



RECOGNITION OF

PERTH'S FIRST PUBLIC WATER SUPPLY SCHEME

FOR AN

ENGINEERING HERITAGE MARKER

PREPARED BY ENGINEERING HERITAGE WESTERN AUSTRALIA | WESTERN AUSTRALIA DIVISION | ENGINEERS AUSTRALIA | OCTOBER 2012





ENGINEERING HERITAGE MARKER

In October 2012 Engineering Heritage Australia advised Engineering Heritage WA that its nomination of Perth's First Public Water Supply Scheme met the assessment criteria set down in Engineering Heritage Australia's Heritage Recognition Guidelines and the Scheme had been awarded an Engineering Heritage Marker.

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1. INTRODUCTION

THE FIRST EUROPEAN SETTLERS WHO CAME TO PERTH IN 1829 RELIED ON SWAMPS, LAKES, RAINWATER TANKS AND A FEW FRESHWATER SPRINGS FOR THEIR WATER SUPPLIES.

Early colonists also used wells in Perth and Fremantle. When population started to rapidly increase in the late 1800s due to the gold rushes, summer water shortages and pollution in the wells resulted in disease such as typhoid, and the need for a safe public water supply became urgent.

As there was disagreement between the Town Councils and the Colonial Government about responsibility for public water supply, a number of private proposals were developed by entrepreneurs in the community. One of these proposals, based on a dam on Munday Brook in the “hills”, was prepared by Perth civil engineers Henry John Saunders and James Barratt in May 1887. Following the Government’s rejection of funding assistance in August 1889, Perth City Council awarded a build, own and operate contract to a Melbourne contractor Neil McNeil and Co on 21 October 1889. Neil McNeil and Co was represented in Perth by Edward Keane and their successful tender was based on the proposal prepared by Saunders and Barratt.

Saunders and Barratt’s proposed water supply scheme included a new source of 140,000,000 gallons storage located in the Darling Range east of Perth, 16 $\frac{3}{4}$ miles of 12 inch trunk main, a 1,260,000 gallon service reservoir at Mt Eliza and city reticulation. Site clearing commenced in October 1889 and the site was ready by the time cement and pipes started to arrive four months later from England. When Victoria Reservoir was opened on 1 October 1891, the rapidly growing State’s population was less than 50,000 and Perth’s first public water supply scheme was a major undertaking.

After 99 years of service, a portion of the original Victoria Reservoir wall was demolished and a new Victoria Dam built 300 metres upstream. The original dam is accessible by public walk trails and traces of the original cast iron gravity trunk main, such as concrete pipe supports, still exist. The service reservoir at Mt Eliza has been replaced with significantly larger reservoirs, but the site is still a key operational site supplying the City of Perth today.

PERTH’S FIRST PUBLIC WATER SUPPLY SCHEME IS SIGNIFICANT IN THAT IT ALLOWED PERTH TO GROW IN RESPONSE TO THE STATE’S GOLD RUSH AND WAS THE PREDECESSOR FOR THE MAJOR COOLGARDIE GOLDFIELDS WATER SUPPLY SCHEME.

Engineering and construction of the scheme was “best practice” and was the model used for many of Perth’s subsequent “hills” water supply sources. Management of the scheme was controversial due to unprecedented rapid growth in demand and deterioration in the quality of the water due to timber mill camps in the catchment, issues that are still relevant for water supply authorities today. In the end, the privately owned City of Perth Water Supply Company’s 25 year contract was bought out early by Government. The first of many subsequent public boards of management was appointed on 5 October 1896.

OPENING OF PERTH WATERWORKS
AT VICTORIA RESERVOIR 1 OCTOBER 1891



The valve was turned on by Lilla Keane, the wife of the Mayor of Perth, Edward Keane, who presented the bid for construction of the scheme.

2. STATEMENT OF SIGNIFICANCE

The Scheme is Western Australia's first public water supply. Its opening on 1 October 1891 pre-dated the well known Coolgardie Water Scheme by more than eleven years (the opening ceremonies for the Coolgardie Scheme were on 22 and 24 January 1903).

The Scheme includes Victoria Reservoir which is a permanent entry (Data Base No. 3510) on the Register of Heritage Places by the Heritage Council of Western Australia. In its Statement of Significance the Heritage Council (in part) says:

- the place was the first water reservoir for public purposes in the Darling Range catchment area, and became, until its decommissioning in 1990, an integral component of an important cultural environment that has continuously supplied Perth with water since 1891;
- the place is a rare surviving representative example of a large concrete gravity-arch dam;
- the place is associated with prominent entrepreneur Edward Keane, its original promoter; with Dr. William Traylen, a leading campaigner on public health issues; and (in later years) with F. W. Lawson, engineer.

A list of large dams constructed in Australia¹ up to 1891 is as follows:

Name	Location	Date	Type	Height m	Length m
Parramatta	Sydney NSW	1857	Masonry arch	15	97
Yan Yean	Melbourne Vic	1857	Earthfill	10	963
Enoggera	Brisbane Qld	1866	Earthfill	23.5	475

Name	Location	Date	Type	Height m	Length m
Lower Reservoir	Hobart Tas	1867	Earthfill	18	104
Spring Gully	Bendigo Vic	1868	Earthfill	18	512
Upper Stony Creek No.1	Geelong Vic	1870	Earthfill	26	404
Hope Valley	Adelaide SA	1872	Earthfill	22	765
Lower Stony Creek	Geelong Vic	1873	Concrete Gravity	16	69
Evansford	Clunes, Central Highlands, Vic	1887	Concrete Gravity	17	76
Prospect	Sydney NSW	1888	Earthfill	26	2225
Beetaloo	Pt Pirie, Yorke Peninsula SA	1890	Concrete Gravity	35	180
Golburn Weir	Irrigation Victoria	1890	Concrete granite facing	15	212
Victoria	Perth WA	1891	Concrete gravity / arch	25	222

Note 1: Table extracted from a list available from the Register of Large Dams in Australia, provided by the Australian National Committee on Large Dams (ANCOLD) on www.ancold.org.au.

Lower Stony Creek (1873) is the first mass concrete dam in Australia, and the third in the World. Victoria is nine metres (50%) higher than Lower Stony Creek and the first to clearly incorporate the principles of an arch in the design.

The original Mt Eliza Service Reservoir (demolished in 1935) established the location of today's Mt Eliza reservoirs which remain a key component of Perth's water supply system. The Mt Eliza reservoirs are located in Kings Park which was originally gazetted as a public park and recreation ground in 1872. The boundaries of the land that was excised from Kings Park in 1890 for water supply purposes are essentially the same boundaries today.

The scheme concept of a hills source and pipeline along Bickley Road and what was then known as Canning Road (now Albany Highway) and then across the Perth Causeway established the basis and route for all of Perth's water supply for the next 70 years. It wasn't until the construction of the Serpentine Scheme and its trunk main to Mt Eliza via the Narrows Bridge in the early 1960s that new routes and new concepts were completed. When constructed, Victoria Reservoir could hold 240,000,000 gallons or 1.09 Gigalitres. The total capacity of the hills storages which perform the same concept that was developed in Perth's First Water Supply Scheme, from the new Victoria Dam in the North to Stirling Dam in the South, is now 605 Gigalitres.

Units Used to Specify Water Consumption and Storage

One Gigalitre	=	one thousand Megalitres
One Gigalitre	=	one million kilolitres
One Megalitre	=	one thousand kilolitres
One Megalitre	=	one million litres
One kilolitre	=	one thousand litres
One kilolitre of water	=	one thousand kilograms = one tonne

3. HERITAGE RECOGNITION AWARD NOMINATION FORM

The Administrator
Engineering Heritage Australia
Engineers Australia
11 National Circuit
BARTON ACT 2600

Name of work: Perth's First Public Water Supply Scheme

The above-mentioned work is nominated to be awarded an

Engineering Heritage Recognition Award

Location, including address and map grid reference:

This nomination includes the original Victoria Reservoir wall located at

Shire of Kalamunda, Canning Mills; -32°2'24"S, 116°4'0"E.

Pipeline route down Bickley Brook, along Albany Highway, across the Causeway, along St Georges Terrace and Mount Street to Kings Park. Some pipe supports remain at the crossing of Bickley Brook at -32°1'59"S, 116°3'9"E.

The Mt Eliza service reservoir was located in Kings Park. The current No 1 Reservoir completely replaced the original No 1 Reservoir which was located at -31°57'32"S, 115°50'34"E.

Owner (name & address):

Water Corporation, PO Box 100, Leederville WA 6902

The owner has been advised of this nomination and a letter of agreement is attached.

Access to site:

The original and the new Victoria Reservoir walls are accessible to pedestrian access at all times. Vehicle access is via Masonmill Road to the upper car park on weekdays from 8.00 am to 5.00 pm. The public can access the dam walls from this car park via the signposted walk trail, a 300 to 400 metre walk. On weekends and public holidays the entrance gate is closed but public can still access the site using a number of walk trails in the area.

The Mt Eliza service reservoirs are closed to the public to ensure security of water quality, but there is a popular Kings Park walk trail around the northern and eastern boundary with significant visibility of the current reservoirs and their roofs.

Nominating Body:

Engineering Heritage Western Australia, Western Australian Division.



Prof. Mark Bush, Chair of EHWA

Date: 22 Aug 2012

4. OWNER'S LETTER OF AGREEMENT

Your Ref:
Our Ref: JT1 2011 08537 V01
Enquiries: Terry Murphy
Telephone: 08 9420 2851



17 July 2012

Dr David McCarthy
Engineering Heritage Australia
Engineers Australia
11 National Circuit
BARTON ACT 2600

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Dear Dr McCarthy

**Perth's First Public Water Supply Scheme
Nomination for Engineering Heritage Recognition Award
Owner's Letter of Agreement**

This letter accompanies the nomination by Engineering Heritage WA to Engineering Heritage Australia of Perth's First Water Supply Scheme for a heritage recognition award.

The Water Corporation is very pleased to support this initiative of Engineering Heritage WA and if the nomination is successful, the Corporation would be happy to sponsor installation of the marker and interpretation panel and assist with the organisation of a dedication ceremony.

If you have any queries please contact Terry Murphy or Brian Robertson on 08 9420 2420 or Terry.Murphy@watercorporation.com.au.

Yours sincerely

A handwritten signature in black ink, appearing to read "C. Ferrari".

Catherine Ferrari
General Manager Communications

5. HISTORICAL BACKGROUND

The new settlement of the Swan River Colony in Western Australia, proclaimed on 1 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 shallow wells supplemented by rainwater tanks fed for only a few months each year from house roofs (for the wealthy residents only), 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 built by Governor Kennedy in 1861.

Predictably, water shortages occurred and, worst of all, wells became polluted by 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 as 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; and
- d. the rivers and brooks issuing from the Darling Range.

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

The preferred option initially met with some opposition because of the cost, estimated at about £100,000 (\$A14 million 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.



The service reservoir for the first scheme, constructed on Mt Eliza, Kings Park.

In 1887 two civil engineers, Henry Saunders 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 16 $\frac{3}{4}$ 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 rates of 1 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.



Inlet pipe to Victoria Reservoir

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 balked 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 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 syndicate, Edward Keane, 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.

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 reoccurring 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 (\$A32 million 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.

Among the wide array of achievements in Western Australia since the arrival of Europeans, the management of scarce water resources in this very dry part of the world has been at the forefront of community concern, and remains a concern today. The first public water supply scheme developed by Saunders and Barratt was the start of engineering developments to provide for the growth of Perth and to improve public health. It was the forerunner of a series of similar schemes in following decades that, in tandem with groundwater supplies and more recently with desalination plants has enabled the Perth metropolitan region to become the successful, vibrant place that it is to-day.

6. SCOPE OF SCHEME

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 and attached at Appendix A comprised: "a dam at Munday's Gully² 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 estimated population of Perth 7,000 and Fremantle 4,500, thus allowing for a good margin for future increase. Recognising the importance of this assumption, the document included notes on water works at Geelong and Bendigo in Victoria. (Of interest, the Water Corporation's current target for consumption of 125 kilolitres per person per year, which includes garden use, is 75 gallons per day).

The document also included conditions necessary such as the need for "The Government to bring in and get passed by the Legislative Council a "Water Works Bill" for the purpose of legalising these presents." 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.



Victoria Reservoir depleted at the end of a long, hot summer.

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."

The original Saunders & Barratt proposal of 1887 was for both the City of Perth and the Town of Fremantle. Following a meeting of

ratepayers on 16 August 1887, the Town of Fremantle decided "it is undesirable that Messrs. Saunders and Barratt's scheme should be extended to Fremantle, as we are firmly convinced that a much cheaper supply of pure and wholesome water can be procured from the hills behind the convict prison, or from the supply within the prison walls on a very small outlay".

Note 2: Munday's Gully as referred to by Saunders & Barratt is now known as Munday Brook.

7. DESIGN AND CONSTRUCTION OF THE SCHEME

DESIGN

As stated in the book titled "Dam Technology in Australia 1850-1999, "the construction of large dams called for experienced engineers to choose the site, prepare the plans, produce a reliable cost estimate and, when approval was given, supervise the construction. In the 1850-1900 era, the expertise in dam building was supplied by British engineers with experience in India and Egypt. Fortunately for historians, several of these engineers published quite lengthy papers on their Australian projects in the Proceedings of the Institution of Civil Engineers in London. Members of that Institution took a lively interest in diverse projects in many British colonies, including the construction of major dams in Australia."

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. Later analysis demonstrated that 90% of the dam strength came from gravity and 10% by arch action. By incorporating arch action into the design, considerable savings in quantities of material and therefore cost were achieved. More common use of the arch design did not start until later in the 1890s in NSW.

A dam that was also being built in 1890 and which is similar to Victoria Reservoir was Beetaloo Dam on the Yorke Peninsula in South Australia. The similarities between these two dams show that despite the communication difficulties that existed in Western Australia at that time, Saunders and Barratt incorporated the latest developments in dam technology in their proposal.

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. Site evidence indicates that there were two break pressure tanks between the dam and the Darling Scarp. It is unknown if both were constructed as part of the original scheme or if the second was constructed in 1911 to enable the linking in of the Upper Bickley Brook weir.

On page 5 of 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", it was stated that:

"Accompanying the Report are the following Plans:-"

- No.1 Government map showing the general features of the Scheme
- No.2 Plan of Impounding Reservoir at Munday's Gully
- No.3 Cross Section of Reservoir Site
- No.4 General Plan of Concrete Dam
- No.5 Section from Impounding Reservoir at Munday's Gully to Service Reservoir on Mt Eliza and on to the Railway
- No.6 Plan of Service Reservoir
- No.7 Plan of Perth, showing Distribution Mains
- No.8 Plan of Fremantle, D°. D°.

An extensive search has been made for a set of these plans, but they cannot be located. There are some early 1900s plans of Perth Water Supply, and from one of these there has been a reconstruction of the general features of the scheme. A copy of this plan is on page 12.

Water Corporation records do have a copy of a Victoria Dam plan with the No.4 indicating it was, or is copied from, the Saunders & Barratt original. A copy of this plan is on page 13.

A copy of the 1885 plan of the City of Perth attached to the "Report of the Commission Appointed to Inquire into and Report upon the Sanitary Condition of the City of Perth and the Town of Fremantle" has been located at the State Library of Western Australia, image number 243/16 (1249C). The shaded areas on the plan are the more populous portions of the City in 1885. Newspaper articles (The West Australian 7 September 1891 page 3, Western Mail 12 September 1891 page 6) describe "The Water Area" and location of the distribution mains. From this plan and the newspaper description, "Plan No.7 Plan of Perth, showing Distribution Mains" has been reconstructed. A copy of this plan is on page 14.

Included in the proposal by Saunders and Barratt (item 3) and confirmed to the Perth City Council by Mr Keane (refer West Australian, 10 September 1889, page 3), was a commitment to draw up a working specification for approval by the engineer of the Municipal Council or Director of Public Works. A hand written document has been found which appears to be the specification and detailed estimate for the works. The author is unknown, but it describes in detail the engineer's requirements. A typed up copy of the specification is attached at Appendix B and a scan of the original estimate (which totals £116,324-3-0) is attached at Appendix C.

PLAN NO. 7:
 PLAN OF PERTH,
 SHOWING
 DISTRIBUTION
 MAINS



CONSTRUCTION

Work began on the dam in October 1889. While no reports or photos of the construction of the scheme are available, there are some tantalising brief accounts in the Perth press, including site visits by VIPs on 30 October 1889, 2 December 1889, 7 May 1890 and 7 December 1890.

The report of the visit 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 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.

A plan of the “Storage Reservoir” showing the relocation of the Victoria Dam wall was photographed in 1990. The plan has since been lost but a copy of the photograph is on page 16.

As well as clearing the reservoir basin, the contractor also constructed a weir at the top and by-wash channels around both sides of the basin to divert flows during construction as was the practice at that time.

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). Length and height are taken from a 1966 MWSS&DB plan (MWB 9740) showing reconditioning works as constructed. More detail on the dimensions of the dam is included in the report by Mr. W. Thwaites, Engineer to the Melbourne Water Supply (Western Mail, Saturday 26 September 1891, page 9). In this report Mr. Thwaites also says “In one place the granite has been followed down a considerable depth so as to ensure a thoroughly good connection with the rock right across the valley.” “The total depth at the centre part of the dam from the top of the wall to the bottom of the trench will be 111ft.”

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.

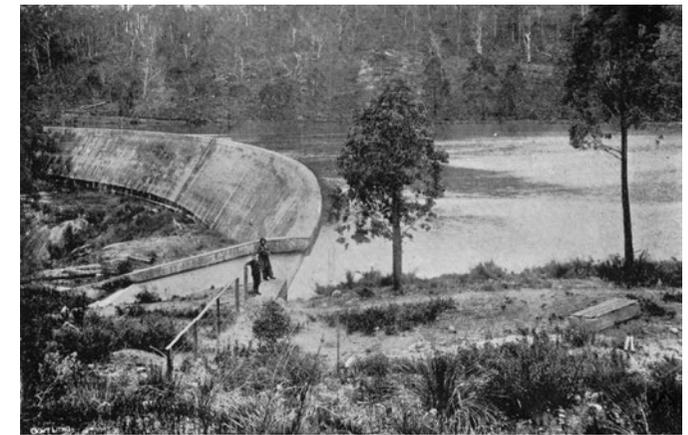
The granite was usually quarried and broken down manually on site. An innovation on this site was the use of a diamond drill worked by compressed air and a stone crusher worked by a six horsepower engine. As the cement was both expensive and of uncertain supply, the practice at that time was to place 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 upstream 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 report in December 1890 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. The service reservoir was in an advanced stage of completion and an eight inch service main had been laid down Wellington Street. The works were inspected by Mr W Thwaites of the Melbourne Water Supply Department who expressed himself perfectly satisfied with what he had seen that day.

While no details are available, it appears from newspaper accounts and information on the demolition that the service reservoir had a concrete base and rendered brick masonry walls. It was also reported that the constructed size was 643,650 gallons (Western Mail, 26 September 1891, page 9) as compared to the Saunders & Barratt proposal of 1,260,000 gallons.

In December 1890 all the pipes had been landed and reticulation work was about to commence. 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 delivery ship, the barque Denton Holme, which was wrecked in September 1890.



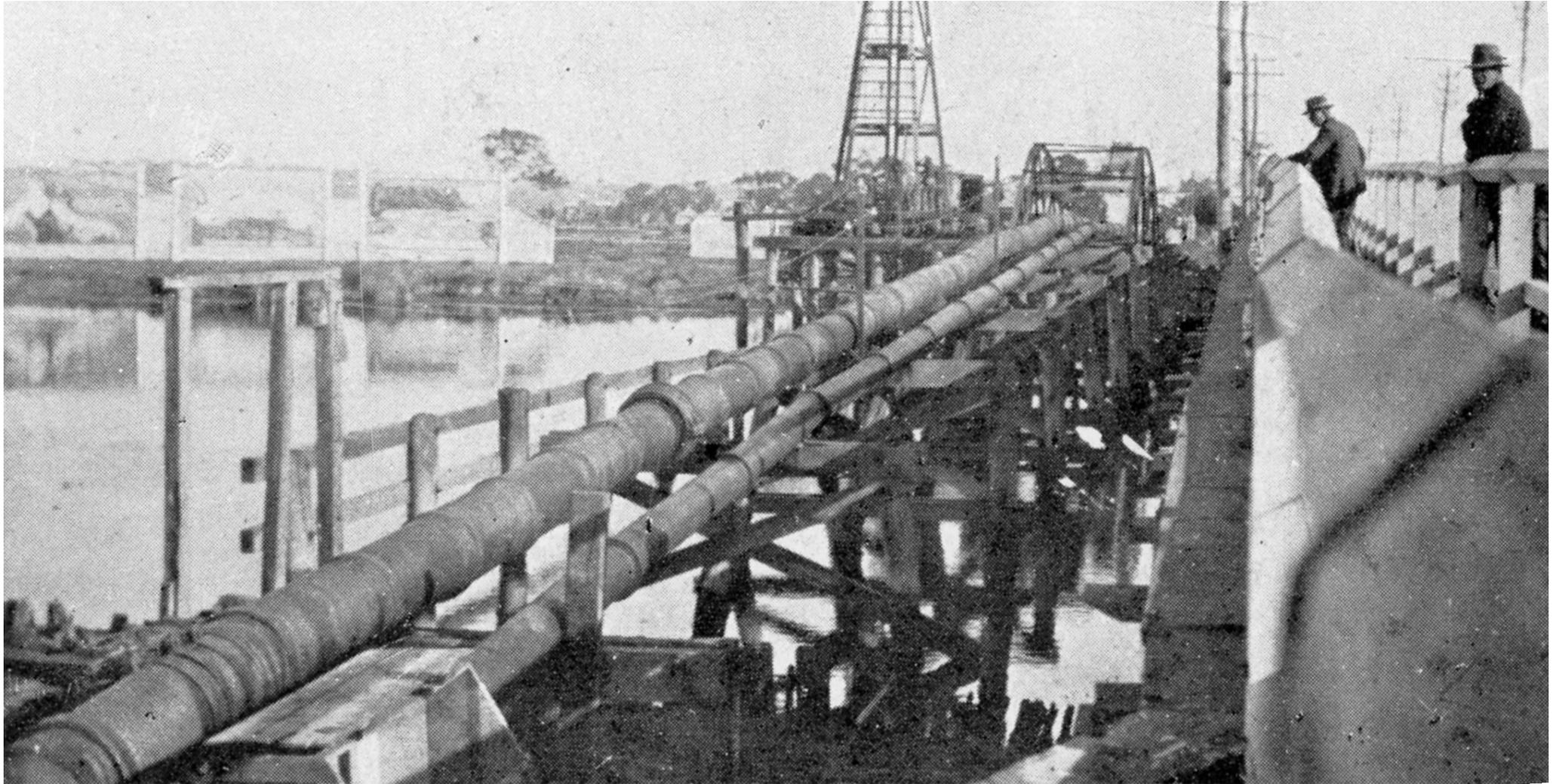
Victoria Reservoir

Works included a storage shed at Fremantle port for incoming materials which were barged upriver to Masons Landing on the Canning River then transported to site via the timber mill railway. The final cost was confidential to the contractor Neil McNeil and Company but later newspaper reports during the negotiations with Government indicate it was £160,000 (just over \$22 million or \$3,200 per person served at 2011 prices).

PLAN NO. 2:
RELOCATION OF
VICTORIA DAM
WALL (FROM
1990 PHOTO OF
A PLAN THAT
HAS SINCE BEEN
LOST)



THE ORIGINAL 12-INCH MAIN AND SUBSEQUENT 21-INCH MAIN FROM VICTORIA RESERVOIR CROSS THE SWAN RIVER NEXT TO THE CAUSEWAY BRIDGE AT PERTH.



8. THE FIRST FIVE YEARS

The first five years of operation of the new Perth Water Supply scheme were not as successful or happy as everyone in the city had hoped. On the contrary, the scheme was plagued by controversy.

The first operator, the City of Perth Water Supply Co. Ltd., faced a rash of complaints about water availability and quality, pressure loss and high charges, and to make matters worse, the catchment became contaminated by farming and timber mill activities, contributing to high rates of typhoid in Perth.

All this happened at a time when Perth was experiencing a particularly dry spell with below average rainfall, but with strong growth in the population and consequent demand for water. It was a test that the new scheme failed to pass.

The Company was reluctant to commit further funding to improve the new scheme. A major fault lay with the main pipeline which quickly became encrusted, thus reducing the flow rate. In addition, the pipeline did not have the structural strength to cope with the full available head of pressure, so was operated at reduced pressure with a proportionate reduction in output. During its first summer, the scheme was providing only limited supplies, with some consumers having piped water for just a few hours per week.

Water quality was affected by suspended sediment and minerals in the pipeline and pollution in the catchment from sewage from the timber mill camps and waste from farm animals – on at least one occasion, even a bullock carcass! William Traylen told Parliament in early 1892 that there had been three cases of typhoid at the mills, resulting in one death. He drew up the Municipal

Water Supply Preservation Bill which, when passed, gave the Perth Local Board of Health power to prosecute cases of pollution of the catchment area.

But the timber industry thrived, and by the end of 1893 there were three saw mills operating in the catchment with a community of about 400 people and up to 40 permanent horses, with an additional 150 horses and bullocks during busy times.

Within just a fortnight of the new scheme coming into operation there had been loud complaints about charges, with the Company facing accusations of gross over-charging of working class clients and a general lack of public consultation. There were inferences of corruption and conflict of interests against Edward Keane, who had negotiated with the Perth City Council on behalf of Neil McNeil and Co. to build the water supply scheme and subsequently chaired an acrimonious public meeting over scheme problems in his role as Mayor.

The meeting resolved to stop paying rates to the Company until reasonable charges were agreed to. A subsequent inquiry into the Company's operations was conducted by the Perth City Council, and an amended scale of charges was fixed for water rates, excess metered water and installations. The Council also assumed advisory and decision making capacities within the Company.

Calls began to be heard for the scheme to be taken away from the Company. A strong campaign to protect the water supply by cleaning up the catchment pollution was led by William Traylen, an MP who campaigned on public health and had been a driving force behind construction of the supply scheme. His Bill, the Municipal Water Supply Preservation Act, in 1892 effectively

placed the catchment in the control of the City Council's Board of Health, however the Board lacked the necessary powers to force improvements.

Water supply problems, complaints and deaths from typhoid grew to such an extent that in 1896 the Premier, Sir John Forrest, obtained parliamentary consent for the purchase of the water supply scheme at a price of £220,000, an increase of some 35 per cent on the construction cost. Control of the scheme was given to an independent Metropolitan Waterworks Board chaired, surprisingly, by Edward Keane, who had been recently bankrupted. At its first meeting the Board resolved to turn off water in the city between midnight and 6am.

The Board launched into scheme improvements, installing several artesian bores and diverting a contaminated stream in the catchment. In a major and effective improvement, it laid a larger 21 inch (533mm) pipeline to Mt Eliza.

Unfortunately, trouble continued to dog the scheme, and the Board's expenditure became the subject of a Government inquiry, led by Forrest who grilled Keane for two days. The old accusations against the hapless chairman were aired once more – and new ones levelled concerning mismanagement. The Board members resigned and a new board was appointed with William Traylen as Chairman. Its first action was to increase the price of water.

9. CURRENT CONDITION OF THE SCHEME



A central one-third section of the original Victoria Dam was blasted to create a channel for overflow water from the replacement dam 300 metres upstream.

The original Victoria scheme was modified and enhanced almost from its inception. Its main constituent portions are still critical parts of the Integrated Water Supply Scheme (IWSS) for Perth but in ways far in excess of that considered by its builders.

DAM

The original dam was taken out of service on 3 April 1990 – 99 years and six months after being commissioned. A new much larger replacement has been constructed 300m upstream, in fact on the dam site originally proposed by Saunders & Barratt.

To allow for the maximum flood overflow from the new dam, the old dam had a section blasted out of it which extends down to the current upstream ground level (approx 2m above natural surface level). Apart from the removed section, the wall is otherwise intact showing the original wall, the 1966 upstream skin, the intake tower and spillway.

Immediately downstream of the old dam are twin microscreen filters (1996), a Chemical Dosing building (1994) and a Pump Station (1966, upgraded 1995).

PIPELINE

There is nothing left above ground of the 1890 or 1896 pipelines apart from some support pillars near Bickley Dam. The original 1890 pipeline was largely taken up in the mid 1920s, reconditioned and put to use as feeder main in other parts of the metropolitan scheme.

There is a considerable length of the 1896 21 inch (510 mm) cast iron main still in use in Bickley Road, and this pipe is the oldest water pipe in its original location in the metropolitan system.

In 1992 the new dam was connected by a DN1200 mild steel concrete lined outlet main to the DN1400 main from Canning Dam and which runs along Tonkin Hwy. The new Victoria Dam now acts as both a source and as a balancing storage for the IWSS.

SERVICE RESERVOIR

There is now nothing left of the original 1890 service reservoir which was demolished in 1934/1935 with the demolition material carted to the Causeway for fill. (State Records Office Consignment No. 903, Item No. 1934/1540, Metropolitan Water Supply, Reservoirs, Mt.Eliza, Working File)

The 1901 pond #2 was demolished at the same time, but the floor and one wall of pond #2 was incorporated in a new Pond #1 constructed in 1935 and remains in use today. The current ponds #2 and #3 were constructed in 1911 and 1923 respectively.

10. ASSESSMENT OF ENGINEERING HERITAGE SIGNIFICANCE

HISTORIC SIGNIFICANCE

The completion of Perth's First Public Water Supply Scheme was of historic significance because without it Perth and Western Australia would never have been able to respond to the large numbers of people who arrived with the opening of the goldfields. Between 1880 and 1891 the population in Western Australia grew by 84% to 53,285. By 1901 there was a further increase of 245% to 184,124.

While most of the population in farmlands and goldfields relied on their own sources for water, the outbreaks of disease in Perth in particular that are documented in the publication "Cleansing the Dughill" by Su-Jane Hunt and Geoffrey Bolton could not continue.

The 1880s were also very difficult financially for the Colonial Government with very limited funds being provided by the British Colonial Office. The Colonial Government was also of the opinion that water supply was a municipal matter as was the traditional model in England. The City of Perth had limited funds so the scheme became Western Australia's first Public - Private - Partnership (PPP).

Based on this model, the Western Australian Legislative Assembly in 1894 resolved that the supply of water to the Goldfields would be left to private enterprise. However by the time details of the Goldfields Water Supply Scheme were reported on by the Engineer-in-Chief C. Y. O'Connor in July 1896, it was recognised that this would be a Government scheme. While there is no direct evidence, the performance of the City of Perth Water Supply Co. Ltd. would have had some influence on the strategy and ultimate success of the Goldfields Scheme.

Government versus private ownership of public water supply is an issue that continues today. The question was again examined by the Productivity Commission in 2011 (refer West Australian, 15 February 2011, page 12). While there are now a number of examples of private ownership of water treatment and desalination sources in New South Wales and Victoria, as far as it is known, Perth's First Water Supply Scheme is Australia's first and only privately owned "Public Water Supply Scheme".

HISTORIC INDIVIDUALS OR ASSOCIATION

The dominant individual in Western Australia at that time who influenced the approach for the provision of a water supply scheme was the first Premier Sir John Forrest. Sir John was consistent in believing water supply was a municipal issue, but ultimately agreed to State Government funding of the purchase of the scheme for £220,000 and the appointment of the first Board on 5 October 1896. Sir John went on to Federal politics and was Australia's first Postmaster-General, Minister for Defence and Home Affairs and Treasurer for 15 federal budgets.

CREATIVE OR TECHNICAL ACHIEVEMENT

Water supply schemes existed in all of the capital cities in Australia as far back as the first schemes in Sydney and Melbourne in the 1850s. The achievement of Perth's First Water Supply Scheme was the adaption of the latest technical approach by local engineers to local conditions. The design of Victoria as a concrete gravity arch wall was leading practice and the construction of the entire scheme (including shipping of cement and pipes from England) in 23 months reflects a very effective approach to construction.

SOCIAL

The provision of a water supply scheme would have made a major difference to the health and amenity of the citizens of Perth. Newspaper articles talk not only of the water for personal use, but also of its importance for fire fighting and dust suppression during the long hot summers. Ultimately, as the City of Perth Water Supply Co. Ltd. was not able or willing to respond to:

- pollution on the catchment;
- corrosion in the cast iron mains; or
- demand for expansion of the system, particularly into other local authorities,

the social need for a water supply forced a reluctant State Government to act and provide funds for a Government appointed Board.

RARITY

Because the new Victoria Reservoir wall has been built upstream and the centre of the original wall removed, a cross section and both upstream and downstream faces are available for public inspection. This would be the only location in Australia where an 1890 dam can be viewed in this way.

Part of the original 1890 pipeline was laid in dry sandy conditions in Kings Park. This section has never been disturbed and a section of the 12 inch diameter cast iron pipeline still in good condition and complete with lead joints has been recovered for display. In addition, a number of lengths of the 1897 riveted steel 21 inch pipe are on display at Victoria Reservoir. Both these pipes pre-date the locking bar technology pipe that was developed for the Goldfields Water Supply Scheme.

11. PEOPLE ASSOCIATED WITH THE SCHEME



HENRY JOHN SAUNDERS

Born in England in 1855, Saunders was co-designer of Perth's first public water supply scheme, having arrived in the colony in 1884 after training and working in England as a civil engineer. He worked on railway development in Perth and established a partnership with James Barratt, the other co-designer of the scheme. Saunders had

experience on hydraulic projects, and he probably designed the total system for the new Perth supply scheme, including choosing the design for the dam wall.

The partnership was dissolved in 1888 and Saunders continued alone, turning his attention to the mining industry and bringing the state's mineral resources to the attention of London investors. He obtained capital for development of first-class leaseholds and employed up to 26 men on clerical and mine management work. He was a Perth City Councillor for five years, Mayor for two years and was elevated to State MLC for Metropolitan Province, 1894-1902. He filled an extraordinary vacancy in the first Federal Senate in 1903 then returned as a WA MLC in 1918.

He was an officer and member of a number of racing and exclusive clubs, and was a horse breeder and ran sheep, cattle and pigs on a large property in the Swan Valley. He died in 1919.

JAMES BARRATT

Born in England in 1858, Barratt worked there as a contract engineer for some time on railways. In 1880 he spent a year in New South Wales on military reconnaissance and railway work then returned to England from 1881-84 for more railways work. In 1884 he moved to Perth where he continued with railway work, commencing as chief engineer for the Midland Railway Company.

His role in the new water supply project for Perth probably focused on fieldwork and mapping, and he located the site for the reservoir. He also conducted a thorough survey which enabled him to draw a contour plan of the reservoir basin, and he surveyed the fall from the storage reservoir to the service reservoir in Perth.

After ending the partnership with Henry Saunders (see above), he went into partnership with surveyor William Angove, and both men moved to Albany where they conducted a business as surveyors and civil engineers. This partnership was dissolved in 1889, and Barratt officially became a licensed surveyor. He moved back to Perth the next year but shortly after moved to Melbourne, working as a civil engineer for another 22 years. It is not known when or where he died.



EDWARD KEANE

Keane acted in Perth for the Melbourne based Neil McNeil and Company when it successfully bid for the Perth Water Supply Scheme.

He was born in England in 1844 and trained as a civil engineer, helping to build railways

before moving to South Australia where he continued that work before moving again in 1882 to Western Australia where he built some 500 miles of track and became involved in surveying, building and timber milling through the family of his wife, Lilla. One of his "building" projects was the completion of St Georges Cathedral in Perth.

Keane was elected MLC for Geraldton in 1886 and was a member of the select committee that inquired into the Saunders and Barratt proposal for the water supply scheme. In 1889 he was elected MLC for Perth and bought a timber concession from Mason and Bird at Canning Mills. He also began negotiations with the Perth City Council on behalf of Neil McNeil and Co. to build the water supply scheme. He went on to manage the works until the end of 1890 when he was elected MLA for Geraldton and became a Perth City Councillor, being elected Mayor the following year. His wife officially opened the new water supply scheme at Victoria Reservoir on 1 October, 1891. However, Keane soon faced pressure over subsequent pollution of the new catchment from his Canning mills, and he resigned as Mayor in 1892.

Keane was involved in more railway construction and timber milling work in Perth, and invested in gold mining – financing prospecting parties and trading leases. In 1895 he became manager of the Midland Railway Co.

Following purchase by the new State Government of the Perth Water Supply scheme in 1896, Keane was made chairman of a board of management, but after one year the board was asked to resign following an investigation into its activities. Keane was declared insolvent amid questions of corruption, and pursued farming at his Grass Valley property. In May 1904 he won the Legislative Council seat of Eastern Province but died in July of that year before taking it up.

NEIL MCNEIL

McNeil was born in Scotland in 1855 and migrated to Victoria with his parents in about 1860. He was educated at Ballarat College and went to work with his father, a railway contractor. After a few years he branched out on his own and won railway works contracts in Victoria, South Australia and Tasmania. In 1882 he turned his attention to Western Australia, undertaking railway works before taking on the Perth water supply scheme in association with two other Melbourne businessmen. When Keane ceased to manage the project in December, 1890, the task was taken up by William George (see below), a Neil McNeil and Co. employee.

McNeil also became heavily involved in timber milling in Perth and sold timber to London buyers while raising capital there for his operations which in 1897 became Jarrahdale Jarrah Forests and Railways Ltd., eventually employing some 300 men in mills.

Around 1890, McNeil bought ten acres of prime riverside land at Peppermint Grove in Perth and built a mansion, largely of jarrah, which still stands. In the 1890s his business interests expanded and diversified rapidly, going into mining, fruit growing, real estate and breeding of carriage horses. He died in Perth in 1927.



WILLIAM JAMES GEORGE

Born in England in 1853, George studied mechanical engineering, later working as an iron merchant and bicycle maker. In 1884 he moved to Victoria where he joined Neil McNeil and Co. and was involved in the building of Tasmanian and Victorian railways and an aqueduct. He moved with his new wife, Mary Ann, to WA in 1890 to manage the company's Jarrahdale timber station and construction of the Perth Water Supply Scheme.

In 1894, with a partner, he established the successful Black Swan foundry in Perth and was elected to the Perth City Council. In 1895 he won the seat of Murray in the Legislative Assembly, becoming a campaigner against government railways policy, and in 1899 became chairman of the Chamber of Manufacturers. On retiring from the Parliament and foundry in 1902 he became Commissioner of Railways and made a number of improvements to railways administration at a time when traffic volumes and track mileages grew.

George retired in 1907 and took up farming but later returned to Parliament, again representing Murray. He had terms as Minister for Works and Trading and Water Supply. He finally left Parliament in 1930 and died in Perth the following year.



WILLIAM TRAYLEN

Born in England in 1843, Traylen migrated to Western Australia aged 24 and became ordained as a Wesleyan minister in 1870. He served in several country towns but left the ministry for health reasons to set up business as a printer in Perth.

He became a Perth City councillor and a member of the Sanitation Commission that led to the construction of Perth's first public water supply scheme. But, claiming the commission's report had been 'pigeon-holed' by the Government, Traylen promoted the newly designed Barratt and Saunders scheme, and was shown the proposed site of a new reservoir by Henry Saunders. He then raised a petition calling for a public meeting which produced a resolution calling for urgent action.

He was elected for the district of Greenough in the Legislative Assembly in the first state Parliament in 1890 and became a leading campaigner on public health, becoming known as 'water on the brain' Traylen. Following completion of the supply scheme Traylen claimed that timber milling activities were contributing greatly to pollution of the water storage in the new Victoria Reservoir. He drafted and printed his own Bill, the Municipal

Water Supply Preservation Act, in 1892, and it quickly passed through both Houses, effectively placing the catchment in the control of the local board of health.

Following a tour of the eastern colonies examining sewerage schemes, he made several unsuccessful attempts to introduce measures to bring water and sewerage in Perth under a single authority and to introduce deep sewerage.

Finally, in 1896 the Perth City Council handed control of the water supply scheme to the State Government which purchased the scheme and created a board of management in 1896. But more problems plagued the scheme, and following an investigation into the Perth water supply by a Parliamentary Select Committee the Board members resigned. A new Board was set up and William Traylen was appointed Chairman.

The new Board made important improvements to the scheme, and Traylen served on it until 1904 when the Metropolitan Water and Sewerage Act was enacted with a provision for a Minister to exercise the Board's powers. Traylen died in 1926.

WALTER HOWARD JONES

Jones was the company secretary of the City of Perth Water Supply Company Ltd which was set up to operate the new scheme upon its completion in 1891. He became secretary of the independent board of management for the scheme that was established in 1896 upon sale of the scheme to the State Government.

Scant accounts of his life remain today, however it is perhaps worth recording that in a touch of irony in 1898 he was replaced as secretary after being absent for four months – two of them in hospital and the other two convalescing at Albany – suffering from an episode of typhoid – the very disease that the scheme had been built to combat.

12. ACKNOWLEDGEMENTS

Considerable material on Victoria Reservoir and the history of Perth's Water Supply was already available as listed in the References. This work focused on the First Water Supply Scheme as designed by Saunders and Barratt and was successful in finding the original Saunders and Barratt proposal and the works specification.

The working group of Water Corporation employees involved in the development of this engineering heritage recognition proposal were:

Mike Taylor (Chair), Terry Murphy, Brian Robertson, Peter Minson and Perry Beor.

The support for heritage recognition and establishment of a display in the John Tonkin Water Centre by Catherine Ferrari, General Manager Communications, was greatly appreciated.

While a search for the eight original Saunders and Barratt plans was unsuccessful, efforts by staff at the City of Perth History Centre and the State Records Office was appreciated. The reconstruction of Plan No. 7 "Plan of Perth Distribution Mains" based on the 1885 plan of Perth and a description in the West Australian of 7 September 1891, page 3, was by Karen McGregor in the Water Corporation Infrastructure Design Branch.



Victoria Reservoir

13. REFERENCES

PARLIAMENTARY REPORTS, BOOKS, PAMPHLETS

Government Printer (1885), Report of the Commission Appointed to Inquire into and Report upon the Sanitary Condition of the City of Perth and the Town of Fremantle, especially with regard to the questions of water supply and the disposal of sewage, Presented to the Legislative Council.

Saunders & Barratt (1887), Proposals and Report on the Proposed Water Supply for the City of Perth and Town of Fremantle, State Records Office of Western Australia, Item No. 1887/063 Consignment No. 1067, Item No. 1887/2255 Consignment No. 527.

Government Printer (1887), Report of the Select Committee of the Legislative Council Appointed to Inquire into the Proposals of Messrs. Saunders & Barratt for a Water Supply for the City of Perth and Town of Fremantle.

State Law Publisher (1889), The Water-works Act, An Act to enable Municipal Councils to construct Water Works, or to Contract for a Water Supply, Assented to 4th December, 1889.

Traylen, W. (1889), The Agreements with the City of Perth Water Supply Company Limited, the Company's By-laws, and Parts III & IV of the Waterworks Act 1889, with explanatory notes.

State Law Publisher (1896), Metropolitan Water Works Act, An Act for the Purchase, Extension, and Management of the Metropolitan Water Works, Assented to 8th October, 1896.

Government Printer (1897), Metropolitan Water Works Board, Report of Works carried out to date, Presented to both Houses of Parliament, Second Session, Third Parliament.

Government Printer (1898), Report of the Select Committee of the Legislative Assembly Appointed to Inquire into The Perth Water Supply and Administration of the Metropolitan water Works Board, Laid upon the Table of the House on Tuesday, 4th October, 1898.

Government Printer (1907), Hills Water Supply - Report of Board on Schemes to Supply the Metropolitan Area (Fremantle to Midland Junction Inclusive) with Hill Water.

Metropolitan Water Supply, Sewerage, and Drainage Department (1925), Commemoration Volume 1925.

Hunt, Su-Jane (1977), Sanitation and Water 1827-1930.

Hunt, Su-Jane & Bolton, Geoffrey (1978), Cleansing the Dunghill: Water Supply and Sanitation in Perth 1878-1912, Studies in Western Australian History II, UWA.

Metropolitan Water Board (1980), Water the Abiding Challenge, Research by Su-Jane Hunt, Edited by F. B. Morony.

Gregory, J. A. (1983), Chronology of Metropolitan Water Authority Services.

Field, C. A. R. (1985), A Brief History of Perth's Water Services, The Institution of Engineers Australia, Western Australia Division, Retiring Chairman's Address.

Hunt, H. E. (1984?), Perth's Early Water Supplies, Australian Heritage Engineering Record, Institution of Engineers Aust, WA Division.

Water Authority of Western Australia (1989), A Historical Archaeological Study of Victoria Reservoir and its Catchment, Prepared for the Water Authority by Jane Wesson for Centre for Prehistory, University of Western Australia.

Water Authority (1991), 1891-1991 Centenary Celebration of Perth's Water Supply, Pamphlet produced for the ceremony in Kings Park on 1 October 1991.

Water Authority (1991), New Victoria Dam, Pamphlet produced for the opening ceremony on 22 November 1991.

Water Authority (1992), A Brief History of Perth Water Supply 1829-1985, Pamphlet written by Ken Kelsall and compiled by Meg Anklesaria & Rochelle Murphy July 2005.

Water Corporation (1996), Metropolitan Water 100 Years of Management, Pamphlet produced for the opening of the William Traylen Waterwise Gardens on 20 October 1996.

Watson, E. J. (1998), Rottnest - Its Tragedy and its Glory, The Wreck of the "Denton Holme", 84-87.

Australian National Committee on Large Dams (2000), Dam Technology in Australia 1850-1999, Edited by Bruce Cole.

LIST OF NEWSPAPER ARTICLES

Date	Paper1	Page	Label
11 August 1887	WA	3	Perth and Fremantle Water Supply
20 August 1887	WM	4	Report of the Select Committee
15 October 1887	WA	14	The Water Supply Question
18 October 1887	WA	3	Meeting of Fremantle Ratepayers
4 February 1888	WM	17, 18	Perth City Council – Water Supply for the City – Notice to Citizens
14 April 1888	WA	7	Water Supply for Perth – Public Meeting of Ratepayers
29 May 1888	WA	2	Fremantle Municipal Council
1 March 1889	WA	2	Letter regarding Water Scheme
11 March 1889	DN	3	Sale of Household Furniture
12 March 1889	WA	3	James Barratt leaving for Albany
13 March 1889	WA	3	Notice of Dissolution of Partnership by Henry J Saunders and James Barratt
14 March 1889	DN	3	Vigilans Et Audax
23 August 1889	WA	3	Water supply and levying a rate
10 September 1889	WA	3	Self Protection
1 November 1889	WA	3	Question of obtaining adequate supply
2 November 1889	WM	22	Water Supply for Perth
3 December 1889	WA	3	Last Night's Meeting
7 December 1889	WM	40	The Proposed Water Supply for Perth
9 May 1890	WA	3	The Result of the Voting
10 December 1890	WA	4	The Proposed Perth Water Works 1890
2 May 1891	DN	3	Result of the Polling
7 May 1891	WA	4	The City of Perth Water Supply Company
9 May 1891	WM	19	Issue of Prospectus

Date	Paper1	Page	Label
16 May 1891	WM	6	The City of Perth Water Supply Company
6 June 1891	WA	4	Particulars from the Prospectus
7 September 1891	WA	3	Water Supply
8 September 1891	WA	2	Item on water use.
12 September 1891	WM	6	Perth Local Board of Health
12 September 1891	WM	24	Report of monthly meeting
22 September 1891	DN	2	The Perth Waterworks
22 September 1891	WA	3	The City Water Supply I
26 September 1891	WM	9	The Perth Waterworks
28 September 1891	WA	3	The City Water Supply II
2 October 1891	I&CN	3	The Perth Waterworks
2 October 1891	WA	6	The Water Area and The Contract
3 October 1891	WM	8	The Perth Waterworks
3 October 1891	WM	19	The City Water Supply II
9 October 1891	I&CN	4	The Perth Water Works
10 October 1891	WM	7, 9	Letters to the Editor, The Waterworks
10 October 1891	WM	9	T. G. Molloy re cost of works
10 October 1891	WM	11	Letters to the Editor, The Proposed Municipal Bill and the Water-Rate
25 November 1891	WA	5	Perth Water Supply
26 March 1892	WM	31	The Water Works By-Laws
28 March 1892	WA	3	The City Council
16 April 1892	WM	11	The Waterworks Question

Date	Paper1	Page	Label
16 April 1892	WM	25	Legislative Assembly, Thursday March 17
27 September 1892	WA	4	Questions. Perth Water Supply
21 December 1892	WA	6	Perth Local Board of Health
18 February 1893	WA	2	The Pollution of the Water Supply
14 July 1893	WA	6	The Water Question
17 July 1893	WA	4, 5	Board of Health and Canning Mills
19 August 1893	WA	3	The Perth Water Supply
20 September 1893	WA	6	Quality of water supply
8 December 1893	I&CN	6	Contamination of Perth Water Supply
20 June 1894	WA	6	Letter from Mr Traylen
7 January 1896	WA	4	The Water Supply of Perth
13 January 1897	WA	5	The Water Supply Question North-West Perth - A Water Famine
10 June 1897	WA	5	The City Water Supply Proposed Improvements
15 October 1897	WA	4	Vigilans Et Audax Opening of 21 inch main
26 November 1897	WM	44	Metropolitan Waterworks Board Report of works undertaken

Note 1: Full title of newspapers referred to and which are available from trove.nla.gov.au/newspaper are:

WA The West Australian (Perth, WA : 1879 – 1954)
 WM Western Mail (Perth, WA : 1885 -1954)
 DN The Daily News (Perth, WA : 1882 – 1950)
 I&CN The Inquirer & Commercial News (Perth, WA : 1855 – 1901)

APPENDIX A

PROPOSALS AND
REPORT ON
THE PROPOSED
WATER SUPPLY
FOR THE CITY
OF PERTH
AND TOWN OF
FREMANTLE,
WESTERN
AUSTRALIA,
BY MESSRS.
SAUNDERS &
BARRATT.

1887/63

PROPOSALS AND REPORT

ON THE PROPOSED

WATER SUPPLY

FOR THE

CITY OF PERTH

AND

TOWN OF FREMANTLE,

WESTERN AUSTRALIA.

By Messrs. SAUNDERS & BARRATT,

ASSOC. MEMBERS INST. C.E.,
St. George's Terrace,
Perth, W. A.

May, 1887.

PERTH:
SANDS & MCGOWGALL LIMITED, PRINTERS AND STATIONERS,
ST. GEORGE'S TERRACE,
1887.

Perth & Fremantle Water Works.

To His Excellency Sir Frederick
Napier Broome K.C.M.G., Governor and
Commander-in-Chief, in and over the Territory
of Western Australia, and its Dependencies &c. &c. &c.

Sir,

In pursuance with the Reports of the Select Committee of 1885 on the Sanitary condition of the City of Perth, and the Town of Fremantle, we have the honour to submit for the consideration of your Excellency in Council, the following proposals for the construction of Water Works to supply the City of Perth, and the Town of Fremantle with Water from the Darling Range. —

Your Committee was of opinion on the question of the proper Water Supply of Perth and Fremantle: —

- (a) That this is one of the greatest importance, and that the time has arrived when steps should be taken to provide a constant supply of pure potable Water to these places
- (b) Your Committee considers, however, that the financial position of the Colony at the present precludes it from recommending the expense of providing Guildford, Perth, and Fremantle, and intermediate places, with a supply of pure Water from the Darling Range, which evidently must be ultimately the proper source of supply; and Your Committee anticipates that contractors or others

①

might readily be found who would undertake to provide such a supply, upon terms that would enable the residents of the localities named to procure their supply of pure potable water at rates not exceeding those paid in the centres of population in the Mother Country.

(c.) Your Committee recommends that the Government be requested to prepare a thoroughly comprehensive scheme of water supply from the Darling Range, with estimates and the best means of carrying the project into execution, and that Water-Works Engineers and Contractors be communicated with to ascertain upon what terms they would be willing to undertake the supply, so that Your Honourable House may have sufficient information upon which to arrive at a definite conclusion upon so important a matter."

(1.) The Works we propose will consist of a Dam at Mundy's Gully in the Darling Range, at a distance of $14\frac{1}{2}$ miles from Perth, thus forming a Storage Reservoir, capable of holding 140,000,000 gallons; a Service Main from this Reservoir to Perth and Fremantle; a Service Reservoir in Perth, and all necessary Street Mains, with Valves, Air-cocks, &c. —

(2.) A detailed Report, together with Plans, Sections, and Estimates of the proposed works accompany these proposals; also a scale of charges, — such scale of charges to be embodied in the Bill hereafter mentioned. —

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- (3.) The Works to be constructed in accordance with Plans, Sections, & Specifications, to be approved by the Director of Public Works. —
- (4.) The Works to be entirely completed in two years from the date of signing the Contract. —
- (5.) The Works to be the property of the Concessionaires and to be carried on by them, or by a Company established for the purpose. —
- (6.) The Government to resume all land required for the proposed Works, and to declare a Water reserve area. —
- (7.) The Concessionaires or Company to have power to break open all streets, and roads for the purpose of laying their Mains, and works connected therewith. —
- (8.) The Concessionaires or Company to have power to levy rates or to supply Water in bulk by meter, according to the annexed scale of charges. —
- (9.) All Materials required in the construction of the Works to be admitted into the Colony duty free: — and to be carried free of charge on any Gov^t Railway. —
- (10.) The Concessionaires or Company to be allowed to cut all timber required for the Works free of any license fee or duty. —
- (11.) If after deducting from the gross yearly receipts the cost of the Working expenses and 1 per cent to be carried to a Sinking Fund, the net receipts being insufficient to pay a dividend of 4 per cent on the

III

authorised Capital of £150,000; the Government to agree to pay to the Concessionaires or Company such sum as will be sufficient to make up the amount of such yearly dividend to 4 per cent. —

- (12.) Should the net receipts in any year be more than sufficient to pay a dividend of 6 per cent on the authorised capital, such extra amount to be equally divided between the Government and the Concessionaires or Company. —
- (13.) The amount of the authorised Capital of the Company to be £150,000 on which a 4 per cent dividend is to be guaranteed in accordance with Clause 11., of these proposals. —
- (14.) The Government to have free access to the books of the Company at all times. —
- (15.) The Government to bring in and get passed by the Legislative Council a "Water-Works Bill" for the purpose of legalising these presents. —

II. 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. —

We have the Honour to be Sir,
Your Obedient Servants,

Samuel & Barratt

Assoc^s Members, Inst. C. E.

5⁵ George's Terrace,
Perth N. A.
May 1887.

IV

APPENDIX B

SPECIFICATION

(Original hand written copy in the Water Corporation Library)

PERTH WATER SUPPLY

SPECIFICATION

for

IMPOUNDING & SERVICE RESERVOIRS

MUNDY'S BROOK & MOUNT ELIZA

MAINS & etc.

SPECIFICATION

The construction etc. of the works & every operation necessary for the Construction of Impounding Reservoir at Mundy's Brook in the Darling Range a distance of about 13 miles from Perth with a holding capacity of 240,000,000 gallons, also the construction etc. of a Service Reservoir on Mount Eliza with a capacity for 643,650 gallons - of the various materials etc. of every kind - altogether with mains etc. from impounding to Service Reservoir & reticulation mains also the clearing of all timber, fences, buildings or other obstructions, in short everything necessary for the full & entire completion of the works to the satisfaction of the Commissioner of Public Works of West Australia for the time being also the removal of all useless plants, materials, staging, centering, etc.etc. off the works on completion of same.

All timber (fallen or standing) scrub and bushes to be removed from the land - required for reservoir.

All tree stumps etc. standing in the lines of excavation for side drains are to be grubbed, and those not so situated, but within the specified area for reservoir to be cleared may be felled - all stumps, butts, branches, and debris to be placed outside the fences or destroyed by burning.

All fences, hedges, buildings and other obstructions to be entirely removed from site of reservoir.

The fencing is to be placed on the boundaries of the Impounding & Service Reservoirs and is to be executed to the satisfaction of the Director of Public Works - both as to workmanship and materials.

At the Impounding Reservoir Mundy's Brook it will be of the description known as post and top rail with 5 wires - and at the Service Reservoir Mount Eliza picket or shingle fencing.

The posts are to be of jarrah - perfectly sound and not less than seven feet 6 in. long, five feet of which must be above the surface of ground and the dimensions at the smallest place 7" x 3" seven by three inches, the posts are to be placed not more than 8 feet, 3" inches, centre to centre, to be well rammed and firmly fixed in ground. Corner posts to be round properly mortised, bored and fixed. Corner posts 8 ft. long 9" dia. properly mortised, fixed and finished. Each post is to be charged to a depth of 3/8" for 3 feet in length, and to have proper mortise holes each 6" x 2" for reception of rail and properly bored for wires.

The rails are to be jarrah, clean and free from large knots, gum veins or other defects and shall not be less than 7" x 2 1/2" seven inches by two inches - the ends to be neatly dressed and properly scarfed so as to completely fill mortise holes and come at least 3" inches through the post at each end of rail.

The fencing is to be in a true line on top and curve lines to be strictly observed and of a uniform height from surface.

Holes are to be dug to a depth of 2ft. 6 in. for receiving posts, but in sinking such holes should the Contractor come upon stone or hard substances, or any stump, roots etc. such must be taken out to the depth above described, and the holes filled in again with suitable material, and rammed round the posts so as to secure it firmly in the ground.

The schedule rate per rod of fencing is to include all materials, tools and labour of every description required for completing the fence and also the excavation for posts etc - the removal of all stumps or other obstructions that may be in the line of fence, also - filling and ramming post holes and everything necessary for executing the work in accordance with the Specification.

The site of Concrete Dam etc. and Service Reservoir etc. to be excavated to the levels etc. and dimensions shown of Drawings or to such others as may from time to time be determined.

The line of excavation for dam and other works, whether it be straight or on the curve, is generally to follow the lines as pegged out; and if from any circumstances, it shall be deemed necessary to widen any cutting, the Contractor shall perform the work and be paid for the actual quantity removed.

Any inflowing water, whether arising from springs or surface drainage, shall be properly and effectually pumped out of the excavations and the sides of same shall be properly shored and planked up where necessary and all slips which may arise are to be removed by the Contractor at his sole expense. Foundations are to be kept dry until concrete, stone-work, or brickwork are properly set and consolidated.

All surplus earth, rock, or other material arising from excavations etc. are to be deposited in spoil banks or as may be directed.

The several prices set against the different items of excavation in schedule shall include the cost of all labour, tools and plant of every description necessary for the completion of the work in strict accordance with the items of the Specification.

All additional expense that may be incurred in repairing slips, damaged by floods or other causes, or in lead to spoil herein before mentioned, and only the neat quantity actually necessary to be removed etc. will be measured and paid for.

Such excavations as shall be necessary for the diversion of surface water for the purpose of carrying out the works in this Contract shall be made in such positions etc. as shall be approved by the Engineer in Charge.

The material from side drains to be deposited in spoil banks and shall be directed on lower side of drain.

The price per cub yard for side drains to include all labour, tools etc. necessary for the completion of the work, inclusive of the removal of all trees and stumps in the line of ditch and of putting excavated material to spoil.

Should it be found necessary to form embankments etc. the cost of carting and ramming in layers, and all labour, tools etc. and plant necessary for the completion of the work is to be included in the rates in schedule for embankments per cubic yards.

The materials to be used in the construction of the several works herein specified shall be of the best description of their several kinds, all faulty or rejected materials must be removed from the site or site of the works by the Contractor at his own expense within 24 hours after having been served with a written notice, in default of which such rejected material shall be removed at the Contractor's risk and expense.

The cement used in this Contract shall be the best Portland, of approved brand, subject to the following tests if necessary.

The colour to be a dull grey, it must be finely ground and be capable of passing through a sieve 1600 meshes to the square inch without residue.

It must weigh at least 87 lbs. per cubic foot, filled into a measure from an inclined shoot and struck over without shaking or packing.

The whole of the mortar used in this Contract shall be cement mortar, composed of one part cement and three parts sand. The mortar is to be only mixed as required and used fresh - should any be left standing until it becomes partially set it must be thrown away.

Cement concrete shall consist of the measure of Portland cement, two measures of sand and four measures of clean, good, hard, approved stone as hereinafter specified, broken to a two and a half inch gauge. Where the walls are of greater thickness than five feet large stones not greater than 10 cub feet may be used but they must be thoroughly clean and bedded in fine concrete.

The materials to be gauged in suitable measuring boxes without bottoms, thoroughly mixed by turning over three times before being wetted, then to be wetted with a sufficient quantity of water applied from hose or pot with rose nozzle, and again thoroughly mixed before being used. All concrete to be used only while fresh.

The price per cubic yard for cement concrete in schedule, measured when in position wherever used, is to include the cost of all materials, carriage, tools, labour, staging moulds - machinery, and plant of every description necessary for completing the whole work in accordance with the Specification and Drawings. Cement grouting is to be composed of one part of Portland cement to two parts of sand, mixed with water to such a consistency that it will run freely with and fill all joints and interstices, and in no case is more to be made than can be used for setting at once.

The whole of the sand required for mortar concrete or grouting, to be clean, sharp, and coarse, free from earth, loam, or other objectionable matter.

All the bricks shall be hard, sound and well burnt, and equal to sample and of uniform size, free from all defects, moulded if necessary as may be required; they shall be well wetted before being laid in the works, the work in walls to be laid in English bond, properly worked with a bed of cement mortar as specified.

No joint to exceed one quarter of an inch in thickness or as close as the nature of the bricks will permit and every joint is to be flushed up with cement mortar, and good bond to be kept throughout, and be grouted every other course with cement grout as specified.

No broken bricks are to be used in any part of the works except for closing a course, and the work shall be equally good for the interior as for the exterior. The joints to be left ready or raked out for cementing as may be directed.

Top of Concrete Dam to be set with cement plaster, as also inside of Service Reservoir, and break pressure tank. Consisting of one to one cement and clean sharp sand. The rendering to be in one coat 3/4 inch in thickness, finished smooth and out of winding, and shall be measured and paid for at per superficial yard - according to schedule rate for same.

The price for every description of brickwork per cubic yard is to include all materials etc. etc. scaffolding, plant etc. of every description necessary for completing the whole of the works, in strict accordance with the Specification and Drawings.

All wrought iron in nuts, bolts, etc. in this Contract, is to be of the best South Staffordshire iron, or other description as shall be approved or equal thereto. All welds to be perfectly sound and workmanship of a first rate quality, the threads to be cut clean to whitworth's thread and threaded 1" within wood. The same to have thoroughly welded heads.

The price per lb. for wrought ironwork is to include all materials, labour, workmanship, tools etc. required for making and fixing same complete. All hardwood used in this Contract must be of the best quality, thoroughly seasoned Jarrah, free from shakes, sap, large and unsound knots, and all other defects, and cut from well matured trees.

The workmanship must be of first rate quality, of the best description of their various class; all mortice, tenons, housings, etc. etc. are to be well and truly formed and fitted.

All planking to be well and truly laid, close jointed, firmly spiked, with spikes twice as long as planks are thick and two of them at each crossing with joins etc.

All outside finished work, such as barge boards, doors etc. etc. (and the wrought is) and to have 3 coats - best oil paint common colour of approved finish.

The general sections of Dam Wall to be adhered to as shown on Drawing excepting where otherwise directed.

The Batter 1 in 20 on face etc. to be strictly adhered to. The Concrete carefully placed in position, and when in position to be worked with a shovel, rammed, or trodden in till all the interstices are filled in such a manner that the finest particles shall come to the top, and the whole to be brought to a good and fair surface, the Batter to be kept by properly constructed moulds - each layer to be worked and rammed as before described. The moulds are not to be removed until the concrete shall have properly set. In all cases the surface of such concrete as shall be in position is to be well wetted before any new portions are added to it. If on removal of the moulds, there appear any holes - or wants in the concrete, these shall be carefully filled in with cement grout etc. at the sole expense of the Contractor.

Where the work of one day is to be connected with that of another, the function is to be effected on a broken line.

The necessary pipes etc. shall be built in the walls etc. in the position shown on drawing. They shall be solidly and fairly bedded throughout their full length, and in the walls thoroughly watertight joints shall be secured. Should it be found necessary to use moulded bricks to ensure this condition, the Contractor will be paid for same at extra rates as shall be agreed upon according to the extra labour this caused.

From the Impounding Reservoir and Service Reservoir the Contractor shall lay a 12" cast iron pipe main of the Glasgow pattern, tested up to a 600 feet head of water with thoroughly good joints etc. and in a workmanlike manner with all necessary valves - meters etc.etc.

Where the 12" main crosses the River Swan etc. the same to be carried on 15" piles and stringers with distance pieces struts etc. as per drawing securely fastened down by 4 x 3/4" iron straps or clips bolted to piles etc. independent of existing bridge and at such a height as may be deemed necessary and in no way to impede river traffic. Piles to be driven until firm bed is obtained with a 20 cwt monkey and strutted where shown on plan. The piles at openings for lighters etc. must be protected in a proper manner by spring piles as directed the whole to be executed in a thorough workmanlike manner and to the satisfaction of the then Director of Public Works of Western Australia for the time being.

Lay the reticulation mains in a similar manner with all valves, meters, hydrants, connection etc. etc. consisting of cast iron pipes of the Glasgow pattern 8", 6", 4", 3" diameter tested to a 600 feet head of water as for larger pipes.

Wherever any existing roads etc. are interfered with or obstructed by opening up for execution of the works - the Contractor shall at his own cost take every precaution to prevent inconvenience and danger to the public.

The covering of Service Reservoir to be of 'Gospel oak' 24 gauge galvanized corrugated iron, or other approved brand, laid in the most approved manner with 6" end lap and 1 1/2 corrugations side lap fastened to purlins at every other corrugation with 1 1/2 screws and washers under heads.

Doors to reservoir platform etc. to be provided with all necessary fastenings etc. etc. all outside woodwork at Service Reservoir to be painted 3 coats best oil of approved colour and the same carried out to full intent and manner of Drawings in every respect in a thorough workmanlike manner.

The Contractor may be required to supply material for work generally along the line of works other than those which are scheduled for particular works; also day labour etc. etc. as per Schedule of Rates.

APPENDIX C

1887 ESTIMATE

No.	Description	Estimate for Perth		Water Works.								
		Quantity	Rate	£	s	d	£	s	d	£	s	d
1	Fencing	4	miles post	560	0	0						
2	Gates	2	to £ post	20	0	0						
3	Clearing site of Reservoir inside fence line	5	acres post	1710	0	0						
4	Stripping soil off site of Reservoir	799	cub yds	1149	19	6						
5	Catchment drains	500	cub yds	612	10	0						
6	Weir at Head of Reservoir	1	to	150	0	0						
7	Small Weirs	2	" post	60	0	0						
	<i>Barrening up 10000 cub yds - 1/2</i>											
	5% Contingencies											
8	Concrete Wall											
	Excavation - Rock	3200	c. yds	3/6	560	0						
	" Earth	5100	"	1/9	1116	5						
	Concrete	20,000	"	35/-	25,200	0						
	Rendering	2,000	sq. yds	1/6	150	0						
	Valve Tower - Concrete	150	c. yds	35/-	262	10						
	Tunnel	150	"	35/-	262	10						
	By wash	50	"	35/-	87	10						
	Rendering	150	sq. yds	1/6	7	10						
	5% Contingencies											
	High Pressure Sawt.											
	Excavation	180	c. yds	3/6	31	10						
	Concrete	100	"	35/-	175	10						
	Rendering	130	sq. yds	1/9	11	7						
	Roof.	2 1/2	sq	4/-	9	0						
	5% Contingencies											
	Bridge over Causeway											
	Piles	5000	lin. ft	3/6	1050	0						
	Caps	1000	c. ft	3/6	175	0						
	Walings	500	"	3/6	87	10						

Item	Description	Estimate for	Units	Rate	Amount	Subtotal	Total
	Brought Forward					4268 12 0	280 15 4
11	Service Reservoir - Perth						44706 7 4
	Excavation		200	c. yds 45	867 3 11		
	Concrete		131	" 176	546 5 0		
	Brickwork		279	" 144	2112 10 0		
	Rendering		200	sq yds 30	125 0 0		
	Roof		6	sq. 744	495 0 0		
	Valve Tower and Tunnel		112	C. yds 144	440 0 0		
	Fencing and gate		150	lin yds 14	150 0 0	4392 18 4	
	5% Contingencies						214 12 11
12	Excavating trenches for 12" mains, re-filling, jointing, including lead and yarn.						4507 11 3
	Bits	Bits	160	chains 504	960 0 0		
	to	to: turned and bored	22	" 544	562 15 11		
	to	to 8" Pipes - socket and spigot	582	" 24	682 0 0		
	to	to 6" " "	181	" 24	265 6 0		
	to	to 14" " "	24	" 144	297 14 0		
	to	to 14" " "	72	" 156	1143 6 0		
	to	to 5" " "	64	" 156	204 12 0	3877 13 11	
	5% Contingencies						168 17 5
13	Pipes						3516 11 0
	12" Main						
	to	to	101	tons 944	8224 15 10		
	8"	to	136	" 144	3132 6 0		
	6"	to	154	" 944			
	14"	to	142	" "			
	3"	to	12	" "			
			102	" "			
			102	" "	10620 19 2	5016 1 0	3118 1 0

Description		Estimate for 1887			
No.		£	s	d	
	Brought Forward.				10219 4 8
14	Special Castings, valves, Short Pipe &c. &c. 10% Contingencies	2286	0	0	2286 0 0
15	Tools &c. for pipe laying.	100	0	0	100 0 0
16	Cottages	900	0	0	900 0 0
17	Purchase of land and compensation	1500	0	0	1500 0 0
18	Saunders & Barnatt	2000	0	0	2000 0 0
19	Shed and Wharf at Salters Point Wharf at Canning Landing Shed at Fremantle	107	14	10	107 14 10
		123	0	7	123 0 7
		<u>379</u>	5	0	379 5 0
20	Tramway Including Rails, Sleepers, Timber, repairing old road &c.	1111	0	0	1111 0 0
21	Management &c.	1500	0	0	1500 0 0
					11516 5 1
					2707 17 11
					14224 3 0

APPENDIX D

SIGNIFICANT DATES

Significant Dates for Western Australia

1 June	1829	The Colony of Western Australia was founded by James Stirling.
	1856	Queen Victoria declared Perth a city.
	1868	The transportation of convicts ceased.
	1870	Representative Government introduced with a Legislative Council.
	1872	Crown Reserve of Mt Eliza gazetted as a public park.
	1872	Telegraph line links London and Adelaide via Darwin.
Dec	1877	East-West telegraph between Adelaide and Albany completed.
1 Mar	1881	Opening of the Eastern Railway between Fremantle and Guildford through Perth. During the 1880s, the line was extended to York and Northam.
	1885	Gas street lighting commences in Perth.
	1888	The Yilgarn Goldfield was proclaimed.
9 April	1889	Telegraph line via Cable Beach, Broome open for business.
2 May	1889	Opening of Armadale railway line. The original stations were Perth, Kelmscott and Armadale.
21 Oct	1890	Responsible Government proclaimed.
	1891	O'Connor appointed Engineer in Chief and Manager of Railways.
	1892	The Coolgardie Goldfield was proclaimed.
	1893	The Kalgoorlie Goldfield was discovered.
	1894	Perth Gas and Coke Company commence to generate electricity.
	1896	Coolgardie Scheme approved.

Significant Dates for Perth's First Water Supply Scheme.

	1875	Poor drainage blamed for 137 deaths in Perth.
	1885	Report upon the Sanitary Condition of the City of Perth and the Town of Fremantle.
	1886	Central Board of Health established.
May	1887	Proposals and Report prepared by Messrs Saunders & Barratt.
5 Aug	1887	Report of the Select Committee into the Proposals of Messrs Saunders & Barratt
12 Mar	1889	City of Perth ratepayers polled on the Proposed Water Supply, 247 votes for and 74 against.
Nov	1889	Perth Water Works Company commenced installation of water scheme for Perth.
4 Dec	1889	Governor assented to The Water-works Act to enable Municipal Councils to construct Water Works, or to Contract for a Water Supply.
	1890	Mt Eliza Reservoir No. 1 pond constructed on land excised from the Park. 784,000 gallons.
1 Oct	1891	Public Water Supply Scheme opened.
	1895	Population increases due to gold rush, very hot summer, highest daily consumption 238,000 gallons, typhoid epidemic starts, highest incidence for a decade.
	1896	Perth's "Great Water famine" begins, highest daily consumption 537,000 gallons.
5 Oct	1896	City of Perth Waterworks Company bought out and Government Board installed (Keane chairman).
	1896	Supply main from break pressure tank to Mt Eliza duplicated with 2½ miles of 18 inch cast iron, 2½ miles of 20 inch cast iron and 10 miles of 21 inch riveted steel.
	1897	Typhoid at peak, 1,408 cases, 134 deaths. Timber settlement on catchment blamed, side stream diverted. First artesian bore for Perth's water supply completed. Supply main from break pressure tank to Mt Eliza duplicated with 2½ miles of 18 inch cast iron, 2½ miles of 20 inch cast iron and 10 miles of 21 inch riveted steel.
Oct	1898	Second Metropolitan Water Works Board (Traylen chairman).

	1901	Mt Eliza Reservoir No. 2 Pond constructed. 2,413,000 gallons.
	1902	Victoria Dam by wash weirs raised by one foot – capacity increased by 12,000,000 gallons.
Nov	1904	Traylen Board dismissed and control of Perth Water Supply rested with the Minister for works with administration by the Public Works Department.
	1908/1909	12 inch cast iron main reconditioned into reticulation main.
	1911	Upper Bickley Brook weir constructed and linked in at break pressure tank #2.
Feb	1912	Mt Eliza Reservoir No. 3 Pond constructed. 10,153,000 gallons.
	1912/1913	Filter beds and lime dosing facilities constructed.
	1923/1928	12 inch cast iron and 21 inch steel taken up. 21 inch steel reconditioned, cement lined and reused. Old 12 inch cast iron cleaned, cement lined and used as feeder mains elsewhere in metropolitan area.
Aug	1924	Mt Eliza Reservoir No. 4 Pond constructed. 13,600,000 gallons.
	1934/1935	Mt Eliza Reservoir New No. 1 Pond constructed (incorporates the floor and one wall of old No. 2). 10,000,000 gallons. Incorporated 1890 No. 1 and 1901 No. 2. The 1890 reservoir and 1912 filter beds demolished and carted to Causeway as fill.
	1966	Victoria Dam wall reconditioned with new upstream skin, new intake tower and new spillway.
	1989	Victoria Dam decommissioned.
22 Nov	1991	Opening ceremony for New Victoria Dam.

APPENDIX E

PROPOSED INTERPRETATION PLAN

The owner proposes to implement the following interpretation plan for Perth's First Public Water Supply Scheme, incorporating three permanent installations:

- A wall display at the John Tonkin Water Centre (JTWc), West Leederville – head office of the Water Corporation.
- Markers and interpretation panels at two sites: First site being at the remains of the original Victoria Reservoir wall and the second site next to a public footpath adjacent to the Water Corporation service reservoirs in Kings Park, Perth.

It is proposed that there be two separate functions in front of the JTWc wall display during October 2012, 121 years on from the original dam opening on 1 October, 1891. On Friday, 19 October, as part of a Corporate recognition event, the wall display will be launched with attendance by Water Corporation personnel. At a separate function during the following week (Monday 22 October 2012), also National Water Week, the Engineering Heritage Australia marker award will be commemorated and a PVC facsimile of the interpretation panel unveiled. This function will be attended by representatives of Engineers Australia and other organisations as well as senior Water Corporation personnel.

The wall display, outside the executive area of the building, will incorporate five panels, each approximately 2 metres x 1.5m. They will present text, photos and copies of original scheme drawings and documents adapted from the award submission. The display will also include a section of the original 12-inch cast iron main pipeline, excavated from near the site of the service reservoir in Kings Park, and, remarkably, a dam worker's shovel that was retrieved from the interior of the old dam wall. The shovel was exposed when a central section of the old dam was blasted to allow passage of flood water from the new Victoria dam constructed in 1990.

The interpretation panels at the Victoria Reservoir wall and Kings Park, both locations accessible to the public, will conform to Engineering Heritage Australia requirements. Images of the interpretation panels are on pages 34 and 35. Engineering Heritage 300 mm diameter recognition markers will be fixed and displayed with both panels.

Perth's first public water supply scheme

Perth's first public water supply scheme was constructed at a time when the settlement still relied on a fragile system of private wells and rainwater tanks and a few public springs.

Increased population and unreliable rainfall caused water shortages. With water shortages, water borne diseases, mainly typhoid, became more prevalent with greater reliance on groundwater that was polluted by poor sanitation methods.

The first scheme was constructed under a 'build, own and operate' contract between the Perth City Council and a Melbourne based syndicate, Neil McNeil and Company, at a cost of about 160,000 pounds (\$21 million at 2011 prices).

It incorporated the 240 million gallons (1 billion litres) capacity Victoria Reservoir on Munday Brook in the hills at Carmel, 16.33 miles (26.3 kilometres) of 12-inch (305mm) diameter gravity trunk main to a 660,000 gallons (3 million litres) capacity reservoir at Mt Eliza in Kings Park and city reticulation with an eight-inch (200mm) main along Wellington Street.

Work began in October, 1889, and the storage reservoir of 42 acres (16.2 hectares) was cleared by manual labour, while concrete for the dam wall, with a crest length of 722 feet (220 metres) and a maximum height of 71 feet (22 metres) was mixed and put in place by 60 or more men at a time using shovels and hand rammers.



Mrs Lilla Keane, wife of Perth Lord Mayor Edward Keane, officially opens the "Perth waterworks" by turning on a valve at Victoria Reservoir, October 1, 1891.

The new scheme was officially opened on 1 October, 1891, and operated by the newly established City of Perth Water Supply Company. But due to problems of water availability and contamination, the scheme was purchased by the recently proclaimed State Government in 1896 and control given to an independent Metropolitan Waterworks Board which made improvements.

In 1990 the dam wall was partly demolished to allow for overflows from a larger capacity dam built 300 metres upstream. The original Mt Eliza reservoir was demolished in the 1930s to make way for much larger storages over the years.

Apart from about two thirds of the original dam wall still standing, virtually no other physical evidence remains of the first scheme. The Victoria scheme became the model for future "hills" schemes that made Perth the thriving city that it is today.



The original service reservoir, Mt Eliza, Kings Park.



The original 12-inch main and subsequent 21-inch main pipelines from Victoria Reservoir cross the Swan River at the Causeway bridge.



Victoria Reservoir, completed 1891.



Drawing of pipeline route from Victoria Dam to Mt Eliza, pipeline shown in blue (Part of 1903 Plan W.S. & W.S. 299).



Henry Saunders

Perth's first public water supply scheme was designed by civil engineers Henry Saunders and James Barratt.

Saunders, who had worked on railway development, later became a mining entrepreneur and manager. He was a Perth City Councillor, and elected to terms as Lord Mayor and MLC, then became a member of the first Federal Senate in 1903. He died in Perth in 1919.

Barratt also worked on railways, for a time as Chief Engineer for the Midland Railway Company, and later moved to Albany. He worked in Melbourne for 22 years but it is not known where or when he died.

The engineering significance of Perth's First Public Water Supply Scheme was recognised by the award of an Engineering Heritage Marker by Engineering Heritage Australia (the heritage arm of Engineers Australia) in October 2012.



Perth's first public water supply scheme

Near this sign was the site of the first water storage reservoir for Perth. It was built in 1891 as part of the city's first public water supply scheme and could hold 3 million litres.

Water came from the newly built Victoria Dam (capacity: 1 billion litres) on Munday Brook in the hills at Carmel via a 26 kilometre long, 305 mm diameter pipeline. The scheme was designed

by engineers Henry Saunders and James Barratt, and constructed under a 'build, own and operate' agreement between Perth City Council and the contractors, Neil McNeil and Company of Melbourne.

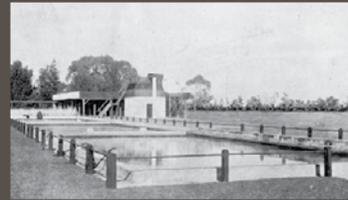


Henry Saunders

The dam's water storage area of 16 hectares was cleared by manual labour. Concrete for the dam wall, with a crest length of 220 metres and a maximum height of 22 metres, was mixed and put in place by workmen using shovels and hand rammers.



Diagram of pipeline route from Victoria Dam to Mt Eliza, pipeline shown in blue (Part of 1903 Plan M.S. & W.S. 299).



The original service reservoir, Mt Eliza, Kings Park.



Mrs Lilla Keane, wife of Perth Lord Mayor Edward Keane, officially opens the 'Perth waterworks' by turning on a valve at Victoria Reservoir, 1 October 1891.



The original 12-inch main and subsequent 21-inch main pipelines from Victoria Reservoir cross the Swan River at the Causeway bridge.

The original storage reservoir on this site was demolished in the 1930s to make way for much larger storages over the years. In 1990 the original Victoria Dam wall was partly demolished to allow for overflows from a larger dam built 300 metres upstream.

The scheme was the forerunner of the Canning Dam and other hills schemes that helped make Perth the thriving city that it is today.



Victoria Reservoir, completed 1891.

The engineering significance of Perth's first public water supply scheme was recognised by the award of Engineering Heritage status by Engineers Australia (the heritage arm of Engineers Australia) in October 2012.

