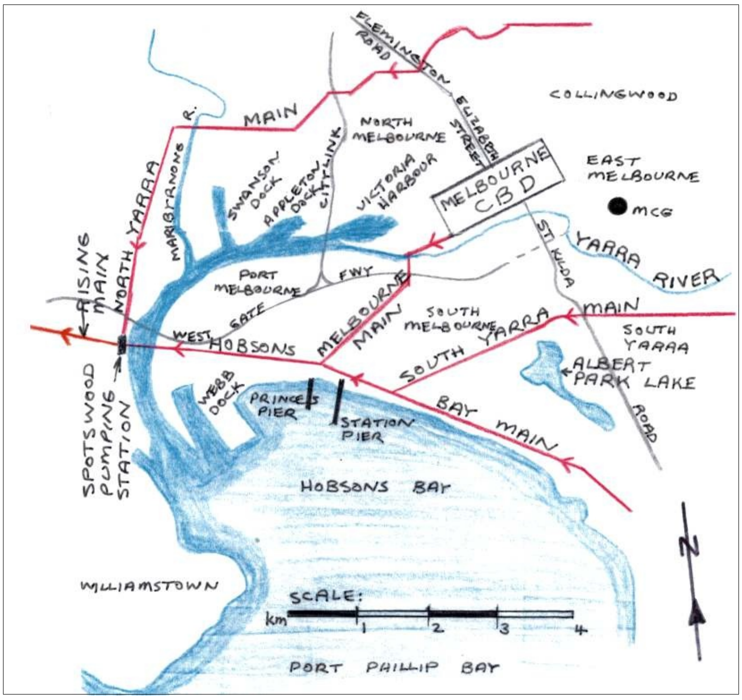
Spotswood Sewage Pumping Station viewed from the Westgate Bridge in May 1985 Photo - M Doring

By the late nineteenth century Melbourne had grown to be the largest city in the country and very prosperous following the Gold Rushes throughout Victoria. However one aspect of life in Melbourne was far from pleasant – it lacked a sewerage system. This led to serious health problems with alarming death rates from Cholera and Typhoid. It also led to the city being foul-smelling which earned it the title "Marvellous Smellbourne".

Westgate Bridge seen between the Pumping Station towers. M.Doring

By 1889 an expert consultant from the UK, James Mansergh, was commissioned to make recommendations on a sewerage system for Melbourne. He reported in 1890 and the government formed the Melbourne & Metropolitan Board of Works (MMBW) to undertake the task of building and operating a sewerage system. Work commenced in 1892 and the first stage went into service in 1896. The system was engineered and built by MMBW Engineer-in-Chief William Thwaites, who was an early engineering graduate of the University of Melbourne and proved to be a first class project manager and a very competent engineer.

The system grew with the city and much of the original infrastructure is still in service including thousands of kilometres of sewers and also the Western Treatment Plant, originally called the Werribee Sewage Farm.



Sketch Map of the major components of the Melbourne Sewerage System as far as Spotswood Pumping Station. Drawn by Owen Peake.

Sewers and Mains

Eventually, every house and business had a connection to a sewer in the street. For smaller premises these were typically 4 inch diameter (100 mm) earthenware pipes. The network of sewer pipes progressively became larger as they collected larger flows. These emptied into four trunk sewers which converged at Spotswood Pumping Station. Another main trunk sewer, from Williamstown to Spotswood was added in 1906.

The construction of the main sewers was commenced in 1893, generally using deep tunnelling methods, although some sections, such as the Hobsons Bay Main sewer from the south eastern suburbs, running along Beach Road, used open cut methods where possible. The Hobsons Bay Main was constructed in five sections, generally following the Beach Road and running through the undeveloped Fishermans Bend, with the final section crossing the Yarra at Spotswood. It was completed in 1896, but not fully operational until 1898.

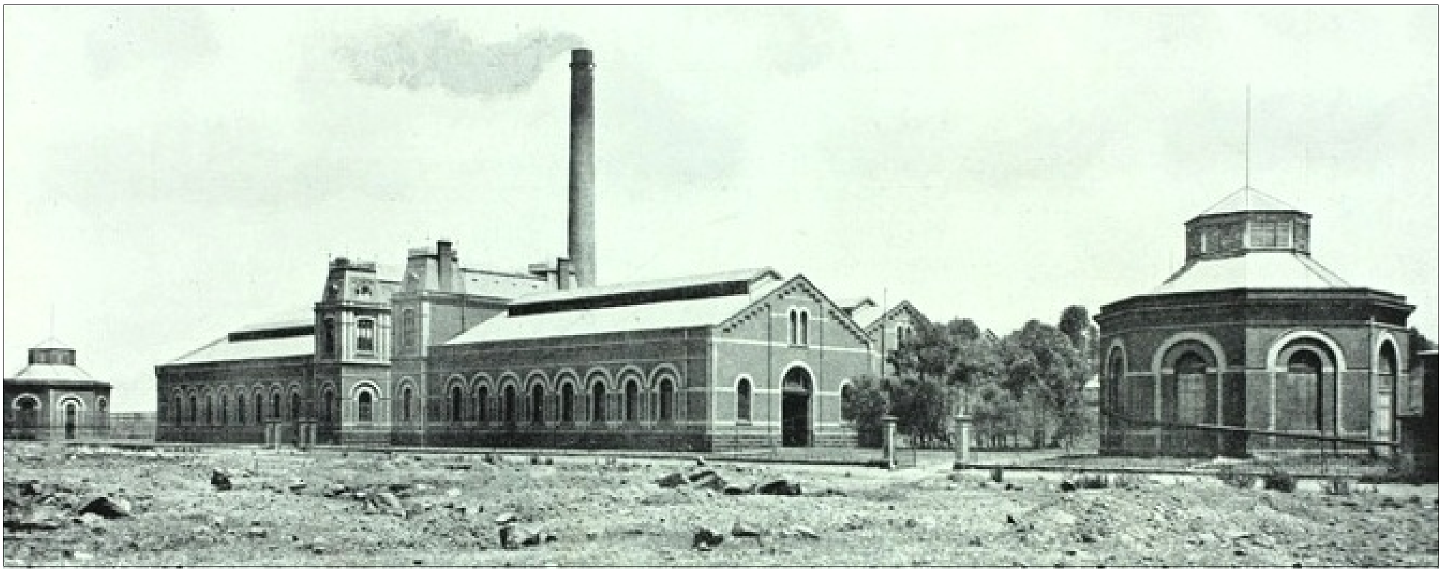
Tunnelling the North Yarra Main Sewer. Image - Water Services Assoc of Aust

The main sewer from the Central Business District, termed the Melbourne Main Sewer, crossed the river twice; downstream from Spencer Street to South Melbourne, then again after it joined the Hobsons Bay Main Sewer where that crossed the river at Spotswood.

The South Yarra Main from the eastern suburbs commenced in 1894, joining the Hobsons Bay Main Sewer near St Kilda. It was completed in 1897.

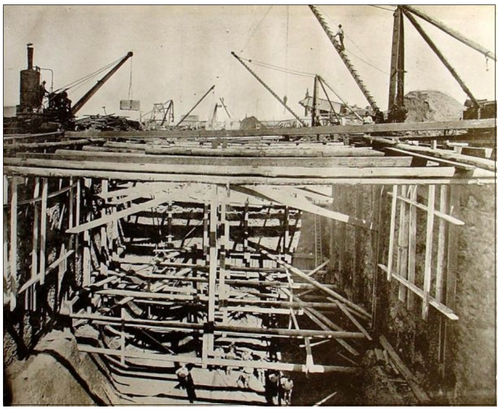
The next trunk sewer, termed the North Yarra Main Sewer, started in the Collingwood, Abbotsford area and skirted the northern edge of the city travelling west then south before crossing under the Maribyrnong River and entering Spotswood Pumping Station.

Spotswood Pumping Station

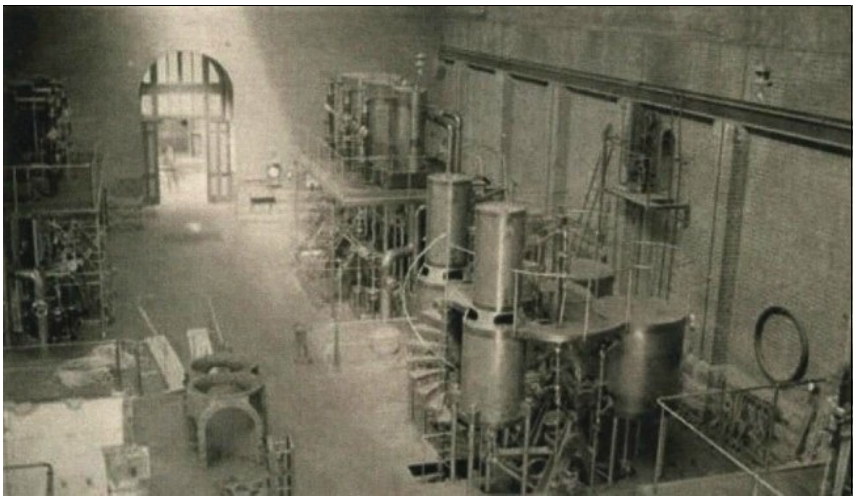


The Spotswood Pumping Station photographed in the 1890s. Photo courtesy Museum Victoria

A large steam pumping station was built at Spotswood close to west bank of the Yarra River. Building commenced in 1893 and it first opened in 1897, although development of it continued as ten steam pumping engines were installed progressively up to 1915. The engines all used triple expansion designs in the search for thermal efficiency.



Construction of the pump pits at Spotswood Pumping Station Unknown source



Three generations of steam pumping engines in the South Engine House at Spotswood At right, an original Thompson engine – rear & centre, the Hathorn Davey engine – left, the Austral Otis engine to an E.P. Ellis design. Image courtesy Museum Victoria

The first four engines were non-rotative engines built by Victorian manufacturer Thompson's of Castlemaine. These engines were probably based on a Worthington design acquired from the United States but their efficiency proved to be disappointing.

The Hathorn Davey Steam Pumping Engine at Spotswood Photo M. Pierce.

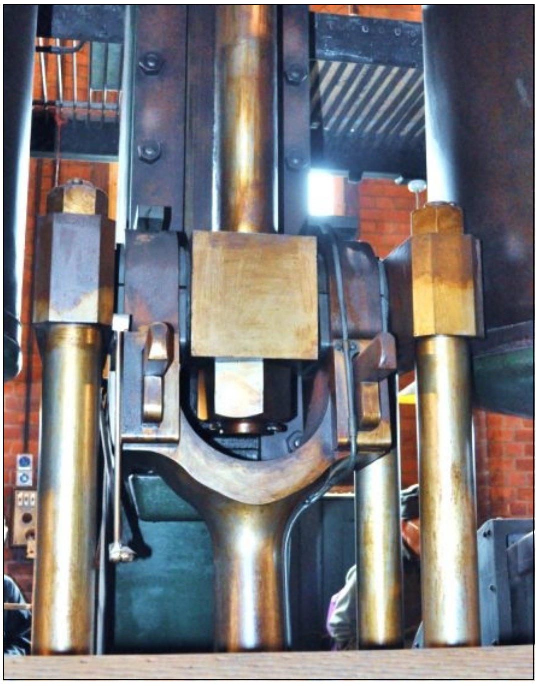
They were followed by two rotative engines which represented a battle between those who considered that imported engines were a better buy and those dedicated to using locally-made products. One of these engine was made by the world-renowned company of Hathorn Davey in Leeds, Yorkshire and the other was made by the Melbourne company Austral Otis using a design from American company E P Ellis.

The result of this experiment was a hybrid solution. Austral Otis were contracted to build two copies of the Hathorn Davey engine which had proved to be the superior performer of the engines installed to that time. They were later contracted to build a further two virtually-identical engines. This group of four Austral Otis engines proved to be as efficient as the Hathorn Davey engine and lasted in service until the end of the steam era.

Today the four later Austral Otis engines and the Hathorn Davey engine remain in the pumping station along with a range of electric pumps. The group of five very large steam pumping engines, the latest technology at the time of their construction, remain as a superb example of the finest steam machinery of international significance.

In 1921 the first electrically-driven pumps were installed and more were added over the years. Early electric pumps were designed for 25 cycles per second power which came from the nearby Newport Railway Power Station. Later electric pumps used 50 cycles per second power. In 1947 steam pumping ceased and all pumping was carried out by electric pumps.

Austral Otis Steam Pumping Engine No.8 at Spotswood   from Museum Victoria



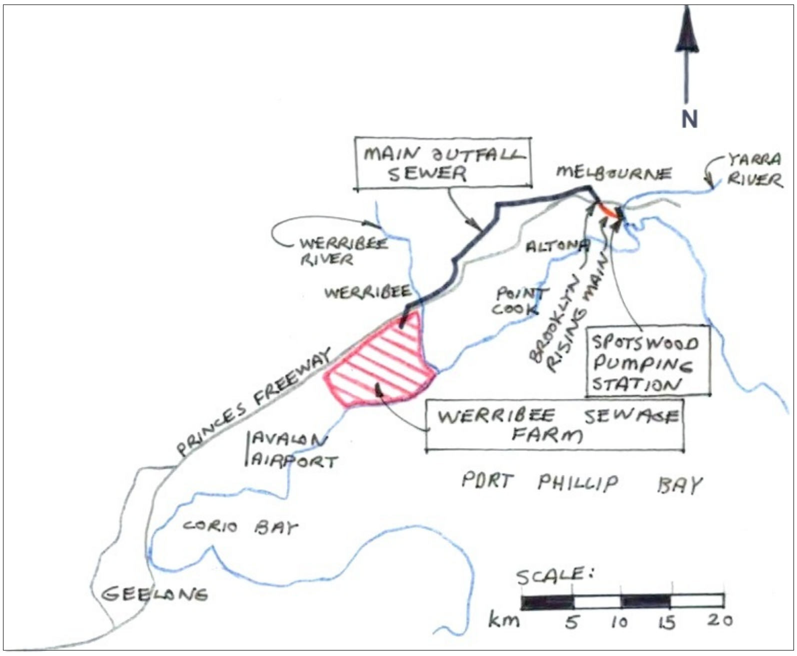
Left: One of the main crossheads of the Austral Otis No.8 steam engine. The four vertical rods (one hidden) below the crosshead are the drive rods driving the reciprocating pump far below the engine. The lower, centre rod is one of 3 con-rods driving 2 flywheels (out of sight).

Right: Mechanical flyball governor of the Austral Otis No.8 engine. The governor controls the speed of the engine.

Both images by Owen Peake

The Austral Otis No.8 steam engine has been fully restored to working order for demonstration purposes only. It can be run daily on compressed air.

Spotswood Pumping Station was closed in 1965 and was replaced by Brooklyn Pumping Station further downstream. The Spotswood Pumping Station is now incorporated into the Museum Victoria technology museum called Scienceworks. Brooklyn Pumping Station is located 4 km to the west of Spotswood and it is an all-electric underground station. The main trunk sewers still run beneath the Spotswood site.

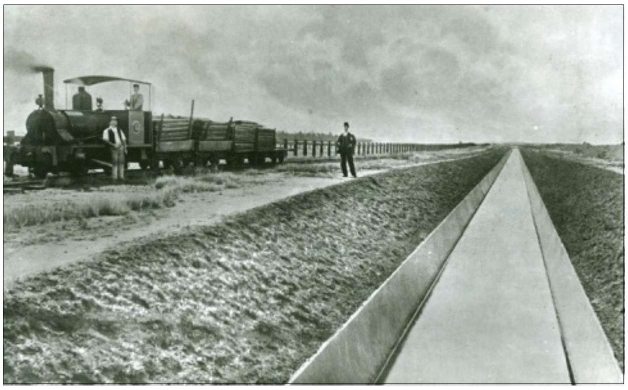


Main features of the Melbourne sewerage system beyond Spotswood. Owen Peake

The Main Outfall Sewer

Spotswood Pumping Station pumped the sewage through three rising mains to Brooklyn. A 25 km long Main Outfall Sewer was built to transport the sewage from Brooklyn to the Werribee Sewage Farm by gravity. This major civil engineering structure included several large aqueducts. Much of the route was open lined channel. It was replaced by underground mains incorporating some pumping in recent times and the old Main Outfall Sewer has now been recycled as a bike trail.

Inspecting the rising main between Spotswood and Brooklyn. Corrosion in this main ultimately led to the closure of Spotswood Pumping Station. The inspector appears to be holding a candle – a dangerous procedure! Image source not known



Building the Main Outfall Sewer Aqueduct. Image - Culture Victoria.

Main Outfall Sewer Aqueduct crossing Kororoit Creek. This aqueduct is now used as a cycleway, from Brooklyn to Werribee. Photo - Owen Peake.

Western Treatment Plant (previously the Werribee Sewage Farm)

When the scheme started the sewage was used to irrigate thousands of acres of land for crops and grazing. However this method could not cope with Melbourne's growing population and a new system was introduced in the 1930s. Natural algae treat the sewage in a system of large shallow lagoons which now handle 60% of Melbourne's total sewage output. Farming is still carried out on the extensive site at Werribee.

In 1975 a second sewerage system, east of Melbourne, was commissioned to serve the booming eastern suburbs. The Eastern Treatment Plant at Bangholme treats about 330 million litres of sewage a day and the treated effluent goes to an ocean outfall at Boags Rocks near Cape Schanck.

Long Term Success

The building of the Melbourne Sewerage System was a huge task, tackled with skill, vigour and determination and built to the highest standards. Generations of engineers and other workers have followed the early lead, augmenting the system and maintaining it diligently over the decades. Engineering Heritage Victoria and Melbourne Water recognised the Melbourne Sewerage System with an Engineering Heritage National Marker on 11 September 2014 at Werribee.

Owen Peake
Engineering Heritage Victoria

Perth's First Public Water Supply Scheme

Historical Background

The Victoria Dam near Perth in the early 1900s – photographed by Rae Bros., Perth. Photo courtesy (WA) Water Corporation

The new settlement of the Swan River Colony in Western Australia, proclaimed on 1st June 1829, lasted for 62 years without a proper public water supply scheme – and its inhabitants paid the price. The lack of a scheme not only presented a major threat to public health and quality of life, it also hampered expansion of the settlement that clung precariously to the shore of the continent's remote and largely unexplored western third. In already harsh conditions which included sporadic droughts, the pioneers survived mostly on water from several swamps and lakes (some of which were later drained and filled in by developers) and a few freshwater springs, notably the still existing stone structure at the foot of Mt Eliza[1] built by Governor Kennedy in 1861. Early colonists also used underground cisterns or shallow wells. By the early 1860s it was becoming economical to use corrugated galvanised iron (cgi) as a roofing material, and collect the rainwater falling on it in cgi tanks[2], but this still provided a very limited supply of water storage.

Predictably, water shortages occurred and, worst of all, wells became polluted by the poor drainage and crude sanitation systems using cesspits in sandy soil, resulting in disease and many deaths. An official medical report in 1883 noted that there had been an upsurge in typhoid and diphtheria, particularly among poorer people, and fever and diphtheria could be considered endemic in Perth and Fremantle because of sewage contamination.

The first productive step in obtaining a reliable managed water supply for the then recently established City of Perth was taken in 1885 when a Sanitation Commission was appointed by the Legislative Council. It strongly recommended cessation of the use of cesspits and identified four available sources of drinking water for Perth:

a. wells sunk into the ground;
b. the roofs of houses and the preservation of water in tanks;
c. the lagoons at the back of Perth, and particularly Monger's Lake and Smith's Lake near the City; and
d. the rivers and brooks issuing from the Darling Range south-west of the City.

The Commission's conclusion, based on a report by the Government Geologist, Edward Hardman[3], was that piping water from the Darling Range *must eventually be the source from which Perth shall be supplied with pure water*.

The preferred Darling Ranges option initially met with some opposition because of the cost, estimated at about £100,000 ($A14M at 2011 prices). The lake proposal was shaky at best because of the threat of the nominated water body suffering from contamination and filling similar to its former counterparts. Some deep bores had been tried for water supply since about 1870 but apart from providing local supplies, the idea did not catch on for a major supply. In addition to odour and taste issues, there was a mistaken belief that reliable quantities of artesian water would not be available due to a lack of the necessary geological formations as described in a March 1885 report by Edward Hardman. It was also thought that all groundwater might be contaminated.

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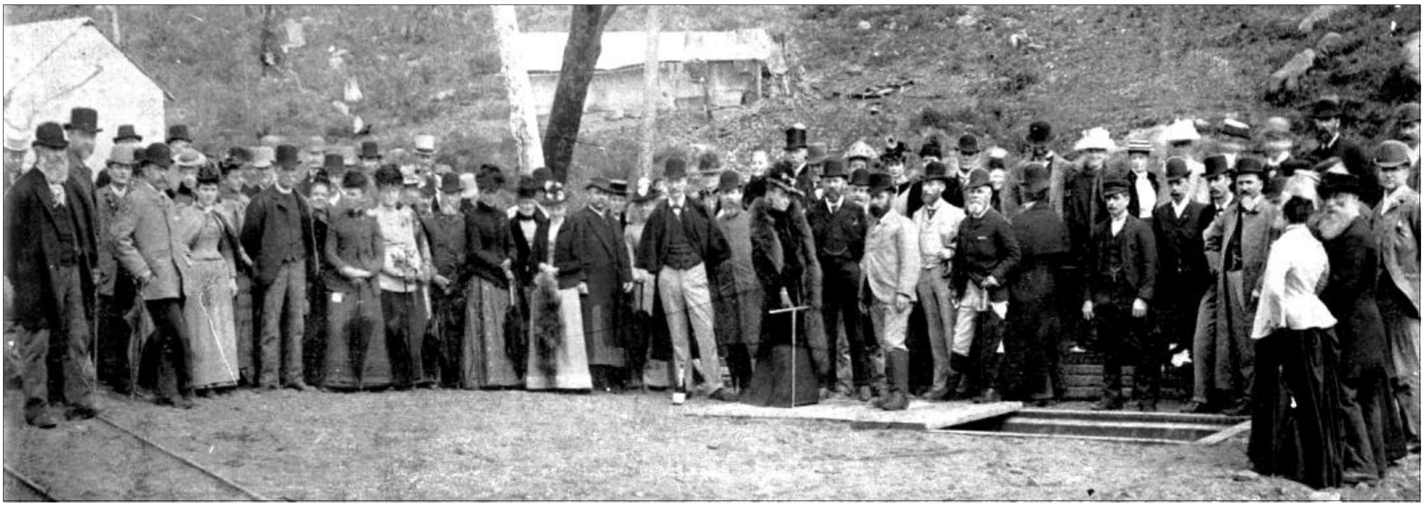
1 Mt Eliza is on the highest part and on the edge of what is now Kings Park, adjacent to the City of Perth.
2 See http://mileslewis.net/australian-building/pdf/08-metals/8.04-corrugated-iron.pdf
3 See http://adb.anu.edu.au/biography/hardman-edward-townley-3713

In 1887 two civil engineers, Henry Saunders[4] and James Barratt, submitted a detailed plan for the city's first water supply scheme. It would be sourced from a dam on Munday Brook at Carmel/ Canning Mills in the hills, covering an area of 32 acres and having a storage capacity of 140,000,000 gallons. A cast iron gravity pipeline of 12 inches diameter would connect with a service reservoir of 1,260,000 gallons capacity at Mt Eliza 16¾ miles away. The reservoir on Mt Eliza overlooked the City of Perth and enabled distribution to surrounding areas. Saunders and Barratt reported that the scheme was designed to supply about 25,000 people while the population of Perth and Fremantle was then about 11,500. Included in the rate of 1/- (one shilling) in the pound, the scheme would provide 30 gallons per person per day, sufficient to service one water closet and one bath only. Excess charges were to be applied to other uses.

After years of near stagnation the economy was stirring in the 1880s due to new gold discoveries. By 1889 Perth's population had finally begun to swell and demand for water increased rapidly. The hills reservoir proposal received enthusiastic support from the Perth City Council, and a public meeting called by the Council, followed by a referendum of ratepayers in March 1889, voiced strong public support for a fresh and dependable water supply – the meeting calling it "highly desirable." But the Government baulked at the cost, and due to British Colonial Office restrictions on loan funds and the perception that water supply was a municipal matter, would not commit the necessary funds. So the Council, also unable to fund the project, entered into an agreement with a Melbourne-based syndicate, Neil McNeil[5] and Company, to build, own and operate a scheme which was, in effect, the Saunders and Barratt proposal. A rival proposal from Messrs. Watson & Co was rejected.

The local representative of the McNeil syndicate, Edward Keane[6], was also a civil engineer and had been involved in construction of some of the first railway lines in Western Australia. He also operated a timber mill which was in the catchment area of the proposed dam, and in 1891 and 1892 was Mayor of Perth. Neil McNeil and Company began the project in October 1889, with work ratified by the new Water Works Act which was assented to on 4 December 1889.



Opening of the Perth Waterworks at Victoria Reservoir, 1st October 1891. Lilla Keane, wife of the Perth Mayor, and representative of the contractors for the scheme, turned on the valve to set the water running. Photo courtesy Water Corporation.

The scheme was opened on 1 October 1891 and a public company, the City of Perth Water Supply Co. Ltd., was floated to buy the scheme from Neil McNeil and Company and operate it for the next 25 years. Unfortunately, the Company quickly fell into disrepute. There were widespread complaints about water availability, pressure loss and high charges, and the scheme source became contaminated, mostly from farming and timber mill activities in the catchment, contributing to re-occurring high rates of typhoid in Perth. The entire scheme was subsequently purchased by the newly established State Government in October 1896 at a cost of £220,000 ($A32M at 2011 prices), at which stage it included about 30 miles (50 kilometres) of reticulation pipes in Perth.

Improvements were quickly made to the scheme, including laying a larger diameter pipeline from the hills to Mt Eliza and drilling a deep bore in the Wellington Street Depot to augment supply. Other improvements followed over the years, and extensive remedial works were carried out to Victoria Reservoir in 1966. But in 1988, it was determined that the dam wall did not meet current design safety levels and in 1990, after almost 100 years of service, it was decommissioned and partly demolished to allow passage of overflows from its larger replacement 300 metres upstream.

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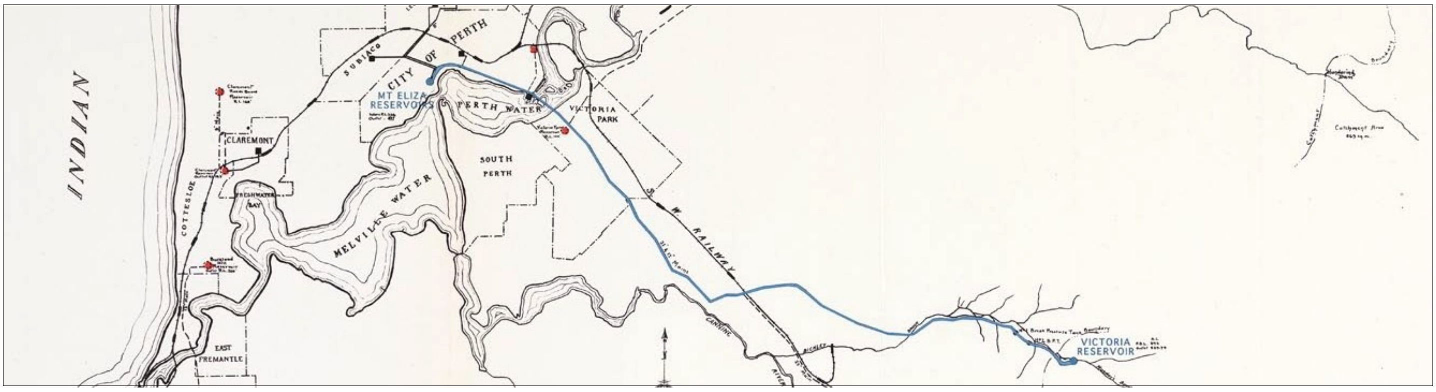
4 See http://biography.senate.gov.au/index.php/henry-john-saunders/

5 See http://adb.anu.edu.au/biography/mcneil-neil-4133

6 See http://adb.anu.edu.au/biography/keane-edward-vivien-harvey-3930



Part of a 1903 plan of Perth & suburbs water supply. The blue line drawn on the plan shows the route of the pipeline from Victoria Reservoir (right) to the Mt Eliza Reservoir (left).
Drawing courtesy Water Corporation.

The Scheme as proposed in the document titled *Proposals and Report on the Proposed Water Supply for the City of Perth and Town of Fremantle, Western Australia by Messrs. Saunders & Barratt*, dated May 1887 comprised: *a dam at Munday's Gully*[7] *in the Darling Range, at a distance of 14½ miles from Perth, thus forming a Storage Reservoir, capable of holding 140,000,000 gallons; a Service Main from the Reservoir to Perth and Fremantle: a Service Reservoir in Perth, and all necessary Street Mains, with Valves, Aircocks, etc, etc..*

The Proposals and Report document was comprehensive in that it also included plans, sections and estimates of the proposed works and a scale of charges required to pay for the scheme. The document included consumption estimates of 30 gallons per head per diem for a population of 25,000 people. With the then population of Perth and Fremantle estimated at 11,500, it thus allowed for a good margin for future increase. (Of interest, the Water Corporation's current target is for consumption of 125 kilolitres per person per year, including garden use – or 75 gallons per day). The document also included conditions such as the need for a government Water Works Bill. The *Water-works Act*, an Act to enable Municipal Councils to construct Water Works, or to Contract for a Water Supply, was assented to on 4 December, 1889. Finally, the document also included the option that: *Should the Government or Municipal Authorities decide to carry out the Works proposed themselves, the Promoters of these proposals are prepared to guarantee to carry out the Works for them for the sum of £130,000.*

Design & Construction of the Scheme

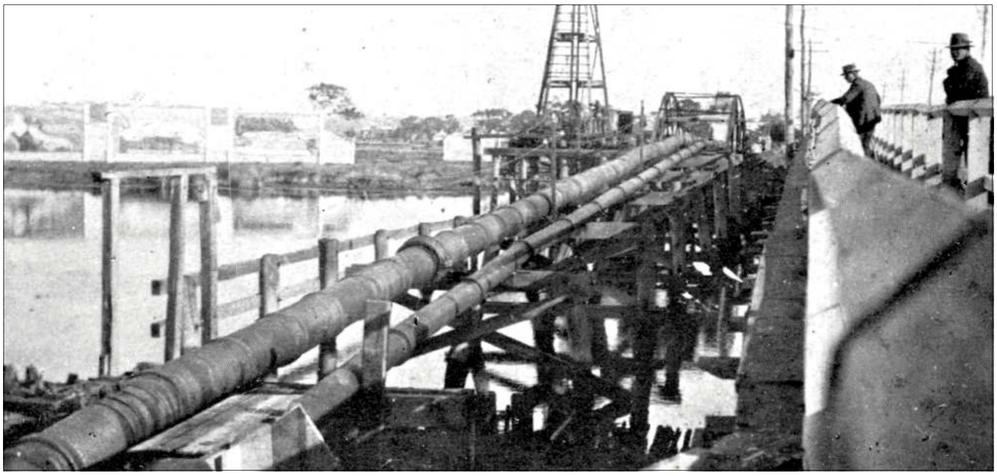
Though it appears that Saunders and Barratt did not have prior experience in dam building, their proposal showed a good understanding of the technology that was known at that time. Until the 1890s, most dams built in Australia were earthfill. When Saunders and Barratt prepared their proposal in 1887, they would have understood that because of the location, earthfill would not be an economical option for the "Munday's Gully" site. At that time, the only concrete gravity dam in Australia was Lower Stony Creek which had been built near Geelong in 1873. Their design for Victoria Dam had an unusual cross-section as the structure had a varying curvature with radii around 150 m. The upper section, 11 metres high, was of triangular cross-section and acted as a gravity dam. The lower 14 metres comprised a curved wall with a near vertical downstream face and behaved as a barrel arch. By incorporating arch action into the design, considerable savings in quantities of material and therefore cost were achieved.

Work began on the dam in October 1889. A press report of a visit by VIPs dated 7 May 1890 advised that on sinking the foundation on the proposed site, the contractor found a thick bed of pipe-clay which precluded an impervious dam there. A site further down the gully was found and the contractor decided to build a higher dam with a larger basin than the original proposal. The new site increased the reservoir area from 32 to 42 acres and the storage from 140,000,000 to 240,000,000 gallons at an additional cost of £20,000.

The gravity arch dam was built by manual labour using unreinforced concrete on a solid granite foundation. The dam wall had a crest length of 726 feet (222 metres), a maximum height above ground level of 82 feet (25 metres) and base width of 48 feet (14.5 metres)[8]. The mix of material for the dam wall was reported by a newspaper to be *one part of Portland cement, two parts of sand and four of granite broken to a 2 inch gauge.* All the cement was imported in 60 kg casks/barrels from England and on arrival would have been tested to expose any deterioration from the long sea voyage. It is calculated that the dam would have required in the order of 3,500 tonnes (55,000 casks) of cement.

7 Munday's Gully as referred to by Saunders & Barratt is now known as Munday Brook.
8 Length and height are taken from a 1966 MWSS&DB plan (MWB 9740) showing reconditioning works as constructed.

The granite was usually quarried and broken down manually on site. An innovation on this site was the use of a diamond drill worked by compressed air and a stone crusher worked by a six horsepower engine. As the cement was both expensive and of uncertain supply, the practice at that time was to place large stones into each concrete layer to save concrete and therefore cement. This also reduced the need to break large stones down into smaller sizes. Known as "plums", the size was limited for manual handling. This practice with granitic plums up to about 500 mm in diameter is clearly visible in the exposed section of Victoria Dam. Later investigations revealed interconnected voids associated with the difficulties of embedding plums leading to moderate dam leakage. To stop leakage, the wall was reconditioned with a new skin in 1966. Concrete was placed relatively dry and compacted using hand rammers. Great care was needed to place the concrete before the cement began to set. In the 1890s concrete was placed in panels with a layer thickness of 230 mm. The size of the panels was limited by the rate at which concrete could be produced using manual mixing and transport while ensuring there were no cold joints. The site visit in December 1890 said there would be upwards of 60 men concreting.

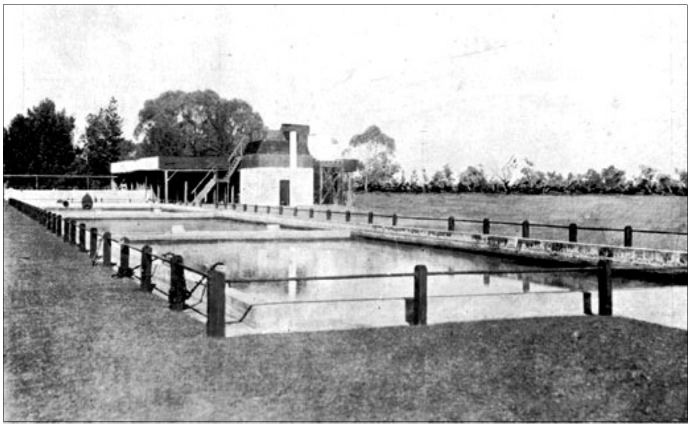


The original 12 inch main & later 21 inch main from Victoria Reservoir cross the Swan River next to the Causeway bridge at Perth. Ph oto courtesy Water Corporation

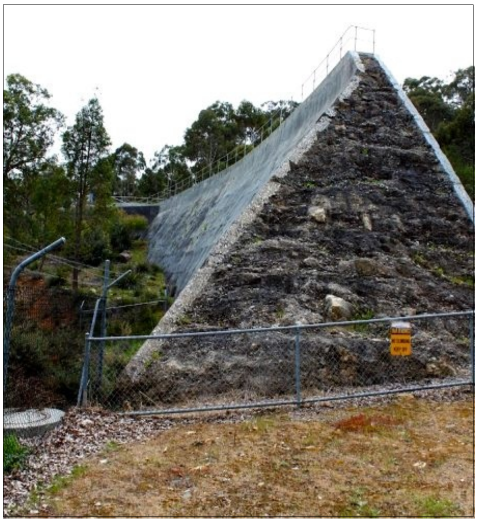
As the water level in the reservoir when full would be 530 feet above the entrance to the Town Hall in Perth and would exceed the safe working pressure of the pipes, Saunders and Barratt included a break pressure tank to give a working head of 300 feet. The December 1890 report also commented: that the twelve inch main had been laid from the break pressure tank to the foot of the hills and also from the Causeway to Mt Eliza; that the service reservoir was in an advanced stage of completion; and that an eight inch service main had been laid down Wellington Street.

The 12 inch diameter cast iron pipes had an effective length per pipe of 12 feet and it is calculated that the pipeline from Victoria Reservoir to the Mt Eliza reservoir would require 6,940 pipes with a total weight of 3,700 tonnes. Not all the pipes that were ordered made it to Fremantle, as 1275 tons of pipes still rest on the seabed off Rottnest Island after going down with the barque Denton Holme, which was wrecked in 1890. The final cost of the works was confidential to Neil McNeil & Co. but later newspaper reports during the negotiations with Government indicate that it was £160,000 (just over $22 million at 2011 prices).

From Michael Taylor and Terry Murphy, EHWA & Water Corporation



The first Mt Eliza Service Reservoir. Photo courtesy Water Corporation



Old Victoria Dam wall cut when a new wall was built 300m upstream in 1990 Photo Stuart Smith

Editor's Notes:

In 2012 Engineering Heritage WA nominated Perth's First Public Water Supply System for a heritage recognition award. The WA Water Corporation was very pleased to support the nomination and was happy *to sponsor installation of the marker and interpretation panel and assist with the dedication ceremony*. Engineering Heritage Australia presented the award at a ceremony held at the Water Corporation headquarters in October 2012.

Information panels about the scheme were erected near the site of the first water service reservoir in Kings Park, and at the remaining wall section of the original Victoria Dam. The comprehensive nomination document was written by Michael Taylor and Terry Murphy. Their original contains a great story, supported by comprehensive references and appendices – vastly more stuff than could be fitted in this Magazine. For those wanting more information, go to the PDF at:
https://www.engineersaustralia.org.au/sites/default/files/shado/Divisions/Western%20Australia%20Division/Groups/Heritage/perths_first_water_supply.pdf

the Innovators — a Book Review

Author Walter Isaacson — Published by Simon & Schuster, 2014

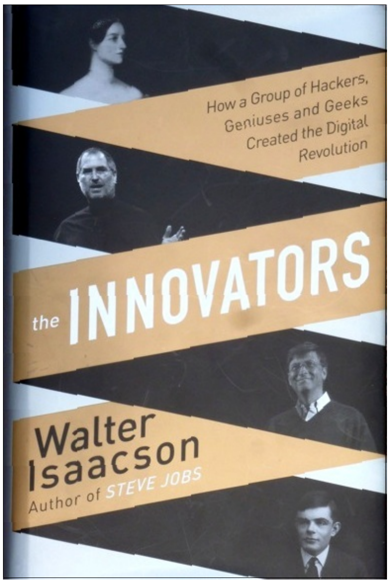
This book, by the author of 'Steve Jobs – a biography', looks at the evolution of computing from Charles Babbage's difference engine in the 1820s, through the successive steps in digital computer hardware and software development up to the creation of the Internet and the world wide web. Isaacson identifies key players in the progressive development of computer technology and provides profiles of their individual backgrounds, motivations, foibles and leading innovations. Whilst some critical innovations had their genesis with one individual, Isaacson emphasises that in most instances, practical developments involved collaboration. Engineers typically worked alongside mathematicians, psychologists, and other parties to bring a new innovation to commercial reality. Sometimes new developments arose by building on the work of predecessors, but in other instances things went forward by people branching out in a new direction to 'make the impossible possible'. While corporations were sometimes central to advances, at other times hobbyists, alternative lifestyle or 'hippy' individuals made the decisive moves. The provision of startup funds from venture capitalists also often played a vital role in turning a 'dream concept' into a commercial product.

The book starts in the first half of the nineteenth century, with Charles Babbage and his uncompleted mechanical engine for solving differential equations, using the numerical finite differences method, and his subsequent, and also never completed analytical engine. Babbage corresponded with Lady Ada Lovelace, Lord Byron's daughter, who studied mathematics and crystallised a vision for a 'general purpose computing machine'. The concept of a 'logical computing machine' that could handle any mathematical computation by suitable programming, was notably further advanced theoretically by Alan Turing (of Enigma code breaking fame at Bletchley Park during WW2) in his 1937 seminal paper on 'Computable Numbers'. Claude Shannon further progressed the idea with his vision to use electric circuits with electromechanical relays to perform logic operations based on Boolean algebra.

The first fully functional electromechanical programmable digital computer is credited to German engineer, Konrad Zuse who completed his Z3 model in 1941. This was followed by the 'Colossus' computer at Bletchley Park in 1943, which was used to crack the German high command message codes. Colossus used vacuum tubes (thermionic 'valves') to achieve much higher logic circuit switching speeds and thus computing speed. The first truly stored-program vacuum tube based electronic computer was ENIAC, built in 1945 for the USA military. The invention of the transistor at the Bell Laboratories in 1947 ushered in a major advance in computer hardware by replacing the vacuum tube technology with much smaller, low energy demand devices. Subsequent developments in semi-conductor technology led to the microchip by the Fairchild Corporation in 1959, to be followed in 1971 by the first microprocessor – the heart of a computer on a single silicon chip – the Intel 4004.

The microprocessor created the 'window' for the development of the personal computer, which interestingly was initially pursued by hobbyists working in 'proverbial home garages', rather than by corporations. Probably the most well known such enterprise was that of Steve Jobs and Steve Wozniak and the first Apple desktop computer.

The development of computer programs or 'software' was also critical to progress. The first compiler was created by Grace Hopper for the USA 'Univac' mainframe computer in 1952. In 1975, Allen and Gates formed Microsoft and produced the first version of the programming language 'BASIC' for the Altair personal computer. The 1967 ARPANET project for linking computers in academic and military institutions in the USA led ultimately to the Internet, with Tim Berners-Lee announcing the World Wide Web in 1991. Internet browsers followed, with Google launched in 1998 and the open encyclopaedia 'Wikipedia' was started by Jimmy Wales in 2001.



Isaacson's book encompasses some 490 pages plus a further 30 pages of 'notes' or references that indicate extensive research by the author. It is very readable, although I was personally irritated by the constant use of the USA term 'math' instead of 'mathematics'. A more substantive criticism was the omission of the Wi Fi technology that was developed in Australia by the CSIRO as an offshoot from work with radio telescopes. The only mention of this clever innovation that makes wireless communication on modern digital devices (including Smart phones and tablets) practical, is in a footnote comparing data transfer speeds. The Australian CSIRAC mainframe computer that was built by the CSIR Radio Physics Division and ran its first program in 1949 is also not mentioned, but although Australia was then arguably up with the vanguard of first generation valve based digital computer construction, its omission by a USA author is understandable. (The CSIRAC computer hardware, now a static exhibit at Museum Victoria, was accorded national engineering heritage recognition in 2004 and is believed to be the most complete first generation digital computer hardware surviving anywhere in the world).

The evolution of computing and its offshoots including the Internet and the world wide web, has involved many engineers along with other disciplines, and collectively is a heritage continuum stretching from the early nineteenth century to the present time. In this context, Isaacson's book is a useful record of key steps along the way and of notable individuals who influenced them.

Miles Pierce EHV

Engineering Heritage & Conservation Guidelines Revised

The Engineering Heritage & Conservation Guidelines of Engineering Heritage Australia (EHA) were first published in 1992. The Guidelines need periodic revision and improvement, and the third edition was published last year, in 2014.

The objective of the Guidelines is to inform engineers about how to deal with engineering heritage sites or works. This document provides engineers of all disciplines and types of practice with a mechanism to deal with heritage projects. We hope that the Guidelines will enable engineers to deal with heritage issues themselves or be persuaded of the need to seek assistance from Engineering Heritage professionals.

The review process was triggered after the adoption by the International Council on Monuments and Sites (ICOMOS) of the updated ICOMOS Burra Charter in October 2013. As well as updating the Burra Charter section in our Guidelines, we added two new appendices, No.3 on Movable Cultural Heritage and No.4 on Heritage Records. We also revised the list of museums which have collections relevant to engineering heritage – see Appendix 5.7. However, we removed the website addresses of these museums from the list because of difficulties in keeping the addresses up-to-date. These days, current contact details for an organisation can be quickly obtained by a web search.

Members of the National Board all had input into the process via their Division Groups and the document management was undertaken by Richard Venus, the Engineering Heritage SA Chairman.

Our philosophy is one of "continuous improvement" and we encourage anyone who reads this to provide feedback to the EHA Board through the Executive Officer Fiona Kethel. fkethel@engineersaustralia.org.au.

EH members can provide feedback through your Divisional Group representatives.

Any suggestions about how we can improve our communications with the broader engineering community would be most welcome.

Featured on the cover (see above) of the new edition is the Dunmore Bridge over the Paterson River at Woodville, NSW – an excellent example of heritage and conservation practice in action. The bridge is a rare and representative example of an Allan truss road bridge. It was reconstructed in 2011-2012 to meet current load requirements and reduce future maintenance costs while retaining its heritage values. The project received a "High Commendation" in the 2013 Colin Crisp Award.

From Richard Venus & Owen Peake

The Guidelines are available as a downloadable PDF at:
https://www.engineersaustralia.org.au/sites/default/files/shado/Learned Groups/Interest Groups/Engineering Heritage/ehc_2014.pdf

The Burra Charter of Australia ICOMOS

Readers who would like to see a copy of the *Burra Charter*, can download a copy from the Australia ICOMOS website at :
http://australia.icomos.org/wp-content/uploads/BURRA_CHARTER.pdf

The *Illustrated Burra Charter* (2004) of Australia ICOMOS is *an excellent guide to heritage practice in Australia* (and probably lots of other places). However, it is available only in hard copy. It can be purchased directly from Australia for a reasonable price.
See : http://australia.icomos.org/publications/burra-charter-practice-notes/illustrated-burra-charter/

Connections

International Water History Conference 2015, to be held in Delft, the Netherlands from 24th – 26th June 2015.

A reader in Adelaide alerted me to this event some time ago, but I mislaid his email. However, it's not too late for anyone who might be travelling in Europe soon, and it's appropriate – this issue of the magazine is all about water history !
Get conference information at : http://www.iwha.net/conference/date-and-location

2015 European Industrial and Technical Heritage Year.

In November 2009 industrial heritage associations from different European countries and regions met in Calais (France) to discuss cross-border co-operation and exchange of experiences and information. There was a large concensus on the proposal to launch the idea of an European Industrial and Technical Heritage Year. The idea came to pass, and you can find out all about it, and the programme, at: http://www.industrialheritage2015.eu/idea_industrial_heritage_year

The Australian Best Practice Guide to Collecting Cultural Material,

prepared by the Ministry for the Arts, will assist museums, galleries, libraries and archives to navigate the complex ethical and legal requirements of acquiring works by incorporating national and international guidelines into a single document.

Find a downloadable pdf of the document at : http://arts.gov.au/collections/best-practice

At left – The Guide cover image – Svetlana Bailey, 12/08, 2012 – from Artbank.

Big Stuff 2015

is an international meeting focussed on the challenges of conserving large industrial structures and technical objects. The 5th Big Stuff conference will be held on 3rd to 4th September 2015 at the mining museum of Centre Historique Minier (CHM) in Lewarde/France. The conference theme is *Technical heritage: preserving authenticity – enabling identity?* Conference homepage is at: http://www.bergbaumuseum.de/index.php/de/forschung/tagungen/big-stuff-2015

Big Stuff 2015 Call for papers: If you would like to present a paper at the conference please a send a one page abstract to Alison Wain (alison.wain58@gmail.com) **by 30 April 2015**. Please indicate your preferred conference session on the abstract. While the focus of the conference is on large technical and industrial heritage, comparative papers on size-related issues in other heritage areas will be considered.

The Guardian on Facadism

An email in NSW Heritage Advisors drew our attention to a Guardian article about Facadism – *Some front: the bad developments making a joke of historic buildings.* You can find it in this picture essay: http://www.theguardian.com/artanddesign/gallery/2014/aug/25/face-off-when-facades-go-bad-in-pictures

The travesty of good design at left is (unbelievably so) *The Art Gallery of Ontario in Toronto, Canada* – photo Alamy. Not strictly speaking engineering heritage, but we should beware of the same thing happening to our own historic industrial buildings and engineering structures.

And a couple of websites:

From Ken McInnes – The Conference Proceedings from the 4th Australasian Engineering Heritage Conference held in Christchurch last November are now available online at: http://www.ipenz.org.nz/heritage/Conference2014/Proceedings.cfm
and: See the article in *The Age* from 27 Feb 2015, *A bird's-eye view of Melbourne's transformation from 1945 to 2015* at
http://www.theage.com.au/victoria/a-birdseye-view-of-melbournes-transformation-from-1945-to-2015-20150227-13pd5v.html
The article describes the brilliant website that map enthusiast Nathaniel Jeffrey has created, combining and contrasting aerial photos of Melbourne from 1945 and 2015, at: http://1945.melbourne/ A great way to gain an overview of changes in Melbourne's infrastructure and land use. And for those of you, like me who love maps, a great time consumer. Enjoy!

Glenda Graham thought I might find this site interesting – I did! (and by the way – it's Portland Oregon not Portland Vic.)
http://magazine.good.is/articles/portland-pipeline-water-turbine-power