Fact Sheet 1

Merimbula Sewage Treatment Plant

Merimbula Sewage Treatment Plant

Merimbula Sewage Treatment Plant (STP) is an intermittently decanted extended aeration (IDEA) activated sludge plant designed to serve an equivalent population (EP) of 15,500. The STP has a capacity to accommodate an average dry weather flow (ADWF) of up to 3.72 megalitres per day (ML/day) and a peak wet weather flow (PWWF) of seven times the ADWF, or 26 ML/day.

The current ADWF into the STP is approximately 1.4 ML/day during non-peak periods and is approximately 2.1 ML/day during the peak holiday period in December / January. Since influent flow monitoring at the STP began in 2006, the peak wet weather event recorded was 18.4 ML/day in February 2010.

The current total average inflow to the STP is approximately 700 ML/year. A future inflow of 900 ML/year in the year 2025 has been adopted for this study to allow for population growth and to ensure all options are considered and compared for long-term viability. However, recent census data shows the population to be relatively stable and it is considered that this level of increase will more likely occur beyond 2025.

Sewage is pumped to the sewage treatment plant from pump stations in Merimbula, Pambula and Pambula Beach. The sewage flows into the inlet works and is screened by mechanical step-screens to remove non-organic macro solids such as plastics, rags etc.. The screened sewage then flows into two IDEA tanks for secondary treatment.

The IDEA tanks provide a regulated supply of oxygen from surface aerators for bacteria and other micro-organisms (known as "activated sludge") to coagulate and biochemically degrade the organic matter and reduce the number of faecal bacteria and pathogenic microorganisms. The aeration phase is followed by a settlement phase and then a decant phase. These three phases cycle about six to eight times a day (i.e. 180 to 240 minute cycles).

Secondary treated effluent is decanted from the IDEA tanks and flows to a catch pond for temporary storage. From the catch pond the effluent flows to a chlorine contact pipe and is dosed with chlorine (sodium hypochlorite) to reduce the number of microorganisms in the effluent. Chlorinated effluent flows from the chlorine contact pipe to the STP effluent pond.

The STP effluent pond stores approximately 17 ML of effluent, providing a residence time of between 5 and 9 days, depending on inflow and outflow. A wet weather overflow pond is located next to the effluent pond and is kept empty to accept effluent during extended wet weather events and enable more controlled discharge after the wet weather event has ended. The wet weather overflow pond has a capacity of approximately 20 ML.

An effluent pump station is located at the end of the STP effluent pond and pumps effluent to the ocean outfall and dunal exfiltration pond. A smaller pump station pumps effluent to Oaklands storage dam. The PMGC pump station draws effluent directly from the effluent pump station.

Merimbula STP is licenced by the NSW Environment Protection Authority under the Protection of the Environment Operations Act 1997. The licence number is EPL1741. EPL1741 defines discharge points, monitoring points, load limits, concentration limits and volume limits for the effluent discharged from Merimbula STP.

The effluent discharged from Merimbula STP is clear and low in organic material (biological oxygen demand), suspended solids and total nitrogen, but relatively high in total phosphorus. Faecal coliform counts are occasionally higher than that required by the NSW EPA licence due to recontamination of effluent in the STP effluent pond by birds.

The STP is currently operated by Tenix Alliance under contract with Bega Valley Shire Council.

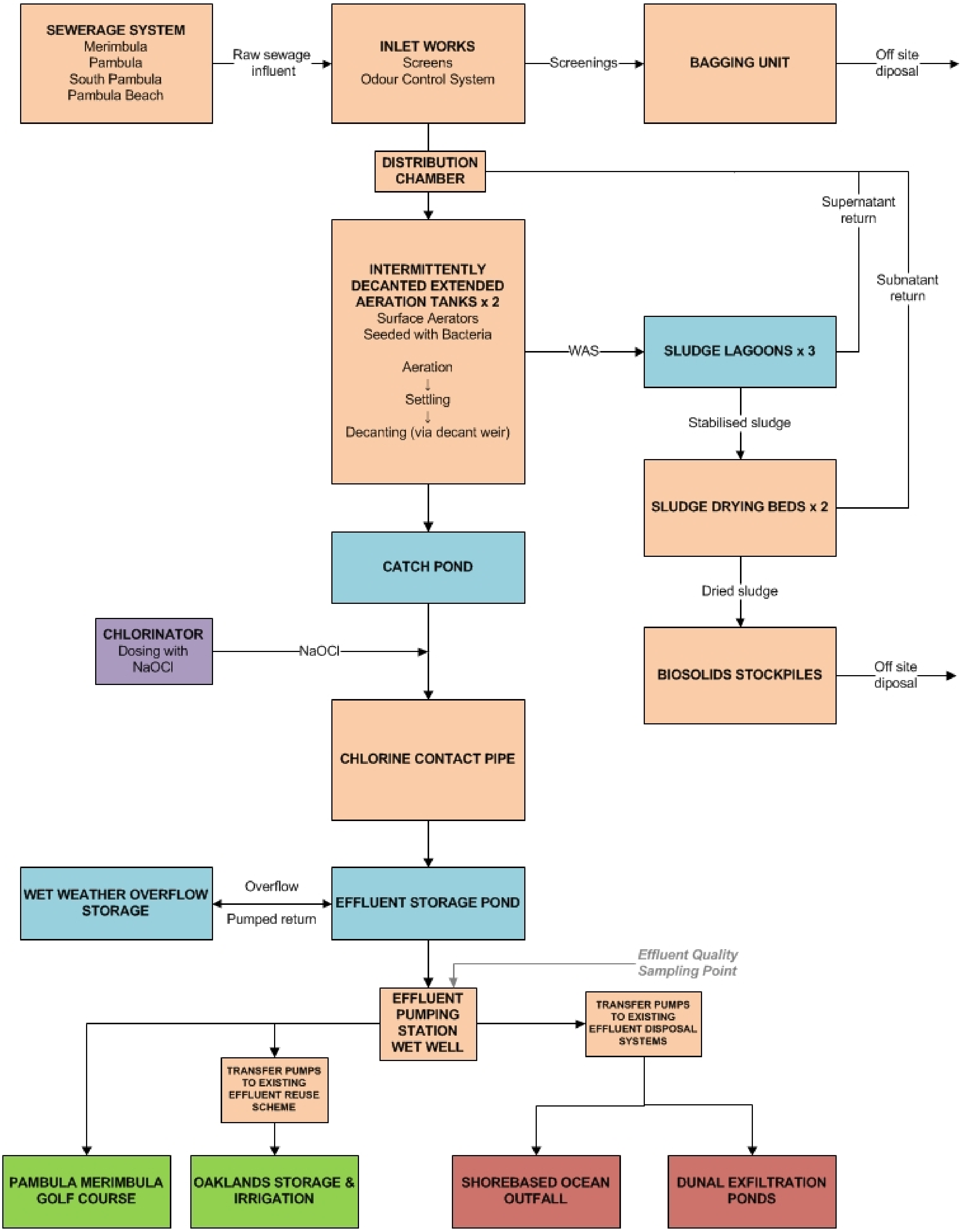
Table 1 provides data on existing effluent quality. Figure 1 is a schematic illustrating the existing Merimbula STP process.

Table 1: Summary of Effluent Quality from the Merimbula Sewage Treatment Plant (April 2004 to June 2012)

Parameter	Units	Sample count	Merimbula STP Effluent Quality			EPL Limit[1]
			50%ile	90%ile	100%ile	
pH		419	7.9	8.4	9.4	6.5-8.5
Electrical Conductivity	uS/cm	157	720	780	1500	
Biological Oxygen Demand (BOD)	mg/L	420	2.0	7.0	31.0	15 (10)
Chemical Oxygen Demand (COD)	mg/L	418	29.0	43.0	93.0	
Dissolved Oxygen (DO)	mg/L	137	9.2	14.0	24.0	
Oil & Grease	mg/L	420	1.0	1.0	7.0	10 (2)
Suspended Solids (TSS)	mg/L	410	6.0	14.0	56.0	30 (20)
Ammonia & Ammonium (asN)	mg/L	421	0.3	2.2	18.0	
Total Oxidised Nitrogen (as N)	mg/L	416	1.8	9.7	29.0	
Total Nitrogen	mg/L	421	4.5	12.0	30.0	`
Orthophospate (as P)	mg/L	141	8.4	11.0	13.0	
Total Phosphorous	mg/L	417	9.6	12.0	18.0	
Pre chlorinator operation Nov 2008						
Faecal Coliforms	cfu/100mL	241	170	1800	13000	
Chlorine Free	mg/L	0	0	0	0	
Chlorine Total	mg/L	0	0	0	0	
Chlorophyll "a"	ug/L	70	6.25	71.1	300	
Post chlorinator operation Nov 2008						
Faecal Coliforms	cfu/100mL	169	76	384	1100	200
Chlorine Free	mg/L	129	0.05	0.092	0.39	
Chlorine Total	mg/L	129	0.1	0.232	0.53	
Chlorophyll "a"	ug/L	15	5	82.8	160	

[1] Environmental Protection Licence 1741, 100%ile concentration limits (90%ile limits in parentheses)

Figure 1: Merimbula Sewage Treatment Plant Process



Fact Sheet 2

Existing Effluent Disposal Systems

Shore Based Ocean Outfall & Dunal Exfiltration Ponds

Shore Based Ocean Outfall

The existing shore-based ocean outfall consists of a 250 mm pipeline from the STP effluent pumping station to a pipe head structure located in the hind dunes at the centre of the beach between the estuary entrances of Merimbula Lake in the north and Pambula Lake in the south. The pipeline length is approximately 1 km from the STP effluent pumping station to the discharge point on the beach. The effluent is discharged just above the normal high water mark and flows across the beach and into the ocean waters of Merimbula Bay. The pipeline originally extended into the surf zone but was damaged in a large storm event in the 1970s and has not been reinstated.

The shore-based ocean outfall is used in preference to the dunal exfiltration ponds during the cooler winter periods of the year, when beach and swimming activities are reduced. The outfall is also used when the groundwater level around the dunal exfiltration ponds is high or being allowed to fall. In 2009/10, total effluent disposal to the ocean accounted for approximately 51% of the total effluent discharged from the STP.

The continued operation of the existing shore-based ocean outfall has created significant community concern, particularly when algal blooms occur in Merimbula Bay. The impact of the algal blooms on beach experience, recreational use and local area image, has focused community attention towards the outfall and effluent discharged into the bay.

Council considers the ongoing use of the shore-based ocean outfall inadequate to meet current environmental objectives or community expectations. Council is committed to finding an alternative to the current ocean outfall through further investigations, planning and capital works..

Dunal Exfiltration Ponds

The existing dunal exfiltration system consists of two exfiltration ponds located in a disused quarry in the sand dunes east of the STP. Effluent is pumped from the STP to the ponds and drains (exfiltrates) into the underlying groundwater aquifer. The ponds are used preferentially during summer to minimise effluent disposal via the outfall when beach use is highest. Groundwater level monitoring near the ponds is undertaken to ensure that the induced groundwater level rise remains below acceptable levels. Groundwater level monitoring determines the timing to switch disposal from the ponds to the ocean outfall and vice-versa.

The volume of effluent disposed to the dunal exfiltration ponds varies according to rainfall, particularly summer rainfall. In 2009/10, total effluent disposal to the ponds accounted for approximately 23% of the total effluent discharged from the STP.

The dunal exfiltration ponds have limited capacity and are not considered suitable for the disposal of effluent volumes above their design capacity (0.6 ML/d). A condition of the NSW EPA Licence permits the use of the exfiltration ponds for effluent disposal up until 30 April 2014.

Fact Sheet 3

Existing Effluent Reuse Scheme

Pambula Merimbula Golf Course and Oaklands Agricultural Irrigation

The existing effluent reuse scheme includes the irrigation of treated effluent at the Pambula Merimbula Golf Course (PMGC) and the irrigation of Oaklands agricultural land on the Pambula River flats. It also includes treatment plant upgrades that will be undertaken as a minimum as part of future effluent management upgrades.

Pambula Merimbula Golf Course Irrigation

The PMGC is located adjacent to the southern end of the Merimbula Sewage Treatment Plant (STP) and the backwater of Merimbula Lake known as Golf Course Lake. This 27 hole golf course has been using effluent from the Merimbula Sewage Treatment Plant (STP) for irrigation of approximately 37 hectares (ha) of tees, greens and fairways for over 20 years. In the 2009/2010 financial year, the PMGC used 182 megalitres (ML) of effluent, the equivalent of 26% of the effluent discharged from the STP in the year. The 2010/11 financial year was significantly wetter with only 90 ML used and equivalent to 13% of the effluent discharged from the STP in the year. Average annual use over the last 10 years is approximately 137 ML/year, equivalent to about 20% of the total existing volume of effluent discharged from the STP per annum.

Oaklands Agricultural Irrigation

Oaklands agricultural irrigation area is located on the Pambula River flats at South Pambula. Treated effluent is pumped from the STP under 39 m of pump head through a 4 km pipeline to a 20 ML storage dam on the property. The scheme was commissioned on 14 February 2013.

An area of approximately 40 ha is available for irrigation of either fodder crops or pasture. Currently about 20 ha of the northern paddock is irrigated using a k-line irrigation system to grow lucerne. The southern paddocks have yet to have an effluent irrigation system installed.

In 2008, EA Systems consultants completed an assessment of the suitability of the soils at Oaklands for irrigation with effluent and found that approximately 2.7 ML/ha/year could be irrigated sustainably in a median rainfall year across the site, equating to about 15% of the total existing volume of effluent discharged from the STP per annum. The current concentration of phosphorous in the effluent of approximately 9.6 mg/L was the limiting factor. EA Systems reported that up to 4.5 ML/ha/year of effluent could be beneficially used in a median year if phosphorus was reduced to 1 mg/L, equating to about 25% of the total existing volume of effluent discharged from the STP per annum.

AECOM consultants have undertaken a desktop review of soil data and conducted water balance modelling to optimise the irrigation potential across the Oaklands property. Modelling estimated that around 161 ML or 4.0 ML/ha/year could be sustainably used on an average year, assuming that phosphorus levels are to be reduced to 1 mg/L. This would equate to about 23% of the total existing volume of effluent discharged from the STP per annum.

Infrastructure Requirements

STP upgrades are needed for these existing schemes to realise their full reuse potential. These upgrades include phosphorous removal (chemical alum dosing with caustic dosing for pH correction), improved chlorine disinfection and the addition of ultraviolet disinfection to reduce further the potential viral risk.

Further commentary for STP upgrades for effluent reuse is provided in Fact Sheet 14.

Features of the existing scheme, capital costs, net present value (NPV) costs and other relative performance criteria for 2025 projected STP loadings are shown in Table 1. Both a conceptual arrangement of the scheme and a plan view of the scheme are provided in Figures 1 and 2 respectively.

Table 1 Existing Effluent Reuse Scheme Features and Performance Summary

Infrastructure requirements	Alum and caustic dosing system for phosphorus removal and pH correction Improved chlorine dosing disinfection system Ultraviolet (UV) disinfection system		
Potential Effluent Demand	298 ML per annum = 137 ML (PMGC) + 161 ML (Oaklands)	**Reliability of Supply**	99%
2025 potential reuse of total STP effluent	33% (296 ML per annum)	**2025 disposal of total STP effluent**	66% (594 ML per annum)
Scheme Capital Cost (for infrastructure requirements)	$2,081,000	**NPV Cost (30 years)**	$4,587,000
O&M Cost per annum	$165,000	**NPV Cost / ML reuse**	$517
Greenhouse Gas Emissions kg CO2-e per annum	228,720	**NPV Cost / ML / ha reuse**	$6.72

Key Opportunities:

- Approved scheme and operational
- Utilises existing PMGC irrigation infrastructure and Oaklands irrigation infrastructure financed by the users
- Community and golfers benefit by providing reliable irrigation water to PMGC
- Supports local agricultural by providing reliable irrigation water to Oaklands
- Substitutes historical use of river water at Oaklands to reduce stress on natural water resources
- Relatively small carbon footprint through operation and relatively low operational cost

Key Constraints:

- Ongoing management controls for the PMGC and Oaklands are required in accordance with the *Merimbula Sewerage Scheme Operational Environmental Management Plan* to minimise the potential risk to receiving environments and public health (i.e. ongoing Council resourcing required)
- Reliant on a private operator (Oaklands) with financial capacity to purchase, install and operate an efficient and appropriate irrigation system in an appropriate manner

Figure 1 Existing Scheme Conceptual Arrangement

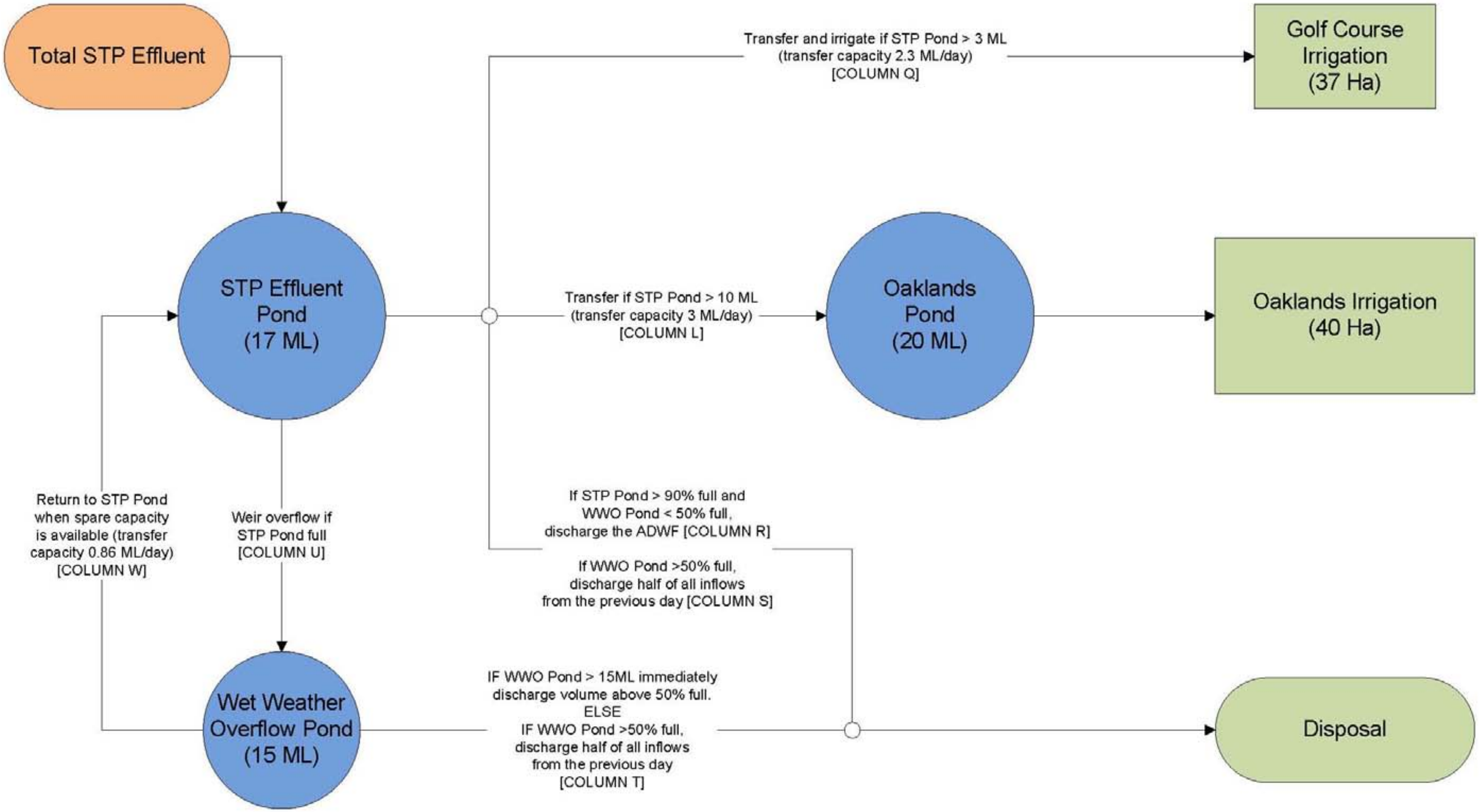


Figure 2 Existing Scheme Plan View

Fact Sheet 4

Effluent Reuse Option Scheme 1

Pambula Merimbula Golf Course EXPANSION and Oaklands Agricultural Irrigation

Scheme 1 includes an expansion of the irrigation of treated effluent on the Pambula Merimbula Golf Course (PMGC), the construction of an on-site effluent storage dam on the PMGC and the continued irrigation of Oaklands agricultural land on the Pambula River flats. It also includes treatment plant upgrades that will be undertaken as a minimum as part of future effluent management upgrades.

Pambula Merimbula Golf Course Expansion Irrigation

Council received a proposal from the PMGC in 2009 to expand the irrigation area of the golf course from the existing 37 hectares to approximately 59 hectares, by including the "rough" areas and tree-lined surrounds bordering the fairways. A report commissioned by the PMGC found that irrigating the additional area would increase effluent usage to around 295 ML per year, equating to about 43% of the total existing volume of effluent discharged from the STP per annum. The augmentation of the existing system at the PMGC would include upgrades to irrigation pipe work, pumps and field controllers. It was also reported, that by replacing the existing irrigation system with an entirely new system covering the entire course, effluent usage could increase slightly further to 310 ML per year, equating to about 44% of the total existing volume of effluent discharged from the STP per annum.

The report's projected demands are considered optimistic. Eleven years of monitored usage data on the golf course between July 1999 and June 2010 shows that the average annual use for 37 ha is approximately 137 ML per year. Assuming a similar irrigation rate per hectare across the expanded 59 ha area suggests a projected annual demand of 219 ML per year is more realistic. This equates to about 31% of the total existing volume of effluent discharged from the STP per annum.

To meet the increased irrigation demands of the golf course expansion and to manage competing demands for effluent in dry times, increased effluent storage would ideally be required. With this in mind, Council engaged a local engineer to investigate effluent storage potential on the golf course. The investigation identified two possible storage options that would provide around 70 ML or 120 ML of storage. The feasibility of either storage would be dependent on soil suitability, embankment volumes and construction costs.

Oaklands Agricultural Irrigation

Commentary for Oaklands Agricultural Irrigation is provided in Fact Sheet 3.

Infrastructure Requirements

Commentary for STP upgrades for effluent reuse is provided in Fact Sheet 14.

Infrastructure requirements for Scheme 1, inclusive of the STP upgrades identified for the existing reuse scheme, are shown in Table 1. Also shown in Table 1 are Capital and Net Present Value (NPV) costs and relative performance criteria for 2025 projected STP loadings. A conceptual arrangement of the scheme and a plan view of the scheme are provided in Figures 1 and 2 respectively.

Table 1 Effluent Reuse Scheme 1 Features and Performance Summary

Infrastructure requirements	Alum and caustic dosing system for phosphorus removal and pH correction Improved chlorine dosing disinfection system Ultraviolet (UV) disinfection system PMGC effluent storage dam (70 ML capacity) New irrigation pumps, effluent transfer pipeline and expansion of golf course irrigation system pipe, controller and sprinkler network to service 59 ha		
Potential Effluent Demand	379 ML per annum = 219 ML (PMGC) + 161 ML (Oaklands)	**Reliability of Supply**	99%
2025 potential reuse of total STP effluent	42% (377 ML per annum)	**2025 disposal of total STP effluent**	55% (496 ML per annum)
Scheme Capital Cost (for infrastructure requirements)	$5,759,000	**NPV Cost (30 years)**	$8,482,000
O&M Cost per annum	$181,000	**NPV Cost / ML reuse**	$750
Greenhouse Gas Emissions kg CO2-e per annum	240,890	**NPV Cost / ML / ha reuse**	$7.58

Key Opportunities:

- Upgrades existing PMGC irrigation system infrastructure, which is aging, with a more efficient system able to be controlled and operated more effectively
- Moderate increase in 2025 potential reuse potential (~9%) and decease in the volume of effluent for disposal
- Improved playing amenity and appearance of the golf course with potential social benefits through increased visitation
- Less BVSC management controls and oversight is required because professional greenkeeper staff operate the system efficiently
- Community appreciation of increased effluent reuse and water recycling practices
- Relatively small carbon footprint through operation and relatively low operational cost
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Key Constraints:

- Relatively high construction cost, particularly for the 70 ML effluent storage dam (AECOM estimated construction costs are $1.5M higher than previous estimates
- Existing PMGC system is old and total replacement may be required, potentially further increasing the capital cost
- Minor works anticipated in road verge of Arthur Kaine Drive and truck movements for storage earthworks and construction may impact on local traffic
- Minimal remnant vegetation removal for effluent storage, however environmental footprint is relatively high in comparison to other beneficial reuse options
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Figure 1 Effluent Reuse Scheme 1 Conceptual Arrangement

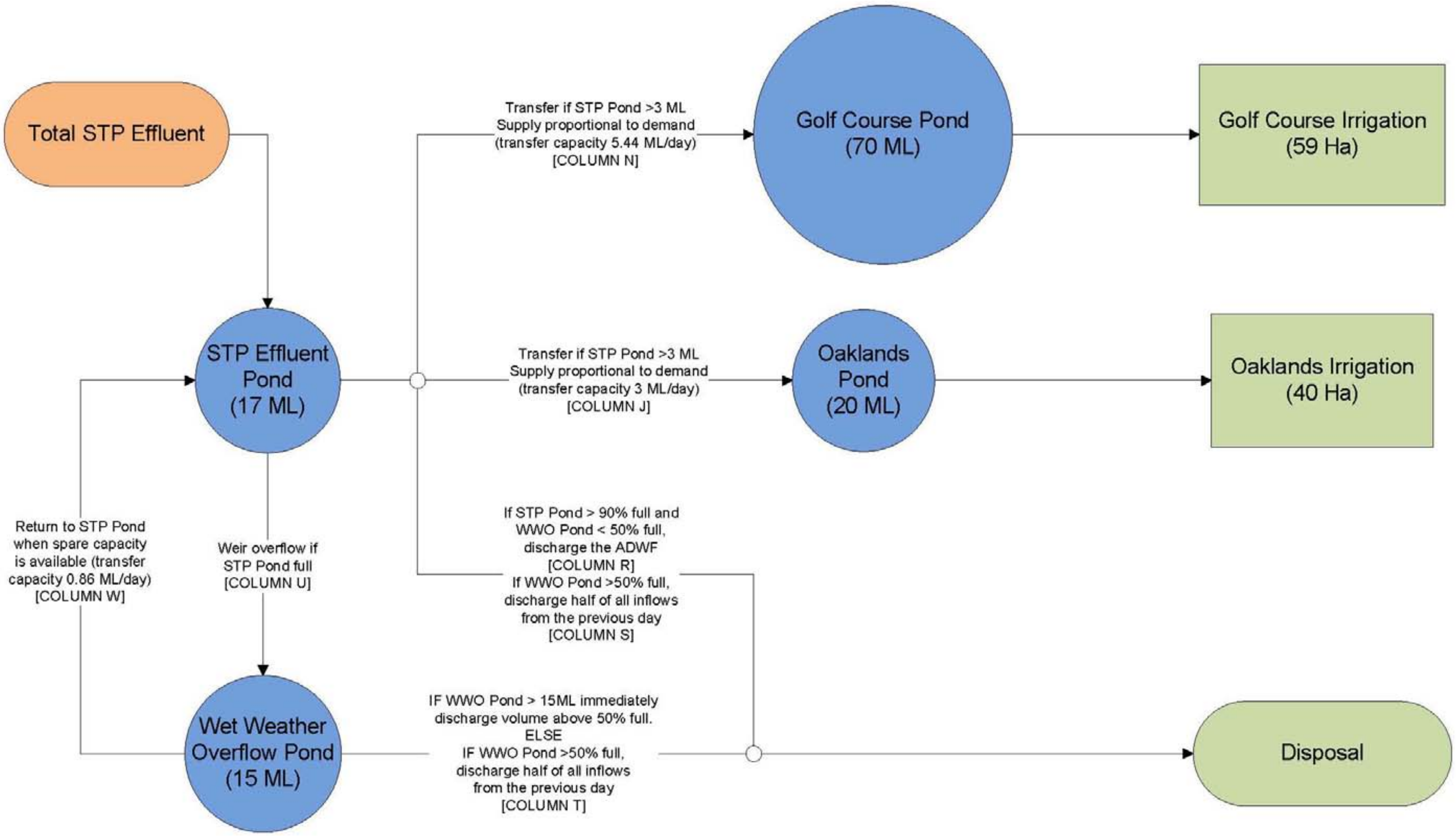
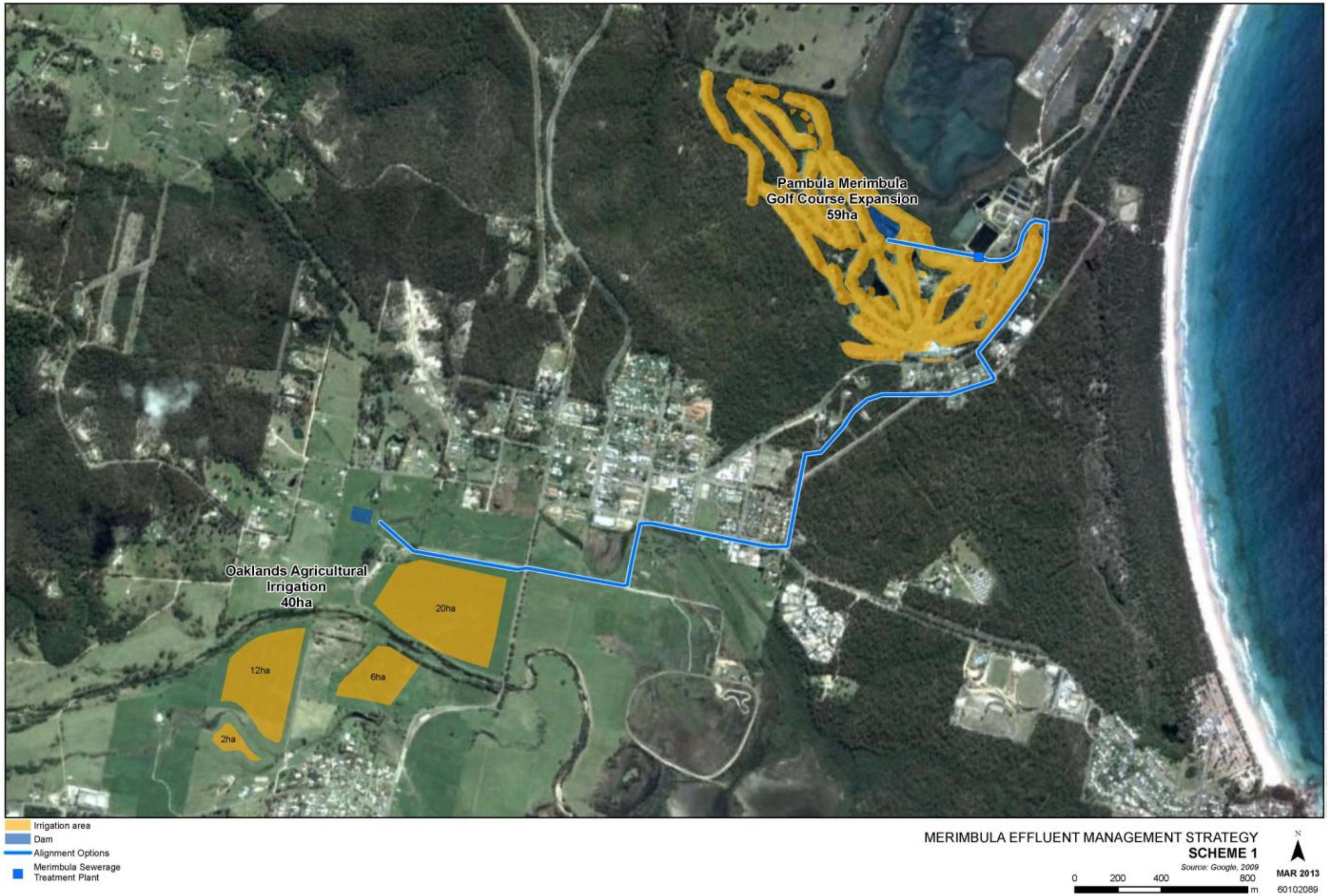


Figure 2 Effluent Reuse Scheme 1 Plan View



Fact Sheet 5

Effluent Reuse Option Scheme 2a

Pambula Open Space, Pambula Merimbula Golf Course and Oaklands Agricultural Irrigation

Scheme 2a includes the supply of effluent for use at the open space areas of Pambula Sports Complex, Pambula Recreation Ground and Pambula Cemetery. It also includes the existing effluent reuse scheme at the Pambula Merimbula Golf Course (PMGC) and Oaklands and the treatment plant upgrades that will be undertaken as a minimum as part of future effluent management upgrades.

Pambula Open Space

There are a number of open space areas in the Pambula urban area that could benefit from being irrigated with effluent. These open spaces have the advantage of being relatively close to the STP and within close vicinity and direction of the already constructed Oaklands pipeline. The open spaces identified include a potential total irrigation area of 3 ha at the Pambula Sports Complex and 1 ha each at the Pambula Recreation Ground and Pambula Cemetery. These areas would be serviced by new pumping infrastructure located at the STP, approximately 3 km of additional transfer pipelines, three small (~0.5 ML) on-site storage tanks and respective irrigation pipe networks and sprinkler systems.

AECOM consultants have undertaken a desktop review of soil data and conducted water balance modelling to optimise the irrigation potential across the Pambula Open Space areas. Modelling estimated that around 18.5 ML or 3.7 ML/ha/year could be sustainably used on an average year. This would equate to about 3% of the total existing volume of effluent discharged from the STP per annum.

Pambula Merimbula Golf Course Irrigation

Commentary for PMGC Irrigation is provided in Fact Sheet 3

Oaklands Agricultural Irrigation

Commentary for Oaklands Agricultural Irrigation is provided in Fact Sheet 3

Infrastructure Requirements

Commentary for STP upgrades for effluent reuse is provided in Fact Sheet 14.

Infrastructure requirements for Scheme 2a, inclusive of the STP upgrades identified for the existing reuse scheme, are shown in Table 1. Also shown in Table 1 are Capital and Net Present Value (NPV) costs and relative performance criteria for 2025 projected STP loadings. A conceptual arrangement of the scheme and a plan view of the scheme are provided in Figures 1 and 2 respectively.

Table 1 Effluent Reuse Scheme 2a Features and Performance Summary -

Infrastructure requirements	Alum and caustic dosing system for phosphorus removal and pH correction Improved chlorine dosing disinfection system Ultraviolet (UV) disinfection system Transfer infrastructure (including pumps and pipelines), three 0.5ML storage tanks and irrigation pipe networks and sprinkler systems to service 5 ha		
Potential Effluent Demand	316 ML per year = 137 ML (PMGC) + 161 ML (Oaklands) + 18.5ML (Pambula Open Space)	**Reliability of Supply**	99%
2025 potential reuse of total STP effluent	35% (314 ML per year)	**2025 disposal of total STP effluent**	64% (577 ML per year)
Scheme Capital Cost (for infrastructure requirements)	$2,660,000	**NPV Cost (30 years)**	$5,220,000
O&M Cost per annum	$169,000	**NPV Cost / ML reuse**	$554
Greenhouse Gas Emissions kg CO2-e per annum	231,600	**NPV Cost / ML / ha reuse**	$6.76

Key Opportunities:

- Upgrades existing irrigation system infrastructure with more efficient systems able to be controlled and operated more effectively
- Improved playing amenity and appearance of the playing fields with social benefits through increased visitation and enjoyment
- Reduced town water usage and cost of using town water for irrigation of playing fields and cemetery
- Community appreciation of increased effluent reuse and water recycling practices
- Environmental footprint is relatively low in comparison to other reuse options
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Key Constraints:

- Relatively small increase in 2025 potential reuse percentage (~2%) and decrease in the volume of effluent for disposal
- Relatively high construction cost for the benefit achieved in terms of percentage reduction of effluent disposal
- Minor works anticipated in road verge of Pambula Beach Road may impact on local traffic
- Reliant on Council operations staff and/or volunteer management committees to operate Pambula Open Space area irrigation systems in an appropriate manner
- New management controls for Pambula Open Space areas will need to be developed, implemented and added to the existing management controls for the PMGC and Oaklands in accordance with an updated *Merimbula Sewerage Scheme Operational Environmental Management Plan* to minimise the potential risk to receiving environments and public health (i.e. increased Council resourcing required)
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Figure 1 Effluent Reuse Scheme 2a Conceptual Arrangement

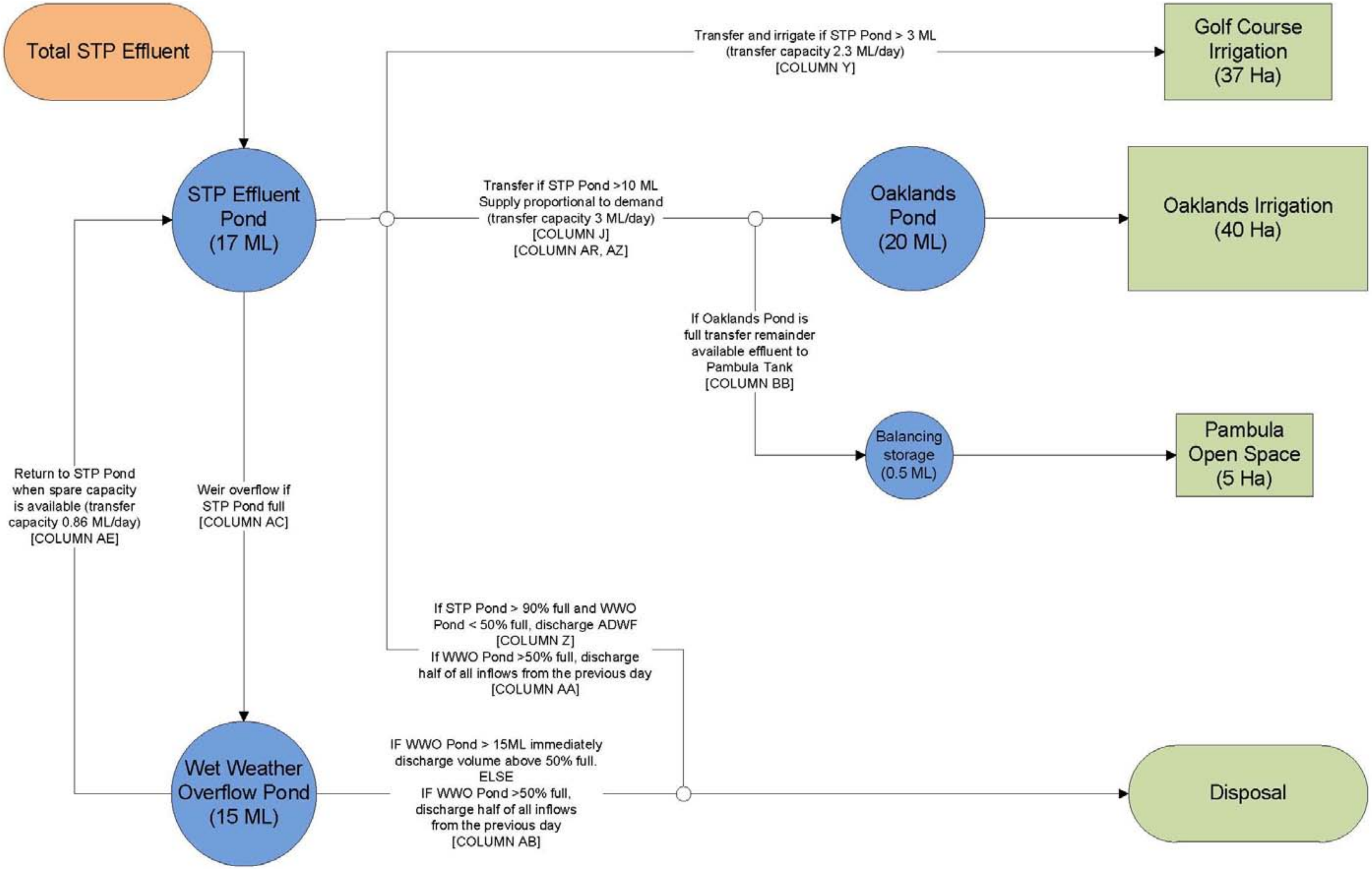


Figure 2 Effluent Reuse Scheme 2a Plan View

Fact Sheet 6

Effluent Reuse Option Scheme 2b

South Pambula Agricultural, Pambula Merimbula Golf Course and Oaklands Agricultural Irrigation

Scheme 2b includes the supply of effluent for irrigation of agricultural land at South Pambula on the Pambula River flats. It also includes the existing effluent reuse scheme at the Pambula Merimbula Golf Course (PMGC) and Oaklands and the treatment plant upgrades that will be undertaken as a minimum as part of future effluent management upgrades.

South Pambula Agricultural Irrigation

South Pambula irrigation area is located approximately 1.5 km west of Oaklands on Pambula River alluvial flats. Development of a scheme to service this area would be an extension of the existing Oaklands scheme. Effluent would be pumped from the STP under 49 m of pump head through the Oaklands pipeline and a new 3.2 km pipeline along the approximate route shown in Figure 2, discharging into two 5 ML on-site storages on two separate private properties at South Pambula. A total area of approximately 6 ha is considered suitable for irrigation of either fodder crops or pasture. The areas identified as suitable for effluent irrigation have been selected based on suitable topography, soil types and land use, with appropriate buffer distances to property boundaries, dwellings, roads and local water courses.

AECOM consultants have undertaken a desktop review of soil data and conducted water balance modelling to optimise the irrigation potential across the two South Pambula properties. Modelling estimated that around 24 ML or 4.0 ML/ha/year could be sustainably used on an average year, assuming that phosphorus levels are to be reduced to 1mg/L. This would equate to about 4% of the total existing volume of effluent discharged from the STP per annum.

Pambula Merimbula Golf Course Irrigation

Commentary for PMGC Irrigation is provided in Fact Sheet 3

Oaklands Agricultural Irrigation

Commentary for Oaklands Agricultural Irrigation is provided in Fact Sheet 3

Infrastructure Requirements

Commentary for STP upgrades for effluent reuse is provided in Fact Sheet 14.

Infrastructure requirements for Scheme 2b, inclusive of the STP upgrades identified for the existing reuse scheme are shown in Table 1. Also shown in Table 1 are Capital and Net Present Value (NPV) costs and relative performance criteria for 2025 projected STP loadings. A conceptual arrangement of the scheme and a plan view of the scheme are provided in Figures 1 and 2 respectively.

Table 1 Effluent Reuse Scheme 2b Features and Performance Summary

Infrastructure requirements	Alum and caustic dosing system for phosphorus removal and pH correction Improved chlorine dosing disinfection system Ultraviolet (UV) disinfection system STP pump sized for ultimate potential transfer to Lochiel 2 x 74kW, 38L/s @49m (1 x duty / 1standby) 3.2km of DN280-PE100, PN12.5 pipeline extending to South Pambula Two 5 ML on-site earthen HDPE or clay lined storage dams at South Pambula Irrigation system to irrigate 6 ha of agricultural land at South Pambula		
Potential Effluent Demand	323 ML per year = 137 ML (PMGC) + 161 ML (Oaklands) + 24 ML (South Pambula)	**Reliability of Supply**	99%
2025 potential reuse of total STP effluent	36% (320 ML per year)	**2025 disposal of total STP effluent**	63% (568 ML per year)
Scheme Capital Cost (for infrastructure requirements)	$3,695,000	**NPV Cost (30 years)**	$6,411,000
O&M Cost per annum	$180,000	**NPV Cost / ML reuse**	$667
Greenhouse Gas Emissions kg CO2-e per annum	239,350	**NPV Cost / ML / ha reuse**	$8.04

Key Opportunities:

- Supports local agricultural by providing reliable irrigation water
- Substitutes historical use of river water at South Pambula to reduce stress on natural water resources
- Scheme has potential for staged expansion to Lochiel
- Community appreciation of increased effluent reuse and water recycling practices
- Relatively small carbon footprint through operation and relatively low operational cost
- Environmental footprint is relatively low in comparison to other reuse options
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Key Constraints:

- Relatively small increase in 2025 potential reuse percentage (~2.5%) and decrease in the volume of effluent for disposal
- Pambula Lake oyster farmers have expressed opposition to increased effluent irrigation in the Pambula River catchment
- Major works in road verge along Pacific Highway and Pambula River bridge crossing, requiring traffic management and possibly night works
- Minor works in road verge along Northview Drive and Mount Darragh Road possibly impacting on local traffic
- A number of watercourse crossings and the bridged crossing of Pambula River, increasing pipeline installation costs
- New management controls for South Pambula areas will need to be developed, implemented and added to the existing management controls for the PMGC and Oaklands in accordance with an updated *Merimbula Sewerage Scheme Operational Environmental Management Plan to minimise the potential risk to receiving environments and public health (i.e. increased Council resourcing required)*
- Reliant on two new private landholders with the capability and willingness to operate an efficient and suitable effluent irrigation system in an appropriate manner
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Figure 1 Effluent Reuse Scheme 2b Conceptual Arrangement

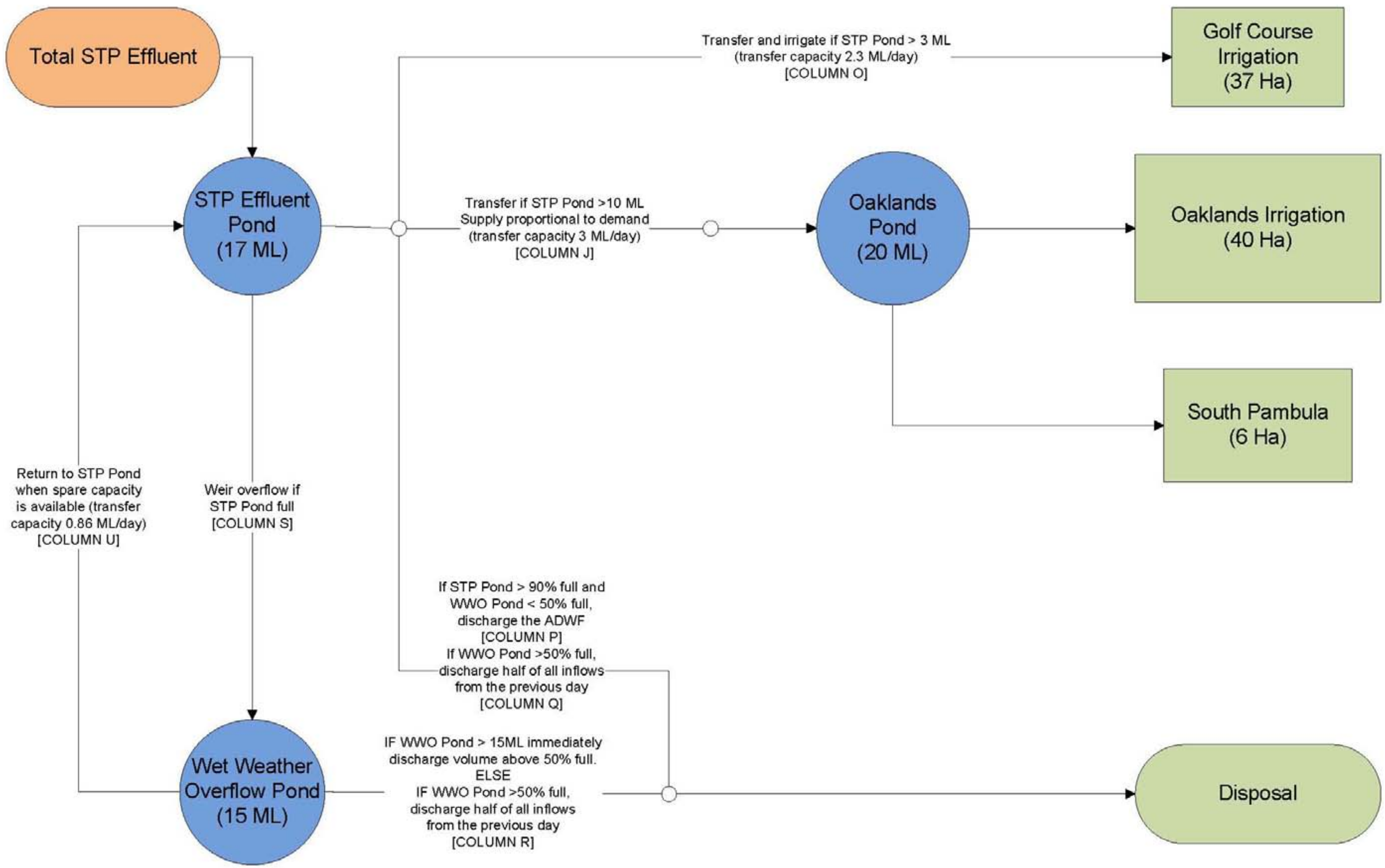
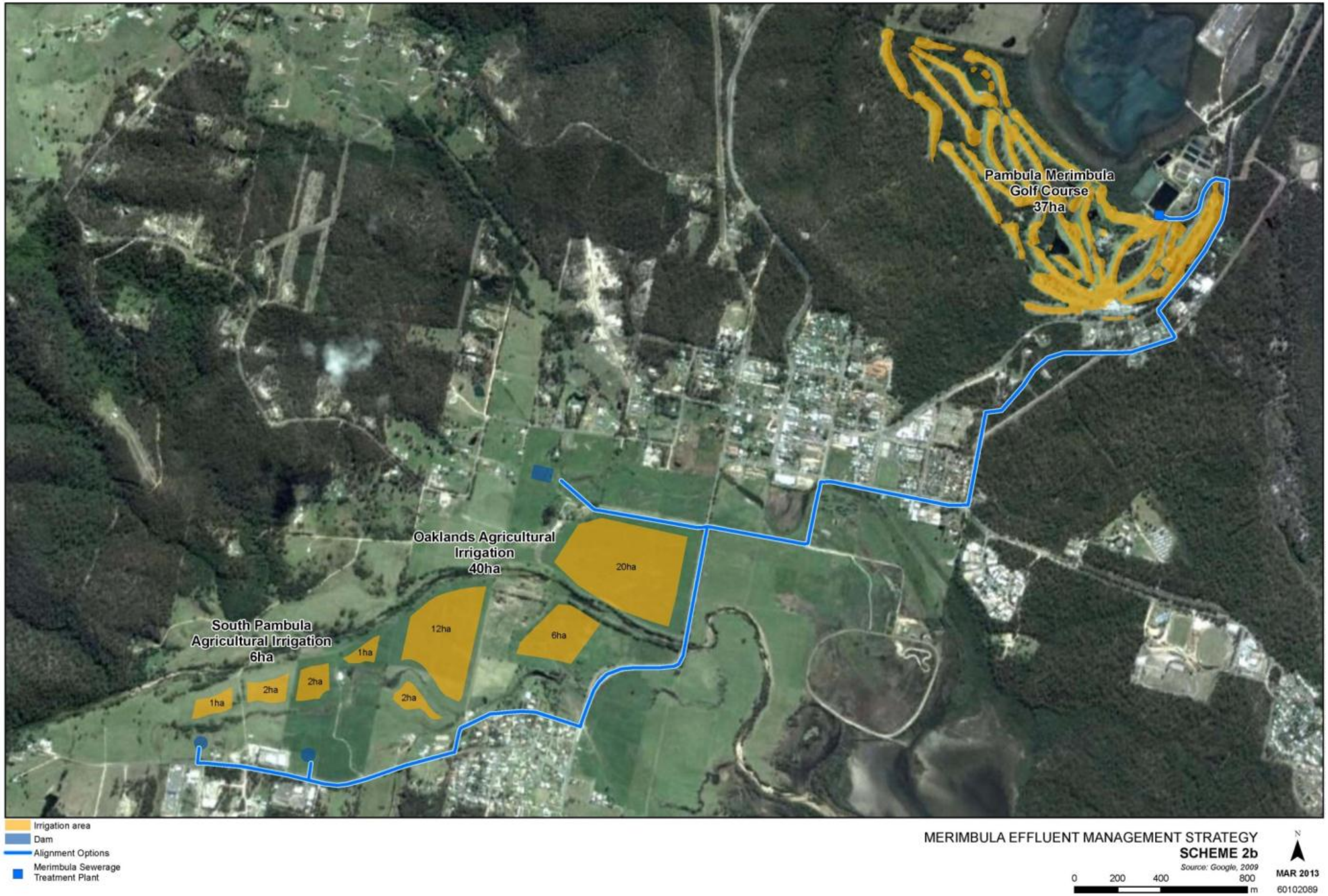


Figure 2 Effluent Reuse Scheme 2b Plan View



Fact Sheet 7

Effluent Reuse Option Scheme 2c

Lochiel Agricultural, South Pambula Agricultural, Pambula Merimbula Golf Course and Oaklands Agricultural Irrigation

Scheme 2c includes the supply of effluent for irrigation of agricultural land at Lochiel and South Pambula. It also includes the existing effluent reuse scheme at the Pambula Merimbula Golf Course (PMGC) and Oaklands and the treatment plant upgrades that will be undertaken as a minimum as part of future effluent management upgrades

Lochiel Agricultural Irrigation

Lochiel irrigation area is located on cleared hill slope areas and alluvial flats approximately 4.5 km west of Oaklands. Development of a scheme to service this area would be an extension of the existing Oaklands scheme. Effluent would be pumped from the STP under 82 m of pump head through the Oaklands pipeline and a new 5.4 km pipeline along the approximate route shown in Figure 2, discharging into a 30 ML earthen dam storage on a private property at Lochiel.

A total area of approximately 50 ha is considered suitable for irrigation of either fodder crops or pasture. The areas identified as suitable for effluent irrigation have been selected based on suitable topography, soil types and land use, with appropriate buffer distances to property boundaries, dwellings, roads and local water courses.

AECOM consultants have undertaken a desktop review of soil data and conducted water balance modelling to optimise the irrigation potential across the Lochiel property. Modelling estimated that around 185 ML or 3.7 ML/ha/year could be sustainably used on an average year. This would equate to about 26% of the total existing volume of effluent discharged from the STP per annum.

Pambula Merimbula Golf Course Irrigation

Commentary for PMGC Irrigation is provided in Fact Sheet 3.

South Pambula Agricultural Irrigation

Commentary for South Pambula Agricultural Irrigation is provided in Fact Sheet 6.

Infrastructure Requirements

Commentary for STP upgrades for effluent reuse is provided in Fact Sheet 14.

Infrastructure requirements for Scheme 2c, inclusive of the STP upgrades identified for the existing reuse scheme are shown in Table 1. Also shown in Table 1 are Capital and Net Present Value (NPV) costs and relative performance criteria for 2025 projected STP loadings. A conceptual arrangement of the scheme and a plan view of the scheme are provided in Figures 1 and 2 respectively.

Table 1 Effluent Reuse Scheme 2c Features and Performance Summary

Infrastructure requirements	Alum and caustic dosing system for phosphorus removal and pH correction Improved chlorine dosing disinfection system Ultraviolet (UV) disinfection system STP pump sized for transfer to Lochiel 2 x 74kW, 38L/s @49m (1 x duty / 1standby) 5.4km of DN280-PE100, PN12.5 pipeline extending to Lochiel One 30 ML on-site earthen HDPE or clay lined storage dam at Lochiel Irrigation system to irrigate 50 ha of agricultural land at Lochiel Two 5 ML on-site earthen HDPE or clay lined storage dams at South Pambula Irrigation system to irrigate 6 ha of agricultural land at South Pambula		
Potential Effluent Demand	509 ML per year = 137 ML (PMGC) + 161 ML (Oaklands) + 26 ML (South Pambula) + 185 ML (Lochiel)	**Reliability of Supply**	90%
2025 potential reuse of total STP effluent	51% (458 ML per year)	**2025 disposal of total STP effluent**	46% (419 ML per year)
Scheme Capital Cost (for infrastructure requirements)	$5,883,000	**NPV Cost (30 years)**	$8,994,000
O&M Cost per annum	$210,000	**NPV Cost / ML reuse**	$655
Greenhouse Gas Emissions kg CO2-e per annum	306,650	**NPV Cost / ML / ha reuse**	$4.92

Key Opportunities:

- Relatively large increase in 2025 potential reuse percentage (~18%) and decrease in the volume of effluent for disposal
- Scheme has potential for further staged expansion and connection to other properties with land suitable for irrigation
- Supports local agricultural by providing reliable irrigation water
- Substitutes historical use of river water to reduce stress on natural water resources
- Community appreciation of increased effluent reuse and water recycling practices
- Environmental footprint is relatively low in comparison to other beneficial reuse options
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Key Constraints:

- Relatively high capital and operational costs, with relatively high carbon footprint through operation
- Pambula Lake oyster farmers have expressed opposition to increased effluent irrigation in the Pambula River catchment
- Major works in road verge along Pacific Highway and Pambula River bridge crossing, requiring traffic management and possibly night works with minor works in road verge along Northview Drive and Mount Darragh Road potentially impacting on local traffic
- A number of watercourse crossings and the bridged crossing of Pambula River, increasing pipeline installation costs
- New management controls for Lochiel area will need to be developed, implemented and added to the existing management controls for South Pambula, the PMGC and Oaklands in accordance with an updated *Merimbula Sewerage Scheme Operational Environmental Management Plan* to minimise the potential risk to receiving environments and public health (i.e. increased Council resourcing required)

- Reliant on three new private landholders with the capability and willingness to operate an efficient and suitable effluent irrigation system in an appropriate manner
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Figure 1 Effluent Reuse Scheme 2c Conceptual Arrangement

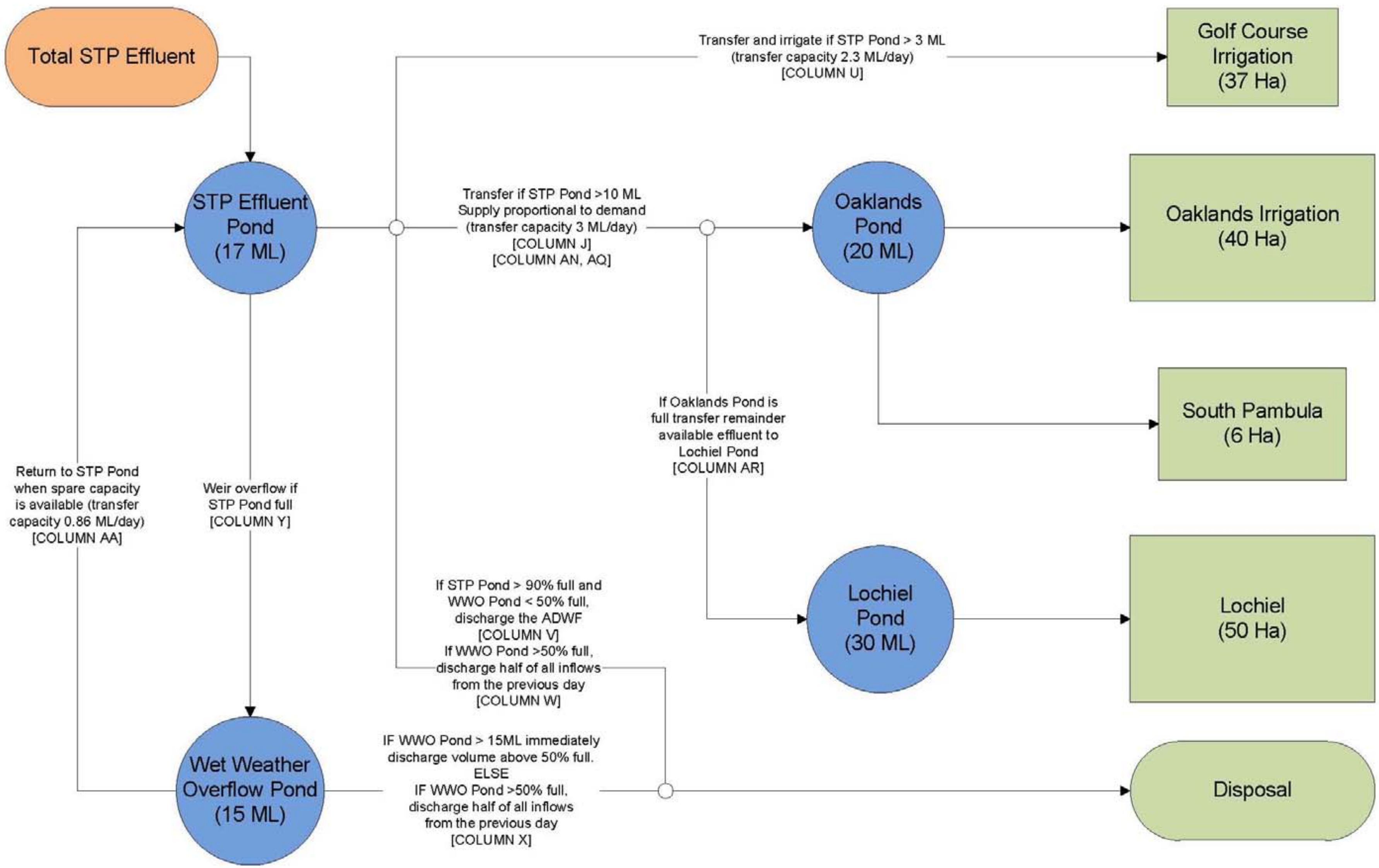
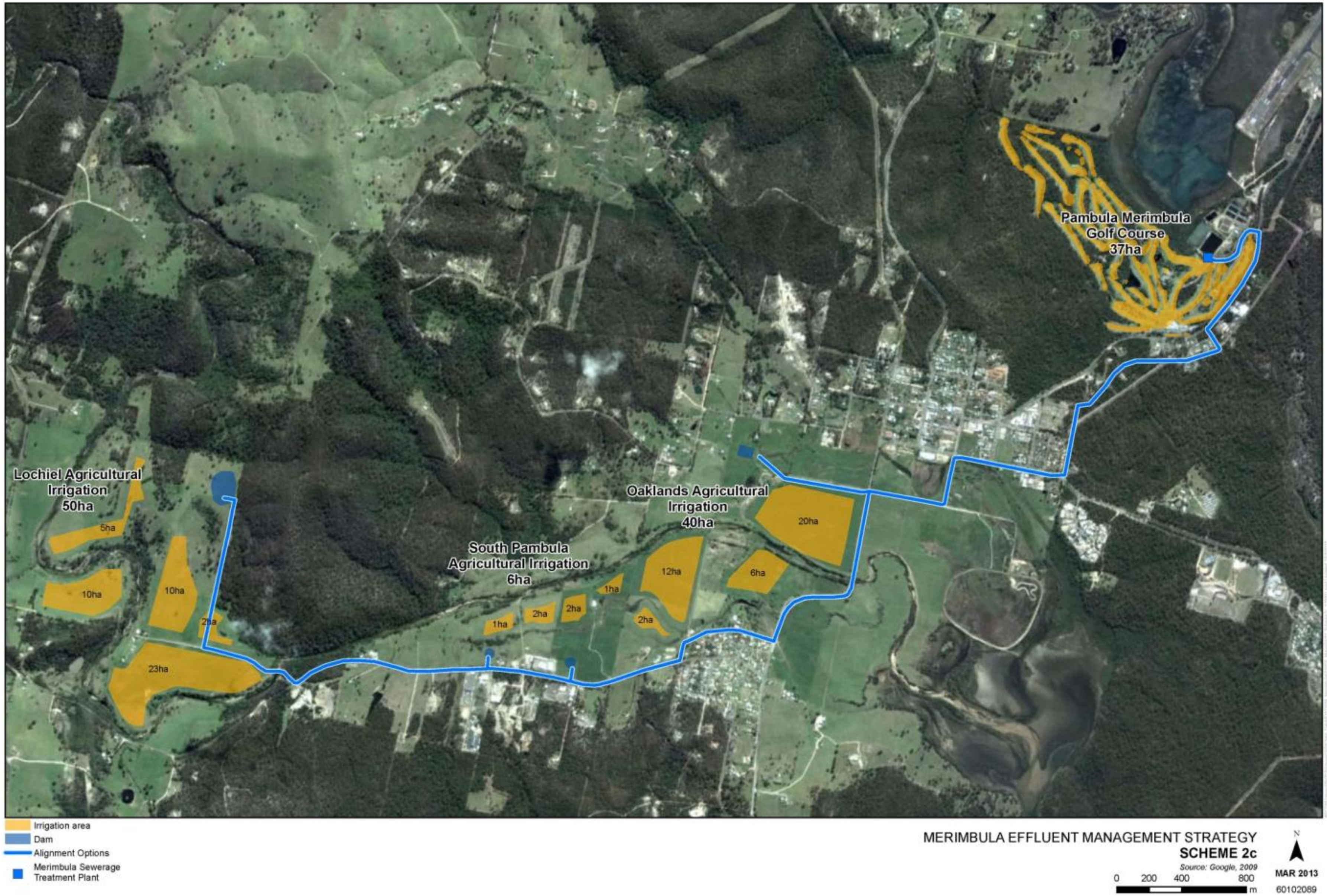
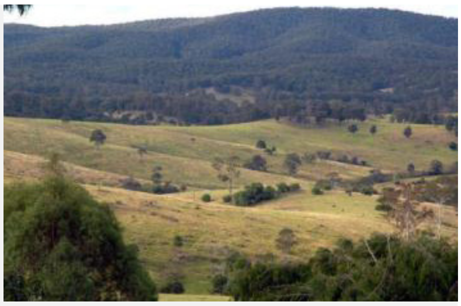


Figure 2 Effluent Reuse Scheme 2c Plan View



Fact Sheet 8

Effluent Reuse Option Scheme 3a



Millingandi Agricultural, Pambula Merimbula Golf Course and Oaklands Agricultural Irrigation

Scheme 3a builds on the existing effluent reuse schemes at the Pambula Merimbula Golf Course and the Oaklands property on the Pambula River flats, with the additional supply of effluent for the irrigation of agricultural areas around Millingandi. The scheme also includes a number of treatment plant upgrades which have been committed as a part of Council's future effluent management strategy.

Millingandi Agricultural Irrigation

Millingandi irrigation area is located on cleared hill slope areas and alluvial flat areas of Boggy Creek in Millingandi. Effluent would be pumped from the STP under 139 m of pump head through a new 8.5 km pipeline along the approximate route shown in Figure 2, discharging into a 25 ML earthen storage dam on a private property at Millingandi.

A total area of approximately 60 ha is considered suitable for irrigation of either fodder crops or pasture. The areas identified as suitable for effluent irrigation – 10 ha to the north of the private road, 20ha to the south between the private road and Boggy Creek and 30 ha in the west of the property north of Boggy Creek Road - have been selected based on suitable topography, soil types and land use, with appropriate buffer distances to property boundaries, dwellings, roads and local water courses.

AECOM consultants have undertaken a desktop review of soil data and conducted water balance modelling to optimise the irrigation potential across the Millingandi property. Modelling estimated that around 192 ML or 3.2 ML/ha/year could be sustainably used on an average year. This would equate to about 27% of the total existing volume of effluent discharged from the STP per annum.

Pambula Merimbula Golf Course Irrigation

Commentary for PMGC Irrigation is provided in Fact Sheet 3.

Oaklands Agricultural Irrigation

Commentary for Oaklands Agricultural Irrigation is provided as per Fact Sheet 3.

Infrastructure Requirements

Commentary for STP upgrades for effluent reuse is provided in Fact Sheet 14.

Infrastructure requirements for Scheme 3a, inclusive of the STP upgrades identified for the existing reuse scheme are shown in Table 1. Also shown in Table 1 are Capital and Net Present Value (NPV) costs and relative performance criteria for 2025 projected STP loadings. A conceptual arrangement of the scheme and a plan view of the scheme are provided in Figures 1 and 2 respectively.

Table 1 Scheme 3a Features and Performance Summary

Infrastructure requirements	Alum and caustic dosing system for phosphorus removal and pH correction Improved chlorine dosing disinfection system Ultraviolet (UV) disinfection system STP pump sized for transfer to Millingandi 6.0km of DN280-PE100, PN12.5 and 2.5km of DN200-PE100, PN12.5 pipeline One 25 ML on-site earthen HDPE or clay lined storage dam Irrigation system to irrigate 60 ha of agricultural land at Millingandi		
Potential Effluent Demand	492 ML per year = 137 ML (PMGC) + 161 ML (Oaklands) + 195 ML (Millingandi)	**Reliability of Supply**	91%
2025 potential reuse of total STP effluent	50% (449 ML per year)	**2025 disposal of total STP effluent**	48% (432 ML per year)
Scheme Capital Cost (for infrastructure requirements)	$5,814,000	**NPV Cost (30 years)**	$8,935,000
O&M Cost per annum	$214,000	**NPV Cost / ML reuse**	$664
Greenhouse Gas Emissions kg CO2-e per annum	313,280	**NPV Cost / ML / ha reuse**	$4.85

Key Opportunities:

- Relatively large increase in the 2025 percentage reuse (~17%) and decrease in the volume of effluent for disposal
- Landholder has expressed keen interest in an effluent reuse scheme on the property identified
- Irrigation areas are further from water courses than those for Schemes 2b and c.
- Scheme has some potential for further staged expansion and connection to other properties with land suitable for irrigation
- Supports local agricultural by providing reliable irrigation water
- Community appreciation of increased effluent reuse and water recycling practices
- Subject to condition assessment, there is a potential opportunity to utilise up to 3.5 km of an existing 225 mm cast iron cement lined Tantawanglo pipeline with an estimated cost saving of up to $600K
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Key Constraints:

- Relatively high capital and operational costs, with relatively high carbon footprint through operation
- Reliant on a new private landholder with the capability and willingness to operate an efficient and suitable effluent irrigation system in an appropriate manner
- Merimbula Lake oyster farmers may oppose increased effluent irrigation in the Merimbula Lake catchment
- Should the Tantawanglo pipeline be utilised, there is large amount of uncertainty around its integrity and cross connection with duplicate water supply mains running in parallel would need to be eliminated
- Major works in road verge along Princes Highway requiring traffic management and possibly night works
- A number of watercourse crossings and up to 1km of pipe installation through siltstone, increasing pipeline installation cost by up to $180,000
- Construction footprint >50,000 m^2 is relatively large in comparison to other reuse options (reduced by up to 40% if the Tantawangalo pipeline can be utilised)

- New management controls for Millingandi will need to be developed, implemented and added to the exist*ing management controls for the PMGC and Oaklands in accordance wit*h an updated *Merimbula Sewerage Scheme Operational Environmental Management Plan* to minimise the potential risk to receiving environments and public health (i.e. increased Council resourcing required)
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Figure 1 Effluent Reuse Scheme 3a Conceptual Arrangement

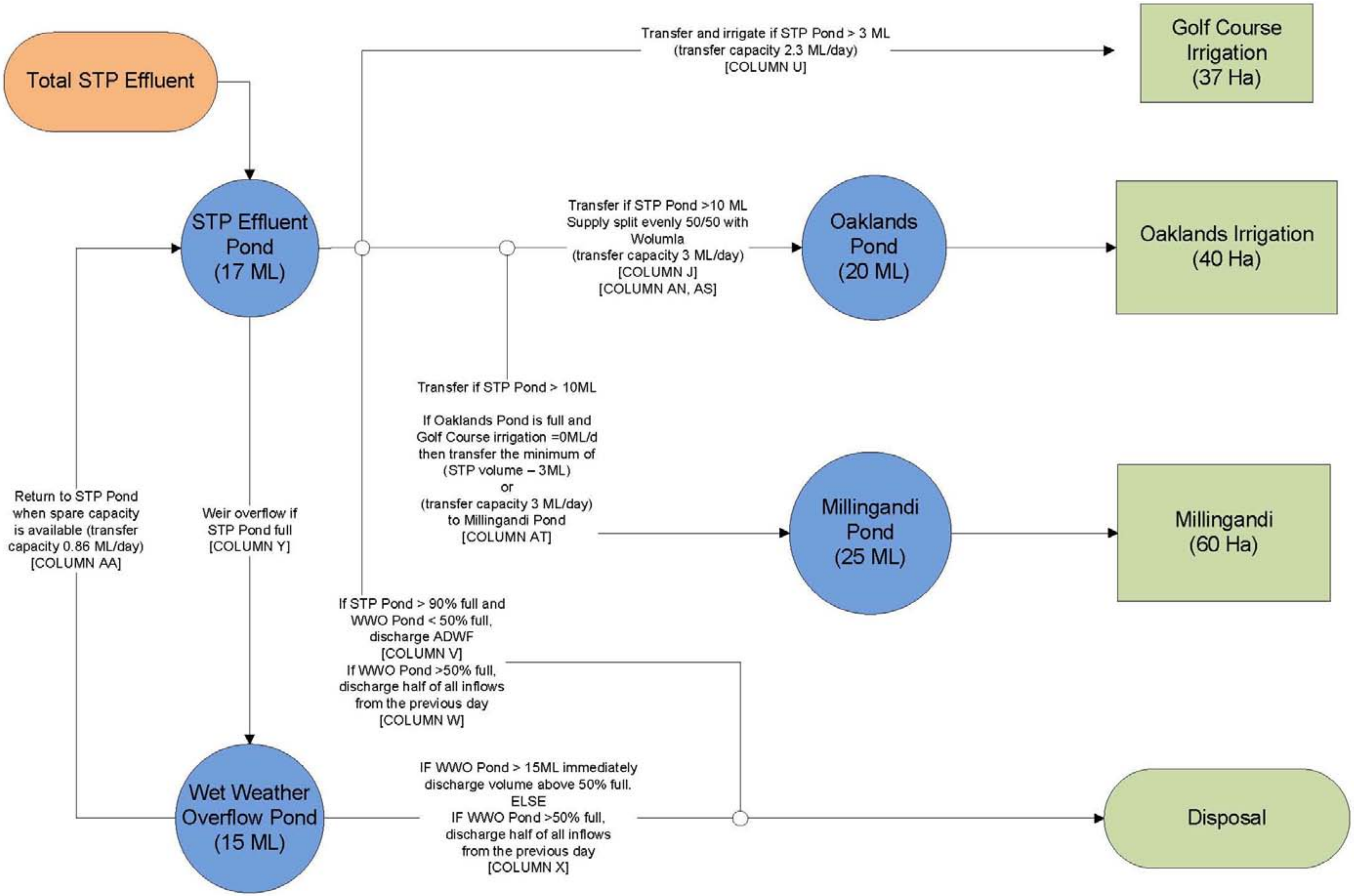


Figure 2 Effluent Reuse Scheme 3a Plan View

Fact Sheet 9

Effluent Reuse Option Scheme 3b

Wolumla Agricultural, Pambula Merimbula Golf Course and Oaklands Agricultural Irrigation

Scheme 3b includes the supply of effluent for irrigation of agricultural land north of Wolumla near Wanatta Lane. It also includes the existing effluent reuse scheme at the Pambula Merimbula Golf Course (PMGC) and Oaklands and the treatment plant upgrades that will be undertaken as a minimum as part of future effluent management upgrades.

Wolumla Agricultural Irrigation

Wolumla irrigation areas are located on the cleared rolling hill slope areas approximately 4.5 km north of Wolumla in the Wanatta Lane area. Effluent would be pumped from the STP under 264 m of pump head through a new 23 km pipeline along the approximate route shown in Figure 2. The transfer system would also include a booster pumping station and two balance tanks. The effluent would discharge into a ~200 ML earthen storage dam on Council's land north of the Central Waste Facility site. An alternative route to that shown in Figure 2 would be to follow Millingandi Road along the Tantawanglo pipeline alignment before rejoining the Princes Highway at Yellow Pinch Dam Road.

Four broad-acre agricultural properties with a total land area of approximately 830 ha adjoin Council's Central Waste Facility site. Of this area, a total of approximately 280 ha is considered suitable for irrigation of either fodder crops or pasture. The areas identified as suitable for effluent irrigation - fourteen separate areas - have been selected based on suitable topography, soil types and land use, with appropriate buffer distances to property boundaries, dwellings, roads and local water courses.

AECOM consultants have undertaken a desktop review of soil data and conducted water balance modelling to optimise the irrigation potential across the four Wolumla properties. Modelling estimated that around 1,036 ML or 3.7 ML/ha/year could be sustainably used on an average year. This would equate to about 148% of the total existing volume of effluent discharged from the STP per annum.

Pambula Merimbula Golf Course Irrigation

Commentary for PMGC Irrigation is provided in Fact Sheet 3.

Oaklands Agricultural Irrigation

Commentary for Oaklands Agricultural Irrigation is provided in Fact Sheet 3.

Infrastructure Requirements

Commentary for STP upgrades for effluent reuse is provided in Fact Sheet 14.

Infrastructure requirements for Scheme 3b, inclusive of the STP upgrades identified for the existing reuse scheme are shown in Table 1. Also shown in Table 1 are Capital and Net Present Value (NPV) costs and relative performance criteria for 2025 projected STP loadings. A conceptual arrangement of the scheme and a plan view of the scheme are provided in Figures 1 and 2 respectively.

Table 1 Scheme 3b Features and Performance Summary

Infrastructure requirements	Alum and caustic dosing system for phosphorus removal and pH correction Improved chlorine dosing disinfection system Ultraviolet (UV) disinfection system STP pumping station sized for transfer to Yellow Pinch and booster pumping station sized for transfer to Wolumla. Power supply to booster pumping station 15.0 km of DN280 rising main and 7.8 km of DN280 gravity main Two 0.2 ML balance tanks One 200 ML on-site earthen HDPE or clay lined storage dam at Wanatta Lane Irrigation system to irrigate 280 ha of agricultural land at Woluma		
Potential Effluent Demand	1,342 ML per year = 137 ML (PMGC) + 161 ML (Oaklands) + 1,043 ML (Wolumla)	**Reliability of Supply**	57%
2025 potential reuse of total STP effluent	85% (771 ML per year)	**2025 disposal of total STP effluent**	10% (90 ML per year)
Scheme Capital Cost (for infrastructure requirements)	$15,172,000	**NPV Cost (30 years)**	$20,501,000
O&M Cost per annum	$384,000	**NPV Cost / ML reuse**	$887
Greenhouse Gas Emissions kg CO2-e per annum	680,320	**NPV Cost / ML / ha reuse**	$2.48

Key Opportunities:

- Very large increase in 2025 potential reuse percentage (~53%) achieved, decreasing significantly the effluent volume for disposal
- Irrigation areas are located outside of the Pambula Lake and Merimbula Lake catchment areas
- Supports local agricultural by providing reliable irrigation water
- Community appreciation of increased effluent reuse and water recycling practices
- Subject to condition assessment, there is a potential opportunity to utilise up to 12.3 km of an existing 225 mm cast iron cement lined Tantawanglo pipeline with an estimated cost saving of up to $4 M
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Key Constraints:

- Very high capital and operational costs, with very high carbon footprint through operation
- Potential for community misperception that Wolumla is a strategic disposal site for the shires solid and liquid wastes
- Reliant on Council and at least three new private landholders with the capability and willingness to operate an efficient and suitable effluent irrigation system in an appropriate manner
- Should the Tantawanglo pipeline be utilised, there is large amount of uncertainty around its integrity, friction losses would be higher (with less flow transferred) and cross connection with duplicate water supply mains running in parallel would need to be eliminated
- Major works in road verge along Princes Highway requiring traffic management and possibly night works
- Minor works in road verge along Wanatta Lane and Millingandi Road may impact on local traffic
- A large number of watercourse crossings and up to 6 km of pipe installation through siltstone, increasing pipeline installation cost by up to $1.35 M (significantly reduced if Tantawanglo pipeline can be utilised)
- Construction footprint >140,000 m^2 is relatively high in comparison to other reuse options

- New management controls for Wolumla will need to be developed, implemented and added to the existing management controls for the PMGC and Oaklands in accordance with an updated *Merimbula Sewerage Scheme Operational Environmental Management Plan* to minimise the potential risk to receiving environments and public health (i.e. increased Council resourcing required)
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Figure 1 Effluent Reuse Scheme 3b Conceptual Arrangement

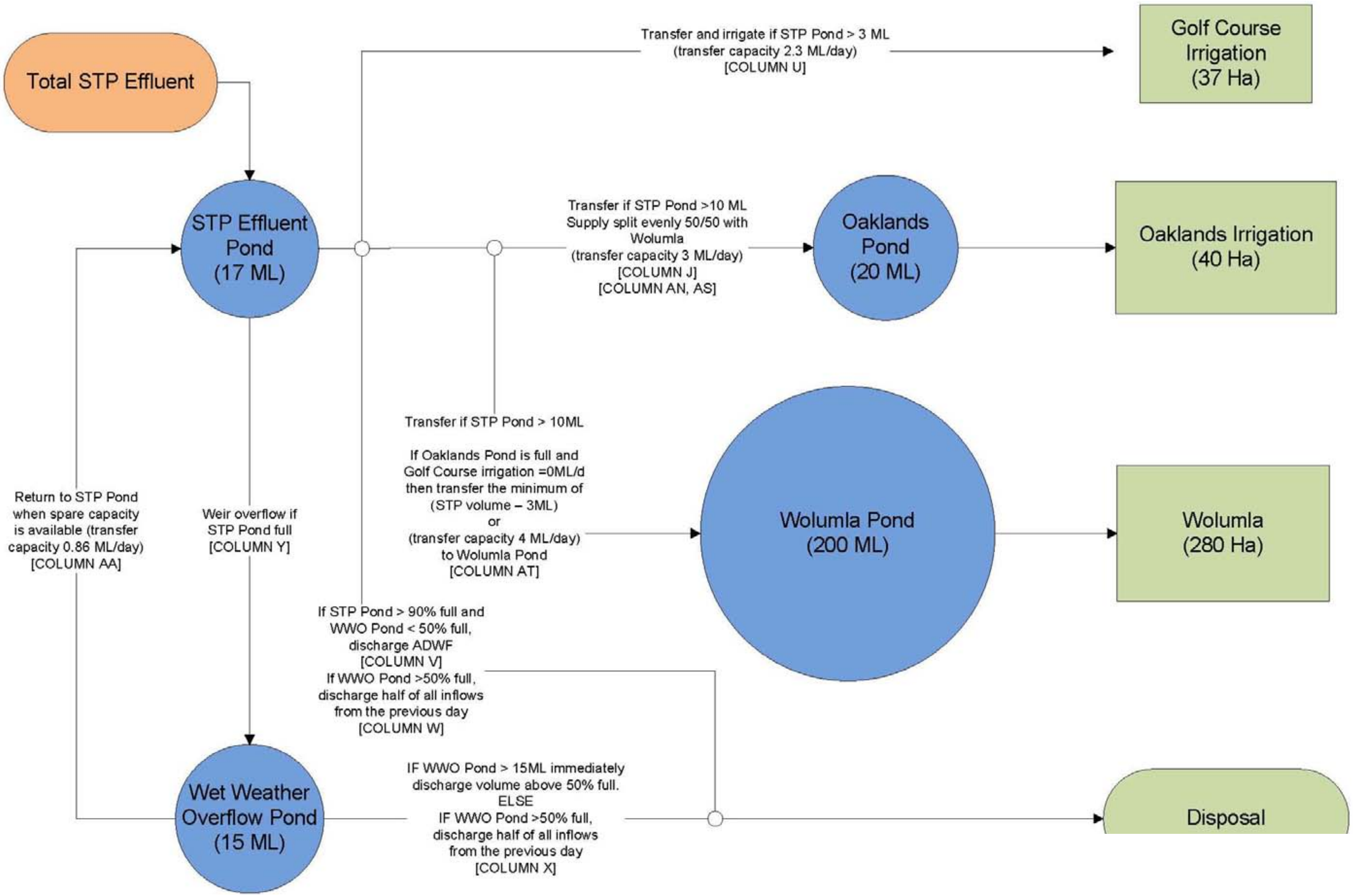
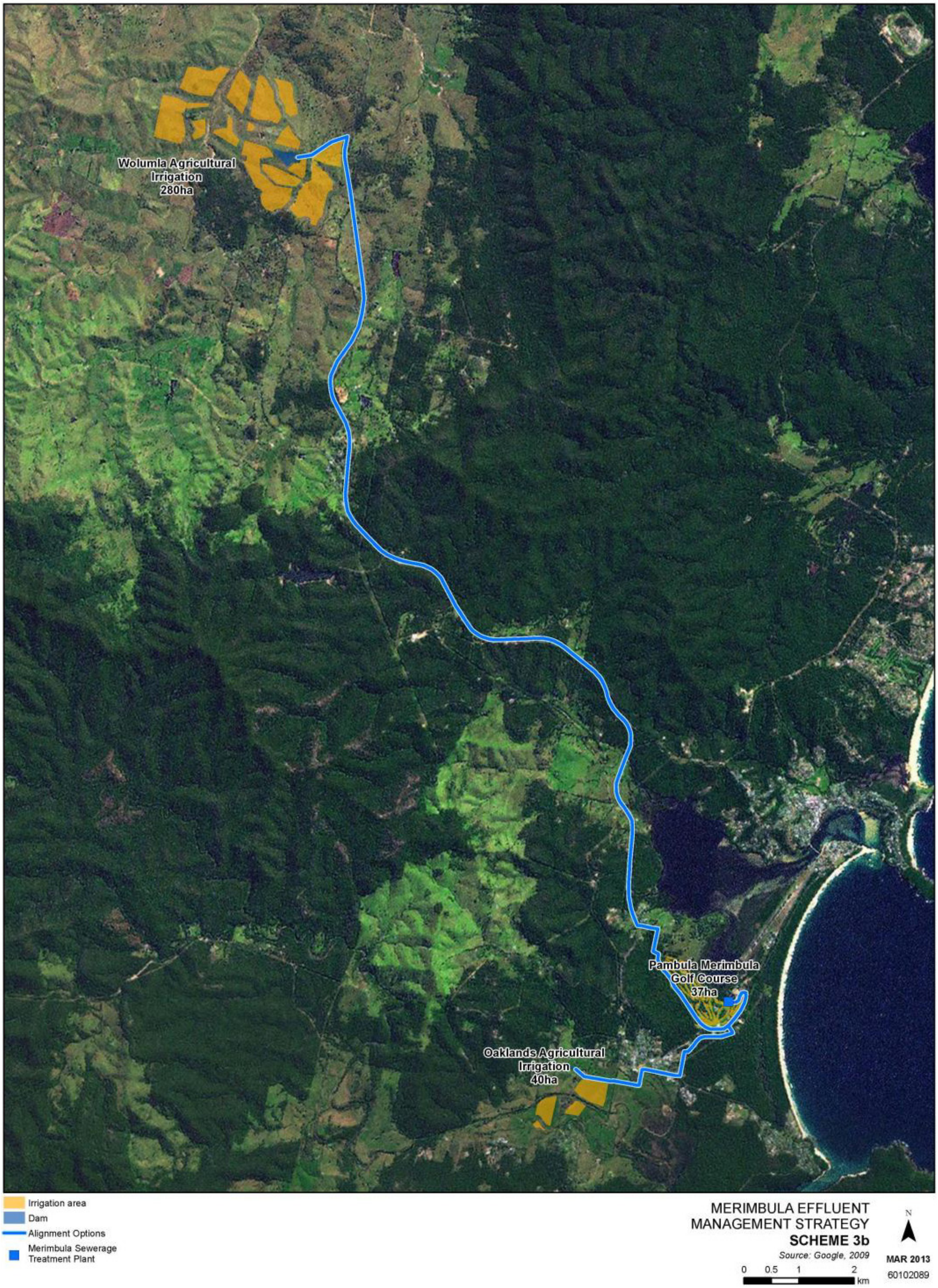


Figure 2 Effluent Reuse Scheme 3b Plan View



Fact Sheet 10

Effluent Reuse Option Scheme 4

Yellow Pinch Dam Indirect Potable Reuse and Pambula Merimbula Golf Course and Oaklands Agricultural Irrigation

Scheme 4 includes the supply of high quality treated effluent to the drinking water storage of Yellow Pinch Dam for indirect potable reuse. It also includes existing effluent reuse schemes at the Pambula Merimbula Golf Course (PMGC) and Oaklands and the treatment plant upgrades that will be undertaken as a minimum as part of future effluent management upgrades.

Yellow Pinch Dam Indirect Potable Reuse

The 3,000 ML off-stream storage of Yellow Pinch Dam is located within the South East Forest National Park and the Yurammie State Forest, just over 2 km south south west of Wolumla and 10 km north west of Merimbula.

Raw water from Tantawanglo Creek weir is the main source of water for the dam and is piped approximately 35 km to the dam, largely under gravity. The Bega River, via the Bega to Yellow Pinch Dam pipeline, is another source of water for the dam and is used to fill the dam during moderate to high flows in the Bega River at Bega. Water stored in Yellow Pinch Dam is used throughout the year and to meet peak holiday supply needs of the towns of Merimbula, Tura Beach, Pambula Beach, Pambula and a number of rural properties downstream of the dam. The dam can also supply the villages of Wolumla and Candelo and a number of rural properties upstream of the dam through pumping, during dry times when available supply from Tantawanglo Creek is limited due to low flows and associated licence restrictions.

Under Scheme 4, high quality treated effluent would be pumped under 262 m of pump head from an Advanced Water Treatment Plant at Merimbula STP through a new 10.0 km pipeline along the approximate route shown in Figure 1. An alternative route to that shown in Figure 1 would be along Millingandi Road and along the Tantawangalo pipeline alignment to the inlet of the dam.

AECOM consultants have estimated that approximately 800 ML per year or 2.2 ML/day of high quality treated effluent could be transferred to Yellow Pinch Dam. This would equate to approximately 114% of the total existing volume of effluent discharged from the STP per annum.

Pambula Merimbula Golf Course Irrigation

Commentary for Pambula Merimbula Golf Course Irrigation is provided in Fact Sheet 3.

Oaklands Agricultural Irrigation

Commentary for Oaklands Agricultural Irrigation is provided in Fact Sheet 3.

Infrastructure Requirements

Commentary for STP upgrades for effluent reuse is provided in Fact Sheet 14.

Infrastructure requirements for Scheme 4, inclusive of the STP upgrades identified for the existing reuse scheme are shown in Table 1. Also shown in Table 1 are Capital and Net Present Value (NPV) costs and relative performance criteria for 2025 projected STP loadings. A plan view of the scheme is provided in Figure 1.

Table 1 Scheme 4 Features and Performance Summary

Infrastructure requirements	Alum and caustic dosing system for phosphorus removal and pH correction Improved chlorine dosing disinfection system Ultraviolet (UV) disinfection system Advanced Water Treatment Plant STP pumping station sized for transfer to Yellow Pinch and booster pumping station sized for transfer to Yellow Pinch Dam. Power supply to booster pumping station 15.0 km of DN280 rising main and a 0.2ML balance tank		
Potential Effluent Demand	N/A	**Reliability of Supply**	N/A
2025 potential reuse of total STP effluent	89% (804 ML per year)	**2025 disposal of total STP effluent**	7% (65 ML per year)
Scheme Capital Cost (for infrastructure requirements)	$26,138,000	**NPV Cost (30 years)**	$53,602,000
O&M Cost per annum	$1,854,000	**NPV Cost / ML reuse**	$4,108
Greenhouse Gas Emissions kg CO2-e per annum	4,861,370	**NPV Cost / ML / ha reuse**	$53.36

Key Opportunities:

- Very large increase in 2025 potential reuse percentage (~56%) achieved, decreasing significantly the effluent volume for disposal
- Subject to condition assessment, there is a potential opportunity to utilise up to 12.3 km of the existing 225 mm cast iron cement lined Tantawanglo pipeline, with an estimated cost saving of up to $4 M
- Reduces extraction of river water from Tantawanglo Creek and the Bega River
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Key Constraints:

- Community objection to drinking recycled water
- There is no immediate need to supplement the supply of water to Yellow Pinch Dam since the 2012 commissioning of the Bega to Yellow Pinch Dam pipeline
- Advanced water treatment facility carries extremely high capital and operational costs, with extremely high carbon footprint through operation
- Should the Tantawanglo pipeline be utilised, there is large amount of uncertainty around its integrity, friction losses will be higher (with less flow transferred) and cross connection with duplicate water supply mains running in parallel would need to be eliminated.
- Major works in road verge along Princes Highway, requiring traffic management and possibly night works
- Minor works in road verge along Millingandi Road may impact on local traffic
- A number of watercourse crossings and up to 5km of pipe installation through siltstone, increasing pipeline installation cost by up to $0.975 M (significantly reduced if Tantawanglo pipeline can be utilised)
- Construction footprint >90,000 m^2 is relatively high in comparison to other reuse options
- Others as identified in Fact Sheet 3 Existing Reuse Scheme

Figure 1 Effluent Reuse Scheme 4 Plan View

Fact Sheet 11

Effluent Disposal System Option 1

Deep Water Ocean Outfall

A new ocean outfall disposal option would require a new transfer pipeline and a submerged diffuser outlet located some distance (up to 5.0 km) offshore and an upgrade of the existing pumping capacity to transfer effluent to the point of discharge.

Construction of the pipeline would require a combination of trenching and horizontal directional drilling (HDD), commencing from a point east of the STP immediately behind the foredunes of the Pambula-Merimbula dunal system and exiting 1 km away at a depth of -20 m beyond the zone of wave influence, before adopting a dredge and lay construction methodology for up to a further 3.5 km offshore to a favoured depth of -40 m.

AECOM (2010) investigated three discharge distances and depths offshore and undertook hydrodynamic water quality modelling for a number of scenarios to define a mixing volume in which sufficient dilution of effluent constituents occurred to meet relevant environmental values. The investigation showed that an outfall at a depth of -40 m would be feasible from a water quality perspective, even with the current treatment system. Water quality objectives would be exceeded for some constituents, however they were all located in a relatively small area in the vicinity of the discharge and there was no accumulation of material within Merimbula Bay or adjacent estuaries.

Infrastructure Requirements

Commentary for STP upgrades for disposal of effluent is provided in Fact Sheet 14.

Infrastructure requirements for Effluent Disposal Option 1, inclusive of the STP upgrades are shown in Table 1. Also shown in Table 1 are Capital and Net Present Value (NPV) costs and relative performance criteria for 2025 projected STP loadings.

Table 1 Effluent Disposal System Option 1 Features and Performance Summary

Infrastructure requirements	Alum and caustic dosing system for phosphorus removal and pH correction Improved chlorine dosing disinfection system Ultraviolet (UV) disinfection system Transfer infrastructure (including pumps and pipelines) Multi-port diffuser to provide mixing and dilution at discharge point		
Scheme Capital Cost (for infrastructure requirements)	$22,988,000	**NPV Cost (30 years)**	$23,315,000
O&M Cost per annum	$26,000	**Greenhouse Gas Emissions kg CO2-e per annum**	27,970

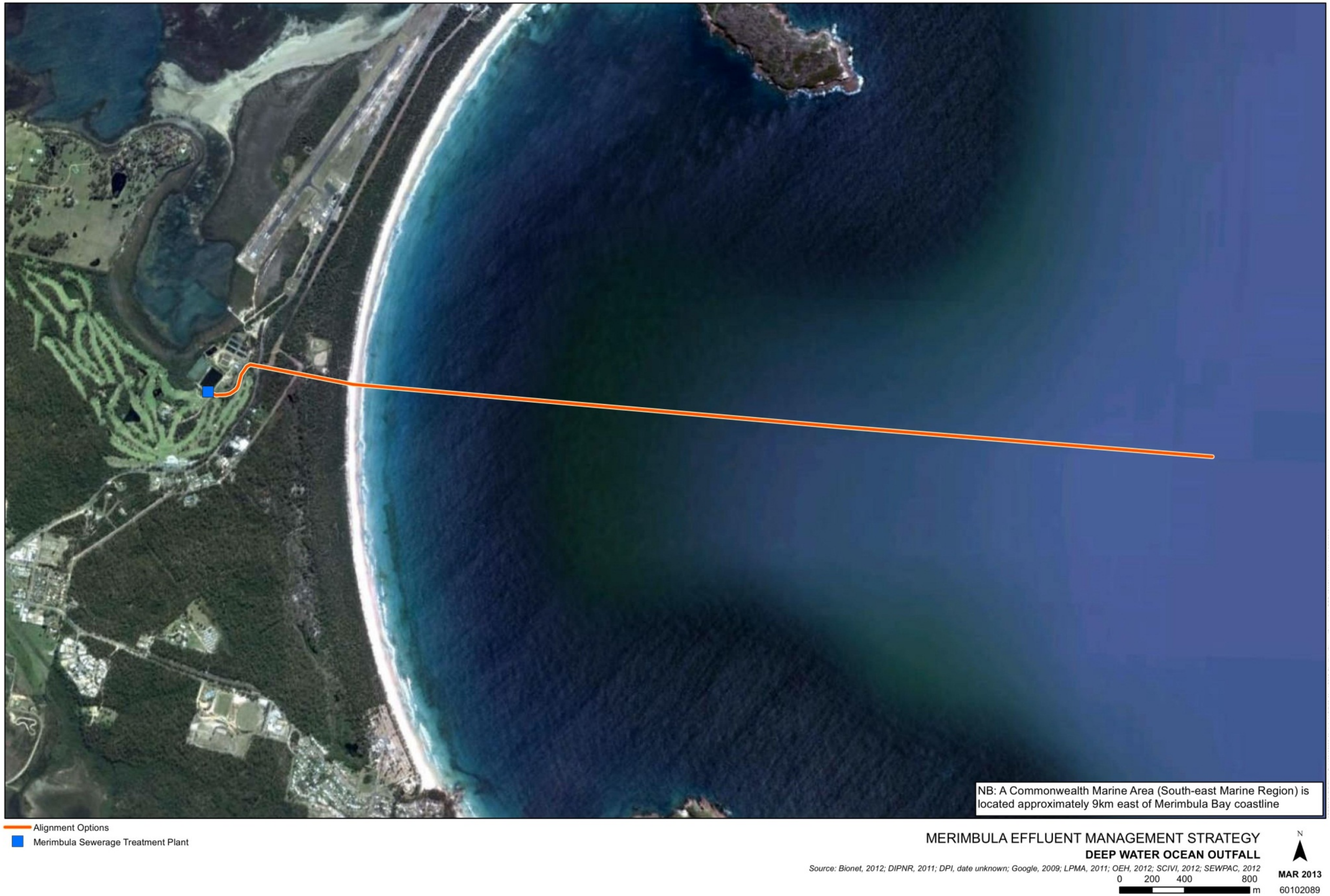
Key Opportunities:

- Full capacity to dispose all effluent discharged for the STP including wet weather flows
- Proven technology
- Potential to meet relevant environmental objectives, particularly if built to the 40 metre depth distance offshore
- Does not impact on Merimbula Beach shoreline or sensitive receptors such as Merimbula and Pambula Lakes, if built to the 40 metre depth distance offshore
- Relatively low landward construction footprint

Key Constraints:

- Higher construction and operational costs than dunal exfiltration or deep aquifer injection systems
- Difficult construction conditions with a risk of unsuitable geological materials for drilling and dredging
- Potentially high pipeline construction impacts, including disruption of marine environments flora and fauna, depending on construction methodology used
- Community opposition is likely to be high

Figure 1 Effluent Disposal Option Scheme 1 Plan View



Fact Sheet 12

Effluent Disposal System Option 2

Shallow Dunal Exfiltration Trench

Effluent Disposal System Option 2 – Shallow Dunal Exfiltration Trench involves the construction of a new exfiltration system within the Merimbula-Pambula dunal system north of the existing ponds. Effluent would be pumped to the exfiltration system, or subsurface "trench" (or "wells") and allowed to exfiltrate and flow in groundwater towards Merimbula Bay and Merimbula Lake.

The construction of an exfiltration trench north of the existing pond to dispose of effluent from Merimbula STP was first recommended in 1987 by Mackie Martin and Associates. In 1994 it was recommended by the Department of Public Works and Services and was the preferred option of Merimbula Part B of the Bega Valley Sewerage Program (2003-2008). However it has never progressed beyond the investigation stage.

A number of investigations have been undertaken to determine the capacity of the shallow dunal aquifer for effluent disposal and the likely impacts on groundwater level, groundwater quality, water quality of groundwater discharge locations and the ecology at groundwater discharge locations.

The most recent investigation by Ian Grey Groundwater Consulting (IGGC 2013) characterises the dunal aquifer hydrogeology and assesses the capacity and impacts at three modelled locations within the dunal system. The results of the IGGC (2013) investigation indicate that the three potential disposal areas were all viable from a hydraulic loading perspective both over the long term and during peak discharge times, with the preferred disposal area being the central part of the dune system, north of the existing ponds, due to the greater area and volume of the dunes in this area and the longer groundwater travel times to Merimbula Lake. The modelling for year 2025 estimated effluent disposal volumes via a 400 metre exfiltration trench located within BVSC land in the dunes east of Merimbula airport, predicted that the majority of effluent disposed would flow in groundwater towards the ocean (approximately 81%) and the remainder would flow westward with the natural groundwater flow towards Merimbula Lake.

Further modelling and investigations were undertaken to assess the potential impact of dunal exfiltration in the BVSC land area location in the dunes on the ecology of Merimbula Lake within the identified groundwater discharge zones. Four scenarios were modelled (IGGC 2013). Under scenarios 2 and 4 of the four scenarios modelled using year 2025 estimated effluent disposal volumes, steady state concentrations of nitrogen (mostly as bioavailable NO_3) and phosphorous (mostly as bioavailable PO_4) were predicted to be discharged from the lake bed after 15 to 27 years, respectively. Nitrogen is widely considered to be the limiting nutrient for plant and algal growth in the marine and estuarine environment.

Under scenarios 1 and 3 neither nitrate nor phosphate from effluent would reach the lake in groundwater within the 57 year modelled period and only the flux of freshwater would increase to the lake receiving environment. Under these scenarios substantive impacts to nutrient cycling and vegetation response would not be expected. However a reduction in mean salinity resulting from the freshwater discharge in the saltmarsh community may result in a change in community structure that favours more freshwater tolerant species to proliferate.

Under scenario 2, the worst case scenario modelled, the discharge of year 2025 estimated disposal volumes to a 400 m exfiltration trench located in BVSC land in the dunes east of the airport would potentially contribute an additional 6.7% of total nitrogen per year to Merimbula Lake (AECOM 2013). This load of nitrogen would enter the system through the benthic environment first and would likely result in increased growth of benthic microalgae, or micro-phyto benthos (MPB) and macroalgae such as filamentous brown alga. Local seagrass productivity would potentially benefit from an increased flux of both inorganic nitrate and phosphate, though the proportion of nutrients assimilated by seagrasses would likely be less than the total proportion assimilated by faster growing algal species including the benthic and pelagic microalgae and macroalgal epiphytes.

At high densities, burrowing fauna may be the dominant process of porewater advective exchange. This could be an important mechanism for enhancing the release of nutrients from the lake bed to be flushed away from the immediate site by tidal currents. It is predicted that the site would be completely flushed on a daily basis effectively diluting and transporting nutrients discharged from sediments away from the site.

The significance of the above potential impacts would also depend on the ability of local hydrodynamics to flush concentrations of nutrients entering the water column out to the ocean. Existing literature suggests that the lake on the whole has very good tidal flushing. However, the backwater area known as Golf Course Lake has a reduced capacity for flushing and longer water residence times and is potentially a more vulnerable area to increased nutrient concentration discharges from groundwater.

The potential for Aboriginal skeletal material and burial contexts to be present in the Merimbula Bay barrier landform is high. Aboriginal skeletal material has been found previously within the landform and is consistent with burial site locational patterning elsewhere along the south coast. The exact location of burial sites in respect of a dunal exfiltration system cannot be predicted.

Construction within the central dune area would impact upon Dune Scrub vegetation dominated by Coast Banksia (*Banksia integrifolia*). Dune Scrub forms a buffer behind which the less salt and wind tolerant eucalypt forests can develop. Construction may also impact upon eucalypt forest dominated by Bangalay (*Eucalyptus botryoides*), depending on the exact location of the exfiltration trench and in particular, how far north it extends. This community is listed as the Endangered Ecological Community (EEC) Bangalay Sand Forest of the NSW Sydney Basin and South East Corner Bioregions, under the *Threatened Species Conservation Act 1995*.

Infrastructure Requirements

Commentary for STP upgrades for disposal of effluent is provided in Fact Sheet 14.

Infrastructure requirements for Effluent Disposal System Option 2, inclusive of the STP upgrades are shown in Table 1. Also shown in Table 1 are Capital and Net Present Value (NPV) costs and relative performance criteria for 2025 projected STP loadings.

Table 1 Effluent Disposal System Option 2 Features and Performance Summary

Infrastructure requirements	Alum and caustic dosing system for phosphorus removal and pH correction Improved chlorine dosing disinfection system Ultraviolet (UV) disinfection system 400m exfiltration trench in the dunes Transfer infrastructure (including pumps and pipelines) Groundwater level and quality monitoring bores		
Scheme Capital Cost (for infrastructure requirements)	$3,606,000	**NPV Cost (30 years)**	$4,529,000
O&M Cost per annum	$72,000	**Greenhouse Gas Emissions kg CO2-e per annum**	33,660

Key Opportunities:

- Relatively small capital and construction cost compared to other disposal system options
- Proven technology
- Subject of numerous investigations confirming the dune system has the hydraulic capacity for future disposal of volumes during wet and dry weather
- Potential to combine with deep alluvial aquifer injection system, constructed wetland or aquifer recharge and recovery system
- Majority of effluent disposed would flow east in groundwater to Merimbula Bay
- Groundwater migration provides long residence times for pathogen die-off and nutrient concentration reduction, particularly the proportion that would flow west towards Merimbula Lake

Key Constraints:

- A number of statutory approvals will require consideration through consultation with respective agencies under the Commonwealth and State legislation: *Environment Protection and Biodiversity Conservation Act 1999* (SEWPaC), *Fisheries Management Act 1994* and *NSW Oyster Industry Sustainable Aquaculture Strategy 1996* (DPI Fisheries), *Threatened Species Conservation Act 1995* (EPA Threatened Species Unit), and *SEPP 71 – Coastal Protection* and *SEPP 14 – Coastal Wetlands* (DoPI).
- Construction footprint of >10,000m^2 , including the clearing of native dune vegetation which may result in the potential for dune destabilisation and impact on Bangalay Sand Forest EEC
- The potential for Aboriginal heritage sites to exist within the proposed footprint and surrounds
- The potential for clogging of the system by algae and suspended solids in the effluent
- Sea level and lake level rise would impact negatively on the system
- The potential for attenuation for phosphate and inorganic nitrogen in the sand aquifer may be limited over time
- A proportion of the effluent would flow in groundwater towards Merimbula Lake

Figure 1 Scheme 2 Plan View

Fact Sheet 13

Effluent Disposal Option 3

Deep Alluvial Aquifer Injection

Deep Alluvial Aquifer Injection is a disposal option involving the pumping of effluent into the deep confined alluvial sequence associated with the former Pambula River. Deep wells would be constructed by drilling bore holes to the required depth (estimated 60 metres or more) and pumping effluent into the deep alluvial sequence. Deep disposal was previously recognised as a potentially promising option for effluent disposal on the assumption that sensitive receptors such as the Merimbula and Pambula Lakes would not be affected. The effluent would instead likely discharge to the ocean at some distance offshore where the Pambula River paleo-channel intersects with the ocean floor.

A feasibility assessment of deep aquifer injection (Parsons Brinckerhoff (PB), 2004) confirmed the existence and location of a deep aquifer beneath the coastal dune system, comprising coarse sand and inter-bedded clay. There remained some uncertainty as to whether the lower sequence was soft sandstone bedrock or unconsolidated alluvium, however based on published geology of the area, it was considered most likely that the lower sequence comprised Tertiary alluvium.

The PB (2004) assessment used a combination of geophysical techniques (4 km of resistivity imaging transects and vertical resistivity soundings) and test drilling of a pilot hole to refusal at a total depth of 61.55 m.

The resistivity imaging identified three sites where there existed the potential for the presence of thick sequences of unconsolidated alluvial sediments. The resistivity imaging also informed the location for drilling the pilot bore.

The pilot borehole was drilled and converted to a groundwater monitoring bore with screens located in coarse sand layers at approximate depths of 34-37 m and 46-58 m. Two constant rate discharge hydraulic tests were conducted indicating a transmissivity of about 50 m2/day and a hydraulic conductivity varying between 1 m/d and 10 m/d.

A preliminary estimate of potential effluent disposal discharge rates of between 0.24 ML/day and 0.39 ML/day were suggested, from a large diameter injection well.

The investigation concluded that there remains substantial uncertainty regarding conditions in the deep groundwater system and that further investigations are required to more fully determine effluent disposal potential. Requirements for further investigation included construction of a test injection well, a long-term (one month) pumping test, hydrochemical studies and groundwater modelling. Further consideration would also need to be given to well losses and the potential for clogging.

AECOM consultants estimated future 2025 peak average dry weather flow (ADWF) disposal volumes of 2,870 kL/day. If a deep alluvial aquifer injection system was to accommodate this disposal volume, then seven (7) to eight (8) injection wells would be required. Allowing for effluent reuse and a lower ADWF would reduce the number of wells required. However allowing for peak wet weather flows (PWWF) of over 18 000 kL/d, would require possibly up to fifty (50) wells at some distance apart. A deep aquifer injection system would need to be combined with another disposal system to cope with PWWF discharge events.

Infrastructure Requirements

Commentary for STP upgrades for disposal of effluent is provided in Fact Sheet 14.

Infrastructure requirements for Effluent Disposal Option 3, inclusive of the STP upgrades are shown in Table 1. Also shown in Table 1 are Capital and Net Present Value (NPV) costs and relative performance criteria for 2025 projected STP loadings.

Table 1 Effluent Disposal Option 3 Features and Performance Summary

Infrastructure requirements	Alum and caustic dosing system for phosphorus removal and pH correction Improved chlorine dosing disinfection system Ultraviolet (UV) disinfection system 8 deep injection wells Transfer infrastructure (including pumps and pipelines)		
Scheme Capital Cost (for infrastructure requirements)	$13,883,000	**NPV Cost (30 years)**	$15,633,000
O&M Cost per annum	$138,000	**Greenhouse Gas Emissions kg CO2-e per annum**	71,720

Key Opportunities:

- Unlikely to affect sensitive receptors such as Merimbula and Pambula Lakes

Key Constraints:

- Deep aquifer hydraulic conductivity, chemistry, flow paths and capacity for injection of effluent into the deep alluvial aquifer are not well understood.
- Limited potential to accommodate wet weather flows, therefore requiring use in combination with another disposal system
- Higher construction and operational costs than shallow dunal exfiltration options
- Relatively high ongoing pumping requirements and associated greenhouse gas emissions
- Increased maintenance requirements due to susceptibility of deep bores fouling
- The potential for Aboriginal heritage sites to exist within the proposed footprint and surrounds
- The potential for clogging of the paleochannel strata by biofolms

Figure 1 Effluent Disposal Option 3 Plan View

Fact Sheet 14

Additional Treatment Options

Sewage Treatment Plant Upgrade and Constructed Wetland Options

Effluent treatment options have been developed based on the requirement to improve effluent quality for existing and future effluent reuse schemes and disposal systems under consideration.

STP upgrades required for the existing reuse scheme and disposal systems include:

- Alum and caustic dosing system for phosphorus removal and pH correction
- Improved chlorine dosing disinfection system
- Ultraviolet (UV) disinfection system

Effluent treatment improvements required for potential new reuse schemes and disposal systems, in addition to the above, include:

Option 1. Effluent Irrigation Reuse and Disposal to Shallow Dunal Exfiltration with:

- N and additional P removal through constructed wetland

Option 2. Effluent Irrigation Reuse and Disposal to Shallow Dunal Exfiltration with:

- N removal through chemical dosing

Option 3. Effluent Irrigation Reuse and Disposal to Ocean Outfall with:

- No N removal

Option 4. Effluent Irrigation Reuse, Indirect Potable Reuse and Emergency Disposal to Existing Disposal Systems with:

- Advanced water treatment for indirect potable reuse

Infrastructure requirements for STP augmentation and treatment upgrade options for the existing reuse schemes, and future reuse schemes and disposal systems are illustrated in Figure 1 to Figure 4. “Black” text treatment train process units and process flow lines indicate existing infrastructure at the STP. “Red” text treatment train process units and process flow lines indicate new infrastructure is required as part of the STP augmentation and treatment upgrade.

Figure 1 Option 1 - Effluent Irrigation Reuse and Disposal to Shallow Dunal Exfiltration

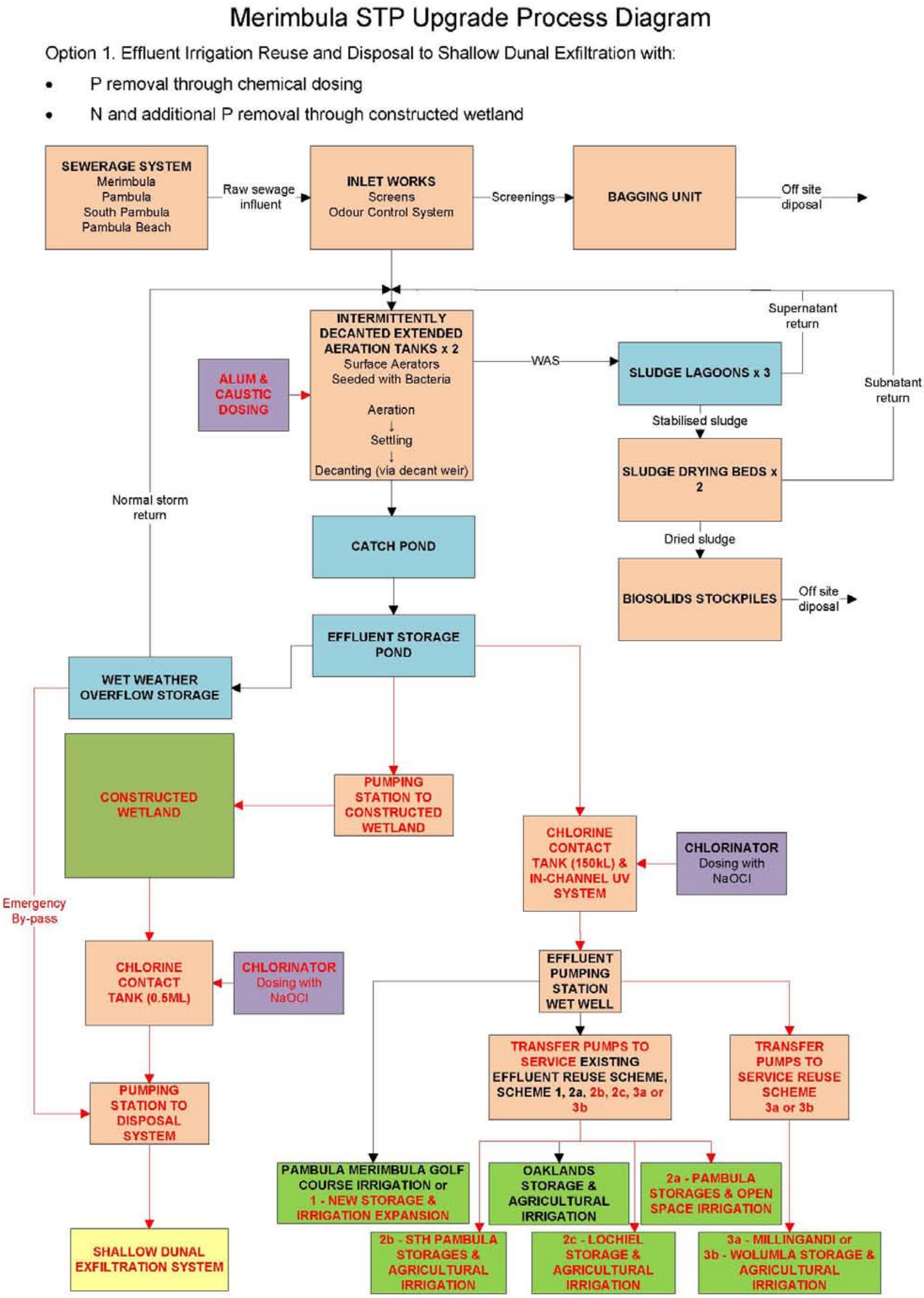


Figure 2 Option 2 - Effluent Irrigation Reuse and Disposal to Shallow Dunal Exfiltration

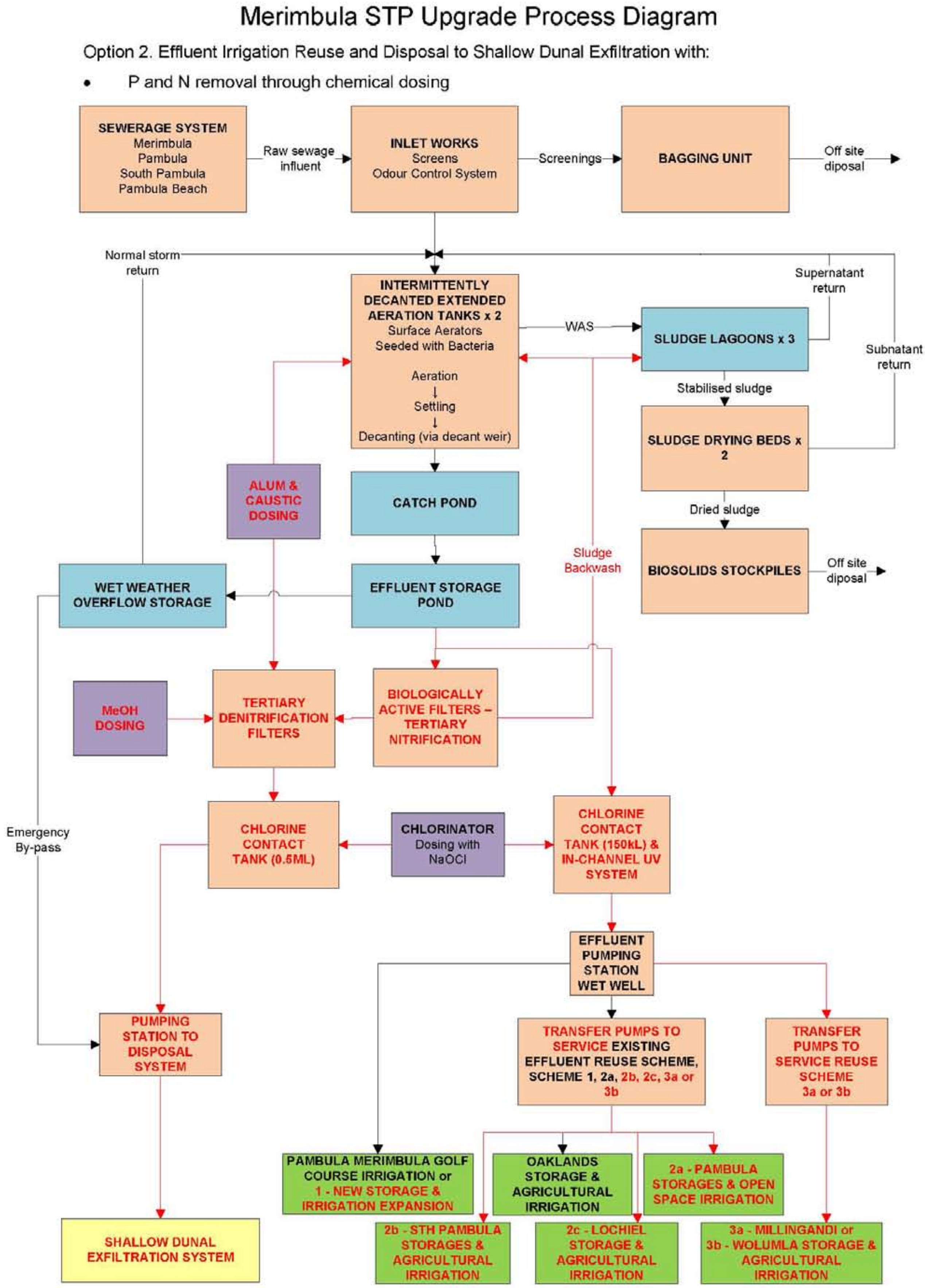


Figure 3 Option 3 - Effluent Irrigation Reuse and Disposal to Ocean Outfall

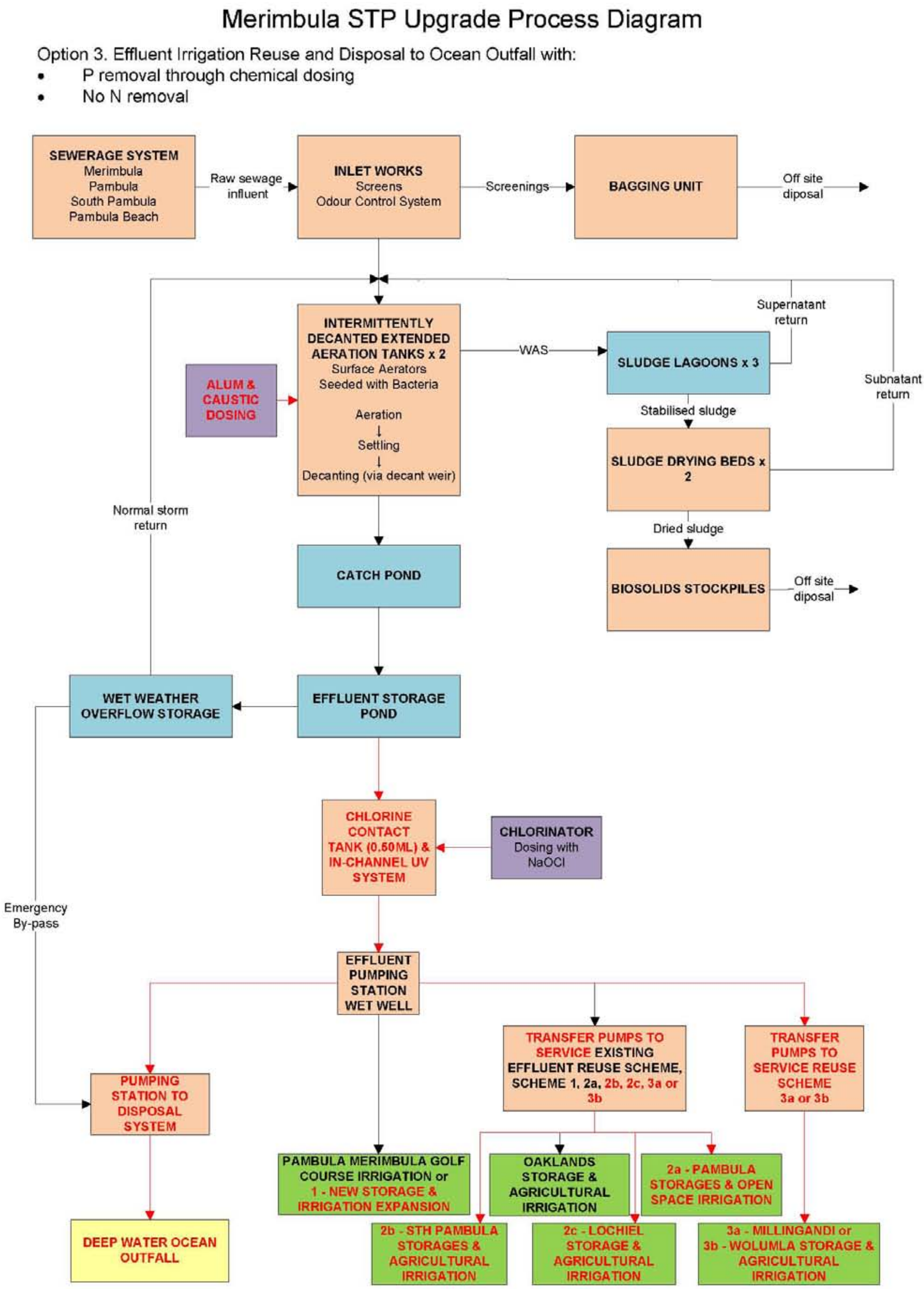
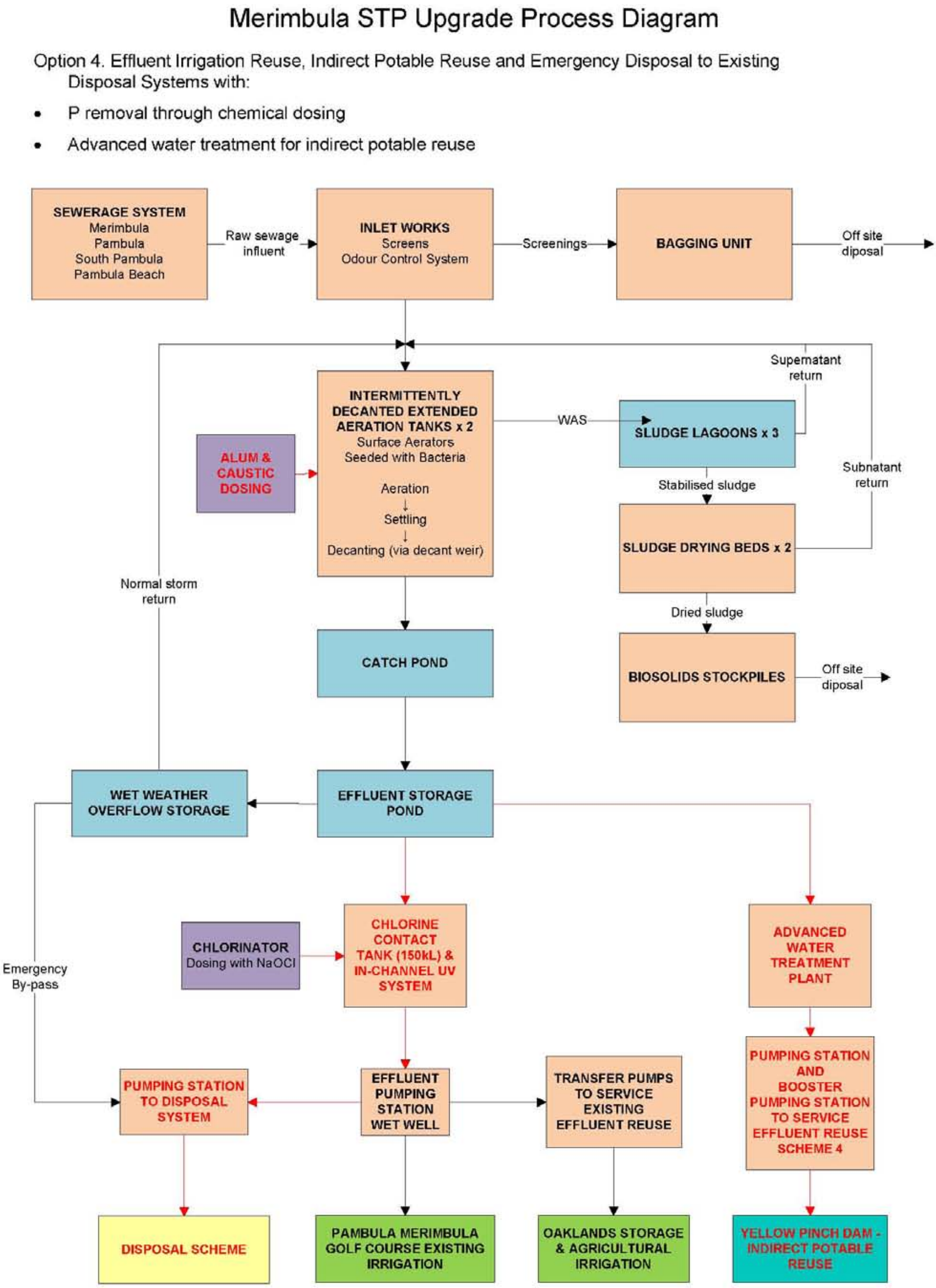


Figure 4 Option 4 Effluent Irrigation Reuse, Indirect Potable Reuse and Emergency Disposal to Existing Disposal Systems



Fact Sheet 15

Additional Nutrient Removal

Constructed Wetland

Additional treatment of the STP effluent could be provided by a constructed wetland located downstream of the STP before discharge to a shallow dunal exfiltration disposal system. A surface-flow constructed wetland would provide an environment for physical, chemical and biological processes to reduce nutrient concentrations and other contaminants in the effluent. Some of the processes which would exist within a constructed wetland would include:

- Microbial nitrification and de-nitrification to releases nitrogen as a gas to the atmosphere
- Phosphorus precipitation with iron, aluminium and calcium compounds located in the root-bed medium
- Suspended solids filtration
- Pathogenic bacteria and virus reduction by filtration and microbial processing

AECOM consultants have considered a number of locations for a constructed wetland system. A location identified is approximately 600 m south east of the STP on crown land, configured in a tiered serpentine flow path some 1,200 m long and 50 m wide, aligned parallel with the natural contours provided by the location. The size required to manage 2025 projected ADWF's would be approximately 5.25 ha. Typical nitrogen treatment capacity possible would be to reduce the 90%ile total nitrogen concentrations to below the 50%ile total nitrogen concentrations of 4.5mg/L.

The wetland could be designed to accommodate a 7-day peak week flow of 50 ML through the addition of extended detention to the wetland structure by including additional 0.75 m operating freeboard above ADWF operating level. However this would result in reduced contact time and treatment capacity. Consideration has also been given to the potential for a sub-surface flow wetland however this would not be practical for the size of wetland required.

Recent advice from the NSW Environment Protection Authority (EPA) suggests that it does not support the use of constructed wetlands for the treatment of effluent. The EPA advice is that constructed wetlands are not able to reliably treat effluent to the standards prescribed in an Environment Protection Licence (EPL), or to levels necessary to ensure protection of environmentally sensitive areas.

The EPA has advised that should Council choose to incorporate the use a constructed wetland as part of a treatment option, performance and licence discharge limits would likely be set upstream of the wetland.

The existence of the nearby Panboola wetlands on the southern side of the Pambula demonstrates the value which wetland environments offer the many people who come for recreational purposes to the wetlands every year. The Panboola wetlands offer nature conservation, protection and restoration of habitat for birds and other indigenous flora and fauna, and community education and passive enjoyment through numerous boardwalks, cycle tracks and picnic tables. There is opportunity through the development of a wetland area downstream of the STP to supplement the environmental and community values currently offered by the Panboola Wetlands. Importantly, a constructed would provide a green initiative for the treatment of effluent from Merimbula STP prior to disposal.

Infrastructure requirements and Capital and Net Present Value (NPV) costs for the Constructed Wetland option are shown in Table 1. A plan view of the scheme is provided in Table 1.

Table 1 Constructed Wetland Features, Capital and NPV Costs

Infrastructure requirements	Approximately 5 ha of tiered serpentine constructed surface flow wetland Transfer infrastructure (including pumps and pipelines) Chlorine dosing disinfection system prior to dunal exfiltration		
Scheme Capital Cost (for infrastructure requirements)	$8,050,000	**NPV Cost (30 years)**	$8,978,000
O&M Cost per annum	$72,000	**Greenhouse Gas Emissions kg CO2-e per annum**	23,140

Key Opportunities:

- Provides treatment through nitrification and de-nitrification, phosphorus precipitation, suspended solids filtration and microbial processing and filtration of pathogens
- Offers habitat for birds and other indigenous flora and fauna
- Detention could be extended to accommodate peak wet weather flows to effectively operate as a large balancing storage
- A potential environment for community education and passive enjoyment
- A green initiative for the treatment of effluent from Merimbula STP prior to disposal to a shallow dunal exfiltration system

Key Constraints:

- The NSW EPA may not support the use of constructed wetlands for the treatment of effluent, with performance and licence discharge limits likely to be set prior to a constructed wetland, negating any treatment benefit offered
- Operational control to achieving consistent and reliable nutrient removal may be difficult, particularly during high flows
- Chlorination would need to occur after the wetland, requiring the construction of a second chlorinator
- Increased pumping to and from wetland to ensure flow is transferred between the STP and the disposal system

Figure 1 Constructed Wetland System Plan View

Fact Sheet 16

Additional Nutrient Removal

Biologically Active Filters and De-Nitrifying Filters with Methanol Dosing

Additional treatment, specifically for the purposes of reducing effluent total nitrogen concentrations of the STP effluent could be provided by the addition of biologically active filters (BAF) followed by de-nitrifying filters with the addition of methanol.

The BAF and de-nitrifying filters would be placed downstream of the effluent storage pond as shown in Figure 2 of Fact Sheet 14.

The BAF process consists of a granular media bed, usually of vitrified clay particles through which pre-treated effluent is passed under gravity flow. Constant aeration results in aerobic biological growth on the media and nitrification through microbial process by which ammonia is sequentially oxidized to nitrite and then to nitrate.

The de-nitrification filters may be operated in a downflow or upflow configuration. Downflow denitrification filters operate in a conventional filtration mode – requiring regular backwashing – and consist of media and support gravel supported by an underdrain. Upflow continuous-backwash filters differ in that influent wastewater flows upward through the filter, counter-current to the movement of the sand bed. In both configurations, the filter media supports growth by facultative anaerobes which flourish in the anoxic conditions of the filter. The facultative anaerobes promote the denitrification of the effluent, a process by which nitrates are reduced to gaseous nitrogen.

A readily biodegradable organic compound (a carbon source) must be available for de-nitrifiers to facilitate the conversion of nitrate to gaseous nitrogen. As most of the organic material present in raw sewage is oxidised through the upstream treatment process, some organic material must be added to the filter influent to sustain the growth of the de-nitrifiers. The carbon source most often selected is methanol. As a result, methanol storage and dosing facilities must accompany the de-nitrifying filter process.

Infrastructure requirements and Capital and Net Present Value (NPV) costs for the Biologically Active Filters and De-Nitrifying Filters with Methanol Dosing are shown in Table 1.

Table 1 BAF, Denitrifying Filters and Methanol Dosing Features, Capital and NPV Costs

Infrastructure requirements	Biologically activated filters for tertiary nitrification Tertiary de-nitrification filters Methanol dosing system		
Scheme Capital Cost (for infrastructure requirements)	$3,758,000	**NPV Cost (30 years)**	$5,908,000
O&M Cost per annum	$166,000	**Greenhouse Gas Emissions kg CO2-e per annum**	10,520

Key Opportunities:

- Provides stable treatment through nitrification and de-nitrification
- Relative capital cost is less than Constructed Wetland
- Additional treatment of biochemical oxygen demand and suspended solids
- Provides tertiary filtration for more efficient removal of phosphorus

Key Constraints:

- Relative operating cost is more than Constructed Wetland
- Increased on-site chemical storage required
- Higher operational complexity and skill requirements
- Hazardous chemical storage requirements