Appendix F

Water Cycle Management Plan

Teralba Sustainable Resource Centre

CiviLake

23 June 2010

Water Cycle Management Plan

Water Cycle Management Plan

Prepared for

CiviLake

Prepared by

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Executive Summary

This report provides a detailed Water Cycle Management Plan for the proposed Teralba Sustainable Resource Centre to be located at Weir Road, approximately 2km north of Teralba, which is approximately 20km from Newcastle CBD.

The Water Cycle Management Plan is required for the preparation of an environmental assessment (EA) for a proposed facility under Part 3A of the *Environmental Planning and Assessment Act 1979 (EP&A Act).*

The objectives of the water management plan for the proposed facility are to:

- Provide sufficient water storage on site to provide a sustainable and reliable water supply for operational demands of the facility such as for the mill and crushing plant and for dust suppression.
- Maximise water reuse and recycling to minimise potable water demands to the site.
- Provide water quality and quantity management to minimise potential impacts associated with discharge to the downstream environment (freshwater wetlands and SEPP14 wetland downstream of the site).
- Recommend best practice stormwater management features appropriate to the study area for construction and operation of the facility.
- Provide suitable perimeter earth bunding to prevent external flood waters entering the site and also provide attenuation of stormwater for reuse and controlled discharge.

Based on the review and preliminary assessment of WSUD treatment and management options, the preferred water cycle management strategy for the facility is summarised below.

Water Conservation and Reuse

- Stormwater from the stockpile areas on site will be treated and stored in the main storage pond for reuse during operations with an estimated resultant 80% of operational water sourced from onsite water ponds.
- Rainwater harvesting from roofs and reuse will be achieved through the use of above ground rainwater storage tanks for fire-fighting and toilet flushing for office and storage shed facilities.

Water Quantity

- Perimeter bunding will be provided to prevent flood waters entering the site from the 100 year ARI flood event of Cockle Creek.
- Provision of a freeboard storage volume (approx 11ML) in the main storage pond will attenuate surface runoff from the development site for events up to the 1 in 100 year ARI, 24 hour rainfall event. Discharge is controlled to maintain pre-development peak discharge flows from the development site.
- Following storm events, water is attenuated in the main storage pond. Discharge can occur from an outlet pipe when the pond water level rises and via a spillway when the pond capacity is exceeded. Water discharged from the main storage pond will follow an existing drainage pathway (man-made channels) through the downstream swamp forest and freshwater wetland communities and conveys flows into a SEPP14 wetland.

Water Quality

- Stormwater from the site is treated to manage sediment, nutrients and other pollutants to meet best practice targets.
- Buffer strips are used around stockpiles to reduce sediment load generated from stockpile areas.
- Silt fences are to be installed along the downstream toe of stockpiles to capture coarse sediments and gross pollutants from stormwater runoff from stockpile surfaces.
- Site graded to drain stormwater via a sedimentation swale to the ‘Dirty’ Water Pond.
- The Dirty Water Pond will capture and remove gross pollutants and coarse sediment. Outlet controls enable the basin to also provide storage for spill containment. Discharge from the Dirty Water Pond will drain by gravity to a bioretention system for effective treatment of fine suspended sediments, dissolved nutrients and heavy metals and hydrocarbons. The design will ensure adequate energy dissipation and flow distribution.
- Overflow and treated flow from the bioretention system would be collected in the main storage pond for use as process and dust suppression water during operations.

A summary of the preliminary requirements for the proposed water management system is provided in Section 7 of this report and a conceptual plan layout and typical section and details of the proposed major water management elements are provided in Figures A1 and A2 respectively (refer Appendix A). The design of these systems will be refined through detailed design development.

Adoption of the above measures will provide an integrated, sustainable approach to water cycle management of the Teralba Sustainable Resource Centre development site by meeting the required performance objectives and targets described in this document.

1.0 Introduction

1.1 Background

The following report provides a detailed Water Cycle Management Plan for the proposed Teralba Sustainable Resource Centre to be located at Weir Road, approximately 2km north of Teralba, which is approximately 20km from Newcastle CBD.

The Water Cycle Management Plan is required for the preparation of an environmental assessment (EA) for a proposed facility under Part 3A of the *Environmental Planning and Assessment Act 1979 (EP&A Act).*

The facility would have the capacity to process up to 200,000 tonnes per annum (tpa) of construction and demolition waste. It is understood that the facility would provide for the storage, separation, processing including crushing of hard waste/ construction and demolition materials including concrete, bricks, gravel, crushed rock, road base, asphalt, soils, green waste and tiles and would provide a centralised facility for the receipt of materials from Council.

Water discharged from the site follows an existing drainage pathway (man-made channels) through the downstream swamp forest and freshwater wetland communities and conveys flows into a SEPP14 wetland. The flow pathway is illustrated in Appendix A of this report (Figure A1).

The Water Cycle Management Plan provides a summary of the objectives and constraints related to water management on the site and the basis for the design approach adopted.

This document supports the environmental assessment of the proposed facility and provides:

- background information about the site,
- detail on water management objectives and targets,
- information related to flooding,
- site conditions and constraints,
- estimates of operational water demands,
- water balance,
- information about the design of the water treatment elements proposed for the site,
- potential water quality impacts resulting from the development and mitigation of impacts,
- MUSIC modelling confirming water quality performance,
- proposed water quality testing,
- contingency in design and operation.

1.2 Water Management Objectives

The objectives of the water management plan for the proposed facility address water conservation, flow management and water quality and include to:

- Provide sufficient water storage on site to provide a sustainable and reliable water supply for operational demands of the facility such as for dust suppression and mill/crushing plant demands.
- Reduce the demand on potable town water supplies.
- Minimise changes in the hydrology of surface runoff from the site to mitigate potential impacts on the downstream receiving environment (freshwater wetlands and SEPP14 wetland downstream of the site).
- Provide water quality management to minimise potential impacts associated with discharge to the downstream environment .
- Ensure peak discharge from the developed site does not exceed the predevelopment peak discharge (for events up to the 1 in 2 year ARI storm event) in order to mitigate the risk of erosion along the flow paths towards the receiving environment and the SEPP 14 wetland.
- Provide adequate flood mitigation and potential spill containment storage for events up to the 1 in 100 year ARI storm event.
- Prevent external flood waters entering the site by raising the site level and providing perimeter earth bunding, and

- Remove stormwater pollutants from runoff to mitigate potential impacts on the downstream receiving environment.

1.3 Integrated Water Cycle Management Approach

Integrated Water Cycle Management (IWCM) aims to combine all aspects of water management treating the system as an interacting whole, as opposed to traditional water management which looks at each component of the urban water cycle in isolation. IWCM deals effectively with the complex linkages between different elements of the water cycle, both within the urban area and between the urban area and its water-related catchment. With IWCM, water use is optimised while minimising impacts to the environment and other water users.

A cost-effective opportunity for implementing IWCM arises when planning for new developments. Urban water cycle infrastructure can be tailored to deliver the best resource management taking into account development constraints and opportunities.

Some of the additional advantages of IWCM include source substitution and water demand reduction through water efficient appliances and practices, etc. The result is an integrated water system that minimises the potable water consumption and the amount of sewage generated, while also minimising water quality and quantity impacts on receiving waters.

2.0 Water Quality Objectives and Targets

Based on the proposed facility usage and operations, the expected pollutants that may contaminate stormwater runoff within the site include:

- Gross pollutants (debris, vegetation litter);
- Oils and greases (from vehicles and operational plant);
- Coarse sediments (from rock/soil/aggregate stockpiles);
- Suspended (fine) solids (from soil stockpiles)
- Nutrients – nitrogen and phosphorus (from green waste stockpiles)
- Heavy metals (which could potentially be present in feedstock)

The above are discussed in more detail in Section 3.

For the proposed development, an integrated water cycle management approach is to be adopted that will include both qualitative and quantitative performance objectives and targets. It is important that these targets can be, and are, met to ensure successful mitigation of development impacts upon receiving environments.

2.1 Statutory Requirements and Guidelines

There are various State and Local planning documents and development guidelines that address development requirements associated with water cycle management strategies. The main relevant documents that have been reviewed are as follows:

- Lake Macquarie City Council DCP No.1 "Stormwater Management, Infrastructure and On-Site Services" (Rev 3), dated February 2009.
- Australian Runoff Quality– Institute of Engineers, Australian National Committee on Water Engineering, 2006.
- Managing Urban Stormwater: Environmental Targets, Department of Environment and Climate Change, Consultation Draft, October 2007
- ANZECC Water Quality Guidelines (2000).

A summary of relevant parts of these documents are provided below:

Lake Macquarie City Council DCP No.1 "Stormwater Management, Infrastructure and On-Site Services"

This DCP relates to the provision of stormwater management and infrastructure that are necessary parts of all developments.

Sustainable solutions protect the environment and minimise cost over a longer term. This approach is known as Water Cycle Management (WCM). WCM required an urban water management approach attuned to natural water and ecological processes and may include:

- Reuse of roof water for appropriate purposes;
- Reuse of runoff for landscape irrigation;
- Minimisation of impermeable surfaces;
- Specially designed landscaping for cleaning runoff and conserving water; and
- Infiltration of stormwater into underground aquifers where ground conditions allow.

For industrial and commercial developments, acceptable solutions for water quality protection measures are summarised below:

- Bunding and/or roofing of storages and process areas to contain possible leaks and/or spills in potential conflict areas;
- "First flush" systems;
- Silt and/or oil traps and rubbish collectors; and
- Establishing formal Trade Waste Agreements with Hunter Water.

Australian Runoff Quality – Institute of Engineers, Australian National Committee on Water Engineering, 2006

The Australian Runoff Quality guide (ARQ) provides an overview of current best practice in stormwater management in Australia within the framework of integrated urban water management. The guide is a companion to Australian Rainfall & Runoff (AR&R), and is endorsed by Engineers Australia.

ARQ provides

- an overview of Water Sensitive Urban Design
- details of stormwater pollutant pathways and
- procedures for estimating the loads of a range of stormwater pollutants
- advice on integrating various urban water cycle management practices
- design guidelines
- best practice targets for treating stormwater for pollutants such as suspended solids, phosphorus, nitrogen, litter, coarse sediment, oil and grease
- procedures for estimating the performance of treatment and management practices.

Managing Urban Stormwater: Environmental Targets, Department of Environment and Climate Change, Consultation Draft, October 2007

The purpose of this document is to outline recommended environmental targets for stormwater management that councils and other stormwater managers can adopt:

a) When preparing stormwater strategies for existing urban areas; and

b) For new urban developments.

An indicative translation of these environmental targets to stormwater targets is:

- Reduce the proportion of the impervious area in a catchment that is directly connected to stream by a stormwater drain to less than around 2 - 5% of the catchment - this will reduce the impacts of changed streamflows on aquatic ecosystems;
- Reduce the duration of streamflows above erosive levels to pre-development levels, to reduce stream erosion;
- Ensure stream crossings (e.g. culverts) do not significantly impact on the movement of aquatic fauna along a watercourse;
- Physical restoration of degraded riparian vegetation and in-stream habitats;
- Reduce nutrient inputs to lakes and reservoirs to “sustainable” levels, whereby no eutrophication (excessive algal growth) is triggered;
- No significant change to the wetting and drying cycles in natural wetlands; and
- Stormwater discharges to urban bushland to be below erosive levels and phosphorus levels in stormwater to be similar to natural levels in low soil fertility areas

Also in this draft it mentions that the Department of Environment, Climate Change and Water (DECCW) recommends that all new urban developments implement a cost-effective level of stormwater management to:

- Minimise impacts on the environmental values of water where the pre-development landuse is not causing significant pollution; or
- Contribute to meeting the environmental values for water where the pre-development landuse is causing significant pollution.

DECCW currently recommends the following environmental targets be adopted by councils and consent authorities for medium to large scale developments (ie. larger than a medium-high density development). These targets are those currently used by the Growth Centres Commission and are an update of the targets recommended by *the NSW EPA Managing Urban Stormwater: Council Handbook (draft 1997)* and widely adopted by Councils. The targets are as follows:

- 90% reduction in the average annual gross pollutant (size > 5mm) load
- 85% reduction in the average annual total suspended solids (TSS) load
- 65% reduction in the average annual total phosphorus (TP) load

- 45% reduction in the average annual total nitrogen (TN) load
- The post development duration of flows greater than the “stream-forming flow” being no greater than 3 – 5 times the natural duration of this flow.

ANZECC Water Quality Guidelines, (2000)

The specific quantitative key water quality indicators and related numerical criteria (default trigger values), are provided in the Australian and New Zealand Environmental Conservation Council (ANZECC) Guidelines, 2000. These trigger values are used to assess risk of adverse effects due to nutrients, biodegradable organic matter and pH in various ecosystem types. However, these trigger values should not be considered as blanket guidelines for natural water quality, as ecosystem types vary so widely throughout Australia.

ANZECC guidelines are a commonly used reference, and are appropriate for use in the assessment of ambient conditions, however not for the assessment of runoff. Guidelines specifically formulated for the assessment of runoff are provided in ARQ. These guidelines accommodate the stochastic nature of rainfall and the widely varying concentrations of pollutants in runoff, while providing protection from pollutants for receiving aquatic environments.

2.2 Adopted Water Quality Targets

Based on the above review of various State and Local planning documents and previous development guidelines that address water cycle management, the following table provides water management targets and objectives that have been adopted for the proposed development site for the purpose of this study.

Table 1 Adopted Water Management Targets

Objective	Performance Measure and Target
Water Quality	90% reduction in the average annual gross pollutant (size > 5mm) load*
	85% reduction in the average annual total suspended solids (TSS) load*
	65% reduction in the average annual total phosphorus (TP) load*
	45% reduction in the average annual total nitrogen (TN) load*
Flow Management	Post-development storm discharge to match pre-development storm discharges for the 1.5 year and up to the 100 year ARI peak flows

Based on comparison with typical urban loads from a site of comparable impervious area

It is noted the removal of suspended solids will result in a reduction of heavy metal concentrations which are largely attached to the solid suspended particles.

3.0 Potential Pollutants in Stormwater at the Site

3.1 Potential Contaminants in Waste to be Processed or Stored at the Site

The waste types proposed to be received at the site include:

1) Concrete and recycled asphalt pavement (RAP)
2) Green waste - limited to chipped trees (to be chipped prior to or after entering the facility) primarily from Council tree maintenance works.
3) Uncontaminated Soil
4) Tiles and bricks

Potential contaminants associated with these wastes are considered to include:

1) Concrete and recycled asphalt pavement (RAP) – Neither concrete nor RAP would be expected to contain significant chemical contamination and any contaminants present would be expected to be bound in by the concrete / asphalt matrix. We note that both recycled concrete and RAP are covered by the recovered aggregate exemption 2008 and the only chemicals required to be tested by this exemption are heavy metals (mercury, cadmium, lead, arsenic, total chromium, nickel, zinc). On this basis we consider heavy metals to be the main potential chemical contaminant in the concrete and RAP. To meet the excavated natural material (ENM) exemption the concentrations of heavy metals need to be relatively low (typically comparable or lower than the environmental investigation levels presented in the NEPM), hence we would not expect significant concentrations of heavy metals to be leached from the concrete and RAP on the site. Asbestos could potentially be present in recycled concrete however Council will have processes in place to prevent asbestos being brought onto the site as discussed earlier in this letter.
2) Green waste – Green waste brought to the site will be limited to trees primarily from Council tree maintenance works which will either be chipped prior to being brought onto site or chipped onsite. On this basis we would not expect any chemical contaminants to be present in the green waste. Nutrients could potentially be generated from the breakdown of the green waste although as no composting will occur on site and the timeframe the waste will be present on the site will be limited, nutrient generation is expected to be limited.
3) Uncontaminated soil.
4) Tiles and bricks – only small quantities of these would be stored and we would not expect significant contamination to be present in them

On the basis of the above we consider suspended sediments and any contaminants entrained within them or absorbed to them to be the main contamination concern on the site with nutrients a lesser concern. Another potential source of contamination on the site is minor oil and grease from plant, vehicles and machinery on the site.

3.2 Potential contaminants that could impact upon water quality

Based on the above, potential sources of pollutants from the site which could impact on water quality are considered to include:

- Receiving waste that may contain low levels of contaminants (heavy metals, oils and grease etc)
- Decomposition of green waste (leading to leaching of nutrients)
- Suspended solids transport from stockpiled materials (Total Suspended Solids (TSS))
- Minor leakage of oils and greases from plant and equipment on site

The risk associated with these pollutants have been minimised through a range of strategies as listed below.

Chemical contaminants - General

- Recycled concrete and RAP are expected to have low levels of chemical contaminants. It is noted that the only chemical contaminant that requires testing under the recovered aggregate exemption 2008 (which covers both recycled concrete and RAP) is heavy metals
- Chemical contaminants in the materials to be received by the site are expected to be mostly bound to the concrete / asphalt matrix minimising the potential for leaching and discharge to the environment

- Green waste is limited primarily to trees from Council maintenance works (unlikely to have chemical contaminants)
- Soils will be tested to confirm that they meet the Excavated Natural Material (ENM) or Virgin Excavated Natural Material (VENM) criteria and hence would not be expected to contain significant contaminants
- Tiles and bricks are not expected to contain significant contaminants

Heavy metals, oils and grease

- Only low levels of heavy metals would be anticipated to be associated with waste brought to the site.
- Minor quantities of oil and grease may be present on the site surfaces associated with the plant, vehicles and machinery on the site
- These contaminants typically bind to particulate matter. On this basis, treatment for suspended solids would also be considered to effectively treat heavy metals and oil and grease. Contaminants are effectively removed via the bioretention system which has a demonstrated capacity for removal of suspended solids in stormwater.
- In addition to the above, regular maintenance of machinery, vehicles and equipment on site will assist in reducing leakage of oils and grease. Council procedures documented in the Operaitonal Environmental Management Plan (OEMP) will also include planning for emergency response to site spills

Nutrients (decomposition of green waste)

- Green waste brought to the site will be limited to trees primarily from Council tree maintenance works. No composting is proposed on the site. It is anticipated that each load of green waste imported will be present on site no longer than 1-2 months and hence will have minimal time to decompose
- Despite the above, should nutrient rich runoff and organic matter from the green waste stockpile area be generated and transported by the stormwater runoff to the treatment area on the site it would be removed through bioretention treatment. Bioretention systems use a soil filter media to effectively reduce concentrations of nutrients and organic matter.

Pesticides and herbicides

- Pesticides and herbicides would not be expected to be present in the waste brought to the site.

Suspended solids from stockpiled materials

- Stormwater runoff to the water treatment area in the site is expected to have higher TSS concentrations due to the presence of exposed soil surfaces and stockpiling.
- Suspended solids can also have contaminants such as heavy metals bound to them.
- Suspended solids are considered the highest risk pollutant for this site. It is considered to be the pollutant with the highest risk of impact on the sensitive downstream environment and also an effective surrogate measure for the adequacy in removal of heavy metals.
- A treatment train approach is proposed to provide multiple elements to reduce TSS concentrations in stormwater runoff which are discussed in Section 7 of this report.

4.0 Flood Study

The proposed development site is within the floodplain of Cockle Creek. Cockle Creek is a waterway that discharges into Lake Macquarie at its north western extent. The catchment for Cockle Creek is approximately 106 square kilometres and includes urban development to the north and east and vast undeveloped areas to the west.

In order to protect the proposed Facility from flooding inundation, it is proposed to fill the site to such a level and such a gradient as to be above any flood level and grade surface water to the retention ponds. These works have the potential to then affect flooding levels in the vicinity. An embankment would protect the perimeter of the retention ponds where necessary.

As a result, a flood assessment study was undertaken by Lake Macquarie Council to analyse and predict any changes to flood levels that may result following construction of the facility. The assessment included flood modelling of Cockle Creek in the vicinity of the site.

The results of the flood study are provided in the Council Report titled *"Analysis on the Impact of Flooding in Cockle Creek for proposed Construction of Recycling Waste Facility",* dated November 2009. A summary of the conclusions from the report are summarised below:

- Modelling has shown that the proposed waste recycling facility has an insignificant impact on the existing flooding regime in Cockle Creek which is governed by a backwater phenomenon created at the confluence of Cockle Creek, Cocked Hat Creek and Brush Creek.
- An increase in flood level of 0.01m occurs at the upstream boundary of the site as a result of the proposed filling required for the development. This increase is negligible, given the vast extent of flooding in the area and is probably within the accuracy of the model.
- Due consideration has been given to the effect of climate change by conservatively increasing flows and downstream tail water controls. Modelling indicates that an increase in flood level, as a result of climate change, would be approximately 0.2m from RL 2.7m AHD to RL 2.9m AHD at the site. It was also found that filling to the site in this scenario also resulted in a negligible increase of 0.01m at the upstream boundary of the site in comparison to pre-developed flood levels at that location.
- It was concluded that the proposed waste recycling facility has negligible effect to the flooding regime of Cockle Creek and would not adversely affect upstream or downstream properties.

5.0 Site Conditions and Constraints

There are various issues, constraints and opportunities on the proposed development that determine the water cycle management strategy that can be developed. These are outlined below.

Issues and Constraints

The constraints to be considered in the preparation of the water management strategy for the site include:

- The site ground surface ranges from about RL 0.6m AHD in the south to approx RL 3.0m AHD in the north of the site. Therefore perimeter bunding will be required to prevent flood waters entering the site (RL 2.9m AHD for 100 year ARI flood event including climate change effects).
- The groundwater levels are relatively close to the surface which limits the depth of stormwater management ponds (records of groundwater level of 0.5m RL in dry periods and 1.5-1.8m RL in recent monitoring following high rainfall)
- Compacted fill material will be used to raise the site levels. The post development infiltration to groundwater will be limited, resulting in more runoff and representing a change from the predevelopment infiltration processes. Also water management strategies that rely on infiltration that slowly seep water into natural ground (ie. infiltration basins, porous pavements, irrigation) are therefore not considered appropriate for this site.
- The receiving environment includes sensitive ecological communities as outlined in the *Ecological Study* (Ecotone, 2008, Appendix H of the EA. The vegetation communities include Ball Honeymyrtle Swamp Forest, Freshwater wetland, Swamp Mahogany / Paperbark / Woollybutt Swamp Forest and an area mapped as a SEPP 14 wetland. The existing drainage flow path from the site through the receiving environment and mapped ecological communities is illustrated in Figure A1.
- The downstream drainage line is a man made channel that passes through the communities mentioned above.
- The *Ecological Study* (Ecotone) notes that the freshwater wetland is ephemeral.
- The *Ecological Study* also notes that the Ball Honey Myrtle Swamp forest would technically be classified as an endangered ecological community Swamp (EEC) Sclerophyll Forest on Coastal Floodplain (SSFCF) but is dominated by *Melaleuca nodosa* which is not a characteristic species of that EEC.
- The discharge along the drainage flow path through the vegetation communities downstream would need to be managed to prevent any potential erosion points and ensure hydrologic conditions along this flow path are appropriate for these ecosystems.

Opportunities

The opportunities to be considered in the preparation of the water management strategy for the site include:

- Surface slopes on the development site will generally be less than 1% therefore soil erosion of surface soils will be limited.
- The facility will have a relatively large non-potable water demand requirement for mill and crushing plants processes and for dust suppression, and therefore there is opportunity for stormwater reuse and recycling on site.

6.0 Water Balance Model

A water balance was developed for the proposed Teralba Sustainable Resource Centre to understand the following:

- Predicted stormwater runoff volumes and frequencies and impacts on hydrology
- Estimated pollutant loads and treatment train effectiveness in water quality improvement
- Predicted storage volume fluctuations and water supply reliability

6.1 Modelling Data

Rainfall data

The Bureau of Meteorology provides Weather Station Data from a number of climatic stations in the local area. Stations nearest to Teralba were located and assessed and have mean annual rainfall of:

- 1132 mm/yr (Edgeworth WWTP 61393),
- 1081 mm/yr (Bolton Point (The Ridge Way) 61133),
- 1167mm/yr (Toronto WWTP 61322),
- 1254mm/yr (Swansea (Catherine St) 61377)

Water quality modelling requires pluviograph data (6 minute time step rather than daily data). A five year time series (1982-86), has been used that reflects typical Sydney coastal rainfall data (Observatory Hill, with annual rainfall 1278 mm/yr). The results have been also validated with a 30 year time series from the same rainfall station.

Rainfall intensity

Using design Intensity/Frequency/Duration (IFD) curves for the Lake Macquarie area (sourced from the LLMC Handbook of Drainage Design Criteria), the calculated 24 hour duration rainfall totals is summarised in the table below.

Table 2 Rainfall Totals for Specific ARI Storm Events in the Lake Macquarie Area

ARI Event	Rainfall Intensity (mm/hr)	24 Hour Total Rainfall (mm)
2	4.4	106
5	6.0	144
10	6.8	163
20	7.1	170
50	9.2	220
100	10.3	247

Based on the above results, the highest recorded daily rainfall of 275mm (in 1990) is estimated to be greater than the 100 year ARI, 24 hour event. It can therefore be concluded that the adopted rainfall data used for the water balance model is representative of a long term record having both dry and very wet annual and daily rainfall years.

Estimated operational water demands

CiviLake has provided indicative daily usage requirements during operation of the facility as follows:

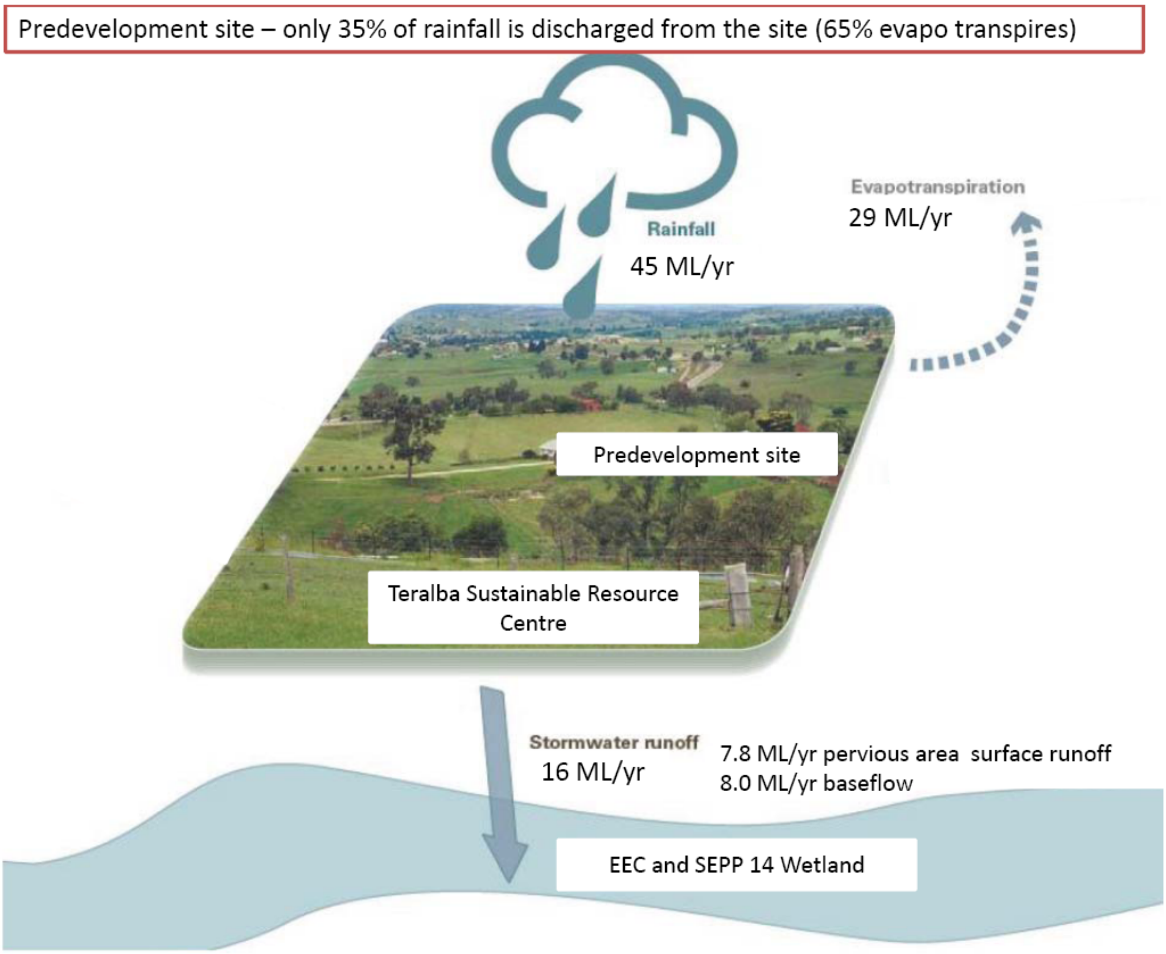
- Pug mill requiring approximately 50kL per day (assumes minimal moisture in the feed stockpiles).
- Dust suppression (watering) requiring approximately 30kL per day
- Concrete crushing requiring approximately 20KL per day for an estimated average 1 week/month operation during the year.

Based on the above, a maximum average daily usage of approximately 72kL/day is adopted as an estimate of operational water demands. Note that demands are likely to increase gradually as operations on the site increase over a number of years.

6.2 Water Balance Modelling

A preliminary water balance has been established for the site – in the pre-development (existing) condition and for the site once developed and operational (Figure 6.1 & 6.2 below). The pre-development water balance illustrates the typical quantities of rain that fall on the site in an average year and the proportion that is lost via evapotranspiration and through runoff as surface and subsurface flow (groundwater). Approximately 8 ML/yr is discharged from the site as surface flow.

Figure 6-1 Pre-development water balance

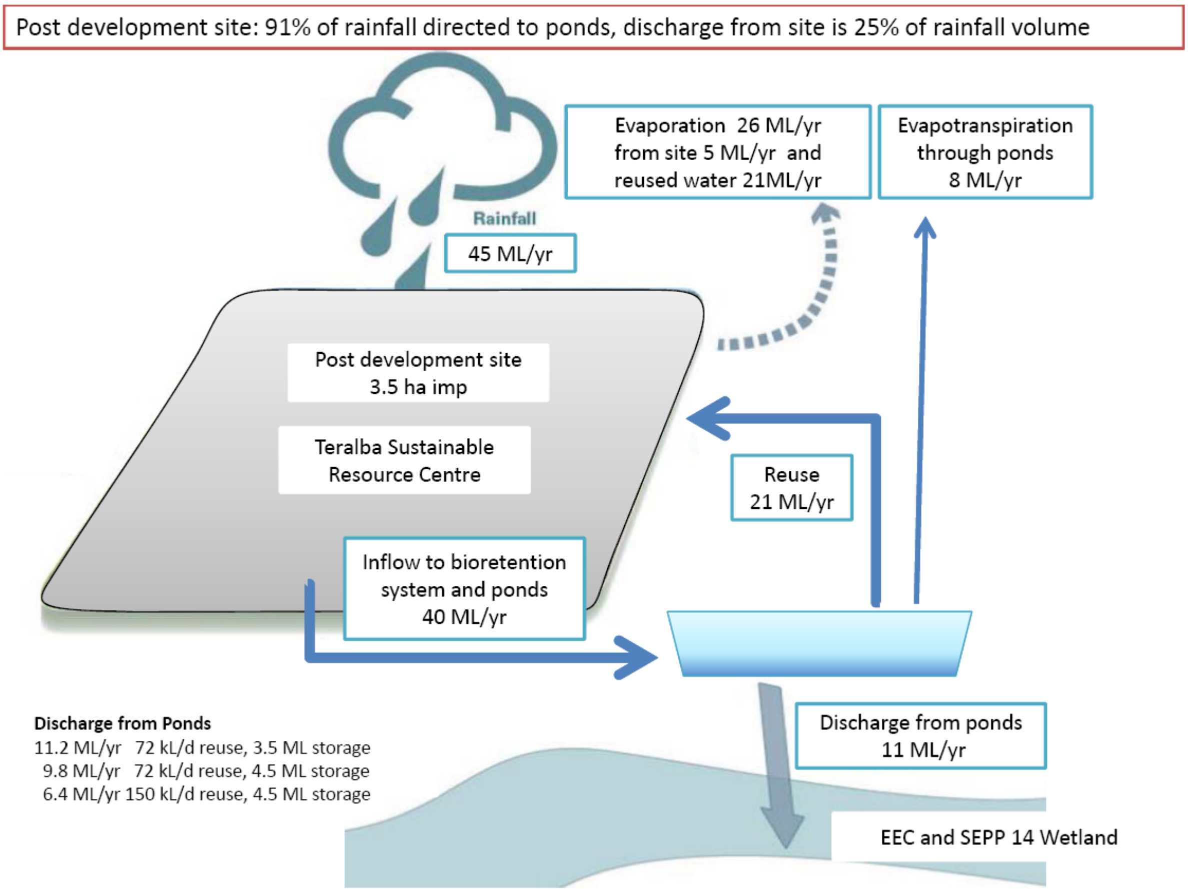


In the post development case, the site will comprise largely compacted earth (for stockpiling areas), buildings, car parks and roadway areas. The internal site area that drains to the water quality treatment area has conservatively been assumed to be entirely impervious. Modelling indicates that almost all rainfall is directed to the water treatment ponds (90% of rainfall), with the remainder initially wetting the site and being lost to evaporation.

Key water balance components of the water directed to the ponds, in an average year are summarised as follows:

- Evaporation - approximately 8 ML will evaporate,
- Reused / recycled within the site - 21 ML (80% of the estimated 26ML/yr demand)
- Discharged off-site - approximately 11 ML will exceed the storage capacity of the site and will discharge off-site as surface runoff.

Figure 6-2 Post-development water balance



6.3 Changes in hydrology

The development of the site will result in a small increase in estimated discharge of surface runoff from the site from 8 to 11 ML. Baseflow / subsurface flow contribution from the site will be significantly reduced through the placement of the compacted fill layer that will limit infiltration to groundwater following development.

The net discharge to the receiving environment is an overall reduction in volume from a mean annual flow of 18 ML to 11 ML. However, the 11 ML of flow discharged from the site is primarily by surface flow, which represents an increase of 3ML from the pre-development surface discharge of 8 ML.

Modelling of the site hydrology indicates that in the predevelopment case, runoff occurs on average 7 times a year (from approximately 100 days of rainfall each year). In the post development case, this is increased to 23 times per year. This indicates that reuse of water within the site ensures that for the majority of events, discharge does not occur. Note also that flow velocities are significantly reduced through attenuation in the pond which may cause discharge over a longer period than in the predevelopment modelling.

6.4 Water reuse

Surface water runoff from the site is to be collected and reused on the site for activities including dust suppression and the operation of the mill. As detailed in Section 6.1, CiviLake has provided data that supports an estimated average daily demand of approximately 72 kL/d (26 ML/yr). The main water storage pond provides approximately 3.5ML storage volume (equivalent volume to approximately 50 days water use). The two smaller ponds provide an additional 1ML storage volume. The modelled reuse is estimated at approximately 21ML/yr (80% of the 26ML/yr demand) with periods where the storages will be dry and unable to meet the assumed uniform water demands of the site.

6.5 Operational control of water reuse to minimise changes in hydrology

Reuse of stormwater is important in maintaining the existing hydrology to the downstream environment and therefore it is important for CiviLake to maintain expected water reuse including when the site in not operational or operating at reduced capacity.

It may be possible to increase the dust / irrigation usage (to nearly double that assumed in the modelling) to draw down the water storage capacity so as to reduce the volume of water discharged.

Refining the design and operational procedures for the proposed water treatment system will enable the predevelopment mean annual surface runoff volume to be more closely matched. The key parameters that influence the resulting mean annual discharge to the environment include:

- Water storage volume in the ponds
- Reuse rate

The additional 1 ML of storage available in the two smaller ponds can be used operationally to maximise water storage, increase the amount of water reuse and reduce the discharge to the environment.

Increasing the modelled daily reuse from 72 kL/d to between 100 - 150 kL/d would reduce discharge from the site to between 6 - 8 ML/yr (the modelled predevelopment surface runoff is 8 ML/y). The higher reuse rate (150 kL/d) is equivalent to an approximately 4mm application across the site (which is considered feasible to facilitate evaporative losses without the reuse water draining back to the ponds).

The adaptive operational management of water usage may also enable an even greater proportion of the expected demand to be met as the water usage can be reduced to the essential demands when storage levels are low and increased when pond storage levels are high.

The reuse strategy will be developed as part of the OEMP for the site to manage expected discharge from the site and to ensure high supply reliability in meeting the reuse demands for water on the site.

6.6 Mitigating impacts from changes in hydrology

These changes in hydrology are not expected to cause detrimental effects on the receiving environment. Most wetland vegetation and ecological communities respond to variations in hydrology through wet and dry years. The changes expected from the development of the site are likely to be within the tolerance limits of the communities.

Note that assessing the supporting hydrology of the downstream freshwater wetland and SEPP 14 wetland would be particularly complex as the extent of the catchment is difficult to identify within the flat floodplain area. Our strategy aims to minimise changes to the hydrology from the site.

7.0 Water Management Strategy

The proposed water management strategy uses treatment elements to address water harvesting / conservation, flow management and water quality. The main treatment elements of the water management treatment train include:

- buffer strips around stockpiles,
- drainage swale flow path to sedimentation pond,
- sedimentation pond,
- bioretention system,
- bypass swale,
- main storage pond,
- on-site water reuse,
- rainwater tanks and
- additional smaller water storage ponds.

The function of each of these key elements is described in Section 7.2 below.

The treatment elements proposed are shown in Figure A2 of Appendix A of this document – in plan view and also along a longitudinal section through the water treatment train. The section illustrates the connections between the major elements and the relative levels of the various components.

7.1 Why Discharge of Stormwater from the Site is Required?

The water management strategy requires discharge from the site for the following reasons:

- The quantity of water that is expected to be reused on the site (26 ML/yr, CiviLake estimate) is substantially less than the expected rainfall on the site (45 ML/y). The water balance for the site (Appendix A, Figure A3) demonstrates that discharge from the site is approximately 25% of the rainfall volume, and this discharge occurs as surface runoff. Doubling the estimated reuse could potentially reduce discharge from the site to approximately 15% of the rainfall volume, however a substantial volume of water would still need to be discharged as surface flow from the site.
- A bioretention system is proposed to remove pollutants in stormwater runoff generated within the site. It requires a free draining outlet in order for flow to move through the filter media and sets the maximum operational level of the main storage pond, and thus sets the maximum storage volume available.
- Discharge from the site is required to minimise the changes to the existing catchment hydrology that sustains the vegetation of the downstream wetlands. Altering excessively (either increasing or decreasing) the existing discharge from the site may impact on the receiving environment (including the Freshwater Wetland community and the SEPP 14 wetland).

Alternative strategies that aim to store and reuse as much water as possible, with minimal discharge from the site could be adopted however it is considered an inferior approach for the following reasons:

- Within the available site area, allocating the majority of available space to storage would reduce the area available for treatment. The ability to treat water within the site is therefore compromised by the requirement to maximise the available storage volume. As a result, when discharge does occur, the water discharged from the site would be largely untreated.
- During lengthy wet periods the ability to reuse water (for dust suppression, mill/crushing operations) is limited and thus quantities of untreated water discharged would be significant.
- The hydrological nature of the site would be altered from predevelopment with potentially detrimental impacts on the receiving environment (including the Freshwater Wetland community and the SEPP 14 wetland).

Discharge from the site will occur regardless of which strategy is adopted owing to the mean annual demand for water reuse being less that the mean annual runoff from the site. The proposed strategy is to treat, reuse and discharge the residual water, aiming to minimise changes to the hydrology of the receiving environment and ensure best practice reduction in pollutant loads in stormwater that will be discharged.

7.2 Stormwater Treatment Elements

The key proposed stormwater treatment system elements have been sized using the stormwater quality modelling software MUSIC, with conservative (i.e. high) assumptions relating to the potentially higher TSS load in stormwater runoff from stockpile areas compared with typical urban environments. The mean TSS concentration for storm flow modelling has been increased by an order of magnitude (from 150 mg/L, which represents the mean TSS concentration observed in urban stormwater, to 1500 mg/L) and thus reflects TSS loads equivalent to construction sites with exposed soil and stockpile surfaces.

The modelling results indicate that the treatment train is able to reduce the load of suspended solids discharged from the site to the same load that would be generated by an equivalent urban impervious area. This is described in Section 7.3.

Multiple elements are used in a ‘treatment train’ to provide effective sediment removal for the full range of particle sizes, together with the harvesting and reuse of a substantial proportion of stormwater runoff, represent contingency in design. The system will be subject to monitoring and maintenance of each of these elements to ensure effective operation. These requirements will be clearly outlined in the OEMP – including checklists of weekly monitoring, record keeping and reporting, the mechanisms for corrective action and review. The effective operation of each of the elements of the treatment train then provides confidence that the system will operate as designed – reflecting the extensive scientific research that underpins the design and modelling of these systems.

A description of the key elements is provided below (see Figures A1 and A2 for plan layout and section through the water management elements):

Preliminary Sedimentation Controls

Buffer strips are to be installed around stockpiles to capture coarse sediments and gross pollutants from stormwater runoff from stockpile surfaces. Vegetated swales will be used along the drainage pathways to the Dirty Water pond in order to reduce the sediment load that must be managed within the pond system. CiviLake has extensive experience with sedimentation controls and are able to use techniques to effectively manage sediment within the site and esure the treatment system operates as effectively as possible for the stormwater runoff from the operational part of the site.

Surface grading of the site (0.25% nominal fall) is to be towards the west with collection of all surface runoff from the operational areas within the site (i.e. stockpiles, roads, pug mill, and vehicle parking areas) within the Dirty Water Pond.

Dirty Water (Sedimentation) Pond

The Dirty Water Pond would have an effective storage capacity to contain the “first flush” runoff volume from the development catchment area. The pond would target the efficient capture and removal of gross pollutants and coarse sediment, and reduces the sediment load that enters the bioretention system that is effective in removing finer particulate material. The sedimentation pond also provides storage for spill containment.

The process of sedimentation removes the heavier sediments, where velocities are appropriate to allow adequate detention time for a significant proportion of the suspended particles to settle. The design will ensure that the clean out frequency for the system is appropriate and that access is provided to ensure that maintenance requirements and clean out can be done easily.

The pond will have a total depth of approximately 1m with the bottom 0.5m allocated to sediment storage and the top 0.5m dedicated for sedimentation. An outlet weir controls flow to the bioretention system and is configured to ensure that a significant proportion of flows are treated. Once the capacity within the pond is reached, the pond will discharge into the main storage pond via a bypass swale. Mobile pumps will be used as required to dewater the sediment storage zone so as to provide additional capacity and prior to periodic sediment removal for maintenance purposes.

The concept design provides for a Dirty Water Pond floor base at RL 2.5mAHD with a spillway at RL 3.5mAHD providing a total storage capacity of approx 2ML. The pond base will be lined using a suitable clay or plastic geomembrane liner to prevent infiltration to and from the underlying groundwater system.

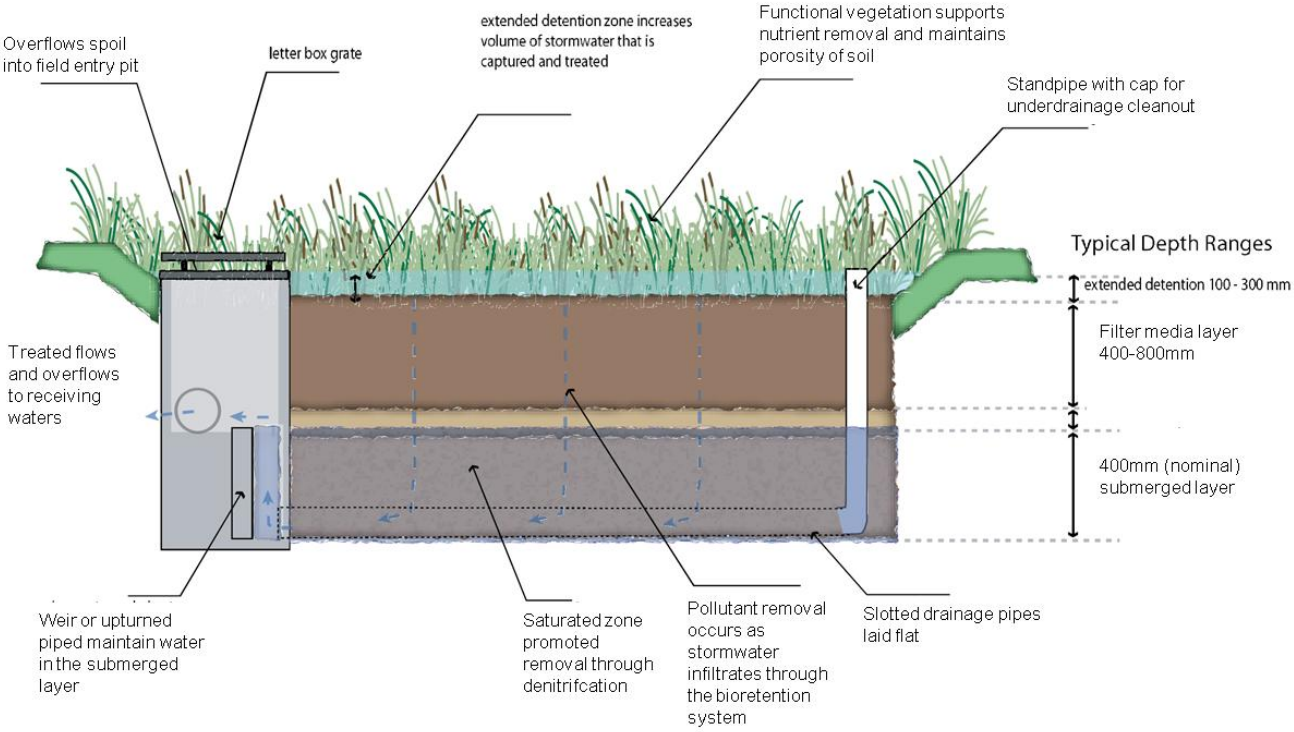
Bioretention System

The bioretention system receives flow from the sedimentation pond and effectively removes fine suspended sediments, dissolved nutrients and heavy metals.

Bioretention systems are typically vegetated filtration systems, where runoff is encouraged to pond above a loamy sand filter media and percolate down at a rate favouring nitrogen uptake by plants and organisms within the media and root mass. Temporary ponding above the vegetated soil media provides additional filtration/biological treatment processes. Treated run-off is then collected through a series of subsoil perforated pipes and discharged to downstream waterways or storage facilities for reuse. The filtration rate through the soil filter media is typically in the order of 100 to 180mm/hr ensuring the capture storage is drained within several hours.

A section through a saturated zone bioretention system is illustrated in Figure 7.1 below.

Figure 7-1 Saturated Zone bioretention system



The concept design of the bioretention system includes the following:

- A total bioretention water surface area of approximately 750m^2
- Filter medium comprising sandy loam with a permeability coefficient of between 100 and 180mm/hr
- Filter medium depth of 0.4m minimum depth, with a saturated zone beneath the media for enhanced nitrogen removal and plant survival through dry periods
- A maximum depth of ponding within the pond area limited to approximately 0.3m (to provide detention and allow plant growth);
- Bioretention system surface at RL 2.7mAHD with a spillway at RL 3.0mAHD to the main storage pond. The pond base will be lined using a suitable clay or plastic geomembrane liner to prevent infiltration to and from the underlying groundwater system.

Main Water Storage Pond

Overflow and treated flow from the bioretention system would be collected in the main storage pond. The pond would include a low level (valved) outlet pipe at approximately RL 2.1mAHD and have an average pond floor level of approx RL 1.1mAHD. This will allow a nominal 1 m deep clean water storage (resulting in approx 3.5ML capacity) for process and dust suppression water during operations. The pond base will also be lined using a suitable clay or plastic geomembrane liner to prevent infiltration to and from the underlying groundwater system.

Given the receiving environment includes sensitive ecological communities and a SEPP14 wetland, it is desirable to provide an adequate freeboard volume to attenuate storm flows and to contain spills. A freeboard up to the 100 year ARI, 24 hour rainfall event prior to discharge occurring has been provided in the pond area. This event would produce a total rainfall depth of 247mm (refer Table 2) which would result in a total runoff volume of approximately 11ML from the 4.7ha site. To achieve this freeboard volume, a high spillway at RL 4.0mAHD is to be provided from the main storage pond. The spillway, in the very rare occasions, will allow spill to occur from the pond (i.e., following rainfall events greater than the 100 year ARI, 24 hour storm). The freeboard volume will extend above the Dirty Water and bioretention system but would be confined within the pond surface areas (i.e. flood waters would not extend to the road and stockpile areas within the site). This freeboard also provides for stormwater detention to mitigate any increases in peak discharge from the development catchment leaving the site.

The Dirty Water Pond would be managed to maintain maximum storage capacity within this storage prior to spill to the Main Storage Pond via a bypass channel. This will reduce the potential for potentially contaminated runoff entering the Main Storage Pond when spill occurs. In the event that the stored water within the Main Storage Pond becomes contaminated due to uncontrolled spill, then the contingency measures would include pump-out back to the Dirty Water Pond for temporary storage and subsequent treatment via the bioretention system, in conjunction with disposal by onsite operational use.

All water ponds will have a suitable base liner comprising either a clay layer or a Geosynthetic Clay Liner (GCL) with the details to be confirmed through the detailed design of the system.

The water detention basins will be installed prior to waste processing operations occurring at the Premises.

Rainwater and Stormwater Reuse

Rainwater harvesting and reuse will be achieved through the use of above ground rainwater storage tanks for fire-fighting and toilet flushing for office and storage shed facilities. High groundwater levels will likely preclude the use of buried tanks. Overflow from these tanks would be directed to smaller clean water storage ponds providing additional storage.

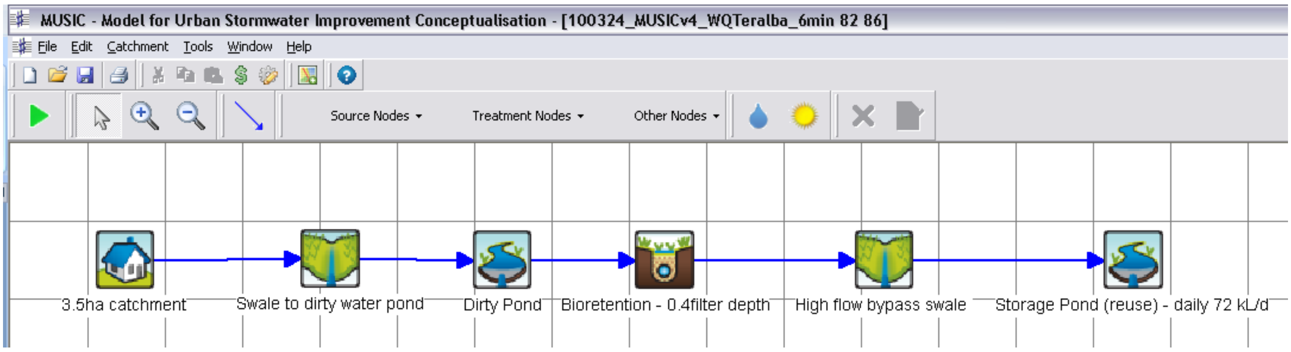
A total minimum fire fighting supply of approximately 50kL is required for the site. This is to be provided by way of two dedicated tanks designated for fire fighting purposes only. Additional tanks providing a total capacity of around 60kL will also be provided on site. The tanks would be topped up from the stormwater storage ponds located within the site or if insufficient water was present in the ponds, from mains potable water supply. Booster pumps and hose reels are to be located adjacent to the tanks for fire-fighting purposes.

Based on the above, there is provision for a total storage capacity of approx 4.5ML on site from the main storage pond and the two smaller ponds. This storage volume can provide an average reliability of supply for process and dust suppression water during site operations of approximately 80%. Therefore, on average, on 80% of the volume required for process and dust suppression water would be sourced from on-site stormwater ponds with substantial reduction in potable (mains) supply. An average reliability of 80% was considered acceptable by CiviLake.

7.3 MUSIC Modelling of Treatment Performance

The treatment elements have been modelled using MUSIC v4 (Model for Urban Stormwater Improvement Conceptualisation). Details of the important modelling parameters and design levels are included as an appendix to this letter. A graphical representation of the MUSIC model is also provided in the figure below.

Figure 7-2 graphical representation of the MUSIC model



Best practice in stormwater quality management is based on reduction of typical urban pollutants runoff rates and expected loads of key pollutants TSS, TP (total phosphorus) and TN (total nitrogen) by 85%, 65% and 45% respectively. Demonstration of attaining these best practice objectives is by computer modelling to predict the expected treatment performance of the water quality management system.

For this site, it is expected that the pollutant profile will be higher in TSS concentration than for urban areas due to the proposed stockpiling and materials handling on the site. To represent the expected high TSS loads associated with exposed soil surfaces / stock piling of fine material, AECOM has increased the mean TSS concentration for storm flows by an order of magnitude (from 150 mg/L which would be expected in an equivalent urban area to 1500 mg/L). This would give TSS loads equivalent to construction sites with exposed soil and stockpile surfaces. The modelled stormwater management system provide load reductions of 98% for TSS, 91% for TP and 84% for TN. The modelled mean annual TSS load discharged from the site in an average year is 1,500 kg/yr.

As shown in the table below, the predicted mean annual load of TSS discharged from the site of 1,500 kg/yr is comparable with the best practice load reduction for an typical urban landuse on the site area. Current best practice in TSS load reduction is 85%. The mean annual TSS load for an equivalent urban impervious area of residential landuse on the site is approximately 9,600 kg/yr and best practice would reduce this to approximately 1,440 kg/yr compared to the 1,500kg/yr modelled from this site.

In conclusion, the treatment train proposed for this site, managing TSS loads equivalent to construction sites, results in a reduction of TSS load that would meet current best practice targets for urban development areas.

Comparative Urban Development Site		Proposed Sustainable Resource Centre	
TSS load for an equivalent urban impervious area	9,600 kg/yr	TSS load from site (modelled with high TSS pollutant conc.)	75,000 kg/yr
TSS discharge from equivalent urban area with WSUD TSS reduction objective of 85%	1,440 kg/yr	TSS discharge from the site	1,500 kg/yr
		Load reduction (%)	98%

The treatment train and expected pollutant removal is considered adequate to ensure the water quality discharged from the site does not result in significant impacts on the downstream ecological communities. The impacts are mitigated as the water quality delivered to the receiving environment and surface hydrology that supports these communities will be within the range commonly experienced by these ecosystems.

8.0 Mitigation of Potential Impacts of Stormwater Discharge to the Receiving Environment

Potential impacts on the receiving environment associated with discharge of surface runoff from the site can be caused by;

- altered hydrology
- erosion
- sedimentation
- changes to water quality

This section outlines the mitigation of these causal factors that have the potential to impact on habitat, flora and fauna.

8.1 Hydrology - average annual flows

The changes to hydrology reflected in the pre and post development water balances suggest that substantial reuse of water on the site mitigates the risks associated with altered surface flow hydrology on the receiving environments. The OEMP should outline operational strategies to further refine the management of water reuse and discharge to minimise changes from the existing hydrology. The modelled changes in hydrology are expected to be within the tolerance limits of the receiving environment.

The creation of a bund around the site will alter predevelopment diffuse discharge pathways and create a barrier for flows within the catchment. This alters flows to the site and concentrates flows from the site. Drainage design for the site will aim to maintain the conveyance of flows from the broader catchment and from the site.

8.2 Hydrology – geomorphic impacts associated with peak flows

The drainage flow path from the site through the receiving environment and mapped ecological communities are illustrated in Appendix A, Figure A1. Surface water runoff currently drains through existing man-made channels located along the perimeter of the site toward the north-eastern corner. The flow path then heads in a south easterly direction and continues through minor culverts and drainage ditches and into a broad floodplain area without an identifiable channel. This area includes ecological communities; Ball Honeymyrtle Swamp Forest, Freshwater wetland, Swamp Mahogany / Paperbark / Woollybutt Swamp Forest and an area mapped as a SEPP 14 wetland.

The drainage flow paths will be designed to disperse flow within the floodplain area to mimic existing conditions that support the communities present. Any localised erosion along the drainage flow paths will be rehabilitated and modified to prevent further concentration of flow and mobilisation of sediment. Maintaining the stability of the drainage flow paths under the expected flow conditions will ensure geomorphic protection. This requirement will be reflected in the OEMP.

The peak discharge from the developed site will be attenuated using the capacity of the main water storage. This will ensure post development peak flows do not exceed the predevelopment peak discharge (for events up to the 1 in 2 year ARI storm event). This mitigates the risk of erosion along the flow paths of the receiving environment.

8.3 Erosion

Erosion risks are associated with discharge of high flows, with velocities that mobilise sediment and expose the soil profile. This is of particular concern for defined waterway channels that must be sufficiently wide to convey flow without increasing the flow velocities and associated shear stress that results in erosion. The water storage pond will reduce the frequency and volume of water discharged from the site for a significant majority of storm events. The drainage lines surrounding the site will be configured to safely convey flows without the risk of mobilising sediment. This may include the use of small rocks (if required) and dense planting for stabilisation. Energy dissipation will be provided at the discharge point from the site.

Flow from the development into the adjoining sites to the east is initially within a man made drainage line but will relatively quickly disperse across a broad flood plain area with significantly reduced potential for erosion.

8.4 Sediment

Suspended solids are considered the highest risk pollutant for this site. It is considered to be the pollutant with the highest potential to impact on the sensitive downstream environment and also an effective surrogate measure for the adequacy in removal of heavy metals. A treatment train approach is proposed to provide multiple elements to reduce TSS concentrations in stormwater runoff.

As discussed above, sediment loads (TSS) have been managed through a treatment train that enables 98% of TSS loads to be removed. This represents a very high level of protection for the mitigation of impacts on the receiving environments.

8.5 Water quality

Stormwater quality has been addressed through the stormwater treatment train that gives modelled mean annual load reductions of 98% for TSS, 91% for TP and 84% for TN – equivalent to the best practice TSS load reduction for an equivalent residential area.

TSS discharge concentrations modelled exceed the urban guideline value reported in Table 2.5 of Australian Runoff Quality of <25 mg/L less than 1% of the time that flow is observed.

It is noted that other pollutants such as heavy metals will also be captured by the treatment train proposed. Heavy metals and hydrocarbons are mostly particulate-bound in that the majority of these pollutants are bound to suspended solids. Thus TSS concentrations are an appropriate surrogate measure of the effectiveness in the removal of many stormwater pollutants. Stormwater treatment systems effective in TSS removal can therefore be expected to be also effective in removal of many of the particulate-bound pollutants. Bioretention systems are also very effective at removing dissolved pollutants such as dissolved metals, nutrients and organic chemicals.

The treatment train proposed for the site is considered adequate to ensure the water quality discharged from the site as demonstrated by the predicted (modelled) performance of the system. Therefore, it is expected that the operation of the site will have minimal impact on the downstream ecological communities. The impacts are mitigated as the water quality delivered to the receiving environment and hydrology that supports these communities will be within the range commonly experienced by these ecosystems.

8.6 Habitat, flora and fauna

The water management strategy for the site has been designed to mitigate the impacts associated with changes in hydrology, geomorphology and water quality. These factors support the habitat and food requirements for flora and fauna. As these have been addressed, it is not expected that there will be any significant impacts on habitat, flora and fauna.

The Koala habitat area identified in the Ecotone Ecology Report will not be adversely impacted upon by any of these causal factors associated with discharge point for water from the site.

9.0 Proposed Water Quality Testing

The water management elements proposed aim to improve water quality as much as possible (reducing loads to those required for treated runoff from urban developments), and to reuse water (to minimise demand for use of potable supplies).

Extensive event based sampling and testing of many storm events is required to get an accurate reflection of the treatment performance achieved and resulting mean annual loads of pollutants discharged in stormwater runoff. The frequency of discharge associated with the water management strategy proposed makes extensive testing of water leaving the site prohibitively complex and costly. Alternative, simple, cost effective strategies exist that can provide confidence in the quality of water discharged from the site.

The regime proposed is for observational monitoring of critical system components and for measurement of turbidity and pH on a weekly basis and following storm events. A maintenance regime specified in the OEMP would ensure that the treatment systems continue to operate as designed and with regular checking and maintenance particularly to remove collected sediment. The intention is to establish a monitoring strategy with a focus on observational monitoring conducted by CiviLake rather than a costly system that would need to be operated and regularly maintained by others. The OEMP will ensure that the observational monitoring and turbidity and pH measurements are able to rapidly inform operations.

9.1 Water quality testing regime – particulate matter (turbidity)

TSS is the critical parameter for testing in the water discharged from the site owing to it being the pollutant with the highest risk of impact on the sensitive downstream environment and also an effective surrogate measure for the adequacy in removal of other stormwater pollutants, particularly heavy metals.

It is proposed that a turbidity meter be used to provide regular testing of the water in the storage pond (weekly and following storm events). Turbidity can be roughly correlated with suspended solids concentrations. Turbidity measurements involve simply placing a probe in the water to make an instantaneous measurement (compared with other water quality parameters that require expensive and time consuming laboratory testing). Importantly a baseline for turbidity in the water storage pond can be established with immediate and simple information then available to the nominated site representative (e.g. foreman, plant operator etc).

The turbidity readings and variations from baseline levels will assist in ensuring the adequacy of the treatment train and provide an additional flag for the need for inspection of each component of the water quality treatment train (siltation fences/buffer strips around stock piles, drainage swale to sedimentation pond, sedimentation pond, bioretention inlet sedimentation zone and flow distribution swale, bioretention system, bypass swale, storage pond and on-site water reuse). If the turbidity measurements deviate from the expected results, this will be an indicator of dysfunction somewhere in the treatment train, and a signal that the treatment system requires inspection.

The sampling point within the pond will be located at the outlet pit, so that the water sampled following a storm event is representative, as much as possible, of the water quality discharged. The modelling of the site and proposed reuse indicates that small events will in many cases result in no discharge at all (due to the large volume of the storage pond and anticipated drawdown for reuse). Where discharge occurs for minor events, it is expected that the water displaced from the pond and discharged will have a lower TSS concentration than the stormwater inflow to the pond, thus sampling the pond at the outlet point following a storm event will give a conservatively higher turbidity reading than would have been discharged from the site. For large but very infrequent events, it is acknowledged that the turbidity of the water discharged would be higher than that monitored in the pond. The impact on the environment of these infrequent events is considered less significant as there will be additional flows from other parts of the catchment during large storm events. The water quality readings (turbidity) monitors will be regularly reviewed to ensure that discussion of any variation in baseline levels is noted and any required maintenance or changes to operations are assessed and undertaken.

9.2 Water quality testing regime – pH

The treatment train will assist in managing pH, primarily through the contact with the filter media of the bioretention system. Weekly testing of pH in the water storage pond is proposed. This can be done simply and cost effectively with a pH probe, at the same time that turbidity measurements are taken. The pH can be a useful indicator in assessing the quality of water in the main storage pond and assist in identifying management issues.

9.3 Testing other parameters - nutrients, heavy metals, oils and grease

Levels of these pollutants are expected to be low as discussed in point 4 above. The bioretention system will improve water quality through the processes of filtration through biologically influenced media. It will provide effective removal of nutrients, heavy metals, oils and grease.

Testing for these parameters is considered unwarranted as it is costly, time consuming, and unlikely to yield informative data.

10.0 Contingency in design and operation

The multiple elements of the treatment train and stormwater harvesting provide effective sediment removal for the full range of particle sizes and represent many levels of protection and contingency in design. The effective operation of the system requires adequate monitoring and maintenance of each of these elements. These requirements will be clearly outlined in the OEMP – including checklists of weekly monitoring, record keeping and reporting and the mechanisms for corrective action and review. The effective operation of each of the elements of the treatment train ensures that the system will operate as designed – reflecting the extensive scientific research that underpins the design and modelling of these systems.

Valves will enable the discharge pipe from the water storage pond, and the inflow point to the bioretention system to be closed if a spill occurs or concerns arise with the quality of the water in the pond (e.g. turbidity readings of concern, presence of weeds that could affect the downstream environment, contaminants suspected). The water storage pond has been designed to allow for flood storage in the water storage pond (approximately 11 ML volume equivalent to runoff volume in 1 in 100 year ARI flood, 24 hour storm duration). When the pond discharge pipe valve is closed, appropriate remediation activities will be immediately undertaken. These will be outlined in the OEMP for a range of scenarios that would require the closure of the system. Where appropriate the water may be treated with a flocculent to reduce suspended solids and suitable water reused on site for additional dust suppression / irrigation within the bunded areas. If these measures are ineffective the final backup contingency plan would involve trucking contaminated water off site. This would only happen as a last resort where all other options have been unsuccessful.

If it is found that stored water is not of a quality fit for discharge (e.g. turbidity levels are high), operational procedures could assist in preventing discharge through additional reuse (e.g. additional dust suppression across the site, irrigation of the vegetation on the internal bund batter, and intermittent transfer to pass the water through the treatment train again).

In the unlikely event that the system does not operate as expected, additional on site sediment management options could be introduced and additional wetland treatment areas can be built on Council land to the north of the Fresh Water wetland (Ecological Study, Ecotone, Appendix H of the Environmental Assessment). The existing vegetation in this area is described as 'Cleared / weedy open pasture with scattered remnant or planted trees.

11.0 Erosion and Sediment Controls during Construction

Erosion and sediment controls will be used to minimise the exposure of the soil surfaces to the actions of stormwater.

Measures are taken to limit discharge of sediment laden stormwater and to restrict stormwater flows over exposed areas during construction.

The construction erosion and control measures will be in accordance with the Landcom (2004) *Managing Urban Stormwater: Soils and* Construction and will include:

- Providing a stabilised access to the site from Weir Road with a facility for removing sediment from truck wheels at the site entrance;
- Provision of silt fencing around the site perimeter;
- Provision of silt fences downstream of stockpiles;
- Provision of temporary sediment basins which are likely to be located at the proposed location of the permanent ponds in the north-western corner of the site – that is the temporary basins will eventually be converted into the permanent basins. Water in the ponds will be used for dust suppression on the site and construction water. Excess water will be tested, treated if necessary through flocculation or similar and then discharged into the drainage channels adjacent to the site;
- As the site is filled, upstream water will be diverted around the site;
- Avoiding disturbance to adjoining areas which are predominantly vegetated;
- Regular monitoring and maintenance of the sediment and erosion control measures

Given the sensitive nature of the downstream environment a Type F sedimentation basin as defined in Table 6.1 of Landcom (2004) is proposed. This is applicable to sites with fine soils and allows longer settling times. The size of the required sedimentation basin was calculated in accordance with Table 6.1 of Landcom (2004) to require a volume of around 7,100m^3 which allows complete storage of the 95th percentile 5 day rainfall. The basin is required to have length: width ratio of >3:1. This would equate to approximate dimensions of 170m length x 55m wide x approximately 1m depth with 1:2 batters.

At this stage it is assumed that as the filling of the site progresses, it will be graded to drain all runoff into the basin in the north-western corner of the site. If the staging of the filling results in portions of the site temporarily grading in a different direction them additional temporary basins may be required which would be sized and located at the time.

A sediment erosion control plan is included in Appendix A showing the main sediment and erosion control features. Note these are indicative and will be refined during the construction process.

The sediment and erosion measures to be implemented during construction will be further developed within the CEMP. These measures will ensure temporary sediment controls are provided to mitigate potential impacts on the downstream environment.

12.0 Conclusions and Recommendations

The proposed Teralba Sustainable Resource Centre requires water cycle management measures to meet adopted water conservation, flow (quantity) and water quality (pollution control) management targets and objectives. These objectives reflect best practice guidelines for stormwater management and relevant State and Local policies and planning documents.

The recommended water cycle management strategy for the Teralba Sustainable Resource Centre is summarised below.

Water Conservation and Reuse

- Stormwater from the stockpile areas on site will be treated and stored in the main storage pond for reuse during operations with an estimated resultant 80% of operational water sourced from onsite water ponds.
- Rainwater harvesting from roofs and reuse will be achieved through the use of above ground rainwater storage tanks for fire-fighting and toilet flushing for office and storage shed facilities.

Water Quantity

- Perimeter bunding will be provided to prevent flood waters entering the site from the 100 year ARI flood event of Cockle Creek.
- Provision of a freeboard storage volume (approx 11ML) in the main storage pond will attenuate surface runoff from the development site for events up to the 1 in 100 year ARI, 24 hour rainfall event. Discharge is controlled to maintain pre-development peak discharge flows from the development site.
- Following storm events, water is attenuated in the main storage pond. Discharge can occur from an outlet pipe when the pond water level rises and via a spillway when the pond capacity is exceeded. Water discharged from the main storage pond will follow an existing drainage pathway (man-made channels) through the downstream swamp forest and freshwater wetland communities and conveys flows into a SEPP14 wetland.

Water Quality

- Stormwater from the site is treated to manage sediment, nutrients and other pollutants to meet best practice targets.
- Buffer strips are used around stockpiles to reduce sediment load generated from stockpile areas.
- Silt fences are to be installed along the downstream toe of stockpiles to capture coarse sediments and gross pollutants from stormwater runoff from stockpile surfaces.
- Site graded to drain stormwater via a sedimentation swale to the ‘Dirty’ Water Pond.
- The Dirty Water Pond will capture and remove gross pollutants and coarse sediment. Outlet controls enable the basin to also provide storage for spill containment. Discharge from the Dirty Water Pond will drain by gravity to a bioretention system for effective treatment of fine suspended sediments, dissolved nutrients and heavy metals and hydrocarbons. The design will ensure adequate energy dissipation and flow distribution.
- Overflow and treated flow from the bioretention system would be collected in the main storage pond for use as process and dust suppression water during operations.

A plan layout and section through the critical components of the water management strategy is provided in Appendix A (Figure A1 & A2) of this report. A description of these components is provided in Section 7 of this report. These elements will be refined through the detailed design phase.

A CEMP will ensure that the environment is protected through the construction phase – in particular, ensuring temporary sediment controls are provided to mitigate potential impacts on the downstream wetland areas. The CEMP will ensure guidelines are followed for the successful construction of stormwater treatments systems so that their operation will reflect the design intent and pollution control described within this report.

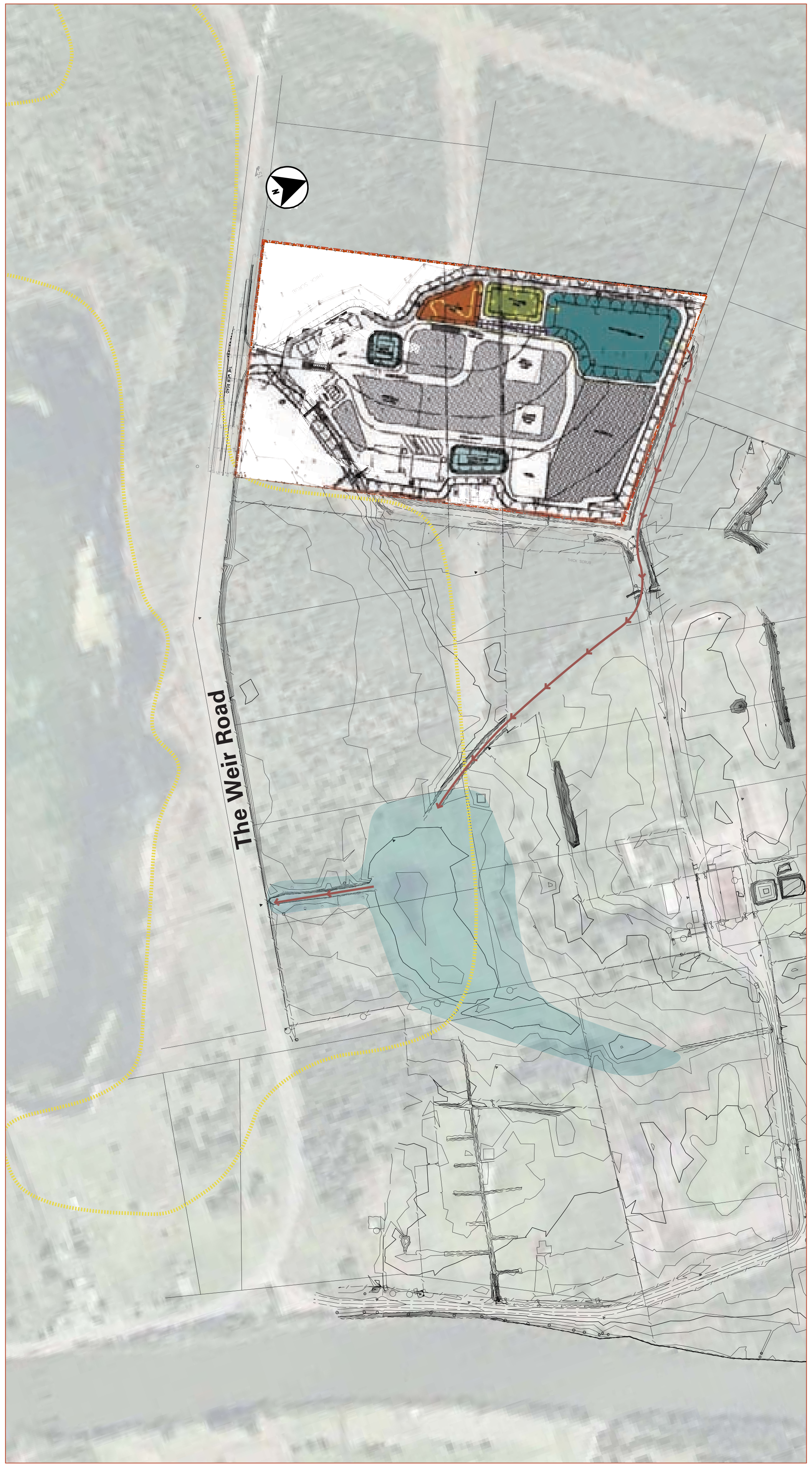
An OEMP will be developed that further refines the water management procedures for the protection of the downstream environment, providing protocols to balance the need to store water to meet operations demands onsite with the need to minimise changes in hydrology for the protection of the receiving environment. The OEMP will also provide details on emergency response measures and maintenance requirements.

Adoption of the above measures will provide an integrated, sustainable approach to water cycle management for the Teralba Sustainable Resource Centre development site by meeting the required performance objectives and targets set in this document.

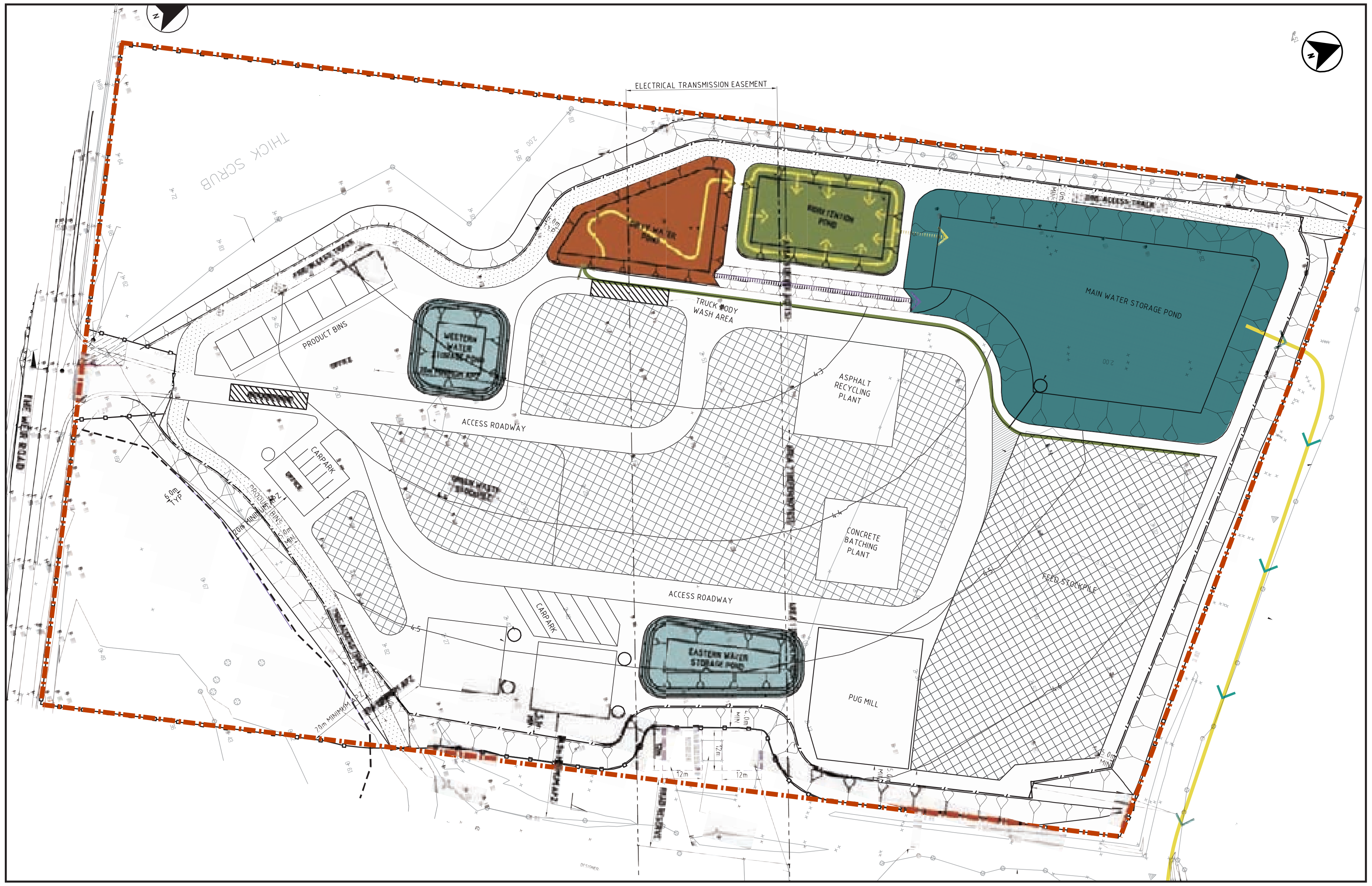
Appendix A

Water Management Drawings

Appendix A1 Plan View Receiving Environment



Plan View Site



Legend

Plan View Receiving Environment

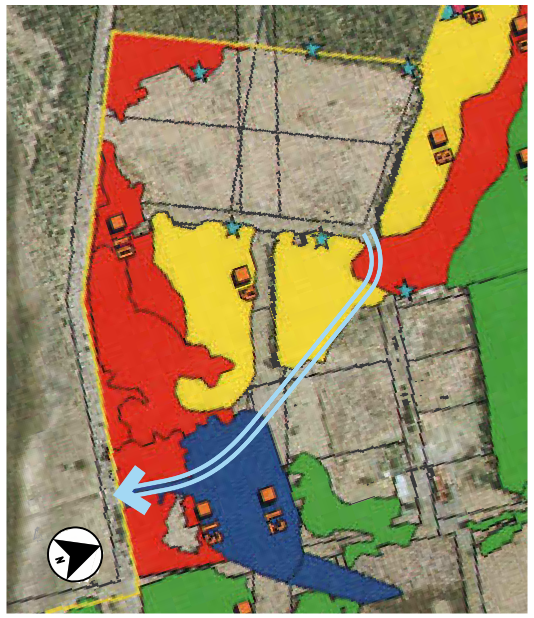
- SEPP 14 wetland boundary
- Freshwater wetland boundary
- Site boundary
- Site runoff drains to Freshwater wetland

Legend

Plan View Site

- Sediment deposition pond
- Bioretention system
- Water storage pond
- Clean water ponds
- Water flow / treatment direction
- Water flow / treatment direction
- Transfer to additional water storage ponds
- High flow bypass

Endangered Ecological Communities

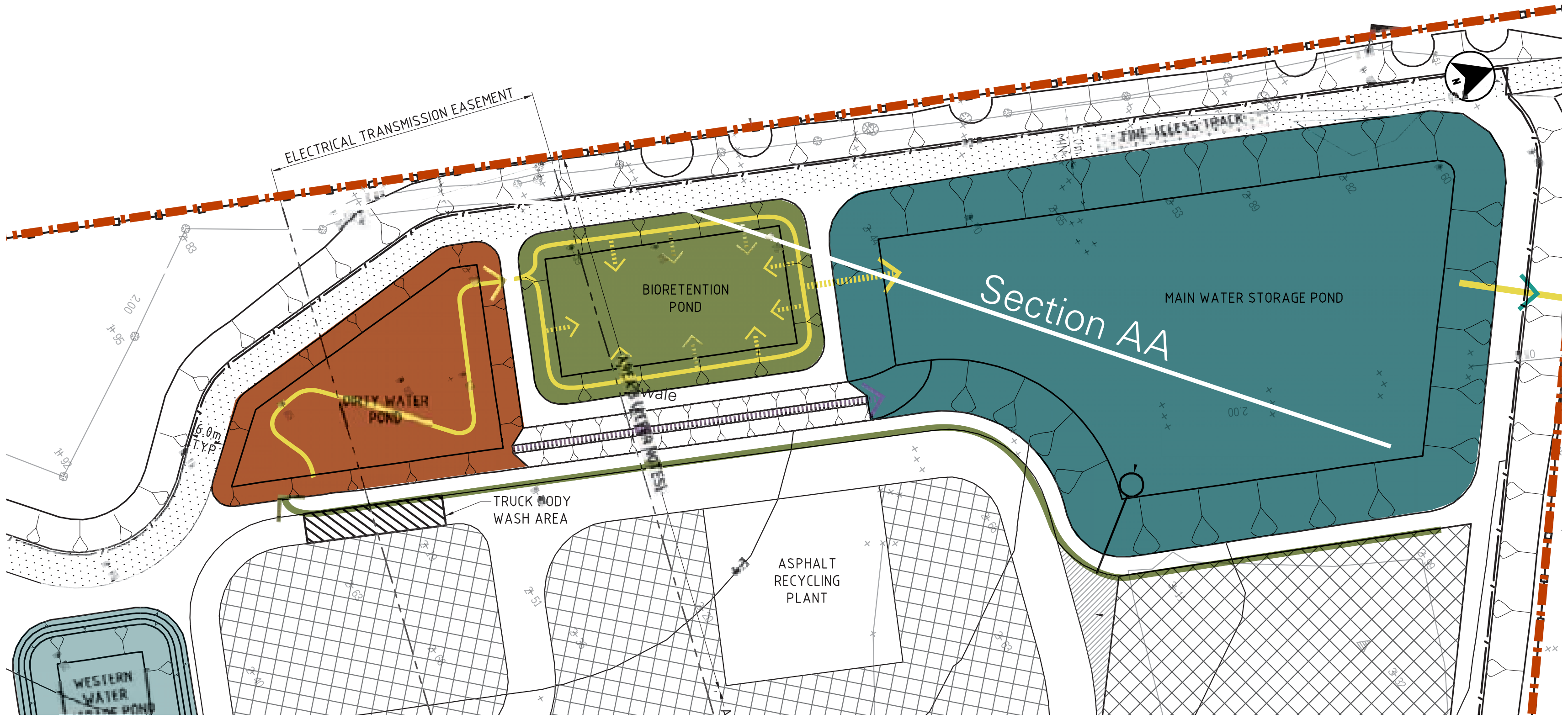


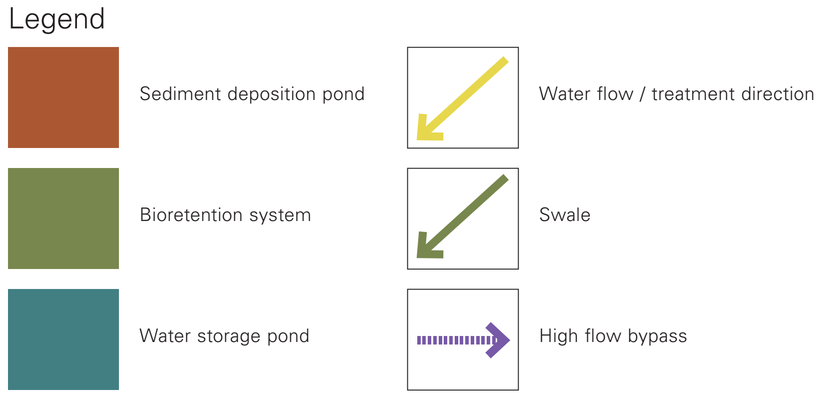
Legend

Endangered Ecological Communities (map from Ecotone report)

- Swamp Mahogany / Paperbark / Woollybutt Swamp Forest
- Ball Honeymyrtle Swamp Forest
- Forest Red Gum / Woollybutt / Mahogany Floodplain Forest
- Freshwater Wetland
- *Angophora inopina*
- Flora Quadrat
- Discharge Pathway

Appendix A2 Plan View Water Treatment Train





Design Parameters

Dirty Water Pond

- 3.5m RL bypass swale
- 3.25m RL overflow weir
- 2.81m RL outlet pipe invert in overflow pit
- 1.8m RL base of pond

Water Storage Pond

- 4.1m RL spillway
- 2.1m RL outlet pipe invert
- 1.1m RL base of pond

Bioretention System

- 3.0m RL top of extended detention
- 2.7m RL bioretention surface
- 2.15m RL bioretention (SZ) outlet invert

Section AA through Water Treatment Train

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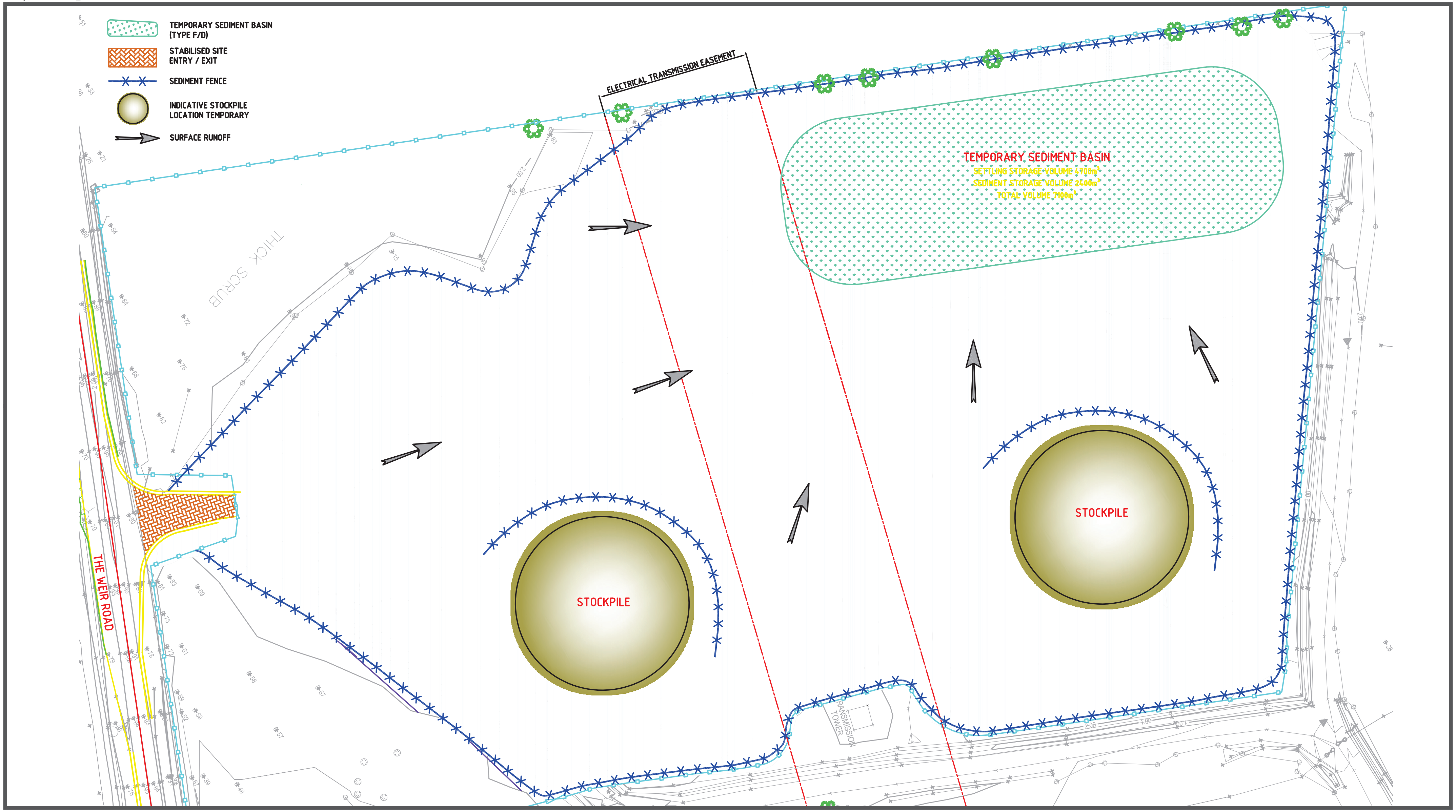

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Construction Sediment and Erosion Control Plan

Lake Macquarie City Council
Environmental Assessment
Teralba Sustainable Resource Centre
Teralba

Figure
7.6