The object of this paper is to give a brief sketch of the history of the Colombo Waterworks from its first inception up to the present time, and also a few notes on the Labugama Storage Reservoir, the two Service Reservoirs, and the main pipe line to Colombo. The time does not permit of much detail being gone into, but an endeavour has been made to touch upon the more characteristic points. The scheme, which was the basis of a water supply to Colombo and out of which the Colombo Waterworks has developed, was formulated during the year 1860, when a Special Committee appointed by the Municipal Council reported upon the water supply and drainage of the town.

This Committee conducted investigations, enquired into the various sources of water supply, and reported that the water used by a large portion of the inhabitants was "utterly unfit" for domestic use, and that the inefficiency, unwholesomeness, and excessive rate of cost of the then existing supply was fully acknowledged by the general public who were urging for a constant supply of good water even at considerable outlay.

The only existing supply at this date was the wells, nearly every house having its own. Many of these wells were impure, yielding discoloured water, being close to cess pits, having a very scanty flow in the dry season, and only yielding a liberal flow after the rains. The water often became tainted...
and unpalatable when the supply was low and it was then bought from the proprietors of a few of the better wells by the inhabitants at one farthing or say one cent per gallon or Rs. 10/- per 1000 gallons.

Comparing this rate of Rs. 10/- per 1000 gallons with existing rates, for metered supplies which are: (a) for shipping Rs. 3/50 per 1000 gallons (b) for trade purposes Rs. 1/- and (c) for garden purposes 50/-, the difference in the rates may be appreciated.

The Committee further reported that though a supply from a catchment area was best, it was inadmissible on account of the distance of suitable gathering grounds and they recommended the Kelani River as the source of supply, the water to be taken at a point not less than 10 miles from the sea to avoid risk from brackish contamination. The water was to be filtered and to be supplied constantly at high pressure from covered tanks holding three or four days' supply.

Following upon the report of the Committee various schemes were submitted, but little or no progress was made until 1871 when it was recommended by Councillor, now Sir John Grimlington, to whom the matter was referred for report, that 3,000,000 gallons per day should be the minimum and as probably sufficient for the next 10 years (bringing it up to 1881). This was based on an estimated allowance of 30 gallons per head for the then existing population of 100,000 and Councillor Grimlington added that but for the existence of a few good wells in different districts he would have fixed at 40 gallons per head. This scheme was in the main the same as the one recommended by a Special Committee of obtaining water from the Kelani River, but the objections to it were (a) that the Service Tank was to be 11 miles from the town, a flooded district and (b) the loss of head which in a 24" pipe (the size proposed) conveying the water to the town would be 110 feet, the River at this point being only about 20 feet above M.S.L.

Further delay took place until in 1873, Governor William Gregory referred the matter home to the Assistant Engineer on Waterworks, Mr. J. F. Bates, who instructed Mr. A. W. Burrett to proceed on to investigate. The Assistant Engineer submitted two schemes for obtaining.
water from the Keani and pumping the water \( \frac{3}{4} \) miles into the town, and the other was the Labugama scheme which was a gravitation supply. The Consulting Engineer's report was submitted in 1874 and in 1876 he was asked to prepare working drawings for the cheaper scheme viz., the supply from the Keani River. In 1877 it was decided to reduce the supply to 2,000,000 gallons, and thus reduce the cost of the schemes. In 1878 to 1879 the drawings and estimates for the Keani pumping scheme were completed. I was then found that the Labugama scheme, owing to the small expenditure on cost of upkeep, was preferable to the Keani pumping scheme, and the Labugama scheme was decided upon, but with a reduced supply of 2,000,000 gallons and during 1880 and 1881 the necessary drawings and surveys were completed. The pipe, being calculated to deliver 2,000,000 gallons per day, the Consulting Engineer selected a 20" diameter C.I. main to give the required amount in 16 hours or a total supply of 9,000,000 per 24 hours, the overflow being taken into the lake. In 1882 the work was commenced, which was sixteen years after the first Special Committee set to report on the Water supply. The work was let out on contract to be completed in years, Messrs. Mitchell and Izard being the contractors and Mr. A. W. Burnett the Resident Engineer. The first temporary supply of water to Colombo was obtained in September, 1885 and in October of the same year Maligakanda Service Reservoir was completed. The reservoir however failed whilst being filled so that the supply to the town was intermittent, the demand exceeding the discharge from the Labugama supply pipe during the hours of maximum consumption. The Service Reservoir at Maligakanda continued to give trouble for 4 years until October, 1889, when it was satisfactorily repaired and has been in constant use ever since.

The Labugama Storag Reservoir was completed in July, 1886 and was filled by the rainfall which fell on the catchment area in 4 months.

A supply to the town was obtained from the Labugama Reservoir in November. The temporary supply during the previous year came from a stream near the Labugama Reservoir, but not included within the catchment area, the water being led into the 20" main, a mile below the Reservoir bund
by a 6" pipe, which tapped the stream at an elevation nearly equal to that of the reservoir at top water level.

The first stand posts and house connections were fixed in Colombo in January, 1887 and each district was in turn supplied from this date, until 1889, when the whole town may be said to have become dependent upon the main pipe supply from Labugama, which was seven years after the commencement of the work. At first only from wells etc. being to a large extent abandoned. As a consequence of the Colombo Municipal Council exercising powers which had been obtained for this purpose.

In 1890 the average daily demand exceeded 2 million gallons per 24 hours and the necessity of duplicating the main at no very distant date became more evident each year. In emphasised the recommendations of the Consulting Engineer, Mr. Bateman, who advised a 24" main being put down in preference to the 20" diameter main, pointing out that a 24" main would give a 50% additional increase in supply for a 25% additional expenditure.

In 1897 the maximum daily consumption became equal to the maximum daily supply and the town became dependent upon the water reserved in the Maligakanda Service Reservoir on two occasions for 10½ and 15 hours respectively, when repairs were necessitated along the main pipe line.

In this year Government gave its sanction for the duplication of 10 miles of the 20" main pipe, viz., for the portion from Ayapatna to Waga which was mostly under flood level. (Diagram No. 1). A commencement was made with this work in November, 1897 and it was completed in 1899, when owing to the newly duplicated portion coming into operation, the scraping of the old portion of the main, an increased supply was obtained of 500,000 gallons per 24 hours.

Government sanction for the complete duplication was obtained in 1902 and this work was completed in 1904.

In connection with the duplication of the main, the construction of an addition Service Reservoir was proposed and sanctioned so that the new 20" main delivers into the new Service Reservoir—at Elle House to the North of Colombo (as shown in Diagram 1).
The present supply to the city from both mains together is 6,000,000 gallons per 24 hours — and taking the population at 160,000, this gives a supply of 37-5 gallons per head.

The foregoing brief history shows the growth of the Colombo Waterworks.

It was in January, 1887, that a constant supply from the main pipe was first maintained and as this main has been in full working order ever since, the Colombo Waterworks may be said to have been in existence for 21 years.

In the following notes the whole Waterworks Scheme has been divided under the four heads:

1. The Storage Reservoir at Labugama.
2. The main pipe line — consisting of two, 20" diameter C. L. Mains.
3. The Service Reservoirs at Mallyakanda and Elio House.
4. The Town distributing mains.

I. LABUGAMA RESERVOIR.

The water supply of Colombo is derived from a catchment area of 2,015 acres at Labugama, about 30 miles distant by road from Colombo. (Diagram No. 1.)

The heights of the hills which encircle this catchment area vary from 900' to 1,500' feet, the highest being Labugama Kanda which is 1,700 feet above M. S. L. (Diagram.

The stream which originally drained this area formed the source of the Wak-Oya, a tributary of the Kelani River.

The average rainfall on the catchment area is 161" per annum and this water, impounded by the Reservoir, and has a top water level of 360 feet above M. S. L.

The capacity of the Reservoir is 1,373,000,000 gallons, which is equal to 25½ inches of rain over the catchment area or about one year's supply to the Town.

On Diagram No. 2 is shown a weir constructed at the mouth of the main stream to intercept debris which may be brought down from the jungle and prevent it entering into the Reservoir.

The jungle, with fringing upon the water line is kept cut for a distance of one chain all
round the top water line. This prevents leaves and debris being washed into the Reservoir. The floating rubbish which is chiefly leaves carried down by the various streams discharging into the Reservoir after rain, collects at the junction of these streams with the Reservoir and the clearing away of this rubbish forms part of the work of the upkeep Staff.

The many streams flowing into the Reservoir will flow on rock or boulders, and the result is that hardly any surface or soil washing takes place and there is little or no fouling from this cause.

The area at the top water level is 1.8 acres.

The Labugama Bund is an Earthwork Embankment with a clay substructure, core resting on and keyed into a concrete foundation which is itself keyed into the solid rock.

Several different sections are given in the Diagram No. 3, which fully illustrates the construction of the Bund.

To prevent wash of waves from the water the Reservoir, the inner face of the Bund has been finished with stone pitching.

The length of the embankment at the ground level is 120 yards. The greatest height of embankment reached in the foundation trench below ground level was 72 feet.

From the lowest foundation to the top of embankment is 102 feet, and the depth of water is 59 feet.

The Valve Tower, from the top of which the various valves are worked, (shown in Diagram 4) is constructed at the inner toe of the Bund and is connected to its top by a footbridge and is divided into two chambers or wells, one known as the cleansing well and the other as the straining well.

From the bottom of the Valve Tower (Diagram No. 3) two 12 feet diameter culverts run through the lower portion of the Bund and through one of these the two 36 inches diameter wash-out pipes discharge from beyond the cleansing well and through the other culvert, the 20 inch Service Main passes, which draws its water from the Straining Well and by the side of it passes the 20 inch Scouring Pipe.

The water for the Colombo supply is drawn by the 20 inch Service Main from the Straining Well. Three intakes into this well are fixed at 12 feet, 24
feet and 36 feet respectively below spill level, the water supply being always taken from the 12 foot level.

The capacity of the Reservoir to the lowest intake level of supply is 1,233,000,000 gallons.

The Straining Well is fitted with a duplicate set of screens through which all the water passes before entering the main pipe to Colombo.

The screens are fixed into large frames (Diagram No. 5) which measure 9 ft. by 6 ft. 6 ins., each fixed into slots in the walls of the Chamber. There are two rows of seven frames to each complete set of screens, making 28 frames in all. The gauge of the wire used in these screens is 900 meshes to the square inch and this is sufficient to arrest whatever floating matter there may be in the water entering the chamber. The working area of these screens is about 25 square feet each or 650 square feet to each set.

In addition to the screens the Straining Well contains two 20 in. diameter Valves, one of which is fixed on the 20 in. main and controls the supply to Colombo and the other is a 20 in. wash-out valve and fixed in the pipe which passes through the bottom of the well and is used for scouring out the Reservoir.

The other Chamber of the Valve Tower is and is known as the Cleansing Well; in it the screens are washed when they become fouled or clogged. The screens being in duplicate can be cleaned alternately, one set always being in. This work is done weekly.

At the bottom of the Cleansing Well the two large 36 in. wash-out or surplus water valves are fixed and they discharge into one of the two 12 feet diameter culverts.

Except in the case of very heavy rainfall these valves control the water level of the Reservoir. Should the water still rise above top water level after these valves are opened, it overflows over a waste water weir 100 feet long. The greatest depth of water flowing over the 100 feet water weir has been recorded as 3 feet 5 ins., but this is quite exceptional.

In connection with the Waterworks extension, a gauge Basin was constructed at one end of the Reservoir Bund for the purpose of measuring the quantity of water supplied to Colombo. This is shown in Diagram No. 8.
In addition to measuring the water over this
gauge, the Basin has the additional advantage of
showing at once whether water is being constantly
supplied to the city. Should any leak occur on the
main line it is immediately indicated by a rush of
water from the Basin below the gauge, or should
the valves be shut for any reason or any obstruction
occur along the main pipe line, the gauge will at
once show this by becoming drowned.

In this way the Inspector at Labugama can at
once see any material alteration in the condition of
the pipe line instead of waiting for news to be
brought him by the patrol, of any leak or obstruction
as was formerly the case.

The gauge is a rectangular notch 7 feet in
length and the quantity of water passing is measured
by the depth over the sill. Similar gauges are fixed
at the Maligakanda and House Service
Reservoirs.

The gauge Basin at Labugama is connected
with the tower by a 20" syphon pipe which
passes through the top of the Bund as shown in
Diagram No. 5. This pipe is taken from the
Straining Well so that all water entering into it has
been through both sets of screens. The intake limb
of the syphon in the Straining Well is 10 feet below
the level and the discharging limb in the Gauge
Basin Well is 12 feet below spill.

The syphon pipe passes from the Valve Tower
to the Bund, being supported midway by a steel pier.
Through the 20" syphon pipe is laid in a
12 feet culvert as shown with concrete collars for
preventing creep of water through the clay puddle
core.

In addition to this syphon pipe, the original 20"
diameter main which passes through the Discharge
Culverts at the foot of the Bund has been brought
up into the Gauge Basin so that all the water
supplied to Colombo may be measured, if necessary,
over the gauge (Diagram No. 4).

2. THE MAIN PIPE LINE.

The main line of pipes consists of two 20"
diameter mains running together in duplicate, from
Labugama Reservoir to Wellampitiya, a distance of
234 miles, from which point they branch off to the two
Service Reservoirs. The main from Wellampitiya
to Maligakanda the Southern Service Reservoir being 1½ miles and that to Elie House the Northern Service Reservoir 3½ miles in length. (Diagram No. 1).

The pipe line is kept above permanent water level and as high as possible in crossing streams, so as to avoid damage from flood water, and to facilitate free drainage and escape of water from the land. Thus, numerous and wide openings over drainage outlets and streams were necessary. The flood along the pipe line between Colombo and Hanwella and as far as the 3rd mile of the Labugama Road rises from 12 to 17 feet above the level of the pipe.

The level of the main at the top of the Labugama Bund is 300 feet above M. S. L. and it discharges at a level of 106 feet into Maligakanda Reservoir and 98 feet into Elie House Reservoir. About ten miles of the main is below flood level.

The two 55-centimeter mains are laid on opposite sides of the road which they follow for the greater part of its length. When leaving the road and going across country the mains are laid six feet apart as in the case of crossing Hanwella flats.

The majority of the Cast Iron piping used had turned and bored joints. Lead jointed pipes and bands of not less than 12 feet radius have been used whenever necessary, owing to the varying alignment of the pipe line. All sharp bends which were originally fixed in the first 20" main have been repaired and bends of larger radius substituted to allow of the main being scraped. In Diagram No. 8 the various joints of the pipes used are shown. The average weight of one 20" diameter pipe is 11 tonnes and they are supplied in 12 feet lengths. The thickness varies, being 3", 1/4" and 3/8" for the ordinary piping, according to the pressure the pipes are required to stand. The flanged pipes for stream crossings being 14" thick.

The turned and bored pipes are the most easily laid. A gang of 30 men can lay 30 of these pipes a day using the pipe machine shown in Diagram No. 9. That is necessary is to ensure that the short coned portion at the spigot and socket ends are quite smooth and cleaned before joining up. The spigot end is smeared, or painted over with a wash of cement and water and after a pipe has been placed in position it is driven home by using the next pipe as a battering ram, a wooden buffer being inserted between the ends.
The lead jointed piping is of the usual type, the joints were yarneled before the lead was poured in and finally caulked.

Two sizes of Air Valves are in use along the main pipe line, they are 4" and 2½" diameter respectively and of the Double Air Valve type. The 2½" diameter air valves are used on the newer main, and the 4" diameter on the old main. There are together 200 air valves of both sizes and these are placed at every summit to get rid of air as it collects at these points.

The Cleansing Valves used are 6" diameter and are placed at every hollow or depression of the pipe line for the purpose of emptying any section. There are about 120 cleansing valves on the two mains and they are of the usual sluice valve type.

The 20" diameter sluice Valves used on the new main are all of the vertical patent anti-friction pattern supplied by the Glenfield Company as shown in Diagram No. 5. The Diagram shows the patent rollers on each side of the valve on which the tongue of the valve slides. These sluice valves are worked from the surface of the ground by means of a key and bar operated by one man.

The old type of valve on the original main has to be worked by gearing and is supplied in most cases with an 8" by-pass. These valves are worked from inside the valve wells and require two or more men to work them.

The number of 20" sluice valves on both mains is about 100 in all. They are placed at an average of half a mile apart, dividing the mains into small sections. Each and any section can be shut off for repairs etc.

There are nine 20" diameter cross-connections made between the two mains, dividing each main into ten sections, any of which section may be shut off without interfering with the working of the remainder of the pipe line or materially altering the supply to the town. These are indicated in Diagram No. 1.

Any of these sections can be cut off to allow of repairs to leaks being carried out or when the main is being scraped. Should damage occur to the pipe line while under flood, the shutting off of any damaged section can be effected without stopping the supply to the city.
As already mentioned numerous and wide stream crossings were necessitated along the pipe line. Sixty of the foundations for these crossings are below sea and permanent water level. The ground consists of beds of sand, gravel clay and peat and soft deposits alternating.

There are 40 crossings varying in span from 6 to 24 feet and 20 crossings of from 48 to 196 feet total spans being made up of smaller spans of from 24 to 30 feet centres.

A section showing the class of foundations used for these stream crossings is given in Diagram No. 6.

When the original 20" main pipe line was constructed, the abutments and piers were throughout built of brickwork or masonry, but when duplicating the main, the piers carrying the new 20" main were built up of steel joists bolted together. By adopting this method and brick work being done away with, a much lighter load was put upon the foundations and massive and expensive foundations were avoided.

The steel stream crossing piers were designed to be driven as piles. They are fitted with (wrought iron) 2 feet square base plates. The two joints were first driven in position as piles until the base plates reached the level of the bed of the stream. Enclosing these, a light rectangular cofferdam 0 ft. 6 inch inside measurement was formed by driving 2-planks as sheet piling and the whole was made water tight by backing up with clay outside, which was easily procurable in most cases along the pipe line. After pumping out the water from the cofferdam the bed was excavated two feet in depth and the pier again driven down 2 extra 2 feet to the base plates. This process was repeated until the required depth was reached, when a foundation of 2 feet of concrete was laid below the base plates and a depth of 1 foot of concrete above the same, making a total thickness of 3 feet. The cross girders and bracing were then fixed and the pier completed.

A further advantage gained by the use of steel piers is their adaptability to the expansion and contraction of the flange pipes used at all stream crossings.

Diagram No. 8 shows horizontal and cross sections of an expansion joint fixed complete. The special end piece fitted to the flange pipes of the stream crossing is shown in the stuffing box of the expansion joint, which is packed with yarn and
tallow, and the chairs and brass bearing balls to allow of the movement of the pipe are shown fixed in position. Upon the original brickwork piers, chairs containing gun metal balls were provided so that the flange pipes might have free movement in the expansive joints and not cause strain upon the brickwork.

The necessity for rollers is very doubtful, as the balls cannot at all times be relied upon to rotate in response to any movement of the pipe. When the new main pipe was carried over on brickwork piers as was done in one case at the Wak-Oya crossing (where the foundations for a duplicate main were provided and originally built up to low water level) the chairs were dispensed with and the pipe was supported upon two pieces of 3" diameter piping laid 1.6" apart on each pier, at right angles to the 20" pipe. The flange pipe being further supported by two brass distance pieces let into the brickwork and this arrangement has been found to work in every respect as satisfactorily as when chairs and ball bearings were provided. The expansion joints on the new main are similarly treated.

In all cases when a stream crossing consisted of two or more spans, expansion joints were provided, as shown in Diagram No. 8, and have worked satisfactorily.

The amount of expansion per each span of 24 feet or 30 feet may be taken as \( \frac{1}{4} \) of an inch.

The maximum expansion took place when the flange pipes were empty, the flow of water equalizing the temperature of the iron.

**SCRAPING OF THE OLD MAIN**

To obtain access to the mains for the purposes of scraping, fourteen hatchboxes have been fixed on each main at an average distance of 2½ miles apart, making a total of 28 hatchboxes.

In 1899 after 10 miles of the main pipe line had been duplicated, the duplicated portion of the old main was thoroughly scraped; to permit of this, the sharp bends in this portion had to be removed and easy bends of not less than a radius of 12 feet inserted. Hatchboxes were put in at convenient points at distances of about 2½ miles apart.
In 1904 the entire length of the original 20" main was prepared for scraping and thoroughly scraped from end to end. This necessitated Maligakanda Reservoir being cut off from the town and the service was continued direct from Labugama through the new main—Elia House being used for storage. The type of hatchboxes employed is shewn in Diagram No. 7, and a sketch of the scraper used is shewn above Diagram No. 4.

The following procedure is adopted when scraping the main. The section of about 24 miles to be scraped is shut off by closing the sluice valves and emptied by opening all cleansing valves. The hatchbox lids at both ends of this section are removed. The scraper is inserted at the Labugama end and pushed into the length of pipe sufficiently far to ensure the piston working properly, if this is not done the water will escape round the piston in the hatchbox and much delay is caused in starting.

Before the scraper is ready to be started the 1st hatchbox lid has to be securely bolted down again and all 20" sluice valves and cleansing valves along the section fully opened and arrangements made, so that the scraper on arrival shall not jump the 2nd hatchbox and enter the next section of pipes. It is started by opening up a 20" valve behind the scraper, about four to six turns of this valve is sufficient for a start.

As the scraper moves, a distinct rumbling noise can be heard if carefully listened for. Watchers are stationed at about 50 yards apart along the main and more particularly, where the pipes cross a stream and at all culverts and air valves along the line.

The scraping party can follow the scraper at a walking pace, the speed of the scraper being regulated by orders sent to the man in charge of the valve behind the scraper.

A constant speed can only be maintained by the regulation of the driving valve as the scraper scrapes and decreases its speed according to the gradients met with.

There is no difficulty in hearing the scraper crossing at a bridge opening and when passing an air valve it can generally be detected. These points should be carefully watched in advance and if the exact position of the scraper be temporarily lost, the air valves and crossing may indicate its whereabouts.
Noises caused by carts travelling on the road and other sounds should be stopped while the scraper is passing along a section, it is nearly always due to these causes that the exact position of the scraper is lost.

After passing the 1st cleansing valve the position of the scraper is known by the discharge from this valve being much increased and the scraper coming to a stop for want of water to drive it. The cleansing valve is then gradually shut when the scraper again continues its course until the next cleansing valve is met with and so forth until the end hatchbox is reached.

The opening of the cleansing valves assist the emission of all encrustation and foul water in front of the scraper and prevents so large a deposit being forced towards and collecting at the end hatchbox.

The encrustation found in the old main pipes consisted of an entire coating of at least a \( \frac{1}{2} \) in. thickness, together with a series of nodules or excresences projecting at an average thickness of 1" from the metal of the pipe, these nodules are from 1/4" to 2 1/2" apart.

This deposit which is black in colour has a thin slime upon it when wet. On the surfaces becoming exposed to the air the slime changes to a rusty red colour and becomes very brittle and friable. The deposit is very heavy, weighing about 80 lbs. per cub. ft. about the same weight as cement, and the estimated weight of the whole of the deposit removed was about 10 tons per mile, in addition to the lighter deposits carried away by the foul black water which continued to run for some time before and after the scraper crossed each cleansing valve.

3. THE SERVICE RESERVOIRS AT MALIGAKANDA AND ELIE HOUSE.

The merits of the two most suitable sites for Service Reservoirs in Colombo, viz. those of Maligakanda and Elie House were carefully considered before the first Reservoir at Maligakanda was built in 1882. The central position of the Maligakanda site was recommended as being the better of the two, for although the level of the ground in the case of the Elie House site was about 25 feet greater elevation than the ground level at Maligakanda, the
added distance of 2 miles in length to the main pipe and the northerly position of this. Reservoir necessitated the conveyance of the bulk of water back three miles to the middle of the town for distribution, and hence from this important point of view the Maligakanda site was the more advantageous. The greater distance of the Elie House site from the town made it necessary that a reservoir there should have a 30 feet higher elevation than one at Maligakanda, to give the same general pressure over the town. The water level of Elie House Reservoir is 95 feet above mean sea level which is 5 feet below Maligakanda. Both Service Reservoirs are provided with branch mains, so arranged that pressure from Labugama can be turned on direct to the town, and by an arrangement of bye-pass and loaded valves, the pressure is controlled so as to prevent excessive strain on the town mains. The loaded balance valves open and deliver into the Service Reservoirs when the fixed pressure is arrived at.

The water level of Maligakanda Reservoir was fixed a 100 feet above mean sea level. The ground level at Maligakanda was 70 feet above mean sea level and there was thus a difference of 30 feet in height between water level and ground level. The Reservoir was required to contain 8½ million gallons. These conditions alone made this Reservoir of exceptional interest from an engineering point of view.

The Reservoir was originally designed with massive concrete walls built up of moulded blocks 10″ × 8½″ × 3″ presenting a castellated appearance. The section of this wall in Diagram 9 gives an idea of the appearance of the outside of Reservoir when first finished. The walls of the Reservoir were not originally intended to be supported by the turfed banks of brickwork which now cover up the original design.

This Service Reservoir was protected by a series of two thicknesses, each consisting of a series of brick arches placed between cast iron joists supported by slender cast iron columns. There was a space between the two thicknesses of roof of 6 feet, to protect the water from the sun. There are two distributing mains from Maligakanda Service Reservoir into the town, a 27″ main for the Northern portion and a 20″ main for the Southern portion.
The depth of the floor of the Reservoir below
the outside surface of the ground, varied from 10 to
15 feet and the inside dimensions were 190 feet by
191 feet (or nearly 190 feet square). The depth of
water was 40 feet and the height of walls 49 feet.
their thickness at top water level 5 feet 9" and at base
19 feet 9".

This Reservoir was completed in October, 1885,
but failed whilst being filled. It was repaired by
doubling the thickness of the floor, thus reducing the
depth of water to 39 feet and by rounding off all
internal angles of walls and floor. By these numerous
repairs the capacity of the Reservoir was reduced to
7½ million gallons.

The reservoir failed a second time in December,
1886 and was repaired by asphalting the large
cracks which occurred, but in February, 1887, whilst it
was being tested and when it was just full, it failed
for the 3rd time.

Mr. Bateman and Sir John Fowler as Consulting
Engineer were then called in to report, and they
recommended an earthen embankment to surround
the entire reservoir; the floor and walls to be covered
with an asphalt lining 2" thick; the walls to be
cut through in six places, separating them into six
distinct lengths; at each cut the work to be made
again with a brickwork plug dovetailed into the
original concrete wall, by means of an elastic asphalt
din the centre of the wall to allow of movement.

The 2" asphalt lining was put on in square
planks and was composed of asphalt mixed with
2½ lb. of bitumen.

The plates of asphalt were made in a frame
18" by 10" and brick chips from 1" and under were
sprinkled over and pressed into the plates.

All these recommendations were adopted and
the repairs completed in Oct 1889, and the
Reservoir was tested for the 1st time since which
date it has been in constant use. The Reservoir
continued to give anxiety owing to the expansion
and contraction of the cracks. (These cracks
were measured by inserting coned plugs between two
brass plates fixed on the walls on either side of the
cracks.)

By experiment it was found that a movement of
15" was registered at each of the cracks.

In 1897 the upper of the two roofs of this
Reservoir were removed and by this improvement
the weight and thrust of the arches forming the upper roof were taken off the wall.

In 1905 when Elie House Reservoir had been completed, the Maligakanda Reservoir was thoroughly cleaned out; during this operation, Elie House Reservoir was used for a reserve, and the town was connected around Maligakanda Reservoir directly with Labugann.

The 2nd Service Reservoir which was completed in 1905 was built at the Elie House site already referred to, exactly 20 years after the 1st Reservoir.

The capacity of this Reservoir is 8,000,000 gallons and roughly speaking its area is double that of Maligakanda, while its depth is one half. The dimensions are 360 feet by 195 feet by 20 feet depth. It is divided for the purpose of roofing into 12 spans 30 feet each and has a total width of 195 feet, divided into 13 spans of 15 feet. The depth of water is 20 feet below overflow level which is 95 feet above mean sea level. It is divided across its width by a half wall 10 feet high, for the purpose of facilitating cleansing without materially interrupting the water supply to the city.

The four corners of each half of the Reservoir are curved to a radius of 30 feet horizontal and the wells inset the floor with a vertical curve of 10 feet radius.

The 18" floor is laid in two layers of 7" of cement concrete and finished with a layer of 2" of cement concrete laid in situ between iron screeds, dividing the floor into rectangular divisions 10 feet \(\times\) 5 feet the divisions in one saw breaking joint (half bond) with those in the adjoining row. The spaces formed on removing the screeds were run with a mixture of tar, cement and pitch, forming a water tight joint.

There are 128Rolled \(\times\) 18" Stanchions 18" \(\times\) 7" supported at 9 feet on footings of concrete upon which are resting on footings of concrete upon which are resting the joists, each of 3½" or 1½". Two Stanchions are spaced 30 feet apart and support 18" by 7½'' H iron joists, on the top of which are the cross girders 15 feet span of 7" by 3½". Rolled steel joists spaced 6 feet apart. Placed between these 7½" by 3½" joists, and supported on their lower flanges, are curved corrugated sheets No. 20 B.W.G having a rise of 6" in the centre. Over this corrugated iron arched sheeting, cement concrete
is laid, being 4" thick at crown of arch and 7" thick at haunches. Upon this concrete a layer of earth 12" thick is laid and finished off with turf which completes the cover to the Reservoir.

The roof of the Reservoir is at an average height of 5 feet above ground level. The walls which are carried up to this level and backed up with earth form a footpath 6 feet wide all round.

The Reservoir is approached by three flights of steps, and has turfed slopes of 1 1/2 to finished off at the toe with a cement drain.

The walls of the Reservoir are faced inside with cement concrete bricks laid one course of header every three courses. The bricks are backed by concrete mixed in the proportion of 5 to 1, laid 9" layers horizontally and the walls are curved at the toe to a radius of 10 feet. (A section of this is shown in Diagram No. 9).

The upper 10 feet of the walling is built with a slight batter of 1/4" to 1 foot.

The excavation was for the greater part in good cabook, admitting of the footings being stepped in to take the curve of the wall, the average thickness of which is 3 feet.

Ventilation is provided for by openings left in the ends of the curved arch roofing and which are protected by wire netting.

Expansion of the stem and cross girders had to be allowed for, beams were put under the ends of the girders, the girders being free to move on the walls and were in no case built in.

The valve chamber placed at one end of the division wall contains six valves controlling the service and wash-out pipes from each half of the Reservoir.

The two service pipes and two wash-out pipes are each connected to a valve chamber by breeches pipes each having controls for the connecting valve.

The two in constant is from each Reservoir are 12 inches in an to the 18" main (with 12" sluice valves) and deliver into an 18" main (with 12" sluice valve) through the breeches piece. The wash-out pipes are 8" in diameter (with two 8" sluice valves) and deliver into the 8" wash-out pipe.

The valves are controlled by hand wheels placed on a level with the roof of the Reservoir and attached to the sluice valves by connecting rods of an average length of 20 feet.
The Valve Tower over the Valve Chamber occupies a central position on the East of the Reservoir and is an ornamental building surmounted by a concrete dome.

The intake chambers occupy central positions in the East walls of the two divisions. In each of these, there is a 7 feet rectangular notch fixed for measuring the water discharged from the 20" diameter main from Labugama.

They are surmounted by towers of similar appearance and construction to the Valve Tower.

Into each of the chambers the main 20" in diameter delivers from a bell mouth 5 feet in diameter, as shown in Diagram No. 10.

The completion of the duplication of main and construction of Elie House Reservoir has more than doubled the quantity of water available for distribution in Colombo, has materially increased the pressure of water in the mains in the eastern part of the City, and rendered it possible, in the event of fire, owing to the new direct connections of the Town mains with the Labugama mains, to materially increase the pressure beyond that due to the elevation of the Service Reservoirs.

4. THE TOWN DISTRIBUTING MAINS.

The total length of distributing mains in the City varying from 27" in diameter to 3" diameter, is over 400 miles, and there are about 5,000 valves, including stop or sluice valves, air valves, etc., besides 713 standposts and 4,648 house connections.

For purposes of inspection and control, the City is divided into 5 districts, each district having its own turncock.

The original city piping, which consisted of both turned and bored and lead jointed pipes, was laid on the 'rider main' principle, so that house connections were made only on the rider mains and could be put in without interruptions to the flow of the larger mains.

The objection to this system is that in the 'rider mains' which have in most cases one or two dead ends, a constant flow through the main is not obtainable.
Since the introduction of the Morris ferrule it has been possible to make the house connections while the main is under pressure, (that is without shutting the water off) so that the necessity for rider mains has been done away with and the system has been abolished and a direct supply from a constantly flowing main which is very desirable may be obtained.

As is the case with all Eastern cities, Colombo supplies a very large proportion of its water through street standposts, as it is practically impossible to provide every small native dwelling with a separate connection.

The standpost system is subject to abuse and consequently waste takes place and to minimise this, constant supervision is required.

The supply from standposts is controlled by push-taps. The type known as Beck’s Patent Push-tap being used. For many years a satisfactory type of push-tap was not obtainable, and much water was wasted in consequence. Even with the improved patterns now in use, constant repairs and supervision are required.

The purity of the Colombo water is ascertained by samples drawn from different parts of the City being submitted to the City Analyst. These samples have always been favourably reported upon by the Analyst.

Meters—The type in use is that known as Frost’s Patent Water Meter (one of which is submitted for inspection). They are found to work satisfactorily and accurately.

Consumption of Water:

The two clock faces in Diagram No. 1 show the consumption of water on two different days, each clock face representing 24 hours.

The dotted circle represents the average daily demand supplied from Maligawatte. The length of the radial lines which are plotted from the centre show the hourly consumption in gallons for each hour. It will be seen that the greatest amount of water is used between the hours of 7 to 9 a.m. and onwards towards midday and the least during the evening and from midnight to 6 a.m.

The foregoing notes have dealt briefly with the more important points of this subject, which it is hoped have been of some little interest.