

RB378.944SR
67



Double Bay Low-Level Sewerage Scheme.

BY W. M. THOMPSON, B.E., ASSOC. M. INST., C.E.

*(A Paper read before the Sydney University Engineering Society,
July 14th, 1897.)*

DOUBLE BAY LOW-LEVEL SEWERAGE SCHEME.

BY W. M. THOMPSON, B.E., ASSOC. M. INST., C.E.

(Read before the Sydney University Engineering Society, July 14th, 1897.)

IT was the original intention of the author to have prepared a Paper dealing in a general way with the subject of Low-level Sewerage, and the various methods adopted for disposing thereof; but, on consideration, it appeared that the description of a work which is at present in course of construction, and at the same time easily accessible, would probably prove of greater interest to the Society. Consequently, it is now proposed to briefly describe the system adopted for dealing with the Sewerage of the Village of Double Bay; including what has been done, and what still remains to be done, before the sewerage matter shall have been effectually disposed of.

In the first place, it is to be noticed that the village, some 30 or 40 acres in extent, is built upon some of the lowest-lying ground to be found in the vicinity of the City of Sydney. To the high-water level of the Harbour there is little or no fall, so that, even if it were deemed expedient to carry the drainage thither, the result would not be satisfactory, apart from the annoyance that such a scheme would cause.

It is not very many years since the portion of Double Bay lying nearest to the main South Head Road was full of small swampy lagoons, and what now appears firm ground is in reality only made ground, formed by the filling-up of these, a fact which can be easily proved by sinking a few feet, when peat and sand highly charged with water are met with. Such being the natural formation of the locality, it must be apparent that, as years go by and the population continues to increase, the surface soil must become more and more impregnated and contaminated with refuse water and garbage from the various dwellings.

To cope with the ever-increasing accumulation of foul water, and to prevent the contamination of the foreshore, it was decided to make use here of what is known as Shone's Pneumatic System, that is, to force the sewerage matter by air-pressure to such a level that it will easily run off by gravitation. This is the first time in the knowledge of the author that Shone's Pneumatic System has been adopted in this Colony as a means for disposing of sewerage matter. As to whether it will prove a

success time will show. There are one or two other methods that might have been adopted, but they are of questionable utility, and, in the author's opinion, the Pneumatic is the only really efficient method for dealing with such a case as that under consideration.

Proceeding now to a description of the finished work and that still in progress, it may be said that the laying of all pipes and mains and other out-door work has been completed, so that all that remains is the erection of machinery for working the System. In the first place, after all surveys were made, levels taken, and necessary plans prepared, a contract was let for laying down the cast-iron air-mains, sewer-mains, and ejectors. The function of the ejectors is to receive the sewerage from the mains, and, when full, to force by air-pressure the contained sewage matter to a higher level.

The ejector-chambers, or receptacles to contain the ejectors, are four in number, situated at the positions shown on the plan, namely, No. 1, at the intersection of Pelham Street and Cross Street; No. 2, at the intersection of Cross Street and Bay Street; No. 3, in William Street, near the stormwater channel; and No. 4, on the so-called Marine Parade, at the western end of the beach.

In making the excavations for the foundations of these chambers the contractors, on account of the swampy nature of the ground, were called upon to cope with the influx of enormous quantities of water flowing from the substrata, which filled up the excavations, forced in the sand from sides, and generally occasioned serious inconvenience and loss of time. However, these difficulties have now been overcome, and the chambers for the ejectors constructed.

The ejector-chambers are constructed of cast-iron plates, cast in segments of circles, and bolted together at the sides in a similar manner to the cylinders of a bridge; the side flanges and upper flanges are strengthened with gussets. The thickness of the plates is 1", and the average depth of the iron cylinders is 6 feet. The upper flange is made 12" wide, in order that it may form a support for the brick lining of shaft, which is built in 9" brickwork set in cement, and tapers upwards from the top of cylinder to an ordinary man-hole at the road-level. The internal diameter of the cylinder at the lowest level is about 9' 8".

In each of the cylindrical chambers provision has been made for two of Shone's patent Pneumatic Ejectors, which, being patent machinery, are imported from England. The mains to supply the ejectors with compressed air are of cast-iron, and vary in diameter. Starting from the machine or compressing-house, they are 9"; in Bay Street, 6"; along Cross Street, 3"; from Cross Street, along Bay Street to William Street, 5"; along William Street, 4"; and from Bay Street to the Marine Parade 3" diameter.

The delivery-mains from the ejectors also vary in size, being 5" diameter from No. 1, 8" from No. 2, 6" from No. 3, 4" from No. 4; and, finally, a 9" main is taken up what is euphoniously called "Break-neck Steps" to the main intercepting sewer under Darling Point, the invert of which is 27.37 feet above high-water mark, Double Bay. Where it joins the sewer the invert of the delivery-main is 29.16', or a little more than 1' 9" above the sewer invert. The size of the Darling Point sewer at this point is 2ft. 2in. x 3ft. 3in., and of egg-shaped section. Once the sewerage has been discharged into the Darling Point sewer gravity comes into operation, and the sewerage finds its way through the main system of sewers to Bondi and the South Pacific.

The delivery-main at Bay-street has a level of 6.00', and at Ejector No. 3 of 3.00', so that the greatest height the sewerage matter is raised or forced is about 26 feet, which corresponds—neglecting friction of bends, junctions, pipes, etc.—with a pressure of about 11.44lb. per square inch.

To return to the ejector-chambers. Close beside each ejector-chamber is sunk in the ground a second iron cylindrical chamber, the dimensions of which are about 5' 0" deep and 4' 0" diameter. The object of this second chamber is to intercept any accumulation of sewer-gas, and prevent the same from being carried into the ejectors, and also to form a reservoir for the sewerage while the ejector is working. The sewerage flows in near the bottom of this cylinder, and out to the ejectors near the bottom on the opposite side, and any gas which may come from the supply-mains finds its way to the upper portion of the chamber, and is carried away from there in a pipe to a ventilating-shaft, the draught up the ventilating-shaft being accelerated by the waste air brought in a second pipe from the ejectors.

The ventilating-shafts, for dispersing any accumulation of sewer-gas which may generate in the mains, are hollow tubes about 45 feet high, securely supported with angle-iron stays near the ground for a height of about 3' 6", and then, somewhat higher, with a cross-bar and wire-rope guys, fitted with nuts and screws for tightening. The whole arrangement is somewhat similar to that employed to guy the topmast on a yacht.

In each ejector-chamber there are two ejectors, so arranged and connected with cut-off valves and pipes that they may be used both together, or each one separately, as occasion requires. The ejectors themselves are cast-iron cylinders, with a valve opening for the admission of sewerage on one side, and a discharge-pipe on the other. The sewerage flows by gravitation from the collecting sewers and mains, first to the air-chamber already referred to, and thence into the ejector through a valve opening with the flow.

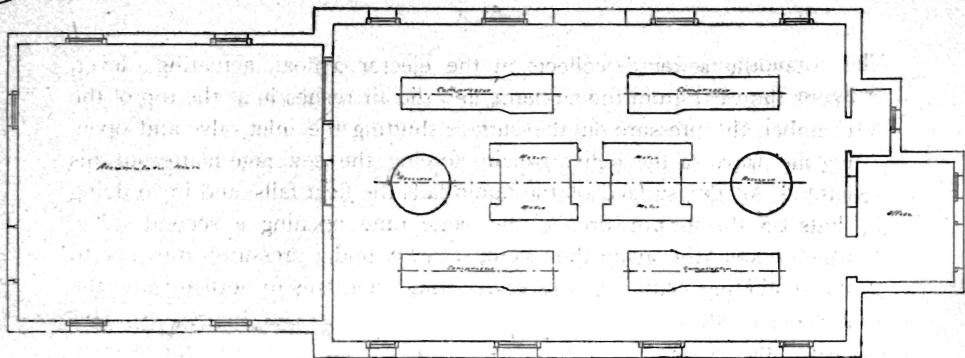
As the sewerage collects in the ejector a float, actuating a lever, opens the valve from the air-main, and the air rushes in at the top of the chamber, the pressure on the surface shutting the inlet-valve and opening the valve of the delivery-main, forcing the sewerage matter up this latter. As the surface of the liquid falls the float falls, and in so doing shuts off the air-pressure, at the same time opening a second valve, which allows the air in the ejector (already under pressure) to escape to the ventilating-shaft. The pressure inside then falls to normal ; and the sewerage, which has been collecting in the mains and outer chamber, again, by its own pressure, opens the inlet-valves and commences to refill the ejector. The whole operation is again repeated as the ejector fills and raises the float sufficiently high to open the air-valve.

Where necessary in the air-mains, and to allow for expansion, air-tight joints are made with cast-iron sleeves or collars, screwed together with strong bolts, squeezing two indiarubber rings against a sleeve.

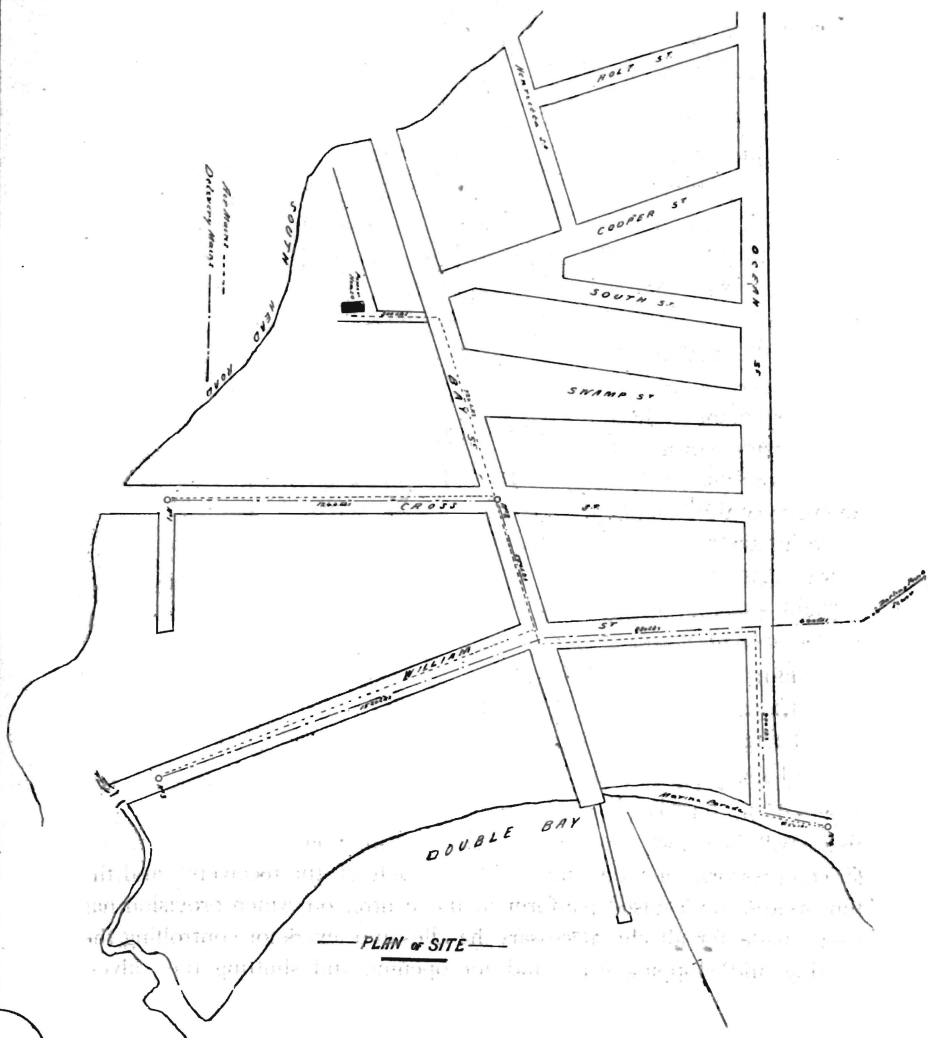
For the generation of the compressed air required, air-compressors and the necessary machinery for working the same are contained in a power house, situated near the main South Head Road.

This power house is built of red ornamental brick, and has an open Queen truss roof, covered with red tiles. The accommodation within the walls consists of three rooms, one 23' x 20' 9", a second 39' x 23' 9", an office 9' x 7' 6", and necessary out-offices ; the clear height to under side of principal rafter is 10' 3". The motor-room, for convenience of setting and handling the machinery, is fitted with a travelling crane made of steel joists, moved forwards or backwards by ordinary worm-wheel gearing. To a casual observer this building looks more like a school than a machine-shop, owing to the absence of chimneys and other accessories of the steam-engine ; but, since steam is not to be the motive power, these are not necessary. The whole of the power required to work the machinery contained in this building will be brought on a cable from the Rushcutter's Bay Cable Tramway Power House, stored in accumulators, and from thence used as required to drive electric motors, these latter actuating the air-compressors.

Accommodation has been provided in the motor house for four air-compressors, four electric motors, and two air-receivers, so arranged that if required the whole four may work together, or, if so many are not required, one or two, as the case may be. The general arrangement of these will be: Two air-receivers, one at either end of the room ; two air-compressors, one on either side of each of the receivers ; and the four motors on a raised platform in the centre, on which provision has been made for all the necessary handles and levers for controlling the starting and stopping gear, and for opening and shutting the valves.



PLAN of POWER HOUSE



PLAN of SITE

The foundations for the motors are raised about 4 feet above the ordinary floor-level, and round this will be built the platform referred to, constructed of iron chequered plates.

The air-receivers are constructed of mild steel plates, $\frac{3}{8}$ thick, rivetted together in a cylindrical form, with domed ends, $\frac{1}{2}$ " thick, and are tested to withstand a pressure of 30lb. per square inch. They are fitted with man-hole, etc., and sides of cylinder are covered with 2 x $\frac{3}{4}$ T. G. and V. lagging. The internal dimensions of the receivers are 4' 6" dia. and about 10' 0" high, and they stand with the longest axis vertical. The compressed air is admitted to them by a 7" pipe, and is carried off to the mains by a pipe passing through the bottom. This pipe rises on the inside some 4 or 5 feet, the object being to prevent any water coming over from the compressors being carried into the mains. The compressors at either end consist of two pair of double-acting horizontal engines, fitted with positive valve gear. The air-cylinders are 11" dia., 18" stroke, and constructed with a 2 $\frac{1}{2}$ " space, or water-jacket, round the cylinders.

The crank shafts to compressors are 4 $\frac{3}{8}$ dia. of steel, and on them are keyed flywheels, 4' 6" diameter. Through the intervening space between the jacket and cylinder a current of cold water is allowed to flow. In addition to this means for cooling the air, a spray is fixed at either end of the compressor, which, regulated by valves, is allowed to play into the inside of the cylinder, hence the object in raising the outlet pipe in the air receivers so that the spray water shall not pass into the mains.

The cylinders of air compressors are fitted with Crosby-Richards's indicators, with all necessary gear for taking diagrams. For the supply of cooling water to the jackets, since the water pressure in the ordinary water mains is considerable, *i.e.*, 90lbs., the supply pipe for the jackets is fitted with a reducing valve, which reduces the pressure from 90lbs. to 5lbs.

The connection of the electric motors with the crank shaft of the compressors is by means of phosphor bronze pinions, gearing with spur wheels, the ratio of the gearing being 4.85 to 1, and the ends of the crank shafts are also fitted with couplings, to allow of one or both compressors being worked.

The delivery pipes from the compressors to the air receivers are 7" dia., cast-iron, metal $\frac{1}{2}$ " thick, fitted with sleeves and collars, as already referred to for air mains, and also with lugs and stay bolts, to prevent the ends by any chance being blown asunder. The cable conveying the current from the power house in Rushcutter's Bay to the electric motors, will, where it enters the building, be carefully insulated and enclosed in a wood casing.

Storage Battery.—The storage battery will consist of 230 “Epstein” “Tudor” or chloride cells, and when completed will contain a storage of 180 amperes. The discharge from these is to extend over a period of six hours without the average pressure per cell falling below 1·8 volts. Connecting cables will have 19 strands of 16 S.W. gauge copper wire, insulated with vulcanised indiarubber, with an insulating resistance of 300 megohms per mile.

The Switch Board will be of white marble, and will be provided with—

One recording ammeter.

One voltmeter, with two-way double-pole switch.

Two ammeters for motors, to indicate from 5 to 75 amperes.

One ammeter for battery, to indicate from 10 to 150 amperes.

One main double-pole switch for line.

One main double-pole switch for battery.

One two-way and break double-pole switch, for throwing lightning current on to line or battery or off.

Two two-point double-pole switches, with water break for field shunt coils, interlocking with the main double-pole switch.

One polarized battery cut off.

Two motor fuses.

Two battery fuses.

Also, registering Wattmeter, of capacity of 100 amperes.

Electro-motors.—These are to be continuous current shunt wound machines, capable of developing 25-h.p., at a speed of 470 to 500 revolutions per minute, when supplied with a current of 500 volts pressure. The motors are to give in useful work on the motor shaft 90 % of the energy absorbed at the motor terminals, when working at full speed, and 85 % when working half load.

The armatures are to be of the ironclad or toothed core type, wound on the Eickemeyer principle.

Commutators are to be practically sparkless, with any current between zero and 50 amperes. All the different parts of the motor are to be interchangeable.

The combined insulation of the armature and field coils must not be less than a megohm, both when cold and after a day's run, and must stand an insulation test of 2,000 volts alternating current, a transformer of 10,000 Watts capacity being used for the purpose, and the rise of temperature is not to exceed 60° Fahr.

Controller.—The controller is to be similar in construction to a series parallel sheet railway controller, provided with a compressed air blow-out, to prevent destructive arcing. The resistances are to be securely mounted on a marble or slate base, and are to be of metal

strips or wire, of such dimensions, as not to heat unduly when the motors are started or stopped.

The resistances to be so proportioned that when the motors are started up to full load and speed, necessary time being allowed for acceleration, the current shall not at any time exceed 80 amperes in either motor. The metal used for circuits shall in all cases be of such an area that the current density when both motors are at work shall not exceed 1,000 amperes per sq. inch. All connecting leads and cables shall be strongly insulated with vulcanised rubber, and shall have a minimum insulation resistance of 1,000 megohms.

In conclusion, I have to thank Mr. A. E. Cutler, Chief Draughts man of the Sewerage Construction Branch, for his kindness in allowing me the use of plans and specifications.

