On its formation in 1891 the Melbourne & Metropolitan Board of Works at once embarked on the project of sewerage Melbourne. The sewerage system that it built and which forms the basis of today’s system was designed to bring all the effluent of the metropolis by gravity through a series of main sewers to a pumping station at Spotswood. There the raw sewage was pumped upwards from deep below the surface to a semi-open outfall sewer which began at Brooklyn and eventually discharged onto a farm at Werribee. At Werribee the sewage was used to irrigate pasture and crops where it was purified by trickle filtering through the earth until it eventually discharged into Port Phillip.

This scheme is so embedded in the subconscious of Melbournians that even today, when more than one third of the city’s sewage is handled by the newer South Eastern system, the very word “Werribee”, with its scatological overtones, can still raise a snigger in casual conversation.

But the sewerage system which we take for granted was only one of several proposals put forward between settlement and 1891, and was the subject of disagreement and controversy even as it was being built. In 1853 when the first of many sewerage schemes was proposed, Melbourne was a small town consisting of today’s central business district, the contiguous nearer parts of Carlton, Jolimont and Hotham, the band through Fitzroy into Collingwood, and the detached villages of Emerald Hill, Williamstown, Richmond and Footscray. By 1890 “Marvelous Melbourne” was a sprawling metropolis which reached in an almost unbroken arc from Williamstown on the western shore of Port Phillip through Footscray, Ascot Vale, Essendon, Coburg, Northcote, Heidelberg, Fairfield, Kew, Hawthorn, Malvern, and Caulfield to Brighton on the eastern shore.

Melbourne had not only grown physically. The metropolis had spawned a plethora of autonomous local government authorities. These city, town and borough councils were responsible for the physical condition of their bailiwicks, including sanitation and drainage. This meant that nightsoil pan services, for example, were a municipal responsibility. The contractors employed to provide this service were often required to remove the nightsoil from the bounds of the municipality. The approved practice was for the contractors to sell the stuff to farmers or to take it to council owned nightsoil depots for disposal. Unscrupulous contractors would empty it over the roads of adjoining municipalities.

In a similar fashion, it is easy to imagine the administrative difficulties presented to the municipal engineers. The efficiency of one local government authority in getting rid of its waste became the problem of another in dealing with it. Rivalries, lack of co-operation, duplication and incompatibility of services have all been hallmarks of Melbourne’s local government for over a century. Repeated efforts to solve this conundrum have always been thwarted, usually by appeals to parochialism.

Even if other factors were equally as responsible for the neglect of the sewerage question prior to 1891, it was the municipal question which ultimately needed to be dealt with before any scheme could be implemented. The sanitary condition of Melbourne had become so bad (or perhaps more pertinent, the sanitary condition of British, European and other Australian cities had improved to such an extent) that a Royal Commission was convened in 1888/9 to investigate it and make recommendations.
The Royal Commission recommended among other things “a complete system of underground drainage” and the creation of a “Metropolitan Board of Works” on the model of the London authority set up in 1854. It also heard evidence from engineers with schemes for sewerage systems. Among them was William Thwaites, destined to be the Board’s first Engineer-in-Chief.

Thwaites offered two schemes. His preferred scheme involved all the sewage arriving by gravity at Spotswood and then being pumped up to an outfall sewer which would then flow to a farm at Werribee. Astute readers will recognise this as the principle of the scheme which was built.

Notwithstanding the schemes of local engineers, the Royal Commission took the then entirely orthodox step of recommending the appointment of a British expert to advise on a complete underground drainage scheme. The Victorian Government acted swiftly and for the enormous fee of £5,000 appointed James Mansergh, a prominent British engineer to prepare a report on the sewerage and sewage disposal of the proposed Melbourne metropolitan district. Mansergh and his son Ernest spent about eight weeks in Melbourne and then sailed back to England to complete the report.

Mansergh suggested a number of schemes but recommended most strongly the adoption of his “Scheme M”. This scheme provided for two sewerage districts divided by the watershed “ridge between the Gardiner’s Creek Valley and Port Phillip Bay, and which, produced to the north-west, divides the Moonee Ponds Valley from the Merri Creek Valley north of the Yarra.” The Eastern District would be drained by gravity to a pumping station at South Yarra where it would be raised and would flow to a farm at Mordialloc. The work was split up into hundreds of contracts which were carried out in such a way that the work progressed “upstream” at a pace which the Board, which was under extreme financial duress due to the effects of the 1890’s depression, could afford.

In outline, the construction work proceeded along the following lines:

**SURVEYS**
- Dec 1891 - Dec 1894

**SEWAGE FARM:**
- May 1892 - Dec 1894

**MAIN OUTFALL SEWER:**
- Jul 1892 - Jun 1894

**RISING MAINS:**
- Jun 1892 - Jun 1893

**PUMPING STATION:**
- Mar 1894 - Feb 1897

**MAIN SEWERS:**
- Jul 1893 - Jan 1900

**SUB-MAIN & BRANCH SEWERS:**
- Jun 1896 - May 1900

**RETICULATION SEWERS:**
- from 1894

**HOUSE CONNECTIONS:**
- from 1897
SURVEYS
Melbourne was very poorly surveyed prior to the setting up of the Board of Works. Indeed, when Mansergh was asked to design a system, the first contour map of Melbourne was hurriedly compiled especially for him by the Surveyor General’s Department from a variety of sources. It is of critical importance to a sewerage system that the height above sea level of every point connected to the sewer is known with a high degree of accuracy. Without this information it would be impossible to design a sewer with the correct flow characteristics.

From December 1891, the Board’s surveyors commenced the first control survey of Melbourne. Referred to at that time as a “standard survey” the technique was to fix a grid of lines connecting permanent survey marks and to establish the correct position of this grid to a high degree of both horizontal and vertical accuracy. Within this grid and relative to it, contractors performed the detail surveys which outlined the streets and houses and obtained levels of the natural surface and of the floor of each and every house. The checking surveyors employed by the Board then reconciled the contractors’ work with the Board’s control or standard system. Using the information gathered by the survey plans for individual reticulation areas could then be drawn up.

SEWAGE FARM
At the meeting on 10 May 1892 the Board authorised the purchase of about 8,847 acres of land at Werribee from the Chimside family for £17.10s per acre. Payment was in the Board’s debentures. On 19 May 1892 the Governor, the Earl of Hopetoun, turned the first sod at the farm which was effectively the beginning of the construction of the sewerage system.

Steam ploughing machinery to the value of £4,500 pounds was ordered from Welch Perrin and Co as well as a special steam cultivator which could cultivate, roll, drill, sow and chain harrow a strip 15ft (4.57m) wide in one operation.

MAIN OUTFALL SEWER
The outfall sewer was designed to be semicircular and open for about 9 miles (14.50km) of its 15 miles 77 chains (25.69km) length and fully circular with an 11ft(3.35m) diameter closer to the pumping station. It included three brick aqueducts - over the Werribee River and the Skeleton and Kororoi Creeks. It was built by 7 contractors in thirteen sections between July 1892 and June 1894 for a contract price of £236,553 although the original estimate for its construction was £440,000.

RISING MAINS
The rising mains were designed to be a parallel pair of wrought iron tubes of 6ft(1.82m) and 4ft(1.22m) diameter respectively. Up these tubes for 2 miles 27 chains (4.56km) would be forced the sewage arriving by gravity at the pumping station. The sewage would then be delivered into the outfall sewer at Brooklyn and travel by gravity to Werribee.

The pipes were laid in a trench cut mainly into bluestone for £2,556 9s 2d. Where the rising main crossed the railway, at the Spotswood line and Braybrook loop, the Railways Department performed the excavation work at the Board’s expense.
PUMPING STATION

Spotswood (formerly Spottiswoode) is on the west bank of the Yarra at its junction with Stony Creek and not far from its junction with the Maribyrnong. It is at the focus of the entire natural drainage system of the Melbourne metropolitan area. The pumping station was designed to eventually house 12 coal fired steam pumping engines in two symmetrically opposed buildings. At first it was thought that coal would be delivered by water to a jetty on the river, but a railway siding was built instead.

The Board selected the land that they required in October 1892. Their offer of £4,625 pounds for nine and a quarter acres was rejected by the Spottiswoode Estate Company and the purchase went to arbitration. In the meantime, the Board was allowed to start work on the excavation for pump wells and buildings.

Extraction for pumping wells at Spotswood Melbourne Water

The successful tenderer for the excavation for engine and straining wells and their connecting tunnels, and the construction of the overflow sewer was Garnsworthy and Smith for £34,322 17s 8d. Starting in March 1894 the contractors pushed this work on in continuous shifts by the light of new-fangled electric arc lamps. By June of the following year they had completed this contract with the removal of 33,400 cubic yards (25,500m³) of rock and the laying of 9,400 cubic yards (7,200m³) of concrete.

The contract for the first four steam engines and pumps was let to Thompson and Company of Castlemaine for £38,925 pounds 19s 7d. The engines and boilers were manufactured in Castlemaine, erected there and then dismantled for shipping to and re-erection at Spotswood. The erection and testing of the boilers and engines took place over 18 months and finally on 8 February 1897 steam was got up in No 1 Engine. There was trouble with the Thompson engines; several defective cylinders had to be replaced and a new high pressure piston rod was fitted to number three engine. The tone of the Engineer-in-Chief’s remarks about the engines and boilers and their constant niggle faults during 1897-8 tends to indicate that he was not very happy with their performance.

Interior of Spotswood pumping station showing the installation of Thompson Steam pumping engines Melbourne Water

In 1899 Thwaites wrote:

After giving a Colonial firm every opportunity of constructing suitable and reliable pumping engines, and in consideration of the emergent necessity of supplementing the engine power in the Southern Engine Room through the danger of one of the engines made by them breaking down and thus throwing the whole system out of gear, I am of the opinion that it is absolutely necessary to obtain a pattern engine from a leading English manufacturing firm of pumping engines at the earliest possible date.

This led in 1900 to the purchase of a single steam engine from Messrs Hathorn, Davey and Co of Leeds which still stands today in pump well number five and which was the pattern for several locally produced Austral Otis engines.

The engine houses and straining well buildings formed the temple of the Board of Works. The familiar French-styling might never have been realised because the Board originally called for alternative tenders for either mansard roofs or brick towers with hipped roofs. The alternative would have given us a far more Italianate building than the one we know. Work was started in April 1895 and the engine houses, boiler houses, coal bunkers, straining well buildings, straining cages, lifting gear, winding
engines, chimney stack, electric lighting plant, wrought iron fence, and managing engineer's house were completed by July 1897 for a total cost (including the purchase price of the land and the pumping engines) of £59,690. For some comparison of prices, one section of one main sewer across the Port Melbourne flats cost £105,624 pounds.

HOBSON'S BAY MAIN SEWER
The waste of Melbourne was brought to Spotswood by two main sewers - the Hobson's Bay Main and the North Yarra Main. Branches of the former serviced the central city as well as the southern and eastern suburbs. The latter serviced the northern and western suburbs.

The construction of these sewers was divided into sections numbered upstream from the pumping station. Despite numbers of bores being sunk to test the kind of ground likely to be met with, there was not a lot known about the nature of subsurface Melbourne. Nearly all contractors faced severe difficulties and some innovative techniques were employed. For each of the sections contractors were asked to tender for three different methods of construction - open cut, ordinary tunnelling and tunnelling with cast iron linings. Open cut simply entailed the opening of a trench to the depth of the sewer, its construction and subsequent backfilling. Ordinary tunnelling meant the sinking of a vertical shaft to the designed invert level and the subsequent driving of a horizontal shaft shored up with wood. The sewer would then be constructed within this tunnel. Similarly, cast iron linings bolted together could replace the wooden shoring of ordinary tunnelling.

In the event, the method of tunnelling adopted by the contractors in the difficult ground of the Yarra delta was none of the above. It was instead the "advancing shield" method where a cast iron shield with a chamfered cutting edge was thrust forward with hydraulic jacks and then the earth inside excavated. The shield was equipped with doors which could be shut to exclude any water or slurry which was inclined to flow into the tunnel. The tunnel was lined with cement blocks laid on the rim of the shield. As the shield advanced, the rear portion was always within the finished work. The blocks were then caulked and rendered with cement to make the sewer.

Section 2 of the Hobson's Bay Main Sewer was the first section of main sewer to be constructed on the upstream side of the pumping station. At its meeting of 11 July 1893 the Board awarded the contract to James Moore for £117,936 pounds 5s 3d (£34,572 pounds 18s 3d lower than the next tender). As soon as the contractor began to drive outward from his first shaft it became clear to him that he would not be able to complete the contract without a severe loss. His options were to give up, renegotiate the amount of the contract or to renegotiate the method of working. Accordingly, on 20 October 1893 the contractor wrote to the Thwaites suggesting that he be allowed to use the advancing shield. Thwaites exercised his prerogative contained in clause 38 of the Conditions of Contract to alter the specifications for the work. But this action by Thwaites caused a furore in the Board and even though he was able to save the Board further £12,311 11s 7d on the contract, he was censured for his conduct.
The contractor had 6 shields made locally and they were lowered down the shafts into position for driving. The use of the shields was a great success and by June 1894 he had completed 1,796ft (547.42m) of sewer. The section of sewer was completed 407 days late in February 1896.

This was not the first time shields had been used on Melbourne’s sewers. The first tunneling shield was used on the section under the Yarra between Port Melbourne and Spotswood. The Melbourne Harbor Trust would not agree to the use of coffer dams and so a contract for tunneling was let to Arthur T. Robb for £39,556 19s 3d in October 1893. His shafts on each side of the river were sunk using cast iron linings and then work ceased while he awaited the delivery of a “Greathead” shield from England. When the shield arrived in July 1894 it was lowered down the shaft on the western or pumping station side of the river and driven forward hydraulically with cast iron rings being placed in position to make the sewer when lined with concrete (one ring and another which is possibly part of a shield are on display at Spotswood today). The going was very difficult with much ingress of water requiring tunneling with compressed air.

On the 12 April 1895 there was disaster when, perhaps due to the passage of a large ship, the river broke through and flooded the tunnel drowning six men. The bodies were not recovered until three days later. After this horrible accident the contractor was unwilling to proceed with the work under the river. A new contract for the remaining portion of the work was let to A.G. Shaw for £14,966. The contract was finished 31 days late and £862 12s 2d over contract after more problems requiring extra thicknesses of iron and concrete. The Governor, Lord Brassey, passed through the tunnel and declared it ready for operation in mid 1897.

Troublesome collapses, street subidences and floodings were a hazard of all the work in the Yarra delta and along the bay. Eventually tunneling by ordinary section was almost universally abandoned in favour of shields and concrete blocks. In September 1895 a shield was driven 194ft (59.13m) or an average of 7ft (2.13m) per day which was “faster than any large shield has been driven on these contracts”.

![](Tunneling_by_advancing_shield_showing_the_shield_and_concrete_block_lining_Melbourne_Water)

**NORTH YARRA MAIN**

With the exception of Section 1 in the extremely bad ground beneath the Stony Creek backwash, the North Yarra Main Sewer was completed with far less difficulty than its southern counterpart. The problems of Section 1 were solved by taking the sewer deeper in an inverted siphon.

**MELBOURNE MAIN SEWER**

While the twin arms of the two main sewers radiated out from Spotswood, it was the sewer of central Melbourne which was eagerly awaited as the symbolic completion of the scheme. The Melbourne Main was designed to take the sewage from the central city area along Flinders Street to the site of the present day Charles Grimes Bridge, thence under the river to join the Hobson’s Bay Main near Graham Street, Port Melbourne.

The most spectacular event in the construction of the Melbourne Main was the river crossing itself. The design was novel. A dredge scooped out the bed of the river to the depth of the sewer. A wrought iron tube was constructed in a long trench on the south bank of the river. This trench was of a depth which when flooded allowed the tube to just float free. The tube, when ready, was floated into position across the river over the trench in the bed to be slowly sunk into place. The tube was then to be pumped dry and lined with concrete to make the sewer inside.

When the time came to actually lower the tube to the bed of the river, the tube broke in three places and sank. Undeterred, Thwaites arranged for divers to join the pipes, which had fallen into approximately their right places, with rubber straps. When sealed the pipe was repaired and the sewer constructed within it as
planned. Then the Harbor Trust was asked to dump silt over the repaired and concreted tube to bring the level of the trench up to the normal river bed. This method, accidentally arrived at, was successfully used at subsequent river crossings.

**RETICULATION SEWERS**

It doesn’t take a very sophisticated knowledge of engineering to appreciate that the first area to be reticulated would be one near the pumping station, and so the construction of Melbourne’s first reticulation sewers was begun in Port Melbourne during June 1894 by two gangs of day labourers. Contracts were let for the excavation and refilling of trenches and the Board’s own men did the pipe laying and jointing.

**HOUSE CONNECTIONS**

In April 1897 Sewer Reticulation Area Number 1, Port Melbourne, was gazetted requiring houses to be connected. Households which made no effort to have themselves connected to the now available sewer would be connected by the Board and costs recovered. On 17 August 1897 with no ceremony, the first property, the All England Eleven Hotel on the corner of Rouse and Princes Streets, was connected to the sewer system. On the 5th of February 1898 in a moving ceremony, the Governor of Victoria, Lord Brassey, lifted the penstock which allowed the sewage of the City of Melbourne to flow into the Melbourne Main, thence to the Hobson’s Bay Main, the Pumping Station, and up the Rising Mains to the Main Outfall Sewer for its journey to the Werribee Farm. The Governor and his party made their way by steamer to the farm in order to watch the stuff arrive. A governor’s life is not an easy one.