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Bellvista II Development: Water Quality and Water Cycle Management Plan

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Bellvista II Development: Water Quality and Water Cycle Management Plan

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Title :	Bellvista II Development: Water Quality and Water Cycle Management Plan
Author :	Brad Dalrymple
Synopsis :	This report documents the stormwater quality and water cycle management strategy the proposed 'Bellvista II' development in Caloundra.

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SUMMARY

Stockland proposes to develop a 65.7 hectare area of land within Caloundra. The proposed development consists of mixed use residential, residential and open space areas.

This report provides a detailed conceptual water quality and water cycle management strategy for the proposed development. The plan explains how the development will satisfy targets related to stormwater quality and water cycle management.

Water Quality Management

Water quality objectives have been derived from Healthy Waterways (2006), Queensland Government (2009) and DERM (2010) in terms of annual stormwater discharge loads. These objectives require an 80, 60, 45 and 90% removal of total suspended solids, nitrogen, phosphorus and gross pollutants respectively. Total pollutant load results were subsequently predicted with the use of the MUSIC modelling software to provide a representation of how the site will perform under different development and stormwater management scenarios.

A stormwater 'treatment train' consisting of education, rainwater tanks and streetscape bioretention systems has been developed for the site of the proposed development.

The modelling results show that with the integration of Water Sensitive Urban Design principles and Stormwater Quality Best Management Practices, the pollutant export loads from the site can be significantly reduced compared to the unmitigated scenario. The proposed Stormwater Management Measures (SMMs) will achieve the water quality objective for total suspended solids, total nitrogen, total phosphorous and gross pollutants.

The load removal rates for the proposed development areas are 81%, 70%, 48% and 99% for total suspended solids, total phosphorus, total nitrogen and gross pollutants respectively.

Water Cycle Management

Every allotment within the development will be required to install a rainwater tank (to collect roof runoff to supplement non-potable water demands) in accordance with MP4.2 of the Queensland Development Code (eg. detached residential dwellings will be required to install a tank of at least 5000 litres). Every allotment will also be required to install dual flush toilets, AAA-rated shower roses and water-pressure limiting devices. Although no detailed water cycle modelling has been undertaken, these water cycle management initiatives are highly likely to achieve Council's target of a 20% reduction of potable water demand and wastewater production.

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1 INTRODUCTION

1.1 Background & Project Description

Stockland proposes to develop a 65.7 hectare area of land within Caloundra. The proposed development consists of a mixed use residential, residential and open space areas. The layout of the proposed development is provided in

Figure 1-1.

1.2 Site Details

1.2.1 Site Location

The site is located to the south west of the Caloundra town centre and immediately to the south of the existing residential development referred to as 'Bellvista 1'. The Caloundra Aerodrome bounds the proposed development site along its eastern boundary and Lamerough Creek is located approximately 1.2 km downstream of the site to the south east.

The location of the subject site is illustrated in Figure 1-2.

1.2.2 Site Description

The site extends across an area of approximately 65.7 hectares. The existing land use is predominantly agricultural, consisting primarily of pine plantations and cleared land. Surrounding land uses include park land, residential development and additional former pine plantations.

1.2.3 Site Topography and Drainage

The existing topography of the site varies from predominantly flat to slightly sloping. The highest elevation is approximately 8m AHD at the north-eastern corner of the site, whilst the lowest point is approximately 2m AHD at the downstream (southern) low-lying area of the site.

Three channelised drains traverse the site, which convey flow from the north to the south towards Lamerough Creek. The proposed site topography will vary significantly from the existing case.

Final site surface levels and falls are expected to be selected to assist stormwater drainage towards stormwater management and flooding control measures integrated into the final site layout.

The existing topography of the site is illustrated in Figure 1-3.

1.3 Report Scope

This report provides a holistic approach to stormwater and water cycle management for the proposed urban residential development during and after construction. The main elements of the report are:

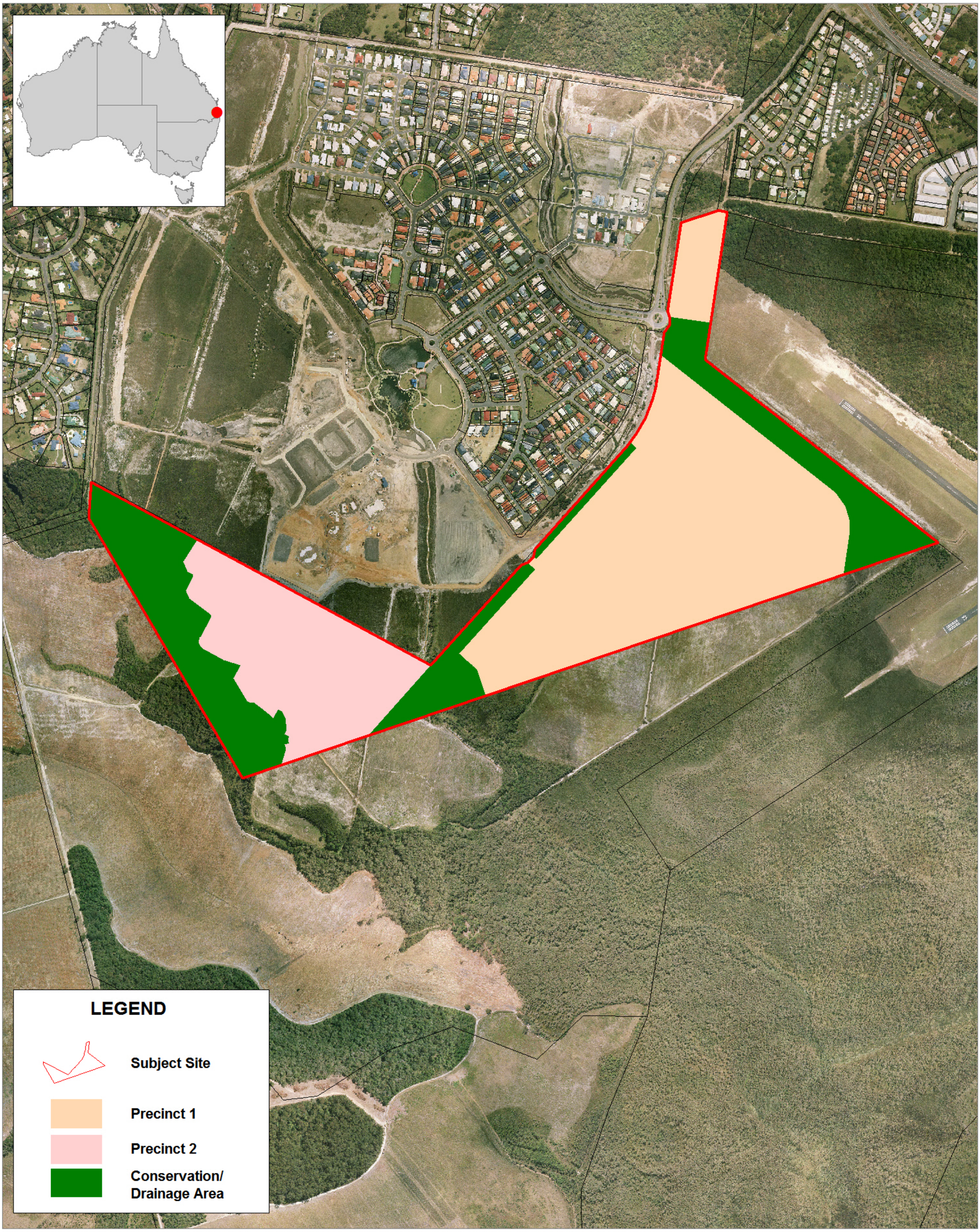
- ***Water Quality Management Plan (Section 2 of this report):*** This section is an assessment and plan relating to the runoff from the urban development and how it will meet the operational phase pollutant load reduction targets. This assessment has been carried out in accordance with Maroochy Shire Council's (2006) IWMP Guidelines and Section 7 of Planning Scheme Policy (PSP) 5.
- ***Water Cycle Management Plan (Section 3 of this report):*** This section is an assessment of the water requirements of the urban development and addresses the ways in which the SCRC's water management targets will be met. This assessment has been carried out in accordance with Maroochy Shire Council's IWMP Guidelines and Section 7 of PSP 5.

A separate Flood Impact Assessment report for this project has also been prepared by BMT WBM.

1.4 Project Team

The study team assembled for the preparation of this Water Quality Management and Water Cycle Management Plan include:

- Senior Water Quality Engineer – Brad Dalrymple, Environmental Engineer (BMT WBM);
- Water Quality Engineer – Andy Huang, Civil Engineer (BMT WBM); and
- GIS and Mapping – Bruce Harris, GIS Manager (BMT WBM).



Title:

Proposed Development Layout

Figure: **1-1**

Rev: **A**

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Approx. Scale

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Title:
Location of Subject Site

Figure: 1-2

Rev: A

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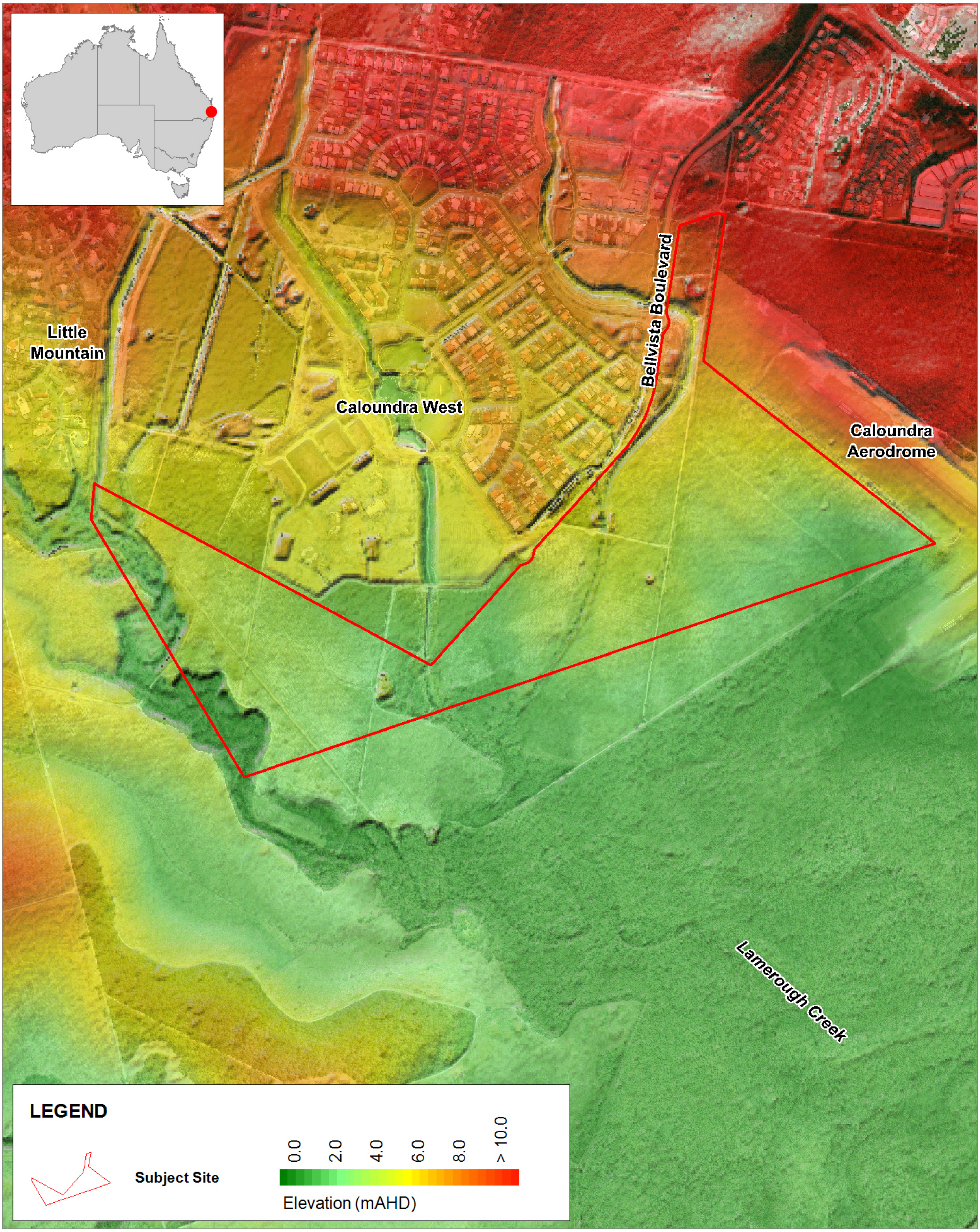

Title:
Topographic Map of Subject Site

Figure: **1-3**

Rev: **A**

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2 WATER QUALITY MANAGEMENT PLAN

This section provides a conceptual stormwater quality assessment of the proposed development. This water quality management plan has been prepared at a conceptual level of detail so as to determine size, configuration and performance of the proposed water quality management strategy. The plan explains how predicted stormwater pollutant loads from the developed site will compare to the given water quality objectives.

2.1 Opportunities & Constraints for Water Quality Management

2.1.1 Site Opportunities

There are a number of opportunities presented by the site for the application of stormwater quality and quantity controls, as described below:

- **Layout –** The proposed site layout offers areas where Stormwater Management Measures (SMMs) could be incorporated, without detracting from the usability of the site.
- **Roof Areas –** Runoff from roof areas of buildings within the proposed development could be collected and used to supplement mains water demand and reduce the volume of runoff discharged from the site.
- **Water Demand –** The site will require a large amount of water for several non-potable household usages (eg. irrigation, toilet flushing). Harvesting stormwater runoff (eg. from roof areas) within the urban development could satisfy a significant portion of these demands. This will reduce the demand from the mains supply and also reduce wastewater generation.
- **Topography –** The vast majority of the site will have relatively flat topography, which is suited for SMMs such as wetlands and bio-retention systems.
- **Education –** The nature of the project makes it an ideal candidate for implementation of a targeted information and educational program including such practices as interpretive signage and information handouts for visitors to the site in relation to stormwater quality management. This can have a significant effect on reducing pollutant loads in stormwater (eg, litter, nutrients).

2.1.2 Site Constraints

The major constraints identified for the site with respect to the application of stormwater quality controls are as follows:

- **External Catchments –** Stormwater flows from a large catchment (to the north) through the subject site. Given the high flow-rates being conveyed through these areas in extreme flood events (see Flood Impact Assessment report), any SMMs incorporated into these drainage areas may be subject to flows that may decrease treatment performance (e.g. cause re-suspension, vegetation damage, erosion) if not appropriately designed (e.g. with adequate flow diversion, elevating/ bunding SMMs).

2.2 Pollutants of Concern

2.2.1 Construction Phase

Table 2-1 lists typical pollutants that are generated during the construction phase of a development (Gold Coast City Council, 2002a).

Table 2-1 Typical Pollutants Generated During the Construction Phase

Pollutant	Source	Priority
Litter	Paper, construction packaging, food packaging, cement bags, off-cuts	High
Sediment	Unprotected exposed soils and stockpiles during earthworks and building works	High
Hydrocarbons	Fuel and oil spills, leaks from construction equipment	High
Toxic materials	Cement slurry, asphalt prime, solvents, cleaning agents, wash waters (eg. from tile works)	Medium
Acid or Alkaline substances or producing substances	Acid sulfate soils, cement slurry and wash waters	High

2.2.2 Operational Phase

Pollutants typically generated by low and high-density residential development types are listed in Table 2-2 (Gold Coast City Council, 2002a). Highlighted cells in Table 2-2 represent the key pollutants to be targeted for treatment.

Table 2-2 Typical Pollutants Generated During the Operational Phase

Pollutant	Low Density Residential	High Density Residential
Litter	Yes	Yes
Sediment	Yes	Yes
Oxygen Demanding Substances	Yes	Yes
Nutrients (N&P)	Yes	Yes
Pathogens	Yes	No
Hydrocarbons	No	Yes
Heavy Metals	Yes	Yes
Surfactants	Yes	Yes
Organochlorines and Organophosphates	No	No
Thermal Pollution	No	No
pH altering substances	No	No

2.3 Water Quality Objectives

2.3.1 Construction Phase

Performance criteria for the construction phase of the development have been taken directly from DERM's (2009) "*Draft Urban Stormwater – Queensland Best Practice Environmental Management Guidelines 2009*". These criteria are given in Table 2-3.

Table 2-3 Construction Phase Performance Criteria

Pollutant/ Issue	Stormwater Design Objective
Coarse sediment	Retain coarse sediment on site
Fine sediment (Total Suspended Solids)	Take all reasonable and practicable measures to collect all run-off from disturbed areas and drain to a sediment basin — up to the design storm event. Site discharge during sediment basin dewatering complies with a TSS concentration less than 50 mg/L up to the design event — flocculation as required. In storms greater than the design event take all other reasonable and practicable measures to minimise erosion and sediment export.
Turbidity	Released waters from the approved discharge point(s) have turbidity (NTU) less than 10% above receiving waters turbidity—measured immediately upstream of the site.
Nutrients (N and P)	Manage through sediment control
pH	Prevent litter/waste entering the site or the stormwater system or internal watercourses that discharge from the site—minimise on-site production, contain on-site and regularly clear bins.
Litter or other waste	As recommended by Acid Sulphate Soil Management Plan.
Hydrocarbons and other contaminants	Prevent from entering the stormwater system or internal watercourses that discharge from the site—control storage, limit application and contain contaminants at source. Waste containing contaminants must be disposed of at authorised facilities.
Wash down water	Prevent from entering the stormwater system or internal watercourses that discharge from the site.
Cations and anions	As required under an approved Acid Sulfate Soil Management Plan, including aluminium, iron and sulfate.
Stormwater drainage/ flow management	Take all reasonable and practicable measures to minimise changes to the natural waterway hydraulics and hydrology from: • peak flow for the 1–year and 100–year ARI event (respectively for aquatic habitat and flood protection) • run-off frequency and volumes entering receiving waters • uncontrolled release of contaminated stormwater.

For more information, see DERM (2009)

2.3.2 Operational Phase

Performance criteria for the operational phase of the development have been taken directly from Healthy Waterways (2006), Queensland Government (2009) and DERM (2010). These criteria are given in Table 2-4 below.

Table 2-4 Operational Phase Performance Criteria

Pollutant	Criteria
Total Suspended Solids	85% reduction
Total Nitrogen	45% reduction
Total Phosphorus	60% reduction
Gross Pollutants (5 mm or larger)	90% reduction

The Environment Protection Agency (EPA, 2007) also provides concentration-based WQOs for Lamerough Creek (downstream of the site). However, we believe that these are not applicable for stormwater discharges from the developed areas of the site as they do not discharge directly to any waterway. The developed areas within the site would discharge (via stormwater treatment devices) into the vegetated channels within and adjacent to the site, which would subsequently discharge into low-lying wetland areas prior to discharging into Lamerough Creek. The EPA (2007) WQOs for Lamerough Creek are given in Table 2-5. The applicability of these WQOs is discussed further in 'Box 1'.

2.3.3 EPA WQOs for Pumicestone Passage

The Environmental Protection Agency (EPA, 2010) also provides WQOs for the high ecological value marine/ estuarine waters of Pumicestone Passage, which are given in Table 2-6. A discuss in relation to how the proposed development and stormwater management strategy comply with the EPA (2009) water quality objectives is given in Section 2.10.

Table 2-5 EPA (2007) Water Quality Objectives for Lamerough Creek

Parameter	Water Quality Objective
PHYSICAL-CHEMICAL INDICATORS	
Temperature	18.9 to 23.2°C
pH	7.26 to 8.37
Dissolved Oxygen*	82 to 102% saturation
Turbidity*	6.0 to 18 NTU
Secchi Depth*	
Suspended Solids*	1.0 to 6.0 mg/L
NUTRIENTS	
Organic Nitrogen*	<500 μg/L
Ammonia*	<10 μg/L
Oxidised Nitrogen*	<130 μg/L
Total Nitrogen*	<500 μg/L
Dissolved Reactive Phosphorus*	<34 μg/L
Total Phosphorus*	<69 μg/L
BIOLOGICAL INDICATORS	
Chlorophyll-a*	<9 μg/L
Microbiological	Faecal coliforms (median) <150 cfu/100mL or Enterococci (median) <35 cfu/ 100mL
Nuisance organisms	No excessive macrophyte growth
VISUAL INDICATORS	
Colour	<10 points change on Munsell scale
Surface films	Oils and petrochemicals not visible or detectable by odour

*: For these parameters, compliance shall be determined by comparing the median value of monthly samples over a running 6-month period.

BOX 1: Discussion: WQOs – Load Removal Targets & EPA (2007) Concentration WQOs for Lamerough Creek

The load-based pollutant removal targets (80% TSS, 60% TP, 45% TN and 90% GPs) have been applied to the proposed development for a number of reasons:

- These targets are considered ‘best practice’ and require a ‘treatment train’ of stormwater quality best management practices (SQBMPs) to achieve them.
- We have applied these load-based targets in all other stormwater management strategies for new developments we have recently completed within the Sunshine Coast.
- We have applied these load-based targets for previous and current ‘Detailed MUSIC Modelling’ projects undertaken for Sunshine Coast Regional Council.

Stormwater from the areas proposed for development within the site will discharge to the vegetated channels, which will be heavily vegetated conservation areas used for the conveyance of stormwater flows from external catchments. Therefore, we believe that the EPA (2007) WQOs for the Lamerough Creek are not applicable.

The aforementioned concentration-based objectives would be impossible to achieve for discharges from SQBMPs without either:

- Not using a flow-based sub-sample to assess pollutant concentrations (ie. including zero flows and associated zero pollutant concentrations), which is erroneous; or
- Utilising bioretention systems with significantly finer filter media (eg. sandy clay) with subsequently extended drainage times. Although this would lead to a ‘finer’ degree of treatment to some flows, the use of finer filter media would have a higher risk of the bioretention system ‘failing’ (eg. vegetation die-off due to hydrologic stress, accumulated sediment blocking surface of filter media) due to the significantly longer times required for the bioretention to drain.

It should be noted that water quality objectives are surrogate objectives aimed at trying to get the hydrology (particularly for small, frequent rainfall events) of a developed catchment to mimic that of a ‘natural’ or undeveloped catchment. This was discussed in the WSUD training course BMT WBM previously presented to Sunshine Coast Council staff and is also discussed at the similar training courses BMT WBM provide as part of ‘Healthy Waterways’ and eWater training. The load-based pollutant removal targets are far more beneficial to protecting the health of waterways (by trying to retain and/ or treat, in particular, low flows and subsequently attempting to mimic the catchment’s natural hydrology) than concentration-based water quality objectives.

Therefore, we believe the load-based pollutant removal targets are far more appropriate to the site than the aforementioned concentration-based objectives.

Table 2-6 EPA (2010) Water Quality Objectives for Pumicestone Passage North

Water Quality Objective
Maintain existing water quality (20th, 50th and 80th percentiles), habitat, biota, flow and riparian areas. (Refer to Appendix D in Queensland Water Quality Guidelines for details.) The 20th, 50th and 80th percentiles of existing water quality for PLE1 waters are: • turbidity: 2 – 4 – 6 NTU • suspended solids: 6 – 12 – 16 mg/L • chlorophyll a: 1.0 – 1.6 – 2.5 µg/L • total nitrogen: 150 – 190 – 220 µg/L • oxidised N: 2 – 2 – 3 µg/L • ammonia N: 2 – 4 – 6 µg/L • organic N: 150 – 180 – 210 µg/L • total phosphorus: 15 – 18– 25 µg/L • filterable reactive phosphorus (FRP): 4 — 5 – 7 µg/L • dissolved oxygen: 90 – 95 – 105% saturation • pH: 8.0 – 8.2 – 8.3 • secchi depth: 1.4 – 1.8 – 2.5m Maintain the existing seagrass depth limit for Zostera muelleri of 0.8m AHD (50th percentile)

As outlined in Table 2-6, existing water quality within Pumicestone Passage must be maintained (ie. ‘no change’).

2.4 Modelling Approach

2.4.1 Methodology

The performance of possible stormwater treatment strategies in managing stormwater pollutants (during the operational phase) has been assessed using the MUSIC software package (Version 3.01) developed by the CRC for Catchment Hydrology and now supported by the eWater CRC. MUSIC is well suited to the assessments required for the proposed development, i.e. prediction of annual discharge loads of total nitrogen (TN), total phosphorus (TP) and total suspended solids (TSS). The software has been specifically designed to allow comparisons to be made between different stormwater management systems and thereby function as a decision support tool.

The site was separated into two sub-catchments with the extents (or boundaries) of the sub-catchments being identical to the extents of Precincts 1 and 2 of the proposed development (see

Figure 1-1). Source nodes and treatment nodes were specified within each sub-catchment and land use categories were selected to represent as accurately as possible how each sub-catchment will generate and treat stormwater.

Stormwater management systems are simulated in MUSIC by the construction of treatment trains comprising various sources, treatment and receiving nodes. A brief overview of the nodes that have been used in the model can be found in the sections below.

2.4.1.1 Source Nodes

Within MUSIC, the user is required to specify source nodes. The source nodes represent the pollutant generating areas of the site.

MUSIC has generic source nodes, which represent different land-uses. The default parameters for soil properties and storm and base flow pollutant concentrations differ for each land use. The option exists within MUSIC for the user to alter the default parameters as required to best represent the land use being modelled, particularly when the land-use which requires modelling does not correspond with the urban, forest or agricultural defaults supplied in MUSIC.

Source nodes were specified within each sub-catchment to represent as far as practicable how each sub-catchment will generate stormwater. To allow for an accurate pollutant generation and hydrologic assessment of the site, each sub-catchment was assigned source nodes representing the various sized areas.

In the absence of MUSIC Modelling Guidelines specific for the Sunshine Coast Regional Council, Water By Design's (2010b) "*MUSIC Modelling Guidelines*" have been applied in the development of the MUSIC models.

As outlined previously, two sub-catchments within the site were identified for modelling purposes. As recommended by Water By Design (2010b), the proposed development areas were discretised into roof, road reserve and other impervious (ground level) areas.

The MUSIC modelling has applied approximate land usage proportions for the proposed developed areas based on information, and the land usage proportions of similar Stocklands residential developments. The assumed land usage proportions are summarised in Table 2-7.

Table 2-7 Assumed Land Usage Proportions for Proposed Developed Areas

Land Use	Units	Proposed Precinct	
		1	2
Total Developed Area	ha	33.87	13.46
Road Reserve Area	ha	9.97	4.82
Lot Area	ha	21.54	7.82
No. of Lots	-	533	190
Average Roof Area	% of total lot area	50%	
Active Open Space Area	ha	2.36	0.82

Approximately 50% of the roof area in each lot was assumed to drain to a rainwater tank, whilst the remaining 50% was assumed to discharge directly to the stormwater drainage system.

An effective impervious percentage of 100%, 70%, 30% and 5% were assumed for roof, road reserve, other lot area at ground level, and internal parks, respectively. Conservation/ drainage areas, undeveloped areas and the pre-developed site were assumed an effective imperviousness of 0%.

For this assessment, the existing land use has been assumed to consist of 'Agriculture' and 'Forest' land usages (60.2ha and 5.5ha respectively).

For the model assessments looking at the entire developed site, the 'Forest' classification has been used to represent the existing vegetated area within the site that is to be retained and the proposed vegetated drainage corridors.

The 'Urban Residential' classification was assumed for the proposed development areas.

Storm and baseflow pollutant characteristics and rainfall and runoff parameters used to describe the existing and proposed site were taken directly from Water By Design (2010b).

2.4.1.2 Treatment Nodes

MUSIC requires the user to specify stormwater treatment nodes. These nodes essentially represent the stormwater treatment train.

MUSIC has a number of generic treatment nodes including gross pollutant traps, ponds, wetlands, swales, bio-retention systems, sedimentation ponds and buffer strips. Each treatment node has several default parameters that can be altered by the user to allow the treatment device to be 'customised' to better represent the treatment device that would ultimately be installed on site.

A treatment train consisting of education, rainwater harvesting tanks and streetscape bioretention has been proposed for the site of the proposed development. The treatment train is illustrated in Figure 2-1. Details of the types of treatment devices proposed for use on the site and how they will be configured are presented in the following sections.

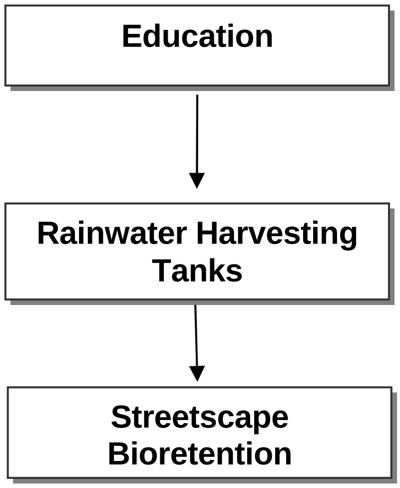

Figure 2-1 Stormwater Treatment Train for the Site

<u>Education</u>

Education has significant potential to decrease pollutant loads at the source and increase peoples' understanding and acceptance of water quality issues and stormwater treatment devices. It is proposed that signage be installed at appropriate locations (eg. adjacent to proposed bioretention systems).

An example of educational signage to improve understanding of water quality issues is given in Figure 2-2. While the potential for pollutant load reduction due to education is noted, it has not been assumed within the MUSIC model.

Figure 2-2 Examples of Signage to Improve Understanding of Water Quality Issues

Rainwater Tanks

Every allotment within the development will be required to install a rainwater tank (to collect roof runoff to supplement non-potable water demands) in accordance with MP 4.2 of the Queensland Development Code (eg. detached residential dwellings will be required to install a tank of at least 5000 litres).

For the purposes of the MUSIC modelling, it has been assumed that all residential lots are detached dwellings[1]. These rainwater tanks have been represented in the MUSIC model as a single 'Rainwater Tank' in each of the residential catchments, assuming that each tank (for each detached residential dwelling) will be approximately 1.8m in diameter with a permanent detention depth of 0.2m. Non-potable water demands from the rainwater tanks have been derived from Water By Design (2010b).

The use of rainwater tanks to supplement potable water demands will significantly reduce peak and volumetric stormwater discharges from the site and substantially reduce mains water demand.

Bioretention

A bioretention system is a soil and plant-based SMM. A typical system consists of a porous medium such as gravel, sand or sandy loam. Vegetation may also be established to promote evapotranspiration, maintain soil porosity, encourage biological activity, and promote uptake of some pollutants. Run-off is directed into the bioretention system and infiltrates through the plant/mulch/soil environment.

As illustrated in Figure 2-3 a number of configurations are available for streetscape bioretention systems. It is proposed that streetscape bioretention systems (bioretention 'pods' or 'rain gardens') be incorporated into the road reserve within the development and have a similar layout to those shown in Figure 2-4. The design of these bioretention 'pods' will be similar to those currently being constructed and established within the Stocklands' 'Birtinya Island' development.

[1] It is understood that some dwellings within the proposed development may be attached. However, this is unlikely to have a significant impact to model results or the proposed stormwater management strategy.

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Figure 2-3 Examples of Streetscape Bioretention

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Figure 2-4 Examples of Bioretention 'Pod' Configuration Similar to that Proposed at Bellvista II

The design of the streetscape bioretention 'pods' at Birtinya Island was undertaken with significant involvement from SCRC staff (Troy Shultz, Brown Consulting, 2009: *Pers.Comm.*). Examples of the detailed design drawings for the bioretention 'pods' at Birtinya Island are included in Appendix C.

All streetscape bioretention has been assumed to have the properties as given in Table 2-8, and have been modelled using Water By Design's (2010) "Interim Bioretention Node".

Table 2-8 Assumed Properties for Bioretention Systems

Parameter	Value
Extended Detention Depth	0.20 m
Saturated Hydraulic Conductivity	200 mm/hr
Median Particle Diameter	0.45mm
Filter Depth	0.60 m
Overflow weir width	Surface area divided by ten (*approximation for modelling purposes only*)

An indicative cross section of the proposed bioretention system design for Bellvista II is shown in Figure 2-5.

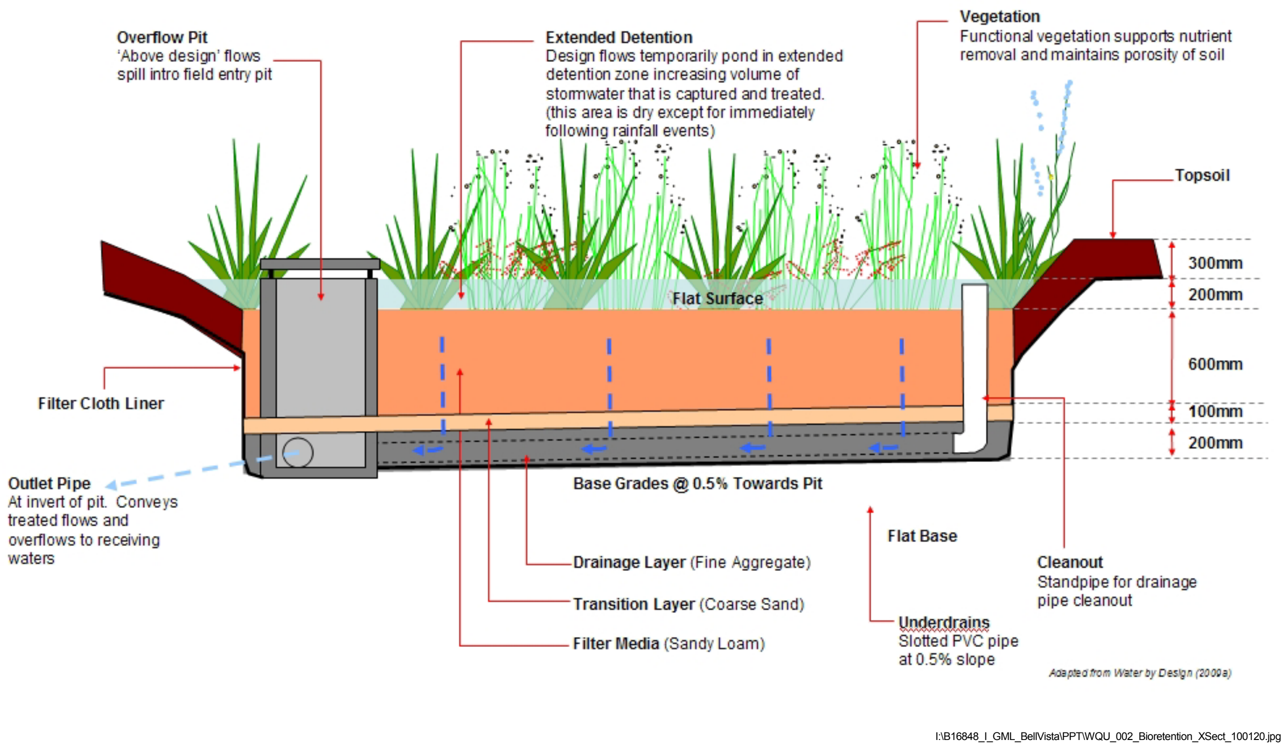

Figure 2-5 Indicative Cross Section of Proposed Bioretention System Design

Appendix D provides a design checklist and calculation summary of an indicative streetscape bioretention system within the proposed development.

For the purposes of this Integrated Water Management Plan, we have provided an estimate of the approximate bioretention filter area (and, of less importance in terms of overall treatment effectiveness, bioretention surface area) required for streetscape bioretention systems within each of the two 'areas' of the proposed development. The configuration, size and number of the individual bioretention systems required to satisfy the given WQOs will be determined during subsequent design stages.

2.4.2 Receiving Node

One node is used to represent the final destination of runoff from the site, which would ultimately discharge to Lamerough Creek.

2.4.3 Meteorological Data

In accordance with Water By Design (2010b), MUSIC modelling was undertaken using meteorological for Caloundra WTP (BOM Station 40496) for a period of ten years (from 1 January 1997 to 31 December 2006) at 6-minute time steps. Average potential evapo-transpiration data has been obtained from Water By Design (2010b).

2.5 Selection of Stormwater Management Options

2.5.1 Construction Phase

The pollutants of concern during the construction phase are not readily modelled due to the site-specific nature of typical construction pollutant sources. Pollutant export would be largely dependent on site management practices and would vary throughout the construction phase depending on the particular activities being undertaken. A Best Management Practice (BMP) approach will be adopted to selecting management options for the construction phase.

During the construction phase of the development, an Erosion and Sediment Control Program (E&SCP) will be implemented to minimise water quality impacts. A detailed E&SCP will be included in the application for Development Permit for Operational Works and be consistent with the requirements of SCRC as specified in their '*Engineering Design Guidelines – Soil & Water Quality Management – D7, Policy No. 15.07'* (MCC, 2006).

The following information is provided to identify the controls and procedures that would be incorporated into the detailed E&SCP. These measures are considered sufficient to ensure the guidelines will be met given the site characteristics and the details of the proposed development.

2.5.1.1 Sedimentation Basin Requirements

Sedimentation basins are usually required where:

- The disturbed area is greater than 1 hectare;
- The disturbed soils are dispersive; and/or
- There is specific need to control runoff turbidity.

Since the proposed development is over 1 hectare in area, sedimentation basins will be required during construction.

2.5.1.2 Pre-Construction Requirements

Before construction activities begin, the following measures need to be implemented to ensure minimal disturbance and no adverse water quality impacts. These measures may be adopted in a staged approach and may be implemented prior to construction beginning in one section of the proposal.

- Designating and delineating, where possible, buffer strips (approximately 10 m wide) adjacent to roadways. These buffer strips will remain vegetated and will filter sediment from construction site runoff and encourage sheet flow from the site. No construction activities will occur within these buffer zones.
- Constructing sediment fences on the upstream edges of the designated buffer areas and at the base of fill embankments.
- Designating areas for machinery and construction material storage (if required). These areas should be somewhat removed from drainage paths and runoff from these areas should be directed to a holding pond in case of spillages.

- Catch drains at the downstream boundary of construction activities should also be created (wherever possible) to ensure any sediment-laden runoff is contained and directed toward treatment areas and not permitted to flow onto downstream, undisturbed areas or off-site. Diversion banks should be constructed approximately along contours to minimise scour along the drains.
- Silt fences and sand bags can be placed along catch drains to slow flow, reduce scour and capture some sediment from runoff.
- Designation and marking of transport routes (including stabilised entry/exit points) across undisturbed portions of the site to ensure minimal unnecessary vegetation disturbance and to minimise sediment tracked onto roads.
- Education of site personnel in regard to the sediment and erosion control measures implemented on site.

2.5.1.3 During Construction Requirements

Prior to construction, detailed designs for the proposal will have been completed. Runoff should be directed through water quality controls before discharging off-site. Measures to mitigate water quality impacts during construction will include:

- ***Revegetation:*** Wherever possible, disturbed areas should be progressively revegetated. If possible, mulching and detention of vegetation and topsoil should be undertaken for final site rehabilitation and landscaping works.
- ***Defined Construction Areas***: Construction activities are to be restricted to defined necessary construction area(s).
- ***Silt Fences***: Silt fences will need to be installed downstream of disturbed areas. Silt fences should be located continuously along contours and should treat areas less than 0.6 ha per 100m of silt fence. A maximum upstream slope length of 60m will also ensure optimal performance.
- ***Inspection***: Regular inspection and maintenance of silt fences, sedimentation basins and other erosion control measures. Following rainfall events greater than 20mm, inspection of erosion control measures and removal of collected material should be undertaken. Replacement of any damaged equipment should be performed immediately.
- ***Fuel/ Oil Storage:*** The storage of petroleum products on site will be restricted to designated areas. Any inadvertent releases of fuel or oil from machinery are to be treated and disposed of in accordance with best industry practice.

- ***Streetscape Bioretention***: The functional elements (eg. underdrain pipes, gravel surround, transition layer and filter media) of the streetscape bioretention systems can be constructed/ installed during road and lot-scale construction activities. However, they will need to be protected (eg. from excessive sediment loads, vehicle damage) by over-laying a temporary filter cloth (bidum or similar) over all the media, followed by a 25mm layer of topsoil and turf. This protection can be applied to all of the filter media or a section (with stormwater flows prevented from entering the remainder of the bioretention system by a plywood barrier or similar barrier). The detailed design drawings in Appendix C illustrate how this can be achieved and Figure 2-6 provides an example of streetscape bioretention with temporary protection (during lot-scale works). Once at least 90% of lots are completed, the turf, topsoil and filter cloth could be removed and vegetation planted throughout the bioretention systems. This has the advantages of constructing the bioretention systems as part of bulk earthworks and improving the aesthetic appearance of the bioretention basin areas during the lot-scale works. Further information in relation to the construction and establishment of bioretention systems is available in Water By Design's (2010a) "*Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands*".

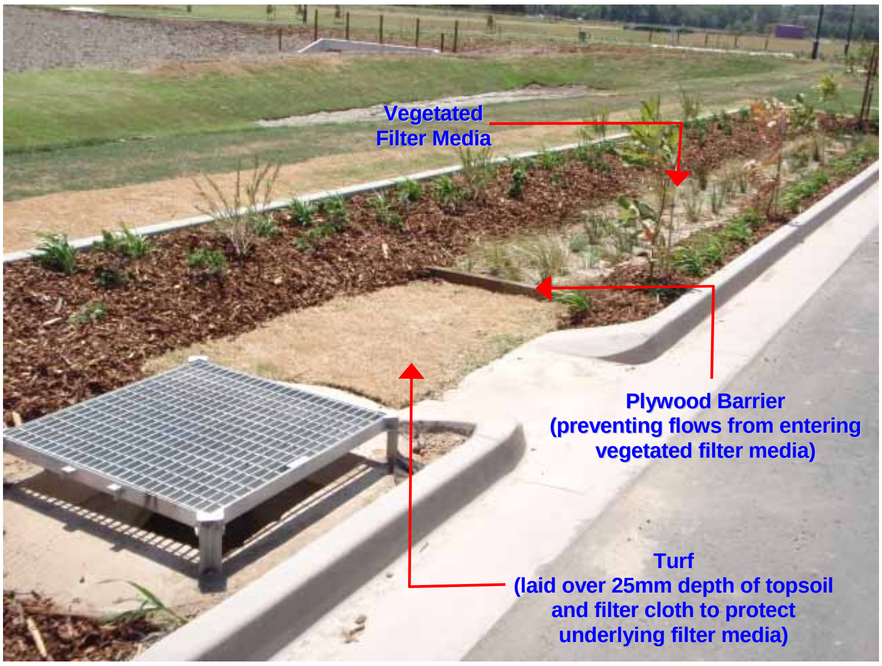

Figure 2-6 Example of Streetscape Bioretention System with Temporary Protection (During Lot-Scale Works)

2.5.1.4 Post Construction Requirements

After the completion of construction works in a section of the development, the following activities will be performed:

- ***Re-Vegetation/ Landscaping***: Re-vegetation and landscaping of remaining exposed areas using topsoil and mulched vegetation retained from initial site clearing. Vegetation should be watered and maintained until it is suitably established.

- ***Streetscape Bioretention*:** As described above, the sites of the proposed bioretention systems can be configured to act as operational stormwater treatment devices. However, it should be stressed that the bioretention systems should not have the filter cloth, topsoil and turf removed (and planted with appropriate vegetation) until at least 90% of the upstream lots are occupied.
- ***Maintenance*:** Maintenance of mitigation measures retained during the operational phases.

2.5.1.5 Monitoring

The E&SCP will specify monitoring requirements for different stages of site construction activities. The general requirement of the monitoring will be to ensure that:

- Work activities are maintained within dedicated construction areas;
- Site clearing, and cut/fill activities occur in accordance with the requirements of the E&SCP;
- E&SC structures are installed in accordance with the requirements of the E&SCP;
- E&SC structures are checked for integrity and functionality on a weekly basis, as well as after (*and/or during*) heavy rain events;
- Stormwater discharges from the site are not causing any damage to downstream waterways or water bodies; and
- Appropriate water quality levels are set on stormwater discharges from sedimentation ponds and these are maintained during the construction period.

Water quality objectives for the construction phase are described in Table 2-3.

2.5.2 Operational Phase

A wide range of Stormwater Management Mesaures (SMMs) were assessed for applicability to the site. From the available suite of SMMs, treatment trains have been proposed for the site to target each of the identified pollutants of concern. The proposed treatment train for the subject site is illustrated in Figure 2-1.

The general concept of the treatment train is to direct the majority of stormwater through rainwater tanks and/ or streetscape bioretention systems prior to discharge from the site. Water quality modelling using MUSIC was undertaken to assess the effectiveness of the treatment train and the application of the WSUD principles to the whole site.

2.5.2.1 Water Quality Modelling

<u>Model Scenarios</u>

Modelling of stormwater discharge quality was performed using MUSIC, as described in Section 2.4.1 for TN, TP, TSS and gross pollutants. Other parameters such as faecal coliform contamination of stormwater cannot be readily modelled at this time. The following three scenarios were considered as part of the modelling exercise:

1. *The Base Case - Undeveloped Site*: The base case is an assessment of the undeveloped site. (This scenario was undertaken for the entire site only).

2. *Developed Case - Unmitigated Site*: The developed case without mitigation is essentially an assessment of what would occur if the site were developed without any integration of stormwater treatment devices or pollution control measures. For consistency, the unmitigated site has been modelled using identical source node parameters as that of the scenario for modelling the developed site incorporating SMMs.
3. *Developed Case - with WSUD*: This case is an assessment of the fully developed site (excluding all passive open space areas) with all WSUD features installed and working at their "design" capacities. Treatment nodes have been incorporated into the model in the form of rainwater tanks, gross pollutant traps, and streetscape bioretention systems.

Assessments were undertaken of the following:

- *Developed Areas Only*: This included all proposed developed areas (ie. the 47.3ha area proposed for lots, road reserves and local parks), but excluded all areas proposed for stormwater conveyance and conservation. This scenario was used to assess the predicted treatment performance against the given pollutant load removal targets.
- *Entire Site*: This is the entire 65.7ha site and included areas that are proposed for development and those to be retained as vegetated drainage corridors and conservation areas (ie. remain undeveloped). This scenario was used to assess the overall impact of the proposed development (ie. development of land and proposed stormwater management) on pollutant loads discharging from the site.

The scenarios were modelled for a ten-year period from 1997 to 2006 at six-minute time-steps.

<u>Model Results</u>

Total annual flow and pollutant loads from the site for each scenario are presented in the tables below. These values represent the flow and loads that are predicted to discharge from the site.

Table 2-9 Predicted Annual Pollutant Loads (1997-2006) – Developed Areas Only

Parameter	Unmitigated Development	Developed Site With Treatment	% Removal	% Removal Target*
Flow (ML/yr)	437	373	15%	-
TSS (kg/yr)	81 300	15 200	81%	80%
TP (kg/yr)	162	52.5	68%	60%
TN (kg/yr)	907	485	47%	45%
Gross Pollutants (kg/yr)	10 360	94.1	99%	90%

*: See Table 2-4

Table 2-10 Predicted Annual Pollutant Loads (1997-2006) for Each Area – Developed Areas Only

Parameter	Area A	Area B	*Total*
SOURCES			
Flow (ML/yr)	312	125	***437***
TSS (kg/yr)	56 700	24 600	***81 300***
TP (kg/yr)	114	48	***162***
TN (kg/yr)	648	259	***907***
Gross Pollutants (kg/yr)	7 380	2 980	***10 360***
RESIDUAL			
Flow (ML/yr)	265	108	***373***
TSS (kg/yr)	10 800	4 400	***15 200***
TP (kg/yr)	37.2	15.3	***52.5***
TN (kg/yr)	345	140	***485***
Gross Pollutants (kg/yr)	69.8	24.3	***94.1***
% REMOVED			
Flow	15%	14%	***15%***
TSS	81%	82%	***81%***
TP	67%	68%	***68%***
TN	47%	46%	***47%***
Gross Pollutants	99%	99%	***99%***

Table 2-11 Predicted Annual Pollutant Loads (1997-2006) – Entire Site

Parameter	Base Case	Unmitigated Development	Developed Site With Treatment	% Decrease from Base Case
Flow (ML/yr)	291	507	443	-52%
TSS (kg/yr)	81 200	84 430	18 330	77%
TP (kg/yr)	87	166	56.3	35%
TN (kg/yr)	536	951	529	1%
Gross Pollutants (kg/yr)	0	10 360	94	-

As shown in the results given in Table 2-9, the proposed SMMs will achieve the operational phase load-based WQOs (given in Table 2-4) for total suspended solids, total phosphorus, total nitrogen and gross pollutants.

The model results given in Table 2-11 indicate that the proposed development (and associated SMMs) will result in a decrease in total suspended solids, phosphorus and nitrogen loads in comparison to the existing 'base case' conditions. It should also be noted that the proposed stormwater management strategy does not include the potential treatment that would be provided by the vegetated drainage corridors or low-lying conservation areas to which some of the bioretention systems would discharge.

The EPA (2007) concentration-based WQOs for total phosphorus and total nitrogen will not be achieved for stormwater discharges from the bioretention systems. However, these WQOs are very difficult to achieve (using currently available SMMs) and it is understood that stormwater discharges from the bioretention systems are not required to meet these objectives.

Based on the assumed water demand (see Section 2.4.1.2), the modelled rainwater tanks are able to satisfy approximately 38% of these water demands.

<u>Model Conclusions</u>

From the conceptual modelling results of the MUSIC model, it can be concluded for the site of the proposed development that with the integration of SMMs, pollutant export loads from the site can be significantly reduced when compared to the unmitigated scenario. The load removal targets (see Table 2-4) for total suspended solids, phosphorus, nitrogen and gross pollutants will be achieved with the proposed treatment train.

Further simulations at a more detailed level of design may be required to verify the model outcomes or if the final development layout differs significantly from the conceptual layout and prevents the implementation of the proposed treatment measures.

Details of the proposed stormwater management measures, assumed for the purposes of the conceptual modelling approach, are provided in Section 2.4.1.2 of this report. Table 2-12 also provides the sizing of the SMMs.

All MUSIC modelling files and results are provided on the DVD in Appendix A.

Table 2-12 Stormwater Management Measure Properties

Precinct	Treatment Measure	Dimensions
1	Rainwater Tanks	5kL rainwater tanks proposed for all of the 533 lots within Precinct 1 as single 'Rainwater Tank' in MUSIC, using indicative dimensions of 2399m^3 volume below overflow, 0.2m depth above overflow, 1332m^2 surface area, 2078mm equivalent pipe diameter, and a total average internal daily demand of 246.5kL, and annual irrigation demand of 30990kL.
2	Rainwater Tanks	5kL rainwater tanks proposed for all of the 190 lots within Precinct 2 as single 'Rainwater Tank' in MUSIC, using indicative dimensions of 855m^3 volume below overflow, 0.2m depth above overflow, 475m^2 surface area, 1241mm equivalent pipe diameter, and a total average internal daily demand of 87.9kL, and annual irrigation demand of 11249kL.
1	Bioretention	Numerous individual (streetscape) bioretention systems (integrated throughout the developed areas) modelled as a single bioretention system in MUSIC. Filter area 3726m^2. (1.1% of total developed area), surface area 4471m^2, 0.2m storage depth, sandy loam media, vegetated, 0.6m filter depth, overflow weir width 447.1m.
2	Bioretention	Numerous individual (streetscape) bioretention systems (integrated throughout the developed areas) modelled as a single bioretention system in MUSIC. Filter area 1481m^2 (1.1% of total developed area), surface area 1777m^2, 0.2m storage depth, sandy loam media, vegetated, 0.6m filter depth, overflow weir width 177.7m.

2.5.2.2 Water Quality Monitoring

No site water quality monitoring is proposed within the development site during the operational phase of the development. The drainage channels within the site that will receive flows from the bioretention systems and external catchments are highly unlikely to contain any standing water in them for an extended period to sample/ monitor.

2.6 Maintenance Plans

Maintenance plans may be required for the following SMMs proposed for the development:

- Rainwater tanks; and
- Bioretention systems.

Maintenance plans would be developed for these SMMs during the detailed design phase of the development and would include the following information:

- Inspection frequency
- Maintenance frequency
- Data collection/storage requirements (eg. information collected during inspections)
- Detailed clean-out procedures (main element of the Plans). These procedures cover aspects such as:
  - Equipment needs
  - Maintenance techniques
  - Occupational health and safety
  - Public safety
  - Environmental management considerations;
  - Disposal requirements (polluted water and solid waste)
  - Access issues
  - Stakeholder notification requirements
  - Data collection requirements (if any)
- SQID design details and supplier contacts (in case modifications to the design need to be made in future).

Indicative maintenance requirements of bioretention systems are provided in Appendix E.

2.7 Life Cycle Costs

Life cycle costing information is provided in Table 2-13. and Table 2-14.

The costs provided in Table 2-13 have been prepared using MUSIC with the methodology as recommended in MSC's (2007) '*Integrated Water Management Guidelines*'. The costs provided in Table 2-14 exclude the costs associated with acquisition (or construction/ establishment) as previously requested by Council for similar projects.

Table 2-13 Life Cycle Costing Summary

Precinct	Treatment Measure	LCC ($2010)	Equivalent Annual Payment ($2010 per annum)				
			Total Cost	Per kg TSS	Per kg TP	Per kg TN	Per kg GP
1	Bioretention	499 841	9 997	0.23	146	49	1.7
2	Bioretention	298 316	5 966	0.30	200	72	2.5

Table 2-14 Life Cycle Costing Summary – Excluding Acquisition Costs

Precinct	Treatment Measure	LCC ($2009)	Equivalent Annual Payment ($2010 per annum)				
			Total Cost	Per kg TSS	Per kg TP	Per kg TN	Per kg GP
1	Bioretention	260 011	5 200	0.12	76	26	0.9
2	Bioretention	180 177	3 603	0.18	121	44	1.5

2.8 Construction & Establishment

All bioretention systems will need to be constructed and established in accordance with Water By Design's (2010a). *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands*.

2.9 Asset Hand-over

It is expected that the proposed bioretention systems (including responsibility for all ongoing maintenance requirements) will be transferred to Sunshine Coast Regional Council after the "on-maintenance" period.

2.10 EPA WQOs for Pumicestone Passage

As outlined in Section 2.3.3, existing water quality within Pumicestone Passage must be maintained in accordance with EPA (2010) (given in Table 2-6).

As described in Section 2.5.2.1 (see Table 2-11), the model results indicate that the proposed development (and associated SMMs) will result in a decrease in total suspended solids, phosphorus and nitrogen loads in comparison to the existing 'base case' conditions. Therefore, the proposed development (and associated SMMs) is expected to contribute to an improvement in water quality in Pumicestone Passage. It should, however, be noted that any improvement would be negligible given the small size of the proposed development (65.7 hectares) relative to the catchment contributing to the Pumicestone Passage and other (eg. tidal hydrodynamics) influencing water quality in Pumicestone Passage.

The proposed development (and associated SMMs) is subsequently anticipated to comply with the EPA (2009) water quality objectives.

3 WATER CYCLE MANAGEMENT PLAN

3.1 Potable Water Demand & Wastewater Reduction

3.1.1 Rainwater Tanks

As outlined in Section 2.4.1.2, every allotment within the development will be required to install a rainwater tank (to collect roof runoff to supplement non-potable water demands) in accordance with the Queensland Government's (2009) Queensland Development Codes MP 4.2 and 4.3 (eg. detached residential dwellings will be required to install a tank of at least 5000 litres).

Assuming that all residential lots are detached dwellings[2], with a 5000 litre rainwater tank on each lot and an average water demand in accordance with Water By Design (2010b), the modelled rainwater tanks are able to satisfy approximately 38% of these water demands. These results are based on the meteorological data described in Section 2.4.3 (using rainfall data for Caloundra WTP for a period of ten years from 1 January 1997 to 31 December 2006 at 6-minute time steps).

The former Maroochy Shire Council's (2006) "*Integrated Water Management Guidelines*" also states that "*A continuous water balance simulation, over at least 30 years, should be undertaken to determine the reliability of substitute water sources. The adopted modelling timestep should be no greater than one day. The estimated reliability should be greater than or equal to 50%".*

We have subsequently established a model using rainfall data for Calounda WTP for a period of over 30 years, from 4 December 1972 (when the station began operating) to 31 July 2010 (the latest valid data available from the eWater's *BOM Rainfall Data Tool*). Contrary to the advice in MSC's guideline, a daily timestep would not be suitable to assess the reliability of the rainwater tanks in MUSIC, and a 6-minute timestep has been used for the 30+ year analysis. This modelling predicts that the aforementioned rainwater tanks (with the assumed water demands as per Water By Design, 2010b) will satisfy approximately 39% of the water demands.

MSC (2006) states that "*the estimated reliability* (of substitute water sources like rainwater tanks) *should be greater than or equal to 50%*". The tanks are subsequently anticipated to provide less than this MSC (2006) target value. Nevertheless, the proposed rainwater tanks would comply with the water savings targets given in the Queensland Government's (2009) "*Queensland Development Code MP 4.2: Water Savings Targets*", which would be anticipated to supersede the former MSC's (2006) targets.

In addition to the reduced potable water demands provided by the rainwater tanks, their use will also significantly reduce peak and volumetric stormwater discharges from the site (particularly for smaller, frequent rainfall events). The influence of the proposed rainwater tanks (based on the assumptions listed above) on the quality and quantity of runoff from the site were incorporated into the MUSIC assessment. These measures were assessed as part of the treatment train of SMMs (as documented in the WQMP).

[2] It is understood that some dwellings within the proposed development may be attached. However, this is unlikely to have a significant impact to model results or the proposed stormwater management strategy.

3.1.2 Water Efficient Appliances & Products

Properties within the proposed development will need to comply with the Queensland Government's (2008) 'Sustainable Housing Code', which requires new houses to install dual flush toilets, AAA-rated shower roses and water-pressure limiting devices.

3.2 Conclusion

Although no detailed water cycle modelling has been undertaken, the installation of the rainwater tanks and the AAA-rated water efficient appliances and plumbing products is highly likely to achieve SCRC's target of a 20% reduction of potable water demand and wastewater production.

4 REFERENCES

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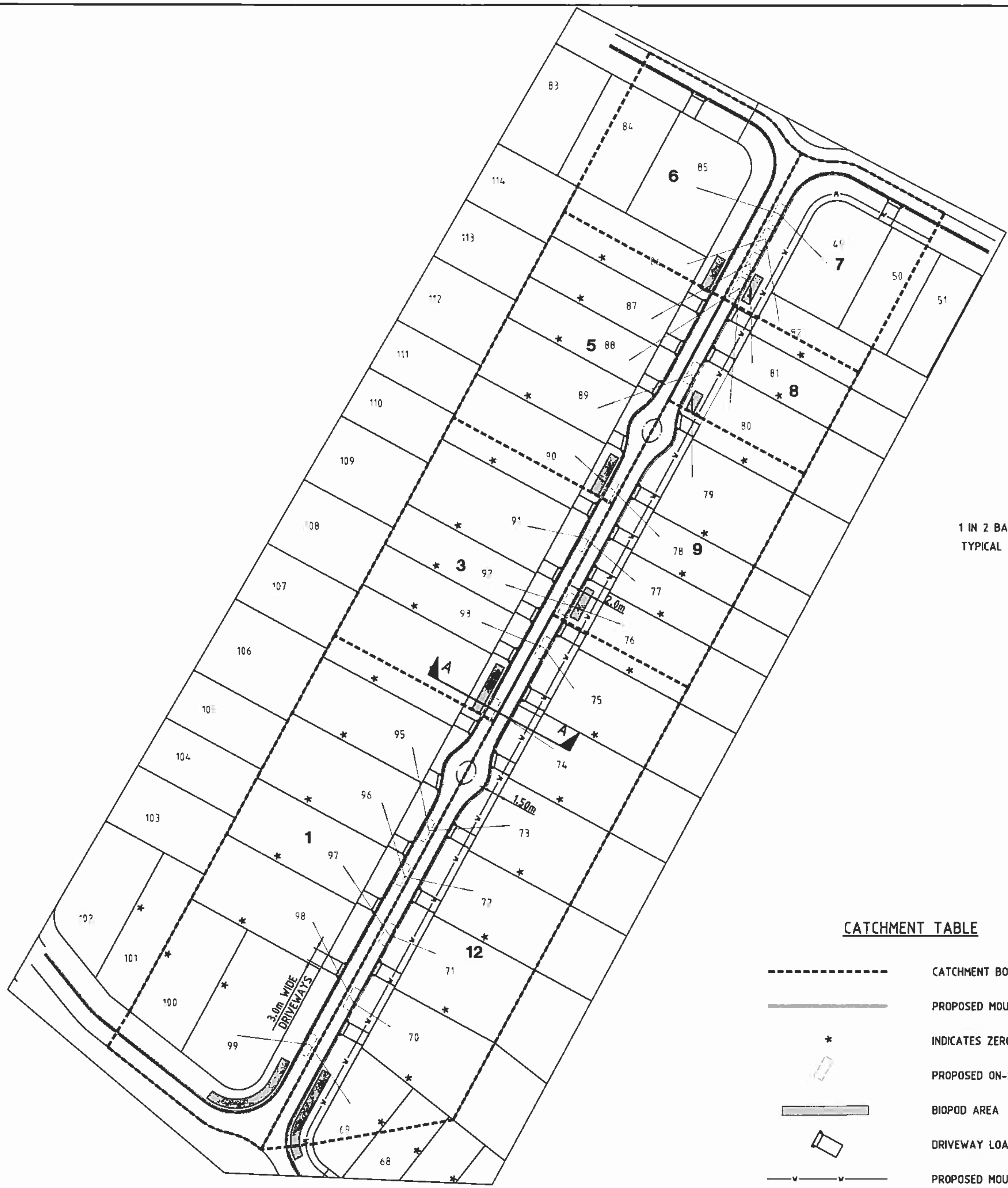
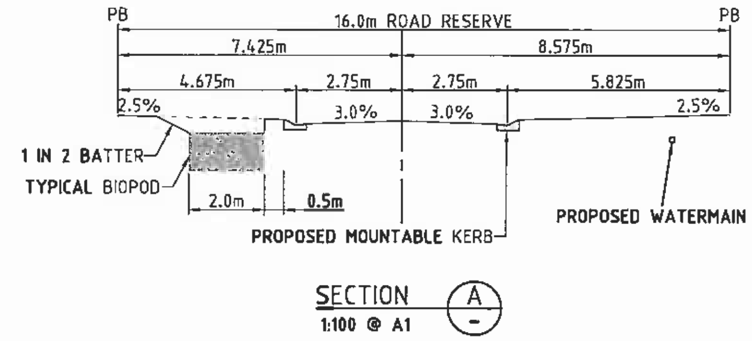
APPENDIX A: MODELLING FILES

APPENDIX B: EXAMPLE BELLVISTA II STREETSCAPE SHOWING INTEGRATION OF BIORETENTION 'PODS'

The following page provides an example drawing showing how the proposed bioretention systems will be incorporated into the streetscape, assuming that the filter area is 1.1% of the developable area.





N

CATCHMENT TABLE

CATCHMENT BOUNDARY

PROPOSED MOUNTABLE KERB AND CHANNEL

INDICATES ZERO LOT BOUNDARY

PROPOSED ON-STREET CARPARKING SPACE

BIOPOD AREA

DRIVEWAY LOACTION

PROPOSED MOUNTABLE KERB AND CHANNEL

CATCHMENT TABLE

CATCHMENT	AREA	FILTER MEDIA	%
1	4139	43.30	1.05
3	2129	22.80	1.07
5	1995	18.80	0.94
6	1522	16.00	1.05
7	1289	13.00	1.01
8	839	9.00	1.07
9	1779	15.00	0.84
12	4027	40.70	1.01
		TOTAL %	1.01

FILE: N08042-MCU14.dwg DATE: 24-06-2010 TIME: 15:19
Xref's: N08042-10 USR: Chris OSullivan

PRINT ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
	CO	CO	31.05.10	
A				
B				
C				
D				
E				
F				

DESIGN CHECK

DRAWN CHECK

SCALE (METRES)
1:500 10 5 0 10 20 A1
1:1000 A3

MICROFILM No.

PROJECT No.
N08042

SURVEYOR
CONICS (SUNSHINE COAST) PTY LTD
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BROWN

DRAWING TITLE
INDICATIVE ROAD AND PARKING DETAIL PLAN

DRAWING NUMBER
N08042-MCU14

ISSUE

APPENDIX C: EXAMPLES OF DETAILED DESIGN DRAWINGS FOR BIORETENTION 'PODS'

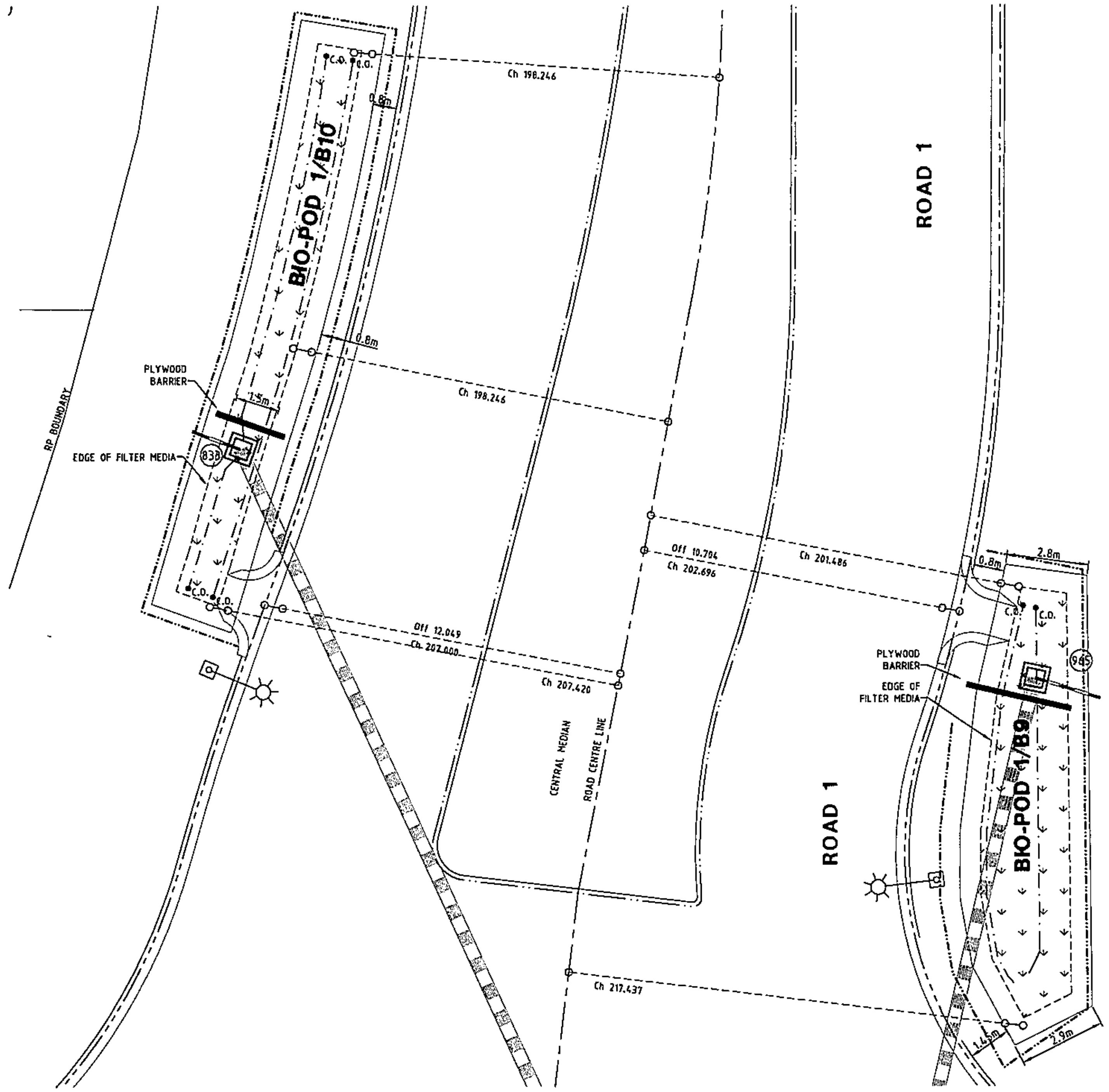
As outlined in Section 2.4.1.2, it is anticipated that the bioretention 'pods' proposed for the development will have a similar design to those currently being constructed and established within the Stocklands' 'Birtinya Island' development.

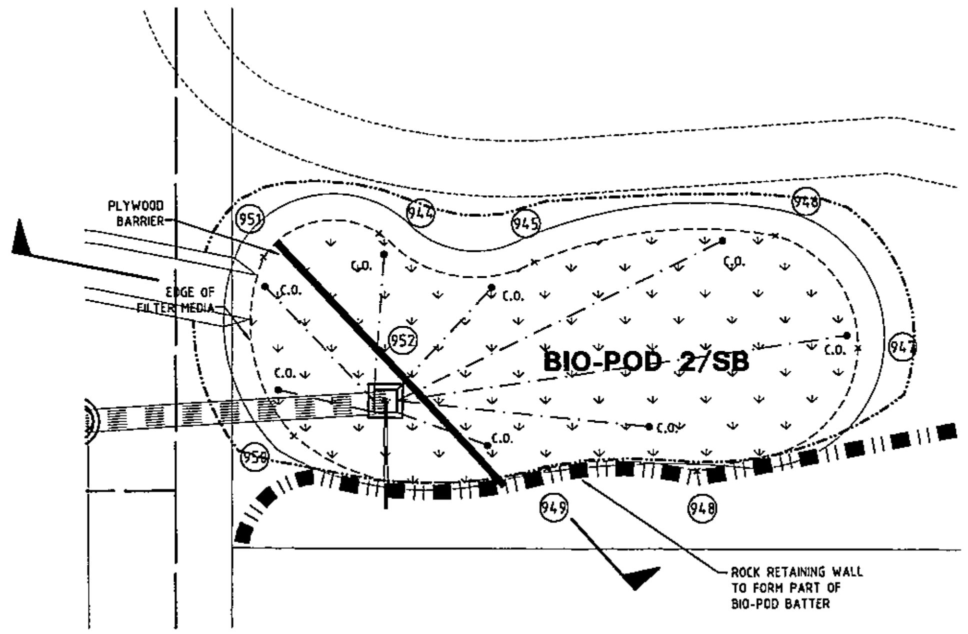
The following pages contain examples of detailed design drawings for a selection of the bioretention 'pods' for the Birtinya Island development.

LEGEND

- SLOTTED PVC CLEANOUT POINT (C.O.)
- SLOTTED PVC
- EDGE OF FILTER MEDIA
- PLYWOOD BARRIER (MARINE GRADE). NOTE: PLYWOOD BARRIER IS AN INTERIM MEASURE ONLY. REFER TO DWG NO. N06081-409 AND 410 FOR FURTHER DETAILS.
- ROOT BARRIER. SHOWN INDICATIVE ONLY IN LOCATIONS WITHIN 5m OF PROPOSED TREES. REFER TO LANDSCAPE DRAWINGS FOR LOCATION AND SPECIFICATION (WORKS BY OTHERS)
- BOULDER RETAINING COMPLETED BY OTHERS REFER TO LANDSCAPE ARCHITECTS DRAWINGS FOR DETAILS
- 1m WIDE COLOURED CONCRETE STRIP RAMP DOWN TO BIO-POD SHUTE TO FORM MINI-PRAM RAMP. REFER CCC STD DRG R-0084. (TO BE CONSTRUCTED BY LANDSCAPE CONTRACTOR) REFER TO N06081-408 FOR DETAIL.

NOTE:
CONTRACTOR TO ENSURE ALL AGG DRAINS ARE CONNECTED TO INLET PITS LOCATED IN BIO-PODS



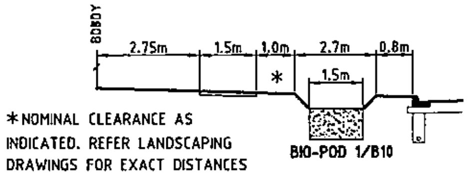


1/B10

PT No.	EASTING	NORTHING	LEVEL
833	548.731	-1970.487	2.209

1/B9

PT No.	EASTING	NORTHING	LEVEL
965	575.574	-1978.358	2.247

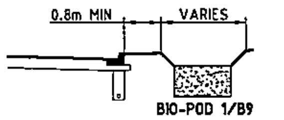


*NOMINAL CLEARANCE AS INDICATED. REFER LANDSCAPING DRAWINGS FOR EXACT DISTANCES

TYPICAL SECTION
BIO-POD 1/B10

SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

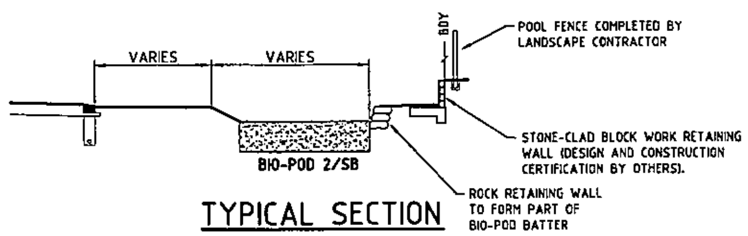
1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.



TYPICAL SECTION
BIO-POD 1/B9

SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.



TYPICAL SECTION
BIO-POD 2/SB

SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.

BIO-POD 2/SB

PT No.	EASTING	NORTHING	LEVEL
944	674.528	-2008.912	1.460
945	678.64	-2009.699	1.460
946	685.035	-2009.021	1.460
947	687.21	-2012.04	1.460
948	682.903	-2015.298	1.460
949	678.935	-2015.212	1.460
950	672.242	-2014.316	1.460
951	671.467	-2009.542	1.460
951	674.672	-2013.394	1.460

FILE: N06081-401.dwg DATE: 16-02-2009 TIME: 15:25
Xref's: N06081-BASE N06081-tit USR: Connie Butler

ISSUE		CALCS	DRAWN	DATE	AMENDMENT DETAILS
FIRST ISSUE		DC	MD	02.01.07	
AMENDMENTS	A	DC	LA	09.07.07	COUNCIL RE-ISSUE
	B	DC	LA	26.03.08	BIO-POD 2/SB AMENDED
	C	DC	CB	15.10.08	AMENDMENTS AS PER COUNCIL RFI
	D	DC	DC	21.10.08	RFI RESUBMISSION
	E	TS	MD	14.11.08	AMENDMENTS AS PER COUNCIL RFI
	F	TS	CB	16.02.09	BIO-POD 2/SB AMENDED

DESIGN CHECK

DRAWN CHECK

SCALE (METRES)
1 : 100 A1
1 : 200 A3

MICROFILM No.

PROJECT No. N06081

ASSOCIATED CONSULTANTS
SURVEYOR: GOODWIN MIDSON & PARTNERS
1/12 TECHNOLOGY DRIVE, WARANA
Ph: (07) 5493 1707 Fax: (07) 5493 4860

APPROVED
BRENT THOMAS RPEQ 7842 FOR & ON BEHALF OF BROWN CONSULTING (QLD) PTY LTD

CLIENT
Stockland Kawana Waters P\L

PROJECT
BIRTINYA ISLAND
STAGE 1A & STAGE 1B

Brown Consulting (QLD) Pty Ltd Engineers & Managers
Level 1, 15 Nicklin Way, Buddina QLD Australia 4575
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Brisbane Canberra Melbourne Sydney Singapore Sunshine Coast

BROWN

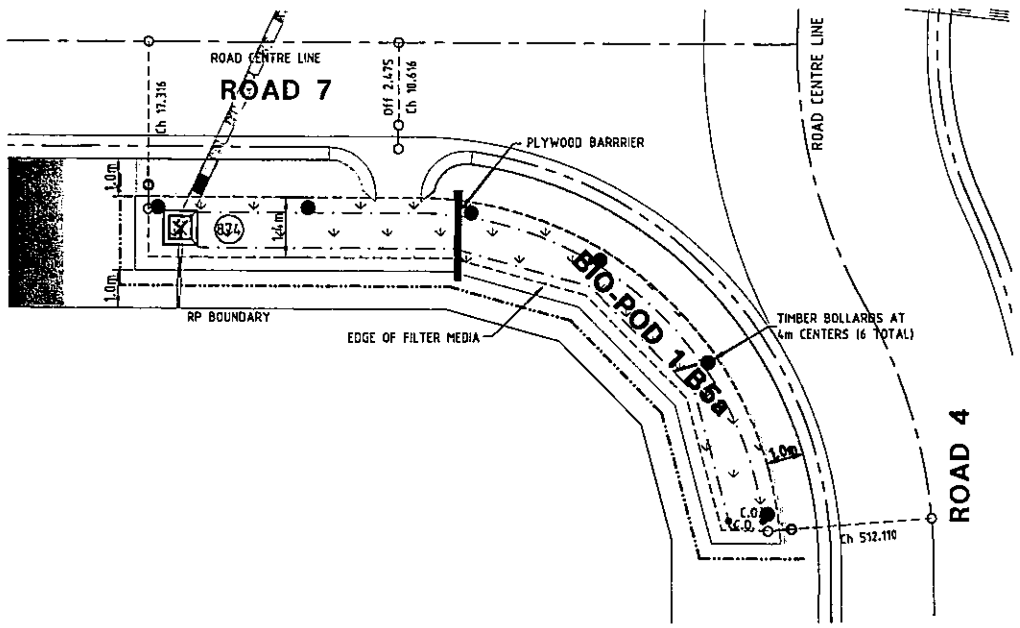
DRAWING TITLE
BIO POD SETOUT PLAN
SHEET 2 OF 8

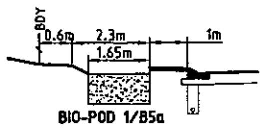
DRAWING NUMBER
N06081-401

ISSUE
F

1/B4a

PT No.	EASTING	NORTHING	LEVEL
874	642.872	-2100.987	1.914





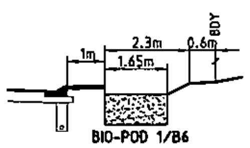
TYPICAL SECTION
BIO-POD 1/B5a

SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

CONCRETE STRIP WITH VERTICAL EDGE TO FRONT OF BIO-POD. 1 IN 2 LANDSCAPED REAR AND SIDE BATTERS

1/B6

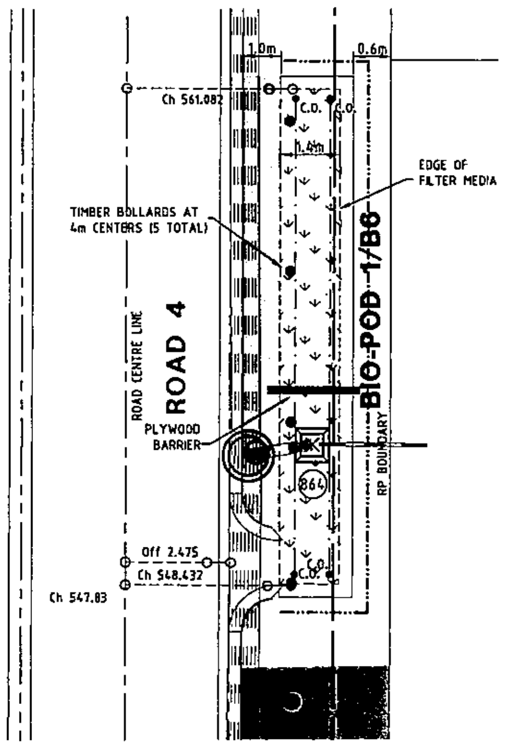
PT No.	EASTING	NORTHING	LEVEL
864	668.133	-2078.534	2.103



TYPICAL SECTION
BIO-POD 1/B6

SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

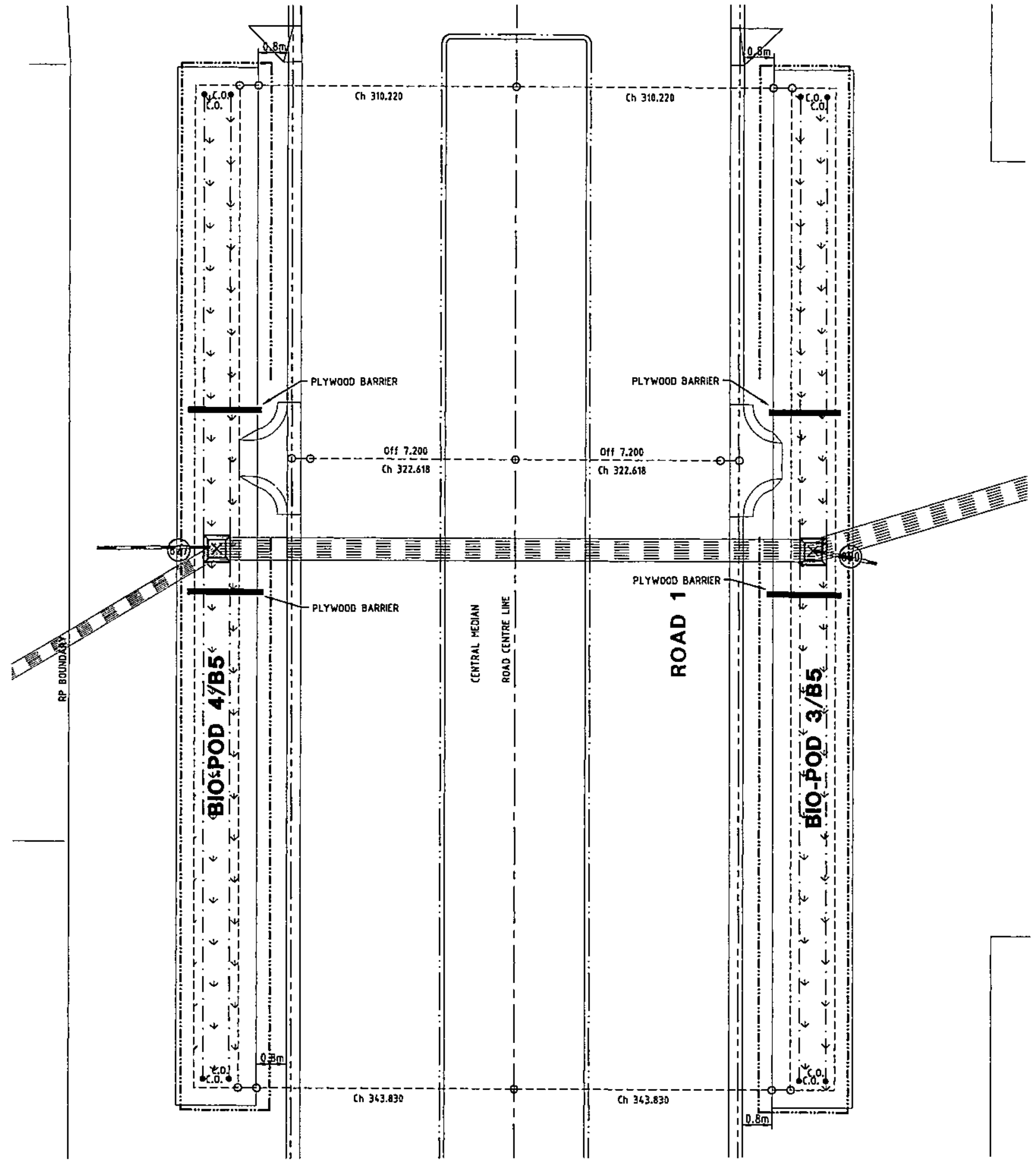
CONCRETE STRIP WITH VERTICAL EDGE TO FRONT OF BIO-POD. 1 IN 2 LANDSCAPED REAR AND SIDE BATTERS



LEGEND

- C.O. SLOTTED PVC CLEANOUT POINT
- SLOTTED PVC
- EDGE OF FILTER MEDIA
- PLYWOOD BARRIER (MARINE GRADE). NOTE: PLYWOOD BARRIER IS AN INTERIM MEASURE ONLY. REFER TO DWG NO. N06081-409 AND 410 FOR FURTHER DETAILS.
- ROOT BARRIER. SHOWN INDICATIVE ONLY IN LOCATIONS WITHIN 5m OF PROPOSED TREES. REFER TO LANDSCAPE DRAWINGS FOR LOCATION AND SPECIFICATION (WORKS BY OTHERS)
- 1m WIDE COLOURED CONCRETE STRIP RAMP DOWN TO BIO-POD SHUTE TO FORM MINI-PRAM RAMP. REFER CCC STD DRG R-0084. (TO BE CONSTRUCTED BY LANDSCAPE CONTRACTOR) REFER TO N06081-408 FOR DETAIL.

NOTE:
CONTRACTOR TO ENSURE ALL AGG DRAINS ARE CONNECTED TO INLET PITS LOCATED IN BIO-PODS

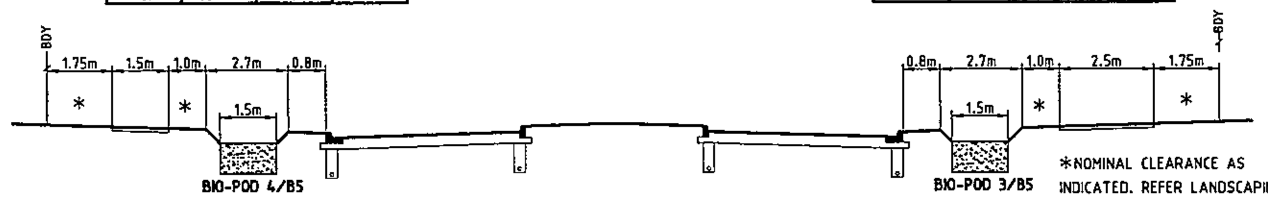


4/B5

PT No.	EASTING	NORTHING	LEVEL
827	556.02	-2095.495	1.929

3/B5

PT No.	EASTING	NORTHING	LEVEL
830	575.994	-2095.592	1.928



*NOMINAL CLEARANCE AS INDICATED. REFER LANDSCAPING DRAWINGS FOR EXACT WIDTHS

TYPICAL SECTION
BIO-POD 4/B5 BIO-POD 3/B5

SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.

FILE: N06081-402.dwg DATE: 23-01-2009 TIME: 09:09
Xref's: N06081-BASE N06081-tit USR: Michael Dobos

PRINT ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
	DC	MD	02.01.07	
A	DC	LA	09.07.07	COUNCIL RE-ISSUE
B	DC	CB	15.10.08	AMENDMENTS AS PER COUNCIL RFI
C	DC	DC	21.10.08	RFI RESUBMISSION
D	--	MD	18.11.08	AMENDMENTS AS PER COUNCIL RFI
E				
F				

DESIGN CHECK

DRAWN CHECK

SCALE (METRES)
1 : 100 1 5 0 1 2 3 4 5 A1
1 : 200 A3

MICROFILM No.

PROJECT No. N06081

ASSOCIATED CONSULTANTS
SURVEYOR: GOODWIN MIDSON & PARTNERS
1/12 TECHNOLOGY DRIVE, WARANA
Ph: (07) 5493 1707 Fax: (07) 5493 4860

APPROVED
BRENT THOMAS RPEQ 7842 FOR & ON BEHALF OF BROWN CONSULTING (QLD) PTY LTD

CLIENT
Stockland Kawana Waters P\L

PROJECT
BIRTINYA ISLAND
STAGE 1A & STAGE 1B

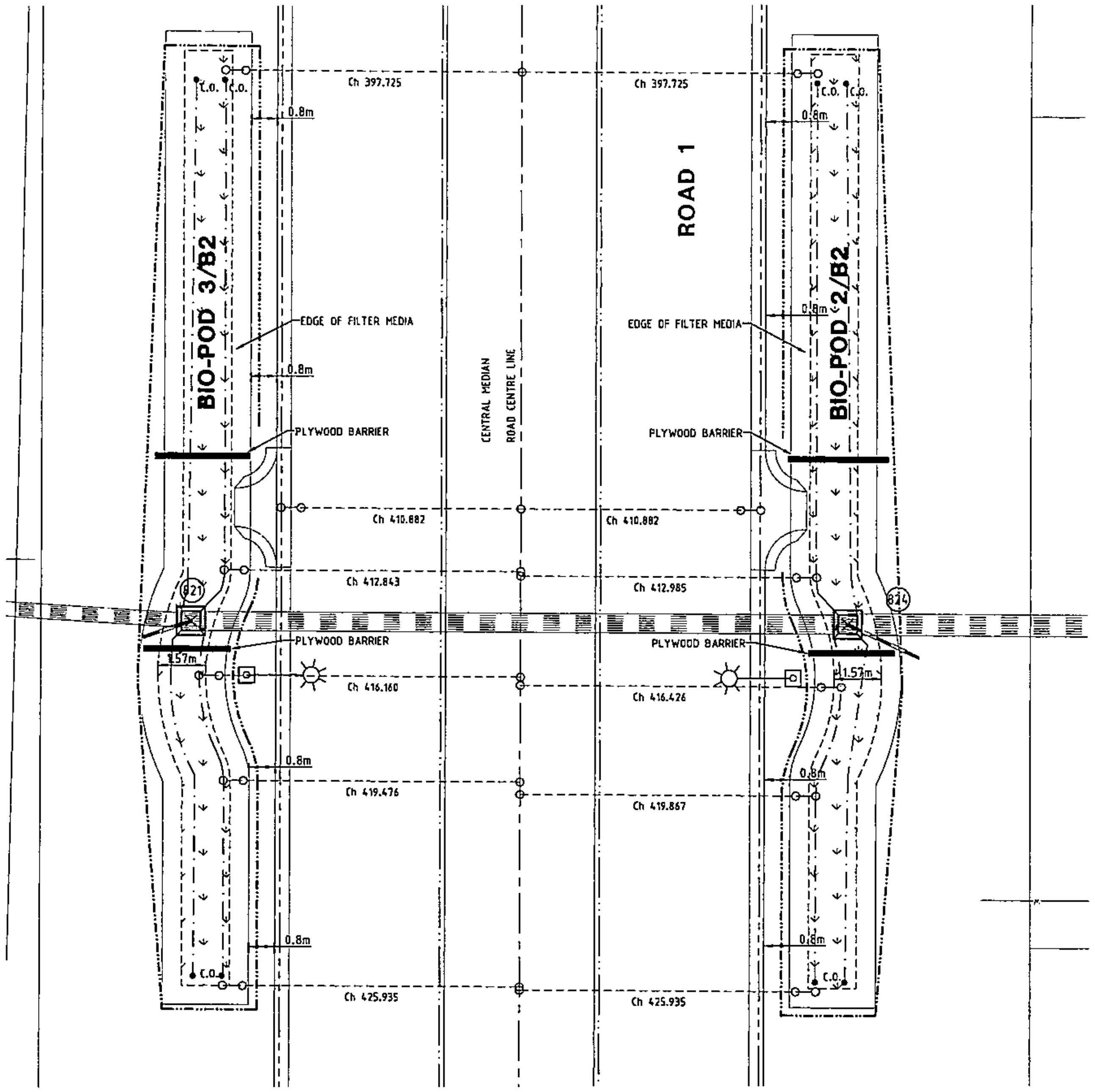
Brown Consulting (QLD) Pty Ltd Engineers & Managers
Level 1, 15 Nicklin Way, Buddina QLD Australia 4575
Telephone 07 5477 6469 Facsimile 07 5477 6486

BROWN

DRAWING TITLE
BIO POD SETOUT PLAN
SHEET 3 OF 8

DRAWING NUMBER N06081-402

ISSUE D

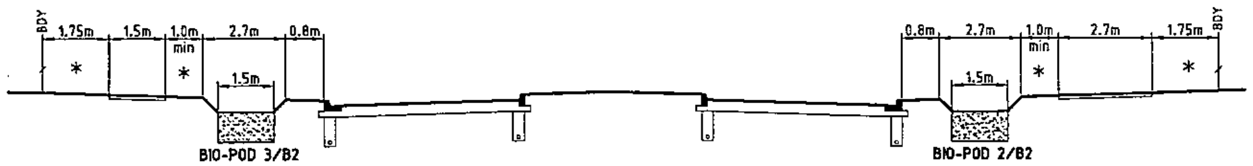


3/B2

PT No.	EASTING	NORTHING	LEVEL
821	555.076	-2184.280	1.950

2/B2

PT No.	EASTING	NORTHING	LEVEL
824	575.617	-2184.428	1.950

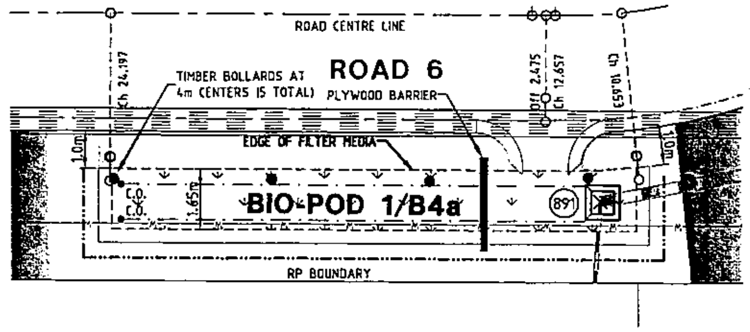


TYPICAL SECTION
BIO-POD 3/B2
BIO-POD 2/B2

SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

*NOMINAL CLEARANCE AS INDICATED. REFER LANDSCAPING DRAWINGS FOR EXACT DISTANCES

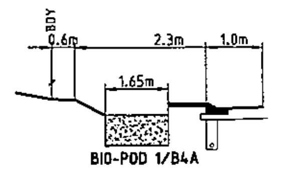
1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.



NOTE: DEFLECT WATERMAIN UNDER BIO-POD.

1/B5a

PT No.	EASTING	NORTHING	LEVEL
891	654.348	-2187.052	1.914



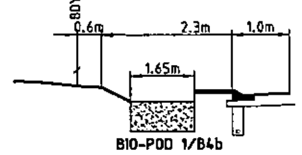
TYPICAL SECTION
BIO-POD 1/B4a

SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

CONCRETE STRIP WITH VERTICAL EDGE TO FRONT OF BIO-POD. 1 IN 2 LANDSCAPED REAR AND SIDE BATTERS

1/B4b

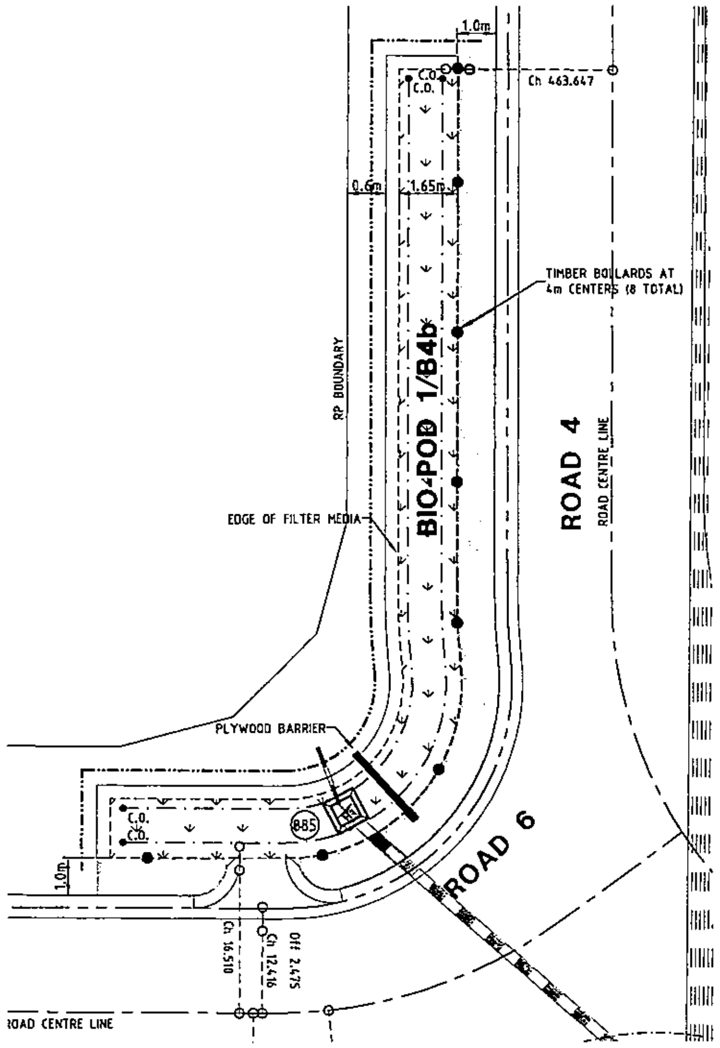
PT No.	EASTING	NORTHING	LEVEL
885	655.390	-2176.843	1.915



TYPICAL SECTION
BIO-POD 1/B4b

SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

CONCRETE STRIP WITH VERTICAL EDGE TO FRONT OF BIO-POD. 1 IN 2 LANDSCAPED REAR AND SIDE BATTERS



LEGEND

C.O.	SLOTTED PVC CLEANOUT POINT
	SLOTTED PVC
	EDGE OF FILTER MEDIA
	PLYWOOD BARRIER (MARINE GRADE). NOTE: PLYWOOD BARRIER IS AN INTERIM MEASURE ONLY. REFER TO DWG NO. N06081-409 AND 410 FOR FURTHER DETAILS.
	ROOT BARRIER. SHOWN INDICATIVE ONLY IN LOCATIONS WITHIN 5m OF PROPOSED TREES. REFER TO LANDSCAPE DRAWINGS FOR LOCATION AND SPECIFICATION (WORKS BY OTHERS)
	1m WIDE COLOURED CONCRETE STRIP RAMP DOWN TO BIO-POD SHUTE TO FORM MINI-PRAM RAMP. REFER CCC STD DRG R-0084. (TO BE CONSTRUCTED BY LANDSCAPE CONTRACTOR) REFER TO N06081-408 FOR DETAIL.

NOTE:
CONTRACTOR TO ENSURE ALL AGG DRAINS ARE CONNECTED TO INLET PITS LOCATED IN BIO-PODS

FILE: N06081-403.dwg DATE: 01-12-2008 TIME: 15:58
Xref's: N06081-BASE N06081-12 USR: michael dobos

AMENDMENTS	CALCS	DRAWN	DATE	AMENDMENT DETAILS
FIRST ISSUE	DC	MD	02.01.07	
A	DC	LA	09.07.07	COUNCIL RE-ISSUE
B	DC	CB	15.10.08	AMENDMENTS AS PER COUNCIL RFI
C	DC	DC	21.10.08	RFI RESUBMISSION
D	--	MD	18.11.08	AMENDMENTS AS PER COUNCIL RFI
E				
F				

DESIGN CHECK
DRAWN CHECK

SCALE (METRES) 1 : 100 A1, 1 : 200 A3 — 1.5 0 1 2 3 4 5

MICROFILM No.
PROJECT No. N06081

ASSOCIATED CONSULTANTS
SURVEYOR: GOODWIN MIDSON & PARTNERS
1/12 TECHNOLOGY DRIVE, WARANA
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APPROVED
BRENT THOMAS RPEQ 7442 FOR & ON BEHALF OF BROWN CONSULTING (QLD) PTY LTD

CLIENT: Stockland Kawana Waters P\L

PROJECT: BIRTINYA ISLAND STAGE 1A & STAGE 1B

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Brisbane Canberra Melbourne Sydney Singapore Sunshine Coast

BROWN

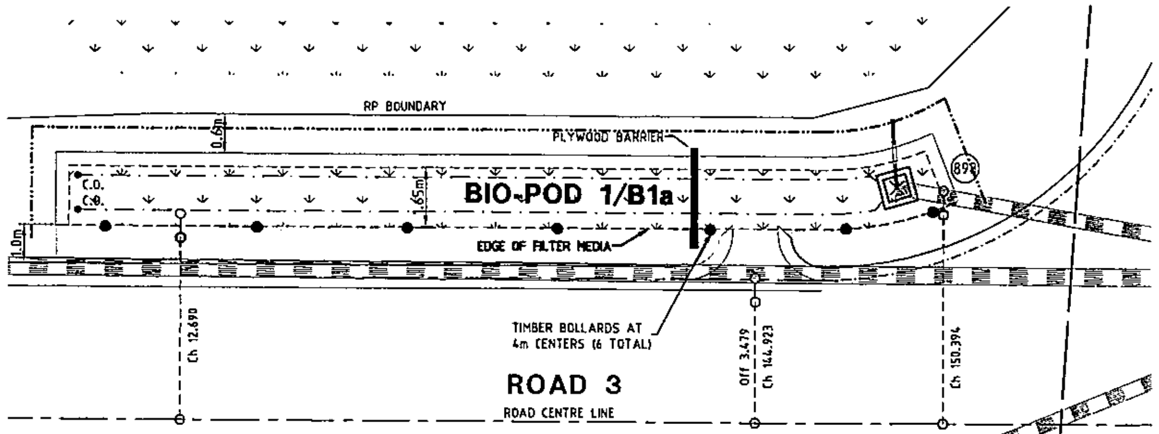
DRAWING TITLE: BIO POD SETOUT PLAN SHEET 4 OF 8

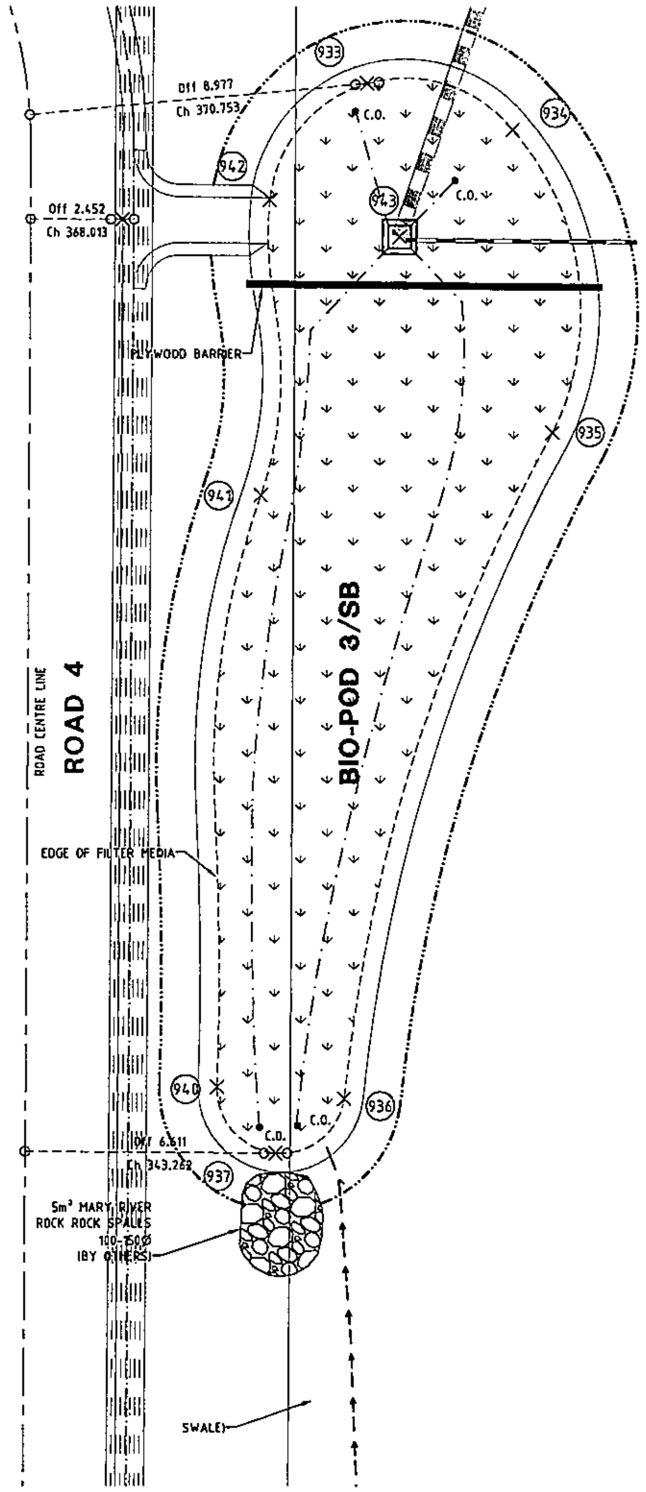
DRAWING NUMBER: N06081-403 | ISSUE: D

LEGEND

C.O.	SLOTTED PVC CLEANOUT POINT
	SLOTTED PVC
	EDGE OF FILTER MEDIA
	PLYWOOD BARRIER (MARINE GRADE). NOTE: PLYWOOD BARRIER IS AN INTERIM MEASURE ONLY. REFER TO DWG NO. N06081-409 AND 410 FOR FURTHER DETAILS.
	ROOT BARRIER. SHOWN INDICATIVE ONLY IN LOCATIONS WITHIN 5m OF PROPOSED TREES. REFER TO LANDSCAPE DRAWINGS FOR LOCATION AND SPECIFICATION (WORKS BY OTHERS)
	1m WIDE COLOURED CONCRETE STRIP RAMP DOWN TO BIO-POD SHUTE TO FORM MINI-PRAM RAMP. REFER CCC STD DRG R-0084. (TO BE CONSTRUCTED BY LANDSCAPE CONTRACTOR) REFER TO N06081-408 FOR DETAIL.

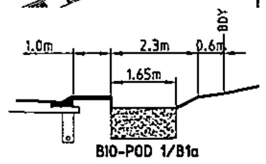
NOTE:
CONTRACTOR TO ENSURE ALL AGG DRAINS ARE CONNECTED TO INLET PITS LOCATED IN BIO-PODS





1/B1a

PT No.	EASTING	NORTHING	LEVEL
898	717.055	-2255.948	1.91



TYPICAL SECTION
BIO-POD 1/B1a
SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

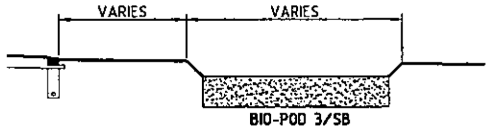
CONCRETE STRIP WITH VERTICAL EDGE TO FRONT OF BIO-POD. 1 IN 2 LANDSCAPED REAR AND SIDE BATTERS

3/SB

PT No.	EASTING	NORTHING	LEVEL
933	737.207	-2193.970	1.450
934	741.037	-2195.184	1.450
935	742.078	-2203.185	1.450
936	736.543	-2220.896	1.450
937	734.714	-2222.325	1.450
940	733.182	-2220.581	1.450
941	734.343	-2204.844	1.450
942	734.597	-2197.025	1.450
943	738.053	-2198.009	1.450

4/SB

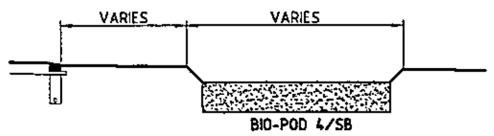
PT No.	EASTING	NORTHING	LEVEL
925	736.046	-2251.297	1.536
926	737.018	-2258.090	1.536
927	737.674	-2265.125	1.536
928	733.495	-2278.215	1.536
929	733.548	-2268.878	1.536
930	733.267	-2257.755	1.536
931	734.598	-2254.663	1.536
932	734.794	-2263.377	1.536



TYPICAL SECTION
BIO-POD 3/SB
SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

NOTE:
BIO-POD AMENDED DEPTH
400mm DEEP (0.45mm MEDIAN PARTICLE)
100mm DEEP (TRANSITION LAYER)
100mm DEEP GRAVEL SCREENINGS

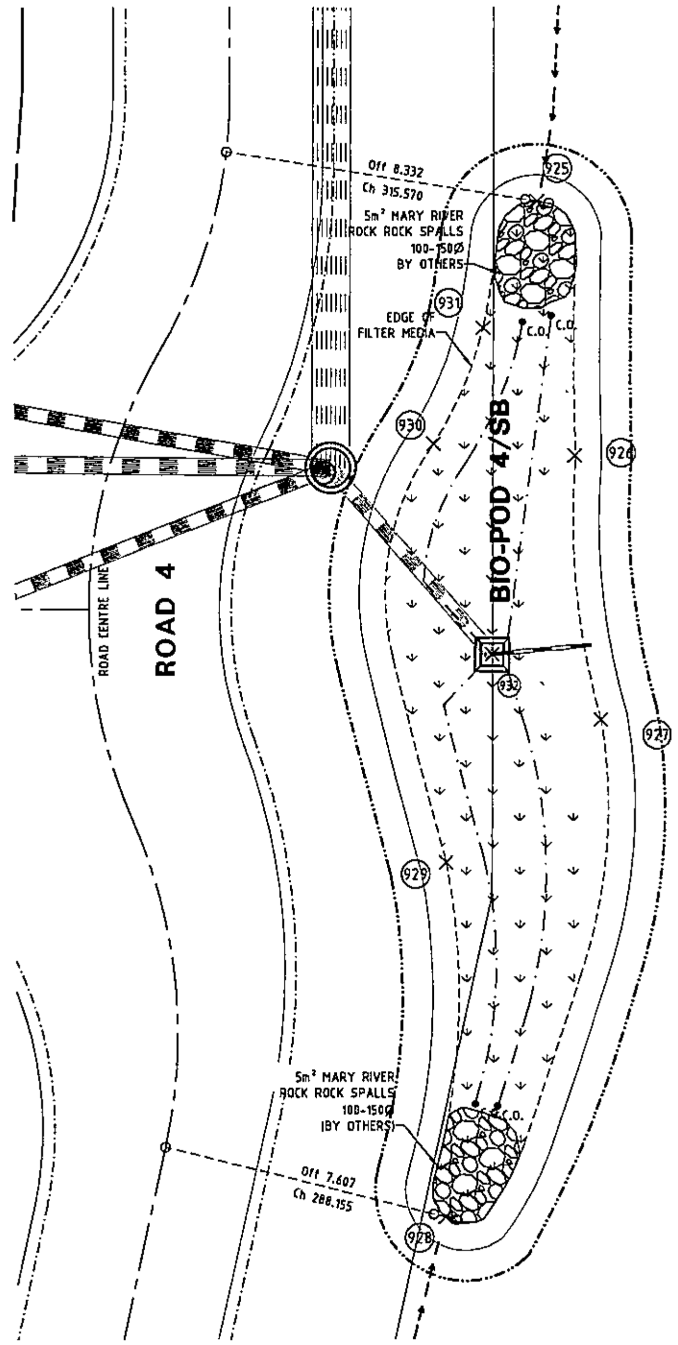
1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.



TYPICAL SECTION
BIO-POD 4/SB
SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

NOTE:
BIO-POD AMENDED DEPTH
400mm DEEP (0.7mm MEDIAN PARTICLE)
100mm DEEP (3.0mm MEDIAN PARTICLE)
00mm DEEP GRAVEL SCREENINGS

1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.



FILE: N06081-404.dwg DATE: 03-12-2008 TIME: 16:
Xref's: N06081-BASE N06081-til USR: michael dabas

	CALCS	DRAWN	DATE	AMENDMENT DETAILS
FIRST ISSUE	DC	MD	02.01.07	
A	DC	LA	09.07.07	COUNCIL RE-ISSUE
B	DC	CB	15.10.08	AMENDMENTS AS PER COUNCIL RFI
C	DC	DC	21.10.08	RFI RESUBMISSION
D	--	MD	18.11.08	AMENDMENTS AS PER COUNCIL RFI
E				
F				

DESIGN CHECK
DRAWN CHECK

SCALE (METRES)
1 : 100 A1
1 : 200 A3

MICROFILM No.
PROJECT No. N06081

ASSOCIATED CONSULTANTS
SURVEYOR: GOODWIN MIDSON & PARTNERS
1/12 TECHNOLOGY DRIVE, WARANA
Ph: (07) 5493 1707 Fax: (07) 5493 4860

APPROVED
BRENT THOMAS RPEQ 7862 FOR & ON BEHALF OF BROWN CONSULTING (QLD) PTY LTD

CLIENT
Stockland Kawana Waters P\L

PROJECT
BIRTINYA ISLAND
STAGE 1A & STAGE 1B

Brown Consulting (QLD) Pty Ltd Engineers & Managers
Level 1, 15 Nicklin Way, Buddina QLD Australia 4575
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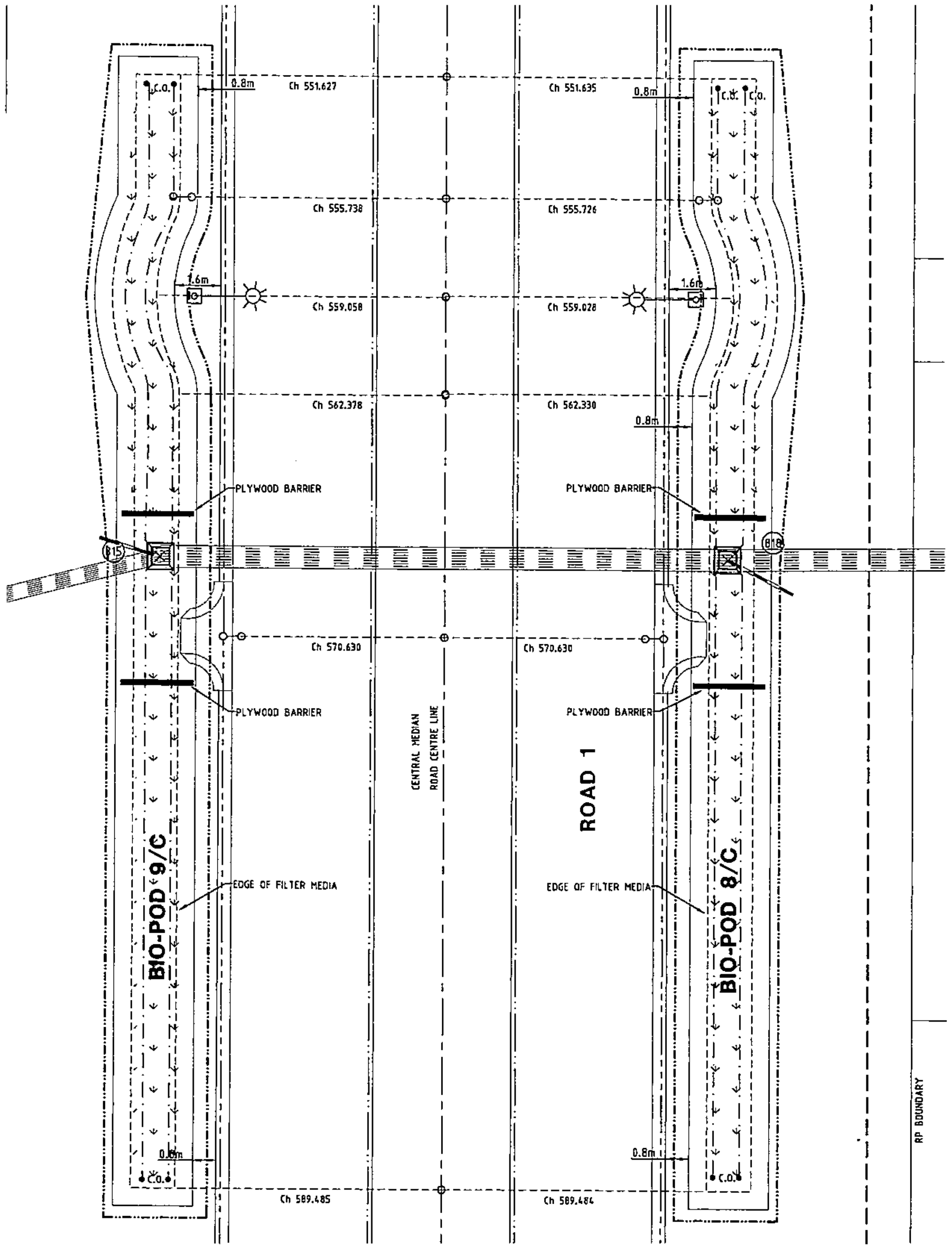
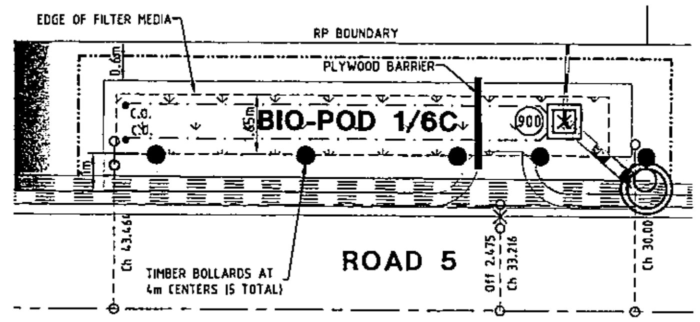
Brisbane Canberra Melbourne Sydney Singapore Sunshine Coast

BROWN

DRAWING TITLE
BIO POD SETOUT PLAN
SHEET 5 OF 8

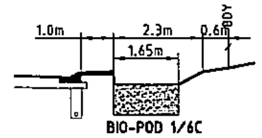
DRAWING NUMBER N06081-404
ISSUE D





BIO-POD 1/6C

PT No.	EASTING	NORTHING	LEVEL
900	678.983	-2336.435	2.064



TYPICAL SECTION
BIO-POD 1/6C

SCALE- 1:100

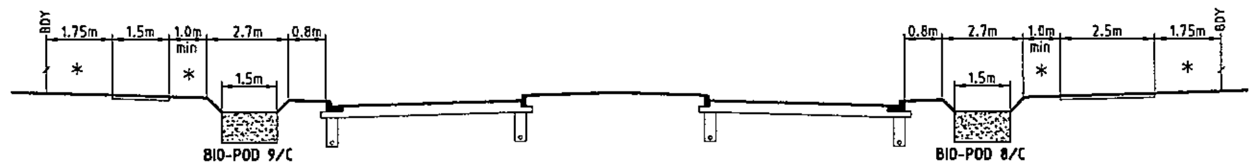
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

CONCRETE STRIP WITH VERTICAL EDGE TO FRONT OF BIO-POD. 1 IN 2 LANDSCAPED REAR AND SIDE BATTERS

LEGEND

- C.O. — SLOTTED PVC CLEANOUT POINT
- SLOTTED PVC
- EDGE OF FILTER MEDIA
- PLYWOOD BARRIER (MARINE GRADE). NOTE: PLYWOOD BARRIER IS AN INTERIM MEASURE ONLY. REFER TO DWG NO. N06081-409 AND 410 FOR FURTHER DETAILS.
- ROOT BARRIER. SHOWN INDICATIVE ONLY IN LOCATIONS WITHIN 5m OF PROPOSED TREES. REFER TO LANDSCAPE DRAWINGS FOR LOCATION AND SPECIFICATION (WORKS BY OTHERS)
- 1m WIDE COLOURED CONCRETE STRIP RAMP DOWN TO BIO-POD SHUTE TO FORM MINI-PRAM RAMP. REFER CCC STD DRG R-0084. (TO BE CONSTRUCTED BY LANDSCAPE CONTRACTOR) REFER TO N06081-408 FOR DETAIL.

NOTE:
CONTRACTOR TO ENSURE ALL AGG DRAINS ARE CONNECTED TO INLET PITS LOCATED IN BIO-PODS



TYPICAL SECTION
BIO-POD 9/C
BIO-POD 8/C

SCALE- 1:100

REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.

*NOMINAL CLEARANCE AS INDICATED. REFER LANDSCAPING DRAWINGS FOR EXACT WIDTHS

BIO-POD 9/C

PT No.	EASTING	NORTHING	LEVEL
815	554.600	-2337.743	2.063

BIO-POD 8/C

PT No.	EASTING	NORTHING	LEVEL
818	573.930	-2337.894	2.064

FILE: N06081-405.dwg DATE: 01-12-2008 TIME: 16:01
Xref's: N06081-BASE N06081-12 USR: michael dobas

AMENDMENTS		CALCS	DRAWN	DATE	AMENDMENT DETAILS
FIRST ISSUE		DC	MD	02.01.07	
	A	DC	LA	09.07.07	COUNCIL RE-ISSUE
	B	DC	CB	15.10.08	AMENDMENTS AS PER COUNCIL RFI
	C	DC	DC	21.10.08	RFI RESUBMISSION
	D	--	MD	18.11.08	AMENDMENTS AS PER COUNCIL RFI
	E				
	F				

DESIGN CHECK

DRAWN CHECK

SCALE (METRES)
1 : 100 — 1 5 0 1 2 3 4 5 — A1
1 : 200 — A3

MICROFILM No.

PROJECT No. N06081

ASSOCIATED CONSULTANTS
SURVEYOR: GOODWIN MIDSON & PARTNERS
1/12 TECHNOLOGY DRIVE, WARANA
Ph: (07) 5493 1707 Fax: (07) 5493 4860

APPROVED
BRENT THOMAS RPEQ 7862 FOR & ON BEHALF OF BROWN CONSULTING (QLD) PTY LTD

CLIENT
Stockland Kawana Waters P\L

PROJECT
BIRTINYA ISLAND
STAGE 1A & STAGE 1B

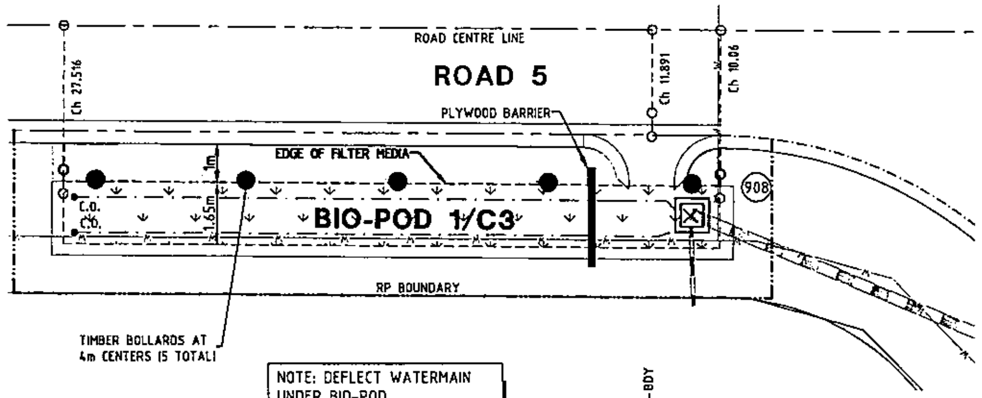
Brown Consulting (QLD) Pty Ltd Engineers & Managers
Level 1, 15 Nicklin Way, Buddina QLD Australia 4575
Telephone 07 5477 6469 Facsimile 07 5477 6486

BROWN

DRAWING TITLE
BIO POD SETOUT PLAN
SHEET 6 OF 8

DRAWING NUMBER N06081-405

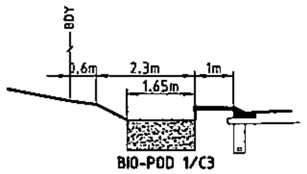
ISSUE D



NOTE: DEFLECT WATERMAIN UNDER BIO-POD.

1/C3

PT No.	EASTING	NORTHING	LEVEL
908	698.695	-2346.289	1.945



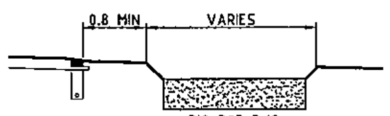
TYPICAL SECTION
BIO-POD 1/C3

SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

CONCRETE STRIP WITH VERTICAL EDGE TO FRONT OF BIO-POD. 1 IN 2 LANDSCAPED REAR AND SIDE BATTERS

3/C

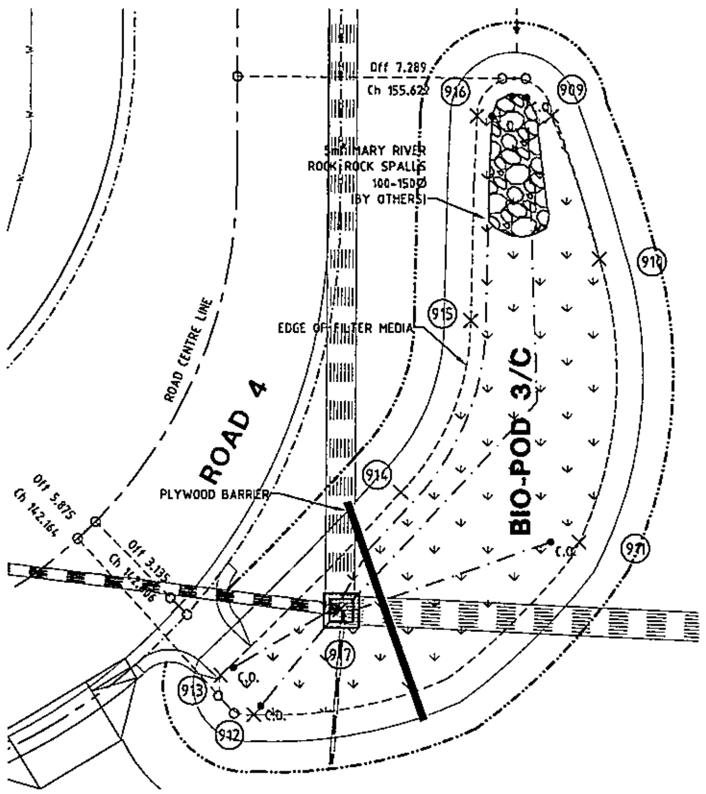
PT No.	EASTING	NORTHING	LEVEL
909	721.070	-2406.956	1.500
910	722.336	-2410.762	1.500
911	721.771	-2418.231	1.500
912	713.174	-2422.760	1.500
913	712.297	-2421.723	1.500
914	717.049	-2416.914	1.500
915	718.903	-2412.388	1.500
916	719.086	-2406.946	1.500
917	715.463	-2420.008	1.500



TYPICAL SECTION
BIO-POD 3/C

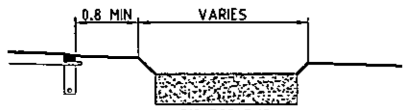
SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.



5/C

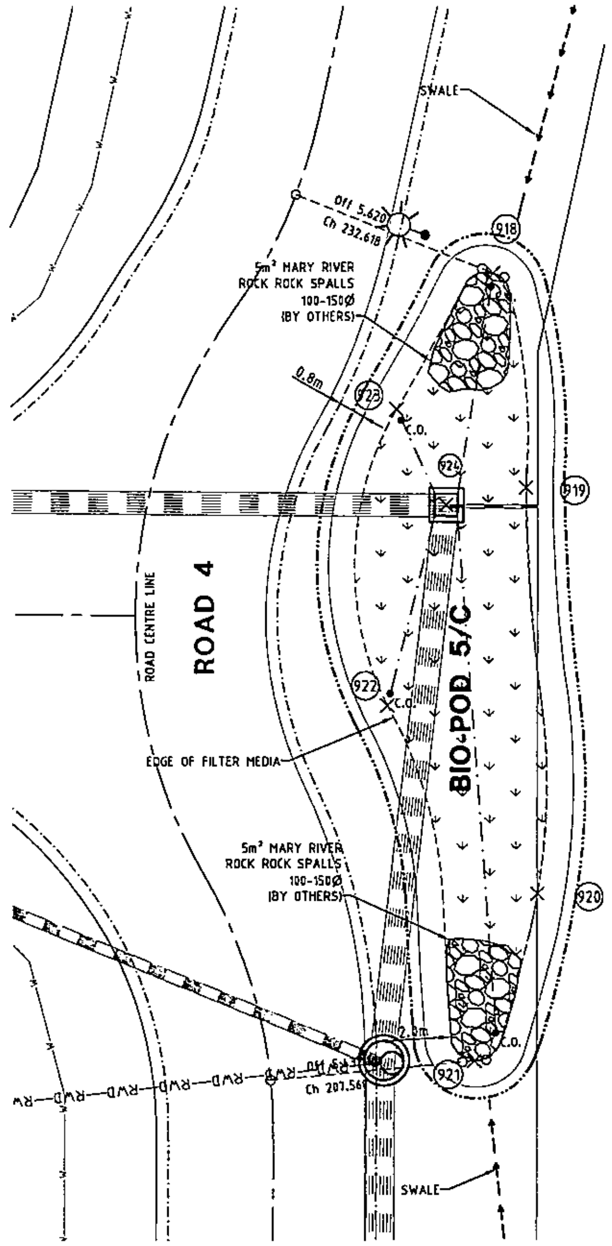
PT No.	EASTING	NORTHING	LEVEL
918	719.103	-2332.582	1.500
919	719.961	-2338.216	1.500
920	720.207	-2348.989	1.500
921	716.250	-2343.960	1.500
922	716.250	-2343.960	1.500
923	716.536	-2336.152	1.500
924	717.840	-2338.666	1.500



TYPICAL SECTION
BIO-POD 5/C

SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.



LEGEND

- C.O. — SLOTTED PVC CLEANOUT POINT
- SLOTTED PVC
- EDGE OF FILTER MEDIA
- PLYWOOD BARRIER (MARINE GRADE). NOTE: PLYWOOD BARRIER IS AN INTERIM MEASURE ONLY. REFER TO DWG NO. N06081-409 AND 410 FOR FURTHER DETAILS.
- ROOT BARRIER. SHOWN INDICATIVE ONLY IN LOCATIONS WITHIN 5m OF PROPOSED TREES. REFER TO LANDSCAPE DRAWINGS FOR LOCATION AND SPECIFICATION (WORKS BY OTHERS)
- 1m WIDE COLOURED CONCRETE STRIP RAMP DOWN TO BIO-POD SHUTE TO FORM MINI-PRAM RAMP. REFER CCC STD DRG R-0084. (TO BE CONSTRUCTED BY LANDSCAPE CONTRACTOR) REFER TO N06081-408 FOR DETAIL.

NOTE:
CONTRACTOR TO ENSURE ALL AGG DRAINS ARE CONNECTED TO INLET PITS LOCATED IN BIO-PODS

FILE: N06081-406.dwg DATE: 01-12-2008 TIME: 16:02
Xref's: N06081-BASE N06081-tit USR: michael dobos

ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
FIRST ISSUE	DC	MD	02.01.07	
A	DC	LA	09.07.07	COUNCIL RE-ISSUE
B	DC	CB	15.10.08	AMENDMENTS AS PER COUNCIL RFI
C	DC	DC	21.10.08	RFI RESUBMISSION
D	--	MD	18.11.08	AMENDMENTS AS PER COUNCIL RFI
E				
F				

DESIGN CHECK

DRAWN CHECK

SCALE (METRES)
1 : 100 A1
1 : 200 A3
1 5 0 1 2 3 4 5

MICROFILM No.

PROJECT No. N06081

ASSOCIATED CONSULTANTS
SURVEYOR: GOODWIN MIDSON & PARTNERS
1/12 TECHNOLOGY DRIVE, WARANA
Ph: (07) 5493 1707 Fax: (07) 5493 4860

APPROVED
BRENT THOMAS RPEQ 7862 FOR & ON BEHALF OF BROWN CONSULTING (QLD) PTY LTD

CLIENT
Stockland Kawana Waters P\L

PROJECT
BIRTINYA ISLAND
STAGE 1A & STAGE 1B

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Brisbane Canberra Melbourne Sydney Singapore Sunshine Coast

BROWN

DRAWING TITLE
BIO POD SETOUT PLAN
SHEET 7 OF 8

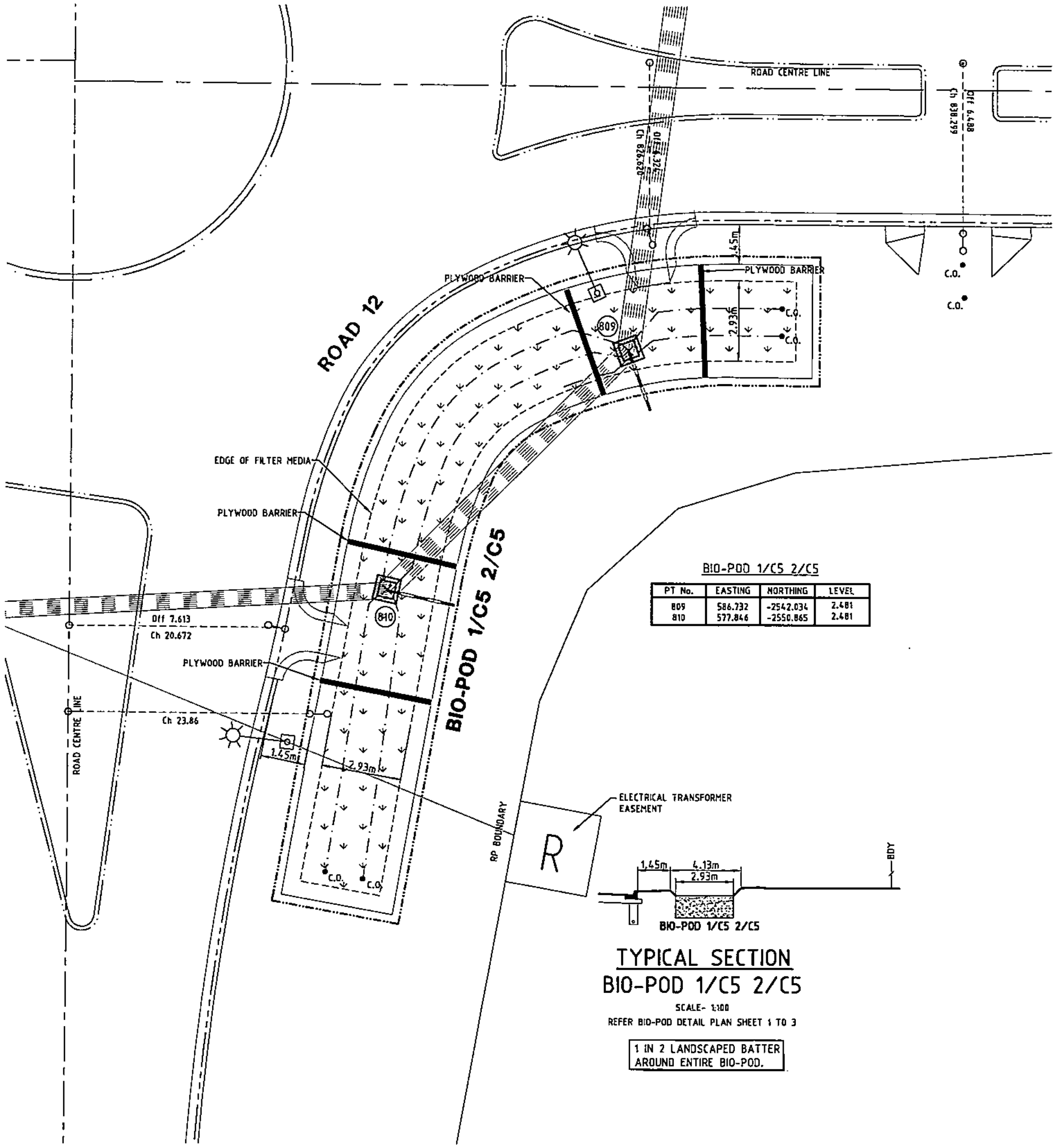
DRAWING NUMBER N06081-406

ISSUE D

LEGEND

- C.O. — SLOTTED PVC CLEANOUT POINT
- SLOTTED PVC
- EDGE OF FILTER MEDIA
- PLYWOOD BARRIER (MARINE GRADE). NOTE: PLYWOOD BARRIER IS AN INTERIM MEASURE ONLY. REFER TO DWG NO. N06081-409 AND 410 FOR FURTHER DETAILS.
- ROOT BARRIER. SHOWN INDICATIVE ONLY IN LOCATIONS WITHIN 5m OF PROPOSED TREES. REFER TO LANDSCAPE DRAWINGS FOR LOCATION AND SPECIFICATION (WORKS BY OTHERS)
- 1m WIDE COLOURED CONCRETE STRIP RAMP DOWN TO BIO-POD SHUTE TO FORM MINI-PRAM RAMP. REFER CCC STD DRG R-0084. (TO BE CONSTRUCTED BY LANDSCAPE CONTRACTOR) REFER TO N06081-408 FOR DETAIL.

NOTE:
CONTRACTOR TO ENSURE ALL AGG DRAINS ARE CONNECTED TO INLET PITS LOCATED IN BIO-PODS

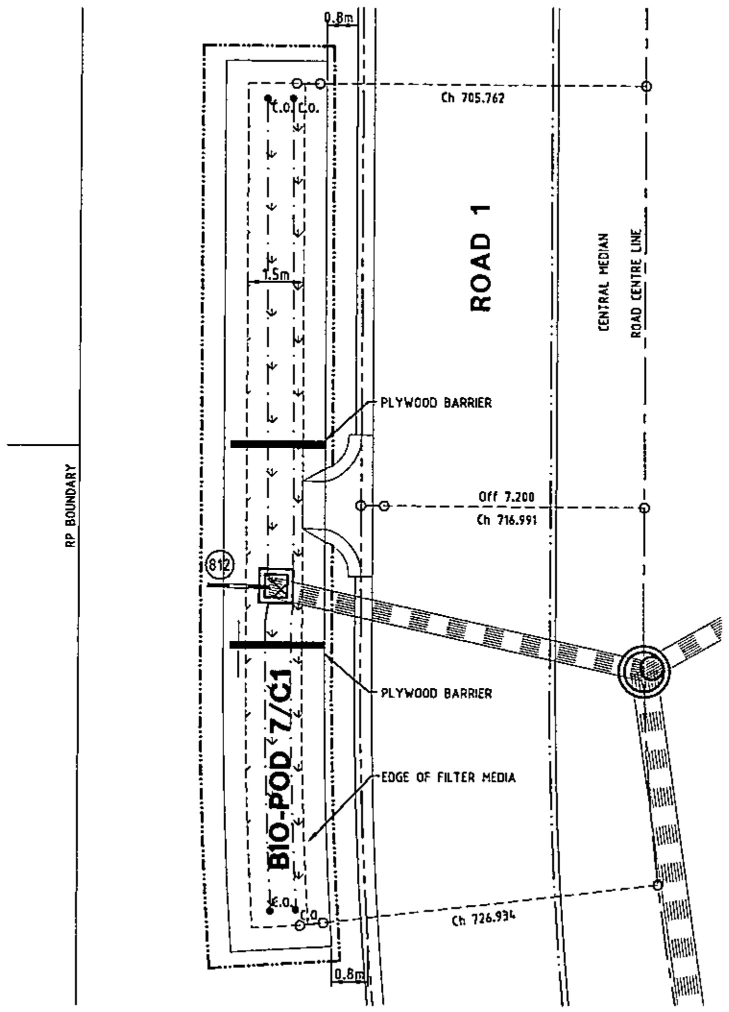


BIO-POD 1/C5 2/C5

PT No.	EASTING	NORTHING	LEVEL
809	586.732	-2542.034	2.481
810	577.846	-2550.865	2.481

TYPICAL SECTION
BIO-POD 1/C5 2/C5
SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

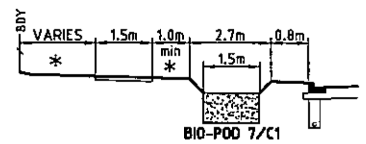
1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.



BIO-POD 6/C1

PT No.	EASTING	NORTHING	LEVEL
812	553.262	-2489.014	2.037

*NOMINAL CLEARANCE AS INDICATED. REFER LANDSCAPING DRAWINGS FOR EXACT DISTANCES



TYPICAL SECTION
BIO-POD 7/C1
SCALE- 1:100
REFER BIO-POD DETAIL PLAN SHEET 1 TO 3

1 IN 2 LANDSCAPED BATTER AROUND ENTIRE BIO-POD.

FILE: N06081-407.dwg DATE: 23-01-2009 TIME: 12.57
Xref's: N06081-BASE N06081-hl USR: Chris Osullivan

ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
FIRST ISSUE	DC	MD	02.01.07	
A	DC	LA	09.07.07	COUNCIL RE-ISSUE
B	TR	TR	09.09.08	LEVELS FOR POD 1/C5 2/C5 AMENDED
C	DC	CB	15.10.08	AMENDMENTS AS PER COUNCIL RFI
D	DC	DC	21.10.08	RFI RESUBMISSION
E	--	MD	18.11.08	AMENDMENTS AS PER COUNCIL RFI
F	CO	MD	23.01.09	REGATTA BOULEVARD ALIGNMENT AMENDED

DESIGN CHECK
DRAWN CHECK

SCALE (METRES)
1 : 100 1 5 0 1 2 3 4 5 A1
1 : 200 A3

MICROFILM No.
PROJECT No. N06081

ASSOCIATED CONSULTANTS
SURVEYOR: GOODWIN MIDSON & PARTNERS
1/12 TECHNOLOGY DRIVE, WARANA
Ph: (07) 5493 1707 Fax: (07) 5493 4860

APPROVED
BRENT THOMAS RPEQ 7862 FOR & ON BEHALF OF BROWN CONSULTING (QLD) PTY LTD

CLIENT
Stockland Kawana Waters P\L

PROJECT
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Telephone 07 5477 6469 Facsimile 07 5477 6486
Brisbane Canberra Melbourne Sydney Singapore Sunshine Coast
BROWN

DRAWING TITLE
BIO POD SETOUT PLAN
SHEET 8 OF 8

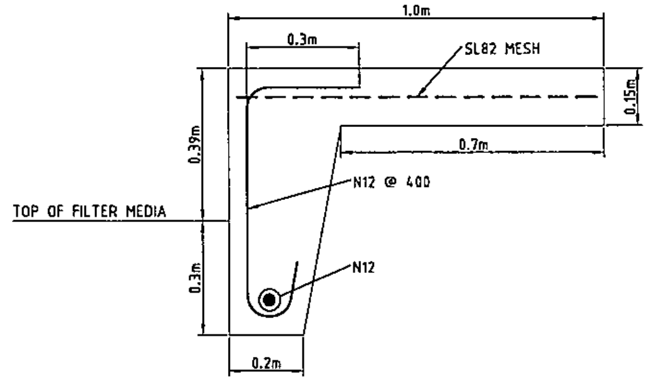
DRAWING NUMBER
N06081-407

ISSUE
F

BIO-POD CONSTRUCTION INFORMATION (FINAL CONSTRUCTION)

NAME	PIT DETAILS: GRATE SIZE	PIT TOP SIZE	PIT BASE SIZE	POD DETAILS: TOP OF POD LEVEL (Top of Media Level)	TOP OF PIT (Concrete Level)	BASE LEVEL (Bottom of Media Level)	BASE AREA	FILTER MEDIA VOLUMES: SANDY LOAM FILTER 0.45 mm Da 600mm DEEP	SAND TRANSITION 2.0 mm Da 100mm DEEP	GRAVEL SCREENINGS 5-7mm AGGREGATE 200mm DEEP	TOTAL 900mm DEEP	PVC CONNECTIONS TO PIT
	mm	mm	mm	m	m	m	m2	m3	m3	m3	m3	No.
1/B10	900x900	600x600	600x600	2.21	2.41	1.31	29.0	17.4	2.9	5.8	26.1	4
1/B9	900x900	600x600	600x600	2.25	2.45	1.35	36.2	21.7	3.6	7.2	32.6	4
●2/SB●	900x900	600x600	800Lx600W	1.51	1.71	0.91	83.0	33.2	8.3	8.3	49.8	7
1/B6	900x900	600x600	600x600	2.10	2.30	1.20	19.0	11.4	1.9	3.8	17.1	4
4/B5	900x900	600x600	900x900	1.93	2.13	1.03	50.2	30.1	5.0	10.0	45.2	4
3/B5	900x900	600x600	1100Lx900W	1.93	2.13	1.03	50.4	30.2	5.0	10.1	45.4	4
1/B5a	900x900	600x600	600x600	2.04	2.24	1.14	28.0	16.8	2.8	5.6	25.2	2
3/B2	900x900	600x600	900Lx600W	1.95	2.15	1.05	44.0	26.4	4.4	8.8	39.6	4
2/B2	900x900	600x600	900x900	1.95	2.15	1.05	44.0	26.4	4.4	8.8	39.6	4
1/B4a	900x900	600x600	600x600	1.92	2.12	1.02	20.0	12.0	2.0	4.0	18.0	2
1/B4b	900x900	600x600	600x600	1.92	2.12	1.02	38.0	22.8	3.8	7.6	34.2	4
●3/SB●	900x900	600x600	600x600	1.40	1.60	0.80	162.0	64.8	16.2	16.2	97.2	2
1/B1a	900x900	600x600	600x600	1.91	2.11	1.01	32.0	19.2	3.2	6.4	28.8	2
●4/SB●	900x900	600x600	600x600	1.54	1.74	0.94	96.0	384.0	9.6	9.6	403.2	4
9/C	900x900	600x600	1000x1000	2.06	2.26	1.16	57.0	34.2	5.7	11.4	51.3	4
8/C	900x900	600x600	1000x1000	2.06	2.26	1.16	57.0	34.2	5.7	11.4	51.3	4
1/8C	900x900	600x600	600x600	2.06	2.26	1.16	19.5	11.7	2.0	3.9	17.6	2
5/C	900x900	600x600	1000x1000	1.50	1.70	0.90	66.0	39.6	6.6	13.2	59.4	6
1/C3	900x900	600x600	600x600	1.95	2.15	1.05	27.0	16.2	2.7	5.4	24.3	4
●3/C●	900x900	600x600	1000x1000	1.50	1.70	0.90	72.0	28.8	7.2	7.2	43.2	5
7/C1	900x900	600x600	900x900	2.04	2.24	1.14	33.1	19.9	3.3	6.6	29.8	4
2/C5	900x900	600x600	900x900	2.49	2.69	1.59	91.0	54.6	9.1	18.2	81.9	4
1/C5	900x900	600x600	1100Lx1200W	2.48	2.68	1.58	-	-	-	-	-	4
										TOTAL VOLUME =	1261	m3

●2/SB● Denotes Biopod in Park Area with - 400mm deep SANDY LOAM (0.45mm median Diameter) SATURATED CONDUCTIVITY 180mm/hr
- 100mm deep TRANSITIONAL LAYER (2.0mm median Diameter)
- 100mm deep LAYER (5-7mm gravel screenings)



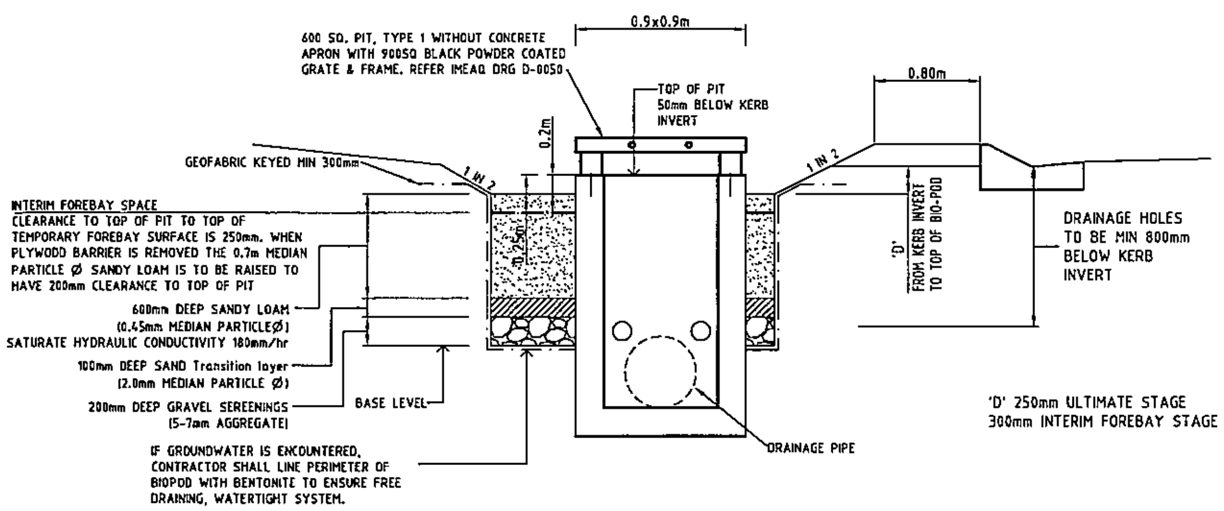
CONCRETE STRIP DETAIL

PROVIDE 1/100Ø STUB OUT OF PIT TO 1.0m PAST BIO POD TOP OF BANK FOR LANDSCAPE CONTRACTOR TO CONNECT TO. THIS WILL PROVIDE OUTLET FOR LANDSCAPE ARCHITECTS SURFACE PITS

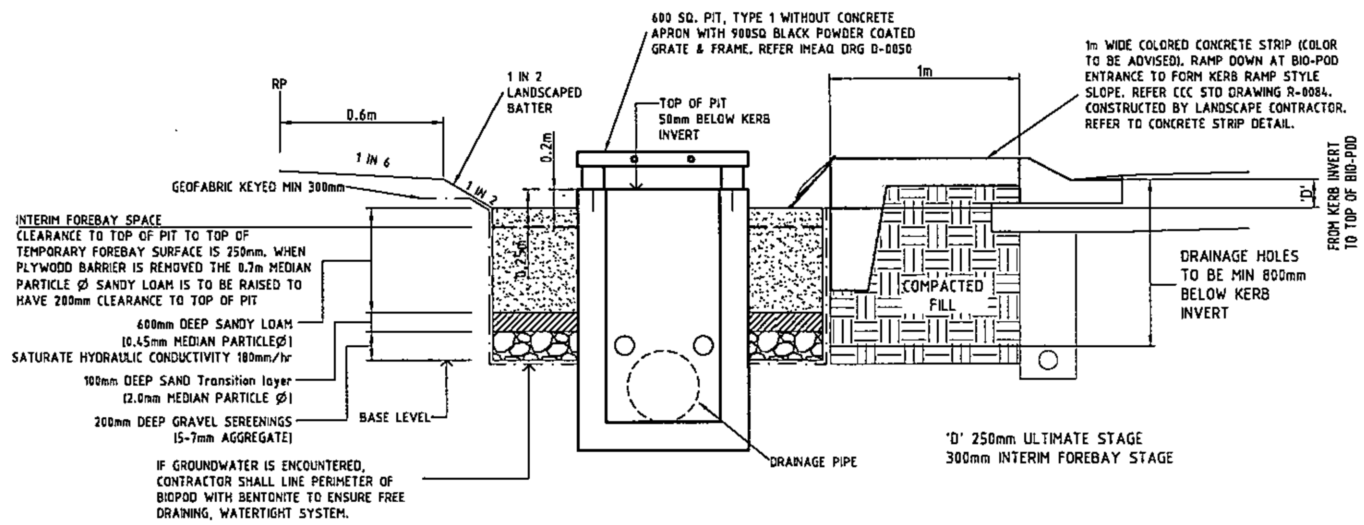
BIOFILTRATION FILTER MEDIA TO MEET THE CRITERIA OUTLINED IN THE MARCH 2008 VERSION OF THE GUIDELINE SPECIFICATION FOR SOIL MEDIA IN BIORETENTION SYSTEMS (VERSION 2.01), FACILITY FOR ADVANCING WATER BIOFILTRATION.

TOP OF PIT LEVEL IS 'DESIGN SURFACE LEVEL' AS SHOWN IN STORMWATER LONGITUDINAL SECTIONS.

BIO BASIN IN THE PARK AREAS TO HAVE 1 IN 2 LANDSCAPED BATTERS.



TYPICAL CROSS SECTION THROUGH PIT/FOREBAY
(ROAD 1 & 12 ONLY)



TYPICAL CROSS SECTION THROUGH PIT/FOREBAY
(ROAD 2, 3, 4, 5, 6 & 7)

FILE: N06081-408.dwg DATE: 23-01-2009 TIME: 09:36
Xref's: N06081-BASE N06081-tit USR: Michael Dobas

		CALCS	DRAWN	DATE	AMENDMENT DETAILS
FIRST ISSUE		DC	MD	02.01.07	
AMENDMENTS	A	DC	LA	09.07.07	COUNCIL RE-ISSUE
	B	DC	LA	26.03.08	REMOVAL OF LOTS 10-31 (NORTHERN STAGE 1A)
	C	TR	TR	09.09.08	FSL OF 2/CS AND 1/CS AMENDED
	D	DC	CB	15.10.08	AMENDMENTS AS PER COUNCIL RFI
	E	DC	DC	24.10.08	RFI RESUBMISSION
	F	--	MD	18.11.08	AMENDMENTS AS PER COUNCIL RFI

DESIGN CHECK
DRAWN CHECK

SCALE (METRES)
1 : 100 1 5 0 1 2 3 4 5 A1
1 : 200 A3

MICROFILM No.
PROJECT No. N06081

ASSOCIATED CONSULTANTS
SURVEYOR: GOODWIN MIDSON & PARTNERS
1/12 TECHNOLOGY DRIVE, WARANA
Ph: (07) 5493 1707 Fax: (07) 5493 4860

APPROVED
BRENT THOMAS RPEQ 7842 FOR & ON BEHALF OF BROWN CONSULTING (QLD) PTY LTD

CLIENT
Stockland Kawana Waters P\L

PROJECT
BIRTINYA ISLAND
STAGE 1A & STAGE 1B

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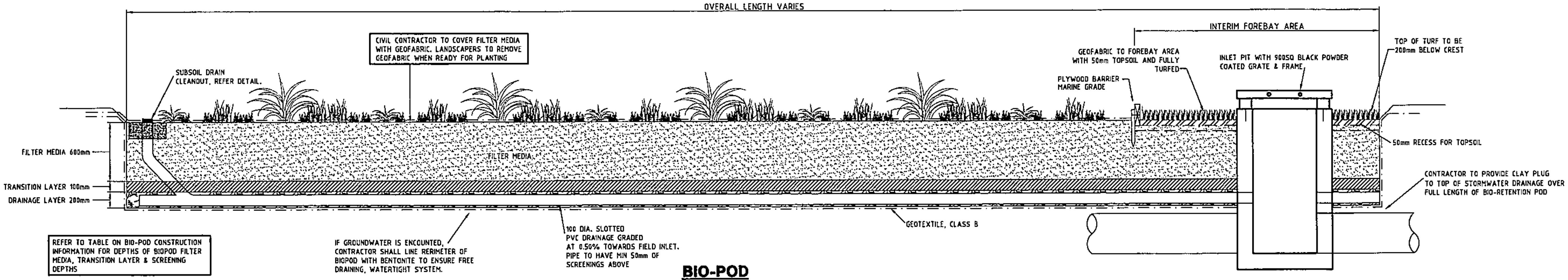
Telephone 07 5477 6469 Facsimile 07 5477 6486
BROWN

DRAWING TITLE
BIO POD CONSTRUCTION INFORMATION

DRAWING NUMBER
N06081-408

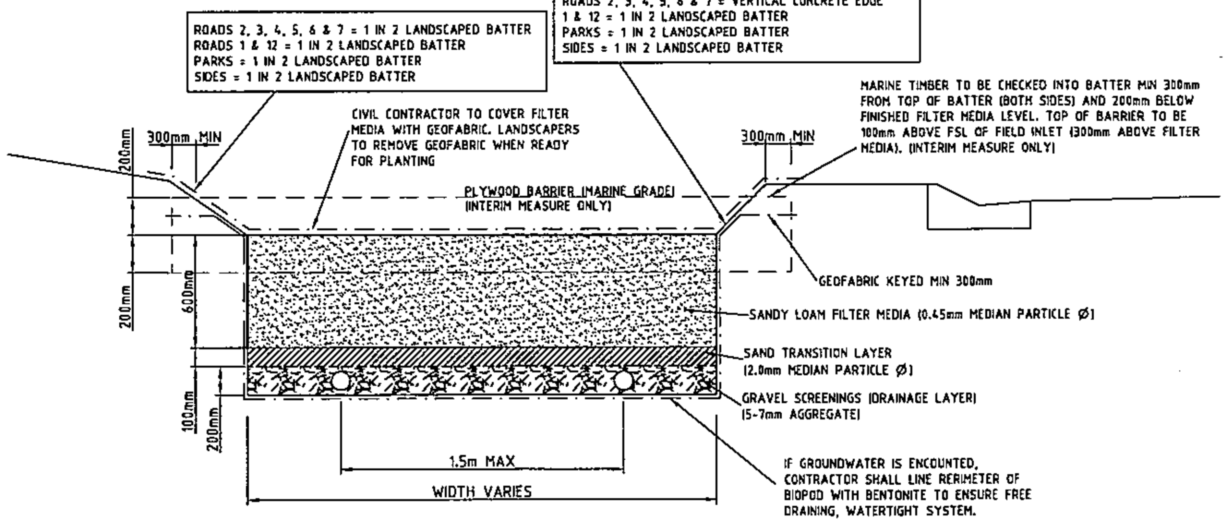
ISSUE
F



BIO-POD
SCALE 1:20

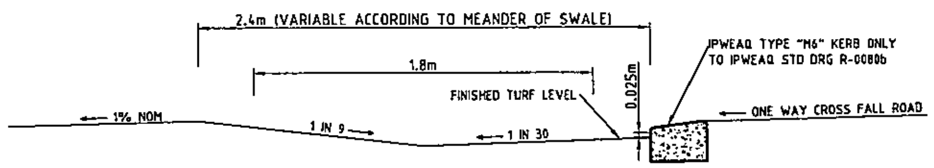
PROVIDE 1/100Ø STUB OUT OF PIT TO 1.0m PAST BIO POD TOP OF BANK FOR LANDSCAPE CONTRACTOR TO CONNECT TO. THIS WILL PROVIDE OUTLET FOR LANDSCAPE ARCHITECTS SURFACE PITS

NOTE: FOREBAY AREA IS AN INTERIM MEASURE ONLY. THIS AREA IS TO BE REPLACED WITH SEDIMENT FOREBAY AND PLANTING WHEN UPSTREAM CATCHMENT IS STABILISED (IN ACCORDANCE WITH OPW APPROVAL NO. 2007\-53-00085.



BIO-POD TYPCIAL SECTION
SCALE 1:20

NOTE: PLYWOOD BARRIERS ARE AN INTERIM MEASURE ONLY.



SWALE TYPICAL CROSS-SECTION
SCALE 1:20

NOTE:
FOR FINAL LOCATIONS REFER LANDSCAPING DRAWINGS

FILE: N06081-409.dwg DATE: 16-02-2009 TIME: 15:29
Xref's: N06081-tit USR: Connie Butler

AMENDMENTS	CALCS	DRAWN	DATE	AMENDMENT DETAILS
FIRST ISSUE	DC	MD	02.01.07	
A	DC	LA	09.07.07	COUNCIL RE-ISSUE
B	DC	CB	15.10.08	AMENDMENTS AS PER COUNCIL RFI
C	DC	DC	21.10.08	RFI RESUBMISSION
D	--	MD	18.11.08	AMENDMENTS AS PER COUNCIL RFI
E	TS	CB	16.02.09	DETAILS AMENDED
F				

DESIGN CHECK
DRAWN CHECK

SCALE (METRES)
1:20 / 1:40 — 0.2 0 0.2 0.4 0.6 0.8 1 — A1 / A3
1:25 / 1:50 — 0.25 0 0.25 0.5 0.75 1.0 1.25 — A1 / A3

MICROFILM No.
PROJECT No. N06081

ASSOCIATED CONSULTANTS
SURVEYOR: GOODWIN MIDSON & PARTNERS
1/12 TECHNOLOGY DRIVE, WARANA
Ph: (07) 5493 1707 Fax: (07) 5493 4860
APPROVED
BRENT THOMAS RPEQ 7862 FOR & ON BEHALF OF BROWN CONSULTING (QLD) PTY LTD

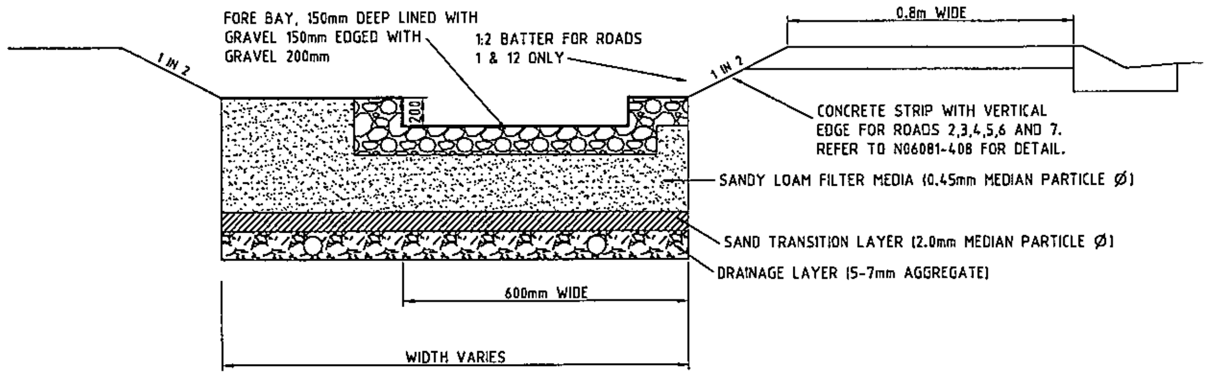
CLIENT
Stockland Kawana Waters P\L

PROJECT
BIRTINYA ISLAND
STAGE 1A & STAGE 1B

Brown Consulting (QLD) Pty Ltd Engineers & Managers
Level 1, 15 Nicklin Way, Buddina QLD Australia 4575
Telephone 07 5477 6469 Facsimile 07 5477 6486
Brisbane Canberra Melbourne Sydney Singapore Sunshine Coast
BROWN

DRAWING TITLE
BIO POD DETAIL
PLAN
SHEET 1 OF 3

DRAWING NUMBER
N06081-409
ISSUE
E

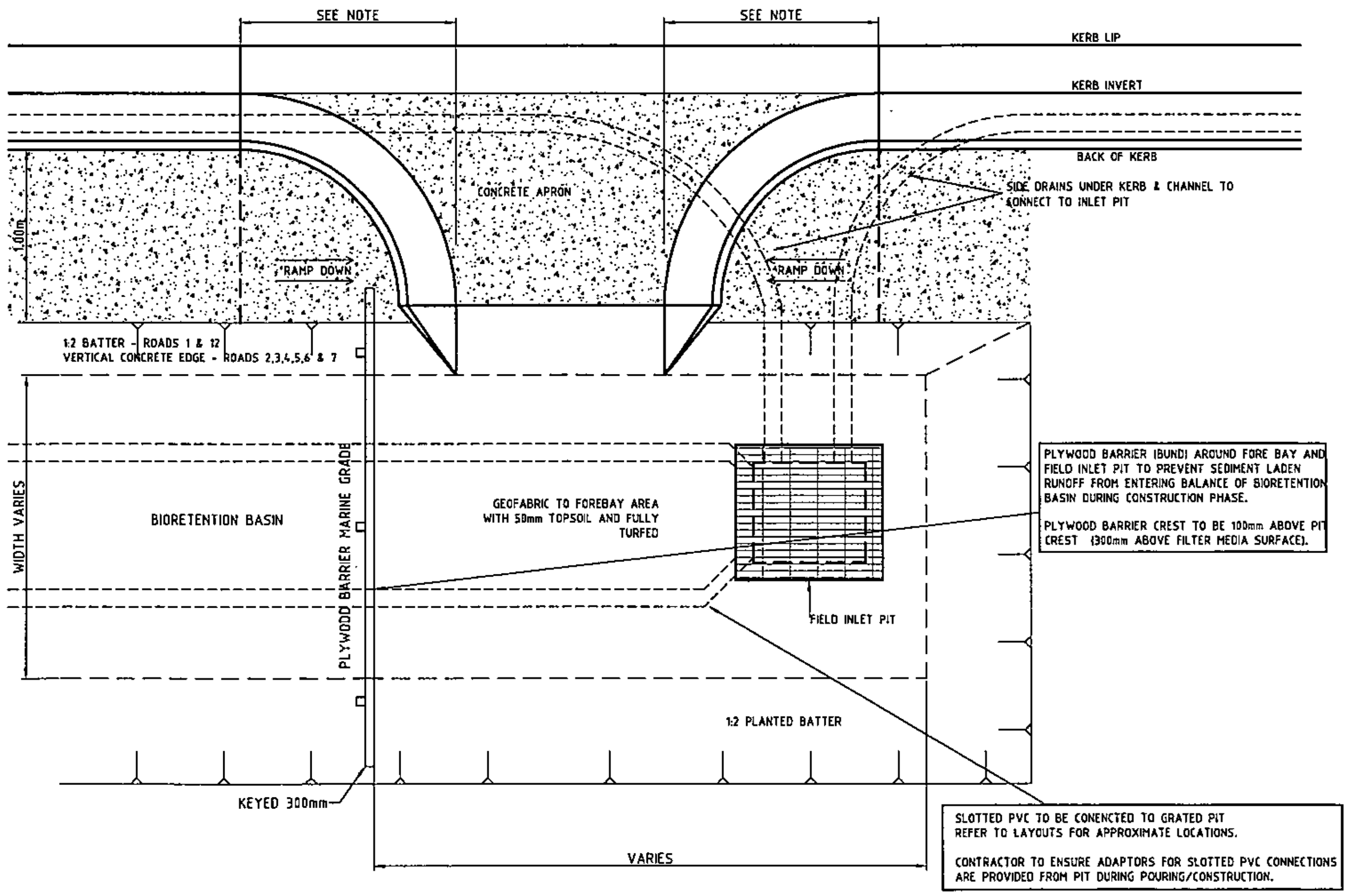


COMPLETED FOREBAY TYPICAL SECTION
SCALE 1:25

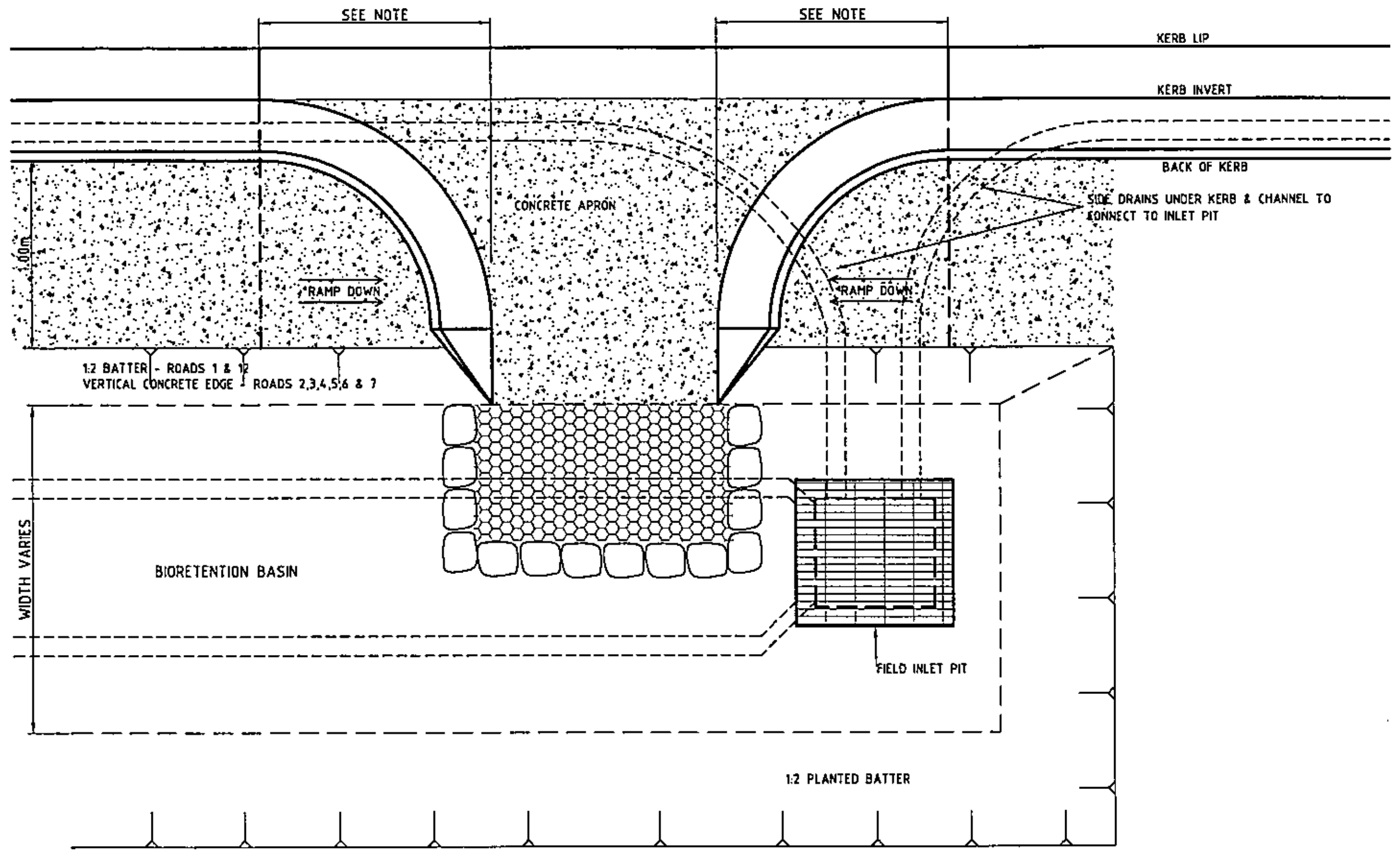
AT REMOVAL OF PLYWOOD BARRIER (NOMINALLY OFF MAINTENANCE STAGE)

NOTE 1:
RAMP 1m WIDE COLORED CONCRETE STRIP, DOWN TO CONCRETE APRON INLET AS PER PRAM PAMP CROSSING REFER CCC STD DRAWING R-0065 AND R-0084. TO BE CONSTRUCTED BY LANDSCAPE CONTRACTOR. INTERNAL ROADS ONLY

BIOFILTRATION FILTER MEDIA TO MEET THE CRITERIA OUTLINED IN THE MARCH 2008 VERSION OF THE GUIDELINE SPECIFICATION FOR SOIL MEDIA IN BIORETENTION SYSTEMS (VERSION 2.01), FACILITY FOR ADVANCING WATER BIOFILTRATION.



TYPICAL INTERIM FOREBAY DETAIL
SCALE 1:25



TYPICAL COMPLETED FOREBAY DETAIL
SCALE 1:20

AT REMOVAL OF PLYWOOD BARRIER (NOMINALLY OFF MAINTENANCE STAGE)

FILE: N06081-410.dwg DATE: 16-02-2009 TIME: 15:25
Xref's: N06081-tit USR: Connie Butler

	CALCS	DRAWN	DATE	AMENDMENT DETAILS
FIRST ISSUE	DC	MD	02.01.07	
A	DC	LA	09.07.07	COUNCIL RE-ISSUE
B	DC	CB	15.10.08	AMENDMENTS AS PER COUNCIL RFI
C	DC	DC	21.10.08	RFI RESUBMISSION
D	--	MD	18.11.08	AMENDMENTS AS PER COUNCIL RFI
E	TS	CB	16.02.09	DETAILS AMENDED
F				

DESIGN CHECK

DRAWN CHECK

SCALE (METRES)
1:20 / 1:40 — 0.2 0 0.2 0.4 0.6 0.8 1 — A1 / A3
1 : 25 / 1 : 50 — 0.25 0 0.25 0.5 0.75 1.0 1.25 — A1 / A3

MICROFILM No.

PROJECT No.
N06081

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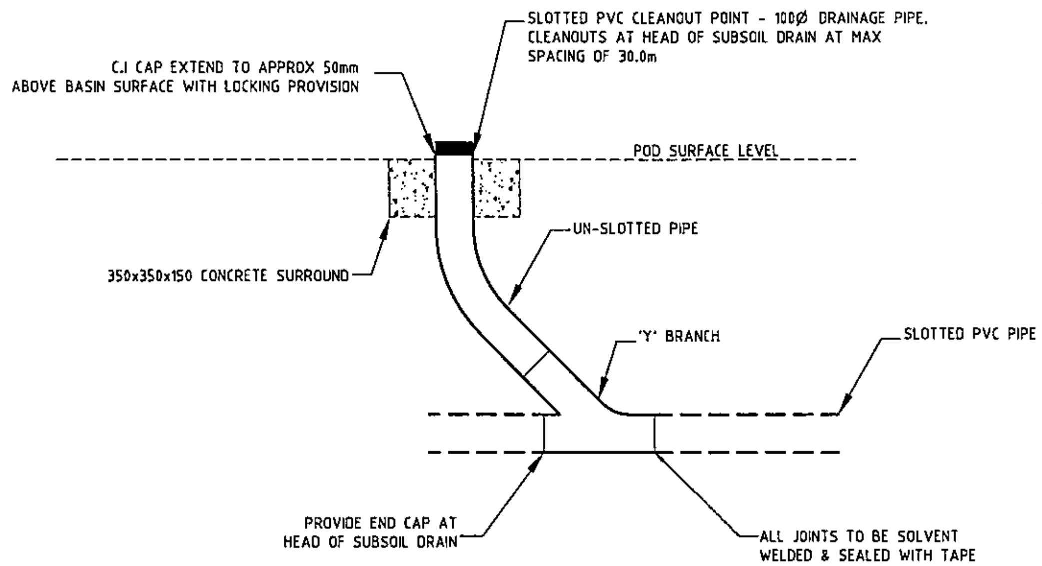
BROWN

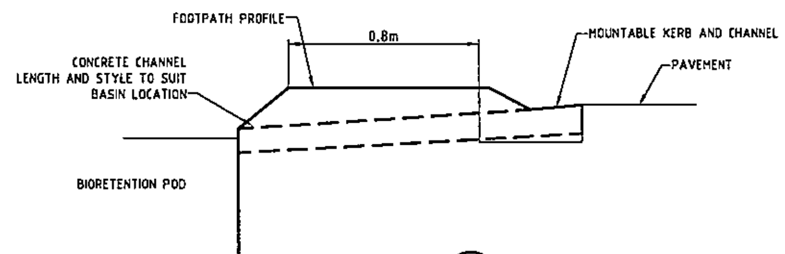
DRAWING TITLE
BIO POD DETAIL
PLAN
SHEET 2 OF 3

DRAWING NUMBER
N06081-410

ISSUE
E



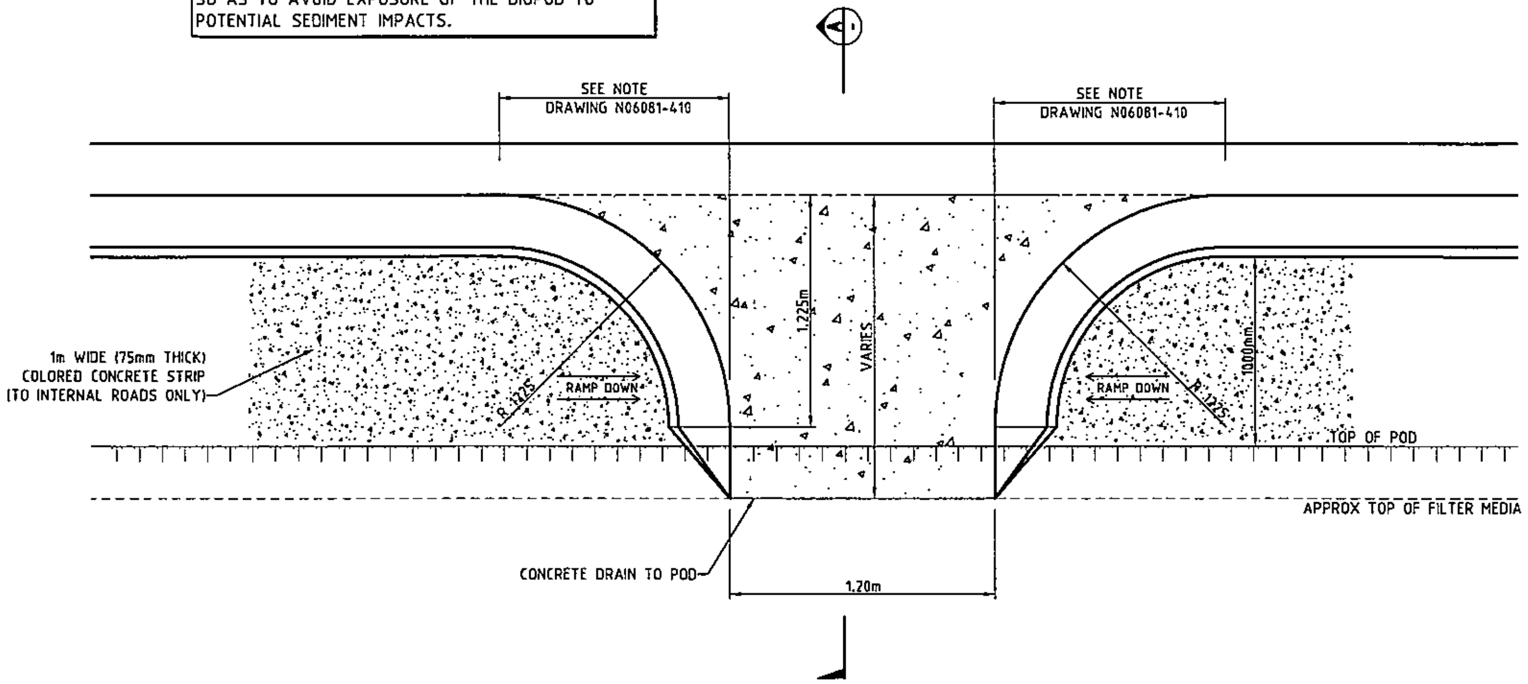
BIOPOD POD SUBSOIL DRAIN CLEANOUT
SCALE 1:20



SECTION A
SCALE 1:20

NOTE:
THE CONTRACTOR SHALL NOT PROCEED WITH THE FINALISATION OF BIOPODS (IE. PLACEMENT OF SUB-SOIL DRAINS, FILTER MEDIA ETC.) UNTIL THE SUPERINTENDENT HAS APPROVED COMPLETION BASED ON SUFFICIENT STABILISATION OF UPSTREAM CATCHMENT.

NOTE:
THE CIVIL CONTRACTOR AND LANSCAPE CONTRACTOR SHALL CO-ORDINATE THEIR WORK TO ENSURE THAT THE CIVIL AND LANDSCAPING COMPONENTS OF ANY PARTICULAR BIO-POD ARE COMPLETED THE SAME DAY SO AS TO AVOID EXPOSURE OF THE BIOPOD TO POTENTIAL SEDIMENT IMPACTS.



KERB TURNOUT DETAILS
SALE 1:20

BIOPOD CONSTRUCTION SEQUENCE AND NOTES:

1. Establish sediment and erosion control measures in catchment, including silt fences, seeding of allotments, & full width verge turfing.
2. Survey pod location.
3. Install overflow pit and ensure pit crest is at design level. This pit crest will then be used as a datum from which other levels within the pod will be measured. The pit requires holes for drainage pipe connections which can be drilled at this stage or after step 5 below.
4. Construct kerb turnouts.
5. Excavate surrounding landform to design subsoil level (achieving surrounding level at this stage reduces the need for earthworks adjacent to the pods after they have been constructed).
6. Excavate pod to design depth ensuring base of pod has minimum 0.5% grade towards pit. Ensure base of pod is free from debris.

SUPERINTENDENT INSPECTION AND SIGN OFF REQUIRED BEFORE PROCEEDING.

7. Line system with geofabric, and extend geofabric a minimum of 500 mm beyond top of excavation. These are the flaps referred to in Item 13 below.
8. Place drainage layer (using clean 5-7 mm aggregate) to design level.
9. Note that correct functioning of the drainage pipes is critical to the performance of the bioretention system. Dig trenches in drainage layer and place drainage pipes. Ensure pipes are laid at min 0.5% slope with no localized depressions verified using level or string line. All joints and junctions in pipes to be sealed. Connect clean out points ensuring top of clean out points are not less than 50 mm below overflow pit crest.

SUPERINTENDENT INSPECTION AND SIGN OFF REQUIRED BEFORE PROCEEDING.

10. Cover drainage pipes with drainage media, ensuring design cover.
11. Place transition layer (using only prescribed drainage material: 2.0mm sand) to design level (refer drawings).

SUPERINTENDENT INSPECTION AND SIGN OFF REQUIRED BEFORE PROCEEDING.

12. Place filter media (using only prescribed material: 0.45mm sandy loam) to design level (refer drawings). Spread material using excavator bucket or hand tools to obtain light and even compaction of filter media. Do not drive over filter media with any vehicle as excessive compaction can impede drainage through the filter media. Filter media surface must be level (horizontal) and free from local depressions and set at 200 mm below pit crest (except forebay area which is 300mm). As soon as filter media is placed it must be immediately covered with a geofabric cover which must remain in place at all times except when access to filter media is required.This protective cover is only to be removed by landscapers immediately prior to planting.
13. Lay excess geofabric flaps from pod outward across adjacent subsoil and place landscaping topsoil on top of this geofabric and around pod as per designs.
14. Install protective plywood barriers ensuring the crest is at design level (min 100 mm above elevation of pit crest) and extends laterally to pod batters by 300 mm, and vertically into the filter media by 200 mm. This plywood barrier needs to remain in place for 12 months and prevent sediment laden runoff from entering the majority for the pod area. After 12 months once the vegetation is established and the allotment construction is complete these plywood barriers will be taken out and the system brought online.
15. Cover inlet zone with protective geofabric ensuring geofabric extends over crest of protective plywood barrier. Cover geofabric with min 50 mm topsoil suitable for turf growth. Similar to the plywood barriers, this geofabric is a temporary protective measure to protect the filter media in the inlet zone from being clogged with construction sediment, and will be removed after 12 months.
16. Flush drainage pipes to remove any initial ingress of material and to ensure adequate drainage.

FINAL SUPERINTENDENT INSPECTION AND SIGN OFF

Note that between steps 5 – 16 above the pods will be susceptible to storm damage. Therefore once commenced pods must be completed as soon as possible to minimise the risk of storm damage.
Inspection is required if rainfall event occurs between construction steps 5 – 16 above.

FILE: N06081-411.dwg DATE: 19-11-2008 TIME: 15:14
Xref's: N06081-tit USR: michael dobos

	ISSUE	CALCS	DRAWN	DATE	AMENDMENT DETAILS
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AMENDMENTS	A	DC	LA	09.07.07	COUNCIL RE-ISSUE
	B	DC	CB	15.10.08	AMENDMENTS AS PER COUNCIL RFI
	C	DC	DC	21.10.08	RFI RESUBMISSION
	D	--	MD	18.11.08	AMENDMENTS AS PER COUNCIL RFI .
	E				
	F				

DESIGN CHECK
DRAWN CHECK

SCALE (METRES)
1:20 0.2 0 0.2 0.4 0.6 0.8 1 A1
1:40 A3

MICROFILM No.
PROJECT No. N06081

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DRAWING TITLE: BIO POD DETAIL PLAN SHEET 3 OF 3

DRAWING NUMBER: N06081-411 ISSUE: D

APPENDIX D: DESIGN CHECKLIST & CALCULATION SUMMARY OF INDICATIVE STREETSCAPE BIORETENTION SYSTEM

A design checklist and calculation summary is provided in this appendix for an 'indicative streetscape bioretention system' within the proposed development. The design checklist and calculation summary given in this appendix assumes the bioretention 'pod' configuration illustrated in Figure 2-4 and Appendix C. The calculations also assume that these pods are equally distributed throughout the subcatchment (ie. similar catchment areas drain to each pod).

It should be noted that the checklist and calculation summary given below is indicative only. Personnel (eg. engineers, landscape designers) involved in the detailed design of the streetscape bioretention systems should follow the procedures recommended in the Healthy Waterways (2006) '*Water Sensitive Urban Design Technical Guidelines for South East Queensland*' and subsequently provide design checklists and calculation summaries (at least for some representative bioretention systems within the propose development) as part of their detailed design.

BIORETENTION BASIN DESIGN CALCULATION SUMMARY

		CALCULATION SUMMARY		
	Calculation Task	**Outcome**		**Check**
	Catchment Characteristics			
	Catchment area	0.072	Ha	✓
	Catchment land use (i.e residential, commercial etc.)	Residential		
	Storm event entering inlet	2	yr ARI	
	Conceptual Design			
	Bioretention filter area	8	m^2	✓
	Filter media saturated hydraulic conductivity	200	mm/hr	
	Extended detention depth	200	mm	
1		**Verify size for treatment**		
		Bioretention area to achieve water quality objectives		
	Total suspended solids	See Table 2-4	% of catchment	
	Total phosphorus	See Table 2-4	% of catchment	
	Total nitrogen	See Table 2-4	% of catchment	
	Bioretention surface area	10	m^2	✓
	Extended detention depth	0.2	m	
2		**Determine design flows**		
		Time of concentration		
	Refer to relevant local authority guidelines and QUDM	6	minutes	✓
			Identify rainfall intensities	
	Minor Storm ($I_{2\text{-}10\ year\ ARI}$)	115	mm/hr	✓
	Major Storm ($I_{50\text{-}100\ year\ ARI}$)	146	mm/hr	
			Design runoff coefficient	
	Minor Storm ($C_{2\text{-}10\ year\ ARI}$)	0.61		✓
	Major Storm($C_{50\text{-}100\ year\ ARI}$)	0.65		
		Peak design flows		
	Minor Storm (2-10 year ARI)	0.030	m^3/s	✓
	Major Storm (50-100 year ARI)	0.084	m^3/s	

BIORETENTION BASIN DESIGN CALCULATION SUMMARY

	Calculation Task	Outcome		Check
		CALCULATION SUMMARY		
3	**Design inflow systems**			
	Adequate erosion and scour protection?	Yes		✓
	Coarse Sediment Forebay Required?	No		✓
	Volume (V_s)	N/A	m^3	
	Area (A_s)	N/A	m^2	
	Depth (D)	N/A	m	
*	Check flow widths in upstream channel			
	Minor storm flow width	TBC	m	
	CHECK ADEQUATE LANES TRAFFICABLE	TBC		
*	Kerb opening width	0.5		
	Kerb opening length	0.5	m	✓
4	**Specify bioretention media characteristics**			
	Filter media hydraulic conductivity	200	mm/hr	✓
	Filter media depth	600	mm	
	Drainage layer media (sand or fine screenings)			
	Drainage layer depth	200	mm	✓
	Transition layer (sand) required	Yes		
	Transition layer depth	100	mm	
	Submerged zone depth	200	mm	
5	**Under-drain design and capacity checks**			
	Flow capacity of filter media	0.00047	m^3/s	✓
	Perforations inflow check	Yes		
	Pipe diameter	100	mm	
	Number of pipes	2		
	Capacity of perforations	0.2	m^3/s	
	CHECK PERFORATION CAPACITY > FILTER MEDIA CAPACITY	Yes		
	Perforated pipe capacity			
	Pipe capacity	0.0122	m^3/s	✓
	CHECK PIPE CAPACITY > FILTER MEDIA CAPACITY	Yes		
6	**Check requirement for impermeable lining**			
	Soil hydraulic conductivity	TBC	mm/hr	
	Filter media hydraulic conductivity	200	mm/hr	
	MORE THAN 10 TIMES HIGHER THAN IN-SITU SOILS?	TBC		
7	**Size overflow pit**			
	System to convey minor floods (2-10yr ARI)	0.3m x 0.3m	L x W	✓
8	**Verification Checks**			
	Velocity for Minor Storm (<0.5m/s)	0.16	m/s	✓
	Velocity for Major Storm (<2.0m/s)	0.42	m/s	
	Treatment performance consistent with Step 1	TBC		
*	Relevant to streetscape application only			

BIORETENTION BASIN DESIGN ASSESSMENT CHECKLIST			
Asset I.D.		**DA No.**	
Basin Location:	Precinct 1 (Indicative Bioretention Pod)		
Hydraulics:	Minor Flood (m^3/s): 0.030	Major Flood (m^3/s): 0.084	
Area:	Catchment Area (ha): 0.072 ha	Bioretention Area (ha): Filter area $8m^2$	

TREATMENT	**Y**	**N**
Treatment performance verified from curves?		✓
BIORETENTION MEDIA AND UNDER-DRAINAGE	**Y**	**N**
(1) Design documents bioretention area and extended detention depth as defined by treatment performance requirements.	✓	
(2) Overall flow conveyance system sufficient for design flood event(s)?	✓	
(3) Where required, bypass sufficient for conveyance of design flood event?	✓	
(4) Where required scour protection provided at inflow point to bioretention?	✓	
(5) Bioretention media specification includes details of filter media, drainage layer and transition layer (if required)?	✓	
(6) Design saturated hydraulic conductivity included in specification?	✓	
(7) Transition layer provided where drainage layer consists of gravel (rather than coarse sand)?	✓	
(8) Perforated pipe capacity > infiltration capacity of filter media?	✓	
(9) Selected filter media hydraulic conductivity > 10 x hydraulic conductivity of surrounding soil?	TBC	
(10) Liner provided if selected filter media hydraulic conductivity < 10 x hydraulic conductivity of surrounding soil?	TBC	
(11) Maximum spacing of collection pipes <1.5m?	✓	
(12) Collection pipes extended to surface to allow inspection and flushing?	✓	
(13) *Maximum upstream flood conveyance complies with QUDM?	✓	
(14) *Overflow pit has set down of at least 50mm below kerb invert? (where conventional gully/lintel used downstream of bioretention then no overflow pit required)	✓	
BASIN	**Y**	**N**
(15) Bioretention area and extended detention depth documented to satisfy treatment requirements?	✓	
(16) Overflow pit crest set at top of extended detention?	✓	
(17) Maximum ponding depth will not impact on public safety?	✓	
(18) Maintenance access provided to surface of bioretention system (for larger systems)?	✓	
(19) Protection from coarse sediments provided (where required) with a sediment forebay?	✓	
(20) Protection from gross pollutants provided (where required)?	✓	
LANDSCAPE	**Y**	**N**
(21) Plant species selected can tolerate extended dry periods, periodic inundation and design velocities?	✓	
(22) Bioretention design and plant species selected integrate with surrounding landscape or built environment design?	✓	
(23) *Planting design conforms with acceptable sight line and safety requirements?	TBC	

COMMENTS

- (1): MUSIC Modelling applied (which is far more accurate that the use of curves given in WSUD Guidelines)
- (9) and (10): Surrounding soil (infill) properties are yet to be confirmed. However, it is anticipated that a liner will be required.

APPENDIX E: INDICATIVE MAINTENANCE REQUIREMENTS FOR BIORETENTION SYSTEMS

SCHEDULE OF SITE VISITS													
Purpose of Visit	**Frequency**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Routine inspection	12/year	√		√		√		√		√		√	
Annual inspection	1/year					√							
Routine Maintenance	4/year	√			√			√			√		

The above schedule is a guideline only. Inspection and maintenance activities during the plant establishment period (first two years) are likely to be more frequent when frequent weed removal and replanting may be required. Inspections should also be performed after large rainfall events to check for damage or significant pollutant accumulation. Maintenance should only occur after a reasonably rain free period when the soil in the bioretention system is dry. Inspections are also recommended following large storm events to check for scour and other damage. Resetting (i.e. complete reconstruction) of the bioretention basin will be required if the system fails to drain adequately after tilling of the surface.

Mowing will be required at frequent (approximately monthly) intervals if the bioretention system (floor and/ or batters) has been planted with turf.

INSPECTION	
1	**Routine Inspection**
1.1	Routine inspection should be carried out on a regular bi-monthly basis. The purpose of the inspection is to check for weed invasion, litter accumulation and any damage/vandalism.
1.2	The bioretention system (including floor and batters) should be inspected for weed growth.
1.3	The bioretention system (including inflow points, overflow pits, under-drains and vegetation) should be checked for litter accumulation.
1.4	Identify areas of obvious sediment deposition, damage from vehicles and/ or clogging within the bioretention basin (evident by ponding and/ or 'boggy' filter media surface). If there is shallow ponding or evidence of clogging, firstly ensure that cause is not a build up of sediment. Investigate effect of "turning over" or "tilling" filter media soil, and inspect outflow pipes for clogging.
1.5	Identify areas of erosion, including scouring from storm flows and rill erosion of the batters from lateral inflows.
1.6	Any structures such as maintenance accesses, weirs, piping and access restrictions (eg. lock-rails, fencing) should be inspected for damage and or vandalism.
2.	**Annual Inspection**
2.1	Once per year, the condition of the bioretention basin should be closely inspected. Any damage or problems should be noted on the inspection form for action by the relevant maintenance agency.

ROUTINE MAINTENANCE	
3	**Purpose**
3.1	Routine maintenance of the bioretention system involves weed control and the collection of any litter and minor remedial works if required. If turf has been planted across the surface of the bioretention system, this will obviously require mowing (with mowed grass deposited offsite at an appropriate waste management facility).
4	**Weed Management**
4.1	If weeds have been observed within the bioretention system during routine inspection, these weeds should be removed by hand.
4.2	Where physical removal has been specified, the aim is to remove the weed including the roots when the weeds are less than 3 months old.
4.3	Herbicides should not be used.
4.4	The weeds should be disposed of offsite at an appropriate waste management facility.
4.5	Replant plant species as necessary in areas that have been extensively weeded.
4.6	*In general, the planted species should not be harvested. Harvesting plants has little, if any, benefit for treatment performance.*
5	**Litter Management**
5.1	Remove and dispose of any accumulated litter/debris within the bioretention basin.
6	**Surface Tilling**
6.1	If there is evidence of clogging of the bioretention system, tilling the bioretention basin surface or remove of the surface layer.
7	**Sediment Removal**
7.1	Removal of sediment where it is smothering the bioretention basin vegetation. Remove accumulated sediments by surface scraping (if it does not damage the vegetation too much) or reforming of the bio-retention system.
8	**Under-Drainage Cleaning**
8.1	If the bioretention system is not draining, a reason may be due to the under-drainage being blocked by sediment or litter/ debris. This blockage should be removed by ‘rodding’ or ‘jetting’ (using high pressure water) of the under-drainage. As a result, ‘rodding’ points should be provided at the upstream ends of all under-drainage.
9	**Remedial Works**
9.1	Routine inspection may detect minor damage to the bioretention system after storms that should be repaired. This may include erosion on the bioretention system or scouring at the inlet and/or outlet. This damage should be repaired as part of the routine maintenance of the bioretention system. Measures to reduce future damage (eg. erosion) from occurring should also be investigated and, if possible, implemented.
9.2	Resetting (i.e. complete reconstruction) of the bioretention system will be required if the system fails to drain adequately after tilling of the surface and no evidence of sediment accumulation or under-drainage blockage can be identified.

BIORETENTION SYSTEM MAINTENANCE CHECKLIST			
Asset I.D.			
Inspection Frequency:	1 to 6 monthly	**Date of Visit:**	
Location:			
Description:			
Site Visit by:			

INSPECTION ITEMS	Y	N	ACTION REQUIRED (DETAILS)
Sediment accumulation at inflow points?			
Litter within bioretention system?			
Erosion at inlet or other key structures?			
Traffic damage present?			
Evidence of dumping (building waste)?			
Vegetation condition satisfactory (density, weeds etc)?			
Watering of vegetation required?			
Weed removal required ?			
Mowing/slashing required?			
Pruning and/ or removal of dead or diseased vegetation required?			
Replanting required?			
Damage/vandalism to structures present?			
Set down from kerb still present (if road-side bioretention swale)?			
Evidence of ponding?			
Surface clogging visible?			
Drainage system inspected?			
Clogging of drainage points (sediment or debris)?			
Resetting of system required?			
COMMENTS			

APPENDIX F: ASSESSMENT OF STORMWATER MANAGEMENT OPTIONS

The main options available to achieve the given operational performance criteria (see Table 2-4) are streetscape bioretention, 'end-of-pipe' bioretention and wetlands.Streetscape bioretention has been recommended for the proposed development for several reasons, including (but not limited to):

- Reduced area requirements for stormwater treatment (relative to wetlands)
- Reduced life cycle costs (relative to wetlands)
- Reduced risk to public safety (relative to wetlands)
- Reduced risk of attracting birds to site (relative to wetlands)
- Reduced risk of operational problems (eg. scour/ erosion)
- Improved integration into the landscape (particularly relative to 'end-of-pipe' solutions, which necessitate large depths/ batters).
- Considered best practice stormwater management for sites with constraints similar to the proposed development.

This is discussed further below.

It should be noted that this report has been prepared entirely at a conceptual level of detail. Streetscape bioretention is likely to be a preferred method for stormwater management given several reasons (including those described below). Nevertheless, opportunities for 'end-of-pipe' bioretention systems may be explored where considered potentially feasible and a possibly better method of stormwater management. The filter area requirements for 'end-of-pipe' bioretention systems are identical to 'streetscape' bioretention systems.

Reduced Area Requirements

Streetscape bioretention areas are anticipated to require less area relative to 'end-of-line' treatment devices (particularly wetlands). Furthermore, streetscape bioretention system can provide far greater opportunity for integration into landscaped areas.

As described in Table 2-12, the streetscape bioretention filter area required (to satisfy given stormwater objectives) is 1.1% of total developed area. The total filter areas required for 'end-of-line' bioretention basins would be the same as for streetscape bioretention. If wetlands were applied instead, however, the wetland macrophyte zone surface area would be 5.5 and 6% of total development area for Precincts 1 and 2 respectively (based on MUSIC models developed for this project).

It should be noted that the aforementioned areas required for 'end-of-line' systems does not include additional area necessary for inlet zones (or 'sediment forebays'), bypass channels, maintenance access and batters (which would likely be high given the large invert depths of any 'end-of-line' system).

Reduced Life Cycle Costs

As described in Section 2.7, life cycle costs of streetscape bioretention systems have been prepared using MUSIC with the methodology as recommended in MSC's (2007) '*Integrated Water Management Guidelines*'. This method has been used to compare the costs of bioretention systems and wetland systems and (although very approximate) allows a cost comparison between different options. The results of this assessment are provided in Tables F-1 and F-2.

Table F-1 Life Cycle Costing Summary: Bioretention v Wetlands

Precinct	Treatment Measure	LCC ($2010)	Equivalent Annual Payment ($2010 per annum)				
			Total Cost	Per kg TSS	Per kg TP	Per kg TN	Per kg GP
Scenario with Bioretention Systems (End-of Line or Streetscape Systems)							
1	Bioretention	499 841	9 997	0.23	146	49	1.7
2	Bioretention	298 316	5 966	0.30	200	72	2.5
Scenario with Wetlands (Instead of Bioretention)							
1	Wetlands	1 931 833	38 637	0.88	529	170	6.7
2	Wetlands	1 066 924	21 338	1.09	660	224	9.0

Table F-2 Life Cycle Costing Summary: Bioretention v Wetlands – Excluding Acquisition Costs

Precinct	Treatment Measure	LCC ($2010)	Equivalent Annual Payment ($2010 per annum)				
			Total Cost	Per kg TSS	Per kg TP	Per kg TN	Per kg GP
Scenario with Bioretention Systems (End-of Line or Streetscape Systems)							
1	Bioretention	260 011	5 200	0.12	76	26	0.9
2	Bioretention	180 177	3 603	0.18	121	44	1.5
Scenario with Wetlands (Instead of Bioretention)							
1	Wetlands	733 644	14 673	0.33	201	65	2.6
2	Wetlands	366 887	7 338	0.37	227	77	3.1

As shown by the predicted life cycle costs presented above, wetlands are predicted to have significantly higher life cycle costs relative to bioretention systems (regardless of whether acquisition costs are included in the analysis or not).

Reduced Risk to Public Safety

Wetlands typically contain a permanent pool of water, which presents a drowning risk to the public. This risk can be reduced, however, through a variety of means (eg. gradually sloping batters, dense vegetation around wetland edges, fencing).

Bioretention systems do not contain any permanent water. As result, the risk of drowning is typically significantly lower than wetlands.

Reduced Risk of Attracting Birds to Site

As wetlands typically contain a permanent pool of water, wetlands are much more likely to attract birds to the site relative to bioretention systems (Dalrymple et al, 2010).

The use of bioretention systems (relative to wetlands) is significantly less likely to increase the risk of bird strike to users of the Caloundra Aerodrome.

Reduced Risk of Operational Problems

BMT WBM recently undertook a review of Council-owned constructed wetlands and bioretention systems (used for stormwater treatment) within South East Queensland. The results of this assessment are documented in Dalrymple et al (2010) (see References section). This assessment demonstrated that 'end-of-line' stormwater treatment devices had a greater risk of operational problems (relative to 'at source' devices), including (but not limited to) erosion/ scour, poor drainage and vegetation loss.

Where 'end-of-pipe' devices have been applied, the health of downstream environments is often heavily dependent on these 'end-of-pipe' devices due to the small numbers of these devices present (relative to 'at source'/ distributed treatment devices). If these 'end-of-pipe' devices have operational problems, there is obviously greater consequences to the health of downstream environments relative to problems potentially experienced by isolated 'at source'/ distributed stormwater treatment devices (given the increased number of these devices).

Improved Integration into the Landscape

As shown by the examples of streetscape bioretention provided in Figure 2-3 and Figure 2-4, streetscape bioretention systems can be easily integrated into the landscape/ streetscape. 'End-of-pipe' wetlands and bioretention systems are significantly more difficult to integrate into the landscape. This is often due to the invert depths necessary for upstream stormwater infrastructure that necessitates large invert depths of the treatment devices. Given these large depths, 'end-of-pipe' wetlands and bioretention systems often need large batter areas (if gradually sloping) or steep batters with fencing. Figure R-1 provides an example of a poorly integrated 'end-of-pipe' bioretention basin.

Figure R-1 Example of a Poorly Integrated 'End-of-Pipe' Bioretention Basin

Best Practice Stormwater Management

In addition to the aforementioned benefits, streetscape bioretention also is highly effective at reducing pollutant loads, retaining stormwater flows and treats stormwater 'at the source'. As a result, streetscape bioretention is typically considered best practice stormwater management (particularly for flat sites such as the proposed development).

Water By Design's (2009) "*Conceptual Design Guidelines for Water Sensitive Urban Design*" also support the above statement. Section '*Best Planning Practice 2 – Flat Sites*' describes the advantages of streetscape bioretention in great detail and cites the existing Stockland's "*Bellvista Estate*" (and its use as streetscape bioretention) as follows:

"*After considering several approaches, an at-source and at-surface approach was adopted using bioretention pods in residential streets. This strategy is the best outcome for the site given the constraints of low-lying, flat topography and sensitive receiving waters. By using an approach that finds the synergies between stormwater quality, road drainage, traffic calming, and landscape design, Bellvista Estate delivers innovative streetscapes that provide at-source treatment of stormwater integrated into the urban landscape*

The solution represents best practice in stormwater management by protecting natural systems, integrating stormwater treatment into the landscape, protecting water quality, reducing runoff and peak flows, and adding value... "

Water by Design is a capacity building program that was established by the South East Queensland Healthy Waterways Partnership (SEQHWP) as an "*integral part of the South East Queensland Healthy Waterway Strategy*" (Water By Design, 2010). The SEQHWP state that the strategy "*was prepared by the Partners of the SEQHWP*", which includes Sunshine Coast Regional Council (www.healthywaterways.org).

We subsequently believe that our proposed stormwater management strategy (consisting of education, rainwater tanks and streetscape bioretention) represents best practice stormwater management for the proposed development (and associated site conditions).

Conclusion

Streetscape bioretention is likely to be a preferred method for stormwater management given several reasons (including those described above). As described above, however, this report has been prepared at a conceptual level of detail. Opportunities for 'end-of-pipe' bioretention systems may be explored where considered potentially feasible and a possibly better method of stormwater management (relative to streetscape bioretention systems).

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