SOLO Water

Water Utility Solutions

# Catherine Hill Bay Water Utility

## Land Capability Assessment for Effluent Irrigation

Montefiore Street, Catherine Hill Bay

October 2014

Water Utility *Solutions*

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# 1 Introduction

Solo Water has entered into an agreement with the Rose Property Group/Coastal Hamlets to provide an integrated water, sewerage, recycled water and retail service provider solution for the approved residential subdivision at Catherine Hill Bay. The provision of private water services is permitted under the Water Industry Competition (WIC) Act (NSW Government, 2006) and is administered by the NSW Independent Pricing and Regulatory Tribunal (IPART, 2014).

The scheme will be owned, operated and maintained by the Catherine Hill Bay Water Utility (CHBWU) and funding for the scheme will be provided through rating of individual customers in the scheme as is the case with conventional water authorities, e.g. Hunter Water. The CHBWU will take on all risks associated with the scheme and will operate the scheme in accordance with the license issued by IPART.

This Land Capability Assessment for Effluent Irrigation has been prepared to demonstrate there is sufficient land available on site for sustainable management of surplus recycled water by irrigation.

The Solo Water integrated water scheme uses advanced water recycling and dual reticulation that allows for approximately 70% of all wastewater generated to be managed by urban non-potable reuse on private lots. The remaining 30% is managed by controlled irrigation of restricted access open space areas within the approved development footprint.

This report focuses on the management of the 40% surplus recycled water by irrigation of restricted access open space areas. Assessment of the irrigation scheme has generally been undertaken in accordance with the Australian Guidelines for Water Recycling (NRMMC; EPHC; AHMC, 2006) and the NSW Department of Environment and Conservation Environmental Guidelines: Use of Effluent by Irrigation (NSW DEC, 2004).

The issues associated with the treatment and supply of recycled water to individual lots is not covered in the scope of this report. These issues are addressed in the Recycled Water Management Plan to be developed for the scheme prior to construction of the Advanced Water Treatment Plant used to produce recycled water in Stage 2.

The irrigation area will be staged in line with the build out of the residential subdivision. Detailed irrigation management plans, landscape plans and irrigation system design will be developed based on the actual amount of irrigating area required for the number of developed lots. These plans will be developed and approved by Solo Water prior to subdivision of each stage.

## 1.1 Project Scope

The scope of this investigation is to:

- Demonstrate there is sufficient area of restricted access open space irrigation area available inside the development footprint for the sustainable irrigation of the 30% - 40% surplus recycled water;
- Provide sufficient wet weather storage volume onsite to ensure irrigation does not occur during rainfall and that uncontrolled overflows from the storage do not occur;
- Demonstrate through MEDLI modelling that the proposed hydraulic and pollutant loading rates are sustainable and unlikely to result in a significant impact or risk to the local environment;
- Demonstrate through MEDLI modelling that the wet weather storage will theoretically overflow in less than 50% of years as per the NSW EPA irrigation guidelines (2004).

# 2 Background

## 2.1 Location

The proposed scheme is located inside the approved footprint of the Catherine Hill Bay residential subdivision at Montefiore Street, Catherine Hill Bay in New South Wales. The site is located at the southern end of the Lake Macquarie City Council region. An overview of the approximate site location is provided below in Figure 2.1.

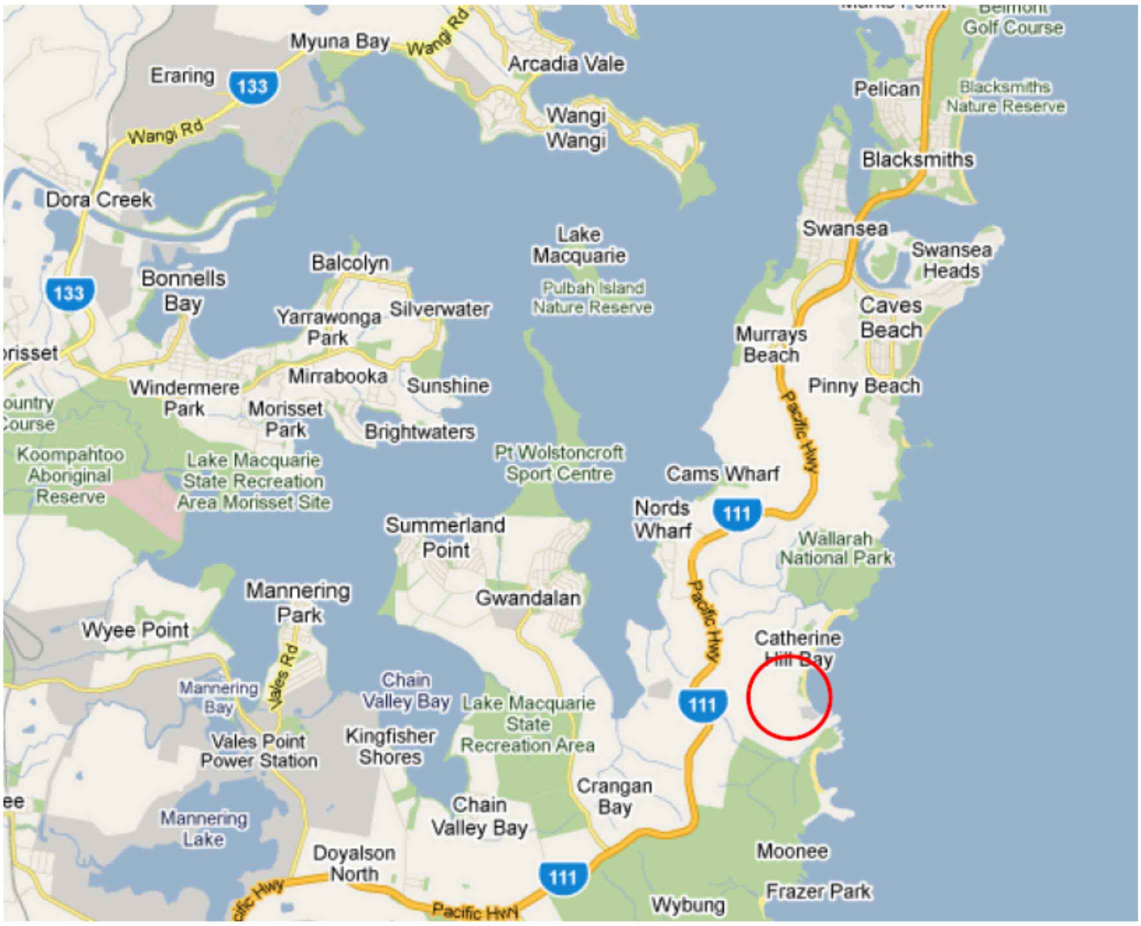


**Figure 2.1 Site Location**

## 2.2 Proposed Development

The CHBWU scheme is being proposed under the WIC Act to service the approved residential subdivision at Catherine Hill Bay being undertaken by Rose Property Group. This development received approval from the Minister for Planning in 2008 for up to 540 residential lots and associated works and facilities. The Catherine Hill Bay subdivision masterplan is included in

Appendix A. The subdivision site is located on a former coal mine; hence the site has been highly impacted and modified from coal related activities.

The proposed irrigation scheme outlined in this report will service up to 470 ET and will be located within the approved footprint of the Catherine Hill Bay subdivision. 470 ET has been assessed the maximum yield that can be sustained by irrigation within the footprint of the approved subdivision.

## 2.3 Previous Water & Wastewater Investigations

A Water and Wastewater Servicing Strategy was prepared for the original development approval by ADW Johnson Pty Ltd (ADW Johnson, 2009). The original strategy involved connection to the Hunter Water Corporation water and sewerage networks located around 8 km to the north of the site and involved the construction of large water and wastewater transfer systems.

This centralised strategy relied on input from other developments in the area and there is now significant uncertainty as when or if these external developments will proceed. The centralised strategy is considered to be too expensive and not a viable option for servicing the development. The centralised strategy will also experience operational issues during early stages of the development when septicity and water quality issues in the transfer systems will be significant.

To overcome these issues and to promote decentralised wastewater management and water recycling, the Rose Property Group has elected Solo Water as the private water utility to service their Catherine Hill Bay residential subdivision.

## 2.4 Previous Environmental Assessment & Approvals

The proposed project received a development approval from the Minister for Planning in 2008. An Environmental Impact Assessment was undertaken for this approval in relation to the residential subdivision. Environmental impact assessment for water and sewerage infrastructure was to be undertaken by Hunter Water prior to construction of assets under Part 5 of the Environmental Planning and Assessment Act.

Given the revised proposal involves the private CHBWU, the existing Development Approval has been modified to allow the proposed wastewater treatment plant building and open space effluent irrigation areas to be located within the approved development footprint.

This report provides sufficient information to demonstrate that irrigation of the proposed restricted access irrigation areas with recycled water will not result in significant environmental impacts. Additional reports will be provided in the REF for other aspects of the private water utility scheme requiring some form of environmental assessment, e.g. noise, odour.

# 3 Overview of the Solo Water Integrated Water & Wastewater Management System

Solo Water has developed a standard model for decentralised wastewater management that has been adapted to the CHBWU Scheme. This land capability assessment for irrigation of surplus recycled water has been prepared based on the Solo Water model. The Solo Water model provides a staged approach to servicing development in remote areas using advanced treatment technology, automated control systems and onsite wastewater recycling.

An overview of the Solo Water decentralised wastewater system as it is applied to the CHBWU Scheme is outlined below in Table 3.1.

**Table 3.1 Solo Water Decentralised Wastewater Management Model**

| Scheme Component | General Description |
|---|---|
| Wastewater minimisation | Water demand management strategy involving mandatory water efficient fixtures, smart metering, customer awareness and education.<br>A sealed low pressure sewerage system has been selected to minimise infiltration of stormwater and groundwater to the sewerage system. |
| Low pressure sewerage network –<br>Constructed in line with development build out | Low pressure sewerage network constructed using PN 16 HDPE pipe with welded joints and fittings to minimise infiltration.<br>Low pressure duplex pump stations service up to 4 lots with duty/standby pumps and 24 hours storage capacity in each pump well.<br>Automated operation of the low pressure sewerage network is integrated with operation of the wastewater treatment plant through the direct digital control system to minimise peak inflow rates.<br>Peak diurnal flows into the wastewater treatment plant are controlled using buffer storage provided in each pump well and at the inlet balance tank. |
| Membrane bioreactor (MBR) + Ultraviolet disinfection (UV) –<br>Constructed during Stage 1 | All wastewater is treated using MBR + UV to produce high quality effluent suitable for controlled irrigation of restricted access open space. Typical MBR effluent quality:<br>– BOD < 10 mg/L<br>– SS < 5 mg/L<br>– TN < 10 mg/L<br>– TP < 0.3 mg/L<br>– Faecal Coliform < 10 cfu/100 mL<br>– Turbidity < 1 NTU<br>The MBR + UV treatment plant has a peak design capacity of 330 kL/day.<br>The full capacity of the MBR is constructed upfront during Stage 1. |

| Scheme Component | General Description |
|---|---|
| Advanced Water Treatment Plant (AWTP) – Constructed during Stage 2 | Approximately 70% of MBR + UV treated effluent undergoes further treatment in the AWTP to produce “Class A+” recycled water suitable for supply to customers in the third pipe non-potable water reticulation network.<br>The AWTP uses a multiple barrier approach to achieve log reduction targets outlined in the Australian Guidelines for Water Recycling (NRMMC; EPHC; AHMC, 2006) using Ultrafiltration membranes, side stream Reverse Osmosis for salinity control, Ultraviolet disinfection and Chlorine contact tank and residual chlorination. All treatment processes in the AWTP will be designed to appropriate USEPA standards using equipment accredited under USEPA guidelines.<br>The AWTP includes a side stream reverse osmosis process with an 85% recovery rate that produces a waste stream that is lost from the system and managed in evaporation ponds. The AWTP and RO reject evaporation ponds will be constructed during Stage 2 and will be operational once 112 lots are connected to scheme.<br>Details associated with the AWTP and supply of recycled water to individual lots is not in the scope of this report and is presented in the Recycled Water Management Plan being developed for the scheme. |
| Third pipe non-potable water network | Compliant recycled water supplied through the urban non-potable water reticulation system is provided for the following uses:<br>– Toilet flushing<br>– Laundry washing machine cold water (hard plumbed only)<br>– Outdoor cleaning and washdown<br>– Unrestricted irrigation of private lots (gardens, lawns, nature strips)<br>The non-potable water reticulation system is supplied from 1 ML recycled water storage tanks using a variable speed drive booster pump set. Pressure in the non-potable water reticulation system is maintained below the pressure in the potable water network.<br>An emergency potable water top-up (with air gap) is used to top-up the recycled water storage tank during consecutive peak day demands for recycled water.<br>During Stage 1 only potable water is used to supply the non-potable water reticulation system until the AWTP is constructed in Stage 2. |
| Open space irrigation system | Surplus MBR treated effluent is managed by controlled irrigation of the irrigation areas to be constructed on the developer’s land inside the footprint of the approved subdivision.<br>All irrigation water is stored in 2 ML wet weather storages prior to supply via a separate independent irrigation supply network.<br>The system is designed to prevent irrigation during or shortly after rainfall through the use of weather station override on the main irrigation supply pump.<br>Automated irrigation controllers are used to schedule effluent irrigation events on the restricted access open space areas in a controlled manner using spray drift controls and vegetated buffers to minimise environmental and public health risks. |

Preliminary civil plans of the Catherine Hill Bay WWTP site are provided in Appendix B and onsite Wastewater Layout Plans including the proposed irrigation areas are included in Appendix C. Preliminary Process Flow Diagrams (PFDs) of the staged wastewater treatment process involved in the CHBWU Scheme are provided in Appendix D.

# 4 Wastewater Generation & Recycled Water Supply

## 4.1 Equivalent Population

The maximum Equivalent Tenements (ET) for the scheme that can be sustained by onsite irrigation is 470 ET. Long term occupancy for the scheme has been assessed based on an occupancy rate of 3 EP/ET, which equates to an Equivalent Population (EP) of 1410 EP for the 470 ET Catherine Hill Bay Utility scheme. During Stage 1 prior to construction of the AWTP, a maximum of 112 ET, or 336 EP, can be connected to the scheme prior to the AWTP becoming operational.

## 4.2 Wastewater Minimisation

Wastewater generation in the CHBWU Scheme will be minimised through implementation of wastewater minimisation measures. The wastewater minimisation measures will be mandatory for all lots in the scheme and will be controlled through agreements/contracts with each resident. The wastewater minimisation strategy for the CHBWU Scheme will include:

- Water efficient fixtures and appliances as per the NSW Building Sustainability Index (BASIX) (NSW Government, 2014);
- New customer contracts and access agreements that outline the responsibilities of the resident with regard to appropriate water usage and waste management practices;
- Ongoing awareness and communication with existing customers through additional information provided at each billing cycle and the CHBWU website;
- Welded polyethylene pressure sewer system to minimise infiltration; and
- Continuous monitoring of pressure sewer pump starts and hours run to detect infiltration, high water use and/or inappropriate waste disposal practices, i.e. swimming pools backwash etc.

The water efficiency and demand management requirements will be audited during the plumbing inspection.

## 4.3 Wastewater Generation

Wastewater generation for the proposed development is estimated based on the per capita wastewater generation rate of 150 L/EP/day. A nominal volumetric allowance of 10% has been made for inflow and infiltration to the pressure sewerage system. This is a conservative allowance given the scheme uses a water tight welded polyethylene sewerage system.

**Wastewater generation during Stage 1 and Stage 2 of the scheme is shown below in**

Table 4.1. During Stage 1 total inflow is estimated to be approximately 55 kL/day, increasing up to 232 kL/day at the end of Stage 2 when 470 Lots are occupied. All wastewater in the scheme will be treated in a Membrane Bioreactor (MBR) with a peak design capacity of 330 kL/day.

**Table 4.1 Wastewater Generation in CHBWU Scheme**

| Stage | Description | Total ET | Total EP | Wastewater Generation (kL/d) | Inflow & Infiltration (kL/d) | Total Inflow (kL/d) |
|---|---|---|---|---|---|---|
| 1 | MBR only | 112 | 336 | 50.4 | 5.04 | 55.44 |
| 2 | MBR + AWTP | 470 | 1410 | 211.5 | 21.15 | 232.65 |

## 4.4 Class A+ Recycled Water Demand

The demand for recycled water taken from the recycled water network was estimated based on an average per property demand of 350 L/ET/day, as per the Sydney Water Version of the WSAA Code (WSAA, 2012). Recycled water will be used for all appropriate non-potable uses including:

- Toilet flushing;
- Laundry washing machine cold water (hard plumbed);
- Outdoor cleaning & wash down, including bin and car washing; and
- Irrigation of private lots, gardens, lawns and nature strips.

The supply of recycled water into the recycled water network will commence in Stage 2 following commissioning of the AWTP. During Stage 1, potable water will be supplied into the recycled water network. The demand for recycled water at each stage is shown below in

**Table 4.2**. Following commissioning of the AWTP in Stage 2, the average demand for recycled water increases up to approximately 165 kL/day for 470 ET.

**Table 4.2 Typical Demands for "Class A+" Recycled Water on Private Lots**

| Stage | Description | Total ET | Recycled Water Demand (kL/d) |
|---|---|---|---|
| 1 | MBR only | 112 | 0 |
| 2 | MBR + AWTP | 470 | 164.5 |

## 4.5 Surplus Recycled Water for Irrigation

All surplus recycled water that is not recycled back to each house is managed by land irrigation of a dedicated irrigation area. During Stage 1 prior to construction of the AWTP, all treated wastewater will be managed by irrigation. During Stage 2 following commissioning of the AWTP, irrigation flows reduce due to the use of recycled water on private allotments.

The estimated surplus recycled water that requires management via irrigation is outlined below in Table 4.3.

**Table 4.3 Surplus Recycled Water Available for Controlled Irrigation of Restricted Access Open Space**

| Stage | Total ET | Total Inflow (kL/d) | Non-Potable Water Supply (kL/day) | Treatment System Losses^ (kL/d) | Surplus for Irrigation (kL/d) | Conservative Value used in Assessment |
|---|---|---|---|---|---|---|
| 1 | 112 | 55.4 | N/A | ≈1 | ≈54.4 | 55 kL/day |
| 2 | 470 | 232.6 | 164.5 | ≈10.6 | ≈ 57.5 | 85 kL/day |

^ Treatment system losses include 2% waste sludge from the MBR and 15% RO Reject from the AWTP.

It can be seen from Table 4.3 that at the maximum yield of 470 ET, there will a surplus of approximately 57.5 kL/day that will require management via irrigation. To be conservative in planning the effluent irrigation scheme, the effluent irrigation area has been sized based on an average daily surplus recycled water of 85 kL/day to take into account the uncertainty in actual recycled water usage and wastewater generation in a scheme that is not yet operational.

# 5 Assessment of Effluent Irrigation Areas

## 5.1 Effluent Irrigation Areas

The proposed irrigation areas are shown in Appendix C. The irrigation area will be constructed on private land owned by the developer in the future development stages 6 and 7. Future Stages 6 and 7 includes the entire parcel of land to the north of Montefiore Road, hence it is isolated from existing and future residential areas.

Future Stage 6 and 7 occupy a total development area of approximately 14.7 ha, of which 8.5 ha is suitable for effluent irrigation once the following buffers have been applied, as shown in Appendix C:

- Minimum 30 metre buffer to down gradient property boundary;
- Minimum 40 metre buffer to down gradient property boundary in the steeper North East corner of the irrigation area;
- 20 metre buffer to up gradient property boundary;
- No irrigation within the 40 metre wide future waterway corridor; and
- Minimum buffer to the nearest residential dwelling is 70 metres.

The total 8.5 ha of irrigation area will be staged in line with the rate of development and wastewater generation.

## 5.2 Site and Soil Assessment

A site and soil assessment for effluent irrigation has been undertaken for the restricted access open space effluent irrigation areas provided within the CHBWU Scheme.

A site and soil assessment has been undertaken based on the existing information provided from the Environmental Assessment prepared for the existing planning approval of the residential subdivision. Following approval of the IPART license more detailed assessment will be undertaken at each of the future development stages through detailed soil testing and documentation of effluent irrigation area management plans.

The preliminary site assessment in this report was generally undertaken in accordance with the following effluent irrigation and recycled water guidance documents:

- NSW Department of Environment & Conservation - Environmental Guidelines: Use of Effluent by Irrigation (NSW DEC, 2004);
- Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (NRMMC; EPHC; AHMC, 2006);
- Australian Standard for On-site Domestic Wastewater Management AS1547 (AS/NZS, Feb 2012).

A summary of the preliminary site assessment is provided below in Table 5.1.

**Table 5.1 Summary of Site Assessment**

| Parameter | Preliminary Assessment of Site Constraints for Effluent Irrigation |
|---|---|
| **Climate** | Review of BOM and MEDLI model climate data indicates average annual pan evaporation exceeds average annual rainfall.<br>Site specific MEDLI climate data derived for the site by the QLD Department of Science, Information Technology, Innovation and the Arts, indicates the site receives an average annual rainfall of 1217 mm/yr and average annual pan evaporation of 1431 mm/yr.<br>This corresponds to an average annual rainfall-evaporation deficit of 214 mm/year, or approximately 0.6 mm/day. Given that evaporation exceeds rainfall, climate is not likely to be a significant constraint to effluent irrigation, provided there is sufficient irrigation area and wet weather storage. |
| **Exposure** | The irrigation area is located on a north facing slope with good exposure to sunlight even during winter months to assist with plant growth and evapotranspiration. The site also receives good exposure to winds to assist with evaporation. |
| **Topo-graphy** | The proposed irrigation areas are located on undulating terrain with levels varying from 20 to 45 m AHD with average slope across the irrigation areas of approximately 10%.<br>To minimise the potential for soil erosion the following controls are to be implemented:<br>– Diversion drains along uphill slope to divert upslope stormwater around the irrigation areas;<br>– Catch drain/swale along the downhill boundary of irrigation areas;<br>– Dense deep rooted grass vegetation will be established, e.g. kikuyu pasture;<br>– Low application rate sprinklers are to be used;<br>– No irrigation during rainfall when there is increased potential for run off;<br>– Contour mounds to be constructed at intervals of approximately 30-50 metres;<br>– 30 metre down gradient buffer to the property boundary. |
| **Surface Water and Flooding** | All effluent irrigation areas are located within the urban development footprint of the approved residential subdivision, hence flooding is not an issue.<br>Effluent irrigation in the Possum Gully Reserve in low lying gullies between the two irrigation areas will be avoided.<br>The proposed effluent irrigation scheme includes a 2 ML wet weather storage so effluent is stored during and shortly after periods of rainfall, hence this is not considered a significant constraint.<br>The following stormwater controls are to be implemented:<br>– Diversion drains along uphill boundary of irrigation areas to divert upslope stormwater around the irrigation areas;<br>– Catch drain/swale along the downhill boundary of irrigation areas;<br>– No irrigation in low lying or water logged areas;<br>– Dense deep rooted grass vegetation will be established, e.g. kikuyu pasture;<br>– Low application rate sprinklers are to be used;<br>– No irrigation during rainfall;<br>– 30 metre down gradient vegetated buffer. |

| Parameter | Preliminary Assessment of Site Constraints for Effluent Irrigation |
|---|---|
| **Vegetation** | The site has been previously cleared from former coal mining related activities. Additional clearing and earthworks is being undertaken as part of the approved residential subdivision.<br>All irrigation areas are located inside the footprint of the approved subdivision, hence issues associated with clearing of native vegetation and earth works were dealt with the in the EIS for the residential subdivision.<br>Vegetation in the irrigation areas shall be established by a landscape specialist using a dense deep rooted turf species, e.g. kikuyu pasture. |
| **Soils** | Geotechnical investigation of the site undertaken by Geotech Solutions Pty Ltd (Geotech Solutions, 2010) indicates the natural soils across the site consists of:<br>– Clean Aeolian quartz sand overlying silty and clayey quartz sand;<br>– A mixture of sand, gravel, clay and silt overlying extremely to highly weathered rock;<br>– Higher plasticity clays at depth near the interface of bedrock;<br>– Triassic and late Permian age bedrock.<br>Given the site's former use as a coal mine, topsoil conditions vary across the site based on the specific mining activities that have previously occurred, e.g. stockpiles, tailings dams, earthworks etc.<br>Post development soil conditions will vary from what is currently on site due to the remediation works being undertaken by the coal mine and the bulk earth works that will occur as part of the residential subdivision.<br>During establishment of the open space areas by the developer, a minimum of 100 mm of high quality sandy loam topsoil sourced from the site and other areas will be used to develop suitable soil conditions for plant growth in the irrigation areas.<br>Given the high sand content of the top soil layers where effluent will be applied, issues associated with poor drainage, sodicity, soil pH and soil salinity are not expected to be a significant constraint to effluent irrigation.<br>Average irrigation rates have been kept low at around 1 mm/day to minimise the potential for deep drainage and contamination of groundwater.<br>Detailed evaluation of soil physical and chemical properties will be undertaken following land clearing and earth works activities and if required appropriate soil amendments will be added, i.e. organics, gypsum, nutrients etc. |
| **Ground Water** | Geotechnical investigation undertaken by Geotech Solutions Pty Ltd (Geotech Solutions, 2010) indicated minimal groundwater was encountered in the upper soil profile where effluent irrigation will occur.<br>Groundwater is expected to occur at depth in the rock strata that underlies the site, hence contamination of groundwater from effluent irrigation is not expected to be a significant constraint provided application rates are controlled.<br>Some localised areas of the site were noted to be susceptible to water logging during extensive rain periods, particularly in areas of the site impacted by mining activities, e.g. where dams and ponds had been filled.<br>Average irrigation rates have been kept low at around 1 mm/day to minimise the potential for deep drainage and contamination of groundwater.<br>The proposed irrigation scheme includes a 2 ML wet weather storage to enable effluent to be stored during and following periods of heavy rainfall when localised saturated soil conditions may occur. |

| Parameter | Preliminary Assessment of Site Constraints for Effluent Irrigation |
|---|---|
| **SEPP 14 Wetlands** | A SEPP 14 wetland exists to the south of the residential development site.<br>The proposed effluent irrigation areas are located on the northern side of Montefiore Rd and are in a separate catchment to the SEPP 14 wetland, hence there is no potential for effluent irrigation activities to impact the wetland. |
| **Rock Outcrops** | The geotechnical report noted minimal rock outcrops are present in the site, except for some areas around the headland in the eastern extreme of the site. No effluent irrigation is occurring on the headland. There are no rocky outcrops identified within the proposed effluent irrigation areas.<br>Any areas of rock outcrop identified during site earthworks will be avoided for effluent irrigation or adequate topsoil cover provide. Any such areas identified will be included in the Effluent Irrigation Management Plan prepared at each stage of the development build out. |
| **Land Use** | All treated effluent irrigation will be on private land within the footprint of the approved residential subdivision.<br>The existing village of CHB is located approximately 400 metres east of the irrigation areas. The nearest future residential dwelling within the Coastal Hamlets approved subdivision will be >70 metres from the irrigation area.<br>The neighbouring land use is a Nature Reserve. A 30 metre wide vegetated buffer is being provided down gradient (>40 metres in steep areas in the NE corner of the site) and a 20 metre wide vegetated buffer up gradient is being provided between the irrigation areas and the property boundary. |
| **Site Water Supply** | There is currently no potable water supply in the area and all existing dwellings rely on the use of rainwater tanks and water cartage.<br>The CHBWU will be providing a potable water supply to the future residential subdivision. The water source for the drinking water supply will be potable water supplied under a volumetric supply agreement with Wyong Council.<br>Given the recycled water use at the site, a cross connection and backflow prevention strategy will be employed to ensure water quality in the potable water system is maintained. |

# 6 Effluent Quality Hazard Assessment

A preliminary effluent quality hazard assessment has been undertaken for the restricted access irrigation areas be irrigated with MBR + UV treated recycled water.

The restricted access open space irrigation water supply is MBR + UV treated recycled water. The proposed MBR + UV treatment train will produce high quality effluent. No log reduction is being claimed for the MBR membranes, however a USEPA accredited UV disinfection unit pre-validated to achieve a 3-log reduction in bacteria and protozoa at a UVT 60% is being provided to disinfect MBR permeate prior to irrigation.

The effluent quality Hazard Analysis and Critical Control Points (HACCP) for the proposed recycled water supply system that supplies AWTP treated recycled water to individual lots will be included in the Recycled Water Management Plan (RWMP) for the scheme. Commissioning and validation requirements of the AWTP are outlined in the RWMP and will be undertaken prior to the supply of recycled water to individual lots.

An overview of the preliminary effluent quality hazard assessment for the proposed restricted access irrigation system is outlined below in Table 6.1.

**Table 6.1 Preliminary Effluent Quality Hazard Assessment for MBR + UV Treated Recycled Water**

| Effluent Quality Hazard | Effluent Quality Target | Control Measures |
|---|---|---|
| Microbiological hazards – bacteria, protozoa and viruses | Faecal Coliform < 10 cfu/100 mL<br>Log Reduction Targets for municipal irrigation from Table 3.7 in the Australian Guidelines for Water Recycling (NRMMC; EPHC; AHMC, 2006):<br>– Bacteria – 4 log reduction<br>– Protozoa – 3.7 log reduction<br>– Viruses – 5.2 log reduction | MBR + UV treatment train will achieve:<br>– Faecal Coliform < 10 cfu/100 mL<br>– Turbidity < 1 NTU<br>– UVT >60%<br><br>To be conservative and reduce validation testing requirements no log reduction credits are being claimed for the membrane bioreactor.<br>A USEPA accredited UV disinfection unit prevalidated to achieve a 3-log reduction in bacteria and protozoa at a UVT 60% is being provided to treat MBR permeate prior to irrigation.<br>In addition to the 3-log reduction being achieved by the UV, log reduction targets are also being achieved through the following site controls (NRMMC; EPHC; AHMC, 2006):<br>– Restricted access & signage – 3 log<br>– Buffers to residential dwellings – 1 log<br>– Spray drift control irrigation system design and automatic weather station over ride – 1 log<br>The WWTP SCADA system undertakes continuous online monitoring and control with alarms on MBR permeate turbidity, trans-membrane pressure, dissolved oxygen, flow, UV Transmission and UV intensity.<br>An automatic weather station will also be used in the SCADA system to ensure irrigation does not occur during rainfall or strong winds. |
| pH | pH 6.5 – 8.5 | The WWTP includes continuous online monitoring of pH and automated pH correction dosing facilities. |
| BOD | BOD < 10 mg/L | The WWTP includes continuous online monitoring of DO and MLSS with automated alarm systems. Air supply to the MBR is controlled using a variable speed aeration system. |
| Nutrients – Nitrogen and Phosphorus | Total Nitrogen <10 mg/L (50%ile)<br>Total Phosphorus <0.3 mg/L (50%ile) | High quality MBR effluent with low nutrients.<br>Low irrigation rates and per hectare nutrient loads.<br>Appropriate irrigation management and stormwater management practices to reduce the potential for surface runoff of nutrients to waterways will be employed.<br>Assessment of nutrient loads using the MEDLI model as discussed in Section 7. |

| Effluent Quality Hazard | Effluent Quality Target | Control Measures |
|---|---|---|
| Salts | TDS <1000 mg/L, varies with inflow characteristics.<br>Sandy topsoil profile will assist with flushing salt through the soil profile during heavy rain. | Appropriate selection of vegetation species in effluent irrigation areas that can tolerate salt concentrations.<br>Low irrigation rates and per hectare salt loads.<br>Assessment of salt loads using the MEDLI model as discussed in Section 7. |
| Sodium Adsorption Ratio (SAR) | Predominately sandy top soil profile is unlikely to pose a significant risk of Sodicity.<br>No effluent quality target for SAR is proposed. | Irrigation water SAR and soil ESP will be monitored annually during operation.<br>If Sodicity impacts are observed in operation Gypsum application to irrigation areas will be undertaken, and/or addition of Ca/Mg at the WWTP to reduce effluent SAR to <5. |
| Trace contaminants | Majority domestic catchment with minimal trade waste inputs, hence there is low likelihood of trace contaminants being present. | Residential customer supply agreements, trade waste agreements and ongoing awareness and education with water bills will assist to reduce this risk.<br>Detailed annual monitoring for trace metals and other contaminants will be undertaken during operation. If detected an investigation into the source will be undertaken and rectified.<br>Given the use of low pressure sewerage system, raw water quality monitoring from individual pump wells can be undertaken to identify the source of contaminants if required. |

A more detailed risk assessment tables based on the recommendations in the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) (NRMMC; EPHC; AHMC, 2006) was conducted and is presented in Appendix F of this report.

# 7 Effluent Irrigation Scheme Water Balance Modelling

## 7.1 Introduction

Water and pollutant balance modelling of the open space effluent irrigation scheme was undertaken using the MEDLI model version 1.3 (Model for Effluent Disposal by Land Irrigation) developed by the Queensland Department of Natural Resources (Department of Natural Resources, 1998).

MEDLI is a daily water and pollutant balance model that uses derived site specific daily rainfall, pan evaporation, temperature and solar radiation data to simulate the water balance, plant growth and nutrient and salt transport in an irrigation system.

MEDLI modelling was undertaken to demonstrate the proposed CHBWU Scheme complies with the requirements outlined in the Environmental Guideline - Use of Effluent by Irrigation (NSW DEC, 2004).

Under the NSW DEC (2004) Use of Effluent by Irrigation Guideline, schemes involving irrigation of “low strength” effluent are permitted an overflow discharge from the wet weather storage in 50% of years. Effluent quality requirements for NSW DEC (2004) low strength effluent and a comparison with the proposed Solo Water MBR effluent quality is provided below in Table 7.1.

**Table 7.1 Comparison of NSW DEC (2004) Low Strength Effluent with MBR & AWTP Effluent**

| Parameter | NSW DEC (2004) Low Strength Effluent | Surplus Recycled Water Quality |
|---|---|---|
| Indicative Treatment Level | Secondary treatment | Tertiary treated MBR + UV<br>Faecal Coliforms <10 cfu/100 mL<br>Turbidity < 1 NTU |
| Biochemical Oxygen Demand | <50 mg/L | <10 mg/L |
| Total Nitrogen | <50 mg/L | <10 mg/L |
| Total Phosphorus | <10 mg/L | <0.3 mg/L |
| Total Dissolved Solids | <600 mg/L | <1000 mg/L dependant on influent conditions |
| Overflow Frequency | Storage overflows in <50% of years | Storage overflows in <50% of years |

As indicated above in Table 7.1, the proposed Solo Water MBR produce high quality effluent with low nutrient concentrations that exceeds the effluent quality requirements for low strength effluent under the NSW DEC (2004) guidelines. The water balance has also been designed to minimise the risk of overflow from the wet weather storage by using a large storage with low average irrigation rates. This strategy will therefore result in less environmental impacts than the standard NSW DEC model.

## 7.2 Performance Objectives

The following performance and environmental objectives have been developed for the planning and design of the effluent irrigation scheme:

- Provide sufficient irrigation area, wet weather storage and appropriate irrigation rates to ensure overflows occur in less than 50% of years based on historic climate data;
- Maximise plant uptake of nutrients and ensure long term build up or export of nutrients from irrigation areas does not occur;
- Minimise the potential for contamination of surface and groundwater by scheduling irrigation events to replenish soil moisture and avoid irrigation during or shortly after rainfall;
- Minimise the size of irrigation area and wet weather storage by scheduling irrigation events to generally occur every day except rain days; and
- Ensure the salt loading onto irrigation areas does not result in reductions in plant yield or accumulation within the soil profile.

The above performance objectives have been demonstrated through MEDLI modelling of the proposed effluent irrigation scheme, as outlined in the following sections of the report.

## 7.3 MEDLI Modelling

MEDLI modelling of the effluent irrigation scheme servicing 470 ET was undertaken to demonstrate the proposed scheme is sustainable in terms of water, nutrient and salt loads applied through irrigation.

MEDLI modelling based on 100 years of historic local climate data has shown the above performance objectives have been achieved.

### 7.3.1 Model Input Parameters

The input parameters used in MEDLI modelling are summarised below in Table 7.2. More information on the MEDLI modelling inputs is provided in the MEDLI Summary Output in Appendix E.

**Table 7.2 Summary of Input Parameters used in MEDLI Modelling**

| Modelling Parameter | Adopted Value |
|---|---|
| Irrigation Flow | Maximum average daily flow: 85 kL/day<br>Note: Conservative maximum flow, the calculated surplus recycled water based on the water balance in Section 4.5 is 57.5 kL/day. |
| Effluent quality | Total Nitrogen – 20 mg/L<br>Total Phosphorus – 1 mg/L<br>Total Dissolved Solids – 1,500 mg/L<br>Note: Conservative concentrations as the MBR will achieve average nutrient concentrations of TN 10 mg/L and TP 0.3 mg/L. |
| Irrigation area | 8.5 ha |
| Wet weather storage | 2 x 1 ML tanks |
| Climate data | 100 years of derived daily local climate data for coordinates 33.2° S, 151.6° E. |
| Modelling period | 100-year historic modelling period from 1/1/1912 to 31/12/2011. |
| Soil type | The standard MEDLI soil type “sand” was used with minor adjustments to the number of layers and layer thickness.<br>A conservative soil profile was modelled using the standard MEDLI “sand” soil type with a 100 mm sandy topsoil layer over a 500 mm sandy subsoil layer. |
| Crop type | Standard MEDLI crop type “temperate pasture”. |
| Irrigation scheduling | General philosophy: “No irrigation during wet weather”<br>Irrigation Scheduling:<br>• Irrigation Trigger: Soil moisture < 100% Plant Available Water Capacity;<br>• Minimum Irrigation Application: 0 mm<br>• Maximum Irrigation Application: Drained Upper Limit + 3 mm<br>Daily irrigation volumes are calculated in the MEDLI model based on climatic conditions.<br>The average daily irrigation rate (equivalent to DIR) is approximately 1 mm/day. |

### 7.3.2 Modelling Results

**Average Water Balance Results**

MEDLI modelling was undertaken based on the input parameters and performance targets presented above. A summary of average water balance results from MEDLI is provided below in Table 7.3. Water balance modelling indicates the proposed scheme is predicted to achieve >98.9% reuse with overflows from the wet weather storage occurring in 38% of years based on historic climate data.

**Table 7.3 Summary of Average Water Balance Results**

| | Parameter | Ultimate |
|---|---|---|
| **Wet Weather Storage** | Max Tank volume (ML) | 2 ML |
| | Average volume (ML) | 0.35 ML (17.5% full) |
| | Effluent inflow (ML/year) | 31.05 ML/year |
| | Climate inputs (ML/year) | 0.1 ML/year |
| | Irrigation (ML/year) | 30.63 ML/year |
| | Tank overflow (ML/year) | 0.32 ML/year |
| | Volumetric % Reuse | 98.94% |
| | Average overflow frequency | Overflows occurred in 38% of years |
| **Irrigation Area** | Irrigation Area (ha) | 8.5 ha |
| | Rainfall (mm/year) | ≈ 1217.6 mm/year |
| | Irrigation (mm/year) | ≈ 360.4 mm/year |
| | Evapotranspiration (mm/year) | ≈ 765 mm/year |
| | Runoff (mm/year) | ≈ 2 mm/year |
| | Deep drainage (mm/year) | ≈ 811 mm/year |

### Average Pollutant Balance Results

Review of resultant nutrient and salt loadings on the 8.5 hectare irrigation area was undertaken using MEDLI. A summary of this assessment is provided below in Table 7.4.

**Table 7.4 Summary of Average Nutrient and Salt Balance Results from MEDLI**

| | Parameter | Ultimate |
|---|---|---|
| **Nitrogen Balance** | Nitrogen added in irrigation | 68.6 kg/ha/year |
| | Nitrogen removed by plant uptake | 83.6 kg/ha/year |
| | Nitrate concentration in deep drainage | <0.1 mg/L |
| | The irrigation scheme is considered sustainable in terms of nitrogen loading as the plant uptake of nitrogen is predicted to exceed the amount of nitrogen applied in effluent irrigation.<br>Some supplementary organic nitrogen fertilisers may be required.<br>Nitrate export from the irrigation area is minimal as the predicted nitrate concentration in deep drainage is <0.1 mg/L, which is the lowest concentration predicted by MEDLI. | |
| **Phosphorus Balance** | Phosphorus applied in irrigation | 3.6 kg/ha/year |
| | Plant uptake of Phosphorus | 3.2 kg/ha/year |
| | Phosphorus sorption into soil profile | 0.3 kg/ha/year |
| | Phosphorus leached | <0.1 kg/ha/year |

| | Parameter | Ultimate |
|---|---|---|
| | Soil P-sorption capacity and life | 166 to 500 years |
| | Phosphorus concentration in deep drainage | <0.1 mg/L |
| | The irrigation scheme is considered sustainable in terms of phosphorous loading as the plant uptake of phosphorous is predicted to account for approximately 90% of the phosphorous applied in effluent irrigation and MEDLI indicates negligible leaching of Phosphate from the soil profile. A conservative estimate P-Sorption capacity of clean Holocene sand is 150 kg/ha (NSW DEC, 2004), with a critical P-sorption capacity estimated at 50 kg/ha (NSW DEC, 2004). This equates to a P-Sorption life of 166-500 years at the predicted adsorption rate of 0.3 kg/ha/year. The actual P-sorption life is expected to exceed this given the clay content of the sandy top soils and the increasing clay content with depth in the soil profile. | |
| Salinity | Average salinity of irrigation water | 2.4 dS/m |
| | Average salinity rainwater | 0.3 dS/m |
| | Average salinity at base of root zone | 1.1 dS/m |
| | Reduction in crop yield due to salinity | Zero |
| | The irrigation scheme is considered sustainable in terms of salt loads as MEDLI predicted no reduction in plant yield due to salinity as the EC of irrigation water in the root zone was within the salinity range of the crop. This would be expected given the relatively high rainfall in the area. | |

It can be seen from Table 7.4 that plant uptake accounts for the majority of nutrients (nitrogen and phosphorus) applied in effluent irrigation and that excessive nutrient accumulation or export from the irrigation area is not occurring, hence the proposed scheme is considered sustainable.

MEDLI modelling also indicated there were no reductions in plant yield due to soil salinity and salt accumulation within the irrigation area is not occurring. This was based on a conservative TDS of 1500 mg/L which is unlikely to be achieved with recycled water sourced from a domestic sewerage catchment.

The proposed restricted access effluent irrigation scheme is considered sustainable and there is sufficient area available and wet weather storage for the sustainable management of surplus recycled water for 470 ET.

### Review of Daily Irrigation Rates & Wet Weather Storage Volumes

Review of the MEDLI model daily output data was undertaken by exporting the detailed daily model output data into Excel. Review of daily data was undertaken to demonstrate how the proposed scheme would have operated during the historic 100-year modelling period used in the analysis.

The scheduling of irrigation is dependent on climatic conditions and soil moisture, hence future performance of the system during a finite time period will depend on future climatic conditions. Information presented below is based on historic climate data used in MEDLI modelling.

For effluent irrigation schemes that utilise a wet weather storage, irrigation rates are not the same every day. Such systems generally utilise the following three modes of operation throughout a year:

- "Normal irrigation" at average flows during dry periods → The wet weather storage is empty and irrigation is limited by the supply of recycled water;
- "No irrigation" due to rainfall or high soil moisture → The wet weather storage fills;
- "Higher irrigation" when the storage contains water → The wet weather storage empties and irrigation is limited by the irrigation demand of the crop.

A plot of the daily irrigation rate for the 100-year modelling period arranged in 1%ile increments is provided below in Figure 7.1.

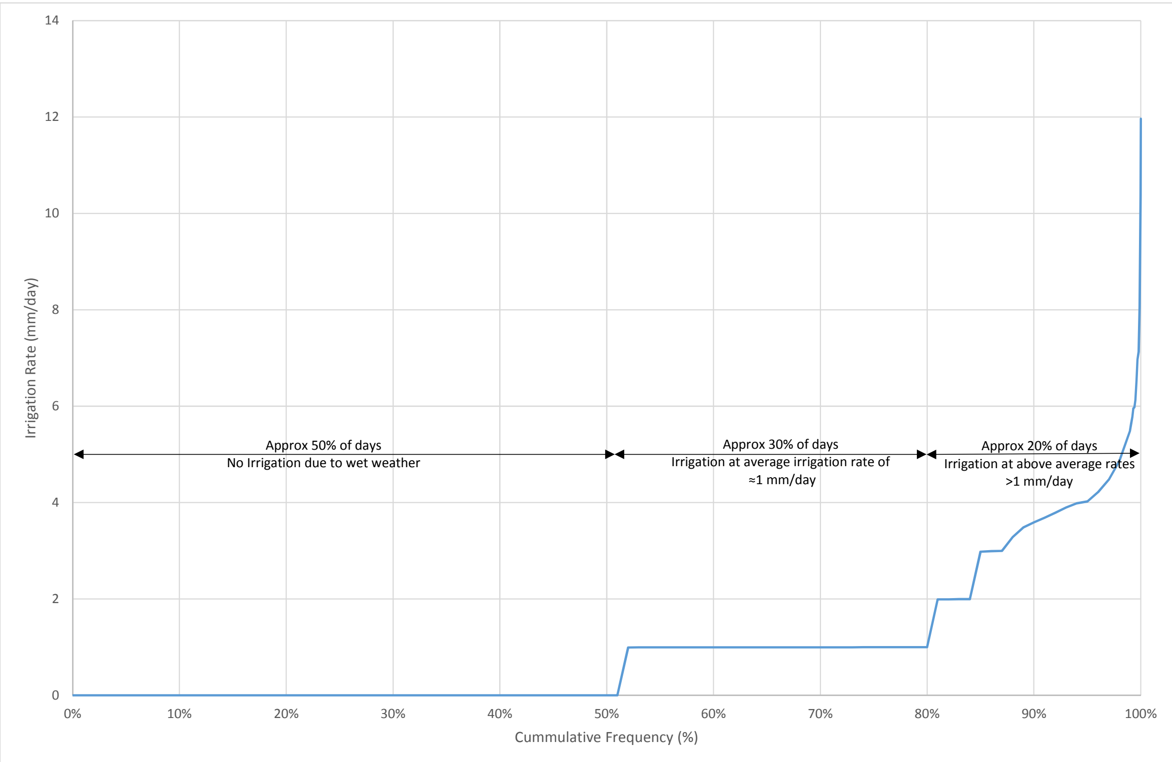


**Figure 7.1 Daily Irrigation Rate – Cumulative Frequency Plot**

Review of Figure 7.1 indicates that during the historic modelling period:

- Days with "No irrigation" due to rainfall and elevated soil moisture conditions occurred on approximately 50% of days. During such periods the wet weather storage would accumulate water.
- Days where "Normal irrigation" at average rate of <1 mm/day occurred for approximately 30% of days. During such periods the wet weather storage would typically be empty and irrigation is limited by the supply of effluent.
- Days with "Higher irrigation" >1 mm/day occurred for approximately 20% of days. During such periods the wet weather storage typically contains water and irrigation is limited by the evapotranspiration demands of the crop.

- High irrigation rates above 6 mm/day occurred infrequently on less than 1% of days and only during periods of peak evapotranspiration.

A review of the daily water levels in the 2 ML wet weather storage was also undertaken to assess performance of the storage over time. A plot of the daily volume in the wet weather storage in 1%ile increments is provided below in Figure 7.2, and a plot of volume in the wet weather storage verses time is shown in Figure 7.3.

The figures show that the end of day volume in the wet weather storage is at the assumed minimum operating volume on approximately 38% of days and overflows occur on approximately 1% of days. For a large proportion of the modelling period the majority of the storage capacity is not utilised therefore the storage will provide some buffer against future variation in climate and irrigation demands.

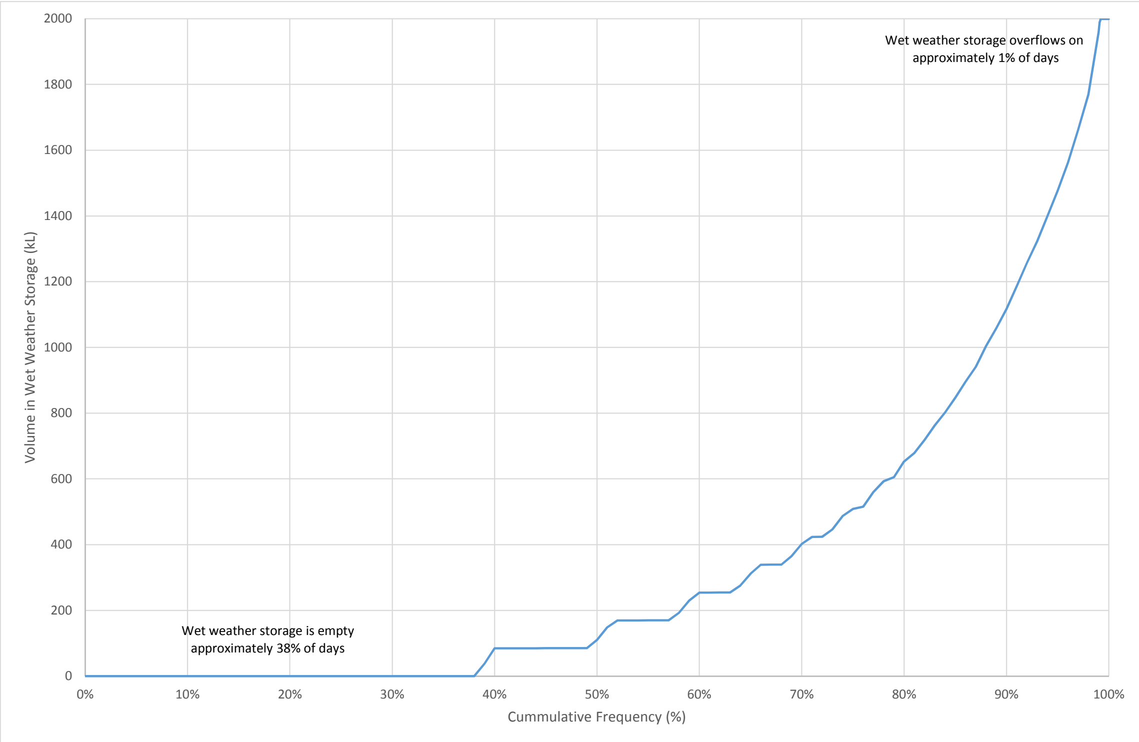


**Figure 7.2 Daily Volume in Wet Weather Storage – Cumulative Frequency Plot**

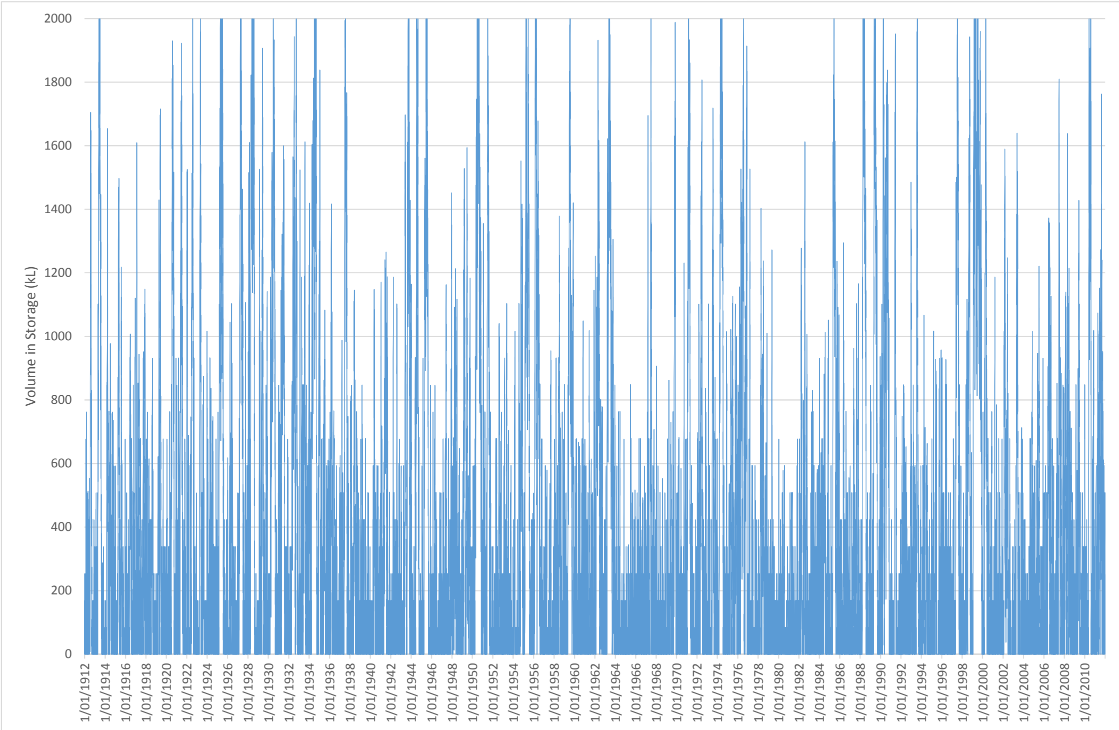


**Figure 7.3 Daily Volume in Wet Weather Storage**

A plot of the total annual overflow volume is provided below in Figure 7.4.

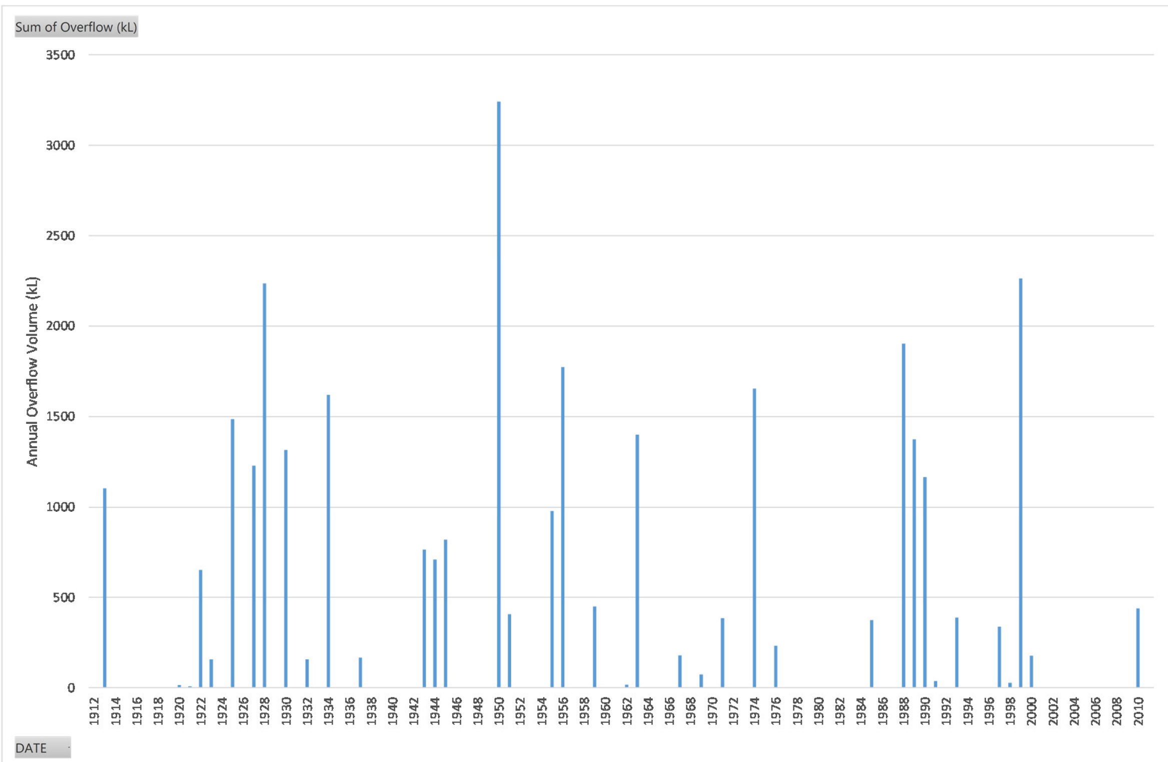


**Figure 7.4 Total Annual Overflow Volume**

It can be seen from Figure 7.4 that overflows occur in 38 years out of the 100 years in the modelling period (38% of years) which complies with the NSW DEC (2014) requirements of overflows in less than 50% of years.

# 8 Environmental & Public Health Risk Assessment

A preliminary environmental and public health risk assessment of the proposed restricted access open space effluent irrigation scheme has been undertaken. The preliminary risk assessment was undertaken based on the methodologies outlined in ISO 31000:2009 Risk management—Principles and guidelines (AS/NZS, 2009) and Australian Guidelines for Water Recycling (NRMMC; EPHC; AHMC, 2006). These documents provide a similar methodology for assessing risks that were adapted for the project as follows:

- Define context, assessment boundaries and scheme component for assessment;
- Identify hazards relevant, hazardous events and potential impacts;
- Assessment of unmitigated risk using the risk criteria in the Australian guidelines for water recycling (NRMMC; EPHC; AHMC, 2006);
- Document the risk control strategy and control measures; and
- Assessment of mitigated risk.

The preliminary risk assessment was undertaken for the following components of the onsite wastewater scheme:

- Wastewater generation and source controls;
- Wastewater Collection - Low pressure sewerage collection system;
- Wastewater Treatment Plant - Membrane bioreactor + Ultraviolet disinfection;
- Wet weather storage tanks; and
- Restricted Access effluent irrigation system.

A preliminary qualitative environmental and public health risk assessment of the sewerage system is presented in Appendix F of this report.

An overview of typical hazards and control measures is presented below in Table 8.1.

Risk assessment for the urban recycled water supply system that supplies “Class A+” recycled water to individual dwellings in the scheme is included in the Recycled Water Management Plan to be developed for the scheme prior to Stage 2 when the AWTP is constructed and commissioned.

**Table 8.1 Overview of Wastewater Scheme Hazards and Control Measures**

| Scheme Component | Typical Hazards | Typical Controls |
|---|---|---|
| Wastewater generation and source controls | Indoor water usage<br>Stormwater drainage<br>Gross pollutants<br>Chemical usage<br>Cross connections | Supply agreements with residential customers.<br>Trade waste agreements with non-residential customers.<br>Water demand management with efficient fixtures and smart metering.<br>Domestic plumbing contractor induction and training.<br>Domestic plumbing inspections during house construction.<br>Monitoring of each PSU to detect high inflows. |
| Wastewater Collection - Low pressure sewerage collection system | Inflow and infiltration<br>Sewer blockages<br>Pump faults<br>Power outage<br>Pressure main breaks | 24 hours storage in each pressure sewer unit (PSU).<br>High level alarms and flow monitoring in all PSUs.<br>PSUs are centrally controlled through the direct digital control system at the WWTP.<br>PSU start-up procedures integrated into the central control system logic to minimise peak flows to the MBR following power blackout.<br>Grinder pumps macerate sewage to minimise blockages.<br>Pressure and flow monitoring throughout the network to detect breakages.<br>Continuous online monitoring, data logging and alarms on wet well water level, pump faults, flow, electrical faults. |
| Wastewater Treatment Plant - Membrane bioreactor + Ultraviolet disinfection | Equipment failure<br>Process upset<br>Noise & Odour<br>Peak inflows<br>Power failure | Continuous online monitoring, control and alarm system for MLSS, DO, pH, transmembrane pressure, turbidity, UV intensity.<br>Continuous online fault detection for all critical mechanical electrical items.<br>Inlet buffer tank to absorb peak flows.<br>The MBR is located inside the WWTP building to minimise noise and odour impacts.<br>Sealed tanks with externally ventilated through activated carbon filters on the building roof.<br>Noise enclosures around specific noisy mechanical items.<br>Process tank overflows to the inlet balance tank.<br>Automated power failure recovery procedure integrated into direct digital control system logic.<br>Monthly effluent quality monitoring.<br>Neutralisation of MBR CIP waste and recirculation back through the MBR. |

| Scheme Component | Typical Hazards | Typical Controls |
|---|---|---|
| Wet weather storage | Human access<br>Vermin/ mosquitoes<br>Algae growth<br>Tank overflows | 2 ML storage capacity.<br>Continuous online monitoring of wet weather storage level and control of Irrigation scheduling to avoid overflows.<br>Storage tank hence no algae growth will occur.<br>Tank designed to prevent vermin access.<br>Tank located in fenced secure WWTP with locked manhole access. |
| Effluent irrigation | Human contact<br>Irrigation rates<br>Nutrient loads | Appropriate vegetation selection and soil preparation within irrigation areas.<br>Low water and pollutant loading rates in irrigation.<br>Centrally controlled irrigation scheduling and monitoring.<br>Cross connection controls.<br>Appropriate buffer distances to sensitive receptors. |

# 9 Irrigation Management

The irrigation area will be staged in line with the rate of build out of the subdivision up to a maximum 8.5 ha for 470 ET. An Irrigation Management Plan (IMP) will be prepared for the each stage of the development based on the actual irrigation areas required for the number of lots in each stage prior to connection of any dwelling to the system. The IMP will be updated as the subdivision is built out.

The IMP will include the following specific controls for health and environmental risks identified in the risk assessment processes. An overview of the controls to be included in the IMP for the scheme is outlined below in Table 9.1.

**Table 9.1 Irrigation Management Requirements**

| Issue | Measures to be Incorporated into detailed Irrigation Management Plan |
|---|---|
| Preparation of irrigation areas | During development of each stage of the residential subdivision, a minimum of 100 mm of good quality sandy loam topsoil cover is to be provided in all new irrigation areas.<br>Detailed soil testing will be undertaken following the bulk earthworks and land clearing activities. Soil testing will include assessment of top soil and sub soil physical and chemical properties as well as field permeability testing. If required soil amendments, e.g. organics, gypsum, lime etc will be incorporated into the soil profile prior to commencement of irrigation.<br>Detailed landscape design, vegetation species selection and irrigation system design plans are to be prepared for each stage of the development prior to construction. |
| Pathogen exposure controls | Restricted access irrigation area with minimum of 70 metre distance to the nearest dwelling.<br>Spray drift controls through the use of large droplet sprinklers and weather station assisted irrigation scheduling, i.e. avoid irrigation during high wind or rain.<br>Warning/advisory signage around all irrigation areas. |
| Cross connection | Separate pipe network and irrigation pump supplies water to irrigation areas.<br>Lilac pipe with identification tape and signage. |
| Irrigation scheduling controls | Irrigation scheduling to be controlled by the central control system with adjustable settings to control the time of day, frequency and duration of irrigation events.<br>Weather station sensor override on the irrigation supply pump to ensure irrigation does not occur during or shortly after rain or during high wind conditions. |
| Buffers | Minimum 30 metre buffer to down gradient property boundary.<br>Minimum 40 metres buffer to down gradient property boundary in the steeper NE corner of the irrigation area.<br>20 metre buffer to up gradient property boundary.<br>No irrigation within the 40 metre wide future waterway corridor.<br>Minimum buffer to the nearest residential dwelling is 70 metres. |

| Issue | Measures to be Incorporated into detailed Irrigation Management Plan |
|---|---|
| Monitoring | Continuous online monitoring of turbidity, UVT%, UV intensity and other critical process parameters at the WWTP.<br>Monthly effluent quality compliance monitoring.<br>Detailed annual effluent quality monitoring for trace contaminants.<br>Annual soil monitoring.<br>Flow monitoring to each irrigation zone.<br>A detailed monitoring plan will be developed prior to commencement of operation. |

# 10 Responsibilities

The CHBWU is responsible for all aspects of the operation and maintenance of the treated effluent irrigation system. The developer is responsible for development and installation of the effluent irrigation areas.

Critical Responsibilities of the Treated Effluent Irrigation Scheme are outlined below in Table 10.1.

**Table 10.1 Critical Responsibilities of the Treated Effluent Irrigation Scheme**

| Issue | Responsibility |
|---|---|
| Development of treated effluent irrigation areas including topsoil, irrigation system and kikuyu pasture establishment. | Coastal Hamlets with the assistance of landscape and irrigation contractor.<br>Final sign off by CHBWU is required for compliance. |
| Operation and maintenance of the irrigation system and landscape maintenance activities. | CHBWU with the assistance of a landscape contractor. |
| Funding of the scheme. | Funding for the scheme will be worn by the developer Coastal Hamlets. |

# 11 Conclusion

This report has been prepared to demonstrate there is sufficient area of restricted access irrigation area on land provided within the approved Catherine Hill Bay residential subdivision to allow for the sustainable irrigation of surplus recycled water.

MEDLI modelling of the proposed scheme using conservative assumptions indicates that the 8.5 ha irrigation area and 2 ML wet weather storage is sustainable in terms of water and pollutant loads applied in irrigation. Modelling indicates the wet weather storage will overflow in 38% of years based on historic data and hence exceeds the requirements of the NSW EPA effluent irrigation guidelines (NSW DEC, 2004).

This report demonstrates there is sufficient irrigation area and wet weather storage available to sustainably manage the surplus recycled water from up to 470 ET by land irrigation. CHBWU will operate and maintain the irrigation area.

It is recommended the scheme be approved.

# 12 References

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Appendix A

# Subdivision Masterplan


## LEGEND

- EXISTING TREES
- PROPOSED FEATURE TREES
- PROPOSED NATIVE TREES
- SHRUB / HEATH PLANTING
- MACROPHYTE PLANTING IN BASIN
- DRY CREEK BED
- TURF
- FOOTPATHS & DRIVEWAYS
- CONCRETE SERVICE PATHS
- PICNIC TABLES & BBQ
- CHILDRENS' INTERPRETIVE PLAY

## LANDSCAPE VISION

The landscape setting will be residential development nestled within a restored and enhanced coastal landscape. A framework of planted streets and parks will provide habitat corridors, shade and environmental amenity to the development, enriching the character and identity of the site. Existing trees in the Village Park and Hamlet 1 will be retained.

The Village Park will be enhanced with new plantings, pathway and interpretive playground for the enjoyment of the residents and visitors to Catherine Hill Bay. Landscaped pocket parks are spaced around the perimeter, terminating major street views with a green vista.

Montefiore Street will be widened and planted with Eucalypts to establish an East-West 'Green Ridge'. The planted ridge defines the entry to the proposed development and forms a landscape screen and buffer from the village of Catherine Hill Bay. A compact village square will be centred within the retail precinct at the corner of Hale Street and Montefiore Street.

A pair of North South 'Green links' – pedestrian pathways with widened park verges planted with endemic trees and shrubs - will thread through the development and link the open spaces north of Montefiore Street and the Village Park to Munmorah Conservation area and Monee Beach.

A Coastal Walk is proposed to link Middle Camp Beach with the Headland. Running roughly parallel to the cliff line, the Coastal Walk will include directional and interpretive signage and connect with pedestrian pathways in the development.

## LANDSCAPE PRINCIPLES

The key landscape principles will include the following:

- Provide a robust and attractive framework of landscaped streets and local open spaces to complement the development.
- Reinforce the Coastal Villages feel by using predominantly endemic coastal species in the public and private domain
- New landscaping will ensure that the development is unified and integrated with the Conservation area backdrop
- Keep the principal ridge line(s) green, with tree canopies as the dominant feature.
- Create public open spaces for passive recreation suited to all age groups.
- Establish a safe and permeable pedestrian network throughout the development .
- Create major 'Green Links' and new pathways to linking Middle Camp Beach and parks to Monee Beach and the Headland
- Provide a high standard of design for private gardens, integrated with the new housing and contoured slopes
- Introduce water sensitive urban design principles to manage and control runoff from the site.
- Retain significant trees where possible.
- Establish a landscape maintenance and management strategy for the public domain to ensure a consistent standard and healthy vegetation cover throughout the year.

## PLANTING PRINCIPLES

The planting principles focus on the creation of a relaxed and informal coastal development dominated by landscape. The planting designs will:

- Encourage a sense of place
- Frame and enhance desirable views and screen undesirable views
- Provide scale, colour, and soften the dwellings
- Define edges
- Provide shade, windbreaks and environmental amenity
- Encourage wildlife habitat areas

The proposed planting palette is based on endemic species and select cultural plantings typical of coastal villages in the region.

0 10 20 50 100 200m 1:2500 @ A1

**PRELIMINARY Not for Construction**

| Date | Amendment | Issue |
|---|---|---|
| 13.12.10 | Planning Approval | B |
| 12.11.10 | Draft Issue for Client Review | A |

NOTES:
VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK.
REPORT ALL DISCREPANCIES TO LANDSCAPE ARCHITECT PRIOR TO CONSTRUCTION.
USE FIGURED DIMENSIONS IN PREFERENCE TO SCALED DIMENSIONS.

DRAWINGS MADE TO LARGER SCALES AND THOSE SHOWING PARTICULAR PARTS OF THE WORKS SHALL TAKE PRECEDENCE OVER DRAWINGS MADE TO SMALLER SCALE AND FOR GENERAL PURPOSES.

ALL WORK IS TO CONFORM TO RELEVANT AUSTRALIAN STANDARDS AND OTHER CODES AS APPLICABLE TOGETHER WITH OTHER AUTHORITIES' REQUIREMENTS AND REGULATIONS.

adw johnson

ROSE
Creating a quality way of living

LANDSCAPE ARCHITECT
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www.context.net.au ACN 055 972 248
context

PROJECT APPLICATION

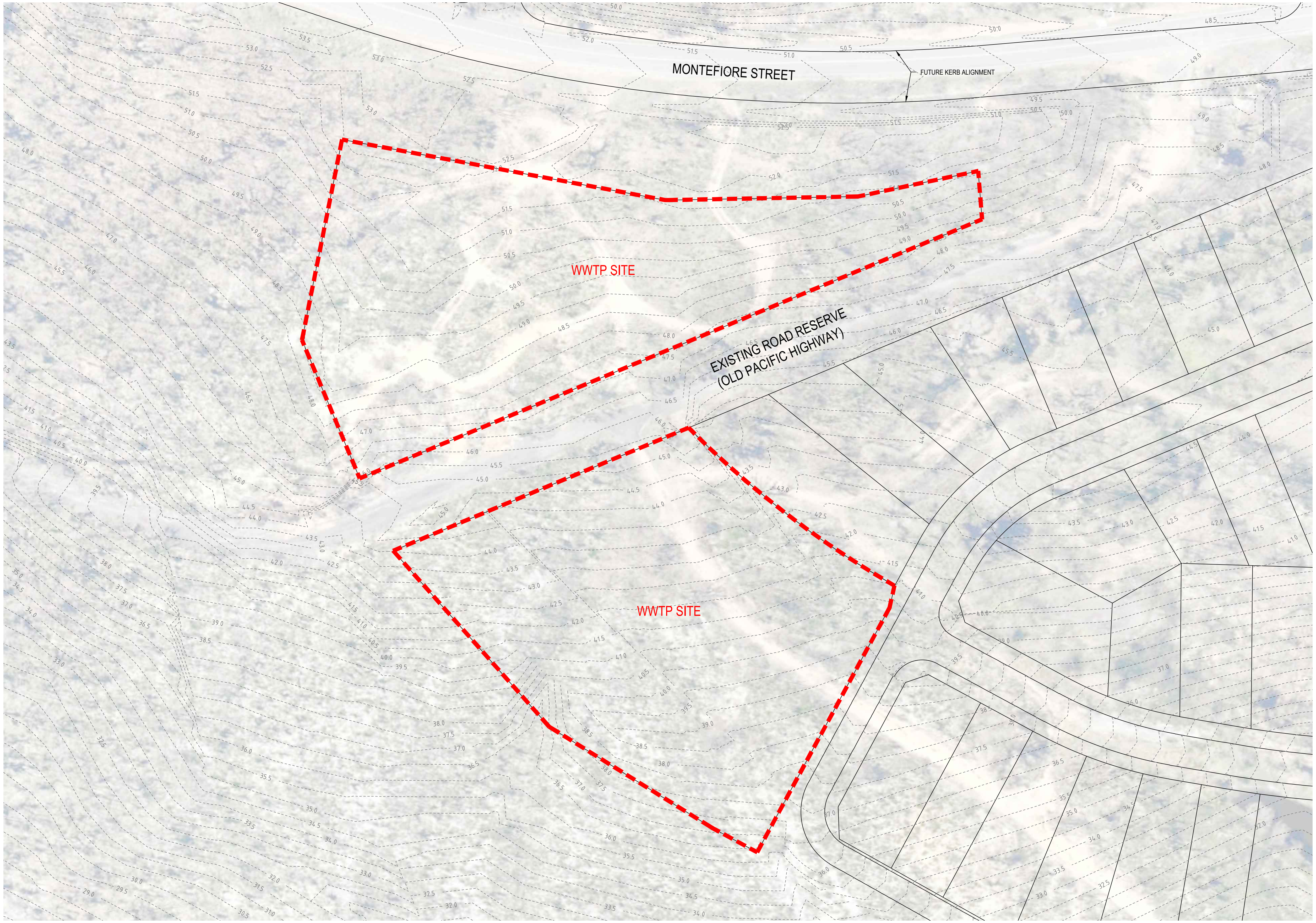
| | |
|---|---|
| Project | The Moonee Hamlets Catherine Hill Bay |
| Client | Rose Property Group Pty Ltd |

| | | | |
|---|---|---|---|
| Title | Landscape Master Plan | | |
| Date | November 2010 | Dn/Ch | JR-JD/UB |
| Drwg No | 10629-L-101 | Issue | B |

Appendix B

# WWTP Site Civil Plans

DATE PLOTTED: 13 June 2014 4:34 PM BY : LUKE WARD




NORTH

## LEGEND

| | |
|---|---|
| ▬ ▬ ▬ | PROPOSED WWTP BOUNDARY |
| - - - - 30.0 - - - - | EXISTING CONTOURS (0.5m INTERVAL) |

## EXISTING SITE PLAN

SCALE 1:500

0 10 20 30 40 50m
SCALE 1:500 @A1
SCALE 1:1000 @A3

| Rev | Date | Description | Des. | Verif. | Appr. |
|---|---|---|---|---|---|
| 1 | 13/06/2014 | ISSUED FOR REVIEW | LJW | JMK | JMK |

SOLO Water
Water Utility Solutions



Cardno
Shaping the Future
ABN: 95 001 145 035
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Phone (+61 2) 4228 4133 Fax (+61 2) 4228 6811
Email: CFR@cardno.com.au Web: www.cardno.com.au

| | | Date |
|---|---|---|
| Drawn | LJW | 12/06/2014 |
| Checked | JMW | 12/06/2014 |
| Designed | JMK | 12/06/2014 |
| Verified | JMK | 12/06/2014 |
| Approved | JMK | 13/06/2014 |

Client: SOLO WATER - CATHERINE HILL BAY WATER UTILITY

CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

EXISTING SITE PLAN

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

| Datum | Register | Scale | Size |
|---|---|---|---|
| A.H.D. | ---- | 1:500 | A1 |

Drawing Number: 8201405802-C5001 Revision: 1

XREF's: x_STAGE_1_BASE; X-CO-Contours-Existing-500
CAD FILE: U:\FY14\058-02_Catherine Hill Bay WWTP\02 - Catherine Hill Bay WWTP\Drawings\Build\8201405802-C5001.dwg


## SITE PLAN
SCALE 1:500

DATE PLOTTED: 2 October 2014 4:20 PM BY : DAMIEN COUNTER

XREF's: X-8201405802-WWTP; x-design; x_STAGE_1_BASE; X-CO-Contours-Design; X-CO-Contours-Existing
CAD FILE: U:\FY14\058-02_Catherine Hill Bay WWTP\02 - Catherine Hill Bay WWTP\Drawings\Build\82014058-02-C5002.dwg

| Rev | Date | Description | Des. | Verif. | Appr. |
|---|---|---|---|---|---|
| 5 | 2/10/2014 | SITE LEVELS AMENDED | DAC | JMK | JMK |
| 4 | 23/09/2014 | SITE LEVELS AMENDED | DAC | JMK | JMK |
| 3 | 30/07/2014 | GENERAL AMENDMENTS | LJW | JMK | JMK |
| 2 | 25/07/2014 | GENERAL AMENDMENTS | LJW | JMK | JMK |
| 1 | 13/06/2014 | ISSUED FOR REVIEW | LJW | JMK | JMK |

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Email: CFR@cardno.com.au Web: www.cardno.com.au

| | | Date |
|---|---|---|
| Drawn | LJW | 28/07/2014 |
| Checked | JMW | 28/07/2014 |
| Designed | JMK | 28/07/2014 |
| Verified | JMK | 28/07/2014 |
| Approved | JMK | 28/07/2014 |

Client: SOLO WATER - CATHERINE HILL BAY WATER UTILITY

CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

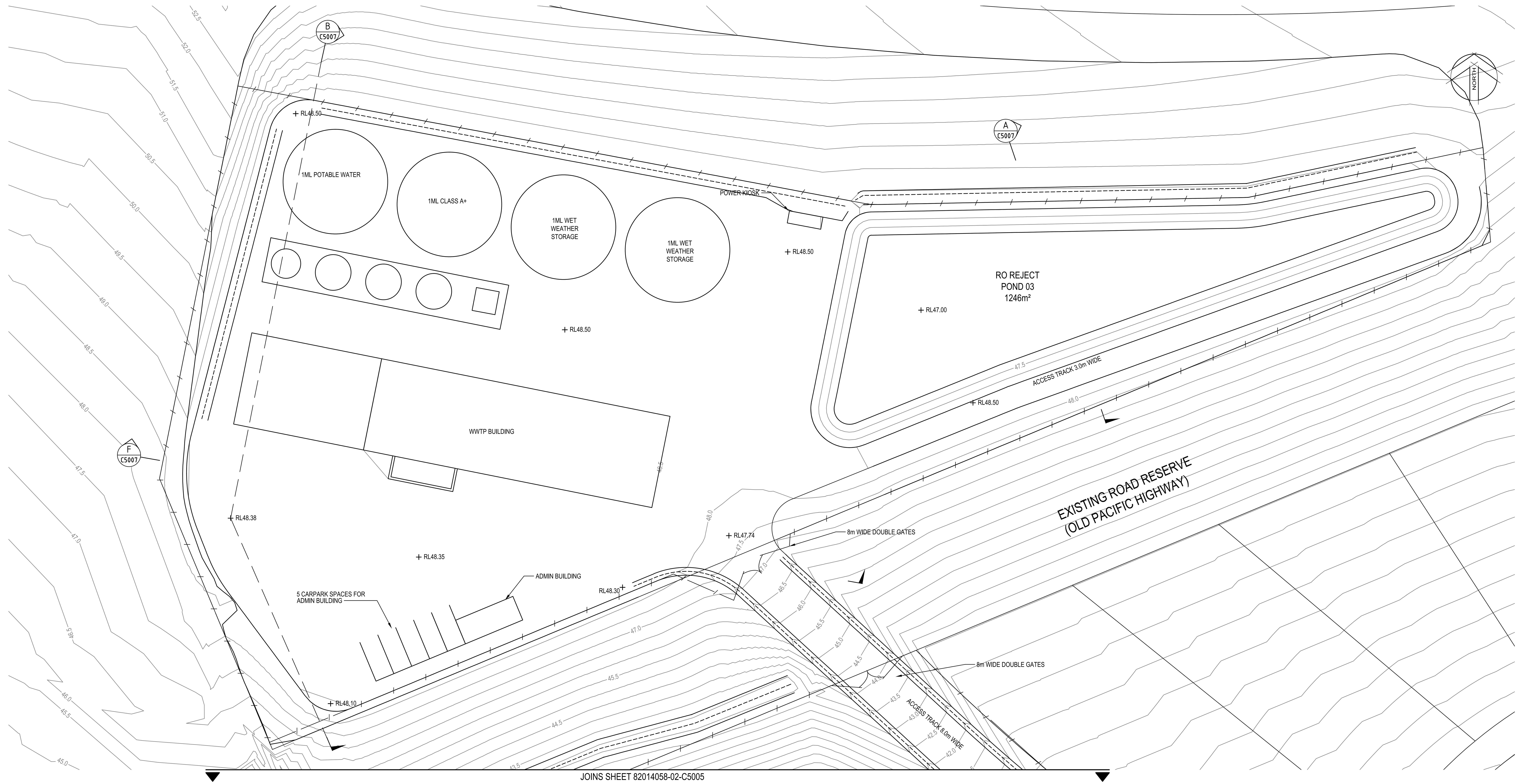
SITE PLAN

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

| AHD | Register | Scale | Size |
|---|---|---|---|
| Datum | ---- | 1:500 | A1 |

Drawing Number: 82014058-02-C5002
Revision: 5

DATE PLOTTED: 2 October 2014 4:20 PM BY : DAMIEN COUNTER




## GENERAL ARRANGEMENT PLAN 1

SCALE 1:250

**LEGEND**

PROPOSED FENCE

CONTOURS (0.5m INTERVAL)

0 5 10 15 20 25m

SCALE 1:250 @A1

SCALE 1:500 @A3

XREF's: X-8201405802-WWTP; x-design; x_STAGE_1_BASE; X-CO-Contours-Design; X-CO-Contours-Existing

CAD FILE: U:\FY14\058-02_Catherine Hill Bay WWTP\02 - Catherine Hill Bay WWTP\Drawings\Build\82014058-02-C5004.dwg

| Rev | Date | Description | Des. | Verif. | Appr. |
|---|---|---|---|---|---|
| 3 | 2/10/2014 | SITE LEVELS AMENDED | DAC | JMK | JMK |
| 2 | 23/09/2014 | SITE LEVELS AMENDED | DAC | JMK | JMK |
| 1 | 30/07/2014 | ISSUED FOR REVIEW | LJW | JMK | JMK |

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| | | Date |
|---|---|---|
| Drawn | LJW | 28/07/2014 |
| Checked | JMW | 28/07/2014 |
| Designed | JMK | 28/07/2014 |
| Verified | JMK | 28/07/2014 |
| Approved | JMK | 28/07/2014 |

Client: SOLO WATER - CATHERINE HILL BAY WATER UTILITY

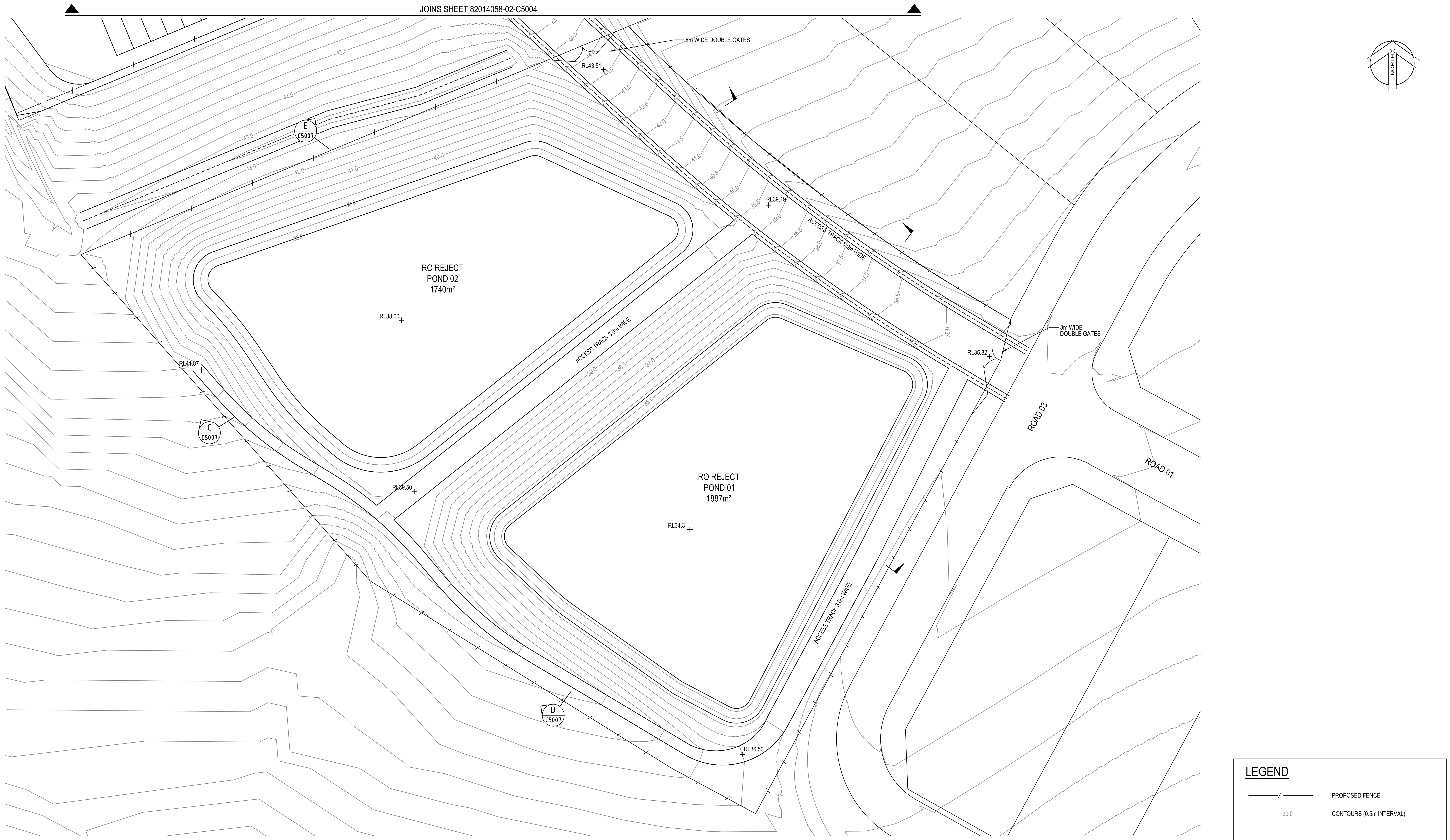
CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

GENERAL ARRANGEMENT PLAN 1

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

| AHD | Register | Scale | Size |
|---|---|---|---|
| Datum | ---- | 1:250 | A1 |

Drawing Number: 82014058-02-C5004 — Revision: 3




GENERAL ARRANGEMENT PLAN 2
SCALE 1:250

0 5 10 15 20 25m
SCALE 1:250 @A1
SCALE 1:500 @A3

| Rev | Date | Description | Des. | Verif. | Appr. |
|---|---|---|---|---|---|
| 3 | 2/10/2014 | SITE LEVELS AMENDED | DAC | JMK | JMK |
| 2 | 23/09/2014 | SITE LEVELS AMENDED | DAC | JMK | JMK |
| 1 | 30/07/2014 | ISSUED FOR REVIEW | LJW | JMK | JMK |

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| | | Date |
|---|---|---|
| Drawn | LJW | 28/07/2014 |
| Checked | JMW | 28/07/2014 |
| Designed | JMK | 28/07/2014 |
| Verified | JMK | 28/07/2014 |
| Approved | JMK | 28/07/2014 |

Client
SOLO WATER - CATHERINE HILL BAY WATER UTILITY

CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

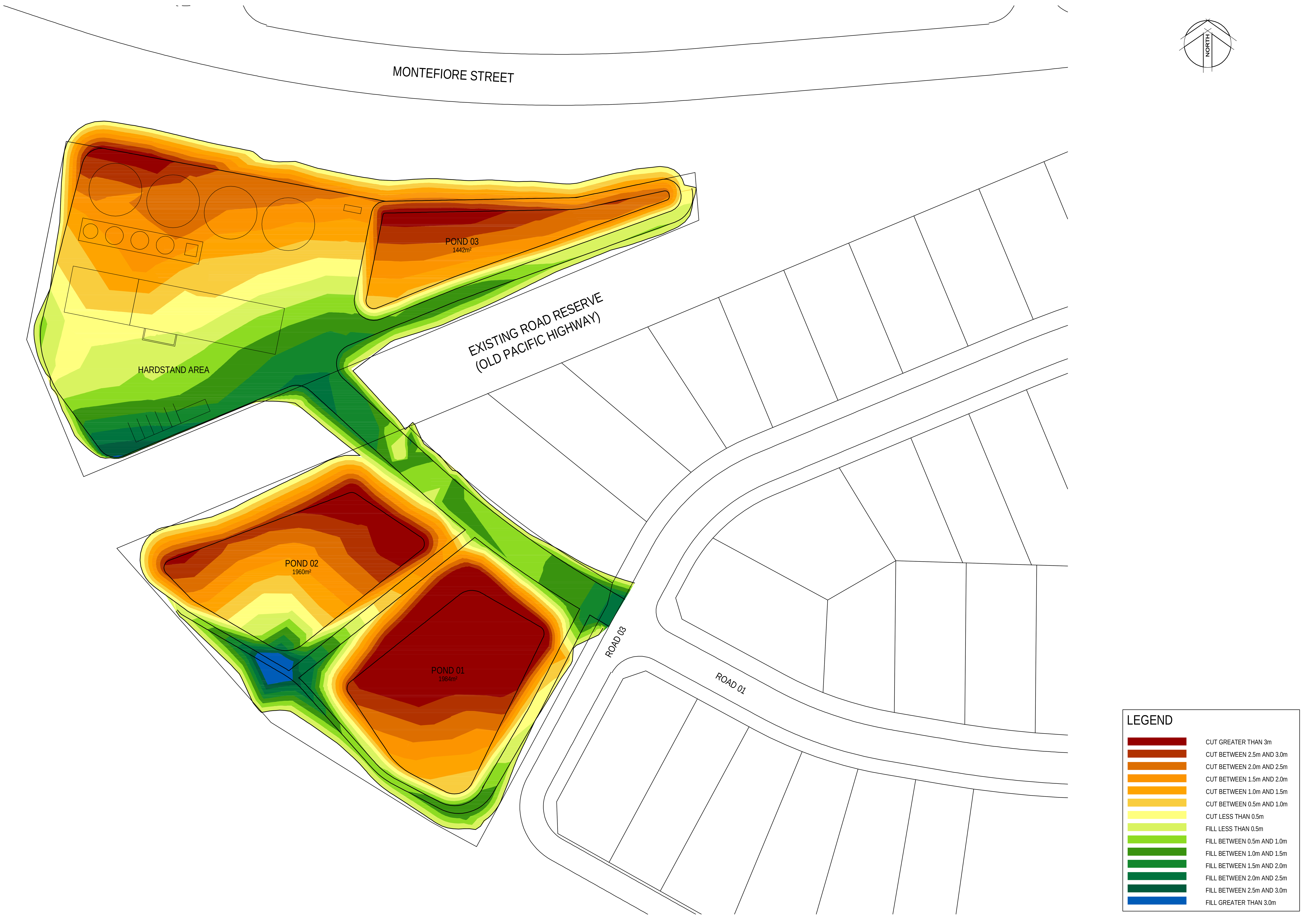
GENERAL ARRANGEMENT PLAN 2

Status
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

| AHD | Register | Scale | Size |
|---|---|---|---|
| Datum | ---- | 1:250 | A1 |

Drawing Number: 82014058-02-C5005
Revision: 3

DATE PLOTTED: 2 October 2014 4:20 PM BY : DAMIEN COUNTER
XREF's: X-8201405802-WWTP; x-design; x_STAGE_1_BASE; X-CO-Contours-Existing; X-CO-Contours-Design
CAD FILE: U:\FY14\058-02_Catherine Hill Bay WWTP\02 - Catherine Hill Bay WWTP\Drawings\Build\82014058-02-C5005.dwg




CUT/FILL PLAN
SCALE 1:500

0 10 20 30 40 50m
SCALE 1:500 @A1
SCALE 1:1000 @A3

DATE PLOTTED: 30 July 2014 9:32 AM BY : LUKE WARD
CAD FILE: U:\FY14\058-02_Catherine Hill Bay WWTP\02 - Catherine Hill Bay WWTP\Drawings\Build\8201405802-C5006.dwg
XREF's: X-8201405802-WWTP; x-design; x_STAGE_1_BASE

| Rev | Date | Description | Des. | Verif. | Appr. |
|---|---|---|---|---|---|
| 2 | 30/07/2014 | AMEND CUT FILL TO MATCH DESIGN | LJW | JMK | JMK |
| 1 | 13/06/2014 | ISSUED FOR REVIEW | LJW | JMK | JMK |

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Water Utility Solutions



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| | | Date |
|---|---|---|
| Drawn | LJW | 12/06/2014 |
| Checked | JMW | 12/06/2014 |
| Designed | JMK | 12/06/2014 |
| Verified | JMK | 12/06/2014 |
| Approved | JMK | 13/06/2014 |

Client
SOLO WATER - CATHERINE HILL BAY WATER UTILITY

CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

CUT/FILL PLAN

Status
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

| Datum | Register | Scale | Size |
|---|---|---|---|
| A.H.D. | ---- | 1:500 | A1 |

Drawing Number: 8201405802-C5006
Revision: 2

DATE PLOTTED: 2 October 2014 4:20 PM BY : DAMIEN COUNTER


| Rev | Date | Description | Des. | Verif. | Appr. |
|---|---|---|---|---|---|
| 5 | 2/10/2014 | SITE LEVELS AMENDED | DAC | JMK | JMK |
| 4 | 23/09/2014 | SITE LEVELS AMENDED | DAC | JMK | JMK |
| 3 | 28/07/2014 | GENERAL AMENDMENTS | LJW | JMK | JMK |
| 2 | 25/07/2014 | GENERAL AMENDMENTS | LJW | JMK | JMK |
| 1 | 13/06/2014 | ISSUED FOR REVIEW | LJW | JMK | JMK |

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| | | Date |
|---|---|---|
| Drawn | LJW | 12/06/2014 |
| Checked | JMW | 12/06/2014 |
| Designed | JMK | 12/06/2014 |
| Verified | JMK | 12/06/2014 |
| Approved | JMK | 13/06/2014 |

Client
# SOLO WATER - CATHERINE HILL BAY WATER UTILITY

CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

TYPICAL CROSS SECTIONS

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

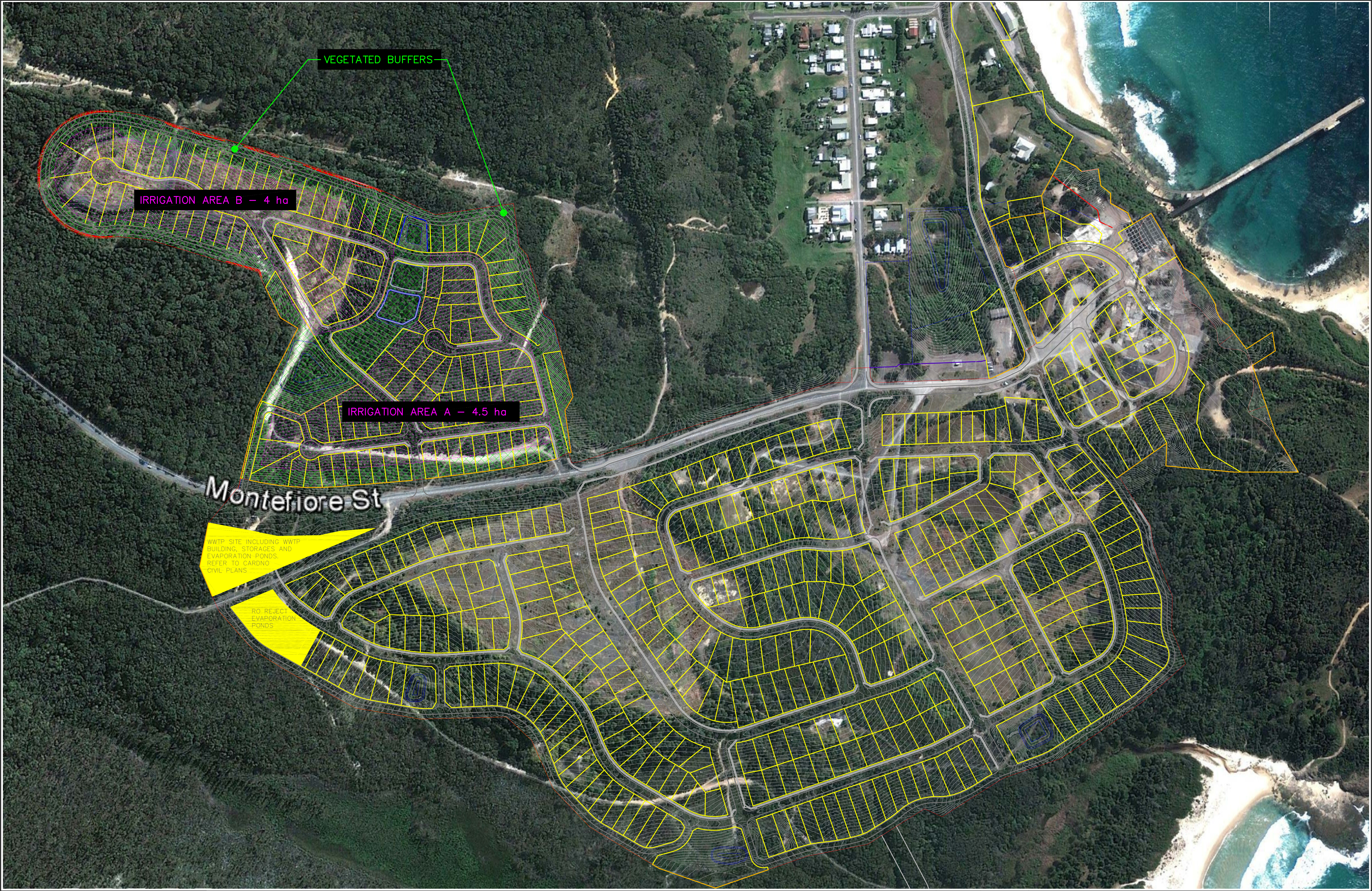
| AHD | Register | Scale | Size |
|---|---|---|---|
| Datum | ---- | 1:200 | A1 |

Drawing Number: 82014058-02-C5007
Revision: 5

XREF's: X-8201405802-RP; X-8201405802-WWTP; X-Sections
CAD FILE: U:\FY14\058-02_Catherine Hill Bay WWTP\02 - Catherine Hill Bay WWTP\Drawings\Build\82014058-02-C5007.dwg

Appendix C

# Onsite Wastewater Layout Plans




| ISSUE | DATE | ISSUE DETAILS |
|---|---|---|
| D | 25/9/2014 | TEMPORARY IRRIGATION AREA FOR PART 5 APPROVAL |
| C | 5/7/2013 | REVISED IRRIGATION AREAS FOR IPART APPLICATION |
| B | 26/6/2013 | REVISED IRRIGATION AREAS FOR DISCUSSION |
| A | 13/3/2013 | FOR LMCC COMMENT |

SOLO Water — Water Utility Solutions

Solo Water Pty Ltd
A: 22/13 Norval Court
Maroochydore QLD 4558
P: (07) 5456 6700
W: www.solowater.com.au

ROSE

CLIENT: COASTAL HAMLETS – CATHERINE HILL BAY WATER UTILITY

PROJECT: CATHERINE HILL BAY RESIDENTIAL SUBDIVISION ROSE GROUP

SITE: MONTEFIORE ROAD CATHERINE HILL BAY NSW

| DESIGN | DRAWN | APPROVED |
|---|---|---|
| BI | BI | BI |

Bradley Irwin RPEQ (10637) CPENG NPER
Environmental Engineer

Signed ______ Date ______
for and on behalf of Solo Water Pty Ltd

DRAWING TITLE: ONSITE WASTEWATER PLAN

PROJECT NO.: H10052

SCALE: 1:4000 at A3 (0 40 80 120 160 200)

DWG TYPE: CONCEPT NOT FOR CONSTRUCTION

DWG NO.: P09–2

ISSUE: D


| ISSUE | DATE | ISSUE DETAILS |
|---|---|---|
| D | 25/9/2014 | TEMPORARY IRRIGATION AREA FOR PART 5 APPROVAL |
| C | 1/7/2013 | REVISED IRRIGATION AREAS FOR IPART APPLICATION |
| B | 26/6/2013 | REVISED IRRIGATION AREAS FOR DISCUSSION |
| A | 13/3/2013 | FOR LMCC COMMENT |

SOLO Water
Water Utility Solutions


Solo Water Pty Ltd
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Maroochydore QLD 4558
P: (07) 5456 6700
W: www.solowater.com.au


ROSE

CLIENT
COASTAL HAMLETS – CATHERINE HILL BAY WATER UTILITY

PROJECT
CATHERINE HILL BAY
RESIDENTIAL SUBDIVISION
ROSE GROUP

SITE
MONTEFIORE ROAD
CATHERINE HILL BAY
NSW

| DESIGN | DRAWN | APPROVED |
|---|---|---|
| BI | BI | BI |

Bradley Irwin RPEQ (10637) CPENG NPER
Environmental Engineer

Signed ______ Date ______
for and on behalf of Solo Water Pty Ltd

DRAWING TITLE
8.5 ha TEMPORARY EFFLUENT IRRIGATION AREA– 470 ET WITH WATER RECYCLING

PROJECT NO.
H10052

SCALE
1:2000 at A3
0 20 40 60 80 100

DWG TYPE
CONCEPT NOT FOR CONSTRUCTION

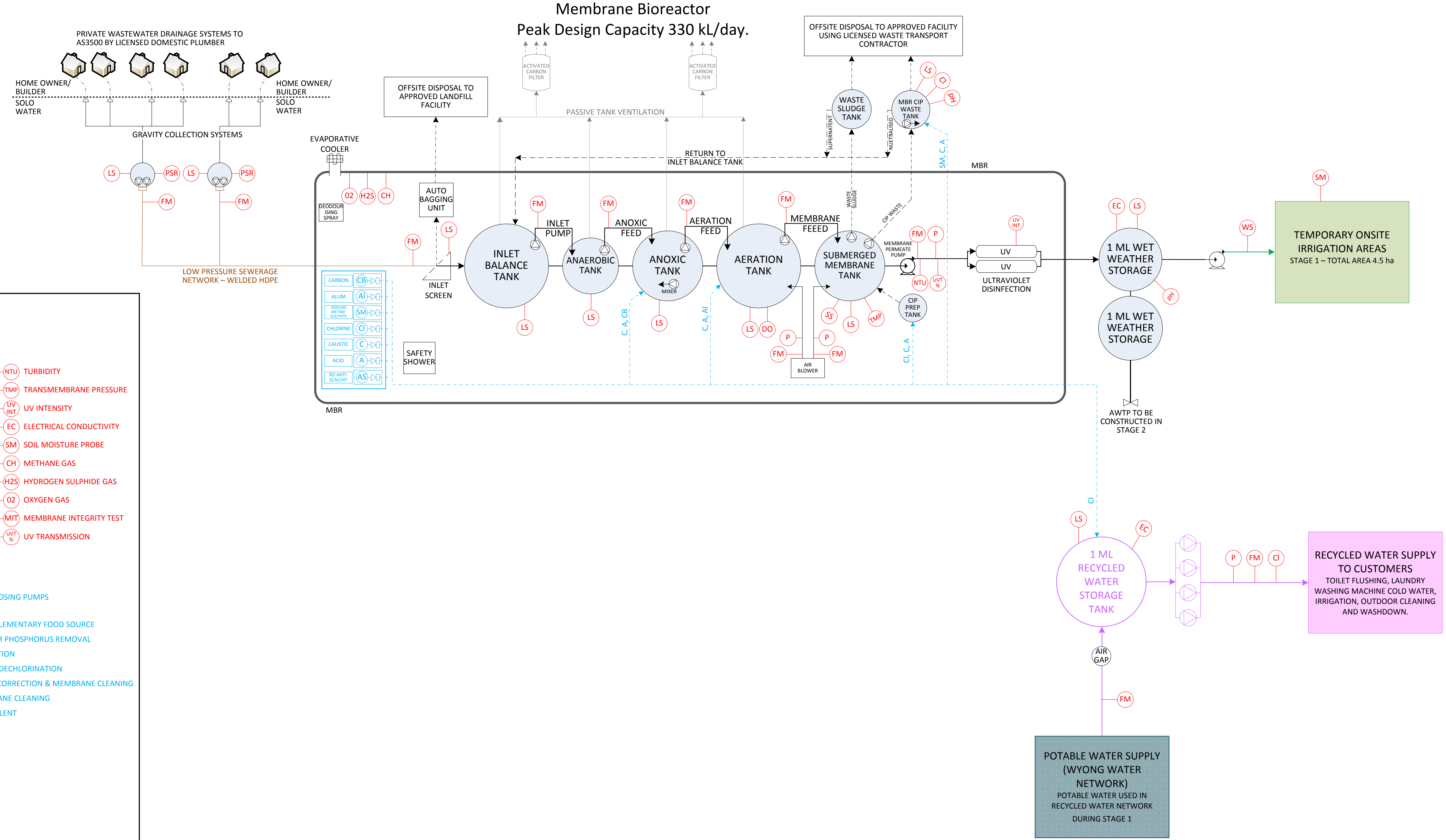
| DWG NO. | ISSUE |
|---|---|
| P09 | D |

Appendix D

# Onsite Wastewater Scheme Process Flow Diagrams

# PROCESS FLOW DIAGRAM
# STAGE 1 WASTEWATER TREATMENT PLANT
# (UP TO 112 ET)

Membrane Bioreactor
Peak Design Capacity 330 kL/day.




## LEGEND

### PROCESS MONITORING

- FM FLOW METER
- P PRESSURE
- PSR PUMP STARTS AND RUN HOURS
- LS WATER LEVEL
- DO DISSOLVED OXYGEN
- SS MIXED LIQUOR SUSPENDED SOLIDS
- pH pH
- Cl FREE CHLORINE RESIDUAL
- WS WEATHER STATION
- NTU TURBIDITY
- TMP TRANSMEMBRANE PRESSURE
- UV INT UV INTENSITY
- EC ELECTRICAL CONDUCTIVITY
- SM SOIL MOISTURE PROBE
- CH METHANE GAS
- H2S HYDROGEN SULPHIDE GAS
- 02 OXYGEN GAS
- MIT MEMBRANE INTEGRITY TEST
- UVT % UV TRANSMISSION

### PROCESS CHEMICALS

- BUNDED CHEMICAL STORAGE AREA
- BUNDED CHEMICAL CONTAINERS AND DOSING PUMPS
- CHEMICAL DELIVERY LINES
- CB ACETIC ACID (CARBON) DOSING AS SUPPLEMENTARY FOOD SOURCE
- Al POLYALUMINIUM CHLORIDE DOSING FOR PHOSPHORUS REMOVAL
- Cl SODIUM HYPOCHLORITE FOR CHLORINATION
- SM SODIUM METABISULPHIDE DOSING FOR DECHLORINATION
- C SODIUM HYDROXIDE (CAUSTIC) FOR pH CORRECTION & MEMBRANE CLEANING
- A ACID FOR pH CORRECTION AND MEMBRANE CLEANING
- AS REVERSE OSMOSIS MEMBRANE ANTISCALENT

### PROCESS EQUIPMENT

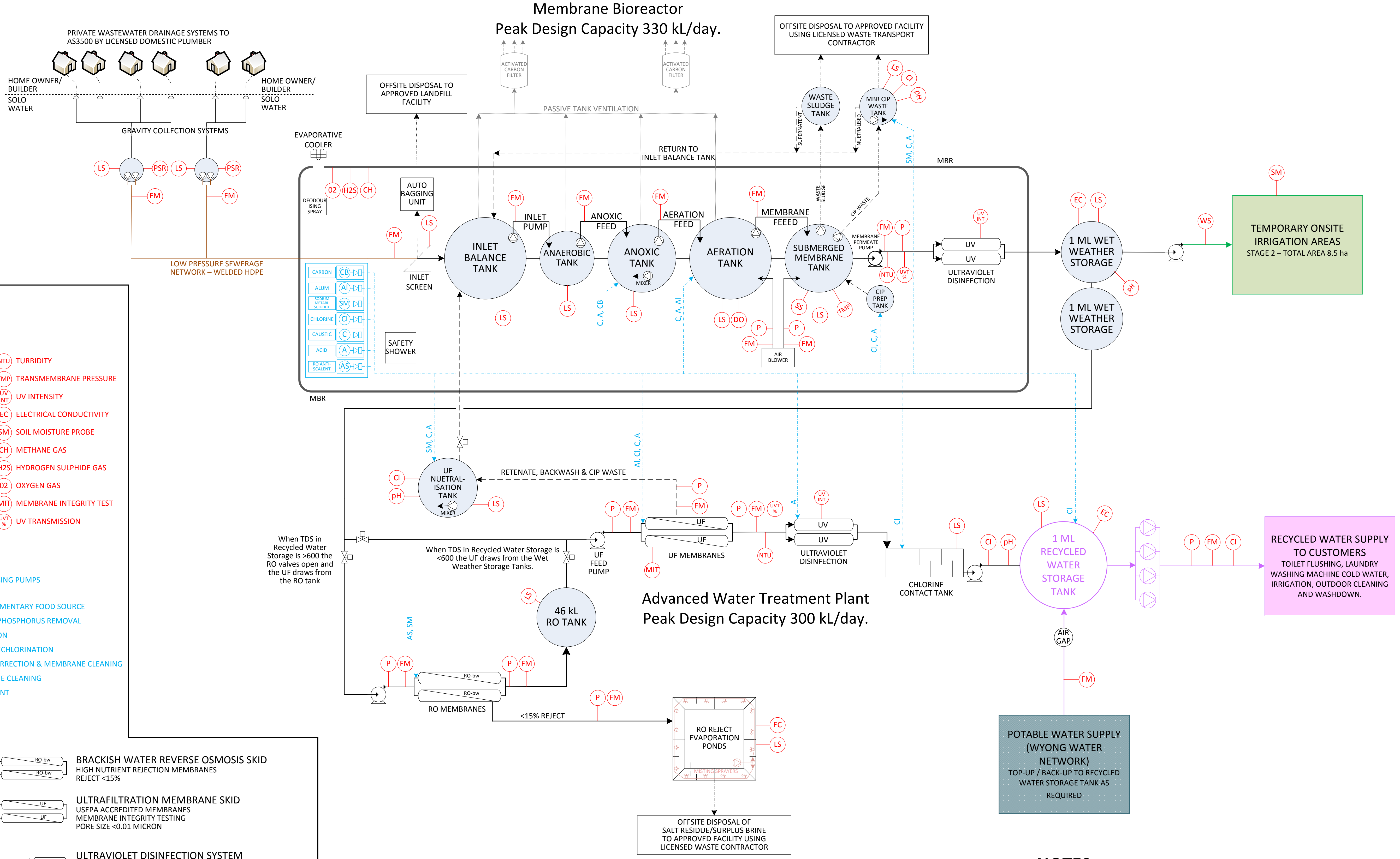
- INLET SCREEN
- MEMBRANE BIOREACTOR PROCESS TANKS
- SUBMERSIBLE PUMP
- DRY-MOUNTED PUMP
- MIXING PUMP
- MOTORISED VALVE
- HOUSEHOLD SEWERAGE CONNECTION POINT
- EVAPORATIVE AIR CONDITIONING UNIT
- ULTRAVIOLET DISINFECTION SYSTEM
  SELF CLEANING SYSTEM WITH UV INTENSITY MONITORING
  UV TRANSMISSION OF 60%
  USEPA ACCREDITED UV DISINFECTION SYSTEM

## NOTES

1. PRELIMINARY PROCESS FLOW DIAGRAM FOR IPART APPLICATION ONLY. NOT FOR CONSTRUCTION.
2. NOT TO SCALE.
3. SUBJECT TO MINOR CHANGES DURING DETAILED DESIGN.

| CLIENT: | PROJECT: | PHASE: | PRIVATE WATER UTILITY: | DRAWING TITLE: | DRAWING NUMBER: / DATE: |
|---|---|---|---|---|---|
| ROSE PROPERTY GROUP PTY LTD (ROSE) | CATHERINE HILL BAY RESIDENTIAL SUBDIVISION MONTEFIORE STREET, CATHERINE HILL BAY | IPART LICENSE APPLICATION | CATHERINE HILL BAY WATER UTILITY PTY LTD (SOLO Water – Water Utility Solutions) | PROCESS FLOW DIAGRAM STAGE 1 WASTEWATER TREATMENT PLANT (UP TO 112 ET) | H10052_P04E / 26/09/2014 |

# PROCESS FLOW DIAGRAM
# STAGE 2 WASTEWATER TREATMENT PLANT
# (UP TO 470 ET)




## LEGEND

### PROCESS MONITORING

- FM FLOW METER
- P PRESSURE
- PSR PUMP STARTS AND RUN HOURS
- LS WATER LEVEL
- DO DISSOLVED OXYGEN
- SS MIXED LIQUOR SUSPENDED SOLIDS
- pH pH
- Cl FREE CHLORINE RESIDUAL
- WS WEATHER STATION
- NTU TURBIDITY
- TMP TRANSMEMBRANE PRESSURE
- UV INT UV INTENSITY
- EC ELECTRICAL CONDUCTIVITY
- SM SOIL MOISTURE PROBE
- CH METHANE GAS
- H2S HYDROGEN SULPHIDE GAS
- 02 OXYGEN GAS
- MIT MEMBRANE INTEGRITY TEST
- UVT % UV TRANSMISSION

### PROCESS CHEMICALS

- BUNDED CHEMICAL STORAGE AREA
- BUNDED CHEMICAL CONTAINERS AND DOSING PUMPS
- CHEMICAL DELIVERY LINES
- CB ACETIC ACID (CARBON) DOSING AS SUPPLEMENTARY FOOD SOURCE
- Al POLYALUMINIUM CHLORIDE DOSING FOR PHOSPHORUS REMOVAL
- Cl SODIUM HYPOCHLORITE FOR CHLORINATION
- SM SODIUM METABISULPHITE DOSING FOR DECHLORINATION
- C SODIUM HYDROXIDE (CAUSTIC) FOR pH CORRECTION & MEMBRANE CLEANING
- A ACID FOR pH CORRECTION AND MEMBRANE CLEANING
- AS REVERSE OSMOSIS MEMBRANE ANTISCALENT

### PROCESS EQUIPMENT

- INLET SCREEN
- MEMBRANE BIOREACTOR PROCESS TANKS
- SUBMERSIBLE PUMP
- DRY-MOUNTED PUMP
- MIXING PUMP
- MOTORISED VALVE
- HOUSEHOLD SEWERAGE CONNECTION POINT
- EVAPORATIVE AIR CONDITIONING UNIT
- BRACKISH WATER REVERSE OSMOSIS SKID
  HIGH NUTRIENT REJECTION MEMBRANES
  REJECT <15%
- ULTRAFILTRATION MEMBRANE SKID
  USEPA ACCREDITED MEMBRANES
  MEMBRANE INTEGRITY TESTING
  PORE SIZE <0.01 MICRON
- ULTRAVIOLET DISINFECTION SYSTEM
  SELF CLEANING SYSTEM WITH UV INTENSITY MONITORING
  UV TRANSMISSION OF 60%
  USEPA ACCREDITED UV DISINFECTION SYSTEM
- CHLORINE CONTACT TANK
  CONTACT TANK TO BE DESIGNED TO USEPA GUIDELINES TO ACHIEVE CT VALUES FOR THE REQUIRED LOG REMOVAL TARGETS

## NOTES

1. PRELIMINARY PROCESS FLOW DIAGRAM FOR IPART APPLICATION ONLY. NOT FOR CONSTRUCTION.
2. NOT TO SCALE.
3. SUBJECT TO MINOR CHANGES DURING DETAILED DESIGN.

| CLIENT: | PROJECT: | PHASE: | PRIVATE WATER UTILITY: | DRAWING TITLE: | DRAWING NUMBER: |
|---|---|---|---|---|---|
| ROSE PROPERTY GROUP PTY LTD | CATHERINE HILL BAY RESIDENTIAL SUBDIVISION MONTEFIORE STREET, CATHERINE HILL BAY | IPART LICENSE APPLICATION | CATHERINE HILL BAY WATER UTILITY PTY LTD | PROCESS FLOW DIAGRAM STAGE 2 WASTEWATER TREATMENT PLANT (UP TO 470 ET) | H10052_P03E |
| | | | | | DATE: 26/09/2014 |

## Appendix E

# MEDLI Model Summary Output File

****************************************

SUMMARY OUTPUT
MEDLI Version 1.30

Data Set: H52 temp max h L
Run Date: 26/09/14 Time:10:00:07.39

****************************************

## GENERAL INFORMATION

*******************

Title: H10052 CHB
Subject: Prelim Effluent Irrigation Area
Client: Solo Water/Rose Group
User: BI
Time: Wed Sep 24 10:07:21 2014
Comments: [no entry]

## RUN PERIOD

**********

Starting Date 1/ 1/1912
Ending Date 31/12/2011
Run Length 100 years 0 days

---

## CLIMATE INFORMATION

*******************

Enterprise site: Cath -33.2 deg S 151.6 deg E
Weather station: CatherineHillBay_33.15S_151.60E

| ANNUAL TOTALS | 10 Percentile | 50 percentile | 90 Percentile |
|---|---|---|---|
| Rainfall mm/year | 884. | 1181. | 1614. |
| Pan Evap mm/year | 1341. | 1417. | 1545. |

| MONTHLY | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 106 | 122 | 128 | 129 | 124 | 125 | 84 | 70 | 74 | 77 | 82 | 95 | 1217 |
| Pan Evap (mm) | 179 | 142 | 127 | 96 | 69 | 59 | 68 | 91 | 117 | 143 | 161 | 181 | 1431 |
| Ave Max Temp DegC | 26 | 26 | 25 | 23 | 20 | 18 | 17 | 18 | 21 | 23 | 24 | 26 | 22 |
| Ave Min Temp DegC | 19 | 19 | 18 | 15 | 12 | 9 | 8 | 9 | 11 | 13 | 16 | 18 | 13 |
| Rad (MJ/m2/day) | 22 | 20 | 17 | 14 | 11 | 9 | 11 | 14 | 18 | 20 | 22 | 23 | 16 |

---

## MONTHLY IRRIGATION

*****************

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Irrigation (mm) | 31 | 27 | 29 | 28 | 28 | 28 | 31 | 33 | 31 | 32 | 30 | 31 | 360 |

---

## SOIL PROPERTIES

***************

Soil type: CHB Sand

SOIL WATER PROPERTIES

| | | Layer 1 | Layer 2 |
|---|---|---|---|
| Bulk Density | (g/cm3) | 1.3 | 1.5 |
| Porosity | (mm/layer) | 50.6 | 213.2 |
| Saturated Water Content | (mm/layer) | 50.1 | 211.5 |
| Drained Upper Limit | (mm/layer) | 10.9 | 68.0 |
| Lower Storage Limit | (mm/layer) | 4.0 | 32.0 |
| Air Dry Moisture Content | (mm/layer) | 4.0 | |
| Layer Thickness | (mm) | 100.0 | 500.0 |

Profile Max Rootzone

| | | | |
|---|---|---|---|
| Total Saturated Water Content | (mm) | 261.6 | 261.6 |
| Total Drained Upper Limit | (mm) | 78.9 | 78.9 |
| Total Lower Storage Limit | (mm) | 36.0 | 36.0 |
| Total Air Dry Moisture Content | (mm) | 4.5 | 4.5 |
| Total Depth | (mm) | 600.0 | 600.0 |

| | | |
|---|---|---|
| Maximum Plant Available Water Capacity | | 42.9 |
| Saturated Hydraulic Conductivity | | |
| At Surface | (mm/hr) | 50.0 |
| Limiting | (mm/hr) | 50.0 |

RUNOFF

Runoff curve No II 70.0

SOIL EVAPORATION

| | | |
|---|---|---|
| CONA | (mm/day^0.5) | 4.5 |
| URITCH | (mm) | 10.0 |

---

AVERAGE WASTE STREAM
*******************

Other waste stream
(All values relate to influent after any screening and recycling, if applicable).

| | | |
|---|---|---|
| Inflow Volume | (ML/year) | 31.05 |
| Nitrogen | (tonne/year) | 0.62 |
| Phosphorus | (tonne/year) | 0.03 |
| Salinity | (tonne/year) | 46.57 |
| Nitrogen Concentration | (mg/L) | 20.00 |
| Phosphorus Concentration | (mg/L) | 1.00 |
| Salinity | (mg/L) | 1500.00 |
| Salinity | (dS/m) | 2.34 |

WASTE STREAM DETAILS (for last inflow event):

| | | |
|---|---|---|
| Nitrogen Concentration | (mg/L) | 20.00 |
| Phosphorus Concentration | (mg/L) | 1.00 |
| TDS Concentration | (mg/L) | 1500.00 |
| Salinity | (dS/m) | 2.34 |

---

IRRIGATION WATER
****************

Irrigation triggered when plant available water falls to (%PAWC) 100.0
Irrigating upto upper storage limit + 3 mm

AREA

Total Irrigation Area (ha) 8.50

VOLUMES

| | | |
|---|---|---|
| Total Irrigation | (ML/year) | 30.63 |
| Minimum Volume Irrigated by Pump | (ML/ha/day) | 0.00 |
| Maximum Volume must be full irrig. requiremt | | |
| Maximum Vol. Available For Shandying | (ML/yr) | 0.00 |

IRRIGATION CONCENTRATIONS

| | | |
|---|---|---|
| Average salinity of Irrigation | (dS/m) | 2.35 |
| Average salinity of Irrigation | (mg/L) | 1504.06 |
| Average Nitrogen Conc of Irrigation | | |
| Before ammonia loss | (mg/L) | 19.42 |

| | | |
|---|---|---|
| After ammonia loss | (mg/L) | 19.03 |
| Average Phosphorus Conc of Irrigation | (mg/L) | 1.00 |

---

FRESH WATER USAGE
*****************

| | | |
|---|---|---|
| Irrigation (shandying) water | (ML/yr) | 0.00 |
| Avg volume of fresh water used | (ML/yr) | 0.00 |
| Annual allocation | (ML/yr) | N/A |

POND INFORMATION
****************

POND GEOMETRY

| | | Pond 1 |
|---|---|---|
| Final pond volume | (ML) | 0.08 |
| Final liquid volume | (ML) | 0.08 |
| Final sludge volume | (ML) | 0.00 |
| Average pond volume | (ML) | 0.35 |
| Average active volume | (ML) | 0.35 |
| Maximum pond volume | (ML) | 2.00 |
| Minimum allowable pond volume | (ML) | 0.00 |
| Average pond depth | (m) | 1.29 |
| Pond depth at outlet | (m) | 6.00 |
| Maximum water surface area | (m2 x1000) | 0.33 |
| Pond catchment area | (m2 x1000) | 0.33 |
| Pond footprint length | (m) | 18.25 |
| Pond footprint width | (m) | 18.25 |

POND WATER BALANCE

| | | |
|---|---|---|
| Inflow of Effluent to pond system | (ML/yr) | 31.05 |
| Recycle Volume from pond system | (ML/yr) | 0.00 |
| Rain water added to pond system | (ML/yr) | 0.00 |
| Evaporation loss from pond system | (ML/yr) | 0.08 |
| Seepage loss from pond system | (ML/yr) | 0.01 |
| Irrigation from last pond | (ML/yr) | 30.63 |
| Volume of overtopping | (ML/yr) | 0.32 |
| Sludge accumulated | (ML/yr) | 0.00 |
| Sludge accumulated | (t DM/yr) | 0.00 |
| Sludge removed | (ML/yr) | 0.00 |
| No of desludging events every 10 years | | 0.00 |
| Increase in pond water volume | (ML/yr) | 0.00 |

OVERTOPPING EVENTS

| | | |
|---|---|---|
| Volume of overtopping | (ML/yr) | 0.32 |
| No. of days pond overtops per 10 years | | 43.30 |
| Average Length of overtopping events | (days) | 3.77 |
| % Reuse | | 98.94 |

No. of overtopping events every 10 years

| | |
|---|---|
| > 0.000 ML | 11.50 |
| > 0.000 ML* | 11.50 |
| > 1.000 ML | 0.50 |
| > 2.000 ML | 0.00 |
| > 5.000 ML | 0.00 |
| > 10.000 ML | 0.00 |
| > 20.000 ML | 0.00 |
| > 50.000 ML | 0.00 |

* Volume equivalent to 1 mm depth of water

>>> NO-IRRIGATION EVENTS <<<

%Days rain prevents irrigation 36.87

| | | | |
|---|---|---|---|
| %Days water demand too small to trigger irr. | | 14.45 | |
| No. periods/year without irrigable effluent | | 0.00 | |
| Average Length of such periods | (days) | 0.00 | |

POND NITROGEN BALANCE

| | | | |
|---|---|---|---|
| Nitrogen Added by Effluent | (tonne/yr) | 0.62 | Irrig. from pond (ML/yr) 30.6 |
| Nitrogen removed by Irrigation | (tonne/yr) | 0.59 | |
| Nitrogen removed by Volatilisation | (tonne/yr) | 0.02 | |
| Nitrogen removed by Seepage | (tonne/yr) | 0.00 | |
| Nitrogen accumulated in Sludge | (tonne/yr) | 0.00 | |
| Nitrogen lost by Overtopping | (tonne/yr) | 0.01 | |
| Nitrogen involved in Recycling | (tonne/yr) | 0.00 | |
| Increase in pond Nitrogen | (tonne/yr) | 0.00 | |

POND PHOSPHORUS BALANCE

| | | | |
|---|---|---|---|
| Phosphorus Added by Effluent | (tonne/yr) | 0.03 | Irrig. from pond (ML/yr) 30.6 |
| Phosphorus removed by Irrigation | (tonne/yr) | 0.03 | |
| Phosphorus removed by Seepage | (tonne/yr) | 0.00 | |
| Phosphorus accumulated in Sludge | (tonne/yr) | 0.00 | |
| Phosphorus lost by Overtopping | (tonne/yr) | 0.00 | |
| Phosphorus involved in Recycling | (tonne/yr) | 0.00 | |
| Increase in pond Phosphorus | (tonne/yr) | 0.00 | |

POND SALINITY BALANCE

| | | |
|---|---|---|
| Salinity Added by Effluent | (tonne/yr) | 46.57 |
| Salinity removed by Irrigation | (tonne/yr) | 46.07 |
| Salinity removed by Seepage | (tonne/yr) | 0.02 |
| Salinity lost by Overtopping | (tonne/yr) | 0.48 |
| Salinity involved in Recycling | (tonne/yr) | 0.00 |
| Increase in pond Salinity | (tonne/yr) | 0.00 |

POND CONCENTRATIONS

| | | Pond 1 |
|---|---|---|
| Average Nitrogen Conc of Pond Liquid | (mg/L) | 18.9 |
| Average Phosphorus Conc of Pond Liquid | (mg/L) | 1.0 |
| Average TDS Conc of Pond Liquid | (mg/L) | 1502.9 |
| Average Salinity of Pond Liquid | (dS/m) | 2.3 |
| Average Potassium Conc of Pond Liquid | (mg/L) | 0.0 |

(On final day of simulation)

| | | |
|---|---|---|
| Nitrogen Conc of Pond Liquid | (mg/L) | 19.0 |
| Phosphorus Conc of Pond Liquid | (mg/L) | 1.0 |
| TDS Conc of Pond Liquid | (mg/L) | 1503.9 |
| EC of Pond Liquid | (dS/m) | 2.3 |
| Potassium Conc of Pond Liquid | (mg/L) | 0.0 |

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

| | | |
|---|---|---|
| Nitrogen in removed Sludge (db) | (kg/tonne) | 0.00 |
| Phosphorus in removed Sludge (db) | (kg/tonne) | 0.00 |
| Salt in removed Sludge (db) | (kg/tonne) | 0.00 |
| Potassium in removed Sludge (db) | (kg/tonne) | 0.00 |

REMOVED SLUDGE - NUTRIENT & SALT MASSES

| | | |
|---|---|---|
| Nitrogen in removed Sludge | (tonne/yr) | 0.00 |
| Phosphorus in removed Sludge | (tonne/yr) | 0.00 |
| Salt in removed Sludge (mass bal.) | (tonne/yr) | 0.00 |
| Salt in removed Sludge | (tonne/yr) | 0.00 |
| Potm. in removed Sludge (mass bal.) | (tonne/yr | 0.00 |
| Potassium in removed Sludge | (tonne/yr) | 0.00 |

LAND DISPOSAL AREA
******************

WATER BALANCE
-------------
(Initial soil water assumed to be at field capacity)
(Irrigated up to 27.88% of field capacity)

| | | | | |
|---|---|---|---|---|
| Rainfall | (mm/year) | 1217.6 | Irrigation Area | (ha) 8.5 |
| Irrigation | (mm/year) | 360.4 | | |
| Soil Evaporation | (mm/year) | 129.8 | | |
| Transpiration | (mm/year) | 635.3 | | |
| Runoff | (mm/year) | 1.9 | | |
| Drainage | (mm/year) | 811.0 | | |
| Change in soil moisture | (mm/year) | 0.0 | | |

ANNUAL TOTALS

| Year | Rain (mm) | Irrig (mm) | Sevap (mm) | Trans (mm) | Runoff (mm) | Drain (mm) | Change (mm) |
|---|---|---|---|---|---|---|---|
| 1912 | 1433.0 | 364.8 | 178.0 | 685.8 | 0.0 | 965.2 | -31.2 |
| 1913 | 1638.0 | 350.8 | 45.3 | 701.1 | 6.5 | 1246.8 | -10.9 |
| 1914 | 1543.0 | 359.8 | 44.5 | 659.7 | 0.0 | 1151.8 | 46.8 |
| 1915 | 890.0 | 365.8 | 45.9 | 662.1 | 0.0 | 565.7 | -17.9 |
| 1916 | 914.0 | 366.9 | 40.5 | 676.9 | 0.0 | 562.8 | 0.7 |
| 1917 | 1266.0 | 363.9 | 40.3 | 713.9 | 0.0 | 894.2 | -18.5 |
| 1918 | 1019.0 | 363.9 | 43.7 | 657.8 | 0.0 | 692.2 | -10.8 |
| 1919 | 1285.0 | 359.8 | 47.0 | 707.2 | 0.0 | 854.8 | 35.8 |
| 1920 | 1174.0 | 368.7 | 41.4 | 689.1 | 12.9 | 818.6 | -19.2 |
| 1921 | 1633.0 | 353.8 | 42.4 | 742.8 | 0.0 | 1137.2 | 64.4 |
| 1922 | 1061.0 | 366.1 | 45.3 | 705.1 | 0.0 | 754.6 | -77.8 |
| 1923 | 979.0 | 353.6 | 45.1 | 596.2 | 0.0 | 652.6 | 38.6 |
| 1924 | 1156.0 | 373.3 | 42.4 | 714.7 | 1.3 | 794.6 | -23.7 |
| 1925 | 1325.0 | 343.4 | 42.4 | 725.4 | 0.0 | 858.1 | 42.5 |
| 1926 | 1294.0 | 360.8 | 212.0 | 562.9 | 21.4 | 879.6 | -21.1 |
| 1927 | 1340.0 | 353.3 | 41.6 | 713.6 | 15.0 | 921.6 | 1.5 |
| 1928 | 1014.0 | 340.7 | 42.2 | 611.8 | 0.0 | 741.9 | -41.2 |
| 1929 | 1476.0 | 362.9 | 42.8 | 639.5 | 0.0 | 1151.6 | 5.0 |
| 1930 | 1541.0 | 342.4 | 42.1 | 660.9 | 10.9 | 1131.5 | 38.1 |
| 1931 | 1592.0 | 370.8 | 43.1 | 744.9 | 1.8 | 1192.9 | -19.9 |
| 1932 | 947.0 | 362.0 | 44.3 | 685.1 | 0.4 | 595.4 | -16.2 |
| 1933 | 1154.0 | 350.5 | 42.7 | 694.1 | 0.0 | 734.0 | 33.6 |
| 1934 | 1487.0 | 347.3 | 42.0 | 712.1 | 0.0 | 1080.4 | -0.1 |
| 1935 | 763.0 | 373.8 | 43.6 | 763.8 | 0.0 | 360.8 | -31.5 |
| 1936 | 867.0 | 360.8 | 44.8 | 682.0 | 0.0 | 469.1 | 32.0 |
| 1937 | 1173.0 | 365.9 | 44.7 | 742.4 | 0.0 | 778.3 | -26.5 |
| 1938 | 1098.0 | 365.8 | 44.8 | 712.9 | 0.0 | 702.7 | 3.5 |
| 1939 | 1006.0 | 363.9 | 239.3 | 606.4 | 0.0 | 542.2 | -17.9 |
| 1940 | 976.0 | 364.8 | 45.8 | 640.9 | 0.0 | 615.6 | 38.5 |
| 1941 | 827.0 | 360.9 | 41.5 | 691.4 | 0.0 | 493.6 | -38.5 |
| 1942 | 1002.0 | 365.9 | 211.1 | 568.7 | 0.2 | 556.5 | 31.5 |
| 1943 | 1194.0 | 345.2 | 41.0 | 653.9 | 0.0 | 835.1 | 9.2 |
| 1944 | 647.0 | 367.2 | 45.0 | 666.2 | 0.0 | 343.7 | -40.6 |
| 1945 | 1025.0 | 354.3 | 42.1 | 660.6 | 0.0 | 640.2 | 36.5 |
| 1946 | 1105.0 | 363.8 | 138.3 | 602.4 | 2.9 | 762.5 | -37.3 |
| 1947 | 1121.0 | 363.9 | 298.1 | 595.1 | 0.0 | 561.1 | 30.7 |
| 1948 | 1151.0 | 362.9 | 42.5 | 674.1 | 2.1 | 791.8 | 3.4 |
| 1949 | 2009.0 | 365.9 | 41.4 | 706.4 | 3.4 | 1619.1 | 4.6 |
| 1950 | 2056.0 | 323.8 | 39.0 | 652.1 | 2.1 | 1703.2 | -16.5 |
| 1951 | 1250.0 | 361.1 | 42.9 | 629.9 | 0.0 | 938.3 | 0.0 |
| 1952 | 1274.0 | 362.9 | 225.1 | 564.3 | 0.7 | 844.6 | 2.1 |
| 1953 | 1013.0 | 365.9 | 41.0 | 634.7 | 1.0 | 700.8 | 1.3 |
| 1954 | 1053.0 | 361.9 | 250.7 | 601.4 | 0.0 | 570.8 | -8.0 |
| 1955 | 1464.0 | 348.4 | 39.4 | 665.8 | 0.0 | 1089.2 | 18.0 |
| 1956 | 1286.0 | 350.0 | 40.7 | 661.9 | 0.0 | 968.2 | -34.8 |
| 1957 | 652.0 | 360.8 | 83.7 | 515.7 | 0.0 | 362.3 | 51.1 |
| 1958 | 1054.0 | 363.9 | 246.9 | 637.1 | 0.0 | 542.5 | -8.7 |
| 1959 | 1451.0 | 361.7 | 39.9 | 681.9 | 0.0 | 1108.3 | -17.4 |
| 1960 | 1201.0 | 364.9 | 254.5 | 624.8 | 0.0 | 695.2 | -8.6 |
| 1961 | 1037.0 | 359.3 | 252.1 | 634.8 | 0.0 | 484.0 | 25.5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1962 | 1224.0 | 368.4 | 40.6 | 693.3 | 0.0 | 859.1 | -0.6 |
| 1963 | 1722.0 | 345.5 | 39.2 | 672.3 | 2.1 | 1362.3 | -8.3 |
| 1964 | 1035.0 | 366.8 | 257.5 | 634.0 | 3.5 | 537.0 | -30.2 |
| 1965 | 749.0 | 363.8 | 311.6 | 465.3 | 0.0 | 326.4 | 9.6 |
| 1966 | 964.0 | 362.9 | 179.3 | 615.8 | 0.0 | 500.5 | 31.3 |
| 1967 | 1495.0 | 362.8 | 320.3 | 555.8 | 8.1 | 1011.7 | -38.1 |
| 1968 | 878.0 | 364.8 | 293.4 | 529.4 | 0.0 | 401.9 | 18.1 |
| 1969 | 1235.0 | 363.0 | 280.6 | 540.0 | 0.1 | 780.1 | -2.8 |
| 1970 | 1106.0 | 358.8 | 48.7 | 824.5 | 1.0 | 571.6 | 19.0 |
| 1971 | 1262.0 | 364.2 | 47.6 | 722.0 | 0.0 | 869.5 | -12.9 |
| 1972 | 1317.0 | 364.8 | 44.3 | 738.6 | 0.0 | 893.0 | 5.9 |
| 1973 | 1111.0 | 362.8 | 316.3 | 593.5 | 0.1 | 564.4 | -0.4 |
| 1974 | 1646.0 | 345.4 | 43.3 | 723.2 | 4.6 | 1230.2 | -10.0 |
| 1975 | 1349.0 | 363.8 | 45.5 | 669.2 | 0.0 | 982.4 | 15.7 |
| 1976 | 1661.0 | 362.2 | 42.5 | 710.9 | 0.0 | 1307.8 | -38.1 |
| 1977 | 1050.0 | 363.8 | 251.3 | 590.8 | 10.5 | 561.0 | 0.2 |
| 1978 | 1718.0 | 362.7 | 42.0 | 701.2 | 4.3 | 1292.3 | 40.9 |
| 1979 | 875.0 | 365.0 | 277.4 | 541.4 | 0.0 | 434.5 | -13.3 |
| 1980 | 724.0 | 362.6 | 506.3 | 342.0 | 2.7 | 182.1 | 53.6 |
| 1981 | 1328.0 | 363.8 | 236.3 | 664.1 | 14.4 | 818.7 | -41.6 |
| 1982 | 1152.0 | 365.9 | 254.7 | 497.1 | 1.6 | 780.0 | -15.5 |
| 1983 | 1281.0 | 357.9 | 375.1 | 460.3 | 9.3 | 776.4 | 17.9 |
| 1984 | 1406.0 | 367.9 | 276.9 | 650.2 | 1.3 | 855.2 | -9.7 |
| 1985 | 1239.0 | 362.5 | 41.2 | 648.7 | 0.0 | 940.3 | -28.7 |
| 1986 | 1038.0 | 362.9 | 44.1 | 695.2 | 0.0 | 664.4 | -2.8 |
| 1987 | 1136.0 | 361.9 | 41.4 | 666.0 | 0.0 | 752.6 | 37.9 |
| 1988 | 1565.0 | 345.5 | 146.1 | 580.9 | 0.1 | 1191.5 | -8.0 |
| 1989 | 1576.0 | 347.8 | 185.0 | 664.7 | 0.0 | 1074.7 | -0.6 |
| 1990 | 2025.0 | 350.2 | 37.3 | 607.9 | 29.2 | 1715.2 | -14.3 |
| 1991 | 915.0 | 360.3 | 528.3 | 167.5 | 0.0 | 553.5 | 26.0 |
| 1992 | 1278.0 | 356.0 | 170.8 | 614.5 | 0.6 | 847.5 | 0.5 |
| 1993 | 885.0 | 371.4 | 40.7 | 700.6 | 0.0 | 539.4 | -24.2 |
| 1994 | 896.0 | 363.8 | 61.1 | 684.8 | 0.0 | 497.1 | 16.8 |
| 1995 | 1229.0 | 363.9 | 330.8 | 544.4 | 0.0 | 732.3 | -14.7 |
| 1996 | 1185.0 | 362.9 | 207.3 | 681.9 | 1.3 | 644.5 | 12.9 |
| 1997 | 1235.0 | 361.9 | 42.1 | 630.7 | 0.0 | 929.6 | -5.5 |
| 1998 | 1622.0 | 363.6 | 42.4 | 713.5 | 0.0 | 1257.4 | -27.7 |
| 1999 | 1473.0 | 333.4 | 36.9 | 580.0 | 0.0 | 1150.4 | 39.1 |
| 2000 | 882.0 | 366.8 | 40.8 | 678.5 | 0.0 | 567.8 | -38.3 |
| 2001 | 1343.0 | 363.9 | 250.3 | 575.2 | 1.4 | 879.9 | 0.1 |
| 2002 | 1177.0 | 363.8 | 45.8 | 639.7 | 0.0 | 818.9 | 36.5 |
| 2003 | 1090.0 | 363.9 | 238.7 | 594.0 | 0.0 | 657.4 | -36.2 |
| 2004 | 1053.0 | 364.9 | 335.7 | 498.3 | 1.1 | 555.1 | 27.8 |
| 2005 | 1023.0 | 363.9 | 239.2 | 625.3 | 0.0 | 518.6 | 3.7 |
| 2006 | 1067.0 | 363.9 | 261.1 | 610.8 | 0.0 | 571.6 | -12.6 |
| 2007 | 1606.0 | 363.9 | 42.1 | 692.4 | 13.2 | 1214.3 | 8.0 |
| 2008 | 1415.0 | 365.0 | 38.9 | 656.8 | 0.0 | 1091.2 | -6.9 |
| 2009 | 834.0 | 357.9 | 276.6 | 461.6 | 0.0 | 433.6 | 20.1 |
| 2010 | 1210.0 | 364.8 | 289.8 | 537.9 | 0.0 | 770.4 | -23.3 |
| 2011 | 1560.0 | 363.0 | 216.0 | 507.0 | 0.0 | 1178.8 | 21.1 |

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NUTRIENT BALANCE
-----------------

NITROGEN

Total N irrigated from ponds  (kg/ha/year)     70.0   % of Total as ammonium
10.0
Nitrogn lost by ammonia volat.(kg/ha/year)      1.4   Deep Drainage (mm/year)
811.0
Nitrogen added in irrigation  (kg/ha/year)     68.6
Nitrogen added in seed        (kg/ha/year)      0.5
Nitrogen removed by crop      (kg/ha/year)     83.6
Denitrification               (kg/ha/year)      0.0
Leached NO3-N                 (kg/ha/year)      0.9
Change in soil organic-N      (kg/ha/year)    -14.8
Change in soil solution NH4-N (kg/ha/year)      0.0
Change in soil solution NO3-N (kg/ha/year)     -0.6
Change in adsorbed NH4-N      (kg/ha/year)      0.0

| | | |
|---|---|---|
| Initial soil organic-N | (kg/ha) | 1522.5 |
| Final soil organic-N | (kg/ha) | 38.3 |
| Initial soil inorganic-N | (kg/ha) | 62.4 |
| Final soil inorganic-N | (kg/ha) | 0.0 |
| Average N03-N conc in the root zone | (mg/L) | 0.2 |
| Average N03-N conc below root zone | (mg/L) | 1.9 |
| Average N03-N conc of deep drainage | (mg/L) | 0.1 |

PHOSPHORUS

Phosphorus added in irrigatn (kg/ha/year) 3.6 % of Total as phosphate 100.0

| | | |
|---|---|---|
| Phosphorus added in seed | (kg/ha/year) | 0.0 |
| Phosphorus removed by crop | (kg/ha/year) | 3.2 |
| Leached PO4-P | (kg/ha/year) | 0.1 |
| Change in dissolved PO4-P | (kg/ha/year) | 0.0 |
| Change in adsorbed PO4-P | (kg/ha/year) | 0.3 |
| Average P04-P conc in the root zone | (mg/L) | 0.0 |
| Average P04-P conc below root zone | (mg/L) | 0.0 |

SOIL P STORAGE LIFE

| Year | YearNo. | Tot P stored kg/ha | P leached in year kg/ha |
|---|---|---|---|
| 1912 | 1 | 148.2 | 0.1 |
| 1913 | 2 | 151.1 | 0.1 |
| 1914 | 3 | 154.2 | 0.1 |
| 1915 | 4 | 157.1 | 0.0 |
| 1916 | 5 | 160.2 | 0.1 |
| 1917 | 6 | 161.9 | 0.1 |
| 1918 | 7 | 163.9 | 0.1 |
| 1919 | 8 | 165.7 | 0.1 |
| 1920 | 9 | 167.7 | 0.1 |
| 1921 | 10 | 168.4 | 0.1 |
| 1922 | 11 | 169.4 | 0.1 |
| 1923 | 12 | 170.7 | 0.1 |
| 1924 | 13 | 171.9 | 0.1 |
| 1925 | 14 | 171.8 | 0.1 |
| 1926 | 15 | 172.7 | 0.1 |
| 1927 | 16 | 173.1 | 0.1 |
| 1928 | 17 | 173.6 | 0.1 |
| 1929 | 18 | 173.7 | 0.1 |
| 1930 | 19 | 173.9 | 0.1 |
| 1931 | 20 | 174.0 | 0.1 |
| 1932 | 21 | 174.7 | 0.1 |
| 1933 | 22 | 174.4 | 0.1 |
| 1934 | 23 | 174.4 | 0.1 |
| 1935 | 24 | 174.5 | 0.0 |
| 1936 | 25 | 175.2 | 0.0 |
| 1937 | 26 | 174.9 | 0.1 |
| 1938 | 27 | 175.1 | 0.1 |
| 1939 | 28 | 175.6 | 0.1 |
| 1940 | 29 | 176.5 | 0.1 |
| 1941 | 30 | 175.9 | 0.0 |
| 1942 | 31 | 176.6 | 0.0 |
| 1943 | 32 | 176.5 | 0.1 |
| 1944 | 33 | 176.9 | 0.0 |
| 1945 | 34 | 176.6 | 0.1 |
| 1946 | 35 | 176.8 | 0.1 |
| 1947 | 36 | 177.7 | 0.1 |
| 1948 | 37 | 177.8 | 0.1 |
| 1949 | 38 | 177.1 | 0.1 |
| 1950 | 39 | 176.7 | 0.1 |
| 1951 | 40 | 176.6 | 0.1 |
| 1952 | 41 | 177.7 | 0.1 |
| 1953 | 42 | 177.1 | 0.1 |
| 1954 | 43 | 177.7 | 0.1 |
| 1955 | 44 | 177.4 | 0.1 |
| 1956 | 45 | 177.5 | 0.1 |
| 1957 | 46 | 177.2 | 0.0 |

| | | | |
|---|---|---|---|
| 1958 | 47 | 177.9 | 0.1 |
| 1959 | 48 | 177.5 | 0.1 |
| 1960 | 49 | 178.0 | 0.1 |
| 1961 | 50 | 177.7 | 0.0 |
| 1962 | 51 | 177.4 | 0.1 |
| 1963 | 52 | 177.1 | 0.1 |
| 1964 | 53 | 178.1 | 0.0 |
| 1965 | 54 | 178.3 | 0.0 |
| 1966 | 55 | 179.1 | 0.0 |
| 1967 | 56 | 179.0 | 0.1 |
| 1968 | 57 | 179.6 | 0.0 |
| 1969 | 58 | 179.7 | 0.1 |
| 1970 | 59 | 179.1 | 0.0 |
| 1971 | 60 | 178.7 | 0.1 |
| 1972 | 61 | 179.0 | 0.1 |
| 1973 | 62 | 179.2 | 0.1 |
| 1974 | 63 | 178.8 | 0.1 |
| 1975 | 64 | 178.6 | 0.1 |
| 1976 | 65 | 178.8 | 0.1 |
| 1977 | 66 | 178.8 | 0.0 |
| 1978 | 67 | 178.9 | 0.1 |
| 1979 | 68 | 179.2 | 0.0 |
| 1980 | 69 | 180.8 | 0.0 |
| 1981 | 70 | 181.5 | 0.1 |
| 1982 | 71 | 180.9 | 0.1 |
| 1983 | 72 | 181.3 | 0.1 |
| 1984 | 73 | 181.2 | 0.1 |
| 1985 | 74 | 180.0 | 0.1 |
| 1986 | 75 | 179.6 | 0.1 |
| 1987 | 76 | 179.4 | 0.1 |
| 1988 | 77 | 179.6 | 0.1 |
| 1989 | 78 | 179.3 | 0.1 |
| 1990 | 79 | 179.0 | 0.1 |
| 1991 | 80 | 180.4 | 0.1 |
| 1992 | 81 | 181.8 | 0.1 |
| 1993 | 82 | 180.2 | 0.1 |
| 1994 | 83 | 179.9 | 0.0 |
| 1995 | 84 | 180.3 | 0.1 |
| 1996 | 85 | 181.1 | 0.1 |
| 1997 | 86 | 180.0 | 0.1 |
| 1998 | 87 | 179.8 | 0.1 |
| 1999 | 88 | 179.2 | 0.1 |
| 2000 | 89 | 179.7 | 0.1 |
| 2001 | 90 | 179.6 | 0.1 |
| 2002 | 91 | 179.6 | 0.1 |
| 2003 | 92 | 180.0 | 0.1 |
| 2004 | 93 | 181.1 | 0.1 |
| 2005 | 94 | 180.8 | 0.0 |
| 2006 | 95 | 181.0 | 0.1 |
| 2007 | 96 | 180.5 | 0.1 |
| 2008 | 97 | 180.3 | 0.1 |
| 2009 | 98 | 180.1 | 0.0 |
| 2010 | 99 | 180.7 | 0.1 |
| 2011 | 100 | 180.5 | 0.1 |

PLANT
-----

Plant species:  Temperate pasture

PLANT WATER USE

Irrigation (mm/year) 360.   Totl Irrigation Area(ha)
8.5
Pan coefficient (%) 1.0
Maximum crop coefficient (%) 0.8
Average Plant Cover (%) 62.

| | | |
|---|---|---|
| Average Plant Total Cover | (%) | 89. |
| Average Plant Rootdepth | (mm) | 538. |
| Average Plant Available Water Capacity | (mm) | 43. |
| Average Plant Available Water | (mm) | 36. |
| Yield produced per unit transp. | (kg/ha/mm) | 12. |

PLANT NUTRIENT UPTAKE

| | | | | |
|---|---|---|---|---|
| Dry Matter Yield (Shoots) | (kg/ha/yr) | 7917. | | |
| Net nitrogen removed by plant | (kg/ha/yr) | 83. | Shoot Concn (%DM) | 1.05 |
| Net phosphorus removed by plant | (kg/ha/yr) | 3. | Shoot Concn (%DM) | 0.04 |

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)

| Month | Yield kg/ha | Nitr | Temp | Water Defic | Water Logging |
|---|---|---|---|---|---|
| 1 | 732. | 0.6 | 0.3 | 0.1 | 0.0 |
| 2 | 609. | 0.5 | 0.3 | 0.1 | 0.0 |
| 3 | 690. | 0.6 | 0.2 | 0.1 | 0.0 |
| 4 | 588. | 0.6 | 0.1 | 0.1 | 0.0 |
| 5 | 510. | 0.6 | 0.0 | 0.0 | 0.0 |
| 6 | 460. | 0.6 | 0.0 | 0.0 | 0.0 |
| 7 | 560. | 0.6 | 0.0 | 0.0 | 0.0 |
| 8 | 698. | 0.6 | 0.0 | 0.0 | 0.0 |
| 9 | 713. | 0.6 | 0.0 | 0.0 | 0.0 |
| 10 | 776. | 0.6 | 0.1 | 0.0 | 0.0 |
| 11 | 792. | 0.6 | 0.1 | 0.1 | 0.0 |
| 12 | 791. | 0.6 | 0.2 | 0.1 | 0.0 |

>>> NO-PLANT EVENTS <<<

| | |
|---|---|
| %Days due to temperature stress | 0.2 |
| %Days due to scorching | 0.2 |
| %Days due to water stress | 2.1 |
| %Days due to nitrogen stress | 0.1 |
| No. of forced harvests per year | 0.5 |
| No. of normal harvests per year | 1.8 |

SALINITY
--------

Salt tolerance - plant species: tolerant

| | | | | |
|---|---|---|---|---|
| Average EC of Irrigation Water | (dS/m) | 2.4 | Irrigation (mm/year) | 360.4 |
| Average EC of Rainwater | (dS/m x10) | 0.3 | Rainfall (mm/year) | 1217.6 |
| Average EC of Infiltrated water | (dS/m) | 0.6 | | |
| Av. water-upt-weightd rootzone EC | (dS/m s.e.) | 0.4 | | |
| EC soil soln (FC) at base of rootzone | (dS/m) | 1.1 | Deep Drainage (mm/year) | 811.0 |
| Reduction in Crop yield due to Salinity | (%) | 0.0 | | |
| Percentage of yrs that crop yld falls below 90% of potential because of soil salinity | | 0.0 | | |

| Period | ECrootzone sat ext (dS/m) | ECbase in situ (dS/m) | Rel Yield (%) |
|---|---|---|---|
| 1912 - 1921 | 0.36 | 1.00 | 100. |
| 1913 - 1922 | 0.37 | 1.02 | 100. |
| 1914 - 1923 | 0.39 | 1.10 | 100. |
| 1915 - 1924 | 0.41 | 1.15 | 100. |
| 1916 - 1925 | 0.39 | 1.10 | 100. |

| | | | |
|---|---|---|---|
| 1917 - 1926 | 0.38 | 1.06 | 100. |
| 1918 - 1927 | 0.38 | 1.05 | 100. |
| 1919 - 1928 | 0.38 | 1.04 | 100. |
| 1920 - 1929 | 0.37 | 1.01 | 100. |
| 1921 - 1930 | 0.35 | 0.97 | 100. |
| 1922 - 1931 | 0.36 | 0.97 | 100. |
| 1923 - 1932 | 0.36 | 0.98 | 100. |
| 1924 - 1933 | 0.36 | 0.97 | 100. |
| 1925 - 1934 | 0.34 | 0.94 | 100. |
| 1926 - 1935 | 0.36 | 1.00 | 100. |
| 1927 - 1936 | 0.38 | 1.04 | 100. |
| 1928 - 1937 | 0.38 | 1.06 | 100. |
| 1929 - 1938 | 0.38 | 1.08 | 100. |
| 1930 - 1939 | 0.41 | 1.16 | 100. |
| 1931 - 1940 | 0.43 | 1.25 | 100. |
| 1932 - 1941 | 0.47 | 1.38 | 100. |
| 1933 - 1942 | 0.47 | 1.39 | 100. |
| 1934 - 1943 | 0.46 | 1.37 | 100. |
| 1935 - 1944 | 0.51 | 1.55 | 100. |
| 1936 - 1945 | 0.49 | 1.47 | 100. |
| 1937 - 1946 | 0.48 | 1.40 | 100. |
| 1938 - 1947 | 0.49 | 1.45 | 100. |
| 1939 - 1948 | 0.48 | 1.43 | 100. |
| 1940 - 1949 | 0.43 | 1.22 | 100. |
| 1941 - 1950 | 0.38 | 1.05 | 100. |
| 1942 - 1951 | 0.37 | 1.00 | 100. |
| 1943 - 1952 | 0.36 | 0.97 | 100. |
| 1944 - 1953 | 0.36 | 0.99 | 100. |
| 1945 - 1954 | 0.35 | 0.97 | 100. |
| 1946 - 1955 | 0.34 | 0.92 | 100. |
| 1947 - 1956 | 0.33 | 0.90 | 100. |
| 1948 - 1957 | 0.34 | 0.91 | 100. |
| 1949 - 1958 | 0.35 | 0.94 | 100. |
| 1950 - 1959 | 0.36 | 0.99 | 100. |
| 1951 - 1960 | 0.40 | 1.13 | 100. |
| 1952 - 1961 | 0.42 | 1.20 | 100. |
| 1953 - 1962 | 0.42 | 1.19 | 100. |
| 1954 - 1963 | 0.39 | 1.09 | 100. |
| 1955 - 1964 | 0.39 | 1.10 | 100. |
| 1956 - 1965 | 0.42 | 1.22 | 100. |
| 1957 - 1966 | 0.44 | 1.30 | 100. |
| 1958 - 1967 | 0.41 | 1.19 | 100. |
| 1959 - 1968 | 0.42 | 1.22 | 100. |
| 1960 - 1969 | 0.44 | 1.27 | 100. |
| 1961 - 1970 | 0.44 | 1.29 | 100. |
| 1962 - 1971 | 0.42 | 1.23 | 100. |
| 1963 - 1972 | 0.42 | 1.22 | 100. |
| 1964 - 1973 | 0.46 | 1.38 | 100. |
| 1965 - 1974 | 0.42 | 1.24 | 100. |
| 1966 - 1975 | 0.40 | 1.14 | 100. |
| 1967 - 1976 | 0.37 | 1.03 | 100. |
| 1968 - 1977 | 0.38 | 1.09 | 100. |
| 1969 - 1978 | 0.35 | 0.98 | 100. |
| 1970 - 1979 | 0.37 | 1.02 | 100. |
| 1971 - 1980 | 0.38 | 1.07 | 100. |
| 1972 - 1981 | 0.38 | 1.07 | 100. |
| 1973 - 1982 | 0.39 | 1.09 | 100. |
| 1974 - 1983 | 0.38 | 1.06 | 100. |
| 1975 - 1984 | 0.39 | 1.12 | 100. |
| 1976 - 1985 | 0.40 | 1.12 | 100. |
| 1977 - 1986 | 0.42 | 1.22 | 100. |
| 1978 - 1987 | 0.41 | 1.19 | 100. |
| 1979 - 1988 | 0.42 | 1.20 | 100. |
| 1980 - 1989 | 0.39 | 1.10 | 100. |
| 1981 - 1990 | 0.34 | 0.92 | 100. |
| 1982 - 1991 | 0.35 | 0.95 | 100. |
| 1983 - 1992 | 0.35 | 0.94 | 100. |
| 1984 - 1993 | 0.35 | 0.97 | 100. |
| 1985 - 1994 | 0.37 | 1.00 | 100. |
| 1986 - 1995 | 0.37 | 1.03 | 100. |
| 1987 - 1996 | 0.37 | 1.03 | 100. |

| | | | |
|---|---|---|---|
| 1988 - 1997 | 0.37 | 1.01 | 100. |
| 1989 - 1998 | 0.37 | 1.01 | 100. |
| 1990 - 1999 | 0.36 | 0.99 | 100. |
| 1991 - 2000 | 0.41 | 1.14 | 100. |
| 1992 - 2001 | 0.39 | 1.10 | 100. |
| 1993 - 2002 | 0.39 | 1.10 | 100. |
| 1994 - 2003 | 0.39 | 1.09 | 100. |
| 1995 - 2004 | 0.39 | 1.08 | 100. |
| 1996 - 2005 | 0.39 | 1.11 | 100. |
| 1997 - 2006 | 0.40 | 1.12 | 100. |
| 1998 - 2007 | 0.39 | 1.08 | 100. |
| 1999 - 2008 | 0.39 | 1.10 | 100. |
| 2000 - 2009 | 0.42 | 1.22 | 100. |
| 2001 - 2010 | 0.41 | 1.18 | 100. |
| 2002 - 2011 | 0.40 | 1.14 | 100. |

GROUNDWATER
************

Average Groundwater Recharge (m3/day) 188.7
Average Nitrate-N Conc of Recharge (mg/L) 0.1

Thickness of the Aquifer (m) 10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated 1000.0

Concentration of NITRATE-N in Groundwater (mg/L)
-----------------------------------------------

| | Year | Depth Below Water Table Surface 0.0 m | 5.0 m | 9.0 m |
|---|---|---|---|---|
| | 1916 | 0.0 | 0.0 | 0.0 |
| | 1921 | 0.0 | 0.0 | 0.0 |
| | 1926 | 0.1 | 0.1 | 0.1 |
| | 1931 | 0.1 | 0.1 | 0.1 |
| | 1936 | 0.1 | 0.1 | 0.1 |
| | 1941 | 0.1 | 0.1 | 0.1 |
| | 1946 | 0.1 | 0.1 | 0.1 |
| | 1951 | 0.1 | 0.1 | 0.1 |
| | 1956 | 0.1 | 0.1 | 0.1 |
| | 1961 | 0.1 | 0.1 | 0.1 |
| | 1966 | 0.1 | 0.1 | 0.1 |
| | 1971 | 0.1 | 0.1 | 0.1 |
| | 1976 | 0.1 | 0.1 | 0.1 |
| | 1981 | 0.1 | 0.1 | 0.1 |
| | 1986 | 0.1 | 0.1 | 0.1 |
| | 1991 | 0.1 | 0.1 | 0.1 |
| | 1996 | 0.1 | 0.1 | 0.1 |
| | 2001 | 0.1 | 0.1 | 0.1 |
| | 2006 | 0.1 | 0.1 | 0.1 |
| | 2011 | 0.1 | 0.1 | 0.1 |
| Last | 2011 | 0.1 | 0.1 | 0.1 |

ACKNOWLEDGMENTS
***************
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UNCONDITIONAL FINISH

Appendix F

# Environmental and Public Health Risk Assessment

SOLO Water
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# SEWERAGE

# QUALITATIVE ENVIRONMENTAL AND PUBLIC HEALTH RISK ASSESSMENT CRITERIA

From tables 2.5, 2.6 and 2.7 on Page 39 of the Australian Guidelines for Water Recycling Managing Health & Environmental Risks Phase 1 (2006)

## Qualitative measures of likelihood

| Level | Descriptor | Example Description from AGWR |
|---|---|---|
| A | Rare | May occur only in exceptional circumstances. May occur once in 100 years |
| B | Unlikely | Could occur within 20 years or in unusual circumstances |
| C | Possible | Might occur or should be expected to occur within a 5- to 10-year period |
| D | Likely | Will probably occur within a 1-to 5-year period |
| E | Almost certain | Is expected to occur with a probability of multiple occurrences within a year |

## Qualitative measures of consequence or impact

| Level | Descriptor | Example Description from AGWR |
|---|---|---|
| 1 | Insignificant | Insignificant impact or not detectable |
| 2 | Minor | Health — Minor impact for small population<br>Environment — Potentially harmful to local ecosystem with local impacts contained to site |
| 3 | Moderate | Health — Minor impact for large population<br>Environment — Potentially harmful to regional ecosystem with local impacts primarily contained to on-site |
| 4 | Major | Health — Major impact for small population<br>Environment — Potentially lethal to local ecosystem; predominantly local, but potential for off-site impacts |
| 5 | Catastrophic | Health — Major impact for large population<br>Environment — Potentially lethal to regional ecosystem or threatened species; widespread on-site and off-site impacts |

## Qualitative risk analysis matrix: Level of risk

| | | Consequences | | | | |
|---|---|---|---|---|---|---|
| Likelihood | | 1 | 2 | 3 | 4 | 5 |
| | | Insignificant | Minor | Moderate | Major | Catastrophic |
| A | Rare | Low | Low | Low | High | High |
| B | Unlikely | Low | Low | Moderate | High | Very high |
| C | Possible | Low | Moderate | High | Very high | Very high |
| D | Likely | Low | Moderate | High | Very high | Very high |
| E | Almost certain | Low | Moderate | High | Very high | Very high |

**Project:** Catherine Hill Bay Water Utility
**Client:** Rose Group
**Title:** Sewerage Preliminary Risk Assessment
**Author:** BI
**Date (Revision):** 01/10/2014 (Revision D)
**Risk Criteria:** As per Tables 2.5, 2.6 & 2.7: Australian Guidelines for Water Recycling: Managing Health and Environmental Risks-phase 1 (2006)

| Scheme Component | Hazard | Hazardous Event | Impact | Unmitigated Risk | | | | | Control Strategy | Mitigated Risk | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Likelihood | | Consequence | | Risk | | Likelihood | | Consequence | | Risk |
| Wastewater generation | Trace contaminants in domestic wastewater | Poor household chemical use and disposal practices resulting in excessive contaminant levels in recycled water | Potential environmental impacts on effluent irrigation areas | C | Possible | 2 | Minor | Moderate | 1. Customer supply contracts and recycled water use agreement will be developed with each customer and will include obligations and education regarding appropriate substances to be disposed of to sewerage and substances that should be avoided.<br>2. Ongoing customer awareness campaigns and information provided with each water bill and through the CHB Water Utility website. | B | Unlikely | 2 | Minor | Low |
| | Trace contaminants in commercial wastewater | Poor trade waste management practices resulting in excessive contaminant levels in recycled water | Potential environmental impacts on effluent irrigation areas | D | Likely | 2 | Minor | Moderate | 1. Predominately residential sewerage catchment with non-residential customers account for less than 1% of all wastewater generated.<br>2. Trade waste agreement will be developed with each non-residential customers to ensure wastewater is pretreated to domestic standards before discharge into the sewerage system.<br>3. Each non-residential customer will have its own low pressure sewage pump station to enable monitoring compliance of trade waste agreements. | B | Unlikely | 2 | Minor | Low |
| | Shock load of chemical | Poor chemical or trade waste management practices resulting in shock load of contaminants on MBR | Potential biomass die off and reduction in MBR effluent quality.<br>Chemicals may also be an OHS hazard. | A | Rare | 2 | Minor | Low | 1. Continuous online monitoring of MLSS, DO, pH, EC and other process parameters to detect potential impacts on the treatment process.<br>2. Investigation will be undertaken into the source of contamination. This may involve review of Pressure Sewer Unit (PSU) operational data, water usage data, trade waste agreement etc.<br>3. Additional online water quality monitoring probes can be installed into suspect PSUs for tracing persistent sources of contamination if required.<br>4. Road tanker pump out of contaminated water from the inlet balance tank if required. | B | Unlikely | 1 | Insignificant | Low |
| | Gross pollutants in raw wastewater | Poor solid waste management practices resulting sewer blockage and overflow. | Potential sewer blockage and overflow | E | Almost certain | 2 | Minor | Moderate | 1. Low pressure sewerage system with grinder pumps will macerate sewage prior to entering the pipe network.<br>2. Appropriately designed network with self cleansing velocities and high head pumps will minimise the potential for network blockage.<br>3. Sewer/pump blockage Emergency Response Plan will be developed for the scheme and will include step for identification of route cause and preventative actions. Where multiple blockages have occurred on the same pump station, specific customer awareness/education will be implemented or compliance notices issued.<br>4. Flushing and maintenance regime will be developed for the pressure sewer network. | C | Possible | 2 | Minor | Moderate |
| | Excessive wastewater generation | Peak tourist population or excessive water usage | Build up of raw wastewater in the inlet balance tank and PSUs. Potential overflow to the environment. | C | Possible | 2 | Minor | Moderate | 1. Water demand management strategy including mandatory best practice water efficient fixtures, smart water metres, customer awareness.<br>2. MBR capacity based on treatment of average daily flows plus 10% contingency at 2.8 EP/ET.<br>3. Flow and level monitoring at each pump unit to detect sources of inflow.<br>4. Road tanker pumpout from individual PSUs if required. | B | Unlikely | 1 | Insignificant | Low |
| Low Pressure Sewerage Collection System | Inflow and infiltration to the sewerage network | Inflow and infiltration to the sewerage network | Potential overflow from PSU or inlet balance tank if combined inflows exceed capacity of MBR | D | Likely | 2 | Minor | Moderate | 1. Low pressure sewerage system constructed with PN16 HDPE with welded joints and fittings.<br>2. Contractor induction and education.<br>3. Inspection and quality assurance during construction.<br>4. Flow and level monitoring at each pump unit to detect sources of inflow.<br>5. PSU pump operation centrally controlled by the Direct Digital Control System. PSUs with high water level are given pumping priority.<br>6. Road tanker pumpout from individual pump units if required. | C | Possible | 2 | Minor | Moderate |
| | Inflow and infiltration upstream of Pressure Sewer Unit (PSU) | Inflow and infiltration upstream of Pressure Sewer Unit (PSU) | Potential overflow from PSU or inlet balance tank if combined inflows exceed capacity of MBR | E | Almost certain | 2 | Minor | Moderate | 1. Plumbing inspection of all household plumbing installation prior to connection.<br>2. Induction and awareness training for all domestic plumbing contractors working in the scheme.<br>3. Flow and level monitoring at each PSU to identify sources of inflow. Customer education and rectification notices will be provided if required.<br>4. Road tanker pumpout from individual PSUs if required. | C | Possible | 2 | Minor | Moderate |
| | High peak diurnal flows | Excessive peak inflows | Potential overflow from PSU or inlet balance tank if combined inflows exceed capacity of MBR | C | Possible | 2 | Minor | Moderate | 1. Inlet balance tank at WWTP provides buffer storage for diurnal flows.<br>2. Storage capacity in each PSU provides buffer storage for diurnal flows.<br>3. PSU pump operation centrally controlled by the Direct Digital Control System. PSUs with high water level are given pumping priority in the control system.<br>4. Road tanker pumpout from individual pump units if required. | A | Rare | 2 | Minor | Low |
| | Pressure main break | Pressure main failure or breakage due to unapproved excavation activity | Discharge of raw sewage to the environment | C | Possible | 3 | Moderate | High | 1. All mains constructed with PN16 HDPE pipe with welded joints and fittings.<br>2. All mains are pressure tested and certified during construction.<br>3. Pressure sewer mains are generally located at the bottom of a common services trench, hence other pipes will be damaged from poor excavation practices before the pressure sewer.<br>4. Signage and identification tape to be installed above all pressure mains.<br>5. All sewer pipe locations registered with dial before you dig service.<br>6. Flow monitoring at the WWTP will identify major variations in daily flow.<br>7. Customer Service Centre and fault reporting with maximum response times for operations staff.<br>8. Sewer spill Emergency Response Plan and cleanup procedures will be developed.<br>9. Pressure and flow monitoring in the pressure sewer network. | B | Unlikely | 2 | Minor | Low |

**Project:** Catherine Hill Bay Water Utility
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**Title:** Sewerage Preliminary Risk Assessment
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**Risk Criteria:** As per Tables 2.5, 2.6 & 2.7: Australian Guidelines for Water Recycling: Managing Health and Environmental Risks-phase 1 (2006)

| Scheme Component | Hazard | Hazardous Event | Impact | Unmitigated Risk | | | | | Control Strategy | Mitigated Risk | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Likelihood | | Consequence | | Risk | | Likelihood | | Consequence | | Risk |
| Low Pressure Sewerage Collection System continued.. | Leakage from PSU wet well | Failure of PSU wet well resulting in subsurface leakage | Discharge of raw sewage to groundwater | C | Possible | 2 | Minor | Moderate | 1. Clean water static pressure test of each wet well during construction.<br>2. Wet well designed to include allowances for all structural loads including hydrostatic and soil pressures.<br>3. Timber bollards or fencing around all PSUs to prevent vehicle access.<br>4. Water level and flow monitoring at each PSU. | B | Unlikely | 2 | Minor | Low |
| | Pump Failure | Pump failure by power surge, blockage, loss of suction etc | Potential discharge of raw sewage to the environment | D | Likely | 3 | Moderate | High | 1. Duty and standby pumps in each PSU.<br>2. Fail safe in electrical system so pump can operate with failed network connections.<br>3. High quality robust pumps with long design life. Likely supplier is E-One.<br>4. Standard pumps with spare pumps maintained onsite for quick changeover if required. | B | Unlikely | 3 | Moderate | Moderate |
| | Power failure | Extended power failure across pressure sewer network | Potential discharge of raw sewage to the environment | E | Almost certain | 3 | Moderate | High | 1. 24 hours emergency storage is provided in all PSUs.<br>2. Low pressure sewer network start up and recovery process is included in Direct Digital Control System logic to avoid excessive simultaneous pump operation.<br>3. Road tanker pump out from individual PSUs if required. | B | Unlikely | 2 | Minor | Low |
| Wastewater Treatment - Membrane Bioreactor + UV Disinfection | Structural failures of tanks and pipes | Tank failure | Discharge of process water to environment | C | Possible | 3 | Moderate | High | 1. Stainless steel tanks with appropriately designed footings.<br>2. Quality assurance during tank manufacture and installation. | A | Rare | 3 | Moderate | Low |
| | Process tank overflows | Blockage or fault causing overflow of process tanks | Discharge of process water to environment | C | Possible | 2 | Minor | Moderate | 1. All process tanks gravity overflow back to inlet balance tank.<br>2. Screening system on inlet to MBR to remove gross solids. | B | Unlikely | 2 | Minor | Low |
| | Mechanical/ electrical items | Failure of mechanical electrical items | Non-compliant recycled water | E | Almost certain | 3 | Moderate | High | 1. Fault detection on all critical mechanical electrical components.<br>2. Continuous online water quality monitoring of critical process parameters, e.g. DO, pH, MLSS, transmembrane pressure, turbidity, UV intensity | C | Possible | 2 | Minor | Moderate |
| | Power blackouts | Extended power blackout | Loss of treatment capacity | E | Almost certain | 3 | Moderate | High | 1. No sewage inflow to MBR during power blackout as pressure sewer system will also be down<br>2. Wastewater will build up in 24 hours emergency storage at each PSU.<br>3. Road tanker pump out from each PSU if required.<br>4. Electrical connection point for mobile power generator to power MBR if required. | C | Possible | 2 | Minor | Moderate |
| | Blockage of inlet screening unit | Blockage of screening unit caused by excessive solids in raw wastewater | Carryover of solids to MBR with reduced treatment performance and increased risk of membrane failure | C | Possible | 2 | Minor | Moderate | 1. Only grinder pump macerated sewage will enter the plant.<br>2. Water level monitoring and high level alarm in screening unit.<br>3. If screening blockage occurs undertake investigation into source of gross solids and implement preventative actions. | B | Unlikely | 2 | Minor | Low |
| | Hydraulic overload during diurnal peak flows | Excessive sewerage flows | Build up of raw wastewater in the inlet balance tank and PSUs. Potential overflow to the environment. | C | Possible | 2 | Minor | Moderate | 1. When peak capacity of the MBR is exceeded the inlet balance tank provides buffer storage for diurnal flows.<br>2. 24 hour storage capacity in each PSU can also provide buffer storage in extreme events.<br>3. PSU pump operation centrally controlled by the Direct Digital Control System. PSUs with high water level are given pumping priority through the control system logic.<br>4. Road tanker pump out from individual PSUs if required during operation. | B | Unlikely | 2 | Minor | Low |
| | Pollutant overload | Excessive BOD or ammonia load | Non-compliant recycled water | C | Possible | 3 | Moderate | High | 1. Continuous online monitoring of MBR process DO, MLSS, pH with alarms.<br>2. Variable speed drive aeration system to match air supply with inflow. Reserve capacity is designed into the aeration system.<br>3. If process impacts due to high pollutant loads are observed a source control investigation will be undertaken using raw wastewater and trade waste data. | B | Unlikely | 3 | Moderate | Moderate |
| | Membrane CIP waste | Return of chemical laden CIP waste through MBR | Potential upset of treatment process and biomass die off | D | Likely | 3 | Moderate | High | 1. MBR CIP waste is stored and neutralised prior to return to the inlet balance tank.<br>2. If operational problems are experienced MBR CIP waste will be trucked off site to nearest approved facility. | B | Unlikely | 3 | Moderate | Moderate |
| | Process chemicals | Spillage of process chemicals | Potential release of chemicals to the environment<br>Potential OH&S impacts. | C | Possible | 3 | Moderate | High | 1. Appropriate bunding and separation of chemicals in chemical storage and delivery area.<br>2. Standard operating procedures for the transport, receipt and use of chemicals. | A | Rare | 2 | Minor | Low |
| | Waste activated sludge | Inadequate sludge wastage rates | High MLSS in MBR, decline in effluent quality & increased membrane fouling. | E | Almost certain | 3 | Moderate | High | 1. Continuous online monitoring of MLSS, DO and TMP with alarms.<br>2. When MLSS reaches maximum set point sludge is pumped from the bottom of the MBR tank to a sludge holding tank before offsite disposal to approved facility. | B | Unlikely | 3 | Moderate | Moderate |

**Project:** Catherine Hill Bay Water Utility
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**Title:** Sewerage Preliminary Risk Assessment
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**Risk Criteria:** As per Tables 2.5, 2.6 & 2.7: Australian Guidelines for Water Recycling: Managing Health and Environmental Risks-phase 1 (2006)

SOLO Water
Water Utility Solutions

| Scheme Component | Hazard | Hazardous Event | Impact | Unmitigated Risk | | | | | Control Strategy | Mitigated Risk | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Likelihood | | Consequence | | Risk | | Likelihood | | Consequence | | Risk |
| Wastewater Treatment - Membrane Bioreactor + UV Disinfection continued… | Membrane failure | Membrane failure resulting in carryover of human pathogens | Non-compliant recycled water | D | Likely | 4 | Major | Very high | 1. Continuous online monitoring of membrane permeate turbidity and transmembrane pressure.<br>2. Proactive calibration and maintenance of online probes<br>3. Alarms raised and treatment plant shut down if critical limits are reached.<br>4. Potable water emergency backup<br>5. If event occurs, identify and isolate failed membrane module and if required replace failed membrane module.<br>6. Shut off irrigation supply pump and undertake monitoring of wet weather storage water quality to ensure compliance.<br>7. Chemical treatment of wet weather storage water can be undertaken if necessary.<br>8. An Emergency Response Plan will be developed for MBR membrane failure. | B | Unlikely | 3 | Moderate | Moderate |
| | UV failure | Inadequate UV dose due to lamp failure, reactor fouling, high flow or high turbidity | Non-compliant recycled water | E | Almost certain | 3 | Moderate | High | 1. Continuous online monitoring UV intensity, flow, upstream permeate turbidity and lamp failure.<br>2. Proactive calibration and maintenance of online probes<br>3. Alarms raised and treatment plant shut down if critical limits are reached.<br>4. Potable water emergency backup<br>5. If Low UV dose is recorded investigate and rectify.<br>6. Shut off irrigation supply pump and undertake monitoring of wet weather storage water quality to ensure compliance.<br>7. Chemical treatment of wet weather storage water can be undertaken if necessary.<br>8. An Emergency Response Plan will be developed for UV lamp failure. | B | Unlikely | 3 | Moderate | Moderate |
| | Sabotage/ vandalism | Sabotage/vandalism | Potential loss of treatment function | C | Possible | 4 | Major | Very high | 1. Lockable site with 6-foot secure fencing.<br>2. Lockable shed for all treatment equipment.<br>3. Remotely accessible CCTV system at WWTP site.<br>4. Community awareness and involvement in the local water scheme. | B | Unlikely | 3 | Moderate | Moderate |
| | Noise | Excessive noise generation | Noise complaints for nearby residents | C | Possible | 2 | Minor | Moderate | 1. All treatment equipment is located inside the WWTP building.<br>2. 100 metre buffer to the nearest residential dwelling.<br>3. Noisy equipment items will be enclosed in purpose built noise enclosures or insulated plant room.<br>4. Equipment specification and design will ensure compliance with NSW Industrial Noise Policy of 5 dBA above background noise level at the nearest residential dwelling.<br>5. WWTP building located on Montefiore Road, which is impacted by background traffic noise.<br>6. Noise complaint management system through customer service processes. | A | Rare | 2 | Minor | Low |
| | Odour | Excessive odour generation | Odour complaints by nearby residents | C | Possible | 2 | Minor | Moderate | 1. All treatment tanks are located inside the WWTP building.<br>2. 100 metre buffer to the nearest residential dwelling.<br>3. All treatment tanks are sealed with passive ventilation through Mcberns activated carbon filters located on the roof of the WWTP building.<br>4. WWTP building includes deodorising sprayers for use if required.<br>5. Odour complaint management system through customer service processes. | A | Rare | 2 | Minor | Low |
| | Aesthetics | Excessive visual impacts | Complaints from nearby residents | C | Possible | 2 | Minor | Moderate | 1. All treatment equipment is located inside the WWTP building.<br>2. 100 metre buffer to the nearest residential dwelling.<br>3. Vegetation screening around the WWTP site. | A | Rare | 2 | Minor | Low |
| | Indoor air quality inside MBR shed | Contamination of indoor air with harmful sewer gases | OH&S impacts | B | Unlikely | 4 | Major | High | 1. All treatment tanks are sealed and externally ventilated.<br>2. Continuous online monitoring of indoor air quality for oxygen, hydrogen sulphide and methane gas inside the WWTP building, with automated air conditioner/ventilation system operation and alarm systems. | B | Unlikely | 3 | Moderate | Moderate |
| Wet Weather Storage Tanks | Vector borne diseases | Vermin/mosquito invasion of wet weather storage tank | Potential spread of diseases | C | Possible | 2 | Minor | Moderate | 1. Closed tanks to eliminate vermin access with mosquito screens on all tank openings and overflows.<br>2. Regular monitoring and inspection for evidence of vermin or mosquito access. | B | Unlikely | 2 | Minor | Low |
| | Unintended contact with recycled water in storage | Human access into storage | Potential public health impacts | D | Likely | 2 | Minor | Moderate | 1. Storage located inside the fenced and secure WWTP site.<br>2. Warning signage around the perimeter of the site and on each storage tank.<br>3. CCTV recording at the WWTP site.<br>4. Lockable manhole access points. | B | Unlikely | 2 | Minor | Low |
| | Blue green algae | Blue green algae growth in wet weather storage tanks | Non-compliant recycled water | C | Possible | 2 | Minor | Moderate | 1. Storage tank covered to prevent sunlight access and algae growth.<br>2. Regular inspection and monitoring of storage tank.<br>3. Low nutrient concentrations in MBR effluent (TP< 0.3 mg/L, TN < 10 mg/L) | B | Unlikely | 2 | Minor | Low |
| | Uncontrolled overflow | Uncontrolled overflow from the wet weather storage during extended wet weather | Stormwater contamination | D | Likely | 3 | Moderate | High | 1. MEDLI modelling indicates the 10 ML did not overflow based on 100-years of historic climate data.<br>2. Continuous online monitoring of storage water level with automatic scheduling of emergency irrigation events to irrigation areas will be undertaken as required to avoid uncontrolled overflow.<br>3. Removal of excess water by road tanker pump out if required. | A | Rare | 2 | Minor | Low |

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| Scheme Component | Hazard | Hazardous Event | Impact | Unmitigated Risk | | | | | Control Strategy | Mitigated Risk | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Likelihood | | Consequence | | Risk | | Likelihood | | Consequence | | Risk |
| Wet Weather Storage Tanks continued.. | Overflows | Excessive wet weather leading to tank overflow | Uncontrolled overflow | C | Possible | 4 | Major | Very high | 1. High level switch will initiate emergency irrigation events to avoid uncontrolled overflows.<br>2. MEDLI modelling predicts the wet weather storage will not overflow based on historic rainfall data.<br>3. Continuous online monitoring of storage water level with automatic scheduling of emergency irrigation events as required to avoid uncontrolled overflow. | B | Unlikely | 3 | Moderate | Moderate |
| | Tank failure | Tank failure | Uncontrolled release of water | C | Possible | 2 | Minor | Moderate | 1. Tank constructed from steel panel tanks with civil/structural engineer certification for tank and footings.<br>2. Quality assurance in construction.<br>3. Bollard fence around tanks if there is a risk of vehicular or machinery damage. | B | Unlikely | 2 | Minor | Low |
| Opportunistic Construction Reuse of MBR+UV recycled water e.g. dust suppression, establishment of landscaping | Unintended uses or human contact with recycled water | Unintended uses or human contact with recycled water | Potential health impacts | D | Likely | 2 | Minor | Moderate | 1. Minimise human contact by restricted access at construction site with low number of workers.<br>2. Appropriate training of all construction workers.<br>3. Appropriate worker health and hygiene practices (e.g. hand washing with disinfectent).<br>4. Avoid recycled water use during high wind.<br>5. Spray drift controls<br>6. Maintain appropriate buffers to sensitive receptors.<br>7. Avoid ponding and surface run-off.<br>8. Construction recycled water management plan will be developed based on the specific proposed uses prior to supply commencing. | B | Unlikely | 2 | Minor | Low |
| Stage 1 temporary, restricted access Irrigation System | Cross connection with potable or recycled water networks | Cross connection between temporary irrigation network and other water networks | Contamination of other water supplies | C | Possible | 5 | Catastrophic | Very high | Temporary irrigation management plan will be developed for the scheme and will include the following cross connection controls:<br>1. Temporary irrigation system to operate under low pressure.<br>2. Temporary Irrigation Network is to use Lilac HDPE pipe.<br>3. Temporary Irrigation Network pipes to be laid in their own separate trench with identification tape and above ground signage.<br>4. Only approved, trained and supervised plumbing contractors are permitted to work on reticulation systems. | B | Unlikely | 3 | Moderate | Moderate |
| | Unintended uses or human contact with recycled water | Unintended uses or human contact with recycled water | Potential health impacts | D | Likely | 3 | Moderate | High | Log reduction targets for the temporary irrigation system will be achieved with the following site based controls:<br>1. Secure, restrictive access temporary irrigation areas including warning signs, identification and labelling.<br>2. Surface sprinklers with spray drift control including sprinkler nozzles that operate under low pressure with a large droplet size and low throw height.<br>3. Existing village of CHB located approximately 400m east of the irrigation areas.<br>4. Minimum 30m buffer to down gradient property boundary.<br>5. 20m buffer to up gradient property boundary.<br>6. No irrigation within the 40m wide future waterway corridor.<br>7. Minimum buffer to the nearest future residential dwelling is 70m.<br>8. No above ground taps or fixtures in temporary irrigation areas.<br>9. Lockable irrigation valves pits and controllers etc.<br>10. Soil moisture probes and weather station override on irrigation controllers to prevent irrigation during rainfall, high wind or elevated soil moisture.<br>11. Irrigation at night time only under normal operating conditions. | A | Rare | 3 | Moderate | Low |
| | Spray drift during irrigation | Spray drift onto sensitive receptor | Potential ingestion of recycled water | E | Almost certain | 3 | Moderate | High | 1. Weather station override on irrigation controllers to prevent irrigation during high wind.<br>2. Surface sprinklers with spray drift control including sprinkler nozzles that operate under low pressure with a large droplet size and low throw height.<br>3. Existing village of CHB located approximately 400m east of the irrigation areas.<br>4. Minimum buffer to the nearest future residential dwelling is 70m.<br>5. Irrigation at night time only under normal operating conditions. | A | Rare | 2 | Minor | Low |
| | Irrigation during wet weather | Irrigation during wet weather resulting in surface runoff or deep percolation of effluent | Contamination of surface and/or groundwaters | E | Almost certain | 3 | Moderate | High | 1. 2 ML wet weather storage tanks provides approximately >23 days storage at average irrigation rates.<br>2. Soil moisture probes and weather station override on irrigation controllers to prevent irrigation during rainfall, high wind or elevated soil moisture.<br>3. Minimum of 30m non-irrigated, vegetated buffer strip down gradient of the temporary irrigation areas.<br>4. Diversion drains along uphill slope to divert upslope stormwater around the irrigation areas.<br>5. Catch drain/swale along the downhill boundary of irrigation areas.<br>6. Dense deep rooted grass vegetation will be established, e.g. kikuyu pasture.<br>7. Contour mounds will be constructed at intervals of approximately 30-50 metres.<br>8. Groundwater monitoring will be undertaken during operation. | A | Rare | 2 | Minor | Low |
| | Irrigation rates and scheduling | Inappropriate irrigation scheduling | Increased risk of surface and ground water contamination | C | Possible | 2 | Minor | Moderate | 1. Irrigation scheduling will use programmable irrigation controllers to control irrigation frequency, time and duration. Irrigation rates will be calibrated to ensure no ponding.<br>2. Irrigation rates will be seasonally adjusted in the irrigation controller to match seasonal irrigation demand. | B | Unlikely | 2 | Minor | Low |

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| Scheme Component | Hazard | Hazardous Event | Impact | Unmitigated Risk | | | | | Control Strategy | Mitigated Risk | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Likelihood | | Consequence | | Risk | | Likelihood | | Consequence | | Risk |
| Stage 1 temporary, restricted access Irrigation System continued... | Recycled water | Surface runoff during irrigation | Potential contamination of surface water | C | Possible | 3 | Moderate | High | 1. All temporary irrigation areas to use irrigation scheduling controls to control the time, frequency and duration of irrigation events.<br>2. Soil moisture probes and weather station override on irrigation controllers to prevent irrigation during rainfall or elevated soil moisture.<br>3. Minimum of 30m non-irrigated, vegetated buffer strip down gradient of the temporary irrigation areas.<br>4. Diversion drains along uphill slope to divert upslope stormwater around the irrigation areas.<br>5. Catch drain/swale along the downhill boundary of irrigation areas.<br>6. Dense deep rooted grass vegetation will be established, e.g. kikuyu pasture.<br>7. Contour mounds will be constructed at intervals of approximately 30-50 metres. | B | Unlikely | 2 | Minor | Low |
| | Nitrogen | Excessive nitrogen load resulting in leaching of nitrate from irrigation areas | Contamination of groundwater | C | Possible | 3 | Moderate | High | 1. Irrigation of "Class A" recycled water with total nitrogen concentration of 10 mg/L and low average irrigation rates of around 1 mm/day.<br>2. MEDLI modelling indicates all nitrogen applied in irrigation is taken up by vegetation.<br>3. MEDLI modelling indicates negligible nitrate concentration in deep drainage. | B | Unlikely | 2 | Minor | Low |
| | Phosphorus | Excessive phosphorous load resulting in leaching of phosphate from irrigation area | Contamination of groundwater | C | Possible | 3 | Moderate | High | 1. Irrigation of "Class A" recycled water with total phosphorus concentration of 0.3 mg/L and low average irrigation rates of around 1 mm/day.<br>2. MEDLI modelling indicates the majority of phosphorus applied in irrigation is taken up by vegetation.<br>3. MEDLI modelling indicates negligible phosphate concentration in deep drainage.<br>4. MEDLI modelling predicted Phosphorus adsorption into soil at a low rate of 0.3 kg/ha/year.<br>5. Critical P-sorption life of the soil is conservatively estimated to be >166 years based on P-sorption capacity of holocene sand. | B | Unlikely | 2 | Minor | Low |
| | Effluent Salinity | Impacts on plant growth due to salinity | Reduction in plant growth and water and nutrient uptake rates | C | Possible | 2 | Minor | Moderate | 1. MEDLI modelling indicated no impacts on plant growth due to salinity based on a conservative effluent TDS of 1500 mg/L.<br>2. Landscape design processes will ensure appropriate vegetation is selected in temporary irrigation areas that can tolerate the required salt concentrations.<br>3. The natural sandy top soil profile and relatively high rainfall at the site will assist with flushing of salt through the soil profile to minimise potential salinity impacts on vegetation. | B | Unlikely | 3 | Moderate | Moderate |
| | Effluent SAR | Long term sodicity impacts on soil | Soil dispersion, reduction in permeability | C | Possible | 2 | Minor | Moderate | 1. Topsoil profile is dominated by sand, hence the likelihood of sodicity impacts is low.<br>2. Detail geotechnical testing to be undertaken for each development stage will avoid areas with high clay content and Exchangeable Sodium Percentage (ESP).<br>3. Ongoing monitoring of soil cations will detect changes in soil ESP over time.<br>4. If required gypsum/lime application to irrigation areas will be undertaken.<br>5. If required the irrigation water SAR will be adjusted through addition of calcium/magnesium or reduction in sodium inputs to maintain effluent SAR<5. | B | Unlikely | 2 | Minor | Low |
| | Metals and trace contaminants | Trace contaminants in irrigation supply resulting in long term accumulation in irrigation area | Contamination of soil and groundwater | C | Possible | 2 | Minor | Moderate | 1. Source catchment is >99% domestic wastewater hence the likelihood of trace contaminants is low.<br>2. Customer awareness campaigns, supply contracts, trade waste agreements and recycled water use agreements will further reduce the likelihood of events occurring.<br>3. Detailed monitoring of effluent quality for trace contaminant will be undertaken annually using a NATA accredited laboratory.<br>4. Soil monitoring in temporary irrigation area will identify any build up or increase in contaminants.<br>5. If contaminants are detected then an investigation into the likely source will be undertaken and trade waste/source controls implemented.<br>6. If required additional treatment processes can be installed, e.g. BAC, ion exchange. | B | Unlikely | 2 | Minor | Low |
| | Recycled water | Pipe breakage | Potential contamination of surface or groundwater | C | Possible | 2 | Minor | Moderate | 1. Flow and pressure monitoring in the temporary irrigation supply system.<br>2. Visual inspection to identify boggy areas or erosion etc. | B | Unlikely | 2 | Minor | Low |
| | Odour | Odour released during irrigation | Odour impacts on nearby residents | B | Unlikely | 2 | Minor | Low | 1. Irrigation of high quality "Class A" recycled water with low BOD<br>2. Irrigation at night time only.<br>3. A minimum 70m buffer distance between the edge of the temporary irrigation areas and the closest dwelling. | A | Rare | 2 | Minor | Low |
| | Stormwater runon | Stormwater running onto irrigation areas from upgradient | Water logging of irrigation area | D | Likely | 2 | Minor | Moderate | 1. Stormwater diversion drains to divert all upgradient stormwater runoff around temporary effluent irrigation areas.<br>2. Appropriate buffers to waterways, ponds, stormwater drains and SEPP14 wetlands<br>3. Catch drain/swale along the downhill boundary of irrigation areas.<br>4. Contour mounds will be constructed at intervals of approximately 30-50 metres. | A | Rare | 2 | Minor | Low |

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| | | | | Likelihood | | Consequence | | Risk | | Likelihood | | Consequence | | Risk |
| Stage 1 temporary, restricted access Irrigation System continued… | Percolation to groundwater | Excessive percolation of effluent to groundwater | Contamination of groundwater | C | Possible | 3 | Moderate | High | 1. Low long term average irrigation rate of around 1 mm/day, hence low risk of groundwater contamination.<br>2. No groundwater within 3 metres of ground surface in geotechnical investigation.<br>3. Irrigation of high quality "Class A" recycled water with low nutrients.<br>4. MEDLI modelling indicates negligible concentrations of nutrients in deep drainage for conservative sandy soil profile.<br>5. Groundwater monitoring will be undertaken during operation. | B | Unlikely | 2 | Minor | Low |

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**Document Status**

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| | | **Name** | **Signature** | **Date** |
| A | BRAD IRWIN<br>Environmental Engineer | WAYNE WILLIAMSON<br>Project Director | | 16/04/2013 |
| B | BRAD IRWIN<br>Environmental Engineer | WAYNE WILLIAMSON<br>Project Director | | 11/07/2013 |
| C | BRAD IRWIN<br>Environmental Engineer | WAYNE WILLIAMSON<br>Project Director | | 1/10/2014 |
| | | | | |