Cloncurry Sewage Treatment Plant

Environmental Evaluation

Cloncurry Shire Council

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Executive Summary

This Environmental Evaluation Report responds to the Department of Environment and Heritage Protection correspondence dated 16 March 2017.

Sewage Planning Report

This Environmental Evaluation Report presents a summary of the Sewage Planning Report prepared for the Cloncurry township.

The Sewage Planning Report examined the existing and projected sewage treatment plant (STP) loads. It examined the capacity of the existing STP and effluent irrigation scheme.

The Sewage Planning Report examined the environmental values of the receiving waters, land and groundwater and reviewed water quality objectives.

It considered a range of options for sewage treatment and effluent management at Cloncurry viz.

Infrastructure	Option 1 – Continuous Discharge (BAT STP & Creek Discharge)	Option 2 – Sustainable Irrigation (Upgrade Exist STP & Effluent Irrigation)	Option 3 – Existing Licence with Releases (Replace Exist STP & Effluent Irrigation	Option 4 – Existing Licence without Releases (Replace Exist STP & Effluent Irrigation)
Sewage Treatment	New STP	Upgrade Existing STP	New STP	New STP
Effluent Reuse	Nil	95% of ADWF	95 % of ADWF	100% of inflows
Effluent irrig (area / storage)	Nil	25ha / 37.5ML	25ha / 37.5ML	25ha / 365ML[1]
Effluent Discharge	100% of inflows	5% ADWF (18ML/yr)[2]	5% ADWF (18ML/yr)[2]	Nil
Stage 1 Capital Cost	$ 9.6 M	$ 4.3 M	$ 9.4 M	$16 .9 M
Stage 2 Capital Cost	$ 0 M	$ 4.9 M	$ 1.6 M	$ 1.6 M
Average O&M (30 years)	$ 532 K	$ 503 K	$ 667 K	$ 860 K
NPV (7% over 25 years)	$ 14.7 M	$ 11.3 M	$ 16.6 M	$ 25.1 M

Notes: 1. Assumed Zero Discharge storage volume. 2. Effluent discharge is average over the long term and will vary from year to year. 2. Capital costs do not include $190k for Scarr St. and Alice St. PS upgrades or any network refurbishment.

The Consultant's preferred option is Option 2 – Sustainable Irrigation.

Cloncurry Shire Council has yet to adopt its preferred option. This is a complex matter involving significant financial commitments.

Option 2 – Sustainable Irrigation comprises the following components.

Stage 1 (2,800EP)

STP – new inlet works, rock filter,

Effluent Irrigation – 22ML new effluent storage (4.5ML exist), 14ha new irrigation area (Racecourse / Golf Course, Rec Reserve), 5.5ha exist irrigation area (STP, STP surrounds, Lawn Cemetery).

Stage 2 (2,800 EP to 4,000EP)

STP – convert Imhoff tank to balance tank, new 2/4.7ML anaerobic lagoons, new DAF plant,

Effluent Irrigation – 11ML new effluent storage, 7.5ha new irrigation area (Racecourse / Golf Course).

Protection of Environmental Values

STP / Effluent Management Option 2 – Sustainable Irrigation will:

- Significantly reduce sewage releases to waters and make a positive contribution to the protection of local aquatic ecosystems,
- Manage effluent releases to land and achieve sustainable irrigation, and
- Avoid effluent releases to groundwater and protect the associated environmental values.

Modifications to Environmental Authority

The following modifications to the 2017 DEHP EA are proposed for Option 2 – Sustainable Irrigation.

Conditions	2017 DEHP licence	Option 2 – Sustainable Irrigation
Inflows to STP	DADWF 400kL/d (G5-1) Peak design capacity of 5DADWF (2,000kL/d) (G5-1)	DADWF 700kL/d (i.e. 2,800EP x 250L/EP/d) Provide full treatment up to 3DADWF Hydraulically contain flows up to 5DADWF Bypass flows >5DADWF
Release to Waters	Prohibited (Condition WT5-1)	Release 5% of DADWF averaged over long term (as wet weather storage overflow)
Release to Land	Minimum 10ha irrigation area (Table 2 Assoc. Reqmts 1.) Minimum 15ML wet weather storage (G5-1)	Irrigate 95% of DADWF averaged over long term
Release to Land – locations (G5-1)	Lot 160 SP169675 (Adjacent to STP) Lot 11 SP232323 (Lawn Cemetery) Lot 125 SP127357 (Racecourse) Lot 82 CP9044802 (Golf Course)	Lot 99 BD168 (STP) Lots 35-52 & 61-78 RP703304, Lots 87&120 BD204 and Lot 1 RP458845 (Recreation Reserve)
BOD (mg/L) (Table 2)	10, 15, 20 (50, 80%ile, max)	20 (50%ile)
SS (mg/L) (Table 2)	15, 25, 30 (50, 80%ile, max)	30 (50%ile)
TN (mg/L) (Table 2)	5, 8, 10 (50, 80%ile, max)	Delete
TP (mg/L) (Table 2)	2, 5 (50%ile, max)	Delete
STP effluent sampling location	Not specified	After rock filter or DAF plant and disinfection
Table 2 Assoc. Reqmts (L5-1)	4. Monitoring ….. 5. Volume of release ….	4. “Groundwater” monitoring ….. 5. Volume of release to land shall be measured by a flow meter.

1 Introduction

The Department of Environment and Heritage Protection has required Cloncurry Shire Council to commission an Environmental Evaluation.

The report on the environmental investigations is required to address the following matters.

1.1 Sewage Planning Report

Develop a Sewage Planning Report for Cloncurry town in general accordance with the Department of Energy and Water Supply *'Planning Guidelines for Water Supply and Sewerage, April 2010'* and which, at a minimum:

a) Describes the existing sewerage network of the Cloncurry township;

b) Describes the current Sewage Plant treatment train and peak design capacity;

c) Determines the current storage capacity of all water storages at the Sewage Treatment Plant, including the Coffer Dam and Emergency Dam;

d) Describes all current and future predicted sources of inflow to the Cloncurry Sewage Traetment Plant and based on this, the current predicted inflow;

e) Determines the required peak design capacity to meet the needs of the Cloncurry township in the short, medium and long term;

f) Determines the future peak design capacity of inflow based on population growth modelling from a suitable provided of such modelling. The peak design Capacity should include, if applicable, current inflow from industry and potential future inflow from industry growth; and

g) Provides a recommendation of the most appropriate STP design required to meet the current and future peak design capacity of inflow for Cloncurry town.

A separate Sewerage Master Plan (Sewage Planning Report) has been prepared and is summarised in **Section 2**.

The specific matters listed above are addressed in **Section 3**.

1.2 Receiving Environment

Investigate the following aspects of the receiving environment in relation to the proposed plant operations:

a) Identify the environmental values of the receiving environment that will potentially be affected by sewage treatment plant operations on site. This must include any areas of proposed irrigation;

b) Identify the potential effects of the proposed operations on the identified environmental values;

c) Outline any proposed mitigation measures to be incorporated into the management of the plant to protect applicable environmental values; and

d) Provide justification that all proposed mitigation measures will ensure the protection of the identified environmental values.

The receiving environment has been examined in the separate Sewerage Master Plan report which is summarised in **Section 2**.

The specific aspects listed above are addressed in **Section 4**.

2 Cloncurry Sewerage Scheme Master Plan Summary

2.1 Cloncurry Sewerage Scheme

2.1.1 Network

The Cloncurry sewer network comprises 26.2km of 300mm, 225mm and 150mm dia AC sewers and nine pump stations (i.e. PS1 Scarr St, PS2 Alice St, PS3 McKinlay St, PS4 Brisbane St, PS6 Martel Cres / previously Absolom St, PS7 Douglas St, Industrial Estate, Isley St and the Equestrian Centre).

Since 2012/13 Council has undertaken CCTV inspections that have identified a general deterioration in the condition of the underground assets and this has triggered ongoing sewer relining activity. Council has also undertake some road crossing sewer replacement to address the poor condition risk.

2.1.2 Sewage Treatment Plant

The existing STP comprises:

- Inlet screening structure (with flow measuring flume, brush screen and flow diversion to Lagoon 5),
- Imhoff tank (with four sludge drying beds),
- Seven lagoons (1 - 1.5m deep x total volume 4.75ML),
- Coffer Dam (notionally 2ML volume),
- Emergency Storage Dam (notionally 2ML volume).

Effluent is also pumped from the Coffer Dam to a (300kL/d) Polishing Plant that comprises:

- Submersible duty feed pump and DN100 PVC pipeline (from Coffer Dam),
- 250L coagulant dosing tank (with duty dosing pump),
- In-line mixer,
- Reaction chamber,
- Multi-media filter (2 cells) with backwash to the Coffer Dam,
- Activated carbon filter (2 cells) with backwash to the Coffer Dam,
- UV disinfection unit (Wedeco LBX 90e)
- Liquid chlorine dosing to the treated water pipeline (storage tank and duty dosing pump in the old chlorine dosing building,
- 5kL storage tank (with recirculation for maintaining a chlorine residual)

The Cloncurry STP site also includes two bunded evaporation pans (notionally 1ha). Effluent is pumped from the Coffer Dam or the Emergency Dam to assist disposal.

A process flow diagram of the existing STP is shown in **Figure 2-1**.

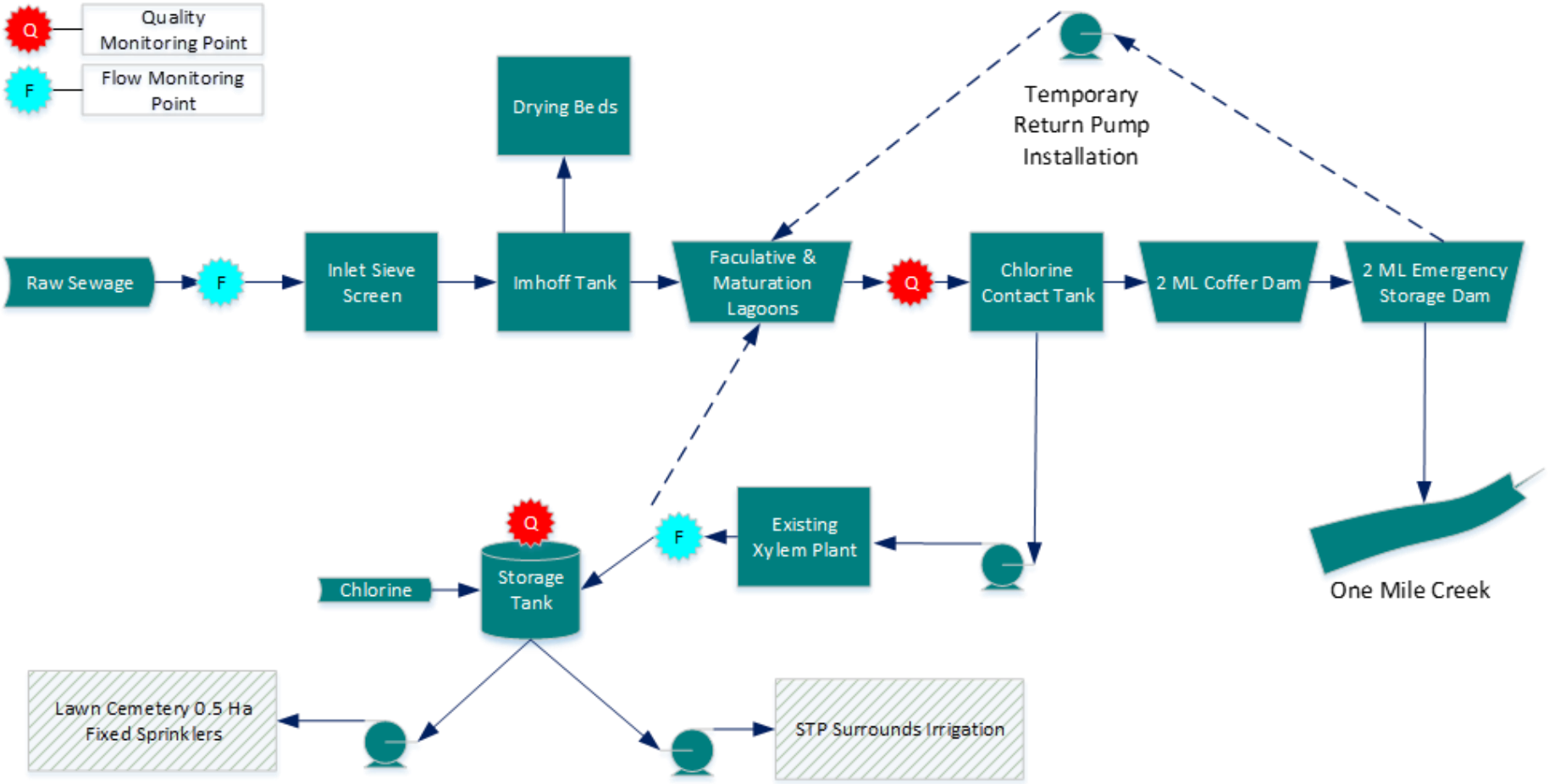


Figure 2-1: Existing STP Process Flow Diagram

Council operates the Cloncurry STP under Development Permit (EPA Permit No IPDE00069804D16) issued on 6 January 2005. This licence nominates the following contaminant release limits (to land).

Table 2-1 Cloncurry STP Limits for Release to Land

	Units	50%ile	80%ile	Maximum / Range	Sampling
BOD	mg/L	10	15	20	Monthly
TSS	mg/L	15	25	30	Monthly
pH	pH units	-	-	6.5 – 8.5	Monthly
Faecal coliforms	cfu/100mL	-	-	1,000	Monthly
TN	mg/L	5	8	10	Monthly
TP	mg/L	2	-	5	Monthly

Council has "monthly" grab sample data from October 2014 and February to October 2015. The analysis of this data is presented below.

Table 2-2 Coffer Dam Effluent Statistics, Oct 2014 & Feb - Oct 2015

	Units	50%ile	80%ile	Maximum
BOD	mg/L	22	42	128
TSS	mg/L	68	87	114
pH	pH units	9.2	9.9	10.2
Faecal coliforms	cfu/100mL	4,100	73,120	890,000
TN	mg/L	9.3	12.1	13.0
TP	mg/L	3.0	3.6	4.4

This analysis indicates that the Cloncurry STP failed to meet licence for any parameter (except for maximum phosphorus) over this period.

It is considered likely that these results are also representative of current performance.

The performance information for the Polishing Plant shows that it does not remove any significant amount of nitrogen or phosphorus. Its performance as a particle filter and disinfection unit is impeded by algae in the feed water (Coffer Dam). With the algae removed the Polishing Plant could be useful for providing higher disinfection quality effluent for irrigating sites with public access.

2.1.3 Effluent Irrigation

The existing effluent irrigation scheme at the Cloncurry STP is quite limited.

Effluent from the Polishing Plant 5kL storage tank can be pumped to:

- An area surrounding the STP lagoons (notionally 1 ha),
- An area adjacent to the STP site (notionally 3.5ha), and
- The Lawn Cemetery.

The area surrounding the STP Lagoons has a DN100 PVC ring main. Irrigation of this area is by fixed sprinklers. The design, includes a truck filling station.

The STP Adjacent Area is irrigated by several fixed low-throw sprinklers and a couple of small scale travelling sprinklers. The operation is essentially manual.

The Lawn Cemetery irrigation is achieved by domestic scale sprinklers that are moved “by” hand. The operation is manual.

The existing effluent irrigations areas are operated manually - a simple irrigation controller could be added to provide, at least, automatic “time of day” operation.

2.2 Previous Investigations

2.2.1 McIntyre & Associates Studies 1994, 1996 and 1999

The Maunsell (2001) report refers to a 1994 McIntyre & Associates study that considered sewerage infrastructure for an Ernest Henry Mine subdivision that was to increase the network and STP capacity to 3,750EP.

The 1996 McIntyre & Associates study found the STP was near its full capacity of 2,500EP and needed augmentation.

The 1999 McIntyre & Associates study presented results showing the STP effluent consistently exceeded its licence limits. The STP load was assessed at 3,232EP well above its capacity of 2,500EP.

Since the 1999 report was commissioned, additional treatment storage lagoons have been provided.

2.2.2 Cloncurry Sewerage Reticulation Review, Maunsell 2001

Maunsell (2001) assessed the 2001 sewage load at 3,232EP (i.e. 2,538EP residential and 694EP accommodation and commercial). Maunsell (2001) projected a 2010 load of 5,012EP.

Maunsell concluded that:

- PS1 (Scarr Street) had insufficient capacity and that the operation needed to be closely monitored e.g. pump run hours, discharge pressure and drawdown testing of flow rate,
- PS2 (Alice Street) had sufficient capacity but that the duty and standby pumps should be identical,
- PS3 (McKinlay Street), PS4 (Brisbane Street), PS6 (Absolom Street) and PS7 (Douglas Street) had sufficient capacity.

Maunsell (2001) concluded that the existing trunk sewers could handle up to 4,000EP before exceeding the S4 sewer capacity at the discharge point to the S sewer.

The S4 (MH 4 to MH 4B) sewer had sufficient capacity but there was little spare capacity. The sewer is very important because it services the town centre and extends to the Hospital.

2.2.3 Cloncurry STP Planning Report, Maunsell 2001

In 2001, the Cloncurry STP environmental authority allowed discharge to the local creek. Maunsell reported that Council considered this a waste of a valuable resource and wished to investigate effluent reuse.

Maunsell (2001a) proposed that the Cloncurry STP be upgraded to meet anticipated population growth and to allow effluent irrigation. The proposed works were:

Year 1	Imhoff tank duplication	$208,000	
	DAF trials / Wetlands trials	$ 20,000	
	Flow meters upgrades	$ 15,000	
	Aerobic lagoon review / desludging	$ 25,000	$268,000
Year 2	“Tertiary” treatment (DAF or wetland)		$280,000
Year 3	Irrigation system		$540,000
Year 4	Aerobic lagoon duplication	$156,000	
	Sludge bed duplication	$ 33,000	$189,000
	Total		$1,277,000

A specialist irrigation and soil consultant, Woodlots & Wetlands, was engaged to investigate effluent irrigation of lands adjacent to the STP, at the Cemetery, at the Golf Course and at the Racecourse.

Woodlots & Wetlands examined the effluent quality, the prospective irrigation sites landscape, soil profiles and soil chemistry and concluded that irrigation was feasible although there were moderate soil instability and surface slaking risks. Amelioration measures including not over-irrigating, maintaining a vegetative cover and gypsum applications were recommended. Salt at 400mg/L was not considered a problem. Nitrogen (at 13.4mg/L) was considered to be significantly less than crop uptake. Phosphorus (at 5mg/L) leaching to the subsoil was considered possible because the crop uptake and the phosphorus sorption of the surface soils were low but this was not considered a significant environmental risk because of the large depth to groundwater.

Woodlots & Wetlands carried out a monthly water balance (over the 1975 to 2001 period) for an inflow of 800kL/d and determined that 16.5ha of pasture and 24ML of storage would achieve 98% reuse. These values calculate to 17.7ML/ha/yr irrigation rate and 1.5ML/ha storage rate.

2.2.4 Cloncurry STP Capacity Review, Hunter Water Australia 2009

HWA essentially concluded that the existing Cloncurry STP had no capacity to meet the existing licence effluent requirements. HWA considered future effluent quality limits may be driven by reuse requirements in accordance with Queensland and National Water Recycling Guidelines (rather than the above licence limits) and that negotiations should be undertaken with “EPA”.

HWA recommended that a Master Plan be prepared investigating short term plant modifications (e.g. for algal control), effluent reuse opportunities, increased sewage monitoring, population projections, odours, STP upgrades and ERA consultation (to set effluent quality requirements).

2.2.5 Cloncurry STP Review, LGIS 2009

The HWA (2009) report above was included in a wider report prepared by LGIS. LGIS (2009) made the following recommendations to Council:

- Implement short term operational improvements,
- Proactively engage the regulator to address immediate compliance issues (including irrigation),
- Develop a planning report to set a medium to longer term strategy.

LGIS listed the short term operational improvements as:

- Research and implement affordable, low cost algal control mechanisms,
- Clean the chlorine contact tank,
- Modify the existing screens and remove the flume to reduce inlet works overflow risk,
- Implement and continue regular pond maintenance (including desludging and vegetation removal).

LGIS noted the existing plant was unable to meet the required effluent quality. LGIS proposed negotiations with the regulator (then DERM) to relax the licence temporarily if an appropriate program of upgrade works can be agreed with the regulator. LGIS advised Council that it had to decide to reinstate irrigation or attempt to negotiate a license condition relaxation.

For the longer term planning study, LGIS proposed water quality modelling (of the receiving waters), exploring effluent reuse opportunities, increasing raw sewage monitoring, analysing population growth potential, conducting an odour study and investigating STP upgrade options. LGIS indicated that Council’s expectation of an 8,500EP STP (as a BNR activated sludge plant) would have a capital cost in the order of $17million.

2.2.6 Cloncurry STP 2016-17 Upgrades, ERSCON 2016

ERSCON (2016) estimated the 2016 ADWF load at 756kLd (2,800 EP x 270L/EP/d). ERSCON reviewed the existing STP and proposed an upgrade with the following components to meet “DEHP discharge requirements”:

- New VSD drives to raw sewage pump stations (6 No) delivering to the STP,
- Convert Lagoon 2 to (wet weather) overflow storage, new (recovery) lift pump station,
- Upgrade spiral screen, convert Imhoff tank to grit tank,
- New parallel aeration / activation tanks (2 no.),

- New clarifier, RAS pump station,
- WAS diversion to Lagoon 1, convert Lagoon 1 to earth digester,
- Retain Lagoons 3 to 8,
- Duplicate Polishing facility.

ERSCON's cost estimate for these works was $3,000,000. ERSCON distributed the costs between a DILGP grant ($1.8M) and Cloncurry SC ($1.2M).

2.2.7 Cloncurry STP Expansion, Desktop Environmental Impact Assessment, RPS 2016

RPS (2016) investigated the environmental impacts of the Emergency Storage Dam (including 0.36ha of clearing) on Lot 106 SP169675 and effluent irrigation areas on Lot 99 BD168 (the STP), Lot 11 SP232323 (the Lawn Cemetery and a south-eastern STP Adjacent area), Lot 160 SP168675 (a northern STP Adjacent area) and Lot 157 BD238 (a western STP Adjacent area).

The findings are summarised below.

Table 2-3 Summary of Environmental Impact Assessment Findings

Issue	Implications and Recommendations
Vegetation (a 20km search radius generally applied)	▪ The site contains Least Concern remnant vegetation, ▪ No threatened RE's are present on the site, ▪ No areas of Essential Habitat are mapped on the site, ▪ The site is not located in a Flora Survey Trigger Area, therefore no formal survey to the Queensland Flora Survey Guidelines is required, ▪ No threatened flora species are considered likely to occur on the site, ▪ Should Council become aware of the presence of threatened flora species on the site during construction a flora survey will be required, ▪ Due to the removal of a small area (0.36ha) of Least Concern vegetation the proposed construction is expected to have a minimal impact on vegetation communities.
Threatened Ecological Communities	▪ No threatened ecological communities with a potential to occur were identified and therefore will not be impacted.
Significant Fauna	▪ Two threatened species have the potential to occur: • Painted Honeyeater: Vulnerable (NC Act and EPBC Act), • Carpentaria Antechinus: Vulnerable (EPBC Act), ▪ Due to the small scale of the project it is unlikely that the construction of the emergency overflow dam will have a significant impact on either of these species.
Introduced Fauna	▪ Previous work suggests the cane toad, dog and cat may occur, ▪ Control of Class 2 should be undertaken where effective control is feasible and effective.
Aquatic Ecosystems & Wetlands	▪ One VMA watercourse (stream order 1) intersects the site and joins the Cloncurry River approximately 1km from the STP, ▪ No DEHP Referable Wetlands (i.e. High Ecological Significance Wetland) is located within 100m of the proposed dam, ▪ No RAMSAR wetlands are located in the vicinity of the proposed dam, ▪ No Nationally Important Wetlands are located in the vicinity of the proposed dam, ▪ A number of Environmental Values relevant to surface water and groundwater of the receiving environment have been identified including the intrinsic value of the aquatic ecosystems, the suitability of water for primary industries, recreation and aesthetics, cultural and spiritual values and industrial use, ▪ Local water quality guidelines are not available for the Cloncurry River catchment as the receiving environment. It is recommended that the default

Issue	Implications and Recommendations
	guideline values located in the ANZECC 2000 Guidelines for water quality of the receiving environment, ▪ The primary potential impact to surface water and groundwater from the operation of the STP storage dam is the degradation of the surface water and groundwater quality because of the release and potential leaching of discharge containing elevated water quality parameters (e.g. nutrients, TSS, faecal coliforms). However, the proposed expansion dam will reduce the potential for uncontrolled discharge by providing greater storage capacity (i.e. provide emergency overflow from the existing dam). Additionally, the proposed polishing plant will improve the quality characteristics of the effluent. Other factors that reduce the risk of groundwater impacts include the constructed depth of the storage dam which is well above the minimum and average groundwater level, and ▪ Therefore, the construction of the emergency dam and polishing plant are expected to mitigate and reduce any existing impacts the STP has on the receiving environment.

Much of the above assessment also applies to other irrigation areas considered for the CloncurrySTP. No major environmental impacts have been identified.

2.2.8 Irrigation Scheme Investigation (MEDLI Modelling), Cloncurry STP and Racetrack, SESL 2017

The SESL study investigated treated STP effluent chemistry and soil chemistry (at the Racecourse and adjacent to the STP). The SESL study also carried out water and nutrient balances using the MEDLI irrigation model.

Cloncurry has its own particular climate, soils and effluent characteristics that determine the local requirements for sustainable irrigation.

The SESL study examined a flow case of 400kL/d over the 1950 to 2016 (66 year) climatic period and determined the following requirements for sustainable effluent irrigation:

- (Sodic) soil amendment with gypsum,
- Rhodes grass (harvested one to two times annually),
- Effluent storage of 15ML, and
- Effluent irrigation over 10ha (i.e. 6.5ha at the Racecourse and 3.5ha adjacent to the STP).

The SESL study adopted a minimum effluent reuse target of 95%.

The SELS study adopted effluent concentrations of 10mg/L nitrogen, 5mg/L phosphorus and 450mg/L TDS (salt). The SESL study determined that the nitrogen would all be taken up by the crop; the upper 2m of the soil profile had from 30 to >50 years storage capacity for excess phosphorus; and the salt concentration in the root zone would not exceed 7dS/m (the upper level at which the crop production would not be impaired).

The average effluent application rate of 14.6ML/ha/yr is high and reflects the dry climate of Cloncurry. The average effluent storage rate is 1.5ML/ha.

These outcomes are acceptable for long term irrigation planning but periodic (say annual) monitoring is required to direct the ongoing management of any effluent irrigation scheme.

2.3 Populations and Sewage Loads

2.3.1 Populations

Council provided information from OESR, now the Queensland Government Statistician's Office (QGSO), for projections of the estimated resident and mining populations for the whole shire to 2031.

Table 2-4 Projected Populations for Cloncurry Shire to 2031

Scenario	Estimated Resident Population (2031)	Mining Population (2031)	FTE Population (2031)
Low Growth (No increase in resident population and 0% growth in mining activity)	3,366 persons	894 workers	4,260 persons
Medium Growth (Moderate resident growth and 50% increase in mining activity)	3,605 persons	1,341 workers	4,947 persons
High Growth (Projected resident growth and 100% increase in mining activity)	3,844 persons	1,788 workers	5,632 persons

This information clearly shows the importance of mining to the Shire.

The QGSO has since released updated projections for the resident population for Cloncurry Shire to 2036. These projections do not include the mining population (that is presumably predominantly "fly-in fly-out").

Table 2-5 Projected Resident Populations for Cloncurry Shire to 2036

Scenario	2011	2016	2021	2026	2031	2036
Low Growth	3,342	3,375	3,383	3,398	3,418	3,430
Medium Growth	3,342	3,379	3,396	3,430	3,486	3,527
High Growth	3,342	3,383	3,408	3,470	3,557	3,630

The more recent projections have slightly lower 2031 resident populations for the medium and high growth scenarios and slightly higher for the low growth scenario.

The average annual growth rates of the projections range from 0.23 to 0.45% pa.

Presumably most of the resident population growth (as opposed to mining population) would occur in Cloncurry town.

2.3.2 Resident Town Population

Little town population growth is indicated above and values of 2,300 persons for 2017 and 2,500 persons for 2036 seem appropriate for Cloncurry Town.

2.3.3 Sewage Volumes

Council has collected (mostly weekly) sewage volumes at the Cloncurry STP inlet and outlet for some years. There is some daily inflow data available for 2017.

It is noted the outflow volumes are substantially less than the inflows – this may be due to evaporation from the lagoons or to flow meter inaccuracy.

Daily flow volumes are required to determine STP loads and Council is requested to make daily flow measurement and recording the normal practice.

The weekly volumes have been analysed. The analysis could not develop "true" daily values from weekly data but it did provide an indication of ADWF.

The available daily flow volumes were also been analysed and compared with weekly flow data for the same period.

The 2015 and 2016 inflow data were considered to be too low and have been disregarded.

Adopting the median flow as representative of ADWF and 250L/EP/d as the ADWF contribution allows an estimate of the current EP load on the Cloncurry STP to be made.

This analysis suggest the current load is about 2,800EP. With the resident population at 2,300 persons this implies a non-residential load of about 500EP. This compares with nearly 700EP estimated in Maunsell (2001).

2.3.4 Design Sewage Loads

From the discussion above, the following STP flow loads would appear to be appropriate.

- 2017 2,800EP,
- 2036 3,000EP

However, this makes limited provision for growth.

Council's previous expectations have been for a future population of 8,000 people (LGIS 2009) – the above analysis suggests that 8,000 people is overly optimistic at this time.

A more realistic value, at this time, is 4,000EP. This has the virtue that the works could be simply doubled in size if an 8,000EP scenario did arise.

2.3.5 Flows

The following design flows (at 250L/EP/d) were adopted.

Table 2-6 Cloncurry Design Sewage Flows

Year	EP	ADWF	3ADWF	5AWDF
2017	2,800	700kL/d (8.1L/s)	2.1ML/d (24.3L/s)	3.5ML/d (40.5L/s)
2036	4,000	1,000kL/d (11.6L/s)	3.0ML/d (34.7L/s)	5.0ML/d (57.9L/s)

STPs are usually required to hydraulically accommodate flows of 5AWDF and to achieve full treatment up to 3ADWF.

2.3.6 Sewage Loads

The following ADWF design loads (at normal Australian domestic sewage loads) were adopted.

Table 2-7 Cloncurry Design Sewage Loads (median)

Year	BOD (kg/d)	COD (kg/d)	TSS (kg/d)	TN (kg/d)	NH4-N (kg/d)	TP (kg/d)
2017	154	322	196	35	28	5.6
2036	220	460	280	62	40	8.0

2.4 Effluent Management

2.4.1 Release to Waters

Although Council is making concerted efforts to prevent STP effluent release to waterways there have been discharges to One Mile Creek for some time. Maunsell (2001) noted the effluent was being discharged to the local creek. HWA (2009) noted that the irrigation scheme had been decommissioned and removed at the time of the site visit on 21 April 2009.

One Mile Creek runs about a kilometre west from the Coffer Dam to the Cloncurry River.

Aerial mapping of the Cloncurry area suggests that One Mile Creek has more extensive riparian vegetation than other tributaries of the Cloncurry River especially downstream from the Coffer Dam.



Figure 2-2 One Mile Creek

The Cloncurry River is a tributary of the Flinders River which drains to the Gulf of Carpentaria. The Flinders River is 1,004km long and has a catchment of 109,000km2.

The Cloncurry River is about 900km long and has a catchment of 47,000km2 (i.e. 43% of the total Flinders River catchment) and 41,000km2 of the catchment is downstream of the Cloncurry town. There is some mining activity in the area but the major land use in the catchment is cattle grazing.

There is a DNRM gauging station (915302C) on the Cloncurry River at Hensley Drive 2km north of Cloncurry. The site has a catchment area of 5,972 km2 and been operational since September 2014.

The daily flow data for Hensley Drive shows the Cloncurry River has a very intermittent flow regime that is strongly influenced by the summer monsoon season.

Table 2-8 Stream Flow Data, Cloncurry River at Hensley Drive

Month	Daily Flow – Minimum (ML/d)	Median (ML/d)	Maximum (ML/d)
January	0	1,166	9,424
February	0	0	1,595
March	0	7	16,139
April	0	0	1
May	0	0	2,905
June	0	0	0
July	0	0	0
August	0	0	0
September	0	0	283
October	0	0	0
November	0	0	0
December	0	0	23,718

Source: Qld Govt Water Monitoring Information Portal

No water quality data has been collected at Hensley Drive.

There is another DNRM gauging station (915212a) on the Cloncurry River, at Canobie Station about 300km NNE of Cloncurry. This site has a catchment area of 41,220km2 and has been operational since September 1972

The daily flow data for Canobie shows a similar pattern to that for Hensley Drive.

Table 2-9 Stream Flow Data, Cloncurry River at Canobie

Month	Daily Flow – Minimum (ML/d)	Median (ML/d)	Maximum (ML/d)
January	0	590	183,833
February	0	2,004	213,584
March	0	278	136,723
April	0	0	128,989
May	0	0	3,485
June	0	0	5,846

Month	Daily Flow – Minimum (ML/d)	Median (ML/d)	Maximum (ML/d)
July	0	0	2,733
August	0	0	5,088
September	0	0	107
October	0	0	21,234
November	0	0	14,229
December	0	0	42,425

Source: Qld Govt Water Monitoring Information Portal

The flow record is limited to the 1973 – 1988 and 2003 – 2016 periods viz.

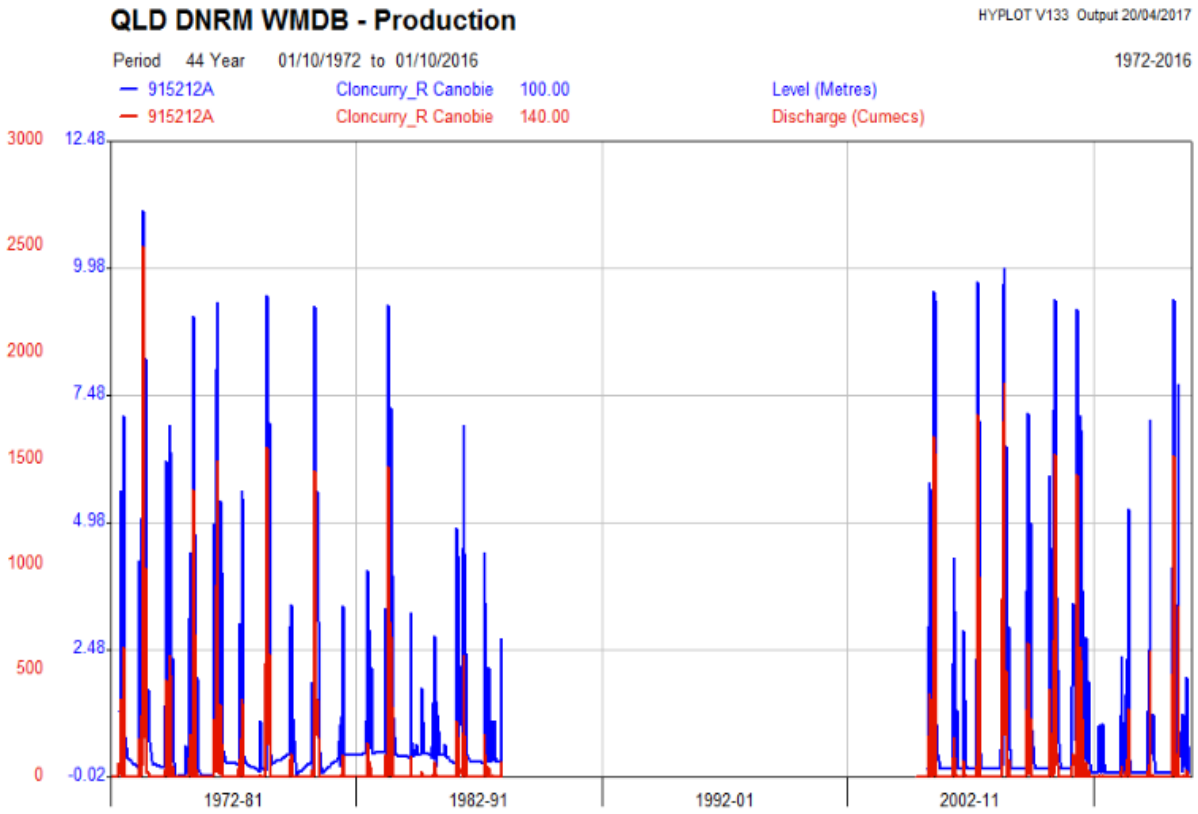


Figure 2-3 Plot of Continuous Height (blue) and Flow (red) Data

The water quality data for Canobie is also quite limited viz.

Table 2-10 Water Quality Data, Cloncurry River at Canobie

Parameter	No Samples	Minimum	Median	Maximum
Turbidity (NTU)	8	77	-	210
Turbidity (NTU) field	2	98	-	272
Colour True (HU)	3	1.0	-	10

Parameter	No Samples	Minimum	Median	Maximum
Water Temperature (°C) field	12	21.8	28.0	40.0
pH	9	7.4	-	8.0
Total Alkalinity as CaCO3 (mg/L)	8	46	-	84
TDS (mg/L)	8	82	-	111
TSS (mg/L)	9	14	-	1,760
Total Nitrogen (mg/L)	2	0.28	-	0.74
Dissolved Oxygen (mg/L) field	2	4.9	-	6.0
Total Phosphorus (mg/L)	2	0.05	-	0.22

Source: Qld Govt Water Monitoring Information Portal

Single water quality samples were collected in 1973, 1979 and annually from 1983 to 1988.

All of the total nitrogen and phosphorus concentrations are above the ANZECC trigger values (refer Table 2-12) but there are only two samples for each. Further, the site is many kilometres downstream of Cloncurry and a case for increased STP nutrient discharge concentrations could not be made from these data.

2.4.2 Protected Environmental Values

DEHP (2009) Appendix H provides a suite of environmental values that can be chosen for protection. The suite is summarised below with a comment about applicability to the One Mile Creek / near Cloncurry River system.

There are no known investigations e.g. of biological diversity etc. that might provide information about the status of the One Mile Creek / near Cloncurry River system (and it is beyond the scope of this investigation to undertake those).

However, from the known human land uses and some value judgements, it is considered that the following environmental values should be protected:

- Aquatic ecosystems (slightly-moderately disturbed),
- Primary industries (stock watering and possibly farm water supply),
- Recreation and aesthetics (visual recreation).

The authors are not aware of any “cultural and spiritual values” in the area.

Table 2-11 Environmental Values

Environmental Value	Definition	One Mile Ck / Cloncurry River
Aquatic ecosystems	Intrinsic value of aquatic ecosystems, habitat and wildlife in waterways and riparian areas – e.g. biodiversity, ecological interactions, plants, animals, key species (such as turtles, platypus, seagrass and dugongs) and their habitat, food and drinking water. Waterways include perennial and intermittent surface waters, ground waters, tidal and non-tidal waters, lakes, storages, reservoirs, dams, wetlands, swamps, marshes, lagoons, canals, natural and artificial channels and the bed and banks of waterways. See below for details of details of three possible "levels of protection" contained in the Australian water quality guidelines (AWQG).	
	Level 1 : High ecological / conservation value (HEV) ecosystems	N/A
	Level 2 : Slightly – moderately disturbed (SMD) ecosystems "Ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity. The biological communities remain in a healthy and ecosystem integrity is largely retained. Typically, freshwater systems would be slightly to moderately cleared catchments and / or reasonably intact riparian vegetation; …. Slightly-moderately disturbed systems could include rural streams receiving runoff from land disturbed to varying degrees by grazing or pastoralism …." (AWQG 2000; 3.1-10) (Note: EPP Water 2009 recognises the potential to distinguish moderately disturbed systems and establish different management intents).	Most likely status
	Level 3 : Highly disturbed (HD) ecosystems	N/A
Primary industries	Irrigation: supply of water for irrigation – e.g. of crops, pastures, parks, gardens and recreational areas.	N/A
	Farm water supply: suitability for domestic farm water supply, other than drinking water e.g. for laundry and produce preparation	Possibly
	Stock watering: suitability for production of healthy stock	Applicable
	Aquaculture: health of aquaculture species and humans consuming aquatic foods from commercial ventures	N/A
	Human consumers of aquatic foods: health of humans consuming aquatic foods	N/A
Recreation and aesthetics	Primary recreation: Health of humans involving direct contact and a high probability of water being swallowed e.g. swimming, surfing, windsurfing, diving and water-skiing	N/A
	Secondary recreation: Health of humans involving indirect contact and a low probability of water being swallowed e.g. wading, boating, rowing and fishing	N/A
	Visual recreation: amenity of waterways for recreation that does not involve any contact with water e.g. walking, picnicking	Applicable
Drinking water	Suitability of raw water drinking supply: assumes minimal treatment e.g. coarse screening and / or disinfection	N/A
Industrial uses	Suitability for industrial use: e.g. food, beverage, paper, petroleum and power industries. Industries usually treat water supplies to meet their needs	N/A

Environmental Value	Definition	One Mile Ck / Cloncurry River
Cultural and spiritual values	Indigenous and non-indigenous cultural heritage e.g. Custodial, spiritual, cultural and traditional heritage, hunting, gathering and ritual responsibilities; Symbols, landmarks and icons (such as waterways, turtles and frogs); and Lifestyles (such as agriculture and fishing).	Unlikely

2.4.3 Water Quality Objectives

There are no QWQG for the Gulf Rivers. Users may default to the ANZECC 2000 Guidelines, although these are unlikely to be appropriate, particularly for intermittent and ephemeral inland streams. Users are strongly encouraged to collect local data and develop local guidelines (DEHP 2009).

The development of local water quality guidelines for One Mile Creek / near Cloncurry River is beyond the scope of this investigation. The ANZECC 2000 Guideline water quality objectives, and the ability of a standard STP to comply with these, are discussed below. No consideration has been given to in-stream dilution / mixing zones in this discussion because of the natural intermittent flow regime of One Mile Creek and the near Cloncurry River.

The key ANZECC 2000 Guideline trigger values for SMD aquatic ecosystem protection are summarised below.

Table 2-12 ANZECC Trigger Values for Aquatic Ecosystem (SMD) Protection

	TP	FRP	TN	NO_x	NH_4^+	DO	pH
Upland rivers	0.01mg/L	0.005mg/L	0.15mg/L	0.03mg/L	0.006mg/L	90-120%	6.0-7.5

For ephemeral streams like One Mile Creek / Cloncurry River the water quality objectives are more complex. After stream flows cease the aquatic biota are mostly confined to permanent and semi-permanent waterholes. The Queensland Water Quality Guidelines (DEHP, 2009) note the normal guidelines are not applicable for small waterholes. For large permanent waterholes, dissolved oxygen and pH are more variable (naturally) due to stagnation, stratification and photosynthesis. Nutrients would not be expected to increase significantly simply because flow had ceased.

These observations suggest that inputs of nutrients and organics from a STP discharge to a large waterhole environment during non-stream flow conditions would have a greater impact than during stream flow periods. DEHP would be unlikely to accept higher concentrations than the above ANZECC trigger values.

A standard STP effluent would not be able comply with the ANZECC nutrient concentrations. Typical treated effluent quality from a STP (with nutrient removal capability) is 2mg/L TP, 5mg/L TN and 1mg/L NH_4^+. The approach taken by DEHP in some circumstances is to accept a Best Available Technology (BAT) STP with 5TN/2TP/1NH_4^+ (median) requirements.

The key ANZECC 2000 Guideline values for livestock watering protection are summarised below.

Table 2-13 ANZECC Trigger Values for Livestock Watering Protection

Thermo Coli	Ca	NO_2	NO_3	SO_4	TDS (cattle)
100/100mL	1,000mg/L	30mg/L	400mg/L	1,000Mg/L	4,000mg/L

A standard STP (with nutrient removal capability) can achieve the disinfection (thermotolerant coliform), nitrite and nitrate requirements. The calcium, sulphate and TDS concentrations are largely determined by the potable water quality – a standard STP is not able to remove these.

The ANZECC 2000 Guidelines for Visual Recreation protection are summarised below:

- Macrophytes, phytoplankton scums, filamentous algal mats, blue green algae, sewage fungus and leeches are not present in excessive amounts,
- The natural clarify of the water is not reduced by 20%,
- The natural hue of the water is not reduced by 10 points on the Munsell Scale,
- There are no noticeable surface films on the water.

The development of excess plants, algae etc. in streams requires various environmental pre-conditions but the availability of nutrients is an important contributing factor and the 5TN/2TP effluent from a standard STP (with nutrient removal capability) can be a sufficient source. In small streamflow conditions a standard STP effluent may be capable of changing the natural clarity and hue of the water. A standard STP may not be able to remove high inflow concentrations of Oil & Grease (that are determined by the actions by others upstream in the catchment) and there can be a risk of surface films in receiving waters.

It is not possible during low (or zero) streamflow conditions to comply with ANZECC 2000 trigger value concentrations in the receiving waters, with a standard STP (even with nutrient removal capability).

2.4.4 Feasibility of Continuous Releases to Waters

DEHP may find it very difficult to accept a continuous discharge from a standard STP (even with nutrient removal capability) to the One Mile Creek / Cloncurry River ecosystem.

The existing Environmental Authority is based on disposal to land (i.e. effluent irrigation) and specifically prohibits (Water 1 condition) release of contaminants to any waters.

2.4.5 Releases to Flood Waters

Release to flood waters can sometimes be supported if adequate dilution e.g. to achieve the Water Quality Objectives can be achieved. The "default" Water Quality Objectives for streams are developed for perennial stream flow regimes. The Water Quality Objectives for flood flows should be much higher but there is little existing information for these conditions and it is expensive and time consuming to establish. Further, large storage structures would be required to store effluent between flood events.

An option that might be considered is opportunistic release from effluent storages during flood events. The only infrastructure needed to allow this is valved drainage pipes. DEHP would need to be advised but permission might be obtained e.g. if storages are high and there is a risk that effluent will have to be released soon anyway. Release to flood waters has a much better environmental outcome than release into low or no stream flow.

2.5 Effluent Irrigation

The SESL (2017) study established the requirements for sustainable effluent irrigation at Cloncurry by MEDLI modelling.

MEDLI analysis outcomes are scalable and the following allowances for sustainable effluent irrigation indicate the provisions that should be made for a range of loads.

The MEDLI modelling targeted 98% reuse i.e. 2% release to the creek.

SESL proposed the use of Rhodes Grass as a forage crop. Rhodes Grass was introduced to Australia from South Africa. It was a suitable crop to use for MEDLI modelling at Cloncurry but an alternative, with similar agronomic requirements, may be more suitable – an agronomist should be engaged for selecting and establishing the crop to be irrigated.

Table 2-14 Effluent Irrigation Requirements (MEDLI)

Flow (ADWF) (kL/d)	Storage (ML)	Irrigation Area (ha)	Release to Waters (2% average over long term 1950 - 2015)
400	15.0	10.0	2.9ML/yr
500	18.8	12.5	3.7ML/yr
600	22.5	15.0	4.4ML/yr
700	26.3	17.5	5.1ML/yr
800	30.0	20.0	5.8ML/yr
900	33.8	22.5	6.6ML/yr
1,000	37.5	25.0	7.3ML/yr

2.5.1 Options for Effluent Irrigation at Cloncurry

Sewage effluent is currently a disposal challenge for Cloncurry but there may also be opportunities to use it as a resource to provide benefits to the Cloncurry community.

The more obvious options at Cloncurry are:

- Irrigation (mostly for disposal) at the STP site (say 1ha),
- Irrigation (mostly for disposal) on Council land adjacent to the STP (say 3.5ha),
- Irrigation (for aesthetic reuse) on Council land at the Lawn Cemetery (say 1 ha),
- Irrigation (for disposal or pasture cropping) on Council land at the Racecourse,
- Irrigation (for recreational reuse) on Council owned land at the Golf Course,
- Irrigation (for recreational reuse) on Council owned land at the Recreation Reserve (say 1ha).

The area inside the track at the Racecourse could be irrigated. The available area is large and could potentially take all of the effluent.

The Golf Course has not been developed yet. An 18 hole golf course typically has 15 – 20ha of land that could be irrigated and potentially this could take most of the effluent.

2.5.2 Water Quality Requirements for Effluent Irrigation

Treated effluent quality requirements for irrigation of public open spaces in Queensland are not clearly defined. The regulator may use national and industry guidelines to determine appropriate water quality criteria for "irrigation other than minimally processed crops".

AGWR (2006) provides the following guidance on water quality and associated on-site preventative (protection) measures. The "equivalent" Queensland water quality class has been added for comparison.

Table 2-15 Australian Guidelines for Water Recycling

Irrigation Use	On-site Preventative Measures	Water Quality	Equivalent Qld Class
Municipal use – open space, sports grounds, golf courses, dust suppression etc. or unrestricted access and application	No specific measures	Determined case by case Could include NTU, Ct or UV dose E.coli <1cfu/100mL	Class A+
-	-	E.coli <10cfu/100mL	Class A
Municipal use with restricted access and application	Restrict public access during irrigation and one of the following: No access after irrigation, until dry (1 – 4 hours) Minimum 25 – 30m buffer to nearest point of public access Spray drift control e.g. low through sprinklers	BOD <20mg/L, SS <30mg/L Disinfectant residual E.coli <100cfu/100mL	Class B
Municipal use with enhanced restriction access and application	Restrict public access during irrigation and the combination of: No access after irrigation, until dry (1 – 4 hours) Minimum 25 – 30m buffer to nearest point of public access Spray drift control e.g. low through sprinklers	BOD <20mg/L, SS <30mg/L E.coli <1,000cfu/100mL	Class C

AGWR (2006) does not provide any specific guidance for Queensland Class A equivalent effluent i.e. E.coli <10cfu/100mL.

Higher water quality requirements apply for more intensive water uses e.g. dual reticulation, industrial reuse and crops (eaten raw). Those requirements are much more costly to achieve and would only be considered for Cloncurry if there was a specific customer.

2.5.3 Effluent Quality / Irrigation Options at Cloncurry

The Cloncurry STP; the area adjacent to the STP and the Racecourse have little public access and, with the combination of no access after irrigation, a 25-30m buffer and spray drift control could be irrigated with Queensland Class C effluent.

The Lawn Cemetery, Golf Course (if developed), and Recreation Reserve would probably have difficulty meeting the combination of site measures (but could readily meet the access after irrigation requirement) and could be irrigated with Queensland Class B effluent.

2.5.4 Registration and A Recycled Water Management Plan?

DEWS has developed a Decision Tree for registration of recycled water schemes and the requirement to develop a Recycled Water Management Plan.

The decision tree indicates that the Cloncurry effluent irrigation scheme falls within the scope of the Water Supply (Safety and Reliability) Act 2008 and would need to be registered with DEWS but does need to have an approved Recycled Water Management Plan.

A registration form can be found on the DEWS website.

2.5.5 Effluent Irrigation Strategy for Cloncurry

An effluent irrigation scheme for Cloncurry would have the following characteristics.

Table 2-16 Effluent Irrigation Scheme Characteristics

EP	ADWF	Reuse	Release	Irrigation Area	Storage
4,000	1,000kL/d				
	365ML/yr	347ML/yr (95%)	18ML/yr (5%)	25.0ha	37.5ML
Stage 1					
2,800	700kL/d				
	256ML/yr	243ML/yr (95%)	13ML/yr (5%)	17.5ha	26.3ML

The actual volume available for irrigation varies from year to year based on climate due to:

- High rainfall leading to I/I and higher sewage inflow volumes and
- Evaporation from lagoons reducing outflow volumes

The required irrigation works could be developed in two stages as follows.

Table 2-17 Effluent Irrigation Scheme Staged Development

EP	Effluent Quality / Site	Irrigation Area (ha)	Storage Site	Storage (ML)
Stage 1				
2,800	**Class C Effluent**			
	STP Lagoons (Lot 99 BD168)	1ha	Coffer Dam	2ML
	STP Adjacent Area (Lot 11 SP232323)	3.5ha	Emergency Storage Dam	2ML
	Racecourse (Lot 125 SP127357)	11ha	New storage	11ML

EP	Effluent Quality / Site	Irrigation Area (ha)	Storage Site	Storage (ML)
	Class B Effluent		New storage	11ML
	Lawn Cemetery (Lot 11 SP232323)	1ha		
	Recreation Reserve (various lots)	1ha		
	Total	17.5ha	Total	26ML
Stage 2				
4,000	Golf Course	7.5ha	New storage	11.5ML
	Total	25.0ha	Total	37.5ML

The largest effluent users are the Racecourse and the Golf Course.

Cloncurry Racecourse (Lot 125 / SP172357)

An effluent irrigation scheme at the racecourse would include the following infrastructure.

- Delivery pumps (duty / standby) at the STP,
- Delivery pipeline from the STP to the Racecourse,
- On site effluent storage (one day) at the Racecourse,
- Irrigation pumps (one per travelling irrigator and one standby),
- Fixed pipework from the irrigation pumps to each travelling irrigator connection,
- Three travelling boom irrigators (with 300m hose) for a 600m run,
- Site preparation of the irrigation area e.g. earthworks for the irrigator runs,
- Gypsum incorporation into the surface soil of the irrigation area,
- Crop establishment

Cloncurry Golf Course (Lot 82 CP904802)

The Cloncurry Golf Course is not operating. In the past it had 9 holes with sand greens.

An effluent irrigation scheme at the Golf Course would include water winch type travelling irrigators running along the fairway alignments and the following infrastructure.

- Delivery pumps (duty / standby) at the STP,
- Delivery pipeline from the STP to the Golf Course,
- On site effluent storage (one day) at the Golf Course,
- Irrigation pumps (one per travelling irrigator and one standby),
- Fixed pipework from the irrigation pumps to each travelling irrigator connection,
- Four water winch type travelling irrigators (with 200m hose) for a 400m run,
- Site preparation of the irrigation area e.g. earthworks for the irrigator runs,
- Gypsum incorporation into the surface soil of the irrigation area,
- Crop (turf) establishment

This infrastructure would service four par 4 fairways.

Grass tees and greens require intensive establishment and maintenance (but not large amounts of water like the fairways) and should be undertaken by the Golf Club.

One of the issues for Golf Course site is that it is flooded in a 1%AEP (1 in 100 year). However, a 7.56m flood (approx. 1 in 10 year) flood does not reach the Golf Course. Irrigation could be practiced sustainably for long periods but it would have to cease for a period after inundation while the soil profile dried out.

Recreation Reserve (Lots 35-52, 61-78 RP703304, Lots 87&120 BD204, Lot 1 RP745845)

The Recreation Reserve is currently irrigated with bore water. There are storage tanks and an irrigation system in place.

A delivery pipeline and disinfection system would be required to deliver effluent from the STP to the existing water storage tanks.

The only difficulty with irrigating the Recreation Reserve is the lack of adequate buffer surrounds – there a higher disinfection standard is required. This could probably be achieved by the Polishing Plant if it was fed effluent from which the algae had been removed i.e. after a rock filter or DAF (if the rock filter was not sufficiently effective).

Wet Weather Storages

The wet weather storages could be located at the STP site generally as shown below.



Figure 2-4 Wet Weather Storage Lagoons (Stage 1) at Cloncurry STP Site

2.5.6 Zero Discharge

The existing STP licence does not allow discharge to waters.

The MEDLI modelling by SESL did not examine this option. Normally Zero Discharge is considered impractical because the modelled storage volumes and irrigation areas become very large. Also, there is insufficient effluent available to maintain the crop on the large irrigation areas during normal climatic periods.

However, a zero discharge option needs to be considered as part of this study. In the absence of MEDLI modelling results it is assumed that storage of a years' effluent would be sufficient i.e. 365ML (at 1ML/d for 4,000EP).

365ML of storage would have a much larger footprint that shown above for 37.5ML but there is probably sufficient land available in Council owned land and reserves. This would need to be confirmed.

2.5.7 Operation of the Effluent Irrigation Scheme

Currently, Councils irrigation scheme is minimal and doesn't incur any significant additional cost. However, when a larger irrigation scheme is implemented Council will need to allocate additional resources and funding.

The Cloncurry effluent irrigation scheme should operate automatically to minimise operator inputs. Automated irrigation systems are common in Australia but most are based on minimising water use and maximising crop production. At Cloncurry, the main objective is maximising effluent disposal.

Automated irrigation systems are usually designed to respond to sub-soil moisture deficit but a time-of day driver would probably be adequate (and involve less instrumentation) for Cloncurry.

Council should anticipate additional activities and costs as follows to operate the Stage 1 effluent irrigation scheme.

Table 2-18 Effluent Irrigation Scheme Annual Operations Costs (Stage 1)

Activity	Annual Cost
Labour for operations (say 0.5 FTE extra)	$50,000
Power	$40,000
Harvesting / mowing	$10,000
Agronomist / soil scientist visit, soil & groundwater sampling & advice / report	$20,000
Total	$120,000

A monitoring program (and annual testing) will be required for Council to be able to demonstrate that the effluent irrigation is sustainable viz.

Table 2-19 DEHP Licence Monitoring of Effluent Irrigation Scheme

Objective	Activity
	Daily effluent application & storage record by operator
Vegetation is not damaged	Daily observation, monthly record by operator
Soil is not eroded	Daily observation, monthly record by operator
Soil structure is not damaged	Annual soil testing by Agronomist / Soil Scientist
Surface ponding does not occur	Daily observation, monthly record by operator
Land can assimilate N, P, salt & organics	Annual soil testing by Agronomist / Soil Scientist
Groundwater is not impacted	Monthly depth record by operator; annual testing by Agronomist / Soil Scientist

2.6 Sewage Treatment

2.6.1 Capacity of Existing Sewage Treatment Plant

This capacity assessment of the STP covers:

- The inlet works
- The Imhoff tank
- The sludge drying beds
- The treatment ponds
- The Polishing Plant

2.6.2 Inlet Works

The inlet works consists of a single sieve screen in the inlet receival channel. The screen removes, washes and compacts screening from all flows to the STP prior to their discharge to the Imhoff tank, or if the Imhoff tank is bypassed, to the primary treatment lagoon.

The sieve screen is designed for a maximum inlet flow rate of 35 L/s, which can be exceeded when both the PS1 (Scarr Street) and PS2 (Alice Street) pumps run concurrently. The capacity of the inlet works is therefore limited by the inlet screen capacity which is insufficient.

2.6.3 Imhoff Tank

The Imhoff tank peak flowrate (for reducing solids washout) should be limited to 20 L/s. But, the peak flowrate (for achieving detention time requirements) should be limited to 34m3/hour or 9 L/s and this becomes the governing criteria.

The Imhoff tank is therefore sized for approximately 1,400EP. As the existing load to the STP is estimated at 2,800EP, the Imhoff tank does not have sufficient capacity to cater for the current load.

The performance of the Imhoff tank is adversely impacted by the lack of inlet flow balancing. Direct receival of peak pumped flows act to exacerbate the Imhoff tank's capacity limitations.

2.6.4 Sludge Drying Beds

There is sufficient drying bed area for approximately 1,400EP which is insufficient for the current 2,800 EP loading. Because the Imhoff tank is severely undersized, the solids capture is low and the drying beds do not appear to be overloaded.

If the Imhoff tank was correctly sized, significant additional sludge load would be captured and transferred to the sludge drying beds. The use of drying beds for primary undigested sludge is generally not recommended due to the associated odour risk.

2.6.5 Treatment Lagoons

There are seven treatment ponds at the STP, all of which have been designed as facultative or maturation ponds, providing both anaerobic and aerobic treatment.

The ponds help to remove BOD, TSS, and nitrogen and to a lesser extent phosphorus. A significant portion of these nutrients and organics are used in the growth of algal cells, contributing to the effluent pollutant concentrations.

There is significant pond volume and even without the Imhoff tank sized correctly, the STP can achieve effluent ammonia concentrations as low as 2-3 mg/L. As the load to the STP increases to the design load of 4,000 EP, the effluent ammonia will double and the primary ponds will be more heavily loaded which could present an odour risk if not addressed.

2.6.6 Polishing Plant

The Polishing Plant was intended to provide pressure filtration and UV disinfection of effluent flows of up to 300kL/day (Xylem 2016).

The use of pressure filters for the treatment of pond effluent with high concentrations of algae can be problematic as:

- The presence of algal extracellular polysaccharides reduces the ability of backwashing to recover sufficient clean bed headloss. In the long term the filter may block up.
- Breakthrough of solids to the media filters effluent can occur periodically, especially with high concentration of influent algal cells.

The above points can be verified when reviewing the effluent quality produced by the Polishing Plant which has a TSS typically over 30 mg/L and up to 60 mg/L.

It is questionable whether the required disinfection could be achieved by the UV system when the effluent TSS is above 30 mg/L. Particles within the effluent act to shield biological contaminants from the UV light, allowing them to pass through unaffected.

Without algae in the feed the system could probably produce a low SS and low E. coli effluent quality.

The Polishing Plant can only remove the nitrogen that is bound-up in SS particles.

2.6.7 STP Upgrade Options

Upgrade options for the STP are determined by the effluent destination and the associated quality requirement. The following broad options have been considered.

- Continuous Discharge to One Mile Creek with Best Available Technology (BAT) STP effluent (10BOD, 10SS, 5TN, 0.5TP all mg/L median),
- Sustainable Irrigation of effluent (20BOD, 30SS mg/L median possibly also 10TN, 5TP) and with sustainability demonstrated by annual soil sampling and assessment,
- Existing Licence effluent (10BOD, 15SS, 5TN, 2TP all mg/L median) irrigation with Releases of wet weather excess to One Mile Creek,
- Existing Licence effluent (10BOD, 15SS, 5TN, 2TP all mg/L median) irrigation Without Release to waters.

2.6.8 Sewage Treatment Technologies

A summary of sewage treatment technologies and associated effluent qualities is provided below.

This shows that there are only a few technologies that can achieve 5TN or better. Low TP concentrations can be achieved (by chemical precipitation) with a wider range of technologies.

Table 2-20: Sewage Treatment Technologies

Identification	Process Description	Typical (Median) Effluent Quality	Discussion
Intermittently Decanted Extended Aeration Tank (IDEAT)	The process of aeration as well as settling and the removal of clear effluent using a decant mechanism occurs in the same reactor tankage. Raw sewage is fed to the reactor tankage throughout all phases of the reactor cycle. Phosphorus removal is typically achieved chemically. It is noted that lagoons have also been used in place of tanks for this option.	TN: 10 mg/L TP: 1 mg/L TSS: 12 mg/L	IDEAT are common in Australia as they provide a reasonable quality of effluent, are not complex and are comparatively cheap to operate.
Sequence Batch Reactor (SBR)	The process of aeration as well as settling and the removal of clear effluent using a decant mechanism occur in the same reactor tankage. Raw sewage feed to the reactor tankage ceases during settle and decant phases requiring the installation of either a balance tank or an additional reactor. Phosphorus removal is typically achieved chemically.	TN: 7 mg/L TP: 0.5 mg/L TSS: 10 mg/L	SBRs provide a higher quality of effluent that the IDEAT however the need to stop the inflow to the reactor increases the process cost and complexity.
Compartmentalised Continuous Process (Modified Ludzack Ettinger or Oxidation Ditch)	The separate aeration (aerobic) and un-aerated (anoxic) fractions are provided in a single tank which is divided into the required fractions. Raw sewage continually flows into the reactor. The mixed liquor from the reactor is settled in a clarifier to allow the active solids to be returned to the process. Chemical dosing would be used for phosphorus removal.	TN: 5 mg/L TP: 0.5 mg/L TSS: 10 mg/L	Oxidation ditches and similar processes can be operated to provide a high quality of effluent and are relatively simple to operate. The system footprint is typically greater than for SBRs due to the need for separate clarifiers.

Identification	Process Description	Typical (Median) Effluent Quality	Discussion
Membrane Bioreactor (MBR) in MLE process or Oxidation Ditch Configuration	The separate aeration (aerobic) and un-aerated (anoxic) fractions are provided in a single tank which is divided into the required fractions. Raw sewage continually flows into the reactor. Micro filter membranes immersed in the mixed liquor are placed under a vacuum to draw the clear effluent for disposal. Chemical dosing would be used for phosphorus removal.	TN: 5 mg/L TP: 0.2 mg/L TSS: 1 mg/L	MBRs can produce low effluent nitrogen concentrations and due to the excellent solids removal, can produce very low effluent total phosphorus concentrations, when chemical phosphorus removal is used.
Advanced Compartmentalised Processes	Additional anoxic and aerobic zones can be added to continuous MLE style processes prior to clarification to provide enhanced nitrogen removal. This type of process is called a 4 Stage Bardenpho. Upfront anaerobic compartments can also be added to provide biological phosphorus removal. There are a broad range of configurations available to improve both biological phosphorus and nitrogen removal.	TN: 4 mg/L TP: 0.5 mg/L TSS: 10 mg/L	These processes are typically more complex to operate than MLE processes and if biological phosphorus removal is required, there is significant additional complexity involved in removing phosphorus from the dewatering return streams. These processes are however ideal if low effluent nitrogen and phosphorus concentrations are required.
Granular Activated Sludge Processes	A commercial granular activated sludge process known as the Nereda process has an installation site in Australia. The process works similarly to an SBR. However, the process operation provides conditions for dense floc to form which allows higher throughput rates. The higher throughput rates in turn enable the construction of smaller reactors.	TN: 10 mg/L TP: 1-2 mg/L TSS: 10-15 mg/L	These processes are more complex than an SBR however operational decisions are in part handled by a proprietary controller. Process may produce a higher TSS and hence TP than a conventional SBR.

2.6.9 Current STP / Irrigation System Capacity

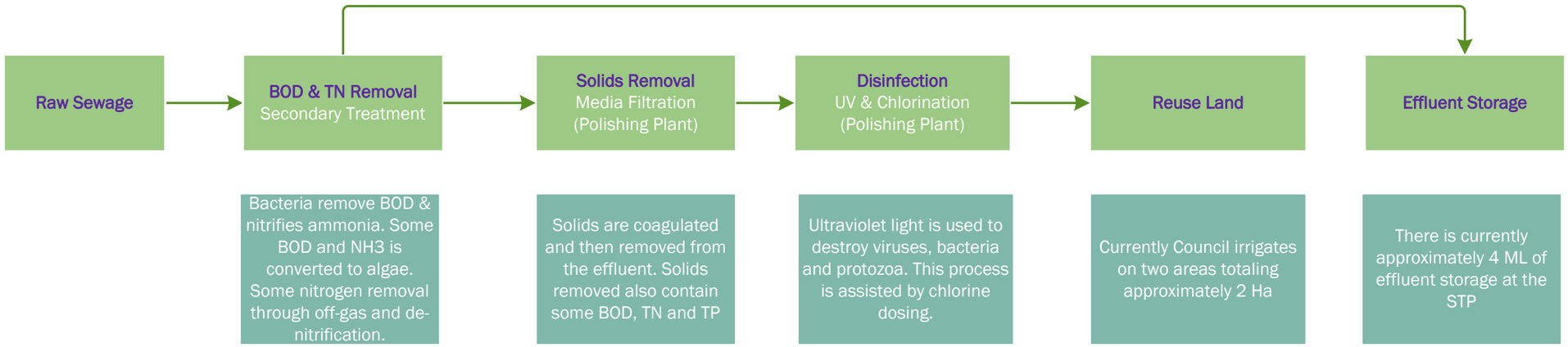
Figure 2-5 below summarises the current system performance viz.

- STP / Polishing Plant 0EP (because it cannot remove nitrogen and phosphorus),
- Effluent storage 430EP (4ML in Coffer Dam and Emergency Dam),
- Effluent Irrigation 320EP (2ha irrigated land around STP).

This summary shows that significant new infrastructure works are required to improve the Cloncurry STP / effluent management system.

Current System Performance

Process Units



Issues with Achieving Licence

Process not overloaded but also not suitable for achieving any of the existing license quality requirements. Difficult in achieving consistent low TN and produces high TSS due to algae.	Insufficient capacity. Algal solids are difficult to coagulate and filter. They also produce surface polymers which can block the filter. Required performance cannot be achieved.	Insufficient capacity. UV disinfection system is only likely to be effective if solids concentration is less than 30 mg/L. Relies on performance of filter. Chlorine dosing assists in making deficit in UV.	Insufficient reuse area is available. Reuse safety and environmental management needs reviewing.	Insufficient effluent storage volume is available. No volume monitoring of overflows is occuring.

Process Capacity

Current Loading: 2,800 EP	Capacity of 0 EP (Cannot Achieve Required Performance)		Capacity of 320 EP	Capacity of 430 EP
Required Quality TN Max.: 10 TP Max. : 5 BOD Max. : 20 TSS Max. : 30 FC Max. : 1,000	Recent Performance TN Max.: 5 TP Max. : 5 BOD Max. : 18 TSS Max. : 60 FC Max. : <10	All Performance TN Max.: 56 TP Max. : 10 BOD Max. : 19 TSS Max. : 290 FC Max. : <10		

Figure 2-5 Current System Performance

2.6.10 Regulatory Decision Tree

The STP / effluent management scheme selected for Cloncurry will depend on a range of issues including regulatory acceptance, cost, operations etc.

The Regulatory Decision Tree below compares the four options described above viz.

- Option 1 – Continuous Discharge,
- Option 2 – Sustainable Irrigation,
- Option 3 – Existing Licence Effluent with Releases,
- Option 4 – Existing Licence Effluent without Releases.

The options are compared by effluent quality, treatment requirements, effluent storage requirements, effluent irrigation area requirements and capital cost.

Regulatory Decision Tree

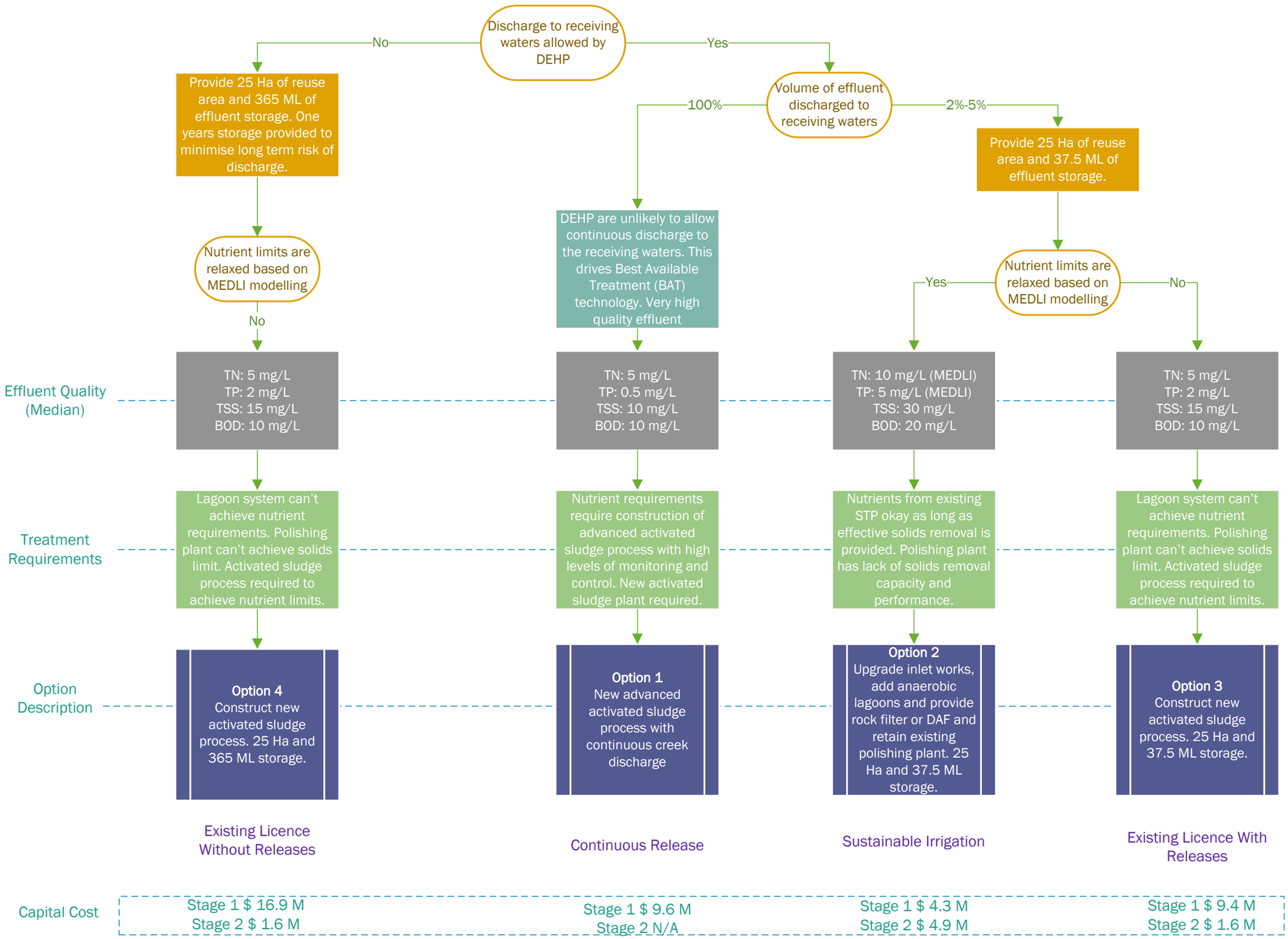


Figure 2-6 Regulatory Decision Tree

2.7 Costs for STP / Effluent Management Options

Cost comparisons for the four STP / Effluent Management options are presented below.

Table 2-21 STP & Effluent Management Options

Infrastructure	Option 1 – Continuous Discharge (BAT STP & Creek Discharge)	Option 2 – Sustainable Irrigation (Upgrade Exist STP & Effluent Irrigation)	Option 3 – Existing Licence with Releases (Replace Exist STP & Effluent Irrigation	Option 4 – Existing Licence without Releases (Replace Exist STP & Effluent Irrigation)
Sewage Treatment	New STP	Upgrade Existing STP	New STP	New STP
Effluent Reuse	Nil	95% of ADWF	95 % of ADWF	100% of inflows
Effluent irrig (area / storage)	Nil	25ha / 37.5ML	25ha / 37.5ML	25ha / 365ML[1]
Effluent Discharge	100% of inflows	5% ADWF (18ML/yr)[2]	5% ADWF (18ML/yr)[2]	Nil
Stage 1 Capital Cost	$ 9.6 M	$ 4.3 M	$ 9.4 M	$16 .9 M
Stage 2 Capital Cost	$ 0 M	$ 4.9 M	$ 1.6 M	$ 1.6 M
Average O&M (30 years)	$ 532 K	$ 503 K	$ 667 K	$ 860 K
NPV (7% over 25 years)	$ 14.7 M	$ 11.3 M	$ 16.6 M	$ 25.1 M

Notes: 1. Assumed Zero Discharge storage volume. 2. Effluent discharge is average over the long term and will vary from year to year.

2.7.1 Preferred Option

The consultant's preferred technical solution is Option 2.

The Council's preferred option is yet to be decided. It is appreciated that Council needs to consider matters other than technical.

A schematic for the consultant's preferred technical solution is shown below.

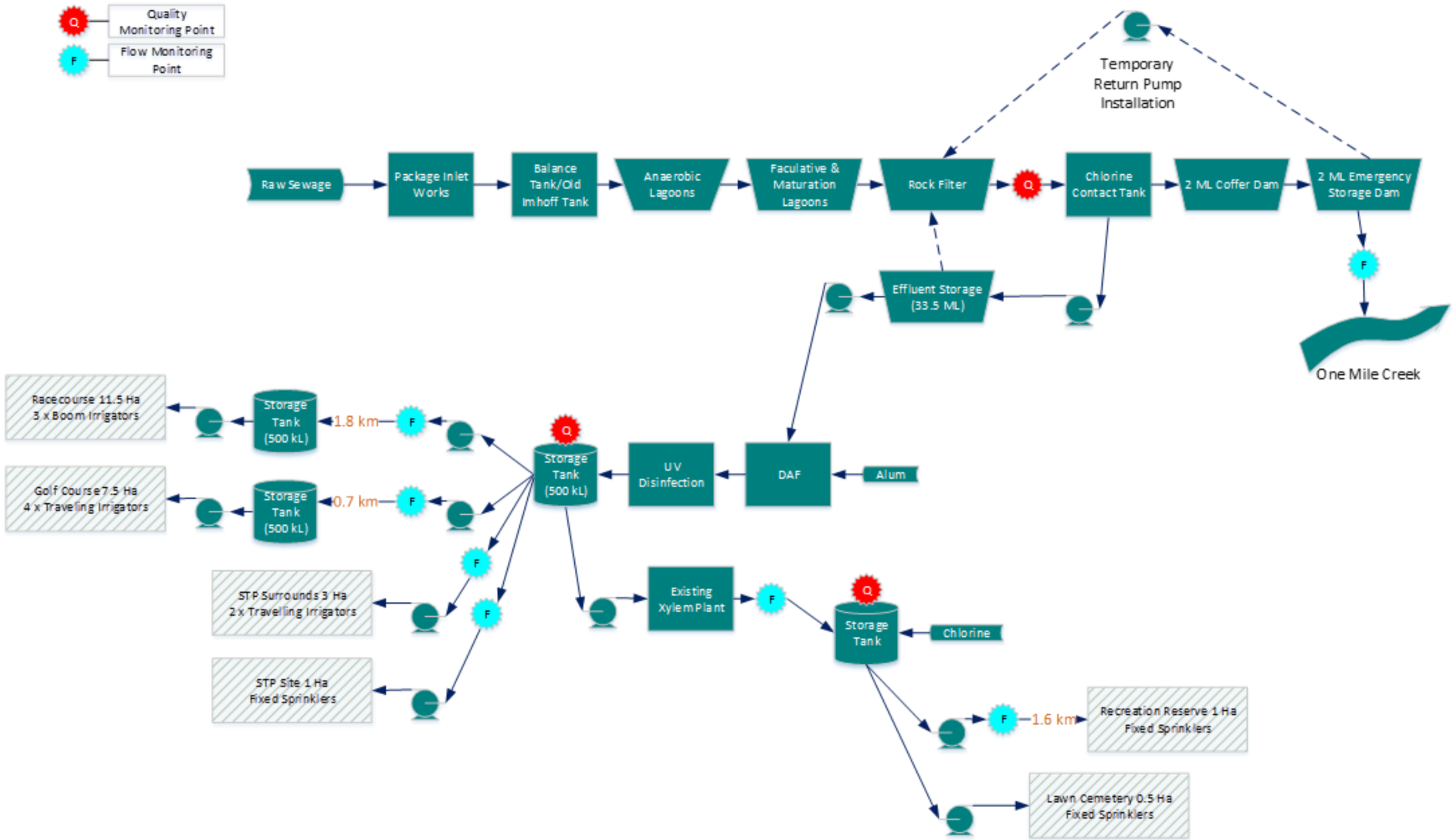


Figure 2-7 Consultants Preferred Technical Solution (Option 2)

2.7.2 Changes to 2017 EA

All of the options require amendments to the 2017 DEHP licence viz.

Table 2-22 EA Changes

Conditions	2017 licence	Option 1 – Continuous Discharge (BAT STP & Creek Discharge)	Option 2 – Sustainable Irrigation (Upgrade Exist STP & Effluent Irrigation)	Option 3 – Exist Licence with Releases (Replace Exist STP & Effluent Irrigation)	Option 4 – Exist Licence without Releases (Replace Exist STP & Effluent Irrigation)
Inflows to STP	DADWF 400kL/d (G5-1) Peak design capacity of 5DADWF (2,000kL/d) (G5-1)	DADWF 700kL/d (i.e. 2,800EP x 250L/EP/d) Provide full treatment up to 3DADWF Hydraulically contain flows up to 5DAWDF Bypass flows >5DADWF	As Option 1	As Option 1	As Option 1
Release to Waters	Prohibited (WT5-1)	Allowed	Release 5% of DADWF averaged over long term (as wet weather storage overflow)	As Option 2	No change
Release to Land	Minimum 10ha irrigation area (Table 2 Assoc. Reqmts 1.) Minimum 15ML wet weather storage (G5-1)	Not applicable	Irrigate 95% of DADWF averaged over long term	As Option 2	No change
Release to Land – locations (G5-1)	Lot 160 SP169675 (Adjacent to STP) Lot 11 SP232323 (Lawn Cemetery) Lot 125 SP127357 (Racecourse) Lot 82 CP9044802 (Golf Course)	Not applicable	Lot 99 BD168 (STP) Lots 35-52 & 61-78 RP703304, Lots 87&120 BD204 and Lot 1 RP458845 (Recreation Reserve)	As Option 2	As Option 2
BOD (mg/L) (Table 2)	10, 15, 20 (50, 80%ile, max)	10 (50%ile)	20 (50%ile)	As Option 2	As Option 2
SS (mg/L) (Table 2)	15, 25, 30 (50, 80%ile, max)	10 (50%ile)	30 (50%ile)	As Option 2	As Option 2
TN (mg/L) (Table 2)	5, 8, 10 (50, 80%ile, max)	5 (50%ile)	Not specified	As Option 2	As Option 2

Conditions	2017 licence	Option 1 – Continuous Discharge (BAT STP & Creek Discharge)	Option 2 – Sustainable Irrigation (Upgrade Exist STP & Effluent Irrigation)	Option 3 – Exist Licence with Releases (Replace Exist STP & Effluent Irrigation)	Option 4 – Exist Licence without Releases (Replace Exist STP & Effluent Irrigation)
TP (mg/L) (Table 2)	2, 5 (50%ile, max)	2 (50%ile)	Not specified	As Option 2	As Option 2
STP effluent sampling location	Not specified	After disinfection	After rock filter or DAF plant and disinfection	As Option 2	As Option 2
Table 2 Assoc. Reqmts (L5-1)	4. Monitoring….. 5. Volume of release …..	4. Not applicable 5. Not applicable	4. "Groundwater" monitoring … 5. Volume of release to land shall be measured by a flow meter.	As Option 2	As Option 2

2.8 Sewer Network

2.8.1 Gravity System

Since 2012/13 Council has undertaken CCTV inspections that have identified a general deterioration in the condition of the underground assets and this has triggered ongoing sewer relining activity. Council has also undertake some road crossing sewer replacement to address the poor condition risk.

Council provided CCTV inspection reports for 50 sewer sections with a combined length of 3.2km. A review of the reports found 28 of the 50 sections had no defects – in the other 22 sections there were five manhole defects, 11 junction defects and 13 pipe defects. All of these defects contribute to infiltration.

It is recommended that inspections of previously uninspected areas be undertaken and a program of works is developed for addressing outstanding issues.

Analyses, by others, indicate the Cloncurry sewer network has sufficient hydraulic capacity for 4,000EP.

2.8.2 Pumped System

An analysis of pump station pumping hours suggests the following:

- PS1 (Scarr St) appears to be over-loaded in peak inflow conditions,
- PS 2 (Alice St) appears to be over-loaded in peak inflow conditions,
- PS 3 (McKinlay St) has sufficient capacity,
- PS 4 (Brisbane St) appears to have sufficient capacity,
- PS 7 (Douglas St) has sufficient capacity,
- Industrial Estate PS appears to be over-loaded in peak inflow conditions,
- Martel Crescent PS appears to have sufficient capacity (but the frequency of duty / standby pump operation suggests further investigation may be needed),
- Isley Street PS had sufficient capacity in 2016; no data was provided for 2017,
- Equestrian Centre PS appears to be non-operational (or not used).

Xylem (Mt Isa) has provided budget price quotations that indicate the cost of upgrading the PS1 (Scarr Street) and PS2 (Alice Street) pumps and switchboards will be in the order of $190,000.

2.9 Affordability

A brief overview of the financial position of the Cloncurry sewerage scheme is provided below.

2.9.1 Income and Expenditure

Depreciation is the largest single cost of the scheme.

Income and expenditure, over the last five financial years, are reasonably constant viz.

Table 2-23 Cloncurry Sewerage Scheme Income & Expenditure ($)

	2015/16	2014/15	2013/14	2012/13	2011/12
Income	751,000	758,000	694,000	729,000	695,000
Depreciation	334,000	271,000	292,000	285,000	279,000
Expenses	414,000	373,000	367,000	580,000	380,000
Surplus	3,000	114,000	36,000	(136,000)	36,000

2.9.2 Asset Valuations

The fair value of the sewerage scheme assets is about $17 million and accumulated depreciation is about $8 million viz.

Table 2-24 Cloncurry Sewerage Scheme Asset Value ($)

	2015/16	2014/15	2013/14	2012/13	2011/12
Opening Value	16,743,000	16,849,000	14,848,000	14,151,000	14,056,000
Revaluations	207,000	(302,000)	1,929,000	-	-
Transfers	345,000	226,000	41,000	697,000	95,000
Closing Value	17,295,000	16,743,000	16,849,000	14,848,000	14,151,000
Opening Accum Dep	8,416,000	7,989,000	9,002,000	8,637,000	8,458,000
Depreciation	334,000	271,000	292,000	285,000	279,000
Revaluations	128,211	158,000	(1,324,000)	-	-
Closing Accum Dep	8,878,000	8,416,000	7,989,000	9,022,000	8,637,000
Additions					
Renewals	346,000	109,000	88,000	-	-
New	-	-	179,000	-	-

2.9.3 Cost Benchmarking

Cloncurry's sewerage charge for a residential property is $449 (i.e. 20 sewerage units for the first pedestal x $22.47 per unit in the 2016/17 budget schedule of charges).

DEWS (2016) lists Cloncurry Shire Council as a Small Service Provider i.e. with 1 – 1,000 connections.

The scheme has just under 1,000 connections.

DEWS (2016) shows the distribution of fixed sewerage charges per year for Queensland service providers in the 2014/15 financial year as follows:

- <$500 69 service providers
- >$500 and <$750 85 service providers
- >$750 and <$1,000 24 service providers
- >$1,000 5 service providers

At $449pa, Cloncurry is in the bottom 37% of service providers.

There appears to be some capacity for the Cloncurry sewerage scheme to increase charges but the quantum of increased revenue would not be large e.g. increasing the charge to the “highest” level of $1,000 pa would only raise an additional $550,000 pa.

Affordability for this project requires further examination because of the sensitivity of cost increases especially for small communities.

3 Sewage Planning Report (EE Matters)

3.1 Sewage Planning Report

A summary of the sewage planning report (Cloncurry Sewerage Master Plan) is provided above.

3.2 Describe Existing Sewerage Network

The existing Cloncurry sewerage network is described above. It is a mostly gravity network with peripheral sub-catchments that are pumped into the main gravity catchment. Pump Stations 1 (Scarr Street) and 2 (Alice Street) pump the sewage to the STP via a common pressure main.

A number of defects have been identified in the sewer network by CCTV inspection. The CCTV inspection program is incomplete and further defects may be identified. Council has yet to develop a program for rectifying the defects.

An analysis of pump station "hours run" established that Pump Stations 1 (Scarr Street) and 2 (Alice Street) pumps need to be upgraded.

3.3 Describe Existing STP Train and Peak Design Capacity

The existing STP comprises an inlet structure (with brush screen), an Imhoff tank, seven lagoons, Coffer Dam and Polishing Plant.

There is also an Emergency Dam off the Coffer Dam.

The existing STP cannot comply with the nitrogen and phosphorus requirements in the existing EA – on this basis the pant has zero capacity.

If only BOD and SS are considered the existing STP has a capacity of about 1,400EP.

3.4 Determine Current Storage Capacity at the STP

The Imhoff tank and treatment lagoons are always full and have zero capacity to store sewage.

The Coffer Dam has a nominal volume of 2ML. The Emergency Dam also has a nominal volume of 2ML.

The Coffer Dam has become (at least in part) a treatment unit because the supply for the Polishing Plant is taken from the Coffer Dam. Therefore the Coffer Dam cannot be drawn-down completely and only part of its 2ML volume is available for effluent storage.

The system capacity of the Coffer Dam (assuming all 2ML was available) and the Emergency Dam is 430EP.

Sewage flows to the STP every day – the current rate is about 700kL/d.

Sewage cannot be stored in the Cloncurry STP.

3.5 Describe Current & Future Sources of Inflow to STP

The current sewage load is estimated at 2,800EP (700kL/d ADWF) from 2,300EP domestic and 500EP non-domestic sources.

QGSO projects low population growth in Cloncurry town for at least the next 20 years.

Industrial developed e.g. associated with the surrounding mineral resources is possible but there are no immediate proposals.

3.6 Determine Peak Design Capacity for Cloncurry Town Needs

A 2036 design population of 3,000EP was developed in the Sewage Planning Report.

However, this essentially provided no capacity for growth. In earlier times Council had expectations of 8,000 population in Cloncurry.

In the current economic environment this is considered optimistic and a design population of 4,000EP has been adopted.

3.7 Determine Future Peak Design Capacity

A future design load of 4,000EP and an ADWF of 250L/EP/d (1ML/d ADWF) has been adopted for the Cloncurry STP.

A peak inflow rate of 5AWDF (5ML/d, 58L/s) has been adopted for design.

3.8 Provide most Appropriate STP Design

The issue of first importance for the Cloncurry sewerage scheme is not the STP - it is effluent management.

The current effluent irrigation infrastructure has a capacity of about 320EP. This constraint forces effluent to be discharged to One Mile Creek (in contravention of the current EA).

The most appropriate STP design is determined by the effluent management approach.

A range of effluent management / STP options were considered in the sewage planning report viz.

Table 3-1 STP & Effluent Management Options

Infrastructure	Option 1 – Continuous Discharge (BAT STP & Creek Discharge)	Option 2 – Sustainable Irrigation (Upgrade Exist STP & Effluent Irrigation)	Option 3 – Existing Licence with Releases (Replace Exist STP & Effluent Irrigation	Option 4 – Existing Licence without Releases (Replace Exist STP & Effluent Irrigation)
Sewage Treatment	New STP	Upgrade Existing STP	New STP	New STP
Effluent Reuse	Nil	95% of ADWF	95 % of ADWF	100% of inflows
Effluent irrig (area / storage)	Nil	25ha / 37.5ML	25ha / 37.5ML	25ha / 365ML[1]
Effluent Discharge	100% of inflows	5% ADWF (18ML/yr)[2]	5% ADWF (18ML/yr)[2]	Nil
Stage 1 Capital Cost	$ 9.6 M	$ 4.3 M	$ 9.4 M	$ 16.9 M
Stage 2 Capital Cost	$ 0 M	$ 4.9 M	$ 1.6 M	$ 1.6 M
Average O&M (30 years)	$ 532 K	$ 503 K	$ 667 K	$ 860 K
NPV (7% over 25 years)	$ 14.7 M	$ 11.3 M	$ 16.6 M	$ 25.1 M

Notes: 1. Assumed Zero Discharge storage volume. 2. Effluent discharge is average over the long term and will vary from year to year. 2. Capital costs do not include $190k for Scarr St. and Alice St. PS upgrades and any network refurbishment.

The consultant's preferred technical solution is Option 2 – Sustainable Irrigation.

Option 2 – Sustainable Irrigation comprises the following works.

Stage 1 (2,800EP)

STP – new inlet works, rock filter,

Effluent Irrigation – 22ML new effluent storage (4.5ML exist), 14ha new irrigation area (Racecourse / Golf Course, Rec Reserve), 5.5ha exist irrigation area (STP, STP surrounds, Lawn Cemetery).

Stage 2 (2,800 EP to 4,000EP)

STP – convert Imhoff tank to balance tank, new 2/4.7ML anaerobic lagoons, new DAF plant,

Effluent Irrigation – 11ML new effluent storage, 7.5ha new irrigation area (Racecourse / Golf Course).

Cloncurry Shire Council has yet to decide on its preferred option – that decision requires consideration of a wide range of matters.

4 Receiving Environment (EE Matters)

The specific aspects raised by DEHP for investigation are discussed below assuming Option 2 – Sustainable Irrigation is implemented.

4.1 Environmental Values

4.1.1 Waters

The EIA undertaken for the emergency storage dam indicated there were no referable wetlands, RAMSAR wetlands or nationally important wetlands in the general area.

One Mile Creek and the Cloncurry River are ephemeral streams with long periods of zero flow. The catchments are dominated by urban development (for One Mile Creek) and pastoral activity for the Cloncurry River.

The applicable Environmental Values for effluent releases to waters are protection of aquatic ecosystems (SMD), stock watering, (possibly) farm water supply and visual recreation.

Aquatic ecosystem protection has the most stringent water quality objectives.

The upgraded Cloncurry STP cannot achieve the nitrogen and phosphorus water quality objectives for protection of aquatic ecosystems. No standard STP (even with nutrient removal capability) is able to achieve aquatic ecosystem protection nitrogen and phosphorus targets.

Option 2 – Sustainable Irrigation seeks to protect environmental values by reducing the releases to waters by 95 – 98%. The MEDLI modelling is based on 98% ADWF reuse.

4.1.2 Land

Effluent irrigation at Cloncurry will be to lands around the STP, the Racecourse, the Golf course and the Recreation Reserve. The potential environmental value impacts associated with these areas are loss of terrestrial habitat, damage to soil structure and groundwater contamination.

The STP and effluent irrigation sites (STP, STP surrounds, Lawn Cemetery, Racecourse, Golf Course and Recreation Reserve) have previously been cleared. The EIA undertaken for the emergency storage dam indicated that there were no threatened regional ecosystems, ecological communities, regrowth, essential habitat, flora survey trigger areas, or threatened flora species in the general area.

The generalised soil types in the region are red smooth-pedality earths where the dominant profile consists of shallow to moderately deep loamy red friable earths with lesser acid and alkaline forms being co-dominant. Deep crusty loamy red duplex soils are common on the alluvium of major streams.

The investigations of soils at the effluent irrigation sites note that the soils are sodic with a potential for loss of soil structure if effluent irrigation is not well managed.

4.1.3 Groundwater

The geology in the area comprises Quaternary and Tertiary age alluvium and Precambrian age meta-sediments and metamorphosed volcanic units. There are approximately 450 registered bores within 10km of the STP. A number of these are used for domestic water use within the Cloncurry town area.

The typical depth of the bores is 80m.

4.2 Potential Effects of Operations on Environmental Values

4.2.1 Waters

A discharge of sewage effluent to One Mile Creek / the Cloncurry River during the dominant zero flow regime periods would lead to either surface flow or in-stream seepage into waterholes containing aquatic ecosystems. The enrichment caused by nutrients in the sewage in the waterholes has the potential for eutrophication.

Based on the available data, releases of effluent from 2,800EP and 4,000EP would contribute the following loads into One Mile Creek / the Cloncurry River system.

Table 4-1 Continuous Release Loads

	Release	2,800EP Load	4,000EP Load
Volume (ADWF)	250L/EP/d	256 ML/yr	365 ML/yr
Total Nitrogen	8.9[1] mg/L (median)	2,274 kg/year	3,249 kg/yr
Total Phosphorus	3.6[1] mg/L (median)	920 kg/yr	1,314 kg/yr
Ammonia - nitrogen	7.0[2] mg/L (median)	1,789 kg/yr	2,555 kg/yr

Notes. 1. Median of seven STP effluent samples Sept 2015 to Apr 2016. 2. Assume 80% of TN.

The STP effluent dataset is limited and based on grab samples but these data provide an indication of contaminant quantities.

Ammonia is a toxicant in aquatic environments and the nutrients could contribute to eutrophication.

4.2.2 Land & Groundwater

Effluent irrigation on land has the potential for runoff, to damage soil structure and to contaminate groundwater.

4.3 Proposed Mitigation Measures

4.3.1 Waters

The potential for eutrophication from the discharge of sewage effluent to One Mile Creek / the Cloncurry River system would be reduced by the preferred STP / effluent management option i.e. Sustainable Irrigation.

Releases to One Mile Creek / the Cloncurry River would be reduced by 95 – 98% by the irrigation of the treated STP effluent on land.

Effluent irrigation would reduce the above TN, TP and ammonia releases as follows.

Table 4-2 Contaminant Release Loads

	Concentration (mg/L median)	Irrigated Percentage	2,800EP Load	4,000EP Load
Total Nitrogen	8.9[1]	95%	114 kg/year	162 kg/yr
Total Phosphorus	3.6[1]	95%	46 kg/yr	66 kg/yr
Ammonia - nitrogen	7.0[2]	95%	89 kg/yr	128 kg/yr

Notes. 1. Median of seven STP effluent samples Sept 2015 to Apr 2016. 2. Assume 80% of TN.

Periodic releases of treated effluent into floods or high stream flows would have a much lesser impact depending on the degree of dilution achieved and on whether the water quality of the flood water was “better” or “worse” that the treated sewage effluent.

4.3.2 Land & Groundwater

Effluent irrigation rates and frequency of application will be controlled to avoid surface runoff.

Soil structure will be protected by site specific investigations by an agronomist or soil scientist to confirm the earlier investigation work done e.g. prior to and for the MEDLI modelling, and to develop site preparation processes e.g. gypsum application.

Annual site sampling, soil chemistry analysis and interpretation will be undertaken by the agronomist / soil scientist to detect any adverse change in soil structure or chemistry and to modify effluent operations to ensure ongoing sustainable irrigation.

Monitoring bores (say 10m deep) will be established on the effluent irrigation areas. The monitoring bores will be inspected monthly for the presence of “groundwater”.

The monitoring bores are expected to be dry but “groundwater” sampling and chemical analysis will be undertaken (to test for evidence of sewage effluent). The irrigation operations would be modified to ensure groundwater contamination does not occur.

4.4 Justification that Mitigations will protect Environmental Values

4.4.1 Water

There are many STPs that discharge to ephemeral streams. The Cloncurry STP has discharged to One Mile Creek / the Cloncurry River system over a period of years.

The nutrient exports will be reduced by 95 – 98% averaged over the long term.

The proposed scheme will reduce nutrient exports substantially (as compared to the current situation) and will lead to improvements in local aquatic ecosystems health.

4.4.2 Land

Effluent irrigation on land is a widely practiced method for preventing or reducing sewage effluent discharge to waters.

Effluent irrigation is a highly developed science. There are many successful operational examples. The irrigation practices (mitigation measures) described above will be undertaken regularly and sustainable effluent irrigation and groundwater protection will be achieved at the Cloncurry sites.

5 Conclusions

5.1 Protection of Environmental Values

STP / Effluent Management Option 2 – Sustainable Irrigation will:

- Significantly reduce sewage releases to waters and make a positive contribution to the protection of local aquatic ecosystems,
- Manage effluent releases to land achieve sustainable irrigation, and
- Avoid effluent release to groundwater and protect the associated environmental values.

5.2 Modifications to Existing EA

The following modifications to the 2017 DEHP EA are proposed for Option 2 – Sustainable Irrigation.

Table 5-1 Amendments to 2017 DEHP Licence

Conditions	2017 DEHP licence	Option 2 – Sustainable Irrigation
Inflows to STP	DADWF 400kL/d (G5-1) Peak design capacity of 5DADWF (2,000kL/d) (G5-1)	DADWF 700kL/d (i.e. 2,800EP x 250L/EP/d) Provide full treatment up to 3DADWF Hydraulically contain flows up to 5DADWF Bypass flows >5DADWF
Release to Waters	Prohibited (Condition WT5-1)	Release 5% of DADWF averaged over long term (as wet weather storage overflow)
Release to Land	Minimum 10ha irrigation area (Table 2 Assoc. Reqmts 1.) Minimum 15ML wet weather storage (G5-1)	Irrigate 95% of DADWF averaged over long term
Release to Land – locations (G5-1)	Lot 160 SP169675 (Adjacent to STP) Lot 11 SP232323 (Lawn Cemetery) Lot 125 SP127357 (Racecourse) Lot 82 CP9044802 (Golf Course)	Lot 99 BD168 (STP) Lots 35-52 & 61-78 RP703304, Lots 87&120 BD204 and Lot 1 RP458845 (Recreation Reserve)
BOD (mg/L) (Table 2)	10, 15, 20 (50, 80%ile, max)	20 (50%ile)
SS (mg/L) (Table 2)	15, 25, 30 (50, 80%ile, max)	30 (50%ile)
TN (mg/L) (Table 2)	5, 8, 10 (50, 80%ile, max)	Delete
TP (mg/L) (Table 2)	2, 5 (50%ile, max)	Delete
STP effluent sampling location	Not specified	After rock filter or DAF plant and disinfection
Table 2 Assoc. Reqmts (L5-1)	4. Monitoring ….. 5. Volume of release ….	4. “Groundwater” monitoring ….. 5. Volume of release to land shall be measured by a flow meter.

6 Glossary

Term / Abbreviation	Description
ADWF	Average dry weather flow
BOD	Biological oxygen demand, a measure of pollution
E. coli	Escherichia coliforms, a microorganism indicator of pollution
DO	Dissolved oxygen
DEHP	Department of Environment & Heritage Protection
DERM	Department of Environment & Resource Management, now disbanded
DEWS	Department of Energy & Water Supply
DNRM	Department of Natural Resources & Mines
EA	Environmental authority, in this case a STP operating licence or permit
E. coli	Escherichia coliforms, a microorganism indicator of pollution
EE	Environmental Evaluation, an investigation process initiated by DEHP direction
EP	Equivalent person
EPBC	*Environment Protection & Biodiversity Conservation Act*
EV	Environmental Value
Faecal coliforms	A microorganism indicator of pollution
FRP	Filterable residual phosphorus, a measure of pollution
NH_4^+	Ammonium, a measure of pollution
NC	*Nature Conservation Act*
NO_2	Nitrite, an oxidised form of nitrogen
NO_3	Nitrate, an oxidised form of nitrogen
NPV	Net present value
QGSO	Queensland Government Statistician's Office
RAMSAR	A wetland classification
RE	Regional ecosystem, a vegetation community classification
SMD	Slightly to moderately disturbed ecosystems
SS, TSS	Suspended solids, a measure of pollution
STP	Sewage treatment plant
Thermotolerant coliforms	A microorganism indicator of pollution
TN	Total nitrogen, a measure of pollution
TP	Total phosphorus, a measure of pollution
VMA	*Vegetation Management Act*

7 References

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