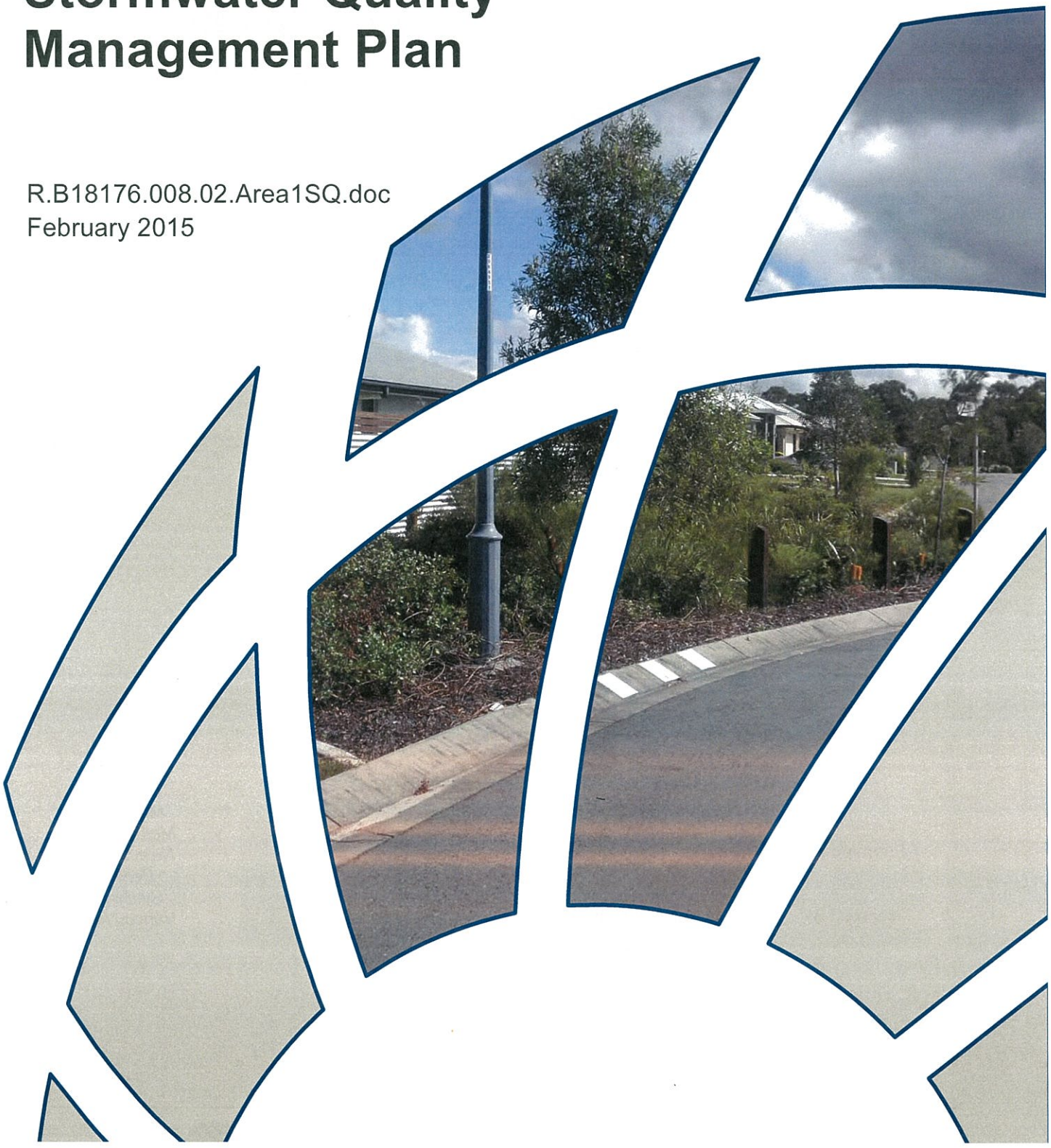
BMT WBM

A part of BMT in Energy and Environment

Precinct 1, Caloundra South Development: Stormwater Quality Management Plan

R.B18176.008.02.Area1SQ.doc
February 2015



Precinct 1, Caloundra South Development: Stormwater Quality Management Plan

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

Offices

Brisbane
Denver
Mackay
Melbourne
Newcastle
Perth
Sydney
Vancouver

DOCUMENT CONTROL SHEET

BMT WBM Pty Ltd

BMT WBM Pty Ltd
Level 8, 200 Creek Street
Brisbane 4000
Queensland Australia
PO Box 203 Spring Hill 4004

Tel: +61 7 3831 6744
Fax: + 61 7 3832 3627

ABN 54 010 830 421

www.bmtwbm.com.au

Document :	R.B18176.008.02.Area1SQ.doc
Project Manager :	Brad Dalrymple
Client :	Stockland
Client Contact:	Mark Stephens
Client Reference	

Title :	Precinct 1, Caloundra South Development: Stormwater Quality Management Plan
Author :	Nicole Ramilo, Brad Dalrymple
Synopsis :	This report presents the stormwater quality management strategy for 'Precinct 1' within the proposed 'Caloundra South' master-planned community.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY		ISSUED BY	
0	14 December 2012	Brad Dalrymple		Nicole Ramilo	
1	18 December 2012	Brad Dalrymple		Nicole Ramilo	
2	19 February 2015	Nigel Hardie		Brad Dalrymple	

DISTRIBUTION

DESTINATION	REVISION				
	0	1	2	3	4
Stockland	PDF	PDF	PDF		
BMT WBM File	PDF	PDF	PDF		
BMT WBM Library	PDF	PDF	PDF		

CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

BMT WBM has been commissioned by Stockland (in support of a Development Application to the Minister for Economic Development Queensland) to prepare a Stormwater Quality Management Plan (SQMP) for 'Precinct 1' – a 35.5 hectare portion of the 'Caloundra South' master-planned community, located on the Sunshine Coast. Precinct 1 is hereafter referred to as the 'site'.

The proposed development consists of residential, park and open space areas. The site drains to Lamerough Creek, and is required to satisfy best practice stormwater pollutant removal targets.

The modelling results show that the proposed stormwater management strategy for the site will achieve the required best practice pollutant load removal targets.

Table S-1 provides a summary of the proposed stormwater management strategy (and its assumed properties in MUSIC).

Table S- 1 Summary of Proposed Stormwater Management Strategy

Component	Description
Education	Signage installed at appropriate locations (e.g. adjacent to rain gardens). No pollutant load removal for education has been assumed in our assessment.
Rainwater harvesting & reuse	Rainwater tanks installed within urban living areas in accordance with QDC MP4.2. Modelled in MUSIC as a single rainwater tank node for each land usage classification. 50% of roof area assumed to drain to a rainwater tank.
Rain gardens	Multiple rain gardens ('bioretention') integrated throughout the site, either within the streetscape or similarly providing treatment 'at source'. Rain gardens provide treatment to all residential and road areas. Modelled as a single bioretention node in MUSIC. Filter area 1.2% of total upstream area for areas draining to Lamerough Creek catchment (excluding, park, open space and stormwater conveyance areas). 0.2m storage depth, 0.4m filter depth, sandy loam media (saturated hydraulic conductivity 200mm/ hour, TN content 400mg/ kg, 20mg/ kg ortho-P content), vegetated with effective nutrient removal plants, zero exfiltration.

1 INTRODUCTION

BMT WBM has been commissioned by Stockland to prepare a Stormwater Quality Management Plan (SQMP) in support of a Development Application to the Minister for Economic Development Queensland for 'Precinct 1', containing a 35.5 ha portion of the 'Caloundra South' master-planned community, located on the Sunshine Coast. It is noted that the development site includes a 14.3 ha area designated as 'stormwater conveyance'. This area is located outside of the site's developable footprint and has therefore not been included in this assessment. The development site, Precinct 1, is hereafter referred to as the 'site'.

The stormwater management plan provides a conceptual assessment and plan relating to runoff from the site and how it will achieve relevant stormwater management objectives during the operational (post construction) phase of the development.

2 SITE DESCRIPTION

2.1 Location

The 30.5 hectare site is located within the Caloundra South master-planned community. The site is located to the south west of the Caloundra town centre and south of the existing residential developments referred to as 'Bellvista' and 'Bells Reach'. Caloundra Aerodrome is located to the east, and Lamerough Creek is located immediately south of the site. The location of the site is shown in Figure 2-1.

It is noted that the 30.5 ha site shown in Figure 2-1 contains a developable area of 21.2 hectares (proposed for lots, roads, park and open space), in addition to a 14.3 hectare area designated as 'stormwater conveyance' that has been excluded from our analyses. The site layout plan can be viewed in Appendix A.

2.2 Site Topography and Drainage

The site generally has a slight gradient towards Lamerough Creek, which flows to Pelican Waters and subsequently Pumicestone Passage. The highest elevation is approximately 4.1m AHD at the north-eastern corner of the site, whilst the lowest point is approximately 1.6m AHD at the southern side of the site.

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 topography of the existing site is shown in Figure 2-2.

2.3 Pumicestone Passage Water Quality

The Ecosystem Health Monitoring Program (EHMP), a multi-agency funded (lead by the Queensland Government) environmental monitoring program, has been collecting water quality data at monthly intervals at a number of sites along Pumicestone Passage for more than 10 years.

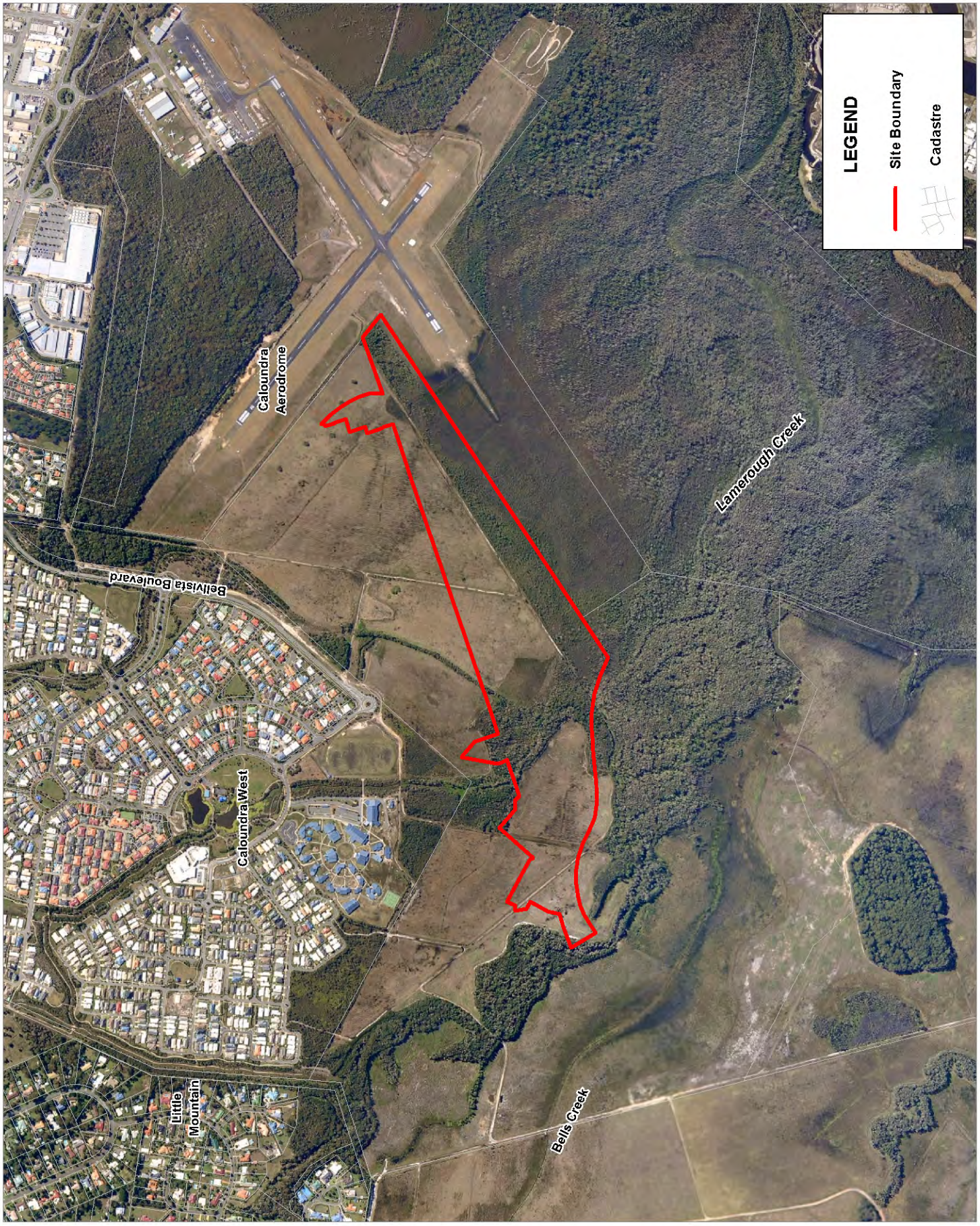
The BMT WBM (2011) report "*Caloundra South Integrated Water Quality Modelling Assessments*" provides a review of this data. The report describes that much of Pumicestone Passage is naturally not compliant with relevant water quality objectives, including those for pH, dissolved oxygen, turbidity, total nitrogen, total phosphorus and chlorophyll-a.

2.4 Existing Site

The existing site is undeveloped. The BMT WBM (2011) "*Caloundra South Consolidated Water Report*" further describes the temporal land use changes across the Caloundra South area. An aerial photo of the site is provided in Figure 2-3.

2.5 Proposed Development

The proposed development of the site includes residential lots, roads, parks and open space areas. A site layout plan of the proposed development is provided in Appendix A.



Title:

Location of Site

Figure: 2-1

Rev: B

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

N

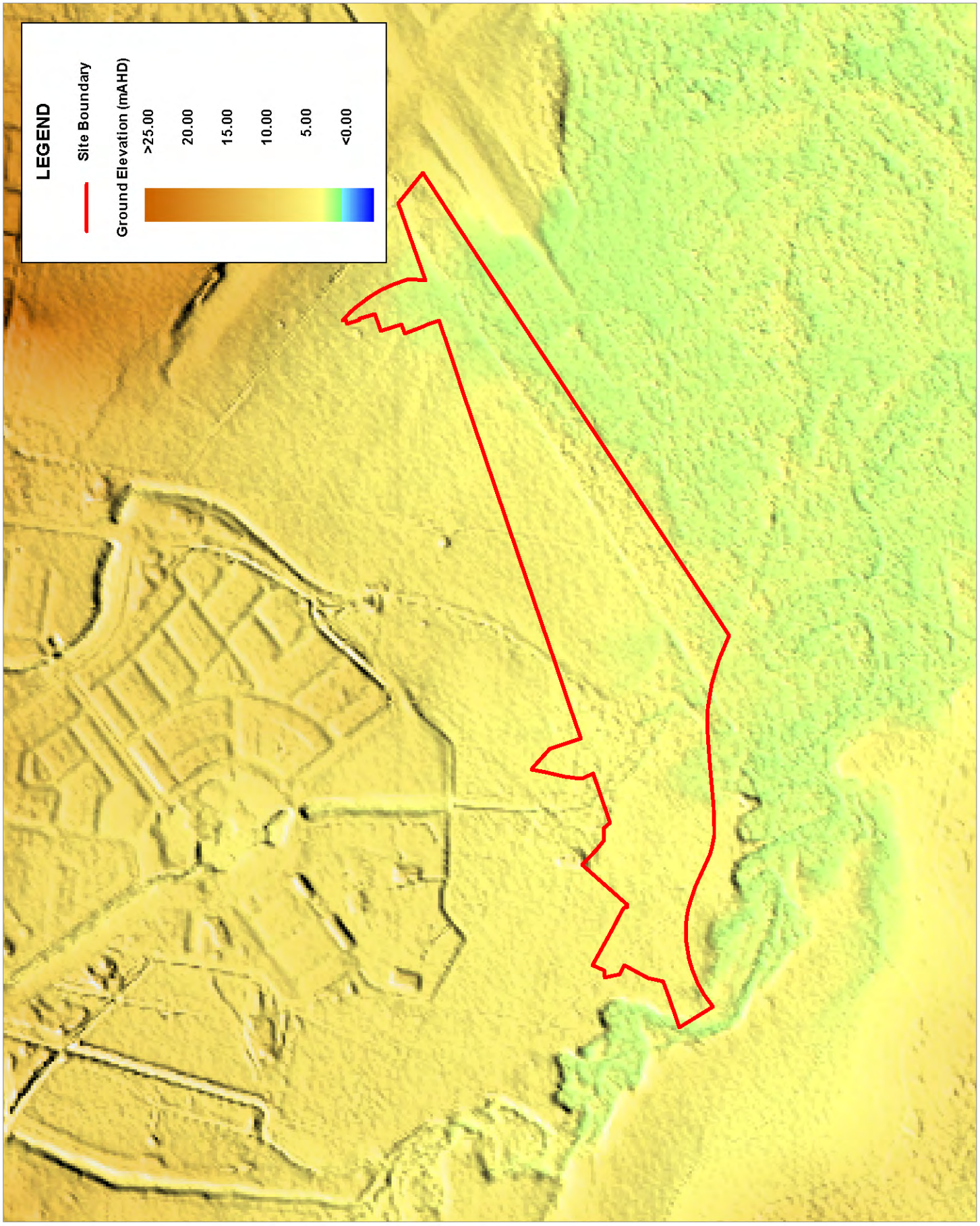
0 300 600m

Approx.Sacle

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B18176_I_AMB_Caloundra_Downs\DRG\AppArea1\UW_002_Location.wor



Title:
Existing Topography of Site

Figure:
2-2

Rev:
B

N

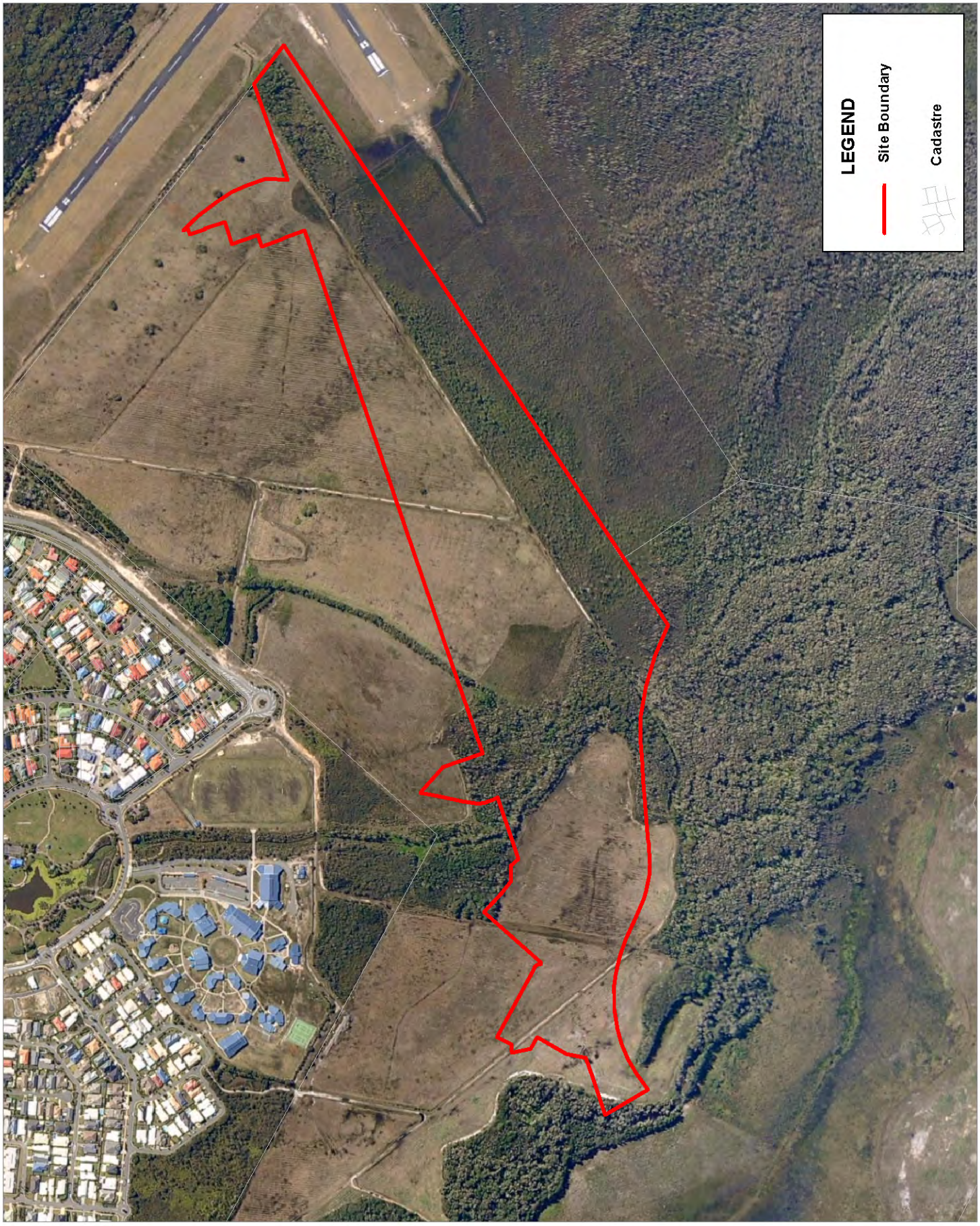
0 200 400m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B18176_I_AMB_Caloundra_Downs\DRG\AppArea1\UW_003_Topography.wor



Title:
Aerial Photo of Site

Figure: 2-3

Rev: B

N

0 100 200m
Approx.Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B18176_I_AMB_Caloundra_Downs\DRG\AppArea1\UW_004_AerialPhoto.wor

3 STORMWATER MANAGEMENT PLAN

3.1 Preamble

This section provides a conceptual assessment and plan relating to stormwater runoff from the site and how it will achieve requisite stormwater management objectives during the operational (post-construction) phase of the master-planned community.

3.2 Stormwater Management Objectives

Performance criteria for the operational phase of the development have been taken directly from DSDIP (2013). These criteria are given in Table 3-1 below.

Table 3-1 Operational Phase Performance Criteria

Pollutant	Criteria
Total Suspended Solids	80% reduction
Total Phosphorus	60% reduction
Total Nitrogen	45% reduction
Gross Pollutants (5 mm or larger)	90% reduction

The criteria (given in Table 3-1) have been adopted for the following reasons:

- These best practice pollutant load removal targets are defined by DSDIP (2013) to ensure development is planned, designed, constructed and operated to manage stormwater in ways that support the protection of environmental values identified in the Environmental Protection (Water) Policy 2009.
- The application of this criteria (for areas draining to Lamerough Creek) achieves compliance with the target for the Caloundra South project of 'no net worsening' in the water quality of Pumicestone Passage. The small change in flows and loads from the portion of the site that flows to Lamerough Creek (due to development of the Caloundra South site) has no significant impact to water quality within Pumicestone Passage. This is largely due to the following:
  - The area of the site within the Lamerough Creek catchment is only a very small portion of the total catchment area contributing to Pumicestone Passage.
  - Pumicestone Passage water quality is dominated by tidal processes, providing significant tidal flushing (and subsequently mitigating significant changes in flows and loads from catchment-based sources).

3.3 Modelling Methodology

3.3.1 Software

The eWater CRC *MUSIC* software (Version 6) has been used in this assessment.

3.3.2 Source Nodes

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

Rainfall-runoff and pollutant export characteristics of the existing (pre developed) site have been developed based on the data collected as part of BMT WBM's baseline monitoring program at the Caloundra South site (documented the BMT WBM report "*Caloundra Downs: Baseline Monitoring Program Final Report*"). The MUSIC source node properties (i.e. rainfall-runoff and pollutant export characteristics) applied for the 'existing site' (and the methodology used to derive them) are described in Appendix B.

Land usage classifications for the proposed site have been based on the development layout plans provided by Stockland. Refer to Appendix A for the proposed development layout.

Rainfall-runoff and pollutant export characteristics for MUSIC source nodes have been applied in accordance with the Water By Design (2010b) "*MUSIC Modelling Guidelines*" for the various land uses as follows:

- *Residential*: for 'residential' lots.
- *Residential Ground Level*: for any 'park' and 'open space' areas.
- *Residential Road*: for all 'road' areas.

Each of the residential lots were further separated into roof and ground level areas, based on the land usage breakdown as recommended by Water By Design (2010b). Pollutant export properties for these land use types were also applied from Water By Design (2010b).

An effective impervious percentage of 0% was assumed for the existing site and all open space and park areas. Effective impervious percentages for other areas were based on recommended values given in Water By Design (2010b). It should be noted that our analyses includes the 21.2 hectare developable area on site only (proposed for lots, road, park and open space). The 14.3 hectare area shown in Appendix A as 'stormwater conveyance' has been excluded from our analyses.

3.3.3 Meteorological Data

Modelling was performed for a period of ten years (from 1st January 1997 to 31st December 2006), using recorded pluvio data from the Caloundra WTP (Station 40496) and monthly areal PET. The application of this meteorological data is in accordance with the Water by Design (2010) "*MUSIC Modelling Guidelines*".

While some years were "dry", it is more important in the MUSIC model to ensure that a reasonable spread of individual rainfall events is represented, rather than just considering whether the annual

rainfall was low or high. For these reasons, the Caloundra WTP data is the best available given its proximity to the site and the period of time (10 years) of data available.

Figure 3-1 illustrates the variation in annual rainfall during the 10-year model simulation.

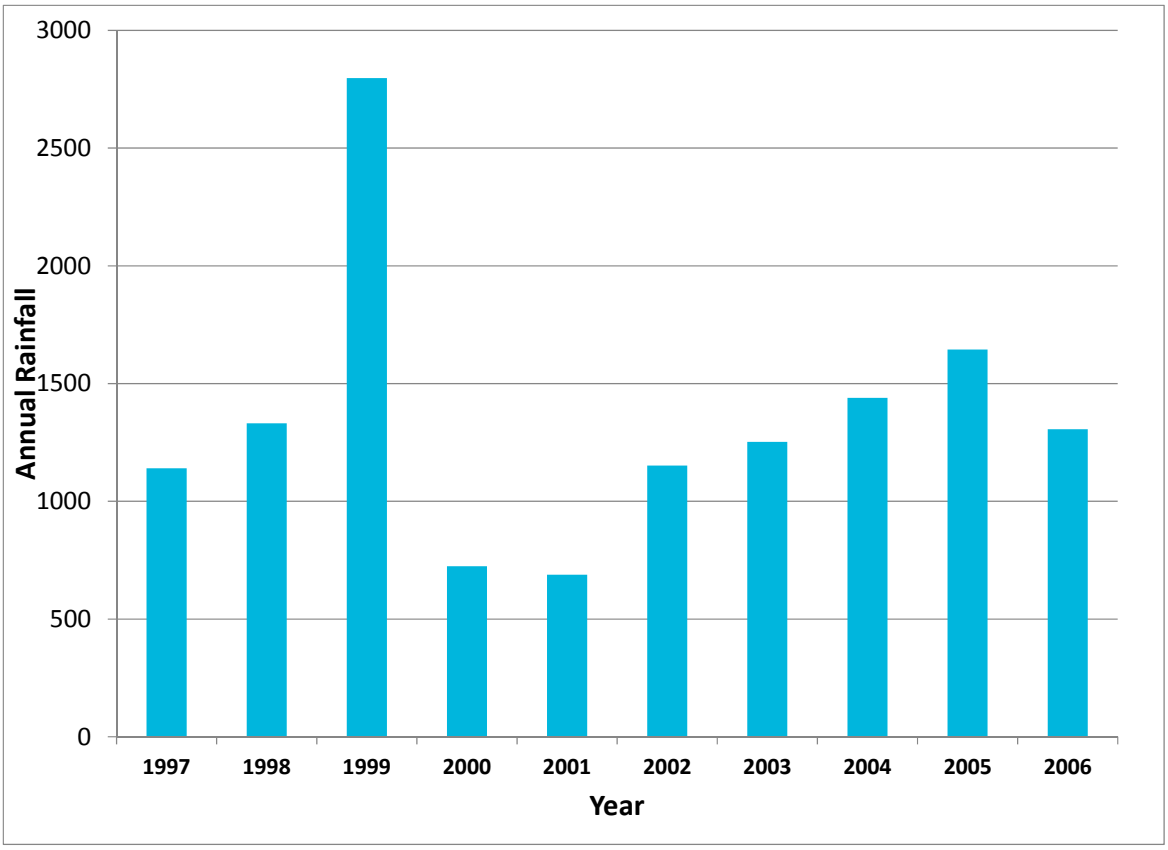


Figure 3-1 Annual Rainfall at Caloundra WTP Station (1997 to 2006)

As shown in Figure 3-1, the highest rainfall in any year during the 10-year model simulation was 1999. During 1999, 2798mm was recorded at the Caloundra WTP station, which is more than two times the annual average for the given 10-year period.

3.4 Proposed Strategy

A 'best practice' stormwater management strategy consisting of education, rainwater harvesting tanks and rain gardens has been proposed for the site of the proposed development. The 'treatment train' is illustrated in Figure 3-2. Details of the stormwater management measures proposed for use on the site and how they will be configured are presented in the following sub-sections.

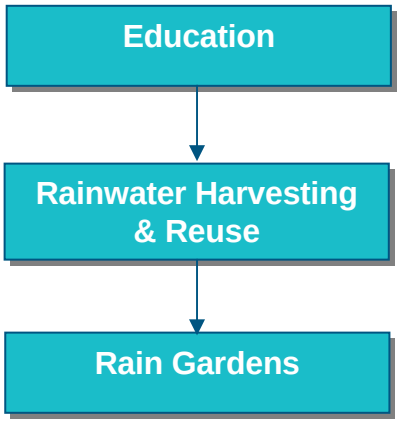


Figure 3-2 Proposed Stormwater Treatment Train for the Site

These stormwater management measures are described in the following sub-sections.

3.4.1 Education

Education has significant potential to decrease pollutant loads at the source and increases people's 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 rain gardens).

It should also be noted that education will need to be ongoing, and relate to pre- and post-development for all stakeholders.

Examples of educational signage to improve understanding of water quality issues is given in Figure 3-3. While the potential for pollutant load reduction due to education is noted, it has not been assumed within the MUSIC model.

Figure 3-3 Examples of Signage to Improve Understanding of Water Quality Issues

3.4.2 Rainwater Harvesting & Reuse

It is proposed that every residential allotment will be required to install a rainwater tank to collect roof runoff, in order to supplement non-potable water demands and comply with Queensland Development Code (QDC) MP4.2. The rainwater tanks have been represented in the MUSIC model as a single 'Rainwater Tank'.

For this assessment, it has been assumed that of the 350 residential lots, 47 are attached lots (terraces) with 3kL rainwater tanks, and 203 are detached lots with 5kL rainwater tanks. In both cases, 50% of the roof area was assumed to drain to a rainwater tank.

The modelling has assumed that roof runoff will be harvested and used to supplement non-potable internal water demands (toilet, hot water supply and laundry) and irrigation demands. Rainwater tank demands for residential lots have been modelled in accordance with Water By Design (2010b) assuming full water saving devices installed within all lots.

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.

3.4.3 Rain Gardens

A 'rain garden' (or 'bioretention system') is a soil and plant-based stormwater management measure. A typical system consists of a porous medium such as sandy loam. Vegetation is also established within the rain garden to promote evapotranspiration, maintain soil porosity, encourage biological activity, and promote uptake of some pollutants. Run-off is directed into the rain garden and infiltrates through the plant/mulch/soil environment. Figure 3-4 provides examples of streetscape (or similar 'ground level') rain gardens.

It is anticipated that the rain gardens will be integrated into the streetscape and/ or drainage reserves within the development.

For the purposes of this conceptual report, we have provided an estimate of the approximate filter area (and, of less importance in terms of overall treatment effectiveness, surface area) as a percentage of development area (excluding conservation areas) required for rain gardens within the proposed development. The configuration, size and number of the individual rain gardens required to satisfy the given WQOs will be determined during subsequent detailed design stages. However, it is anticipated that the rain gardens will be included in the road reserve (or, if present, adjacent open space areas) of the developed area at numerous locations.

All rain gardens have been assumed to have a filter depth of 0.4m and an extended detention depth of 0.2m. The filter media for the rain garden has been modelled as a sandy loam media of effective diameter 0.45 mm and a saturated hydraulic conductivity of approximately 200 mm/hr. The modelling also assumes total nitrogen and orthophosphate concentrations of 400 and 20mg/ kg respectively, and that they will be 'vegetated with effective nutrient removal plants'.

The rain gardens have been assumed to receive flows from all residential allotments and road areas.

Figure 3-5 provides a conceptual cross section of a rain garden, illustrating the modelled properties of the system.

Figure 3-4 Examples of Streetscape Rain Gardens

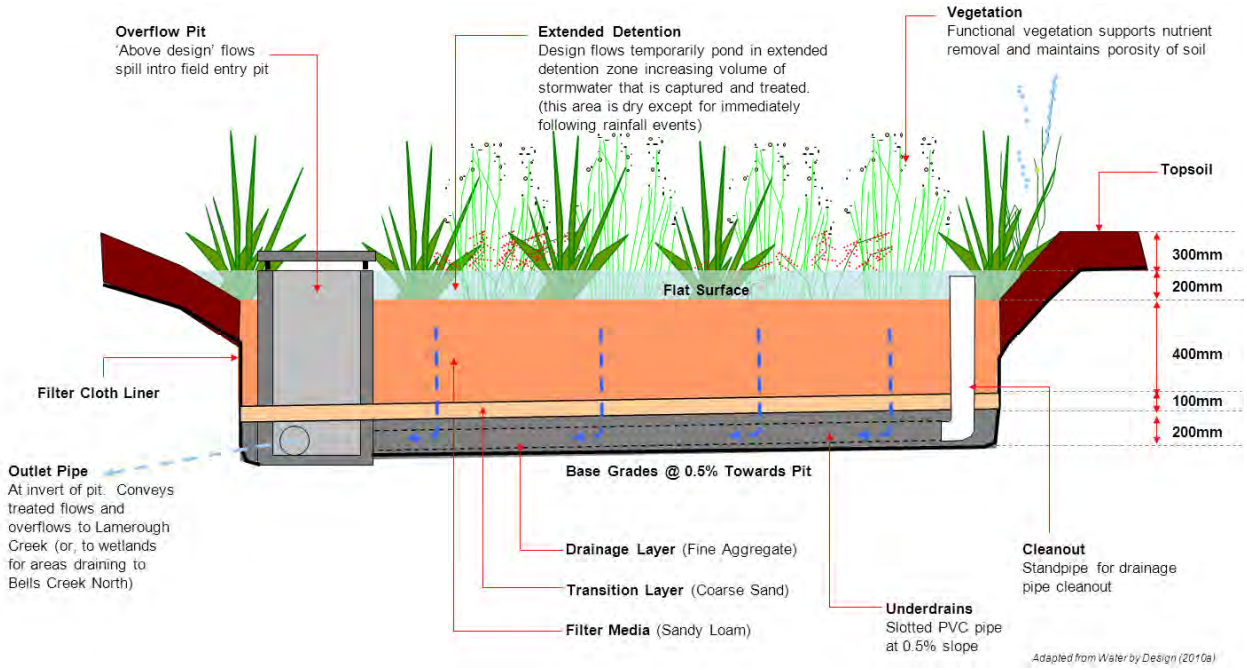


Figure 3-5 Conceptual Cross Section of Rain Garden Properties

3.4.4 Summary of Stormwater Management Strategy

Table 3-3 provides a summary of the proposed stormwater management strategy for the site.

Table 3-2 Summary of Proposed Stormwater Management Strategy

Component	Description
Education	Signage installed at appropriate locations (e.g. adjacent to rain gardens). No pollutant load removal for education has been assumed in our assessment.
Rainwater harvesting & reuse	Rainwater tanks installed within urban living areas in accordance with QDC MP4.2. Modelled in MUSIC as a single rainwater tank node for each land usage classification (detached and attached dwellings). 50% of roof area in urban living areas assumed to drain to a rainwater tank.
Rain gardens	Multiple rain gardens ('bioretention') integrated throughout the site, either within the streetscape or similarly 'at source'. Rain gardens provide treatment to all urban living, district centre and road areas. Modelled as a single bioretention node in MUSIC. Filter area 1.2% of total upstream area, 0.2m storage depth, 0.4m filter depth, sandy loam media (saturated hydraulic conductivity 200mm/ hour, TN content 400mg/ kg, 20mg/ kg ortho-P content), vegetated with effective nutrient removal plants, zero exfiltration.

The properties of the various stormwater management measures (as modelled in MUSIC) are summarised in Appendix C.

3.4.5 Compliance with Caloundra South Master Plan

Section 12.5 of the approved Caloundra South Master Plan outlines the intended infrastructure required for water quality management within the Caloundra South project, and development standards related to water quality management that subsequent applications must achieve.

The proposed stormwater quality management plan complies with the requirements of the approved Caloundra South Master Plan.

As described in Section 2.2 of this stormwater quality management plan, the site flows to Lamerough Creek. In accordance with the Master Plan, water quality management standards (given in Table 3-1) have been subsequently derived from DSDIP (2013).

In accordance with the master plan (and described in previous sections), the stormwater management strategy includes a combination of education, rainwater harvesting and reuse, and rain gardens. Although not described in this stormwater quality management plan, all buildings will be required to use water efficient appliances and products to reduce potable water consumption (in accordance with the master plan).

3.5 Model Results

Total annual flow and pollutant loads from the site and discharging into Lamerough Creek for each scenario are presented in Table 3-3.

Table 3-3 Predicted Annual Pollutant Loads for Lamerough Creek Subcatchment (1997-2006)

Parameter	Existing Site	Developed Site with No Treatment	Developed Site with Treatment	% Removal	% Removal Target
Flow (ML/yr)	92.9	181	155	14%	-
Total Suspended Solids (kg/yr)	921	32 700	6 000	82%	80%
Total Phosphorus (kg/yr)	3.5	64.2	16.8	74%	60%
Total Nitrogen (kg/yr)	90.9	377	166	56%	45%
Gross Pollutants (kg/yr)	0.00	4 150	0	100%	90%

The results presented above demonstrate that the model predicts that the proposed stormwater management strategy will result in a significant reduction in stormwater pollutant loads discharging to Lamerough Creek (relative to the developed site without treatment). The given pollutant load removal targets will be satisfied with the proposed stormwater management strategy.

3.6 Water Savings

Table 3-4 provides a summary of the water savings provided by the proposed stormwater management strategy for the site.

Table 3-4 Summary Water Savings for the Proposed Stormwater Management Strategy for the Site

Parameter	Value
Volume that could be supplied by rainwater tanks (ML/year)	41
Volume supplied from rainwater tanks (ML/year)	23
% rainwater tank demands satisfied	56%

As shown by the results presented in the above table, the proposed rainwater harvesting strategy for the site will achieve a substantial reduction in water demands, with water savings of approximately 23 ML/year predicted.

3.7 Maintenance

Maintenance of the rain gardens, wetlands and bioretention basins should be undertaken in accordance with Water By Design's (2012b) "*Maintaining Vegetated Stormwater Assets*".

3.8 Construction and Establishment

The rain gardens will need to be constructed and established in accordance with Water By Design (2010b) *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands*.

The proper construction and establishment of the rain gardens will be critical to maximising their ability to protect waterway health and minimise operational difficulties (and maintenance requirements). It is highly recommended that BMT WBM be involved in the construction and establishment of the proposed rain gardens – including the provision of ongoing advice, and undertaking inspections and providing certification (where appropriate) at the stages during the construction and establishment period specified in the aforementioned Water By Design guidelines.

3.9 Asset Hand-over

It is expected that the proposed rain gardens (including responsibility for all ongoing maintenance requirements) will eventually be 'handed over' to Sunshine Coast Regional Council.

3.10 Conclusion

This stormwater management plan has provided a conceptual stormwater management strategy for the proposed development. A stormwater management strategy consisting of education, rainwater harvesting tanks and rain gardens has been proposed for the site of the proposed development.

The modelling results show that the proposed stormwater management strategy will achieve the required best practice pollutant load removal targets.

4 REFERENCES

BMT WBM. (2010). *Caloundra Downs Stormwater Quality Management Master Planning Assistance.*

BMT WBM. (2011). *Caloundra Downs Baseline Monitoring Program Final Report*.

BMT WBM. (2011). *Caloundra South Consolidated Water Report.*

BMT WBM. (2011). *Caloundra South Integrated Water Quality Modelling Assessments.*

Brisbane City Council (2011). *WSUD Streetscape Planning and Design Package*.

Dalrymple, B. (2012). *Bioretention Myths Busted!!!* Presented at the Stormwater Industry Association of Queensland Conference, Brisbane.

DERM (2009). *Queensland Water Quality Guidelines 2009*.

DERM. (2010a). *Urban Stormwater Quality Planning Guidelines. Department of Environment and Resource Management*. Queensland State Government.

DERM. (2010b). *State Planning Policy 4/10 Healthy Waters. Department of Environment and Resource Management*. Queensland State Government.

DERM. (2010c). *State Planning Policy 4/10 Guideline Healthy Waters. Department of Environment and Resource Management*. Queensland State Government.

DSDIP (2013). *State Planning Policy*. December 2013.

FAWB. (2009). *Adoption Guidelines for Stormwater Biofiltration Systems. Facility for Advancing Water Biofiltration*, Monash University.

Glaister, B.J., Cook P.L.M., Fletcher, T. D., and Hatt, B. E. (2013). *Long-Term Phosphorus Accumulation in Stormwater Biofiltration Systems at the Field Scale*. Presented at the 2013 WSUD Conference, Gold Coast.

Healthy Waterways. (2006). *Water Sensitive Urban Design - Technical Guidelines for South East Queensland*.

Institute of Public Works Engineering Australia, (2010). *WSUD Standard Drawings*.

Queensland Government. (2010). *Queensland Development Codes MP 4.2. Brisbane: Queensland Government.*

Water By Design. (2009). *Concept Design Guidelines for Water Sensitive Urban Design Version 1*. Brisbane: South East Queensland Healthy Waterways Partnership.

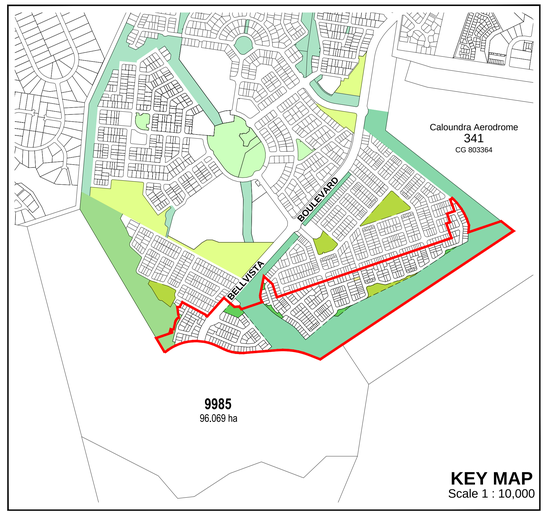
Water By Design. (2010a). *Construction and Establishment Guidelines: Swales, Bioretention systems and Wetlands*. Brisbane: South East Queensland Healthy Waterways Partnership.

Water By Design. (2010b). *MUSIC Modelling Guidelines*. Brisbane: South East Queensland Healthy Waterways Partnership.

Water By Design (2012a). *Bioretention Technical Design Guidelines* (Version 1), Healthy Waterways Ltd, Brisbane.

Water By Design (2012b). *Maintaining Vegetated Stormwater Assets* (Version 1), Healthy Waterways Ltd, Brisbane.

APPENDIX A: PRECINCT 1 SITE LAYOUT



Open Space

School
820
SP 153470

School
Sports Fields

Drainage Corridor

AVENUE

BOULEVARD

BELLVISTA

8001 (Pt)

Open Space
930
SP 170966

Caloundra Aerodrome
341
CG 803364

9993

9997

9999

9995

9998

9992

2001

2002

2003
4990m²

2004
1045m²

2005
3339m²

2006
4990m²

480
CG 4807

Note
All dimensions and areas are approximate only, and are subject to survey and Council approval.

Dimensions have been rounded to the nearest 0.1 metres.

Areas have been rounded down to the nearest 5m².

The boundaries shown on this plan should not be used for final detailed engineers design.

Legend

Site Boundary

Stage Boundary

OVERALL LAND BUDGET

Land Use	Total Site
Area of Subject Site	**35.468 ha**
Saleable Area	
Single Family Allotments	12.982 ha
Total Area of Allotments	12.982 ha
Road	
Sub Arterial Road	0.975 ha
Collector Streets	0.362 ha
Local Access Streets	5.190 ha
Pedestrian Connections-Thresholds	0.034 ha
Total Area of New Road	**6.561 ha**
Open Space	
Active Park	0.499 ha
Passive Open Space	0.656 ha
Linear Park	0.477 ha
Stormwater Conveyance	14.293 ha
Total Open Space	**15.925 ha**
Street Type	**Length**
Shared Access Driveway	442m
11.25m Wide New Road	126m
13.5m Wide New Road	993m
14m Wide New Road	462m
15.5m Wide New Road	1420m
17m Wide New Road	68m
18m Wide New Road	146m
22m Wide New Road	44m
40m Wide New Road	127m
Total Length of New Road	**3827m**

OVERALL YIELD

Single Family Dwellings	Overall	
Urban Lot Product		
Urban Lot Type A	6	1.7%
Urban Lot Type B	6	1.7%
Urban Lot Type C & D	10	2.9%
Subtotal	**22**	**6.3%**
25m Deep Product		
Terrace 7.5m	12	3.4%
Terrace 9.0m	8	2.3%
Villa 10m	24	6.9%
Premium Villa 12.5m	59	16.9%
Courtyard 14m	60	17.1%
Premium Traditional 18m	10	2.9%
Subtotal	**173**	**49.4%**
28m Deep Product		
Terrace 7.5	3	0.9%
Terrace 9.0	2	0.6%
Villa 10m	11	3.1%
Premium Villa 12.5m	19	5.4%
Courtyard 14m	27	7.7%
Premium Traditional 18m	5	1.4%
Subtotal	**67**	**19.1%**
32m Deep Product		
Villa 10m	14	4.0%
Premium Villa 12.5m	28	8.0%
Courtyard 14m	33	9.4%
Premium Traditional 18m	13	3.7%
Subtotal	**88**	**25.1%**
Total Residential Allotments	**350**	**100.0%**
	Lots	Add Dw
Possible Duplex Lots	11	11

Stockland

RPS

SCALE 1 : 1500 @ A0

0 20 40 60 80 100 120 140 160

DATE : 14 DEC 2012 DWG NAME : 7633-105-PRO DWG # 7633-105

Caloundra South - Precinct 1

Stockland

APPENDIX B: EXISTING SCENARIO MUSIC PROPERTIES

The methodology to derive values for each of these is described below.

As described in Section 3.3.2, rainfall-runoff and pollutant export characteristics for the existing (pre developed) site have been developed based on the data collected as part of BMT WBM's baseline monitoring program at the Caloundra South site. Further information in relation to this program is provided in BMT WBM's (2011) "*Caloundra Downs Baseline Monitoring Program Final Report*".

To develop MUSIC properties for the existing site, data from Site 1 was excluded from the analysis as the catchment contributing to this site is partially urbanised. Therefore, only data from Sites 2 and 3 was used.

Rainfall Runoff Properties

To determine suitable rainfall-runoff properties for the site, a meteorological template of the monitoring period (using the recorded pluviometer data and average monthly PET for Caloundra WTP obtained from the Bureau of Meteorology) was developed. Volumetric Runoff Coefficients (VRCs) were calculated for 'Agricultural' and 'Forest' land usage classifications – using rainfall-runoff properties as given in Water By Design's (2010) "MUSIC Modelling Guidelines". These VRCs were subsequently compared to the values given in BMT WBM's (2010) "*Caloundra Downs Baseline Monitoring Program Final Report*". These VRCs are given in Table A-1.

Table B- 1 Calculated Volumetric Runoff Coefficients for Various Scenarios

Site/ Land Usage	VRC	Methodology
Site 2	0.51	Based on recorded rainfall and flow data (see aforementioned BMT WBM (2010) report).
Site 3	0.39	
'Agricultural'	0.48	Using rainfall-runoff properties given in Water By Design (2010b)
'Forest'	0.42	

As shown above, the VRC for 'Agricultural' is similar to the calculated VRC for Site 2 (and between the calculated VRC for sites 2 and 3). 'Agricultural' is also anticipated to be the land usage that most closely qualitatively describes the existing site. Therefore, the rainfall runoff properties for the 'Agricultural' land usage classification (as given by Water By Design (2010b)) have been applied to describe the existing site.

Pollutant Export Characteristics

As described in BMT WBM (2010) recorded pollutant concentration data was separated into 'storm flow' and 'ambient' (or baseflow) categories. Log values of recorded Total Suspended Solids, Total Phosphorus and Total Nitrogen were subsequently calculated and (as required in MUSIC), mean and standard deviations of these log values was calculated for stormflow and baseflow conditions. These calculated values are given in Table A-2.

Table B- 2 Calculated MUSIC Pollutant Export Characteristics for the Existing Site

Pollutant	Stormflow		Baseflow	
	Mean	*St.dev.*	*Mean*	*St.dev.*
TSS Log^{10} values	0.895	0.265	0.935	0.393
TP Log^{10} values	-1.426	0.096	-1.476	0.242
TN Log^{10} values	-0.013	0.084	-0.075	0.150

APPENDIX C: MUSIC TREATMENT NODE PROPERTIES

This appendix provides a summary of the properties of the treatment nodes as applied in the MUSIC modelling for this site.

Table C- 1 Summary of Rainwater Tank Treatment Node Properties as Applied in MUSIC Modelling (to residential lots)

Parameter Description	Detached Dwellings (5 kL tanks)	Attached Dwellings (3 kL tanks)	Comments
Volume below overflow pipe (m^3)	1,364	127	Single rainwater tank node used for residential areas, representing multiple rainwater tanks integrated throughout the site.
Depth above overflow	0.2	0.2	
Surface area (m^2)	758	71	
Overflow pipe diameter (mm)	1,567	617	
Stored water used for irrigation and other purposes ?	Yes	Yes	
Annual demand scaled by PET-Rain (kL/yr)	23,477	1,422	Irrigation water demands, calculated in accordance with Water By Design (2010b)
Daily demand (kL/day)	40	3	Internal water demands (based on dwellings with full water savings devices), calculated in accordance with Water By Design (2010b)

Table C- 2 Summary of Rain Garden Properties as Applied in MUSIC Modelling

Parameter	Value	Comments
Low flow bypass (m^3/s)	0	
High flow bypass (m^3/s)	1 000	
Extended detention depth (m)	0.2	
Surface area (m^2)	2 345	Assumed to be equal to filter area as an approximation for modelling purposes only (in accordance with Water By Design, 2010b)
Filter area (m^2)	2 345	1.2% of total upstream area (excluding park and open space areas).
Filter depth	0.4	
TN content of filter media (mg/kg)	400	See Appendix D.
Orthophosphate content of filter media (mg/kg)	20	
Exfiltration rate	0	
Vegetation	With effective nutrient removal plants	
Overflow weir width (m)	234.5	Assumed to be equal to filter area divided by ten as an approximation for modelling purposes only (in accordance with Water By Design, 2010b)

APPENDIX D: BIORETENTION FILTER MEDIA PROPERTIES

This appendix provides a summary of the properties of the treatment nodes as applied in the MUSIC modelling for this site.

As described in Section 3.4.3, the proposed stormwater management strategy for the site will include rain gardens that will have ('bioretention') filter media. As outlined in Section 3.8, these systems will need to be constructed and established in accordance with Water By Design (2010b) *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands*. This guideline states that filter media must meet the requirements as given in FAWB's "*Adoption Guidelines for Stormwater Biofiltration Systems*".

As outlined in Section 3.4.3 and Appendix C, assumptions have been made about the properties of the filter media (for the MUSIC modelling used to predict their treatment performance). Values have been assumed for the following properties for the filter media:

- Saturated hydraulic conductivity
- Total nitrogen content
- Orthophosphate content.

A potential supplier of the filter media is Southern Pacific Sands. Table D-1 provides a summary of filter media test results (from Southern Pacific Sands) since February 2011 – and the values adopted in our modeling for the site. The most recent laboratory test result for a sample of this media is also provided.

Table D-1 Summary of Southern Pacific Sands Filter Media Test Results Since February 2011 & Adopted Values for Modelling

Sample Name			Bio Plus (3374)	Bioret Plus (3249)	Bioret Plus (3044)	Bioret Plus (3155)	Bio-retention Sand (2825)	Bioret Sand (2800)	Assumed Value
Sample Date			23/12/2013	20/05/2013	15/08/2012	22/02/2013	30/06/2011	23/02/2011	
Sieve Size (mm)	**Description**	**Target Range**	**Value**						
>3.35	Gravel	-	0.1	0.6	0.48	0.3	0	-	-
2.0 to 3.35	Fine gravel	<3%	0.4	0.9	0.32	1.7	0	1.2	-
1.0 to 2.0	Very coarse sand	7 to 10%	3.1	4.1	3.32	5	7.4	2.4	-
0.5 to 0.5	Medium to coarse sand	40 to 60%	61.5	66.1	59.6	62.4	49.9	58.1	-
0.15 to 0.25	Fine sand	10 to 30%	23.9	21.4	23.1	22.5	20.1	24.4	-
0.05 to 0.15	Fine to very fine sand	5 to 30%	7.2	4.2	10.5	4.8	12.5	8.7	-
<0.05	Clay and silt	<3%	3.8	2.6	2.74	3.2	0.1	5.3	-
Hydraulic Conductivity	**Unit**	**Target Range**	**Value**						
Predicted based on PSA	mm/hour	456	372	-	411	-	-	456	-
Actual to ASTM F 1815-06	mm/hour	196	216	207	152	195	290	196	200
Developed Scenario	**Unit**	**Target Range**	**Value**						
Organic matter	% dry weight	>3%	3.9	4.4	4.7	5.6	2.5	4.6	-
pH in H20 (1:5)	pH unit	5.5 to 7.5	5.7	7	5.2	6	6.9	7	-
Electrical conductivity (1:5)	dS/m	<1.2	0.21	0.14	0.1	0.22	0.25	0.09	-
Orthophosphate (Olsen)	mg/kg	<80	<0.8	0	2.15	0.13	19	N/A	20
Total nitrogen	mg/kg	<1000	400	300	0.04	400	125	1	400

SESL AUSTRALIA
Environment & Soil Sciences

FAWB Bioretention

Sample Drop Off: 16 Chilvers Road
Thornleigh NSW 2120
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Mailing Address: PO Box 357
Pennant Hills NSW 1715
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 28778 **Sample N°: 1** **Date Received: 23/12/13** **Report Status: ○ Draft ◉ Final**

Client Name: **Southern Pacific Sands**
Client Contact: **Matthew Daniell**
Client Job N°:
Client Order N°: **24290**
Address: **PO Box 283**
CABOOLTURE QLD 4510

Project Name: **Filter Media Analysis**
Location:
SESL Quote N°:
Sample Name: **3374 - Bio Plus**
Description: **Sand**
Test Type: **SIEVE_US_Wet, HC_USGA, TOC_DC, TN_DC, pHEC_S, P_Bray**

Sieve Size (mm)	Description	% Retained by mass	Target Range*
>3.35	Gravel	0.1	-
2.0 - 3.35	Fine Gravel	0.4	< 3.0%
1.0 - 2.0	Very Coarse Sand	3.1	7 - 10%
0.25 - 0.5	Medium to Coarse Sand	61.5	40 - 60%
0.15 - 0.25	Fine Sand	23.9	10 - 30%
0.05 - 0.15	Fine to Very Fine Sand	7.2	5 - 30 %
<0.05	Clay + Silt	3.8	< 3.0%

Physical Performance	Unit	Result	
Hydraulic Conductivity			
Predicted based on PSA	mm/hr	372.0	
Actual to ASTM F 1815-06	mm/hr	216.0	> 100 mm/hr

Soil Properties**			
Organic Matter	% dry weight	3.9	>3.0%
pH in H_20 (1:5)	pH unit	5.7	5.5 - 7.5
Electrical Conductivity (1:5)	dS/m	0.21	< 1.2 dS/m
Orthophosphate	mg/kg	<0.8	< 80 mg/kg
Total Nitrogen	mg/kg	400.0	< 1000 mg/kg

Commentary from SESL not requested.

Methods
*In accordance withThe Guidelines for Soil Filter Media in Bioretention Systems (Version 3.01) June 2009.
<0.002mm by hydrometer sedimentation (Reference Black et al (1965) Method 43-5)
<0.053>0.002mm by wet sieve analysis
>0.053mm by dry sieve analysis. (Reference ASTM F1632-03 modified)
Hydraulic conductivity to ASTM F 1815-0.
**Soil Properties assessed in accordance with AS4419 - 2003 (Soils for Landscaping and Garden Use) where applicable.

Consultant: Bronwyn Woodward

Authorised Signatory: Ryan Jacka

Method References:
Ahern CR, Blunden B and Stone Y (eds.) (1998). *Acid Sulphate Soils Laboratory Methods* Guidelines Published by the Acid Sulphate Soil Management Advisory committe, Wollongbar, NSW, Australia

Date Report Generated
17/01/2014

Date of Report: 08/01/2014

END OF REPORT

In relation to these assumed filter media properties, the following should be noted:

- The assumed values have been based on a combination of laboratory test results (summarised in Table D-1) for a potential filter media as supplied by Southern Pacific Sands, Water By Design (2010b) and allowing for some increase in nutrient content over the life of the bioretention systems.
- Minimal information is available in relation to the long-term performance of bioretention systems – including changes in saturated hydraulic conductivity and filter media nutrient content. Dalrymple (2012) provides further information regarding the long-term performance of bioretention systems.
- The assumed saturated hydraulic conductivity of 200mm/ hour is based on these test results and recommended values given in Water By Design (2010b).
- The total nitrogen content of 400mg/ kg is based on the most recent laboratory test result for filter media supplied by Southern Pacific Sands, although it is noted that lower values have been recorded previously.
- An orthophosphate content of 20mg/ kg has been based on the filter media test results but with a higher content (relative to the test results) adopted to allow for some increase in orthophosphate content over time associated with incoming flows potentially increasing orthophosphate content of the filter media. Rationale for the adoption of this concentration is as follows:
  - Minimal information is available in relation to the likely long-term change in ortho-phosphate concentrations within bioretention filter media.
  - Glaister et al (2013)'s paper "*Long-Term Phosphorus Accumulation in Stormwater Biofiltration Systems at the Field Scale*" described the investigations (and associated results). Glaister et al (2013) measured the filter media ortho-phosphate concentrations within six bioretention systems in Brisbane and Melbourne, that had been operating from between five and twelve years, with homogenised samples measured at the following depth intervals: 0-10mm; 10-20mm; 20-40mm; 40-80mm; 80-120mm; 150-200mm and; 300-350mm. The results showed that:
    - ortho-phosphate concentrations were typically very low (between approximately 5 and 20mg/kg) at depths greater than approximately 150mm (from the filter media surface).
    - Higher concentrations were typically observed at the inlet of the assed bioretention systems and/ or within the top 100mm of the filter media (although it should be noted that none of the devices have any form of stormwater pre-treatment).
    - No clear signs of phosphorus "breakthrough" were observed, offering positive reinforcement that the current biofilter design specifications are producing systems which function well (and continue to remove phosphorus) in the long-term.
- The bioretention 'rain gardens' have a filter media depth of 400mm. Therefore, the majority of the filter media depths for bioretention systems within Caloundra South are anticipated to have very low long-term ortho-phosphate concentrations – less than approximately 20mg/kg.

- By assuming a lower value (lower than 20mg/kg) for the filter media ortho-phosphate content, the predicted total phosphorus loads predicted to be discharged from the developed site will be lower. However, a value of 20mg/kg has been adopted to provide some conservatism in the modelling (i.e. potentially over-predict total phosphorus loads discharged from the site).
- As outlined by Water By Design (2010a), the filter media supplier and contractor are responsible for ensuring the filter media meets the specifications outlined in these guideline and that the correct material is delivered to site. If significant variations occur between the parameter values assumed in this report (and associated modelling) and that of the media available, then it is recommended that MUSIC modelling be undertaken to confirm whether the strategy will still achieve the given pollutant load removal targets.

BMT WBM Brisbane
Level 8, 200 Creek Street Brisbane 4000
PO Box 203 Spring Hill QLD 4004
Tel +61 7 3831 6744 Fax +61 7 3832 3627
Email bmtwbm@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Denver
8200 S. Akron Street, Unit 120
Centennial Denver Colorado 80112 USA
Tel +1 303 792 9814 Fax +1 303 792 9742
Email denver@bmtwbm.com
Web www.bmtwbm.com.au

BMT WBM Mackay
Suite 1, 138 Wood Street Mackay 4740
PO Box 4447 Mackay QLD 4740
Tel +61 7 4953 5144 Fax +61 7 4953 5132
Email mackay@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Melbourne
Level 5, 99 King Street Melbourne 3000
PO Box 604 Collins Street West VIC 8007
Tel +61 3 8620 6100 Fax +61 3 8620 6105
Email melbourne@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Newcastle
126 Belford Street Broadmeadow 2292
PO Box 266 Broadmeadow NSW 2292
Tel +61 2 4940 8882 Fax +61 2 4940 8887
Email newcastle@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Perth
Suite 3, 1161 Hay Street West Perth 6005
Tel +61 8 9328 2029 Fax +61 8 9484 7588
Email perth@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Sydney
Level 1, 256-258 Norton Street Leichhardt 2040
PO Box 194 Leichhardt NSW 2040
Tel +61 2 9713 4836 Fax +61 2 9713 4890
Email sydney@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Vancouver
401 611 Alexander Street Vancouver
British Columbia V6A 1E1 Canada
Tel +1 604 683 5777 Fax +1 604 608 3232
Email vancouver@bmtwbm.com
Web www.bmtwbm.com.au