BRISBANE
WATER SUPPLY SYSTEM

ISSUED BY
DEPARTMENT OF WATER SUPPLY AND SEWERAGE
BRISBANE CITY COUNCIL
CITY HALL
BRISBANE
A BRIEF OUTLINE

OF THE

BRISBANE WATER SUPPLY SYSTEM

(As revised - 1/10/70)
HISTORICAL

The first settlement in the Brisbane area was made at Redcliffe in 1824 with a group of convicts. The lack of an adequate water supply was the main reason for transferring the settlement to the site of the City of Brisbane in the following year. It is interesting to note that Redcliffe did not receive reticulated water until 1943 - more than a century after the first settlement.

The early water supply for Brisbane was obtained from the creek which formerly flowed through the Roma Street railway yards, through King George Square and into the Brisbane River at Creek Street. Wells also provided water for the town. This creek frequently dried up, so a small earth dam was built across it in about 1839 in the middle of what is now Little Roma Street.

A water main ran from the dam to the site of the Treasury Buildings, and a branch main passed under the present sites occupied by the City Hall and Allan and Stark Limited to-day. This main was not a water main as we know it to-day - no cast iron or steel pipes, but just a series of hard hollowed out grey ironbark logs.

Water was pumped along the pipeline by a convict-operated treadmill pump. These works were all supervised by Andrew Petrie, a civilian engineer employed by the Army.

When Brisbane was opened to free settlers in 1842 additional water was obtained from the creek in Victoria Park which, in those days, was known as York Hollow. There was no further improvement in the water supply of Brisbane until Queensland became a separate State in 1859. The growing population had to make do with the existing inadequate supplies and the water supply dam not only became grossly polluted but the embankment leaked profusely and the reservoir dried up at least once a year. Water carriers plied a thriving trade selling water at two shillings (20 cents) per hundred gallons.

In 1863, after considerable investigation, the Brisbane Board of Waterworks was set up. The first task of the Board was to construct Enoggera Dam on Enoggera Creek and to build an 8 inch diameter trunk main to Brisbane. The supply was
completed in 1866 and water was sold to the residents at two shillings (20 cents) per thousand gallons, i.e. at one tenth of the price charged by the water carriers.

As Brisbane continued to grow the supply from Enoggera Dam was soon outstripped and work was started on Gold Creek Dam. This supply was placed in service in 1886 and the two original dams continue to form part of the supply to the City although the area of distribution is now limited to the suburbs of The Gap and West Ashgrove.

Before Gold Creek Dam was completed, the severe droughts of the 1880's made it clear that a further source of water supply was required without delay.

In 1890 it was decided to go to the Brisbane River itself for further water. The city's first main pumping station was completed in 1893 at Mount Crosby, a distance of eighteen miles by road from Brisbane. Water was pumped from the Brisbane River to a reservoir on the slopes of Mt. Crosby and then travelled through a 24 inch diameter trunk main along Mt. Crosby and Moggill Roads to Brisbane. The station has since been enlarged.

The record drought of 1901-03 made it clear that a storage dam was required on the Brisbane River. After examining the site of Somerset Dam, among other alternatives, it was decided to build a dam on Cabbage Tree Creek, a tributary of the Brisbane River, some eleven miles upstream from Mount Crosby along the river.

Before any moves could be made, the Brisbane Board of Waterworks was replaced by The Metropolitan Water Supply and Sewerage Board in 1910. Under the new Board, the Mount Crosby pumping station was enlarged, additional trunk mains were built and Lake Manchester Dam was completed in 1916 on Cabbage Tree Creek.

Up to this time raw water had been pumped directly from the Brisbane River to the consumers. At times the river became very turbid and there were many complaints from the consumers. This problem was overcome by the completion, in 1917, of a sedimentation basin at Mount Crosby to remove mud from the
water and in 1919 filters were placed in operation on nearby Holt's Hill to remove the final impurities and harmful organisms from the water. In 1925 chlorine was added to the water to kill any harmful organisms which might have passed through the filters and, at last, a century after the original settlement took place, Brisbane had a pure water supply. In 1926 a weir was built across the Brisbane River at Mount Crosby to control the water which otherwise would have flowed down the river to waste.

In 1928 The Metropolitan Water Supply and Sewerage Board was dissolved and the Water Supply System was transferred to Brisbane City Council. The "Great Depression" of the 1930's curtailed further development for several years except for some further filters at Holt's Hill in 1936.

Construction was started on Somerset Dam on the Stanley River, a tributary of the Brisbane River in 1935, to provide more storage for the Brisbane Water Supply System and the dam began to store water effectively in 1943 although, due to the Second World War, the construction was not largely completed until 1954. The dam was finally finished in 1959.

During the Second World War the final expansion of the Mount Crosby installation was started. A block of rapid filters was completed in 1948 and the pumping station converted from steam to electric operation between 1948 and 1951. Since that time, two more blocks of rapid filters and three sedimentation basins have been built and further electrically driven centrifugal pumps have been installed in the Mount Crosby Pumping Station. The final phases of this amplification are now under construction. Two large pumping units are being installed at the pumping station and new and enlarged chemical dosing facilities are almost complete. A 20 million gallon reservoir will soon be completed on Cameron's Hill, near Holt's Hill, to supplement the Holt's Hill storages which were formed by converting the original slow sand filters into reservoirs.

In addition to the supply to Brisbane, water has been delivered in bulk to Ipswich City Council since 1922, Redcliffe City Council since 1943, Albert Shire Council since 1963 and Moreton Shire Council since 1969. Water has been supplied to parts of Moreton Shire indirectly, via Ipswich for many years.
A bulk supply to Beaudesert Shire will be completed in 1971.

During the year ended 30th June 1970 a total of 27,000 million gallons of water was supplied to Brisbane; 2,400 million gallons to Ipswich; 380 million gallons to Redcliffe and 155 million gallons to Albert Shire. So few consumers are as yet connected to the Moreton Shire direct supply that the consumption was negligible.

Of this total of 29,900 million gallons consumed in the year, some 246 million gallons were supplied from Enoggera Dam. The remainder was supplied from the Mt. Crosby treatment plant on the Brisbane River.

**LAKE MANCHESTER DAM**

Lake Manchester Dam is situated 1½ miles from the confluence of Cabbage Tree Creek with the Brisbane River, approximately 12 miles above the Mount Crosby Pumping Station. This dam is built of mass concrete, has a maximum height of 112 feet, a base width of 95 feet, and a crest width of 10 feet, its full length being 745 feet, of which 166 feet is spillway. The crest elevation is 180 feet and the spillway 170 feet and it has a capacity of slightly over 5,700 million gallons, covering an area of 695 acres.

The catchment draining to this reservoir is 28.5 square miles. About half the catchment of this dam is owned by the Council and the majority of the remainder is a State Forest. There is a small fringe of settlement at the extreme end of the catchment at Mt. Nebo.

The dam was completed in 1916 and is now used for the fine regulation of the Brisbane River at Mt. Crosby weir.

**SOMERSET DAM**

Somerset Dam is built across the Stanley River in a rocky gorge between Mount Brisbane and Little Mount Brisbane, at a point four miles above the confluence of the Brisbane and Stanley Rivers, 138 miles by river from the mouth of the Brisbane River in Moreton Bay. The dam is 17 miles by road from Esk and 80 miles from Brisbane.
The area of the catchment is 515 square miles. The dam is of the mass concrete gravity type, i.e. it resists the thrust of the water by its weight alone. The top water level (crest) is 353 feet above sea level, or 155 feet above the original stream bed and 173 feet above bottom foundation. The length of the dam wall is 1,000 feet (925 feet approximately at crest level) and the maximum thickness at the base of the wall is approximately 135 feet. The volume of excavation was 170,000 cubic yards and the volume of the concrete in the completed dam 266,000 cubic yards.

The storage capacity of the dam, at top water level, 353 feet above sea level, is 200,000 million gallons, when the water surface would cover some 20,000 acres and reach upstream 35 miles - almost to Woodford. The storage capacity at present normal water supply level, 320 feet above sea level, is 67,000 million gallons, which is reserved for water supply purposes. The remaining capacity will greatly mitigate the effects of all floods which may occur in the Brisbane River. At the normal water level, the lake covers an area of 8,000 acres, and it is possible to travel 23 miles by launch to Villeneuve. The lake is approximately one mile wide in the widest reach.

It is proposed, this year, to raise the normal water supply level in the reservoir to 325 feet above sea level, thus increasing the storage available for water supply to 81,000 million gallons, to meet the continually increasing consumption of the whole system. Somerset Dam will be adequate for this purpose until approximately 1973 when it is planned to commission the North Pine River Dam.

Water is released as required from Somerset Dam to maintain the supply at Mount Crosby weir. The water travels 80 miles down along the Brisbane River, taking five days to traverse the river.

MOUNT CROSBY PLANT

The catchment area of the Brisbane River and its tributaries contributing water to reservoirs and to the Brisbane River above Mount Crosby weir is some 4,200 square miles. The water used in the city is drawn from a very widespread area
and travels a great distance on its way to the consumer. Such a large catchment area presents its problems. Very frequently the water, by the time it reaches Mount Crosby, has collected a great deal of silt and organic material which results in high turbidity and colour and, in addition, as the catchment area is inhabited, the water at all times carries some degree of pollution, bacteria and other organisms, which must be removed or rendered harmless before the water can be used with safety.

The Mount Crosby pumping and treatment plant can pump 135 million gallons of water per day and deliver it to the trunk mains.

Pumping Station:

At the Mount Crosby Pumping Station, twelve electric pumps each driven by an 1100 H.P. motor are, together with associated equipment, worth nearly one million dollars.

These pumps are each capable of lifting approximately ten million gallons of water daily to the treatment plant 380 feet above the river level. This pumping station is the biggest of its kind in Australia, and at present has a total installed capacity of approximately 160 million gallons per day.

A further stage of amplification of the Mount Crosby Pumping Station will be completed this year. Two pumping units, each capable of delivering 20 million gallons of water per day are being installed in the remaining pump well at the station. Each is double the capacity of the existing pumps and each will be driven by a 2,200 H.P. electric motor. These will be among the largest electric motors in Australia used for driving water pumps.

Purification Plant:

Purification Process -

On arriving at the treatment plant the water undergoes a number of processes designed to give the high quality product which is finally distributed to the consumers. The first step of these processes is the removal of the bulk of the suspended material such as clay and
silt which, on occasions, are present in such large quantities as to give the appearance of a strong milk coffee - something very different from the clear and sparkling liquid which emerges from the consumers' taps. Much of this material is colloidal in nature and will not settle out of the water, no matter how long it is allowed to stand, so coagulating chemicals must be added to the water.

At the Mount Crosby plant the main chemical used is alum. When the turbidity is very high sodium aluminate is also used. The coagulants are first mixed into the water violently and then are stirred gently. These two processes, known as coagulation, result in the formation of myriads of tiny particles of a jelly-like white floe. The floc particles first neutralise the electric charge which keeps the particles of colloids from settling, then the floc particles engulf the colloids and other particles of mud, etc., in the water.

At Mount Crosby the rapid "flash" mixing is caused by turbulence in concrete channels and the stirring is carried out in floc chambers which form the first part of the sedimentation basins. In the original (No. 1) basin, the stirring is carried out by stationary baffles but in each of the later basins the stirring is carried out by four sets of rotating paddles. These may be seen in action as each blade appears, briefly, near the surface of the water.

From the coagulation basins the water passes into the sedimentation basins. Here the water moves very slowly and with as little turbulence as possible. In these basins the jelly-like floc particles settle down to the basin floors, taking with them both the coarse and fine material carried by the water. Fortunately, many of the harmful micro-organisms in the water cling to particles of dirt and clay and are settled out with the floc in the sedimentation basins.

The quantity of this material is quite large. In 1968/69 a record amount of 3,337 tons were removed.
during the year. It is of interest to note that 2,455 tons were removed in one month - January 1969. Further, during part of January, the amount of suspended solid matter in the river reached a record figure of 18 tons for every one million gallons pumped to the treatment plant. These conditions are equivalent to 150,000 parts per million of suspended solid matter. By comparison, the worst raw water conditions encountered in Sydney to date is 300 parts per million.

The sludge of alum floc and dirt is accumulated in the bottom of the basins for a few weeks and is then flushed out of drains using fire hoses.

The settled water then passes to the filtration plants and here, under very carefully controlled conditions, it flows down through beds of meticulously graded sand and gravel which removes the balance of the material in suspension and the colouring agents and also the greater part of the bacterial pollution. After completing this stage, the water has lost all the undesirable constituents and also the chemicals previously added have been removed.

The water is, however, slightly acid and further chemicals, in this case lime, are added to correct this deficiency and finally, chlorine, a strong sterilising agent, together with ammonia, is injected into the water to make absolutely certain that no pathogenic organisms survive. The chemical processes used are very carefully controlled and this is necessary because the doses added are, in many cases, very small. For example, the amount of chlorine used approximates only 1 lb. to every million pounds weight of water.

**Sedimentation Basins -**

Coagulation and sedimentation are carried out in four basins. The oldest basin (No. 1) was constructed as part of the original treatment plant, and has, to some extent, been modified. For example, the mixing and coagulating basins are the original sedimentation tanks, and have a capacity of 559,000 gallons, the top water
level being R.L. 391.25, while the basin now used for sedimentation was originally the clear water reservoir and has a capacity of 4,500,000 gallons, the top water level being R.L. 390. No.2 sedimentation basin completed in 1957, No.3 basin completed in 1966 and No.4 basin completed in 1967, incorporate several features designed to overcome the difficulties experienced in the operation of the older basin. The new basins are rectangular in cross-section to promote uniform flow and the flocculation basin is arranged to discharge straight into the settling basin to avoid the troublesome corners that cause the flow to break down in the original basin. Power operated stirring paddles are used in the flocculation basins to give greater efficiency in causing the floc to grow to the desired size. Some alum floc is required in the water to enable the filters to operate correctly and the water is drawn from the basins in a uniform manner to avoid damage to the floc which is sometimes very brittle.

Filters -
The filter plant consists of rapid filters at both Low Level and Holt's Hill. The filters at Low Level are of the open gravity type of rapid sand filter and comprise six units completed in 1948, six units completed in 1958 and eight units completed in 1968. The filter plant is capable of treating over 120 million gallons of water per day.

These filters are virtually large open rectangular boxes containing 24" of sand over the top of 20" of gravel. Underneath the gravel is a series of collecting pipes. A number of the filters have been resanded with a mixture of sand and finely crushed anthracite as an experiment; experience overseas having shown that this type of filter media has advantage and it is hoped, by this method, to increase the output of the filters.

The top water level of the filters is R.L. 390.
The rate at which water passes through the filters is controlled automatically by the equipment seen in the gallery beneath the filter floor. This rate can be varied from the main control room. The filtered water runs into clear water tanks under the filters.

Clear water storage capacity of the clear water tanks is two million gallons, with a top water level of R.L. 377.50.

As each filter becomes clogged it is washed by running pure water through it from the bottom in the opposite direction to the filtering process. This washes out the accumulated dirt which runs to waste through a series of drains.

At Holt's Hill there are rapid filters of the enclosed multiple cell type completed in 1936. There are twelve (12) cell units, the normal capacity of each being one million gallons per day, and of the complete plant twelve million gallons per day. Under overload conditions the maximum capacity of these filters is approximately 16 million gallons per day. The top water level of the filters is R.L. 374.

The original filters at Mount Crosby were eleven standard slow sand filters constructed at Holt's Hill between 1916 and 1924. Each was half an acre in area and 8 feet deep and was capable of filtering one million gallons per day. In 1936 the Holt's Hill rapid filters were built in one of the slow sand filters and in 1950 five of the slow sand filters were converted to pure water storages. Two more slow sand filters were converted to pure water storages in 1964, and the remaining three are no longer used.

**Pure Water Storage** -

The pure water storages are located at Holt's Hill and consist of a covered storage of 2.5 million gallons' capacity and an open storage of 8 millions, the latter having been converted from slow sand filters. The top water level of the covered storage is R.L. 362 and of
the open storage R.L. 365. A new 20 million gallon pure water storage reservoir will be completed at Cameron's Hill near Holt's Hill very shortly and this will raise the pure water storage capacity at Mount Crosby to 32 million gallons.

**Chemical Supplies:**

**Coagulant** -

Dry alum is delivered to Mount Crosby by road in trucks. The alum is dissolved in water in a mixing tank near the old high level storage reservoir and the alum solution is stored in three storage tanks each holding 50,000 gallons. The alum solution is very acid and the tanks are lined with rubber to prevent corrosion.

The alum solution is pumped into the flash mixing chambers through polythene pipes. These pumps are automatically controlled to give the correct dosage.

Sodium aluminate, which is used only when the turbidity of the raw water is very high, is fed dry by an automatic feeding machine into a stream of water and then taken by pipes to the flash mixing position.

**Correction** -

The lime used for correcting the acidity of the water after filtration is also delivered dry in road trucks and is blown into a 200 ton storage tank. From here the lime is fed by a screw conveyor to the automatic lime feeders which feed the correct quantity of lime into the water.

**Sterilisation** -

The chlorine and ammonia used for sterilising the water are transported in steel drums. Each drum holds one ton of liquid chemical under pressure. The chlorine and ammonia are evaporated to gas and are fed into the water at the correct rate by automatic equipment.
The lime, chlorine and ammonia are housed in a chemical building beside the filters. The wash water pumps for supplying pure water to the old high level reservoir are in the basement and the control laboratories are located in the same building.

**Water Quality Control**

Many samples of the water from the different parts of the plant are taken every day and carefully analysed both for chemical constant and bacteria. A large staff is employed at Mount Crosby to ensure the purity of the water produced by the plant.

**ENOGGERA DAM**

In addition to the main works described above, the other sources of supply are the Enoggera and Gold Creek Reservoirs. In the case of Enoggera Reservoir, the catchment rises in the D'Aguilar Range at a point near its southern termination. The storage reservoir is formed by a clay-cored earthen embankment completed in 1866, having a maximum height of 65 feet, a crest length of 1,122 feet, a top width of 15 feet and slopes of 3:1 on the upstream face and 2:1 on the downstream face, respectively. The bywash, which has twice been widened and strengthened since its original construction, has a present width of 274 feet and an elevation of 244.77 feet above sea level.

The full volume of the storage provided by this embankment is 1,000 million gallons, though of this amount only 600 million gallons are available for direct draw-off. The maximum surface area of this storage is 186 acres when the length of the shore line is 8 miles. The provisions for the withdrawal of water from the reservoir include three 12 inch outlet pipes laid under the embankment at R.L. 232.42 feet. These pipes are connected at their inlet ends to two swing arms which can be raised and lowered, as required, to draw the best quality water from the reservoir.

The catchment area of the dam is 12.8 square miles. For the most part it is rough and mountainous with but a shallow
depth of surface soil. Heavy timber and dense undergrowth are prevalent over the whole area, clearing having been carried out only in the immediate vicinity of the impounded water. The whole catchment is a State Forest and human habitation is practically non-existent. The works for the treatment of the water drawn from the Enoggera Reservoir were erected in 1912 on a site immediately below the embankment and comprised the first treatment plant in Brisbane. They consist of four adjoining slow sand filters, 4 feet in nominal depth, and of an aggregate area of half an acre. These beds are capable of treating a maximum of 1½ million gallons per day. The covered pure water reservoir attached to these works is of groined concrete arch construction and has a capacity of 0.8 million gallons. The top water level is at R.L. 220.92 feet, and the bottom of the reservoir at R.L. 208.92 feet.

The Enoggera system was the original source of supply for Brisbane. With the development of the Gold Creek source of supply in 1886 and the Mount Crosby source of supply in 1893, the area of consumers supplied from the Enoggera source has contracted from the city area proper and is now confined to the suburbs of The Gap and Ashgrove. All the water from the Enoggera treatment plant is now pumped to a service reservoir at The Gap from which the water is distributed. As the development of The Gap proceeds, the Enoggera supply will finally be restricted entirely to this suburb. The original 8 inch trunk main laid in 1865 and the 12 inch trunk main laid in 1876 have worn out and been abandoned and the 16 inch trunk main laid in 1894 will be abandoned in a few years' time.

**GOLD CREEK DAM**

Storage is also provided at Gold Creek, the watershed of which lies immediately to the westward of that of the Enoggera Creek. The dividing range of hills between the two catchments terminates in Mount Coot-tha. The creek itself is a tributary of Moggill Creek. The development of this creek as a source of supply of water to Brisbane was first undertaken in 1885 by the construction of an earthen clay-cored embankment of a maximum height of
86.3 feet, a top width of 20 feet, and a crest length of 625 feet. The upstream side of the slope of this embankment is 2:1, while on the downstream side it is compounded of 3:1 in the upper end, 5:1 in the lower levels. The width of the bywash is 182 feet and its elevation 323.42 feet. Due to the damage caused by the floods of 1890 this bywash had to be rebuilt completely in concrete. The capacity of the storage provided by this embankment is 406 million gallons, of which 400 million are directly available. The maximum surface area of this storage is 67 acres. An outlet tower, equipped with two swing arms and connected at its base to an outlet pipe 16 inches in diameter, laid under the embankment, is installed for the withdrawal of water from the reservoir, together with a syphon of a diameter of 12 inches passing through the embankment above the bywash level.

The catchment of this reservoir has an area of 3.8 square miles. In all its more important characteristics, it exhibits close similarity to the Enoggera catchment being mountainous, rocky, heavily timbered and free from human habitation. The whole of the catchment is owned by the Council. Originally the water from Gold Creek Reservoir was conveyed directly into the city by a 16 inch diameter trunk main, but in 1919, following the introduction of treatment facilities at Mount Crosby, the supply was discontinued, the installation of a filtration plant at Gold Creek not being warranted on account of the relatively small quantity of water available. In 1927 a tunnel 5 feet by 3 feet was driven through the range dividing Gold Creek from Enoggera for a length of 1,105 feet and a main consisting partly of 16 inch diameter cast iron pipes and partly of 16 inch and 18 inch diameter reinforced cast iron pipes, was laid to enable the water from Gold Creek Reservoir to be diverted into Enoggera Reservoir. Gold Creek Reservoir thus forms part of the combined Gold Creek-Enoggera storage and water is diverted regularly from Gold Creek Reservoir to Enoggera Reservoir.

**NORTH PINE RIVER PROJECT**

Construction is now under way on a project to amplify the water supply to Brisbane from the North Pine River. A dam is being built across the North Pine River at a site 3½ miles
upstream of J etrie to provide the necessary storage. Water will be drawn from the dam through a tunnel to pumps located in a deep well and will be pumped to the purification plant which is to be built less than half a mile away from the dam.

The purification plant will be essentially the same type as the Mount Crosby purification plant, but advantage will be taken of the site to construct a compact, efficient plant and the experience gained at Mount Crosby will be utilised to ensure that the most modern and efficient plant is constructed.

Water will be pumped from the purification plant through a 48 inch diameter trunk main to be built to Bald Hills. At Bald Hills a 24 inch diameter connection will be made to the existing Brackenridge reservoir to enable a supply to be drawn from the trunk main and the rest of the water will continue along a 42 inch diameter main to be completed to Aspley reservoir this year. This latter reservoir will have a capacity of 20 million gallons and is now under construction and will be completed in the latter part of 1971. A pumping station at Aspley reservoir will pump Pine River water through the existing water mains to Sparkes Hill reservoir. A new large reservoir with a capacity of 15 million gallons will be built at Sparkes Hill beside the existing reservoir.

From Sparkes Hill reservoir water will flow along existing water mains to Hay Street pumping station which supplies Grovely reservoir and also a pumping to be built at Lloyd Street, Enoggera. This station will pump Pine River water into the Mount Crosby system of mains on days of high demand.

As well as the supply to Brisbane, the North Pine River Scheme will supply both raw and pure water in bulk to Pine Rivers Shire. The Shire presently draws its water supply from the North Pine River about half a mile downstream from the Brisbane City Council's dam site and relies on Lake Kurwongbah for its reserve supply. The Shire pumps the raw river water to its treatment plant at Petrie from which water is supplied to the Petrie paper mill and the City of Redcliffe as well as the Shire area. Pine Rivers Shire propose to build a pipeline to carry raw water from the North Pine River Dam to the existing pumping station for pumping to the Shire's treatment plant. Pure water also will be supplied in bulk to the Shire from the 48 inch diameter trunk main at Strathpine and also at other locations yet to be decided.
NORTH PINE RIVER DAM

The North Pine River Dam is under construction on the North Pine River about 3½ miles upstream of Petrie.

The central section of the dam across the river will be built in mass concrete as at Somerset Dam, but the low flanks of the dam will be completed as earth banks for economy. Only the central section of the dam located in the deepest part of the valley will be straight. The remainder of the dam will be curved to take advantage of ridges on either side of the river.

The concrete section of the dam will be 1,875 feet long and the crest will be 130 feet above the stream bed. A spillway 200 feet long will be located in the river channel in the middle of the concrete section of the dam. The spillway crest will be 95 feet above the stream bed, and the spillway will be equipped with five radial gates each 40 feet long and 28½ feet high. These gates will retain water in the dam during normal times but will be opened in stages to discharge flood water.

The earth bank section of the main dam will be 1,760 feet in length and will be 20 feet high where it joins the concrete section of the dam. In addition to the earth banks at the main dam, there will be three other earth banks at low saddles to prevent the escape of water from the reservoir. The largest of these auxiliary banks will be 1,410 feet long and 22 feet high, whilst the total length of the auxiliary saddle banks will be 3,700 feet. The total volume of material in all the earth banks will be 360,000 cubic yards.

The North Pine River Dam will store 44,500 million gallons for water supply against 81,000 million gallons by Somerset Dam. At this level the area of the reservoir will be 5,260 acres and the shoreline will be 100 miles long. The dam will provide some flood mitigation downstream, but this is incidental to its main purpose which is water supply. During a maximum flood the volume of water stored in the reservoir will rise to more than 55,000 million gallons.

The excavation for the foundations of the main dam started early in 1970 and will be completed in the third quarter of
1970. Tenders for the construction of the main dam will be called early in 1970/71 Financial Year and it is expected that the first water will be delivered to Brisbane late in 1973. The elevated reservoir for the treatment plant is under construction and will be finished in 1971.

TRUNK AND DISTRIBUTION MAINS

There are approximately 236 miles of trunk and distribution mains in the system, the diameters of these mains varying from 14 inch to 66 inch. The value of the trunk mains systems approximates $17 million and the cost of maintenance is approximately $100,000 per year. To give some idea of the rapid growth of the water supply system, attention is drawn to the first trunk main to Brisbane from the Enoggera Reservoir. This trunk main was laid in 1866 and was 8 inches in diameter. In 1876, only ten years later, it was found necessary to lay an additional main. Since that date the pumping station, treatment plant and trunk mains have grown enormously. Trunk main amplification has been achieved by laying mains of 36 inch, 42 inch, 54 inch, 60 inch and 66 inch diameter. The trunk mains are now capable of delivering more than 120 million gallons a day and additional trunk mains now under construction will increase the capacity of the trunk system to meet the increasing demands of the consumers.

The earlier trunk mains were made of cast iron, and it is of interest to note that some of these mains laid in 1876 are still in use. Cast iron has the advantage of being highly resistant to corrosion in almost all types of ground, but has the disadvantage of allowing tuberculation of internal growths which steadily reduce the carrying capacity of the pipe. Cement lining of pipes obviates these growths and ensures full carrying capacity for the full life of the pipes. Since 1936 all pipes used have been cement lined. Because of the very high initial cost of cast iron pipes in large sizes, steel-welded pipes are now used exclusively for the larger sized trunk mains. The steel pipes are also cement lined and the buried pipes are protected against external corrosion by wrapping with hessian impregnated with coal tar pitch enamel. This coating for protection against
external corrosion is reasonably successful, but, where ground waters are highly acid, it is necessary to wrap the pipes with fiberglass. Where laid above ground, steel pipes are protected against weathering by the application of zinc-enriched paint. Steel pipes in use in Brisbane for some 60 years are, for the most part, in reasonably good condition. Since 1939 the new steel trunk mains have been fabricated and joined together by welding, and because the pipeline is continuous, little or no trouble is experienced with leaking joints. The older cast iron pipes were lead jointed and over the years and under traffic even very slight ground movement causes the lead to be pushed out of the joint, resulting in numerous small leaks which are sometimes difficult to locate.

Asbestos-cement pipes are sometimes used for the smaller diameter trunk mains, the pipes being joined by the use of a rubber ring. These pipes are more resistant to certain types of ground corrosion than steel.

Amplification of the trunk main and distribution system is virtually a continuous programme to keep pace with development of the area and of the increased requirements of the inhabitants and involves annual expenditures of the order of one and a half million dollars. This work presents particular problems when highly developed city and suburban areas have to be traversed.

SERVICE RESERVOIRS

The water having been brought to the populated parts of the city by trunk mains as previously described, the next step is its distribution to consumers. First, however, it is desirable, where possible, to deliver the water from the trunk mains into service reservoirs to provide storage in the city to meet peak demands. The demand for water varies greatly with the seasons, and also throughout the twenty-four hours a day. In Brisbane, the maximum day's demand on a hot summer day is approximately one and a half times the average throughout the year for one day, and the maximum hourly rate in a district may well be three times the average throughout the twenty-four hours, that is, more than four times as great as the average daily rate. Without the
use of service reservoirs, trunk mains would need to be designed to carry more than four times the average daily demand. Such mains would be working for much of the time at less than one-quarter capacity, and would be enormously costly. It is found cheaper in water supply systems to provide mains capable of carrying a maximum day's supply and to rely on service reservoirs to meet the hourly variations in demand from the reserve of water held in these storages.

Service reservoirs vary in capacity according to the areas they serve. In general, one maximum day's demand represents a desirable capacity. This allows of the estimated maximum day's demand being exceeded on a number of succeeding days, as during a heat wave, without reducing the storage to a dangerously low level. Whilst at present the reservoir capacity falls somewhat short of the desired requirements, the Council is pushing ahead with the construction of further new reservoirs.

So far, twenty-seven service reservoirs are in use, with a total capacity of 74 million gallons, serving twenty-three zones of supply.

Details of these reservoirs are as follows:

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Date</th>
<th>Capacity</th>
<th>Top Water Level (R.L.)</th>
<th>Outlet Level</th>
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<td>Wickham Terrace</td>
<td>1871</td>
<td>550,000</td>
<td>164.67</td>
<td>146.92</td>
</tr>
<tr>
<td>Highgate Hill</td>
<td>1889</td>
<td>2,176,000</td>
<td>198.42</td>
<td>187.83</td>
</tr>
<tr>
<td>Bartley's Hill No.1</td>
<td>1907</td>
<td>1,803,000</td>
<td>262.50</td>
<td>244.37</td>
</tr>
<tr>
<td>Bartley's Hill No.2</td>
<td>1920</td>
<td>2,560,000</td>
<td>262.50</td>
<td>242.90</td>
</tr>
<tr>
<td>Tarragindi</td>
<td>1923</td>
<td>13,377,000</td>
<td>262.00</td>
<td>241.50</td>
</tr>
<tr>
<td>Paddington Elevated</td>
<td>1927</td>
<td>100,000</td>
<td>340.00</td>
<td>325.00</td>
</tr>
<tr>
<td>Roles Hill</td>
<td>1928</td>
<td>1,790,000</td>
<td>167.66</td>
<td>148.16</td>
</tr>
<tr>
<td>Eildon Hill</td>
<td>1930</td>
<td>5,000,000</td>
<td>264.00</td>
<td>243.50</td>
</tr>
<tr>
<td>Bulimba</td>
<td>1940</td>
<td>750,000</td>
<td>201.75</td>
<td>172.25</td>
</tr>
<tr>
<td>Sparkes Hill</td>
<td>1941</td>
<td>5,000,000</td>
<td>264.00</td>
<td>248.09</td>
</tr>
<tr>
<td>Brackenridge</td>
<td>1942</td>
<td>2,000,000</td>
<td>180.00</td>
<td>165.50</td>
</tr>
<tr>
<td>Cavendish Hill</td>
<td>1948</td>
<td>750,000</td>
<td>300.00</td>
<td>280.50</td>
</tr>
<tr>
<td>Manly Elevated</td>
<td>1953</td>
<td>250,000</td>
<td>244.00</td>
<td>210.00</td>
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<tr>
<td>Grovely</td>
<td>1953</td>
<td>1,000,000</td>
<td>309.00</td>
<td>284.25</td>
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</tbody>
</table>
A 15 million gallon reservoir at Wellers Hill and a 20 million gallon reservoir at Aspley are under construction, together with a 2 million gallon reservoir under construction at Cavendish Hill.

**Table: Reservoir Details**

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Date</th>
<th>Capacity</th>
<th>Top Water Level (R.L.)</th>
<th>Outlet Level</th>
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<tbody>
<tr>
<td>Inala</td>
<td>1954</td>
<td>2,020,000</td>
<td>245.00</td>
<td>225.00</td>
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<tr>
<td>Sunnybank</td>
<td>1954</td>
<td>2,020,000</td>
<td>250.00</td>
<td>230.00</td>
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<tr>
<td>Stafford No.1</td>
<td>1954</td>
<td>300,000</td>
<td>337.50</td>
<td>312.50</td>
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<tr>
<td>(formerly Sparkes Hill High Level)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>The Summit (Mt. Coot-tha)</td>
<td>1959</td>
<td>100,000</td>
<td>961.67</td>
<td>938.67</td>
</tr>
<tr>
<td>Mt. Gravatt High Level No.1</td>
<td>1963</td>
<td>250,000</td>
<td>429.00</td>
<td>409.25</td>
</tr>
<tr>
<td>The Gap</td>
<td>1964</td>
<td>2,000,000</td>
<td>340.00</td>
<td>310.25</td>
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<tr>
<td>Milne Hill</td>
<td>1965</td>
<td>3,000,000</td>
<td>330.00</td>
<td>300.20</td>
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<tr>
<td>Mt. Gravatt</td>
<td>1966</td>
<td>5,000,000</td>
<td>330.00</td>
<td>300.20</td>
</tr>
<tr>
<td>Toohey Mountain</td>
<td>1966</td>
<td>1,000,000</td>
<td>360.00</td>
<td>327.00</td>
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<tr>
<td>Green Hill</td>
<td>1968</td>
<td>17,000,000</td>
<td>310.00</td>
<td>275.00</td>
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<tr>
<td>Mt. Gravatt High Level No.2</td>
<td>1969</td>
<td>1,000,000</td>
<td>429.00</td>
<td>409.25</td>
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<tr>
<td>Stafford No.2</td>
<td>1970</td>
<td>2,000,000</td>
<td>330.00</td>
<td></td>
</tr>
<tr>
<td>Manly No.2</td>
<td>1970</td>
<td>1,500,000</td>
<td>244.00</td>
<td></td>
</tr>
</tbody>
</table>

RETICULATION MAINS

From these reservoirs, water is distributed to the consumers in each area by a branchwork of mains gradually decreasing in size. The outlets from the larger reservoirs are as large as 60 inches in diameter. The mains are gradually decreased in size as they spread over the area until we reach the normal street mains, now a minimum of 4 inch diameter. In parts of the city and suburbs a large number of 3 inch mains exist. These are inadequate for present day requirements; the choice of size in earlier days having been dictated by limited finance as well as a lesser conception of requirements. It has been amply demonstrated, particularly during the past twenty years, that higher living standards in a community are reflected in a higher use of water per person. Both cast iron and asbestos cement pipes are used for reticulation mains.
Problems concerning the size and disposition of mains in a district arise from the nature of the existing and anticipated development in the area. Many industrial concerns require services of a size which would supply hundreds of ordinary dwellings. Again, a decision by housing authorities to erect say, a thousand homes in an area, can render the existing distribution totally inadequate. High elevations adjacent to comparatively low areas also present difficulties, it being necessary in many cases to provide booster pumping units to maintain the supply to these areas at times of peak demand.

Continued expansion of the city and suburban areas calls for a continuous programme of extensions and improvements to the system, yearly expenditure being approximately $1,500,000.

The reticulation system comprises 2,274 miles of mains from 12 inch to 3 inch in diameter, valued at approximately $22,000,000. The maintenance of this system is a task of considerable magnitude, incurring an annual expenditure of over $350,000.

GENERAL

The Council is responsible for the maintenance and reading of some 19,600 water meters and the maintenance of approximately 190,000 consumers' services from the main to the building line. A free tap washering service is also provided in an endeavour to avoid waste of water.

As will be seen from the foregoing, the supply of water to Brisbane is a very costly undertaking and whilst the Council advocates a liberal use of water, it also stresses the necessity for avoiding waste, as any additional costs incurred thereby must be met by the ratepayers themselves. Water is the cheapest commodity available to the community today and, as a result, is frequently undervalued. A great deal of work is constantly in progress to ensure that the city has reasonable supply at all times. The consumer must always appreciate that he is handling a valuable product, even if it costs him little, and treat it accordingly.