ENGINEERS
AUSTRALIA
Canberra Division

NOMINATION OF THE

LOWER MOLONGLO WATER QUALITY CONTROL CENTRE

FOR AN AWARD UNDER THE

ENGINEERING HERITAGE RECOGNITION PROGRAM

BY
ENGINEERING HERITAGE CANBERRA

November 2015

Title page image: Aerial view of the LMWQCC with the Molonglo River in the background.

Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Nomination for an Award
Under the
Engineering Heritage Recognition Program

Name of works: The Lower Molonglo Water Quality Control Centre

These works are nominated for the award: Engineering Heritage National Marker.

Location: In Canberra in the Australian Capital Territory (ACT):

On Stockdill Drive, Holt, west of the Magpies Belconnen Golf Club and the suburb of Holt, ACT.

Owner: Icon Water,
GPO Box 366,
Canberra City, ACT, 2601.

The owner has been advised of this nomination, a copy of the letter of agreement appears at Attachment A.

Access to site; The site is normally closed off to the public but access can be had by appointment.

Nominating body; Engineering Heritage Canberra.
Canberra Division, Engineers Australia
Engineering house
11 National Circuit
BARTON ACT 2600

....	....
Robert Breen	**Lyndon Tilbrook**
Secretary	**Chair**
Engineering Heritage Canberra	**Engineering Heritage Canberra**
November 2015	**November 2015**

Heritage Assessment

1. BASIC DATA

Item Name

Lower Molonglo Water Quality Control Centre (LMWQCC).

Other/Former Names

None.

Location

In the Australian Capital Territory (ACT).

Address

Stockdill Drive, Holt, ACT

Suburb/Nearest Town

Holt, ACT.

State/Territory

Australian Capital Territory.

Local Government Area

The Government of the ACT.

Owner

Icon Water Limited (formerly ACTEW Corporation Limited trading as ACTEW Water).

Current Use

Sewage treatment works.

Former Use

None.

Designer

Commonwealth Department of Works with American engineer David Caldwell in association with the Australian consultants John Connell and Partners.

Maker/Builder

David Caldwell in association with John Connell and Partners.

Year Started: 1974 **Year Completed:** 1978

Physical Description

The plant is situated on a hill west of the Belconnen Golf Club and the suburbs of Holt and MacGregor and north of the Molonglo River. See Attachments B and C for descriptions of the facility.

The plant reduces nutrients, nitrogen and phosphorus to low levels using physical, chemical and biological treatment processes. These processes involve screening, addition of lime and iron chloride followed by centrifugal separation of solids which are incinerated at high temperature. The waste water then undergoes anaerobic and aerobic treatment in biological reactors, followed by secondary clarification, filtration, chlorination and neutralisation before use for irrigation or discharge into the Molonglo River. The ash from the high temperature incineration is used as an agricultural soil conditioner.

Modifications and Dates

The plant's biological nitrification process involves the use of high volumes of air under pressure provided by three high speed, high capacity impeller pumps – see Figure 5.29 of Attachment B. These pumps generate a very high-pitched scream at very high levels in the order of 120dbA creating a most hostile working environment and complaints from neighbours such as the YMCA camp downstream of the plant.

In early 1980s the Department of Works engaged Louis Challis and Associates, Australia's leading acoustician at the time, to investigate and resolve the problem. This resulted in the pumps being enclosed in a "box-within-a-box" enclosure sub-room with walls designed to substantially reduce sound transmission. As a result ear protection was only required when working in the sub-room. Other measures included the fitment of mufflers to each of the outlet pipes.

In 1994 a bypass dam was constructed to temporarily store up to 147 million litres of screened wastewater during periods of prolonged wet weather.

Historical Notes

The need for the national capital to have a modern sewerage system was acknowledged from the very first. On 20 May 1909 the Premier of NSW wrote "I note hitherto no reports have been obtained on the matter of sewerage of the capital city", enclosing a copy of the *Report of the Chief Engineer for Sewerage Construction 12 May 1909* which said:

> *Two alternative sites have been selected for the Federal Capital City in the Yass-Canberra area ... the alternative sites are known as Canberra and*

Mugga Mugga...... The Canberra site undoubtedly presents the better facilities for the treatment of sewage.

Construction of the first sewer commenced in 1915 but was stopped during World War I. After further Parliamentary approval excavation recommenced in 1922 and the system was completed in 1926 to be in operation in conjunction with the treatment works at Western Creek, before the opening of Parliament House in 1927. Many of the workers were returned soldiers from the War.

As the capital slowly developed between the two world wars, minor additions were made to the system With the rapid growth of the city under the Menzies governments after World War II, additional sewer facilities became necessary requiring the expansion of the Western Creek facility and the establishment of separate treatment works in the industrial suburb of Fyshwick, in Belconnen and the Tuggeranong Valley.

However by the 1960s the ongoing need to further increase the capacity and quality of sewage treatment facilities was apparent. In 1967 in a report to the National Capital Development Commission (NCDC), the firm Alan M Vorhees & Associates called for, amongst other things, a review of metropolitan sewerage strategies. This led to prolonged discussions on the subject in the NCDC and the Commonwealth Department of Works.

The NCDC engaged American consultants Camp, Dresser and McKee to review the existing system and prepare a metropolitan sewerage plan. This, together with reports from overseas studies by NCDC and Works engineers, led to a decision to phase out the individual plants of the ACT and replace them with one large sewerage processing plant working to the highest standards.

Design and construction was subsequently managed by the Department of Works on behalf of NCDC, engaging American David Caldwell who was involved in the provision of high quality sewage treatment works in inland California. He associated his firm with the large Australian engineering firm of John Connell and Partners. The project was led by Department of Works engineer Donald Stockdill whose 20 year ongoing involvement in the planning, design and construction resulted in his name being perpetuated in the road leading to the plant.

Heritage Listings

The Lower Molonglo Water Quality Control Centre is not listed on any heritage lists.

2. ASSESSMENT OF SIGNIFICANCE

Historic Phase

As the LMWQCC was constructed to meet the needs of Canberra in the late 20th Century and into the 21st Century, it falls into the late or modern development phase of the development of Canberra as the nation’s capital.

Historic Individuals or Association

W C Andrews, NCDC engineer
C J Price, NCDC engineer.
Charles Speldewinde, NCDC engineer.
Howard Jones, Chief Hydraulic Engineer, Commonwealth Department of Works
Camp, Dresser and McKee, leading hydraulic consulting engineers of the USA
Donald Stockdill, BE, FIEAust, Head of Major Developments, Commonwealth Department of Works
David Caldwell, US sewerage consultant
John Connell of John Connell and Partners
Alan Vorhees of Alan M Voorhees and Partners

Creative or Technical Achievements

The design of the Lower Molonglo plant drew heavily on the experience of engaged US consulting engineers who acquired their knowledge in the design and construction of sewage treatment works to protect the pristine Lake Tahoe-Truckee River area of California – see Attachment C .This complex was initially completed in the late 1960s and the systems have been further developed with export systems enabling the wastewater to discharged away from the lake and river system. This has apparently enabled at least part of the treatment plant to be reduced to advanced secondary operation. Since the Canberra system has no such export system and discharges into a river which downstream cities and towns rely on, it is reasonable to conclude that the LMWQCC discharge has been, at least for a time, to a higher standard than the Lake Tahoe system. In any case it was built and remains the highest quality sewage treatment facility in Australia, discharging from Australia's largest inland city into one arm of Australia's most important irrigation system, the Murrumbidgee Irrigation Area which forms part of the Murray Darling Basin.

Research Potential

The LMWQCC continues to be held in the highest regard in the world of the treatment of the wastewater of inland cities and has over the years been inspected by many international hydrologists researching and planning sewage treatment systems

Social

The rapid growth of Canberra's population in the 1950s and 1960s with the transfer of government departments to the capital, strained the existing wastewater treatment systems which soon became inadequate. If the health of the population was to be maintained, radical changes to the wastewater treatment system were required. The LMWQCC completed in 1978 was to the highest world standards and remains one of the nation's best examples of high quality sewerage treatment. See also Attachment E.

Rarity

The Lower Molonglo Water Quality Control Centre is similar to advanced sewerage treatment works in other parts of the world particularly the Lake Tahoe area of California, but is unique in Australia.

Representativeness

The LMWQCC represented the highest standards of World sewerage treatment at the time of its completion in 1978 and remains an excellent example of the best of wastewater treatment processes.

Integrity/Intactness

Notwithstanding the modifications and improvements made to the system since its commissioning, the integrity of the LMWQCC is essentially as was intended in the early 1970s.

References

See the list of references at the end of this nomination form.

Statement of Significance

The Lower Molonglo Water Quality Control Centre was designed and constructed to meet sewage treatment standards higher than any previously specified for a facility in Australia in order to meet the expectations and needs of downstream communities dependent on the Murrumbidgee River. At the time of its completion in 1978, it was one of the highest standard sewage treatment facilities in the World and today is still regarded as an example and icon of excellence in the treatment of the wastewater of inland cities.

Assessed Significance

At its time of completion in 1978, the Lower Molonglo Water Quality Control Centre represented the pinnacle of world sewage treatment technology and today remains an example of the best in wastewater engineering. It being amongst the highest quality systems in the World and the foremost example of its type in Australia, its significance warrants the award of the ultimate acknowledgment of the Engineering Heritage Recognition Program, that of an **Engineering Heritage National Marker.**

Images with Captions

Images with captions are contained in Attachments A and B and elsewhere in this document.

Interpretation Panel

It is expected the interpretation panel will be located outside the gates of the LMWQCC facility where it will be readily accessible to the passing public. The text will draw heavily on the contents of the attachments to this document and contain appropriate images to support the text. Plans are that the mounted panel will be unveiled with due ceremony on a date convenient to all participants.

Attachments:

A. Owner's letter of Agreement.

B. Extract form "Canberra's Engineering Heritage", Second Edition 1990, Pages 120 to 124.

C. Extract from "A Century of Canberra Engineering", Keith Baker, 2013. **Waste away,** Pages 154 to 156.

D. Lake Tahoe Report 087, "Export of Tahoe's Sewage Protects Lake", Internet 18 June 2015.

E. Molonglo Catchment Group paper "Lower Molonglo Water Quality Control Centre" dated 17 June 2015.

References:

1. Andrews. W C, Shellshear. W, Cooper. I, Pascoe. L, Morison. J, Price. C J, Dalgarno. K J, Jones. HA, Minty. A E, Clark. P, Yonge. P, Corbett. A H, Cooke. T H, Leslie. R, Dalgleish. R P S, Taylder. A E, Downey. K E, Connal. J K, *"Canberra's Engineering Heritage",* Second Edition, 1990.

2. Baker. Keith, "*A Century of Canberra Engineering"*, May 2013.

3. Lake Tahoe Report 087, *"Export of Tahoe's Sewage Protects Lake"*, Internet

4. Molonglo catchment Group, Paper *"Lower Molonglo Water Quality Control Centre"*, November 2015.

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ATTACHMENT A

ACTEW
CORPORATION

ActewAGL House
Level 5, 40 Bunda Street
Canberra ACT 2600
GPO Box 366, Canberra ACT 2601
Tel: 13 14 93
Fax: (02) 6249 7237

17 July 2014

Lyndon Tilbrook
Chairman
Engineering Heritage Canberra
11 National Circuit
Barton, ACT, 2600

Dear Mr Tilbrook

Proposed nomination of the Lower Molonglo Water Quality Control Centre for an award under the Engineering Heritage Australia recognition program

Thank you for your letter dated 18 June 2014, ACTEW willingly accept nomination of the Lower Molonglo Water Quality Control Centre (LMWQCC) for an award under the Engineering Heritage Canberra recognition programme.

I would like to thank you for nominating the LMWQCC and look forward to hearing the outcome of the award process.

Yours sincerely

J Knox.

John Knox
Managing Director

ATTACHMENT B

Extract from:
"CANBERRA'S ENGINEERING HERITAGE"
Second Edition 1990, Pages 120 to 124.

dam at Acton Peninsula with a mere "ribbon of water" downstream of the hospital. Hence, when soon after this, expansion of the Northern Suburbs called for further sewer capacity across the Molonglo, the decision was made to built another inverted syphon in the form of two 380 mm diameter pipes and one 225 mm diameter pipe just downstream of the expected Acton Dam, near the Royal Canberra Hospital.

Unlike the Commonwealth Avenue inverted syphon in tunnel, these pipes were laid across the river in a rock trench and encased in concrete. North of the river, pile supports were added when the lake was built. These syphons are nevertheless regarded as susceptible to sedimentation and possible blockage.

Fyshwick Sewage Treatment Works

The construction of Lake Burley Griffin in the early sixties precipitated the rationalisation of the plethora of minor sewerage systems that had accumulated over the years, upstream of the Lake at places like Fairbairn, Pialligo, Duntroon, Harman, Fyshwick and Narrabundah. Interim rationalisation minimised pollution of the lake in the early years and in 1967, the Fyshwick Sewage Treatment Works was completed, collecting wastes from all these areas except Queanbeyan for which the cost was considered too high.

The plant has a capacity equivalent to 20,000 persons, and the treatment consists of coarse screening, grit removal and primary sedimentation, followed by low rate trickling filters, secondary sedimentation in humus tanks and sludge digestion. Four-stage lagoon treatment is followed by chlorination.

The Fyshwick plant was designed in a new era of emphasis on re-use of water. After final treatment in large maturation ponds, and chlorination, the emerging effluent was to be used for irrigation upstream of the lake. This has been done very successfully on the playing fields of Duntroon Military College but the quantity used is less than that available. Further areas should be established for such irrigation.

Belconnen Sewerage

By 1964, NCDC had decided to move into the Belconnen Valley, and proposed a trunk sewer through the valley leading to a new Water Pollution Control Centre at the western end of the valley.

NCDC engaged the Australian consultants, Scott and Furphy to design both the trunk sewer and the Treatment Works.

The Trunk sewer was a 1500 mm diameter concrete pipe laid in a trench adjacent to the Ginninderra Creek, except for a short length tunnelled through a ridge.

In the very early stages of the development of this valley, sewage was led into a temporary timber septic tank just north of the town centre site. When the permanent sewer down the valley to the proposed treatment plant was completed in 1968, the population was still small and the sewage was led into an Imhoff tank.

When the first stage of the treatment works (50,000 persons) was completed in 1970, the Imhoff tank then served as a stormwater tank. The treatment plant known as the Belconnen Water Pollution Control Centre was later enlarged to serve 100,000 persons.

In addition to the usual components in a modern treat-

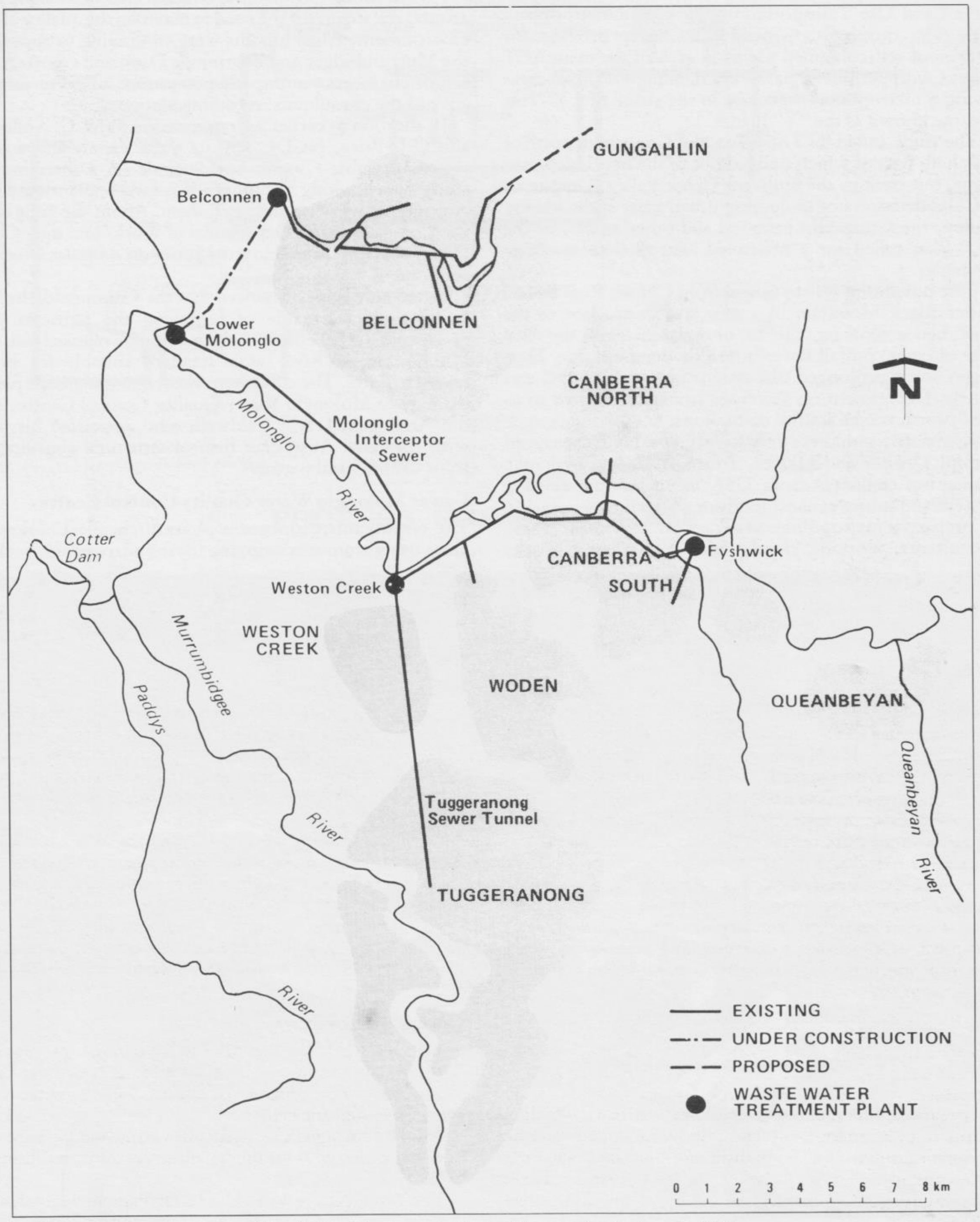


Fig. 5.26: Canberra's Major Wastewater System in 1978.

ment plant, activated sludge was used, followed by maturation ponds. The plant was designed to produce a 15/15 final effluent but in fact, achieved the high standard of less than 10 mg/1 of both biological oxygen demand and suspended solids.

Metropolitan Planning

In 1967, Alan M. Vorhees & Associates submitted to NCDC their report responding to the Commission's brief for a Land Use Transportation Study on a metropolitan scale. The consultant's General Plan Concept provided for a series of self-contained towns in each of the main ACT valleys with peripheral parkways flanking the urban areas giving a metropolitan structure in the shape of a Y. This became known as the "Y" Plan.

The study called for a new Town of Gungahlin, north of Mitchell, part of which drained not to the new Belconnen plant, but back to the Sullivans Creek Valley. Despite an NCDC decision not to develop urban areas in the Majura Valley, the Gungahlin proposal and other aspects of the "Y" Plan called for a review of metropolitan sewerage strategies.

One possibility was to tunnel from Clunies Ross Street, under Black Mountain to a new treatment plant to the west, hence allowing relief to, or replacement of, the sixty year old main outfall sewer tunnel on the south side. Thus began some prolonged discussions between NCDC and Works Department on sewerage strategies referred to as the "North versus South" discussions.

Associated with these in-house studies, NCDC engaged Camp, Dresser and McKee, a firm of leading hydraulic consulting engineers from USA to review the existing system and future expansion, from which they were asked to prepare a metropolitan sewerage strategy plan. These consultants, working closely with NCDC and Works Department engineers recommended that the individual treatment plants in individual valleys be phased out and that one large plant having the economy of scale be built well downstream, capable of staged development to cope with all expected expansion, and treating the wastewater to a high standard that minimised biological growth. These consultants forecast the possible need to reduce the nutrients, nitrogen and phosphorus, to very low figures.

At the time, considerable concern had been expressed around the world for the need to maintain the quality of the environment. Algal blooms were continuing to appear in the Murrumbidgee and Burrinjuck Dam, and reports from senior engineers visiting other countries, all led to acceptance of the consultants' recommendations.

In addition to earlier overseas studies by W.C. Andrews and C.J. Price, NCDC sent its water supply and wastewater specialist Charles Speldewinde on a three-month study tour looking at modern wastewater plants and the consultants who had designed them. About the same time the Commonwealth Department of Works sent their Chief Hydraulic Engineer, Howard Jones on a similar overseas assignment.

Both came back convinced that the Commission had to build a plant capable of removing the nutrients and producing a final effluent which could be released into the Murrumbidgee River at a standard suitable for body contact sports. The consultant chosen to design this plant, the Lower Molonglo Water Quality Control Centre, was the American, David Caldwell, who associated his firm with the large Australian firm of structural consultants, John Connell and partners.

Lower Molonglo Water Quality Control Centre

The consultants proposed a physical/chemical/biological plant using ammonia stripping for the nitrogen side such as

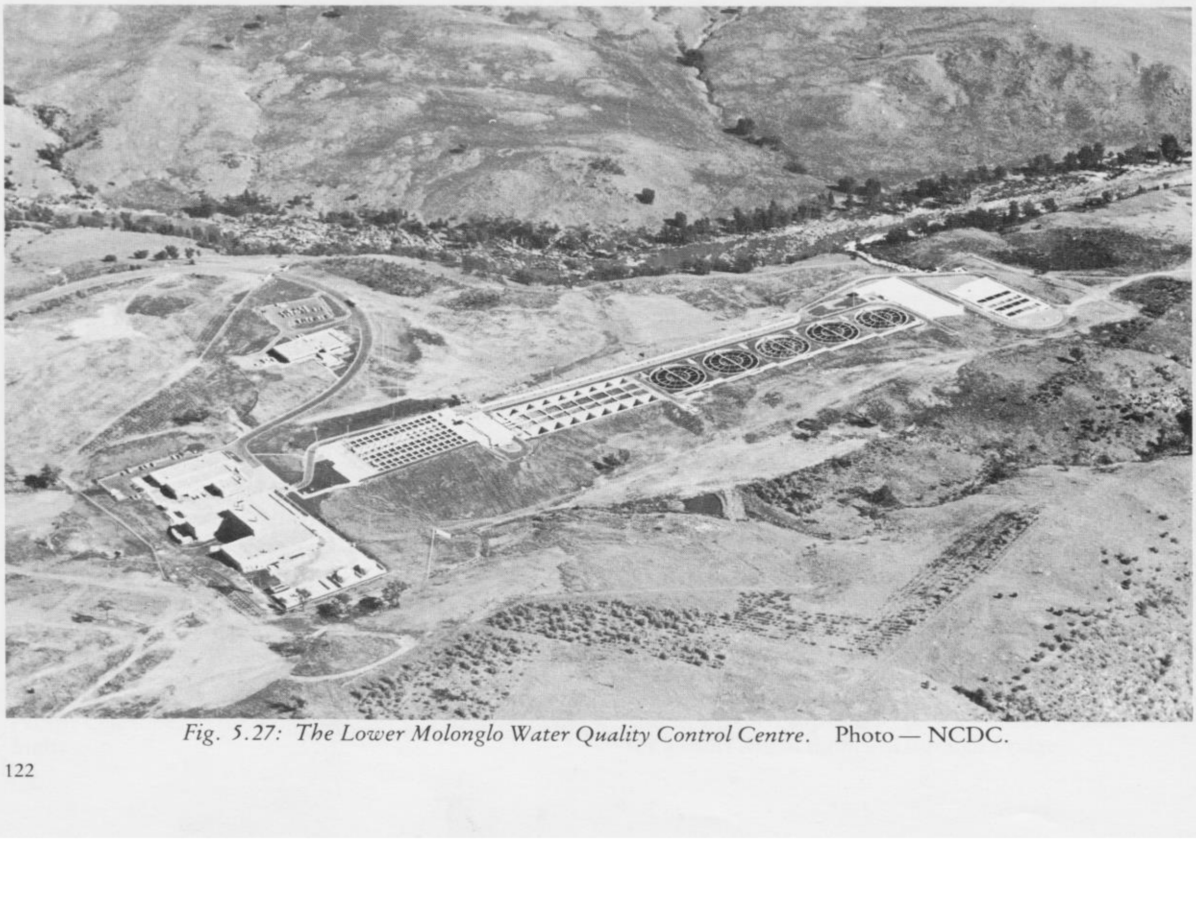


Fig. 5.27: The Lower Molonglo Water Quality Control Centre. Photo — NCDC.

was proposed for use at Lake Tahoe in California. The NCDC and Works' engineers acknowledged the very high standards achieved there, but were concerned about such issues as the environmental effect of the towers and the effect of Canberra's winter climate on the processes.

Accordingly Caldwell proposed the use of nitrification/denitrification using anoxic stripping towers with methanol. Pilot studies were carried out at a similar plant being developed at Contra Costa, north-east of San Francisco, where similar very high final effluent quality was being demanded.

The design adopted is illustrated in the adjacent diagram. It has a potential capacity to treat 109 megalitres/day currently equivalent to 400,000 persons. The site is

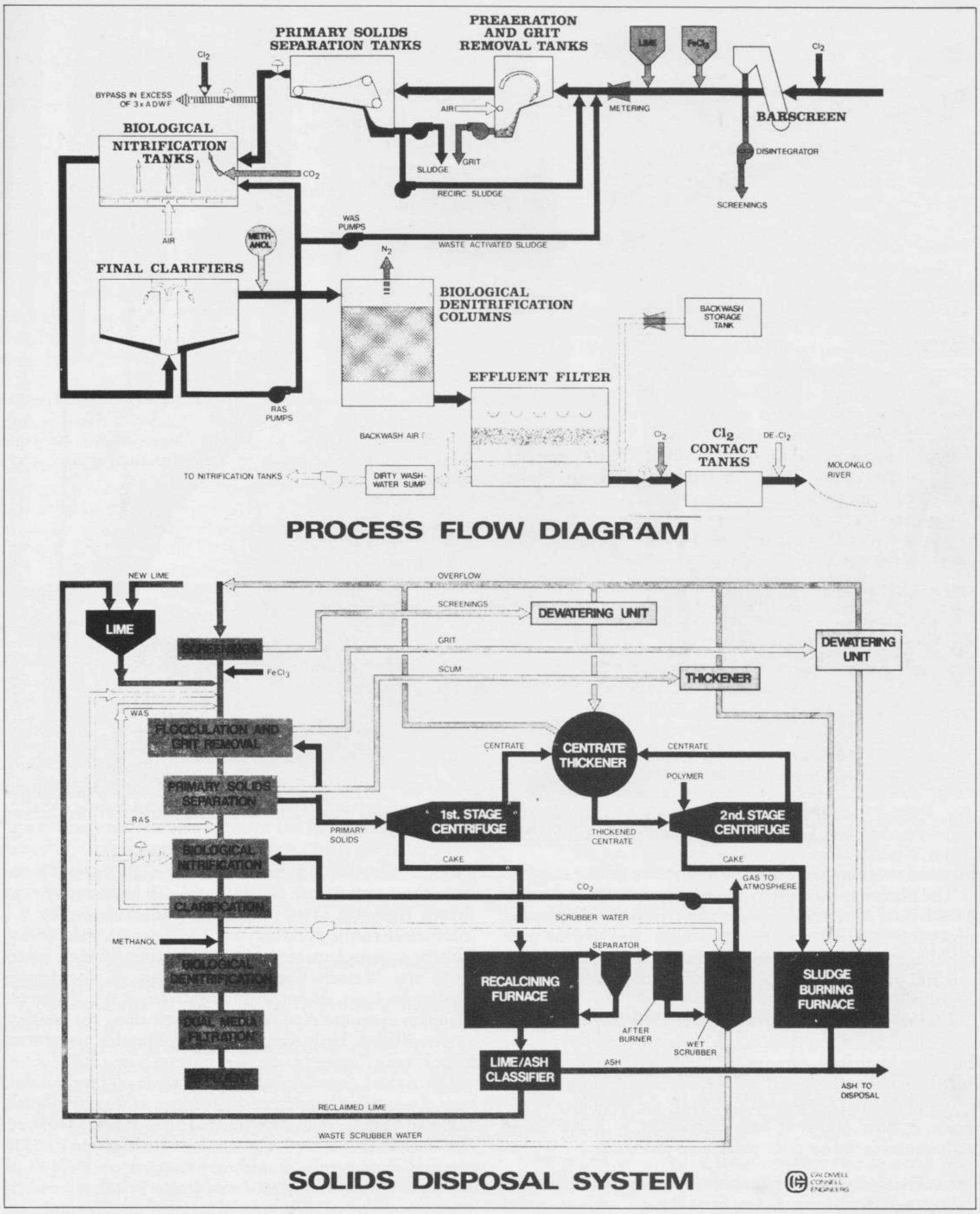


Fig. 5.28: Flow diagrams for the Lower Molonglo Water Quality Control Centre.

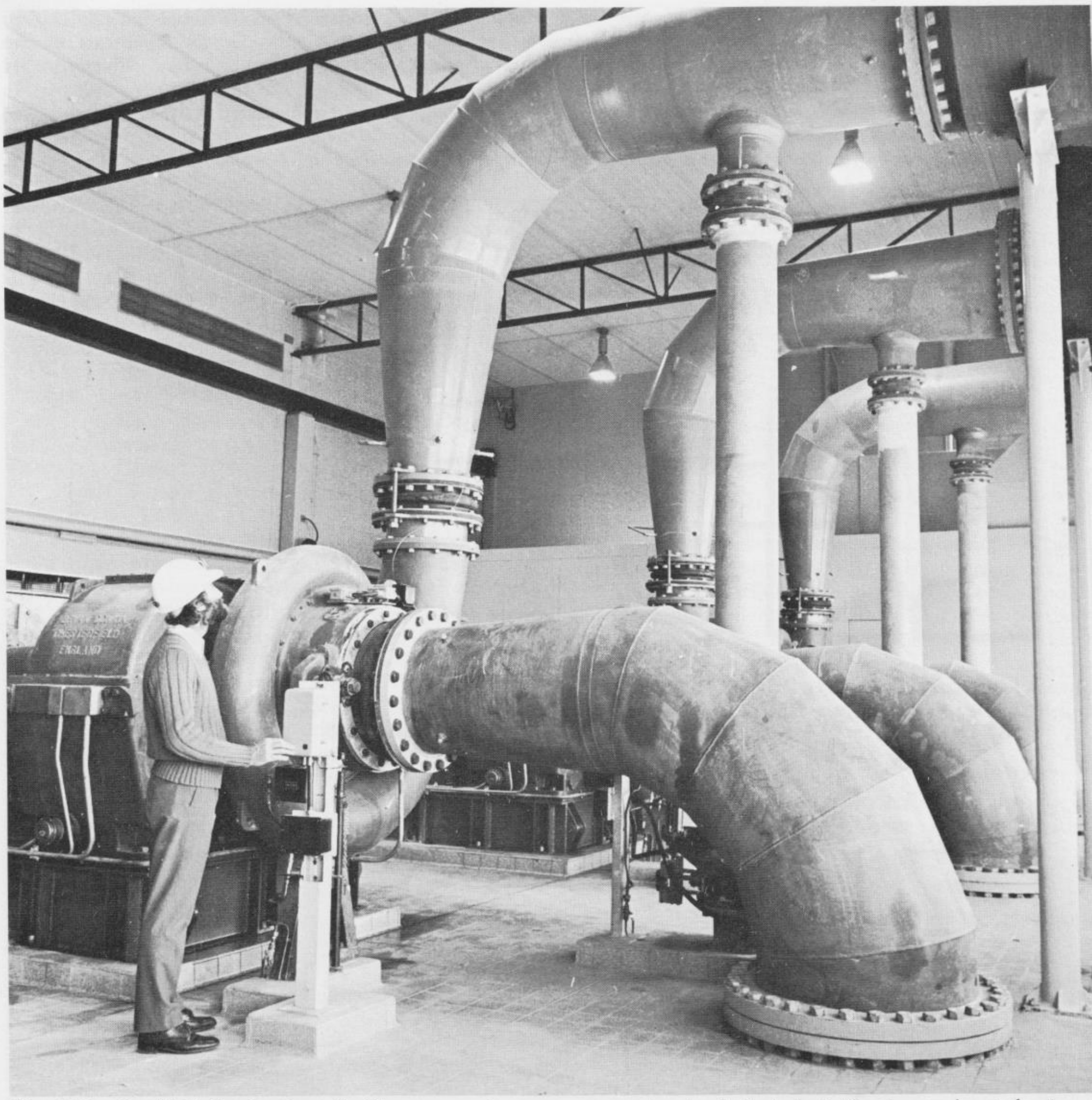


Fig. 5.29: David Philp, Engineer-in-Charge, starting a compressor for the biological nitrification tanks at the Lower Molonglo plant. Photo — R. Trindall for NCDC.

planned to accommodate up to three more similar stages.

The plant was brought to practical completion in August 1978. It is a state-of-the-art plant incorporating some processes that had not previously been used. By the time the plant met the very low figures for the wide range of quality parameters, the plant was ranked amongst the finest in the world.

Due to scale and the latest design techniques, the capital cost of the plant was comparable with conventional plants, but the methanol process and the oil burning sludge furnaces were conceived before the petroleum products crisis of the mid-seventies. However, the flexibility of the plant is now allowing new techniques to make major reductions in the need for petroleum products.

New Trunk Sewers

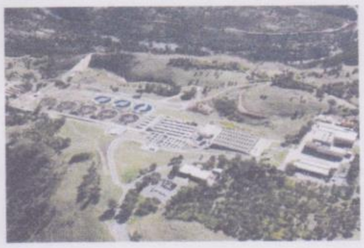
It was found to be economical to use a temporary local sewage treatment works (Pasveer ditches) in the Tuggeranong Valley for the first residents in 1974, but in the meantime a concrete lined tunnel 1.9 m diameter was driven from the lower (northern) end of the valley 9.1 kilometres to the periphery of the Weston Creek works. This was complemented by the Molongo Outfall Sewer from the Weston Creek plant 15 km to the Lower Molonglo plant. Most of this latter sewer is a 2.6 metre diameter concrete pipe laid in a trench along the contour and backfilled. However, there are two tunnels and several large creek crossings using steel pipe on piers.

Once the Lower Molonglo plant came on line, another tunnel was completed from the Belconnen Water Pollution Control Centre, thus allowing that plant to be phased out. The tunnel is 5.3 km long, has a circular section of 2130 internal diameter lined with a minimum of 240 mm of concrete with two vortex drops at the Belconnen end. It was completed in 1979, thus bringing close to completion the majority of the master wastewater strategy plan. Most

ATTACHMENT C

Waste away

By the 1970s the sewerage treatment plant at Weston Creek was overloaded by the growth in population and was causing excessive odour in the nearby suburbs and algal pollution to the creek and river downstream.

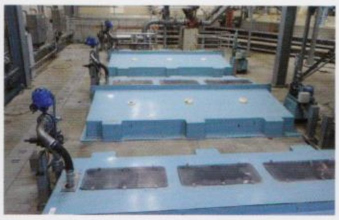


above and top: Lower Molonglo Water Quality Control Centre

In considering a replacement plant there was clearly a need for a much larger plant with capacity for expansion for the future. Unlike coastal capitals, a growing inland city needed higher quality treatment so that the water discharged into the Murrumbidgee River would be clean and non-polluting, even in drought conditions when it would make up the majority of flow in the river to Burrinjuck Dam and the downstream towns of Gundagai and Wagga Wagga. A site was selected on the Molongolo River near the confluence with the Murrumbidgee.

The scheme that was developed jointly by NCDC and Works engineering staff followed from overseas investigations as nothing had been built in Australia to the standard required. The location of proposed satellite towns of Tuggeranong and Gungahlin and the trunk sewers that would be needed were considered as part of the planning as well as the phasing out of existing smaller suburban plants.

The plant that was to be designed and built on the lower Molonglo River was to reduce nutrients, nitrogen and phosphorus to very low levels. A consortium of US consultant David Caldwell and Australian structural engineers John Connell and Partners were engaged by the Department to design and construct the centre. The project was led by Don Stockdill as head of the Major Developments group in Works. His engineering skill and personal qualities were recognised in the name of the road leading to the centre.



Completed in 1978, the Lower Molonglo Water Quality Control Centre (LMWQCC) was the largest and most sophisticated waste water treatment plant in Australia. The input to the plant goes through physical, chemical and biological treatment processes before clean water is discharged into the Molonglo River. Sewage or wastewater is more than 99 percent water because by far the greatest volume comes from showers, baths and washing machines.

The operators, ACTEW Corporation, state that the system normally handles about 80 to 100 million litres a day (35 to 40 Olympic-size swimming pools which the reader might prefer to think of as having been filled at the output end of the plant!) The maximum daily achievement has been 235 million litres. This is significantly higher than originally expected as LMWQCC was designed in the 1970s to handle a maximum of 109 million litres per day, for an expected Canberra population of 400,000. However the inflow is artificially increased in prolonged wet weather through storm water inappropriately entering the sewerage system. Parts of the plant have therefore been expanded and a bypass dam constructed which can temporarily hold back 147 million litres of screened wastewater to avoid overloading the plant, which would reduce the quality of the water discharged to the river.

How LMWQCC works

The treatment process can be summarised in simple terms as follows. The waste water enters the plant where it passes through a screen to remove objects that could interfere with the process (such as dentures and children's toys). It then has lime added to remove the phosphorus, followed by addition of iron chloride to make the matter that is dispersed in the liquid form into flakes which can be separated by a centrifuge, something like an industrial spin dryer. The resulting semi-dried sludge is then incinerated in a high temperature furnace to produce agri-ash which is sold as a farm fertiliser. Lime is also recovered for reuse. The wastewater moves to biological reactors without free oxygen, where micro-organisms remove unwanted nitrogen which would act as fertiliser for algae and water-plants, releasing it into the atmosphere as gas. The water is then fed into a different type of biological reactor where air is pumped through and it is mixed with activated sludge which contains other micro-organisms. The pumped air enables the micro-organisms to oxidise ammonia, further removing nitrogen. Wastewater then moves to secondary clarifiers where the liquid is separated from the settled sludge which still contains the active micro-organisms. A small portion of the activated sludge is recirculated to the biological reactor tanks while the excess is returned to the start to become agri-ash. After the secondary clarification the water is filtered through finely crushed coal and sand to remove suspended solids to produce a clear effluent. The clear wastewater is then chlorinated to disinfect any remaining microbiological pathogens and sulphur dioxide gas is used to remove excess chlorine which would be harmful to the river ecosystem. The treated water is then used for irrigation or discharged into the river.

clockwise from top left: Shredders; reactor tanks; floculation and grit removal; discharge to the Molonglo River; agri-ash soil improver removal; Cake incineration; Biological denitrification

Trunk sewers

The existing sewerage network that previously fed to the old treatment works at Weston Creek remained in service, but changes had to be made to connect it to the new plant at West Belconnen. The Molonglo Valley Interceptor Sewer made that connection by means of a 16 kilometre concrete pipeline and tunnels around 2 to 2.6 metres diameter. After crossing the Molonglo River as a concrete bridge downstream of Scrivener Dam, the sewer takes the form of a concrete lined tunnel 1.5 km long, then the precast pipes follow the right bank of the river before connecting to a second tunnel 2.1 km long to reach the LMWQCC. Each of the concrete pipes weighed 10 tonnes and they were run in a trench below ground, changing to steel pipes on concrete piers where the line ran above ground bridging six valleys along the way.

The Tuggeranong Trunk Sewer was constructed from a temporary treatment plant that catered for early residents in the far southern suburbs, to connect with the Molonglo Valley Interceptor Sewer at Weston Creek. This was achieved by a 1.9 metre diameter concrete-lined tunnel that was driven 9.1 km, allowing the sewage to be treated at LMWQCC.

A similar change was made by constructing the Ginninderra Sewer Tunnel directly to the LMWQCC, allowing the Belconnen Water Pollution Control Centre to be taken out of service. This 5.3 km tunnel had two vortex drops at the Belconnen end, allowing a change in level and dissipation of energy while minimising the turbulent flow that would contribute to greater odour and corrosion problems.

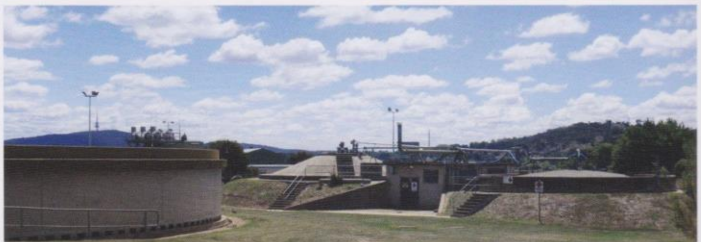
The Main Outfall Sewer has continued since 1927 to transfer waste water from Civic and the inner north and south suburbs by connecting at Weston Creek with the Molonglo Valley Interceptor. To avoid having to duplicate it to cater for the industrial suburb of Fyshwick which is east of the city, a small treatment plant built in the 1960s continues to operate there with the ability to regulate flow into the Main Outfall Sewer and prevent overload.

In the early 1990s ACTEW developed CRANOS, a package treatment plant with a relatively small footprint for commerical. A prototype was constructed at the Fyshwick Plant for demonstration purposes.

top: Trunk sewer near Coppins Crossing

right: Fyshwick demonstration Cranos treatment plant

bottom: Fyshwick sewerage treatment works



ATTACHMENT D

Export of Tahoe's Treated Sewage Protects the Lake

While today's residents at Lake Tahoe are learning about how to reduce nonpoint-source water pollution by implementing best management practices (BMPs), some might not know how Tahoe eliminated its "point source" pollution over 35 years ago.

Water pollution once entered the lake from easily identifiable sources, such as discharge pipes from sewage treatment plants. Septic tanks were used for many years, prior to the construction of wastewater treatment plants in 60s. Even before the Clean Water Act of 1968 was passed, the local jurisdictions knew that such discharges would not be allowed in the future. By 1968, all of Lake Tahoe's treated sewage effluent was pumped out of the Tahoe Basin, and it remains so to this day.

The South Tahoe Public Utility District was formed in 1950 with the intention of treating sewage from the south shore, including Nevada's casinos. Later in that decade, the Nevada side formed its own district (Douglas County Sewer Improvement District #1), and South Tahoe Public Utility District took responsibility for sewage from the city of South Lake Tahoe and from Eldorado County.

By 1965, an innovative advanced tertiary treatment plant was installed, which treated sewage to drinking water standards. However, even the effluent from this plant was not clean enough for discharge to Lake Tahoe. The district built a 27-mile pipeline over Luther Pass and constructed a storage reservoir in Alpine County. All effluent from the City of South Lake Tahoe and Eldorado County areas has been exported through this system since April 1968.

Once the export system was completed, the treatment plant reduced treatment to advanced secondary treatment, which disinfected the treated effluent water, but left trace amounts of nitrogen and phosphorus. This effluent water is stored in a reservoir near Woodfords during winter, and then released for use by ranchers to irrigate pastures and alfalfa crops in the summer. The small amounts of nitrogen and phosphorus are desirable nutrients for crops.

Similar systems have been built in Douglas County and Washoe County. The Douglas County Sewer Improvement District #1 treats all sewage from the casinos and from the Tahoe communities of Douglas County to advanced secondary levels. It then pumps the treated effluent over Kingsbury Grade to its holding ponds in the Carson Valley, in the foothills east of the Douglas County Airport. Again, this water is released during the hot, dry summer months for use by local ranchers to irrigate pasture and alfalfa fields.

In Washoe County, the Incline Village General Improvement District also treats sewage to advanced secondary levels. They pump the effluent over the Sierra to holding ponds in the north end of the Carson Valley. These ponds provide productive habitat for waterfowl, and the water is released for use by ranchers during the growing season.

On the California north and west shores, two local jurisdictions collect all the sewage in the sanitary sewers and pump it to Truckee. The Tahoe City Public Utility District and the North Tahoe Public Utility District cooperated under a Joint Powers Agreement to build a joint sewerage facility in 1968 to treat the sewage of both districts.

In 1978, the Tahoe-Truckee Sanitation Agency built a state-of-the-art tertiary treatment plant in Truckee. Since then, the Tahoe City and North Tahoe Public Utility Districts have collected all sewage between DL Bliss State Park at Emerald Bay and Kings Beach, and transported it to the Tahoe-Truckee Sanitation Agency plant through pipelines. The tertiary treated effluent from this plant is injected into the ground.

In addition to the liquid effluent, several of the plants on Tahoe's south and east shores are now drying their solid waste materials (biosolids) and shipping them to the Carson Valley, instead of incinerating them. Bently Agrowdynamics is combining biosolids with other organic materials and composting them to form a fertilizer suitable for their pastures and alfalfa fields. With innovations like these, Tahoe has been in the vanguard of sewage treatment, water reclamation, reuse and recycling.

The Lake Tahoe Report 087

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Interviewees:

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*Adopt-A-Watershed * Lake Tahoe Basin & Truckeee River Watershed * Revised 2/3/05*

ATTACHMENT E

Lower Molonglo Water Quality Control Centre

Molonglo Catchment Group

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Lower Molonglo Water Quality Control Centre

The following has been extracted from the ACTEW Water web page

The Lower Molonglo Water Quality Control Centre (LMWQCC) is the main wastewater treatment facility for Canberra and is the largest inland treatment centre in Australia.

LMWQCC

Treatment ponds at LMWQCC

Located one kilometre upstream from the junction of the Murrumbidgee and Molonglo Rivers, LMWQCC treats more than 90 million litres of Canberra's wastewater each day. The process includes physical, chemical, and biological treatment processes before the water is discharged into the Molonglo River.

The ACT Environmental Protection Act 1997, under which LMWQCC operates, sets strict licence conditions aimed at protecting the rivers into which water is discharged. LMWQCC meets all these licence requirements, including chemical testing and biological monitoring programs. Performance results are reported monthly.

Extensive monitoring is undertaken to ensure water quality, and ecological monitoring, such as the Fish Monitoring Program, provides information on the river's health. The numbers of macroinvertebrates, which are small crustaceans and insects, are also monitored regularly. Platypuses are often seen near where the treated water re-enters the

Spillway at LMWQCC

Molonglo River, and have been known to visit the plant!

The treated water from LMWQCC plays an important role in keeping the rivers flowing and helps supports aquatic life, especially during dry periods. Also, the treatment process reduces the levels of nutrients that algae feed on, so that they do not grow in our water systems.

During the treatment process all of the solid material, which is called "sewage sludge", is removed and incinerated in a high temperature furnace. The resulting ash, Agri-Ash, is sold to farmers as a soil conditioner.

Wastewater reuse

ACTEW Water operates three wastewater reuse projects in the ACT.

Via the Lower Molonglo Water Reuse Scheme, a proportion of the wastewater treated at LMWQCC is supplied to nearby vineyards (100 hectares) and a golf course (30 hectares) for irrigation.

Frequently asked questions

What population does LMWQCC treat wastewater for?
Currently the LMWQCC serves a population of 310,000.

What is the make up of sewage?
99.9% water and 0.1% solids

How much wastewater does LMWQCC treat each day?
Typically LMWQCC treats 80-100 million litres of wastewater each day. This is equivalent to 35-40 Olympic swimming pools full of water. However, LMWQCC has treated up to 235 million litres in one day.

What exactly does LMWQCC treat?
LMWQCC mainly treats domestic wastewater, such as laundry, bathroom, toilet and

Incinerator at the LMWQCC

kitchen wastes. A small amount of waste comes from industry, but this is controlled to avoid harm to the LMWQCC treatment plant.

Does LMWQCC recycle any of the treated effluent?
Yes, treated effluent is used for such things as irrigation, fire protection sprays, and washing down at the plant.

What chemical do you use to disinfect the sewage effluent?
Chlorine gas is used to disinfect the sewage effluent.

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