

Tallawarra Lands Concept Plan Drainage Assessment

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Tallawarra Lands Concept Plan Drainage Assessment

Prepared For: TRUenergy Tallawarra

Prepared By: BMT WBM Pty Ltd (Member of the BMT group of companies)

Offices
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<p>BMT WBM Pty Ltd BMT WBM Pty Ltd 126 Belford Street BROADMEADOW NSW 2292 Australia PO Box 266 Broadmeadow NSW 2292</p> <p>Tel: +61 2 4940 8882 Fax: +61 2 4940 8887</p> <p>ABN 54 010 830 421 www.wbmpl.com.au</p>	<p>Document : R.1854.001.02</p> <p>Project Manager : Mark Wainwright</p> <hr/> <p>Client : TRUenergy Tallawarra</p> <p>Client Contact: Anthony Savenkov</p> <p>Client Reference</p>
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Author :	Mark Wainwright
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1 INTRODUCTION

TRUenergy Tallawarra Pty Ltd is proposing a mixed use development within Tallawarra Lands located at Yallah on the western shore of Lake Illawarra. The proposed development is being assessed as a major project (Application MP_09_0131) as defined within the Environmental Planning and Assessment Act 1979. Director General's Requirements (DGR's) have been issued for the proposed development outlining the issues to be considered within an Environmental Assessment (EA). This report has been prepared to specifically respond to DGR 12: Drainage, which requires that:

"The EA shall address drainage issues associated with the development/site, including: stormwater, drainage infrastructure and incorporation of Water Sensitive Urban Design measures"

A summary of the approach adopted within this report to address this DGR is provided below.

Section 2 of this report includes a description of the existing site and proposed development focusing on the features most relevant to drainage and Water Sensitive Urban Design (WSUD). Section 3 outlines the principles, objective and targets adopted for Tallawarra Lands that are relevant to drainage and WSUD. Section 4 summarises and discusses the key constraints and opportunities for drainage and WSUD within Tallawarra Lands. Section 5 provides a description of the proposed WSUD strategy that achieves the objective and targets, and responds to the key constraints and opportunities. Section 6 describes the preliminary MUSIC modelling completed to size the WSUD measures incorporated into the Concept Plan.

2 SITE AND PROJECT DESCRIPTION

The Tallawarra site is situated on the western foreshore of Lake Illawarra adjacent to the West Dapto release area and is approximately 13 kilometres south-west of the Wollongong Town Centre. The Tallawarra site comprises the majority of the Yallah locality and lies within the Wollongong City Council LGA. The surrounding area includes the Koonawarra and Dapto suburbs to the north, the recently established suburb of Haywards Bay to the south, Lake Illawarra to the east and the suburbs of Marshall Mount, Penrose and the future West Dapto urban release area to the west.

The Tallawarra site includes the recently commissioned Tallawarra Gas Power Station and the surrounding Tallawarra Lands. Future development in the Tallawarra Lands site is the focus of the Environmental Assessment. The Tallawarra Lands site includes a number of wetlands and watercourses that flow to Lake Illawarra, with the largest being Duck Creek. A site locality plan is provided in Figure 2-1.

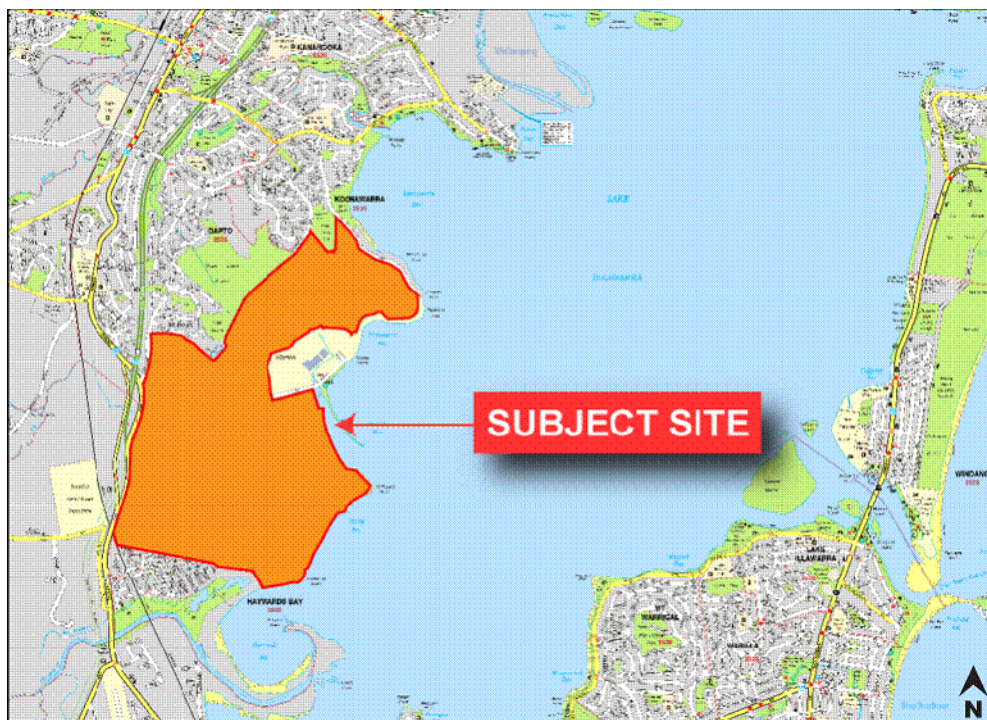


Figure 2-1 Site Locality (source: TRUenergy Tallawarra Pty Ltd)

The Tallawarra site includes a total area of 572.1ha, comprising Tallawarra Lands (535.9ha) and the Tallawarra Gas Power Station (36.3ha). Tallawarra Lands comprises primarily cleared grazing land, banded former ash dams, native vegetation, ephemeral wetlands, constructed open water bodies and, natural and constructed watercourses. The adjacent lake foreshore was dedicated to the Lake Illawarra Authority and public access to this area is available via Yallah Bay Road for which ownership has been transferred to Wollongong City Council. TRUenergy Tallawarra Pty Ltd is proposing to develop Tallawarra Lands to support a range of land uses. The Tallawarra Lands Concept Plan is shown in Figure 2-2.



Figure 2-2 Tallawarra Lands Concept Plan
 (Warren Lee Urban Design / Corkery Consulting, 7 December, 2010)

The concept plan proposes a mix of uses across the site as well as significant areas of environmental protection and open space. The proposed uses include:-

- Approximately 1000 low density lots;
- Approximately 10 large residential lots;
- Approximately 200 independent retirement living units;
- Community facilities including primary school, convenience retail, medical facility, child care, local business services and sports ground;
- Potential future employment uses subject to development of an employment strategy for the site including an office campus, retail, tourism and industrial; and
- Initial employment uses are likely to be local retail, health and community services.

Tallawarra Lands has been divided into three separate areas for the purposes of assessing drainage requirements. These separate areas are referred to within this report as the Northern, Central and Southern Precincts and the extents of each are described below.

The Northern Precinct is located adjacent to existing residential development in Koonawarra north of Mount Brown. The concept plan indicates that the future development within this area would comprise low density residential with some private recreation. Development in this area would straddle a ridge adjacent to Lake Illawarra with the majority of the land grading along moderate to steep slopes to the Lake Illawarra foreshore. An existing minor drainage gully would convey runoff from the northern parts of this precinct into a bay adjacent to the Gilba Road reserve.

The Central Precinct is located adjacent to existing residential development on the southern side of Mount Brown in Koonawarra. The concept plan indicates that future development within this precinct would comprise low density residential, large lot residential and a local centre. A public recreation area is planned adjacent to a minor watercourse that drains centrally through this precinct. A cycle track is planned south of Yallah Bay Road. Development in this precinct would primarily be situated along the slopes of a minor gully. This gully drains in a south-easterly direction along a minor ephemeral watercourse to Duck Creek. The ephemeral watercourse discharges into Duck Creek just downstream of an abandoned railway crossing over the creek. Land located on the eastern side of the Central Precinct is being considered for future development.

The Southern Precinct is bounded by the Princes Highway, new residential development in Haywards Bay, Duck Creek and existing wetlands adjacent to Lake Illawarra. The concept plan indicates that future development within this precinct would comprise low density residential, business, retail, school and retirement developments. The majority of this precinct is located within an existing bunded area that was formerly used as an ash dam for the previous coal fired power station. Based on available data it appears that two minor watercourses would have previously drained through this precinct. One watercourse was diverted around the southern and eastern sides of the bunded area and connected to Duck Creek. The second watercourse was diverted along a trapezoidal channel

excavated through the hillslope on the western side of the bunded area and then connected to Duck Creek. The concept plan proposes to retain the alignment of the existing watercourses.

The Central and Southern Precincts drain either directly or via minor watercourses into Duck Creek. The Northern Precinct drains to Lake Illawarra. The existing wetland area to the east of the Southern Precinct would receive surface runoff directly from the future development areas. This wetland area includes a number of endangered ecological communities (EEC's) that potentially would be impacted if hydrological changes were to occur. These wetland areas are currently fed by direct rainfall, groundwater, overbank flooding from Duck Creek, and surface runoff from the adjacent Haywards Bay development.

3 PRINCIPLES, OBJECTIVES AND TARGETS

3.1 Water Management Objectives

The following overarching objectives for drainage and WSUD are proposed for Tallawarra Lands:

- 1 Promote sustainable water resources management;
- 2 Protect ecological habitats from water pollution;
- 3 Protect watercourses, wetlands, groundwater and riparian corridors from water pollution;
- 4 Protect watercourses from increased erosion and sedimentation;
- 5 Integrate the management of stormwater, water supply, wastewater and flooding;
- 6 Conserve potable water to achieve more efficient use of water resources; and
- 7 Integrate water management into the landscape.

These water management objectives are consistent with local, regional, state and national objectives relevant to Tallawarra Lands. To assist with achieving the water management objectives, specific principles, objectives and targets are described in the following sections for:

- Water quality management (surface runoff);
- Water quantity management (environmental flows, stream forming flows, drainage and overland flows); and
- Water conservation (potable water and stormwater harvesting).

The provision of WSUD within new development in Tallawarra Lands can assist with achieving these objectives.

3.2 Stormwater Quality

3.2.1 The Issue

Urban development often results in significant modification to existing soils, topography, imperviousness and vegetation. Surface runoff volumes from urban development are typically elevated above natural conditions and without mitigation have the potential to convey elevated quantities of pollutants to receiving waters. Water quality impacts that can often be directly attributed to urban development include:

- increased nutrient loads leading to excessive plant growth in receiving waters;
- increased sediment loads leading to increased turbidity, increased erosion, reduced photosynthesis and smothering of aquatic plants and animals;
- increased contaminants and toxic materials including heavy metals, hydrocarbons and pesticides;
- increased litter and debris reducing oxygen levels and degrading aesthetics;
- changes to groundwater levels that impacts on soil moisture and vegetation, and

- conveyance of exotic plant and weed seeds resulting in degradation of riparian habitat.

WSUD will assist to detain, retain, harvest, filter, infiltrate and biologically treat surface runoff to reduce the concentrations and loads of pollutants discharged into the receiving waters. In addition, harvesting and infiltrating runoff can reduce the volume of runoff which has the potential to generate additional pollutants through erosion and sedimentation in the receiving watercourses.

3.2.2 Principles and Objectives

The following fundamental guiding principles relevant to stormwater quality have been considered in developing a WSUD strategy for Tallawarra Lands:

- Discharge of untreated stormwater from urban catchments into receiving waters and ground water is likely to degrade the water quality in those environments.
- Retention of stormwater will reduce the concentrations and loads of stormwater pollutants discharging to groundwater or a surface water environment.
- Filtering of stormwater will reduce the concentration and loads of stormwater pollutants discharging to groundwater or a surface water environment.

Surface water quality objectives include:

- To improve the water quality of Lake Illawarra and tributaries;
- To prevent direct pollution of existing surface and groundwater water systems;
- To minimise the risk of indirect water pollution by appropriate management of land uses and activities;
- To ensure the high quality of discharge to the drainage systems;
- To promote the protection of the aquatic environment through the use of Ecologically Sustainable Development (ESD) principles; and
- Adopt a total catchment management approach to water quality and protection of water systems.

3.2.3 Targets

Wollongong City Council's DCP 2009 (*Chapter E15 Water Sensitive Urban Design*) outlines default stormwater quality performance targets for large residential subdivisions, industrial subdivisions and business parks. The performance targets are load-based targets requiring it to be demonstrated that a particular development with treatment measures in place would achieve the targeted reductions when compared to the development without treatment. The following default load-based reduction targets have been adopted by Wollongong City Council:

- Total Nitrogen (TN) – 45%
- Total Phosphorus (TP) – 60%
- Total Suspended Solids (TSS) – 85%
- Gross Pollutants (GP) – 90%

The DCP also indicates that Council may adjust the performance targets for development located within sensitive catchments (e.g. Lake Illawarra). BMT WBM has spoken to Council in preparing this

assessment (Suri Mora, Environmental Planning) regarding adjustment of the targets for the Tallawarra Lands site. Council has indicated that the Tallawarra Lands development should seek to exceed the default targets whilst also ensuring that the long-term operation and maintenance requirements of the strategy are sustainable.

The following load-based reduction stormwater quality targets were adopted for Tallawarra Lands:

- Total Nitrogen (TN) – 45% to 50%
- Total Phosphorus (TP) – 60% to 65%
- Total Suspended Solids (TSS) – 85% to 90%
- Gross Pollutants (GP) – 90% to 95%

The first target value for each pollutant is Council's default target and the second value represents an ambitious target that would exceed Council's default targets.

The targets are relevant to surface water discharge to receiving waters and infiltration to ground water. The WSUD strategy demonstrates how the load reductions would be achieved prior to discharge to watercourses or interception by the groundwater table.

The targets are compared against modelled post development (without WSUD measures) and post development (with WSUD measures) scenarios in this assessment. MUSIC software was applied to model the performance of a WSUD strategy against the targets and this is discussed in Section 6.

3.3 Water Quantity

3.3.1 The Issue

Tallawarra Lands includes a Category 1 watercourse Duck Creek which drains into Lake Illawarra adjacent to the site (ELA, 2010). A number of other smaller ephemeral natural and constructed streams that flow in response to high rainfall in the catchment are also distributed throughout Tallawarra Lands. The majority of the streams within Tallawarra Lands have been modified by historical land use practices and include on-line storages that intercept runoff. Development in Tallawarra Lands has the potential to significantly increase surface runoff rates and volumes leading to impacts on stream stability, receiving water ecology and flooding.

Surface water hydrology is typically assessed for urban development in the following flow ranges:

- Environmental flows (<1yr ARI) that cumulatively convey high loads of additional flow volume and pollutants to receiving waters, potentially impacting on stream ecology and wetting/drying cycles in wetlands;
- Stream forming flows (1 to 2yr ARI) that influence stream stability and potentially lead to excessive erosion and sedimentation;
- Drainage flows (2 to 10yr ARI) that constructed drainage systems are typically designed for to minimise the potential for nuisance flooding in urban areas; and
- Overland flows (>10yr ARI) that have the potential to increase community hazards and damage infrastructure.

Whilst large natural freshwater/brackish wetlands are located within Tallawarra Lands adjacent to Lake Illawarra, the concept plan proposes to protect these areas by excluding development. The concept plan also ensures that surface water discharges from the proposed development areas will not flow to these wetlands.

3.3.2 Principles and Objectives

The following fundamental guiding principles are relevant to stormwater quantity for Tallawarra Lands:

- Minimising changes to the volume of runoff for frequent runoff events following development will assist with reducing impacts on environmental flows, maintaining ephemeral flows and reducing impacts on wetting and drying cycles in wetlands.
- Minimising changes to environmental flows will assist with protecting stream and wetland ecology.
- Minimising changes to the duration of flows in the 1 to 2 yr ARI range will assist with reducing changes to erosion and sedimentation within the receiving streams following development.
- Intercepting runoff within the development and conveying these flows within a defined drainage system with sufficient capacity to convey the 5 yr ARI flow will assist with minimising nuisance flooding for the community.

The following objectives are considered to be appropriate for management of water quantity within the Tallawarra Lands site:

- To minimise directly connected impervious areas within development to reduce surface runoff volumes;
- To maximise the retention of runoff and provide opportunities for use of the retained runoff;
- To reduce erosion within watercourses and maintain stream stability;
- To ensure that an adequate and environmentally acceptable method for draining stormwater is implemented;
- To ensure that new development does not generate stormwater flows that exceed the capacity of the existing drainage network;
- To minimise nuisance flows of stormwater from one property to adjoining properties;
- To provide a stormwater system which can be maintained economically;
- To provide a stormwater system which utilises open space in a manner compatible with other uses; and
- To prevent damage by stormwater to the built and natural environment.

3.3.3 Targets

Environmental Flows (Watercourses)

The environmental flow target is to retain a 15mm runoff depth from directly connected impervious areas within the site. The retention requirement would be incorporated into WSUD measures that store and re-use or filter runoff (e.g. rainwater tanks and biofiltration). Where the measures are

configured to release the retained stormwater, the stormwater would be released back to the environment at a maximum rate of 3mm of runoff depth per hour or a maximum drainage time of 24 hours at the conclusion of a wet period (whichever is shorter).

Environmental Flows (Wetlands)

A proportion of the Southern Precinct development will drain to an existing constructed wetland that supports saltmarsh species (ELA, 2010). This vegetation is susceptible to impacts from increased frequency of inundation from fresh water flows that potentially could occur following development. The strategy should ensure that changes to hydrological regime, inundation frequency and salinity in the wetland are minimised to mitigate potential impacts on the existing saltmarsh.

Stream Forming Flows

The ratio of the duration of post development stormwater flows greater than the stream forming flow to the duration of the pre-development stormwater flows greater than the stream forming flow (i.e. Stream Erosion Index) shall not exceed 1.5. A critical stream forming flow equivalent to 50% of 2yr ARI pre-development flow is proposed for watercourses receiving runoff from development within Tallawarra Lands.

Drainage

Wollongong City Council's DCP 2009 (*Chapter E14 Stormwater Drainage*) outlines stormwater drainage requirements for residential, commercial and industrial subdivisions. Within commercial and industrial subdivisions, the road and property drainage systems are to be designed and constructed to a 10yr ARI design standard. Within residential subdivisions, road drainage may be constructed to a minimum 5yr ARI standard if appropriate overland flow routes (road reserves or open space) are provided to manage overland flow up to the 100yr ARI event. Drainage systems in residential properties are required to be constructed to a 10yr ARI standard. Tallawarra Lands is defined by Wollongong City Council as a site where on-site detention (OSD) would not benefit downstream flooding. OSD is therefore not required for development within Tallawarra Lands.

WSUD measures that convey or temporarily retain the design flow shall be designed to overflow to a minor drainage system that has sufficient inlet and pipe capacity to capture and convey the design flow without surcharge.

Overland Flow

Major drainage systems shall be provided to safely convey overland flow in excess of the 5yr ARI flow in residential areas and the 10yr ARI flow in commercial and industrial areas to the receiving waters. WSUD measures shall either be located outside overland flowpaths or designed to ensure that the overland flow can be conveyed without excessively damaging the measure. WSUD measures positioned within overland flowpaths should also be assessed to ensure they would not redistribute flows or lead to other impacts on flooding characteristics (e.g. increased flood levels or velocities).

Flooding

WSUD management measures proposed near existing watercourses subject to flooding shall be planned in accordance with Council's flood prone land policy. Any WSUD measures positioned in the Duck Creek floodplain would be constructed outside the 10yr ARI flood extents and impacts on flooding behaviour during less frequent flood events would need to be assessed.

3.4 Water Conservation

3.4.1 The Issue

Water is our most precious resource and existing urban water supply systems are approaching their limits. Opportunities for expanding existing water supply dams and creating new water supply sources are becoming increasingly limited, and there are growing community demands to increase environmental flows downstream from supply dams. As the urban population increases, we therefore need to make more efficient use of water. Tallawarra Lands can contribute to water sustainability by incorporating a variety of water efficiency measures.

3.4.2 Principles and Objectives

The following fundamental guiding principles are relevant to water conservation for Tallawarra Lands:

- Reducing the capture and consumption of water for human uses will reduce the impact of development on the natural water cycle and aquatic ecosystems that rely on fresh water flows.
- Reducing the consumption of potable water assists with delaying augmentation of existing water supply systems.
- Replacing potable water with alternative water sources reduces the discharge of pollutants into urban streams.
- Replacing potable water with harvested rainwater/stormwater assists with protecting urban streams from erosion.

The following objectives are considered to be appropriate for water conservation within Tallawarra Lands:

- Match water sources with appropriate water uses.
- Reduce the consumption of potable water.
- Use potable water more efficiently.
- Minimise the consumption of potable water for non-potable uses.
- Provide controls for water harvesting to ensure that water flows to natural watercourses and river systems are maintained.

3.4.3 Targets

Future residential development within Tallawarra Lands will be required to comply with State Environmental Planning Policy (Building Sustainability Index BASIX) 2004 (BASIC SEPP 2004). The BASIX SEPP 2004 requires new residential dwellings within the concept plan to achieve a 40% reduction in potable water use when compared to 2004 demands. The concept plan commits future

residential development at Tallawarra Lands to achieving potable water reductions equivalent to BASIX +10%.

In addition to residential land, the concept plan commits to applying the BASIX principles to commercial and retail development proposed in Tallawarra Lands. This will be achieved by aspiring to a 40% reduction in potable water use target compared to that of similar types of development in NSW. The intent would be to utilise Green Star and the NSW Water Savings Action Plans as means to target, deliver and report on utility reductions.

4 DRAINAGE/WSUD CONSTRAINTS AND OPPORTUNITIES

4.1 Introduction

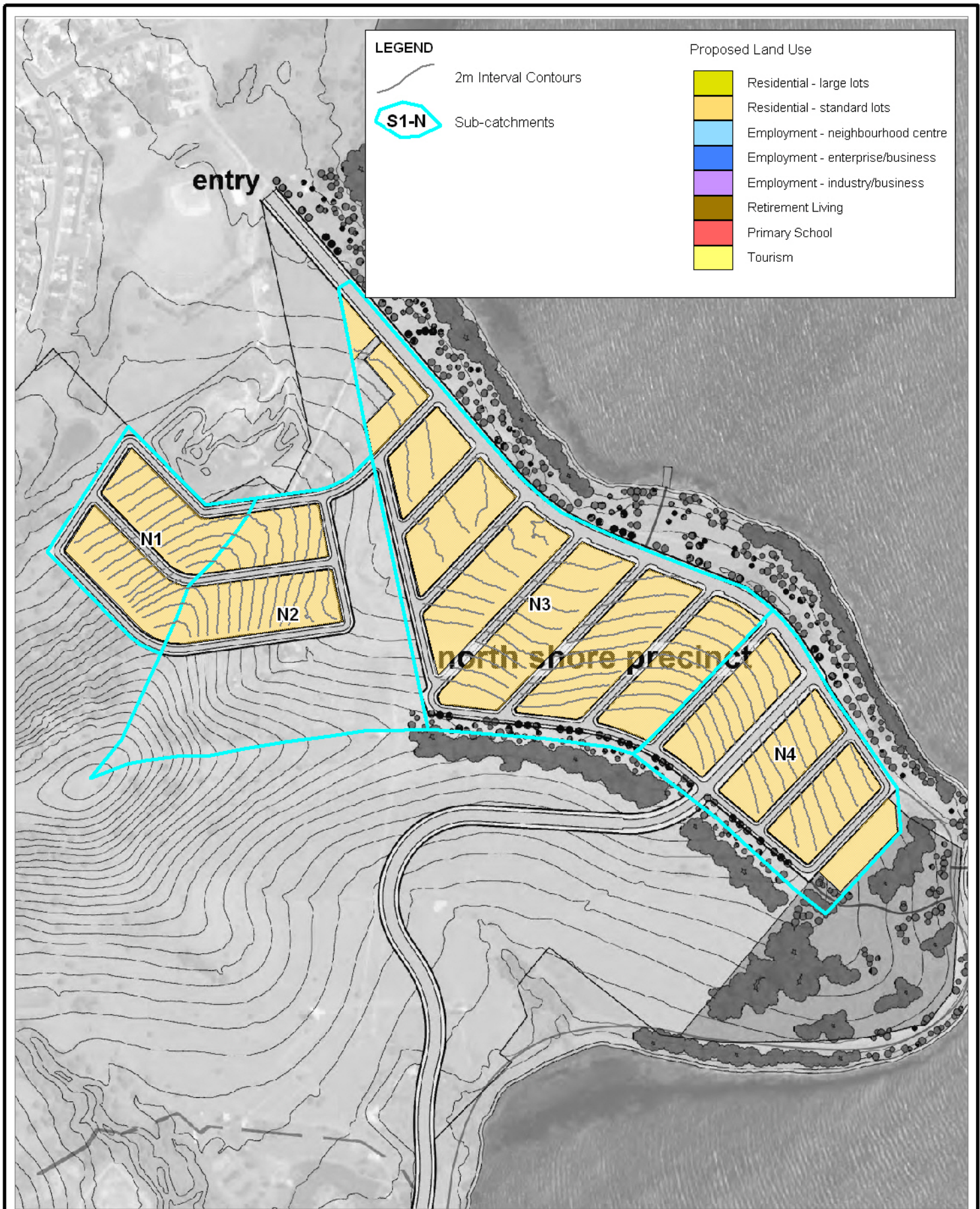
This section of the report describes the existing Tallawarra Lands site characteristics relevant to drainage and WSUD and identifies constraints and opportunities to drainage and WSUD within future development in Tallawarra Lands. The Northern, Central and Southern Precincts have been divided into a number of drainage sub-catchments and these are described below. Constraints and opportunities were identified from available data and relevant specialist reports describing flooding, riparian zones, ecology, terrain, soils and groundwater.

We have assumed that other relevant environmental issues including bushfire risk, transport/access, heritage, archaeology and acoustics would only form a minor constraint to drainage and WSUD in Tallawarra Lands. It is assumed that development would be excluded from areas where environmental impacts on these issues are unable to be mitigated.

Constraints to drainage and WSUD are summarised in tables below for each drainage sub-catchment adopting simple risk assessment categories (Low (L), Medium (M) or High (H)) based on the available data. Further discussion on these constraints and potential opportunities for drainage and WSUD are also discussed below.

4.2 Northern Precinct

The Northern Precinct has been divided into four drainage sub-catchments N1, N2, N3 and N4 which are shown in Figure 4-1.

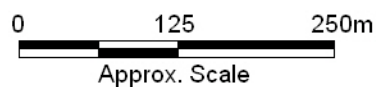


Title:
Northern Precinct - Subcatchments

Figure:
4-1

Rev:
A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.



Key constraints to drainage and WSUD in the Northern Precinct sub-catchments are summarised in Table 4-1 and discussed further in the following sections.

Table 4-1 Northern Precinct - WSUD Constraints

Physical Constraint	Sub-catchment			
	N1	N2	N3	N4
Flooding	L	L	M	L
Riparian	M	L	L	L
Ecology	M	M	M	L
Terrain	H	M	H	H
Soils	M	M	M	M
Groundwater	L	L	L	L

4.2.1 N1

This sub-catchment drains to Barrons Gully which is aligned just west of the N1 sub-catchment boundary. This creek forms a habitat link to a large stand of vegetation to the west (ELA, 2010). The creek currently has a riparian zone less than 10m wide and includes existing farm dams which provide fauna habitat. A core riparian zone (CRZ) of 20m from top of bank and 10m buffer are proposed for this creek (ELA, 2010).

Ecology constraints include an existing artificial wetland located in Barrons Gully which has been identified as having potential habitat for amphibians, reptile bats and birds. The wetland has been categorised as being of moderate environmental significance and is proposed to be retained within the concept plan with appropriate buffers (ELA, 2010).

LiDAR terrain data available for the site (AAMHatch, 2005) indicates that typical slopes in this sub-catchment will be in the 10 - 15% range. This slope range is unsuitable for the majority of WSUD measures with conventional configurations. It is likely that a sub-catchment scale measure with retaining walls/near vertical walls will be required to treat stormwater runoff prior to discharge into the riparian zone.

Site geotechnical investigations indicate that soil characteristics are expected to be similar across the northern precinct sub-catchments. Soils are generally colluvial/residual soils with a depth generally less than 2m except in gullies where deeper soils occur (Coffey, 2010). Soils are likely to have low permeability and are potentially reactive with a high shrink-swell potential in some locations. Soils will be unsuitable for infiltration. Acid sulphate soils are not known to occur in these areas. Soils are underlain by sandstone bedrock.

No groundwater was observed in the test pits and boreholes formed for the geotechnical investigations in all the northern sub-catchments, although investigations indicate that localised wet subsoils are likely to be found in gullies (Coffey, 2010).

4.2.2 N2

Ecological constraints are minor for this sub-catchment, although it drains to Sub-catchment N3 which has ecological constraints.

LiDAR terrain data available for the site (AAMHatch, 2005) indicates that typical slopes in this sub-catchment will be in the 10 - 15% range. This slope range is unsuitable for the majority of WSUD measures with conventional configurations. The sub-catchment drains to an overland flowpath through an existing electricity transmission easement that directs runoff to N3. Gradients along the overland flow path within the easement are lower (approximately 5%) and are more suitable for constructing WSUD measures.

Soil and groundwater constraints are similar to Sub-catchment N1.

4.2.3 N3

Overland flow flooding from N2 will need to be considered in the future N3 road design to ensure that flows in excess of the drainage system capacity can be conveyed within the road reserve in N3 and directed to the foreshore.

Although no riparian corridors are defined within this sub-catchment, Lake Illawarra Authority has requested a 100m buffer to Lake Illawarra. This buffer constraint also applies to Sub-catchment N4.

Ecology considerations include an area of Coastal Swamp Oak Forest situated in a minor drainage gully between the proposed residential development and Lake Illawarra.

LiDAR terrain data available for the site (AAMHatch, 2005) indicated that typical slopes in this sub-catchment are up to 10%. This slope range is unsuitable for the majority of WSUD measures with conventional configurations.

Soil and groundwater constraints are similar to Sub-catchment N1.

4.2.4 N4

Riparian constraints are similar to Sub-catchment N3.

No specific ecological constraints have been identified for this sub-catchment.

LiDAR terrain data available for the site (AAMHatch, 2005) indicated that typical slopes in this sub-catchment are up to 10%. This slope range is unsuitable for the majority of WSUD measures with conventional configurations.

Soil and groundwater constraints are similar to Sub-catchment N1.

4.2.5 Key Opportunities

Sub-catchment N1 drains to the adjacent Gilba Road Reserve. There is potential that filtered harvested stormwater could be utilised for irrigation of the existing baseball field in this reserve. Any stormwater quality and quantity management infrastructure should be positioned outside this CRZ and buffer in Barrons Gully.

Sub-catchment N2 drains through an existing electricity easement situated between Sub-catchments N2 and N3. Provided appropriate access can be maintained to the existing infrastructure, and the requirements of the infrastructure owner can be addressed, positioning of WSUD measures in this easement is considered an appropriate option.

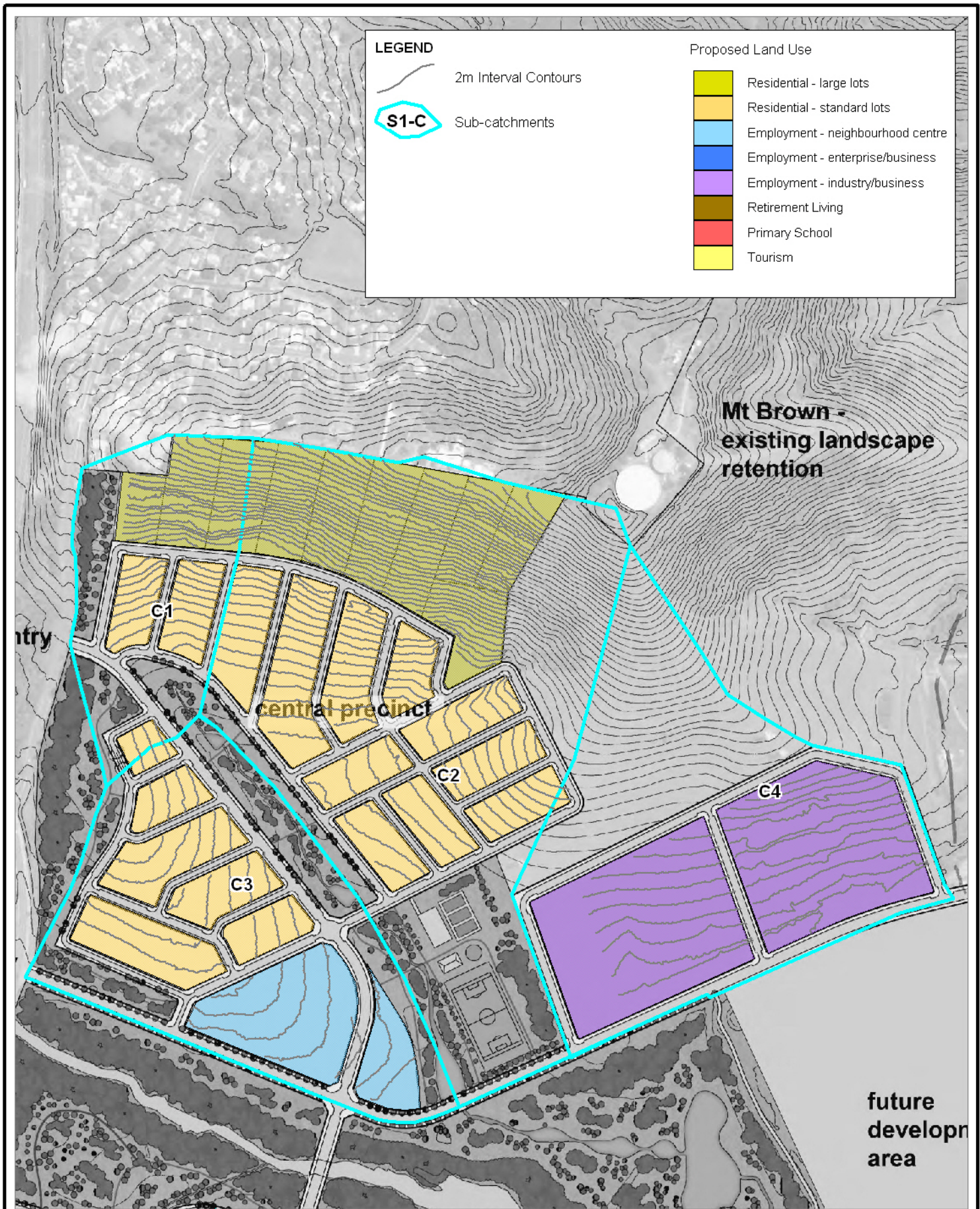
Sub-catchments N3 and N4 drain steeply to the Lake Illawarra foreshore and would be unsuitable for most WSUD measures. Three main opportunities have been considered for positioning WSUD measures for Sub-catchments N3 and N4 including:

- Provide several biofiltration basins within less steep areas within the Lake Illawarra foreshore buffer. This opportunity whilst technically feasible would require approval from LIA to proceed.
- Provide raingardens at each intersection of the main foreshore road and minor residential streets that grade down the contours to the foreshore. This option would require some filling of the land adjacent to the main foreshore road to reduce gradients and would result in the loss of potentially developable land along the foreshore.
- Provide a series of cascading biofiltration raingardens along the development boundary adjacent to the Lake Illawarra foreshore buffer. The raingardens are likely to require vertical walls to achieve sufficient detention volume at this location. The raingardens would be formed to capture runoff from individual minor street drainage lines.

The key constraints and opportunities outlined above for each of the Northern Precinct sub-catchments have been considered in developing the WSUD strategy for Tallawarra Lands.

4.3 Central Precincts

The Central Precinct has been divided into four drainage sub-catchments C1, C2, C3 and C4 which are shown in Figure 4-2.

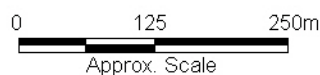


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Central Precinct - Subcatchments

Figure:
4-2

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Key constraints to drainage and WSUD in the Central Precinct sub-catchments are summarised in Table 4-2 and discussed further in the following sections.

Table 4-2 Central Precincts - WSUD Constraints

Physical Constraint	Sub-catchment			
	C1	C2	C3	C4
Flooding	L	L	L	H
Riparian	M	M	M	M
Ecology	L	L	L	M
Terrain	H	H	H	M
Soils	M	M	M	H
Groundwater	L	L	L	H

4.3.1 C1

An existing watercourse draining through this sub-catchment is actively eroding due to the steep topography and degraded riparian vegetation. The Category 3 stream is approximately 1m wide with a proposed CRZ extending 10m from the top of bank (ELA, 2010). No additional buffer width is proposed beyond the CRZ. A small farm dam is located along this watercourse and has been identified as providing limited habitat. The watercourse drains through Sub-catchments C2 and C3.

No specific ecological constraints have been identified for this sub-catchment.

Hill-slope soils are generally colluvial/residual soils varying in depth between 1m in the upper slopes to 3m deep near the watercourse. The soils in this sub-catchment are primarily underlain by sandstone on the hillslopes and gravel/sand alluvium within the watercourse (Coffey, 2010). Soils are similar for Sub-catchments C2 and C3.

No groundwater was observed in the test pits in the upper reaches of this sub-catchment during investigations (Coffey, 2010). Groundwater inflow was observed 3 to 4m deep in the watercourse which also drains through Sub-catchments C2 and C3 (Coffey, 2010). Whilst groundwater inflow depths were observed, no standing water levels were monitored within this sub-catchment.

4.3.2 C2 and C3

Riparian, ecological and groundwater characteristics are expected to be similar to Sub-catchment C1.

Soils are expected to be similar in characteristics and depths as Sub-catchment C1 except in the lower reaches of the watercourse which comprises estuarine soils. Significant ground disturbance has occurred in the lower reaches of the watercourse and estuarine floodplain areas. These areas have been filled and are likely to contain ash and coal wash overlying the estuarine soils (Coffey, 2010). The lower reaches have been assessed to have a low probability of acid sulfate soils between 1 to 3m below the existing ground surface (Coffey, 2010).

4.3.3 C4

This sub-catchment is located upslope of the Duck Creek floodplain and riparian zone. The sub-catchment primarily includes elevated areas outside the floodplain of Duck Creek which have similar constraints to Sub-catchment C2. The floodplain areas downstream of this sub-catchment are typically more constrained with limited potential for construction of WSUD measures.

Duck Creek has been classified as a Category 1 watercourse and a 40m wide CRZ with 10m buffers either side of the CRZ applies (ELA, 2010). Duck Creek forms an important environmental corridor for terrestrial and aquatic habitat within the site.

A constructed drain extending from Yallah Bay Road to Duck Creek currently conveys runoff from this sub-catchment. The drain has no clearly defined riparian zone/vegetation and meanders through two constructed wetlands with limited habitat value (ELA, 2010). The drain is less than 1m wide and is a Category 3 stream with a proposed CRZ extending 10m from the top of bank (ELA, 2010).

The sub-catchment drains to two existing constructed wetlands located within the Duck Creek floodplain. One wetland has a surface area of 1.42ha with limited fringing vegetation and habitat. This wetland is proposed to be removed. The second wetland located closer to Duck Creek has a surface area of 0.19ha and limited habitat value. Whilst the second wetland has limited habitat value, it appears to have a saline influence which supports saltmarsh. The second wetland is proposed to be retained and protected with a 20m buffer (ELA, 2010).

Floodplain areas adjacent to Duck Creek downstream of this sub-catchment have only minor disturbance and comprise estuarine soils less than 2m deep. Based on published acid sulfate soil risk maps and acid sulfate soils testing, there is a high probability of acid sulfate soils occurring in the floodplain areas adjacent to Duck Creek (Coffey, 2010). Soil testing in this area indicates that the soils exceed the concentrations where action would be required to manage exposed acid sulfate soils (Coffey, 2010). Excavation to form WSUD measures to treat runoff from Sub-catchment C4 should be avoided in this area.

Groundwater inflow was observed at depths between 1.2m and 2.8m during sampling within the floodplain area downstream of this sub-catchment adjacent to Duck Creek (Coffey, 2010). Whilst groundwater inflow depths were observed, no standing water levels were monitored within this sub-catchment. Geotechnical investigations have confirmed that wet subsoils and shallow groundwater flows would be key constraints for the low lying areas within this sub-catchment (Coffey, 2010).

4.3.4 Key Opportunities

The central watercourse through this precinct has a gravel/sand alluvium substrate and typical gradient over 4%. The watercourse would be susceptible to further erosion following development if runoff is not mitigated. Without engineering intervention, it is likely that if unmitigated runoff from Sub-catchments C1, C2 and C3 is discharged into the watercourse significant erosion would occur following development. There is an opportunity to divert a significant proportion of runoff from Sub-catchments C1, C2 and C3 into a piped drainage system along future road alignments parallel to the watercourse for conveyance to the lower parts of the sub-catchment. This would assist to protect the steeper upper reaches from increased erosion. Runoff from a proportion of these sub-catchments

would be directed to the watercourse to maintain environmental flows. Discharges to the watercourse could be routed through retention storages to reduce peaks.

The concept plan provides open space areas adjacent to the central watercourse which are outside the riparian zone. This open space area provides opportunities for positioning WSUD measures that can form a retention buffer between the development areas and the watercourse.

The concept plan incorporates a sportsground in Sub-catchment C2. Piped drainage flows that bypass the upper reaches of the central watercourse could be directed to the sportsground, treated and stored either in an above or below ground storage for use as irrigation water.

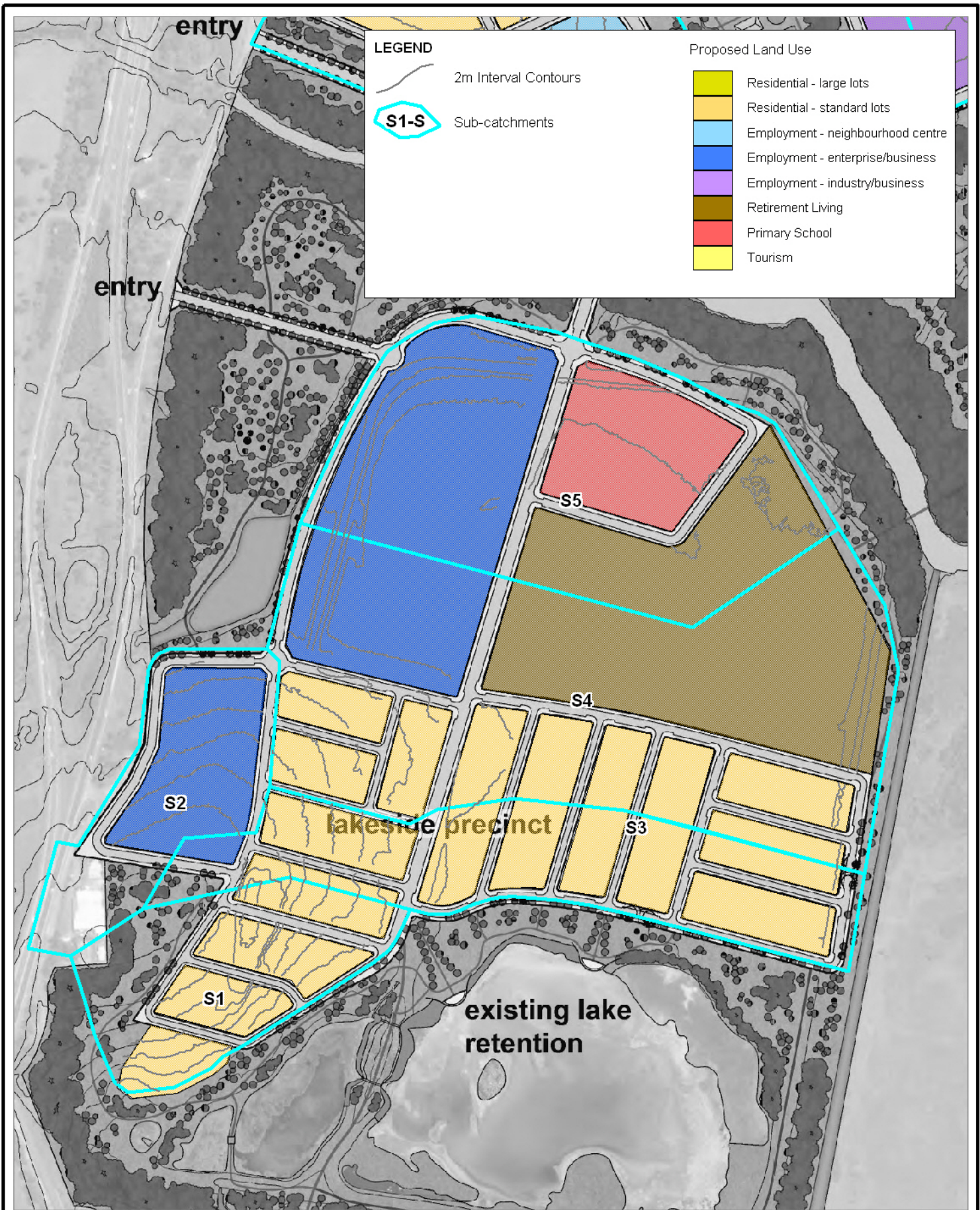
Sub-catchment C4 includes an area of elevated land on the southern side of Yallah Bay Road adjacent to the Duck Creek floodplain that could be utilised for management of stormwater prior to discharge into the downstream wetland.

Sub-catchment C4 includes a large industrial area which potentially could be provided with a separate roof water drainage system connected to a central storage utilised for stormwater harvesting for appropriate uses either within the power station or surrounding lands.

The key opportunities and the constraints outlined above for each of the Central Precinct sub-catchments have been considered in developing the WSUD strategy for Tallawarra Lands.

4.4 Southern Precincts

The Southern Precinct has been divided into four drainage sub-catchments S1, S2, S3 and S4 which are shown in Figure 4-3.



LEGEND

- 2m Interval Contours
- S1-S Sub-catchments

Proposed Land Use

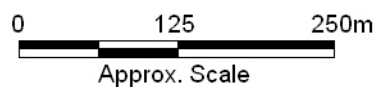
- Residential - large lots
- Residential - standard lots
- Employment - neighbourhood centre
- Employment - enterprise/business
- Employment - industry/business
- Retirement Living
- Primary School
- Tourism

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Southern Precinct - Subcatchments

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4-3

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Key constraints to drainage and WSUD in the Southern Precinct sub-catchments are summarised in Table 4-3 and discussed further in the following sections.

Table 4-3 Southern Precincts - WSUD Constraints

Physical Constraint	Sub-catchment				
	S1	S2	S3	S4	S5
Flooding	L	L	M	M	M
Riparian	M	L	M	L	L
Ecology	M	L	M	L	L
Terrain	H	M	L	L	L
Soils	M	L	M	M	M
Groundwater	L	L	M	M	M

4.4.1 S1

This sub-catchment drains to an existing constructed pond which previously functioned as a coal wash settling pond (ELA, 2010). The existing pond has a surface area of 1.5ha and contains significant areas of fringing sedges and rushes. The pond provides habitat for birds, reptiles, bats and amphibians, and is considered to have high environmental significance (ELA, 2010). The pond is proposed to be protected by a 20m buffer. The pond is connected to the existing wetland in Sub-catchment S3 through a slot in the existing bund. Overflow from this pond discharges into an existing channel formed by the Wollingurry Creek diversion.

Soils generally colluvial/residual soils less than 2m deep. Soils underlain by sandstone and siltstone bedrock. The soils include a small area of general fill which may contain ash and coal wash in addition to local soils (Coffey, 2010).

4.4.2 S2

This sub-catchment includes a constructed farm dam and former ash pond. The pond has been assessed as having low to moderate environmental significance.

Soils generally colluvial/residual soils less than 2m deep. Soils are underlain by sandstone or siltstone bedrock (Coffey, 2010).

4.4.3 S3

This sub-catchment drains to an existing large (9.26ha) shallow constructed wetland with fringing saltmarsh. The wetland is proposed to have a 20m wide buffer (ELA, 2010). The wetland is formed over deposits of ash from the former coal fired power station. The wetland has been identified as providing high quality habitat for birds, reptiles, bats and amphibians, and is classified as having a high environmental significance (ELA, 2010). This wetland overflows to the constructed pond receiving inflows from S1.

Soils comprise ash fill 0.5m to 3m deep, overlying estuarine soils varying in depth from less than 2m to greater than 2m (Coffey, 2010). Based on published acid sulfate soil risk maps, there is a high probability that a proportion of the underlying estuarine soils are acid sulfate soils (Coffey, 2010). Depth to bedrock is estimated to vary in the 2m to 13m range across this sub-catchment (Coffey, 2010).

Groundwater standing water levels were observed to vary between approximately 1m AHD and 2.5m AHD within four monitoring wells established across Sub-catchments S3 and S4. The depth to groundwater from the existing ground surface was observed to vary from approximately 0.5m to 2m.

4.4.4 S4

This sub-catchment includes an existing 0.89ha wetland that has formed within the former ash pond (ELA, 2010). The wetland has been assessed as having low habitat and environmental significance and is proposed to be removed (ELA, 2010).

Soils comprise ash fill 0.5m to 3m deep, overlying estuarine soils varying in depth from less than 2m to greater than 2m (Coffey, 2010). Based on published acid sulfate soil risk maps, there is a high probability that a proportion of the underlying estuarine soils are acid sulfate soils (Coffey, 2010). Depth to bedrock is estimated to vary in the 2m to 10m range across this sub-catchment (Coffey, 2010).

4.4.5 S5

This sub-catchment includes an existing 0.15ha wetland that has formed within the former ash pond (ELA, 2010). The wetland has been assessed as having low habitat and environmental significance and is proposed to be removed (ELA, 2010). The northern extents of this sub-catchment are adjacent to, but outside the proposed CRZ and buffer for Duck Creek.

4.4.6 Key Opportunities

Sub-catchments S1 and S2 is relatively steep and will require a sub-catchment scale WSUD measure to manage stormwater quality and discharges to the existing ponds. The measure shall be located outside the 20m buffer to the existing ponds.

Part of Sub-catchment S3 will drain to the existing 9.26ha wetland which supports salt marsh species. It will be important that flow volumes are controlled from this sub-catchment to minimise changes to the hydrologic regime of the existing wetland. This can be achieved by reducing the catchment area draining to the wetland and providing retention measures to intercept and re-direct stormwater away from the wetland.

Sub-catchments S3, S4 and S5 will require significant regrading and ground modification to achieve a suitable building platform for development. It is expected that surface gradients in these catchment will typically be less than 1% which will be suitable for a range of WSUD measures. There are opportunities for positioning a range of WSUD measures within lot, street and at sub-catchment scales within development in these areas.

4.5 Existing Water Quality

Water quality monitoring has been undertaken by TRUenergy within Tallawarra Lands and the adjacent receiving waters since 2006. Locations of the monitoring sites are shown in Figure 4-4. Water quality data were provided by TRUenergy for a number of these sites. These data were reviewed and median concentrations for TSS, TP and TN were calculated by BMT WBM. The calculated concentrations are plotted on Figure 4-5, Figure 4-6 and Figure 4-7 along with ANZECC trigger values for aquatic ecosystems and typical runoff quality parameters sourced from Fletcher et al, 2005.

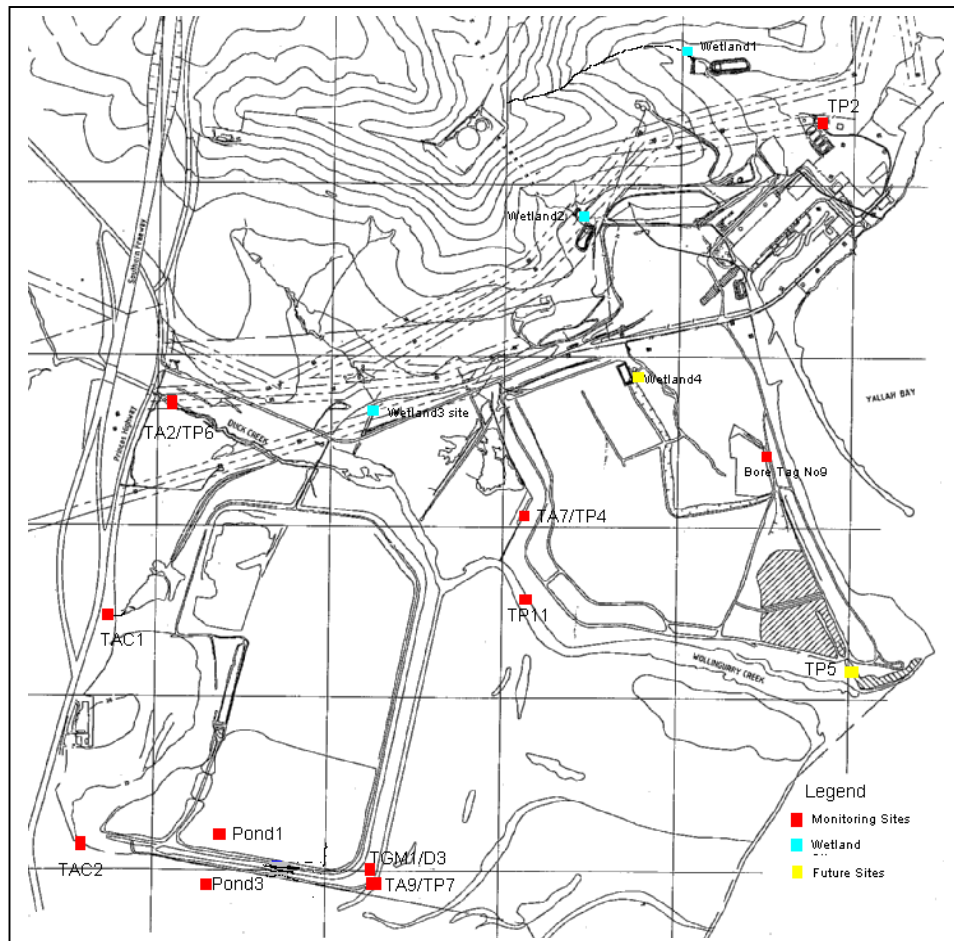


Figure 4-4 Tallawarra Water Quality Monitoring Sites (source: TRUenergy)

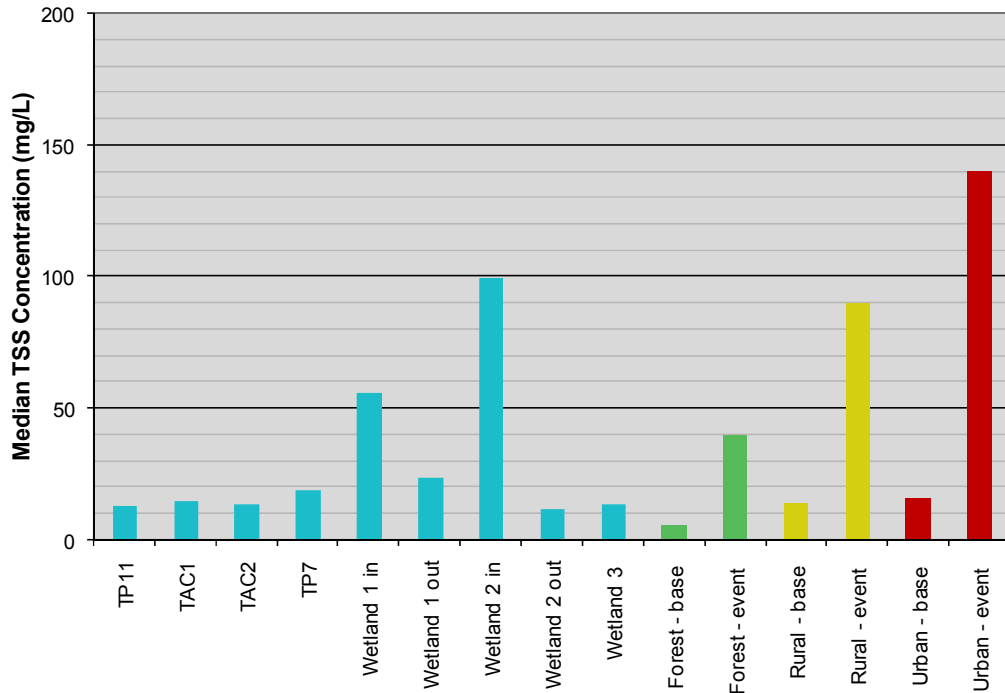


Figure 4-5 TSS Monitoring

The TSS monitoring results shown in Figure 4-5 indicate that median TSS concentrations observed within Tallawarra Lands and the adjacent watercourses are primarily within the range of median base flow concentrations for forested and rural catchments with the exception of inflow to the site wetlands (Wetlands 1, 2 and 3) and downstream of existing urban development in Haywards Bay (TAC). The median concentrations for the sites located in the catchments (Wetland 1, 2 and 3) are closer to typical forested and rural event flow concentrations. Review of rainfall data indicates that sampling at the monitoring sites has typically coincided with recent wet weather and consequently inflow concentrations to the wetlands are likely to be elevated above base flow concentrations. TSS concentrations in the watercourses are likely to be less influenced by catchment runoff due to mixing within the receiving waters.

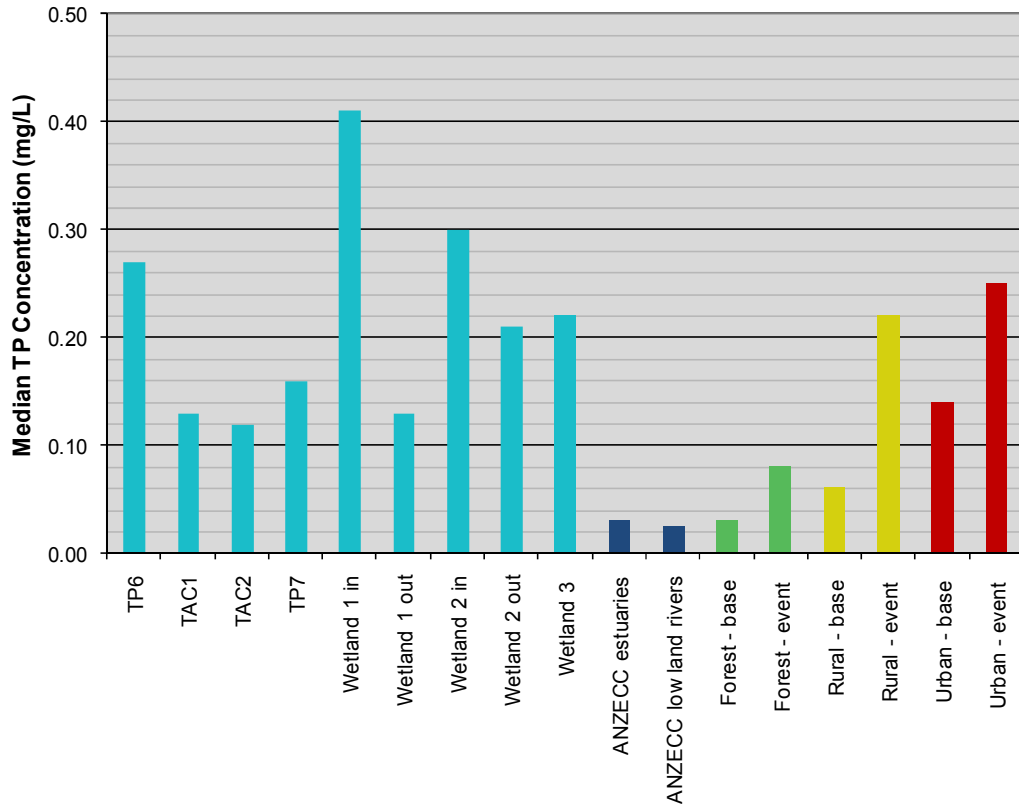


Figure 4-6 TP Monitoring

The TP monitoring results shown in Figure 4-6 indicate that median TP concentrations observed within Tallawarra Lands and the adjacent watercourses are primarily within the range of median event flow concentrations for forested and rural catchments. Median TP concentrations observed at the wetland sites are typically close to or exceed event flow concentrations for rural catchments. Median TP concentrations observed in Duck Creek (TP6) are close to those observed in runoff from typical urban catchments. Median TP concentrations observed in the Duck Creek (TP6) upstream of Tallawarra Lands significantly exceed ANZECC trigger values for aquatic ecosystems.

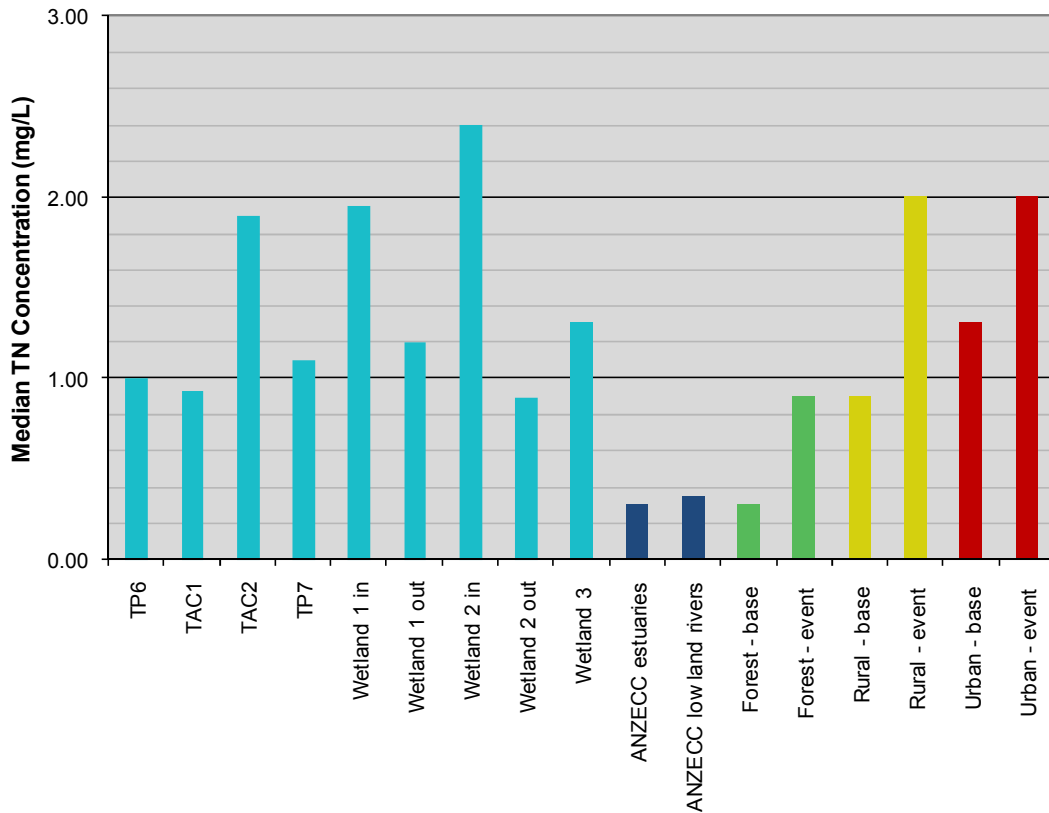


Figure 4-7 TN Monitoring

The TN monitoring results shown in Figure 4-7 indicate that median TN concentrations observed within Tallawarra Lands and the adjacent watercourses are similar to forested event flow or rural base flow conditions with the exception of inflow to the site wetlands (Wetlands 1, 2 and 3) and downstream of existing urban development in Haywards Bay (TAC). Median TN concentrations observed in the inflow at the wetland sites and just downstream of the adjacent Haywards Bay development are more elevated and closer to typical concentrations during event flow from rural or untreated urban catchments. Median TN concentrations observed in the Duck Creek (TP6) upstream of Tallawarra Lands significantly exceed ANZECC trigger values for aquatic ecosystems.

The water quality monitoring results suggest that erosion from existing steep watercourses with Tallawarra Lands is likely to be contributing to the elevated TSS and TP concentrations observed in the inflow to the Wetland 1 and 2 water quality monitoring sites. Although existing data is limited, the existing wetlands appear to be functioning well in capturing sediment and nutrients (as can be observed in the difference in concentrations between the inflow and outflow).

5 WSUD STRATEGY

5.1 Overview

This section outlines the key issues that were considered when determining appropriate types and locations for WSUD measures in Tallawarra Lands. The WSUD strategy for Tallawarra Lands included major and minor WSUD measures. The major WSUD measures are the key measures proposed to manage water quality and quantity within Tallawarra Lands. The size and locations for the major WSUD measures are included in the concept plan and the performance of the WSUD strategy at achieving protection of the receiving waters is reliant on these measures being in place. The minor WSUD measures are additional measures that are recommended for inclusion within the development precincts. These WSUD measures would enhance the performance of the major WSUD measures and provide a degree of redundancy within the system if any one particular measure were not to perform up to expectations.

5.2 Key Considerations

5.2.1 Location and Scale

WSUD measures can broadly be positioned at lot, street or sub-catchment scales throughout future development in Tallawarra Lands. The suitability of each particular scale requires consideration of the water management objectives, physical site constraints and urban design objectives.

Lot scale WSUD measures are positioned within private lots and typically only manage water from that lot. Ownership of the measure is typically retained by the property owner who is responsible for future operation and maintenance. Typically lot scale WSUD measures should have a relatively simple function with low risk to other properties and the environment if the measure does not function as designed (e.g. rainwater tanks).

Street scale WSUD measures can be integrated within the streetscape with close consideration of potential conflicts with services, pedestrians, motorists and the community.

Sub-catchment scale WSUD measures are typically located downstream of subdivisions, minor sub-catchments or off-line of major watercourses. Typically sub-catchment scale measures would be located downstream of all building development.

5.2.2 Site Characteristics

The physical site characteristics are the key factor that influences the range of WSUD measures that are appropriate for Tallawarra Lands. The physical site characteristics for Tallawarra Lands are described in Section 4.

Selection of appropriate WSUD measures that respond to the physical site characteristics is an important step in confirming the ability of the site to support the proposed development without having potentially significant impacts on the receiving water quality and ecology. The key physical site characteristics that potentially constrain the application of WSUD within Tallawarra Lands include:

- Flooding;
- Riparian corridors;
- Ecology;
- Terrain;
- Soils and groundwater; and
- Existing services.

Flooding, riparian corridors, ecology and existing services will typically not constrain the types of WSUD measures that can be provided within Tallawarra Lands but will constrain where the measures can be located. Terrain, soils and groundwater typically each influence the types of WSUD measures that are appropriate for a particular location. Key terrain, soils and groundwater constraints and their relevance to particular WSUD measures are summarised in Table 5-1.

Table 5-1 Terrain, Soils and Groundwater Constraints


WSUD Measure / Typical Scale		Steep slopes	Shallow bedrock	Low permeability soil	High permeability soil	High water table	High sediment load	Land availability
Rainwater tanks	Lot	L	L	L	L	L	L	L
Infiltration measures		H	H	H	L	H	H	H
Permeable paving		H	L	M	L	M	H	L
Media filters		M	M	L	L	M	H	L
Vegetated filter strips	Street	H	M	L	L	L	M	L
Vegetated swales		H	M	L	L	M	M	H
Biofiltration swales and raingardens		H	H	L	M	H	H/M	H
Sediment traps		H	M	L	L	M	L	H
Gross pollutant traps	Sub-catchment	M	M	L	L	M	L	L
Constructed wetlands		H	M	L	M	M	M	H
Biofiltration basins		H	H	L	M	H	M	H
Stormwater harvesting basins		H	M	L	M	M	M	M

H – High constraint may preclude use; M – Moderate constraint that potentially may be overcome through appropriate design; L – Low constraint

5.2.3 Stormwater Quality Management

Particular WSUD measures function most effectively across particular hydraulic loading rate and pollutant size ranges. WSUD measures that are appropriate for particular targeted pollutants and related hydraulic loading rates in Tallawarra Lands are shaded in Table 5-2. From Table 5-2 it can be seen that to capture certain pollutants, one treatment measure may not be sufficient. For example, while a vegetated swale can remove some nutrients, it will not be effective for the colloidal and dissolved nutrients for which a constructed wetland or biofiltration measure will provide more effective treatment. Table 5-2 also shows that to capture gross pollutants and coarse sediment, the hydraulic loading rate can be very high, whereas to treat nutrients or metals a much smaller hydraulic loading rate is required. The space requirements are typically inversely proportional to the hydraulic loading rate (i.e. the higher the rate, the smaller the measure).

Table 5-2 WSUD measures for Stormwater Quality Management

WSUD Measure / Typical Scale		Litter	Organic debris	Coarse sediment	Fine sediment	Metals (particulate)	Nutrients (particulate)	Nutrients (dissolved)
		increasing hydraulic loading rate 						
Rainwater tanks	Lot							
Infiltration measures								
Permeable paving								
Media filters								
Vegetated filter strips	Street							
Vegetated swales								
Biofiltration swales and raingardens								
Sediment traps	Sub-catchment							
Gross pollutant traps								
Constructed wetlands								
Biofiltration basins								
Stormwater harvesting basins								

The pollutants targeted for removal by the WSUD measures can cover a wide range of different sized pollutants. The proposed Tallawarra Lands treatment series focuses on initially capturing gross pollutants (litter, organic debris etc) and coarse particulates (sediment) followed by fine, colloidal and dissolved pollutants. Configuring the treatment series in this manner provides pre-treatment for downstream treatment measures that would be either be damaged or impaired by excessive loads of gross pollutants and coarse sediment if these were allowed to discharge into downstream measures designed to manage fine, colloidal and dissolved pollutants. For example, a biofiltration basin may become clogged with coarse sediment very quickly if no upstream GPT or sediment trap is provided.

5.2.4 Stormwater Quantity Management

The majority of WSUD measures would typically have some impact on reducing the stormwater runoff rates and volumes from future development in Tallawarra Lands. Measures with a high pervious area have the potential to absorb a high proportion of runoff from small urban catchment runoff events (e.g. vegetated swales). Similarly, measures that intercept and divert stormwater away from receiving waters (e.g. rainwater tanks and stormwater harvesting basins) will influence small environmental flows. Larger measures (e.g. biofiltration basins and constructed wetlands) will have a high potential for reducing peak flows in the stream forming and overland flow ranges where a large extended detention volume can be provided.

Table 5-3 WSUD measures for Stormwater Quantity Management

WSUD Measure / Typical Scale		Overland flooding	Minor drainage	Stream forming flows	Environmental flows
		← increasing peak flow rate			
Rainwater tanks	Lot		L	M	H
Infiltration measures				L	H
Permeable paving					L
Media filters			L	M	L
Vegetated filter strips	Street				L
Vegetated swales					M
Biofiltration swales and raingardens			L	M	M
Sediment traps			L	M	M
Gross pollutant traps	Sub-catchment		L	L	L
Constructed wetlands		M*	M*	H	H
Biofiltration basins		M*	M*	H	H
Stormwater harvesting basins		M*	M*	H	H

(L) Potential low influence on reducing development flows, (M) Potential moderate influence, (H) Potential high influence

* Magnitude of the influence will depend on the extended detention volume