Banana Shire Council

Moura

Recycled Water Use Options

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Introduction

Banana Shire Council commissioned a new wastewater treatment plant in Moura early in 2009, to replace the old trickling filter plant which had inadequate treatment capacity and a relatively low standard of treatment by modern standards.

The new treatment plant is a membrane bioreactor (MBR) plant which produces a very high quality effluent – better than many town water supplies for the parameters that are usually measured.

In this region of low rainfall and limited water resources, Council wishes to ensure that the best possible use is made of the high quality recycled water produced by the plant. This report has been commissioned to examine options for reuse.

The Treatment Plant

As commissioned the Moura Wastewater Treatment Plant has a design capacity of 3,000 ep (equivalent people), and it can be increased to 5,000 ep with the installation of additional membranes. In the 2006 census, the "normally resident" population of Moura was estimated at 1,774 people. The growth since 2006 would not be substantial. However a number of mine workers who live in Moura for five days a week probably nominated another place as their normal abode. An indication of the trend is that town water consumption averages 7% more on workdays than on weekends – which is counter to the usual trend where weekend use is higher due to washing and extra garden watering. There is no major industry connected to Moura sewerage, but there are some commercial operations and it would be reasonable to assume the current load on the plant is approximately 2,000 ep - 13% higher than the census population.

At the traditional sewage design flow rate of 250 L/ep/day, the flow into the treatment plant would be expected to average 500 kL/day. (Where water-saving devices are widespread, sewage flow rates of 180 L/ep/day are now the norm.)

In August 2009, when the town swimming pools were empty, the volume of recycled water produced by the plant averaged 560 kL/day during the week and 450 kL/day on the weekend. (The swimming pools and/or the associated plumbing appear to have some significant leakage which adds to the sewage flows when the pools are in use.)

560 kL/day is a surprisingly high flow rate, and the meter accuracy should be confirmed before final design sizing of recycled water infrastructure. Subject to such confirmation, it would be sensible to design recycled water infrastructure for the same capacity as the treatment plant, namely 3,000 ep with consideration for 5,000 ep where the marginal cost is acceptable.

The MBR plant produces a very high quality effluent. At this early stage only one set of test results has been obtained. The results indicate that the microbiological quality is excellent without chemical disinfection, as indicated in the following table.

Sample ID.	UNITS	Moura STP
Sample No.		Mi2060
Date Sampled		09/06/09
Somatic Colifages	Pfu/100mL	1
Male Specific (FRNA) Colifages	Pfu/100mL	<1
E. coli - Including F. Coliforms MF	CFU/100mL	<1
Clostridium Perfringens	CFU/100mL	<1

With only a trace of Somatic Colifages the effluent virtually meets the levels for Class A+ recycled water (the Public Health Regulation 2005 requires <1 for all the above microbiological indicators in 95% of samples). The Public Health Regulation specifies that Class A+ recycled water must be disinfected and retain a minimum free chlorine residual.

With chlorination the microbiological quality indicated by this sample would almost certainly be sufficient.

The new Moura treatment plant can be expected to produce water that meets the standards specified for Class A+ recycled water with a very high standard of reliability. The only potential issue is the cost of weekly testing as specified by the Public Health Regulation. The tests for 4 microbiological indicators (as detailed in the next section) cost $319 at the Government laboratory. With the cost of travel, sampling, transport and administration the total cost will be at least $600 per sample.

A comprehensive range of physical and chemical properties of the effluent is tabulated overleaf. For the parameters tested, the treated water is better than many town water supplies in Queensland, for example turbidity of 0.14 NTU and Total Dissolved Solids of 288 mg/L.

Total Dissolved solids less than 500 mg/L generally indicates good water quality for irrigation purposes. Another issue to be considered is the relative proportions of sodium to calcium and magnesium. When sodium occurs in high proportions, it can break down clay particles and cause the soil to pack hard and become impermeable. The Sodium Adsorption Ratio (SAR) is the index usually used to assess this tendency. Queensland Natural Resources and Water has produced an Information Sheet "Irrigation water quality—salinity and soil structure stability" in which they indicate SAR likely to cause breakdown in soil structure. In the sample tested, the SAR was 3.7, which places the recycled water as shown in the graph below.

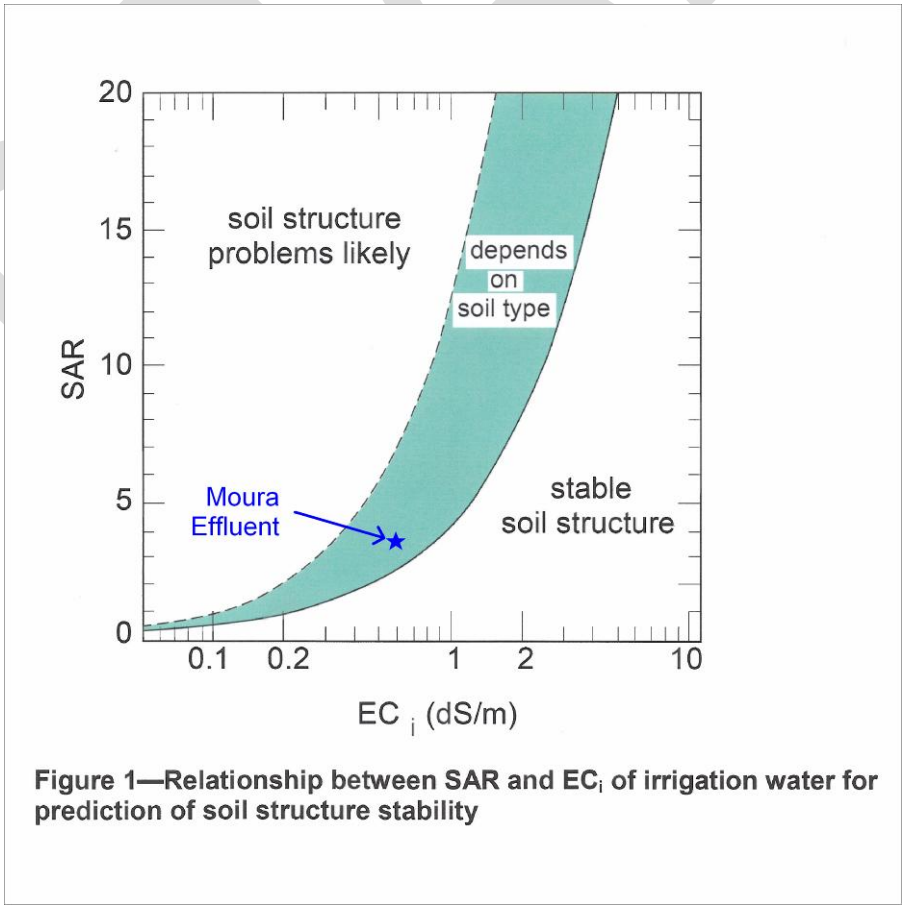


Figure 1—Relationship between SAR and EC_i of irrigation water for prediction of soil structure stability

This indicates that, for irrigation of a susceptible (dispersive clay) soil, periodic treatment with gypsum may be required. This is unlikely to be a significant problem for irrigation reuse in Moura.

There are four lagoons adjacent to the treatment plant. They are approximately 4,000 m^2 in area each, which provides a volume of approximately 4,000 m^3, or one week's sewage flow capacity per lagoon. These could be used to contain flows in the event of plant breakdown or to provide wet weather storage for recycled water or a combination of the two.

Moura Wastewater Treatment Plant
Indicative Water Quality (single result set)

Sample ID.	Units	Moura STP 9/6/09 & 1/7/09	NHMRC Drinking Water Maxima	Meets Drinking Water Standard
pH at 21°C		7.3	6.5-8.5	✓
Conductivity at 25°C	uS/cm	580		
Free Chlorine	mg/L	0.0		
True Colour	HU	15	15	✓
Turbidity	NTU	0.14	1	✓
BOD	mg/L	<2		
Ammonia Nitrogen	mg/L	0.04	0.5	✓
Total Nitrogen	mg/L	6.2		
Total Phosphorous	mg/L	2.48		
Total Dissolved Solids *	mg/L	288	500	✓
Total Dissolved Ions *	mg/L	215		
Total Suspended Solids	mg/L	<5		
Silica	mg/L	17		
Al	mg/L	0.012	0.2	✓
B	mg/L	0.034	4	✓
Ca	mg/L	23		
Cu	mg/L	0.003	1	✓
Fe	mg/L	0.013	0.3	✓
H *	mg/L	<0.1		
K	mg/L	17		
Mg	mg/L	4.9		
Mn	mg/L	0.010	0.1	✓
Na	mg/L	75	180	✓
Zn	mg/L	0.032	3	✓
Chloride	mg/L	66	250	✓
Flouride	mg/L	0.15		
Nitrate	mg/L	8.2	50	✓
Sulphate	mg/L	36	250	✓
Bicarbonate *	mg/L	96		
Carbonate *	mg/L	<4		
Hydroxide *	mg/L	<4		
Total Hardness	mg/L	78	200	✓
Temporary Hardness	mg/L	57		
Alkalinity	mg/L	96		
Residual Alkalinity *	mg/L	<0.1		
pH Saturation *	mg/L	8.0		
Saturation Index *	mg/L	-1.22		
Mole Ratio *	mg/L	3.283		
SAR *	mg/L	3.7		
Figure of Merit Ratio *	mg/L	0.48		

Legislative Requirements

Recycled water use in Queensland is governed by a number of Acts, Regulations and guidelines. These are dealt with in this section in approximate order of precedence.

Public Health Regulation 2005

The Public Health Regulation 2005 specifies minimum standards for recycled water use in the higher risk situations, namely:

- to augment a supply of drinking water,
- for dual reticulation, and
- for irrigation of minimally processed food crops.

The first option requires very high standards of treatment and testing and is not feasible for the scale of operations in Moura. Furthermore it would require extensive additional treatment beyond that provided by the new Moura wastewater treatment plant.

The Public Health Regulation specifies 5 different grades of recycled water and the criteria that apply to each grade.

The highest grade, Class A+, must comply with the testing regime indicated in the following table. (This is a somewhat simplified version of the specification.)

Class A+ Recycled Water		
Factor	**Frequency of sampling**	**95 Percentile**
chlorine residual	daily	> 0.5mg/L
Clostridium perfringens	weekly	< 1 cfu/100mL
Escherichia coli	weekly	< 1 cfu/100mL
F-RNA bacteriophages	weekly	< 1 cfu/100mL
somatic coliphages	weekly	< 1 cfu/100mL
turbidity	daily	< 2 NTU

Lower grades of recycled water are specified as indicated in the next table.

Class	**Factor**	**Frequency**	**95 percentile**
A	Escherichia coli	weekly	< 10 cfu/100mL
B	Escherichia coli	weekly	< 100 cfu/100mL
C	Escherichia coli	weekly	< 1,000 cfu/100mL
D	Escherichia coli	weekly	< 10,000 cfu/100mL

These specifications for recycled water classes supersede those that were included in the Queensland Water Recycling Guidelines, December 2005, published by the Environmental

Protection Agency. The EPA guidelines contained additional test parameters for the higher grades of recycled water.

The Public Health Regulation lists the Class of recycled water that is required for the high exposure uses, for example:

Use		**Class**
Dual reticulation		A+
Crop	**Irrigation method**	
root crops eg carrot and onion	spray, drip, flood, furrow or subsurface	A
crops with produce, other than rockmelons, grown on or near the ground if the produce is normally eaten with the skin removed eg pumpkin	spray	B
	subsurface, drip, flood or furrow	C
rockmelons	spray, drip, flood, furrow or subsurface	A+

Note that the Public Health Regulation is silent on the use of recycled water for purposes other than dual reticulation and irrigation of minimally processed food crops.

Water Supply (Safety and Reliability) Act 2008

The Water Supply (Safety and Reliability) Act 2008 (WSSRA08) requires that a recycled water management plan be prepared for each recycled water scheme in order

(a) to protect public health; and
(b) if the plan is for a critical recycled water scheme—to ensure the continuity of operation of the scheme.

WSSRA08 does provide for exemptions from the recycled water management plan requirement, but in the case of Moura, where a high level reuse is contemplated, an exemption is unlikely. In any case, if a second party user is involved it would be highly desirable to define the operation of the scheme for the benefit of both parties.

The recycled water management plan is subject to approval of the Department of Environment and Resource Management (NRW). DERM does not provide specifications for recycled water quality for different uses, the way the 2005 EPA guidelines did.

To quote the DERM website:

"New regulatory guidelines
To foster compliance with the recycled water requirements of the Act, new regulatory guidelines have been prepared. The regulator will refer to these when making decisions (e.g. about whether or not to approve a recycled water management plan).
- *Recycled water management plan and validation guidelines*
- *Recycled water management plan exemption guidelines*

- *Water quality guidelines for recycled water schemes*

Additional guidelines

Further guidelines being developed include:

- *a regulatory guideline to inform recycled water providers about auditing and annual reporting requirements*
- *non-regulatory guidelines on planning a recycled water scheme and using recycled water, which will replace Parts 3 and 7 of the Queensland water recycling guidelines.*

Other sources of information

The Queensland Water Recycling Guidelines [EPA 2005] *were developed before use of recycled water was regulated in the state. Parts 4, 5 and 6 of these guidelines are no longer relevant, and have been replaced by the:*

- *Public Health Regulations*
- *Recycled water management plan and validation guidelines*
- *Water quality guidelines for recycled water schemes*

However, there is still valuable advisory information in (Part 3) of the guidelines in relation to planning for a scheme, and in (Part 7) in relation to use of recycled water.

The Manual for recycled water agreements in Queensland provides information and guidance on writing a contract to supply and use recycled water, and includes a model agreement. It can be used as a reference for preparing recycled water agreements."

The current guidelines issued by DERM also do not provide specifications for quality for use. For example the NRW "Water quality guidelines for recycled water schemes, November 2008" offer the following:

"5.4 Commercial/Industrial use

Commercial/industrial uses can include, but are not limited to, washdown, boiler feed and cooling towers in addition to a broad range of other commercial/industrial uses. As there is no predetermined water quality criteria for commercial/industrial wastewater, the recycled water provider should first undertake an analysis of the source water characteristics to determine what an appropriate recycled water quality is, depending on the intended use. It is recommended that the recycled water provider contact the regulator to discuss the water quality criteria the regulator is likely to apply to the scheme at the time of granting the RWMP or RWMP exemption approval. This is best done before undertaking validation and submitting a RWMP or RWMP exemption application for assessment. As part of the assessment, the regulator will decide if the proposed recycled water quality is appropriate for the intended use, taking into account any onsite control measures to be implemented by the user

5.5 Irrigation for uses other than minimally processed food crops

These types of irrigation may include:

- *irrigation of public open spaces such as, but not limited to, the irrigation of municipal parks and gardens, recreational sporting fields, racecourses, botanical gardens, school ovals and golf courses*
- *irrigation of non-food crops such as, but not limited to, the irrigation of turf, trees, woodlots, cotton and wholesale plant nurseries*
- *irrigation of heavily processed food crops such as, but not limited to, sugar cane, cocoa, cereal crops (wheat, rice and corn) grown for flour production and crops grown for oil production such as sunflower, canola and flax seed.*

The regulator may use various national and industry guidelines as a benchmark for determining appropriate water quality criteria for the intended use, taking into account onsite control measures implemented by the user. These may include:

- *The AGWR Phase 1 which generally covers sewage and greywater as a source of recycled water. Table 3.8 Treatment processes and onsite controls for designated uses of recycled water from treated sewage outlines a range of recycled water uses, indicative treatment processes, achievable log reductions, onsite control measures, exposure reductions and water quality criteria*
- *Growing Crops with Reclaimed Wastewater, developed by and available through Commonwealth Scientific and Industry Research Organisation (CSIRO), available online at <www.publish.csiro.au>*
- *farm codes dealing with the appropriate use of recycled water, including:*
    - *Queensland Dairy Farming Environmental Code of Practice (Department of Primary Industries and Queensland Dairyfarmers' Organisation 2001), available online at <www.dpi.qld.gov.au>*
    - *Environmental Code of Practice for Queensland Piggeries (DPI 2000), available online at <www.dpi.qld.gov.au>*
    - *National Beef Cattle Feedlot Environmental Code of Practice (Australian Lot Feeders' Association 2000), available online at <www.mla.com.au>*
- *industry codes of practice or similar documents.*

5.6 Construction

The regulator may use various national and industry guidelines as a benchmark for determining appropriate water quality criteria for the intended use, taking into account onsite control measures implemented by the user. These include the following guides that have been issued by the Department of Employment and Industrial Relations:

Model Water Management Plan for the Queensland Civil Construction Industry, available online at <www.deir.qld.gov.au>

Guide to the Workplace Use of Non-Potable Water including Recycled Water, available online at <www.deir.qld.gov.au>.

These documents also indicate the types of control measures which can be implemented to allow the recycled water provider to supply, and the user to make use of, a lesser quality of recycled water."

The NRW "Recycled water management plan and validation guidelines, November 2008" details the requirements for a Recycled Water Management Plan together with guidance as to when an exemption from a RWMP may be granted by the regulator. In general, the higher the level of use (or human exposure), the less likely that an exemption would be granted. Also, where the regulator deems that the recycled water constitutes a critical supply, a RWMP would be required.

A recycled water scheme requires validation to confirm that appropriate water quality will be maintained. The NRW guidelines indicate a point scale for various validation phases. An extract from the guidelines is shown on the next page. The most important stage is the "Commissioning verification – Monitoring of final water quality" which scores 5 points – sufficient for Class A recycled water.

However it should be noted that the guidelines specify that *"A minimum of 13 weeks of twice-weekly testing is required for all schemes."*

Table 2. Typical approaches for validation*.

	Methodology	Augmentation of drinking water supplies	Class A+	Classes A to D	Non–sewage
Pre-commissioning validation	Historical data, for example, from other schemes	✓ (1)	✓ (1)	✓ (1)	✓ (1)
	Scientific literature	✓ (1)	✓ (1)	✓ (1)	✓ (1)
	Manufacturer's specifications	✓ (1)	✓ (1)		✓ (1)
Commissioning validation	Pilot plant	✓ (3)			
	Specific challenge testing	✓ (3)			
	On–site tracer studies	✓ (3)			
	Direct integrity testing	✓ (3)	✓ (3)		✓ (3)
	Continuous indirect integrity testing	✓ (3)	✓ (3)		✓ (3)
Commissioning verification	Monitoring of final water quality	✓ (5)	✓ (5)	✓ (5)	✓ (5)

Table 3. Minimum point requirements*.

Scheme type	Minimum points required
Augmentation of drinking water supplies	14
Class A+	9
Class A to D	5
Non–sewage source, that is, greywater and wastewater	9

*The points referred to in Table 2 and 3 above are indicative only. For example, the weighting and awarding of points for each of the validation methodologies may vary depending on the regulator's assessment of the quality and relevance of the material supplied by the recycled water provider.

Criteria for all schemes:

- Whichever validation method(s) is adopted, the validation method(s) should be appropriate for the type of recycled water scheme, that is, augmentation of drinking water supply, class A+, classes A to D and non-sewage sourced recycled water, the technology used and the hazards identified.
- If the points system is used:
    - The recycled water provider should meet the minimum point requirement applicable to their scheme type; and
    - The validation programme should indicate which combination of methodologies has been selected from Table 2 to meet the minimum point requirement.
- If the 'points system' is not adopted, the provider should give an indication of how an appropriate spread of methodologies were used or how the recycled water provider has otherwise taken steps to guard against statistical errors or other issues in using its validation methodology.

Workplace Health and Safety Act 1995

The use of recycled water in a workplace is also governed by the Workplace Health and Safety Act. Under that Act, recycled water is considered to be a manufactured substance and the requirements include the following.

*"34 **Obligations of manufacturers of substances for use at workplace***

(1) A manufacturer of a substance for use at a workplace has an obligation to ensure that—

(a) the substance is safe and without risk to health when used properly; and

(b) the substance is tested and examined to ensure it is safe and without risk to health when used properly; and

(c) the substance, when supplied to another person, is accompanied by relevant information for the substance."

.....

*"34A **Obligations of suppliers of substances for use at workplace***

(1) A supplier of a substance for use at a workplace has an obligation to—

(a) take all reasonable steps to ensure the substance is safe and without risk to health when used properly; and

(b) to ensure the substance is accompanied by relevant information for the substance."

.....

*"34C **Obligation of person in control of relevant workplace area***

(1) The person in control of a relevant workplace area has an obligation to ensure the relevant workplace area is safe and without risk to health."

In the situation at Moura, Council would be the manufacturer of the recycled water. If recycled water is delivered to a work site by truck then the truck driver is the supplier. It can be seen that all three parties, including the work site supervisor, share responsibility for ensuring that recycled water causes no harm in a work place. It should be noted that the required standard is "without risk", which is at variance with the risk management approach of the guidelines for recycled water use which aim to quantify risk and control it to an acceptable level. An acceptable level of disability adjusted life years (DALYs) does not figure in the workplace safety legislation.

The Queensland Department of Employment and Industrial Relations has produced the "Workplace Health and Safety Queensland, Guide to workplace use of non-potable water including recycled waters, Version 1–June 2007" which expands on the requirements of the Act including:

"Providing written product safety information

***Manufacturers** and **suppliers** must provide written safety information about the nonpotable water to any water user at a workplace. The **written safety information** should include:*

- *any health hazards associated with the water*
- *recommended uses of the water*
- *precautions for the safe use of the water, including guidance on storage*

- *any relevant testing data.*

*A copy of the written safety information should be provided to the **person in control** of the workplace under the following circumstances:*

- *when the water is first supplied*
- *if new information becomes available about the water quality or characteristics affecting its safety*
- *if the water quality changes significantly from what was originally supplied*
- *after receiving a request from a person in the workplace."*

Environmental Protection Act 1994

Last but not least, Council must comply with the Environmental Protection Act. There are general requirements under the Act and supplementary Policies and Regulations, but Council's specific requirements are set out in the Environmental Authority (licence) issued to Council by the EPA, which specifies:

SCHEDULE D - SEWERAGE TREATMENT

(D1) Contaminants must not be released to any waters either directly or indirectly or the bed and banks of any waters except as permitted under this schedule.

(D2) Sewage treatment plants exist at:

A) Biloela
B) Moura
C) Theodore

(D3) A management plan for the Biloela, Moura and Theodore STP effluent irrigation must be implemented.

(D4) The management plan shall detail the following.

- *Soil capability and assimilative capacity*
- *Depth to groundwater and effect effluent is having on groundwater*
- *Nutrient loading and nutrient harvesting.*
- *Sustainability of irrigation practices.*
- *Alternatives to current practices.*

(D5) The final effluent irrigation management plan must be implemented.

(D6) A copy of the final site based management plan must be kept at the licensed premises where practical

(D7) If a complaint is received by the administering authority regarding odour, the holder of this environmental authority must undertake some form of action to reduce odour levels within a reasonable time.

These requirements are not particularly onerous, but they do mean that Council will need to:

- amend their effluent irrigation management plan if a different irrigation practice is to be used, and
- obtain a variation to the licence conditions if reuse other than irrigation is adopted.

As the new treatment process is a vast improvement on the old, it is expected that the EPA would be happy to negotiate a licence change that improves the environmental outcome.

The Options

There are many possible reuse options. Apart from in-plant use, which would be assumed to occur in conjunction with any other reuse option, the most promising ones in Moura appear to be:

- pasture irrigation
- vehicle wash-down bay
- recycled water standpipe
- dual reticulation
- park irrigation
- golf course irrigation
- industrial reuse
- new crop or horticulture venture

Pasture Irrigation

Prior to construction of the new treatment plant effluent was transferred to the adjacent farm where it was used for irrigation by the landowner. A continuation of this practice with the effluent from the new plant would be the cheapest option for Council but it is arguably the lowest value reuse of highly treated recycled water. It is unlikely to be justified as the primary reuse option, but it is likely to be useful if there is surplus effluent or if, for example, the effluent does not meet specifications for the primary reuse option for a period due to breakdown, etc.

Vehicle Wash-down Bay

Council has already commenced work towards connecting recycled water to the weed control wash-down bay.

This use is not specifically identified in the AGWR, but referring to Table 3.8 (extract overleaf) the closest fit is "Municipal use – open spaces, sports grounds, golf courses, dust suppression, etc or unrestricted access and application". It is clearly a lower health risk than dual reticulation where accidental cross-connection and ingestion is possible. This lower risk is reflected in the log reduction targets being 1 to 1.5 units lower. Thus Class A+ recycled water should not be necessary. However an E. coli level of <1 per 100 mL is recommended which is better than the Class A level of <10. The new Moura plant produces recycled water of the required quality.

This is a commercial/industrial use and so workplace safety has to be ensured. It is reasonable to assume that appropriate signage would be sufficient to inform users of the recommended precautions to be observed in using the wash-down facility.

Table 3.8 Treatment processes and on-site controls for designated uses of recycled water from treated sewage

Log reduction targets (V, P, B)[a]	Indicative treatment process	Log reductions achievable by treatment (V, P, B)	On-site preventive measures	Exposure reduction[b]	Water quality objectives[c]
Use — Dual reticulation, toilet flushing, washing machines, garden use					
6.5 5.0 5.0	Advanced treatment required, such as: • secondary, coagulation, filtration and disinfection • secondary, membrane filtration, UV light	6.5 5.0 5.0	Strengthened cross-connection controls required including ongoing education of householders and plumbers		• To be determined on case-by-case basis depending on technologies • Could include turbidity criteria for filtration, disinfectant Ct or dose (UV) • *E. coli* <1 per 100 mL
Use — Dual reticulation — outdoor use only *or* indoor use only					
6.0 4.5 5.0	Advanced treatment required; for example: • secondary, coagulation, filtration and disinfection • secondary, membrane filtration, UV light	6.0 4.5 5.0	Strengthened cross-connection controls required, including ongoing education of householders and plumbers		• To be determined on case-by-case basis depending on technologies • Could include turbidity criteria for filtration, disinfectant Ct or dose (UV) • *E. coli* <1 per 100 mL
Municipal use — open spaces, sports grounds, golf courses, dust suppression, etc *or* unrestricted access and application					
5.0 3.5 4.0	Advanced treatment required; for example: • secondary, coagulation, filtration and disinfection • secondary, membrane filtration, UV light	5.0 3.5 4.0	No specific measures		• To be determined on case-by-case basis depending on technologies • Could include turbidity criteria for filtration, disinfectant Ct or dose (UV) • *E. coli* <1 per 100 mL

B = enteric bacteria; BOD = biochemical oxygen demand; cfu = colony forming unit; Ct = disinfectant concentration × time; P = enteric protozoa; SS =suspended solid; V = enteric virus; UV = ultraviolet

a Log reduction targets are minimum reductions required from raw sewage based on 95th percentiles from Table 3.7.

b Exposure reductions are those achievable by on-site measures as listed in Table 3.3.

c Water quality objectives represent medians for numbers of *E. coli* and means for other parameters.

d BOD and SS are an indication of secondary treatment effectiveness.

e Aim is to demonstrate reliability of disinfection and ability to consistently achieve microbial quality

f Log reductions for public in the vicinity of commercial food crop irrigation areas should comply with total log reductions required for municipal use.

The volume of water used at the Moura wash-down bay in the last 6 years is shown in the table below.

Moura Wash-down Bay Metered Town Water Consumption						
Period Ending	Truck Wash		Car Wash		Total	Ave Daily
	Meter	Cons (kL)	Meter	Cons (kL)	(kL)	(kL)
30-Jun-03	13,832		7,626			
30-Jun-04	18,907	5,075	7,765	139	5,214	**14.2**
30-Jun-05	24,464	5,557	7,928	163	5,720	**15.7**
30-Jun-06	31,547	7,083	8,239	311	7,394	**20.3**
30-Jun-07	36,824	5,277	8,921	682	5,959	**16.3**
30-Sep-07	37,687	863	9,190	269	1,132	**12.3**
31-Dec-07	38,890	1,203	9,345	155	1,358	**14.8**
31-Mar-08	40,484	1,594	9,513	168	1,762	**19.4**
30-Jun-08	42,125	1,641	9,655	142	1,783	**19.6**
30-Sep-08	43,595	1,470	9,899	244	1,714	**18.6**
31-Dec-08	45,374	1,779	9,985	86	1,865	**20.3**
31-Mar-09	47,241	1,867	9,996	11	1,878	**20.9**

It can be seen that the average water usage has been 20 kL/day. This is a relatively small proportion of the total recycled water available. However it is a valuable use for the recycled water because it is a direct replacement of treated town water.

Recycled Water Standpipe

A substantial volume of town water is loaded into water trucks at the Moura standpipe. The volumes used over the last few years are tabulated overleaf. The overall average consumption is 13,500 kL/quarter or 148 kL/day. However since January 2008 the average consumption has been slightly lower at 133 kL/day.

Much of the water is transported to mines and construction camps where potable water is required. Clearly recycled water could not replace all the water currently used at the standpipe. A further constraint is that potable water cannot be carried in a tank that has been used for recycled water. Thus if a contractor only carts relatively small volumes it will not be worth his while to gear up to carry both classes of water.

In the 15 months after January 2008, Moura Sand and Gravel carted half the total volume that was discharged from the standpipe. In May 2009 the company manager, Ian Robinson, advised that they had checked and 25 to 30% of the water they cart is used at drill rigs etc, where recycled water of a satisfactory standard would be satisfactory. Tony Buckton, of T & C Constructions, the second biggest water user also advised that a similar proportion of substitution would be possible.

Therefore it is assumed that an average of 30 to 40 kL/day of recycled water would be used from the recycled water standpipe. This quantity is likely to fluctuate widely depending on the nature of the sites requiring water.

Moura Town Water Standpipe Metered Consumption (kL)															
User	2006				2007				2008				2009	08/09 (15 mths)	
	Qtr1	Qtr2	Qtr3	Qtr4	Qtr1	Qtr2	Qtr3	Qtr4	Qtr1	Qtr2	Qtr3	Qtr4	Qtr1	Total	Av kL/d
Moura Sand & Gravel	6,457	5,632	5,044	6,172	5,626	6,776	6,499	7,358	5,934	6,492	7,131	5,483	5,614	30,654	**67.2**
T & C Excavations	73	9	898	594	980	127	649	971	336	3,462	2,453	2,837	2,303	11,390	**25.0**
Moura Transport			1,647	377	264	403	879	1,126	1,102	1,703	1,102	810	875	5,592	**12.3**
Kalari	776	814	903	870	1,108	850	979	882	738	1,068	845	685	843	4,179	**9.2**
Dawson Vly Tilt Tray											388	1,390	1,867	3,645	**8.0**
Amcor Excavations										45	627	370	166	1,208	**2.6**
BSC	268	30	643		1,005	1,485			249	331		356	82	1,018	**2.2**
Graincorp			206	293		34	37	218		595	84	286		965	**2.1**
Belvedeere Coal		280									561			561	**1.2**
Inseam Engineering												273		273	**0.6**
Evko Power		31						54	83	89	37			209	**0.5**
Barnes Landscaping	9				22	32	114	149	57	26	8	52	46	189	**0.4**
Johny's Truck Hire					273	164	80	64				39	91	130	**0.3**
B F Cross			61		40	20	12	48	102	26				128	**0.3**
S & S Wilson	119	83	80	165	56	88	37	65	14	79		29		122	**0.3**
C.L. & M.J. Moore								26	53				54	107	**0.2**
Mactaggart	45			59	29	53	53	34		59				59	**0.1**
3 MK Pty Ltd											30			30	**0.1**
All Diesel & Mtce Serv													25	25	**0.1**
Utility Asset Mgmt										19	3			22	**0.0**
Pasadena	22	22	44	22		23	23			12				12	**0.0**
Wheaton										12				12	**0.0**
Ostwald Bros	3,775	7,109	6,545	3,043	1,745	1,393	562							0	
Boral Concrete	613	2,957	2,219	1,001	412	444								0	
others	862	1,366	1,285	939	1,392	4,157	445							0	
Total	13,019	18,333	19,575	13,535	12,951	16,049	10,369	10,995	8,668	14,018	13,269	12,610	11,966		**132.7**

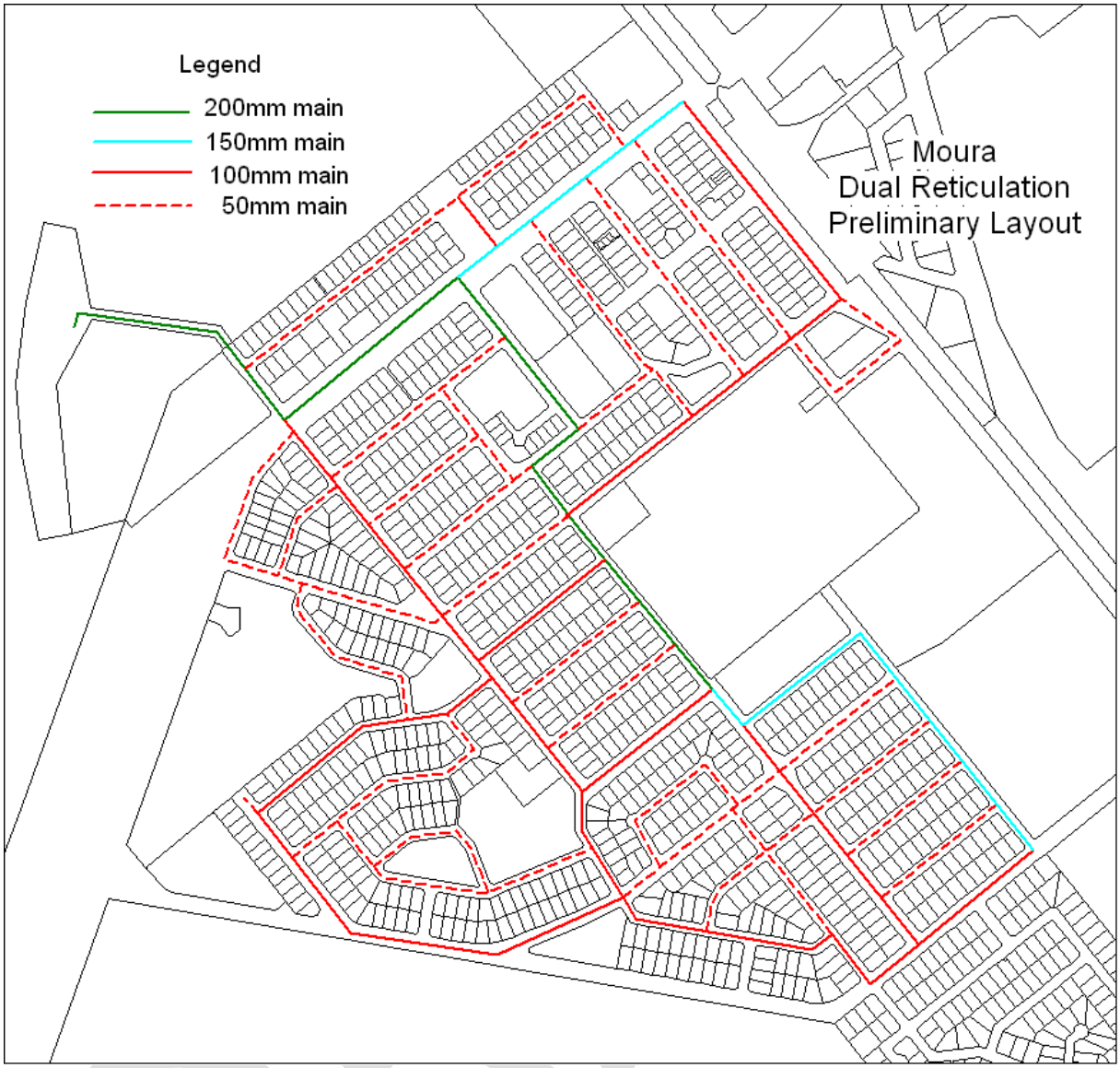
Supply of recycled water via standpipe is another high value use in that it substitutes for town water consumption. However it does require extra expenditure and care on the part of the cartage contractors. While Council may decree that recycled water be used wherever possible, it would be beneficial to provide incentive in the form of a significant price differential between recycled water and town water.

Dual Reticulation

With dual reticulation, recycled water is distributed throughout the community via an additional network of water mains. Generally the water can be used for garden watering, toilet flushing and sometimes for washing machines. The capital cost is substantial, not only for the recycled water reticulation but also for household plumbing alterations, and plumbing inspections become more critical. However this option does provide the maximum replacement of town water usage, not only for irrigation in dry weather but for toilet flushing in any weather.

The most efficient time to install dual reticulation is during initial development of a large greenfield site. However it can be retrofitted where water is sufficiently scarce.

A concept design for recycled water reticulation is shown on the next page.



Moura Water Recycling Options
Dual Reticulation Preliminary Estimate

Component	Qty	Unit	Rate	Amount
Class A+ disinfection		item		100,000
1 ML storage tanks	2	no	600,000	1,200,000
VFD pump station	1	no	80,000	80,000
200mm main	1,900	m	220	418,000
150mm main	1,400	m	160	224,000
100mm main	5,600	m	120	672,000
50mm main	9,800	m	80	784,000
Service connections	930	no	1,200	1,116,000
Subtotal				4,594,000
Design, supervision			10%	459,000
Contingencies			20%	1,011,000
Total estimated cost				**6,064,000**

It can be seen that dual reticulation is an expensive option. The benefit of dual reticulation is that the recycled water replaces a portion of town water consumption. The value of this town water saving varies depending on the supply circumstances at the particular locality.

Water consumption in Moura over the last two water years is shown below. The Moura water scheme supplies Moura and Banana

Water Year	Raw Water Consumption (ML)	Clear Water Produced (ML)	Treatment Losses
2007/08	692	564	19%
2008/09	677	590	13%

Moura has a high priority allocation of 800 ML/year plus a medium priority allocation of 50 ML/year. Thus there is a reasonable margin of comfort for the current population of Moura and Banana.

The township of Banana is part of two rural census collection districts and consequently the population of the town is not separately identified in the census. However the 2008 aerial photograph indicates approximately 76 occupied dwellings, which would indicate a population of 230 to 300, depending on the occupancy rate. Thus the population served by the Moura water supply would be approximately 2,200.

Water consumption of 590 ML/year equals an average consumption of 730 L/person/day. This is perhaps three times the usage of urban communities on the coast, but arguably not excessive in the dry inland climate. However it does indicate some flexibility to reduce consumption if necessary.

The cost of Council's 800 ML water allocation is $98 per megalitre per year. This is equivalent to a net present value of the order of $980/ML.

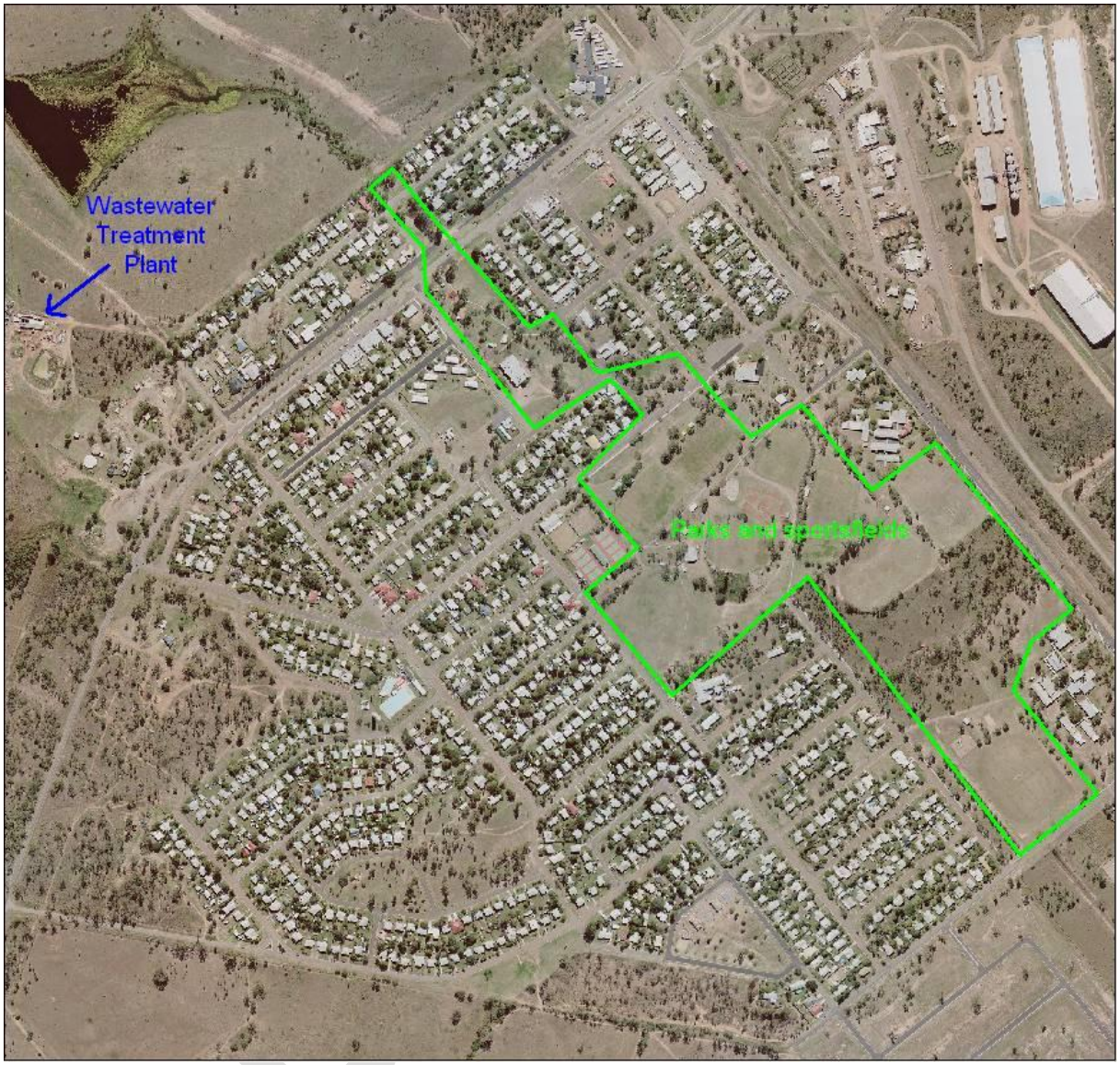
Assuming all the recycled water could replace town water usage, there would be a saving of 180 ML/year. After allowing for treatment losses, this would reduce raw water consumption by 200 ML/year. At a cost of $6million for dual reticulation, the cost of the recycled water would be $30,000/ML.

Thus recycled water via dual reticulation would be of the order of 30 times the capital cost of the river water. This could only be justified as a last resort.

There is another problem with dual reticulation. There would not be enough recycled water to go around, to meet the garden watering needs of all the residents. Extending dual reticulation to only part of the community would reduce the capital cost but may lead to dissatisfaction.

Park Irrigation

A large proportion of the parks and playing fields (including school fields) in Moura are concentrated in one strip as can be seen in the aerial photograph below.



A single trunk main could supply recycled water to all these park areas. If a new main is constructed for the purpose, it could be sized to cater for future expansion, either additional park irrigation or as a distribution main for dual reticulation.

Moura Water Recycling Options
Park Irrigation Preliminary Estimate

Component	Qty	Unit	Rate	Amount
1 ML storage tank	1	no	600,000	600,000
VFD pump station	1	no	80,000	80,000
200mm main	1,900	m	220	418,000
150mm main	650	m	160	104,000
100mm main	400	m	120	48,000
Subtotal				1,250,000
Design, supervision			10%	125,000
Contingencies			10%	138,000
Total estimated cost				**1,513,000**

The recycled water quality recommended for municipal irrigation with unrestricted access is Class A. This is easily achieved by the treatment plant and only requires testing for E. coli, not the suite of four microbiological indicators, and probably monthly testing rather than weekly.

Irrigation rates of at least 6 ML/hectare/year would be beneficial to the park areas – which would indicate that 180 ML/year could irrigate 30 hectares. The park areas identified in the plan have a total area of 28 hectares. This indicates that the parks could readily consume all the available recycled water in dry periods but, as would be expected, they may not need irrigation during rainy periods.

The Dawson Mine currently provides some water for irrigation of the sports fields, but this is reportedly less than 10 ML/year. The greater volume of recycled water would facilitate a much higher level of irrigation which would improve the fields.

Golf Course Irrigation

The Moura Golf Club has expressed an interest in obtaining recycled water for irrigating its course.

The recycled water quality would be adequate. The problem with this option is that it would require construction of a 150mm diameter supply main from the treatment plant 6.9 km back to the bank of the Dawson River. The pipeline would cost of the order of $1million. This seems an inefficient use of resources when the golf course is adjacent to the Moura Weir and has an allocation from the weir.

Industrial Reuse

There are at least two potential industrial customers:

- QNP explosives plant, and
- Dawson Mine.

Both have expressed an interest in obtaining recycled water, QNP for use as high quality water in its manufacturing process, and Dawson Mine to replace the water that it currently allocates to Moura park irrigation.

QNP is 7 km east of Moura and a 7.6 km pipeline would be necessary for its proposed use.

QNP would be expected to meet the cost of the pipeline, but they would need a long-term contract to make it feasible. For example 180 ML/year, even at the full high priority allocation cost, would be worth approximately $180,000 per year. It would take at least 10 years to recover the cost of the 7.6 km pipeline including financing cost.

However if the additional water enabled QNP to expand its operation this could provide employment and community benefit.

Dawson Mine has made an informal offer to Council to assist in extending recycled water to the Moura sportsfields in exchange for a town water connection off the Banana pipeline at their mine site.

These are two known expressions of interest and there may be others when the details of recycled water availability become widely known.

New Crop or Horticultural Venture

There are already irrigated crops adjacent to the Dawson River with medium priority water allocations. It is possible that some higher level venture would be feasible if a 100% reliable water supply could be assured. None are known of at this stage but public notification of the availability could identify an interest.

Recommendations

The opportunities for beneficial use of the high quality recycled water from the Moura wastewater treatment plant are several, and identifying the best will not simply be a matter of tendering the water for sale at the best price.

At this stage it appears that:

- there will be at least 400 kL/day available after the wash-down bay and standpipe have been supplied, and
- the most practical and beneficial use of the remainder would be irrigation of parks and sportsfields in Moura.

It is recommended that:

1. While the best use of the recycled water after the wash-down bay and standpipe use appears to be irrigation of parks and sportsfields in Moura, Council keep options open until all opportunities have been compared.

2. Public expressions of interest be called, detailing the quality and quantity of recycled water that will be available, and specifying that Council will consider financial, environmental and community benefit in selecting the preferred offer.

   To allow for negotiation to enable Council to obtain the best outcome, the invitation should state that Council might later invite all tenderers to change their tenders in accordance with s488 of the Local Government Act.

3. Council undertake negotiations with DERM as the regulator to determine the specifications for recycled water for the proposed use(s). In particular, Council needs to make a case for a standard other than Class A+ which requires weekly testing for a range of microbiological indicators - which will cost approximately $30,000 per year.

4. Council rearrange the flows to the lagoons at the treatment plant so that one (probably the southern one) can be used for storing any surplus high quality recycled water for later use by Council or the adjacent farmer, while the other three lagoons are available for untreated or partially treated flows in the event of treatment plant breakdown