Water Sensitive Urban Design Strategy for Harmony

Netgain Environments

DESIGN BUILD MAINTAIN THRIVING NATURAL LANDSCAPES

Document Control Sheet	
Project	Harmony, Palmview Structure Plan Area, Sippy Downs
Document Title	Water Sensitive Urban Design Strategy for Harmony
Version	1.0
Author(s)	Leon Rowlands and Malcolm Eadie
Approved by	Malcolm Eadie
Signed	
Date	5th August 2015
File Location	
Distribution	Client

Revision	Date	Approved	Details of Revision
A	25/08/2015	Malcolm Eadie	Responds to client comments
B	31/08/2015	Malcolm Eadie	For Council Issue
C	16/12/2015	Malcolm Eadie	Response to Council Feedback
D	04/07/2016	Malcolm Eadie	Revisions as instructed by Client

Water Sensitive Urban Design Strategy for Harmony

For Investa Residential Group Pty Ltd

Netgain Environments

CONTENTS

1 Introduction

The Palmview Structure Plan Area is 926 hectares of land in total (of which 375 hectares is owned by Investa). The site is bounded by the Mooloolah River to the south, Sippy Creek to the north and by the Bruce Highway to the west.

The planning for the Palmview Structure Plan Area has been guided by the Palmview Structure Plan and Palmview Planning Scheme Policy, and by the associated Infrastructure Agreement between Council and Investa. This planning process will also be guided by the principles of Water Sensitive Urban Design. It is envisaged that WSUD will enable the creation of a development zone that promotes sustainable and integrated management of land and water resources, and incorporates best practice stormwater management and environmental protection.

The purpose of this report is to document the Water Sensitive Urban Design (WSUD) strategy to support the application for an Area Development Approval subject to the provisions of Section 242 of the Sustainable Planning Act.

What is Water Sensitive Urban Design?

Water Sensitive Urban Design is a holistic approach to the planning and design of urban development that aims to minimise negative impacts on the natural water cycle and protect the health of aquatic ecosystems. It promotes the integration of stormwater, water supply and sewage management at the development scale. The objectives of WSUD are to:

- *protect existing natural features and ecological processes;*
- *maintain the natural hydrologic behaviour of catchments;*
- *protect water quality of surface and ground waters;*
- *minimise demand on the reticulated water supply system;*
- *minimise sewage discharges to the natural environment; and*
- *integrate water into the landscape to enhance visual, social, cultural and ecological values.*

The principles of WSUD are now recognised and adopted internationally to reduce urban impacts on receiving waterways.

Source: South East Queensland Regional Plan 2009–2031 Implementation Guideline No.7: Water Sensitive Urban Design

Broadly, the WSUD strategy's objectives are:

- Delivering stormwater management to treat urban stormwater to meet best practice water quality objectives for discharge to receiving aquatic environments; and
- Integrating water management measures into the landscape and urban design to maximise the visual and recreational amenity of the development.

This report describes the WSUD Strategy for the Harmony Master Plan Development (the 'Harmony development'), which is the entire Investa landholding within the Palmview Structure Plan Area. The report is limited to stormwater quality treatment objectives with the intent being that stormwater quantity will be addressed with future reconfiguration of a lot applications. The strategy has been conceived in a collaborative and open process with Council's planning and development staff, and by an interdisciplinary team of environmental and civil engineers, urban designers, town planners, ecologists and landscape architects. The integrated design process used to develop this strategy has been underpinned by the principles and concepts described in the *Concept Design Guidelines for Water Sensitive Urban Design* (Water by Design, 2009).

.

2 Existing Site Characteristics

Successful WSUD strategies respond to the specific characteristics and conditions of a site and the local and regional receiving environments.

2.1 Site Description

The Harmony development site is located in the western portion of the Palmview Structure Plan Area. The Structure Plan Area is located in the catchment of the Mooloolah River, with the south-draining portions of the Harmony site draining directly to the Mooloolah River and the northern-draining portions of the site first entering the Sippy Creek tributary of the Mooloolah River. Palmview Structure Plan map *OPM P1* (refer Appendix A) provides the regional context for the Harmony site in relation to the Mooloolah River National Park and other significant regional features.

2.1.1 Existing Land Use

The current land use on the site is grazing. The Harmony site has previously been cleared to accommodate rural activities, however stands of remnant vegetation remain in drainage corridors and adjacent to waterways. The existing landuse is shown on the 2013 aerial image provided in Figure 2.1.

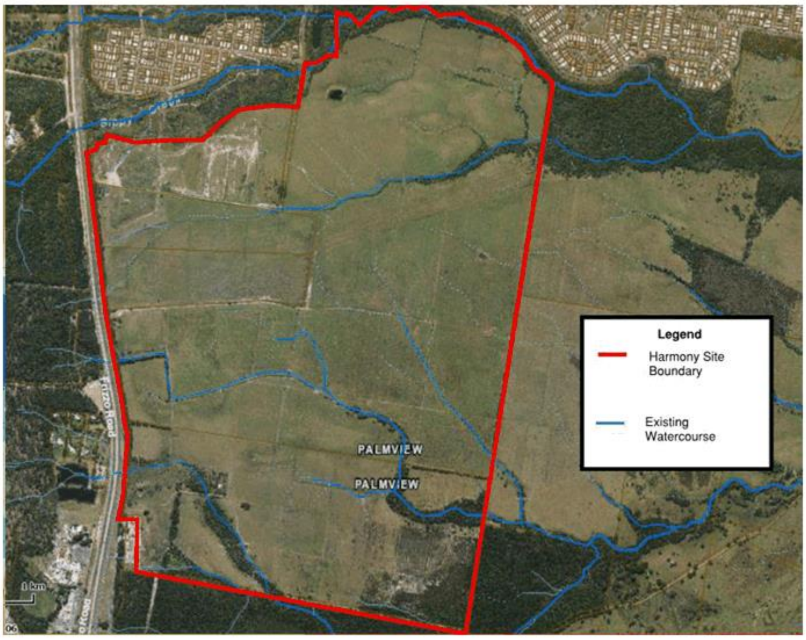

Figure 2.1 – Existing Landuse

2.1.2 Proposed Land Use

The proposed land use within Harmony for the first ~1200 lots is shown in Figure 2.2 and is based on the Palmview Structure Plan landuse Map OPM P3 (refer Appendix A). The dwelling density within the Harmony site ranges from a minimum 18 dwellings/Ha for the mixed density residential area to a minimum 35 dwellings/Ha for the meduium density residential area. This density requires a significant number of small lot and terrace dwelling types with a resultant increase in the infrastructure provision in local road reserves and a higher frequency of driveway cross-overs. This new suburban condition present a number of challenges for WSUD with the more contested road reserves presenting challenges for traditional WSUD approaches of 'at source' stormwater management.

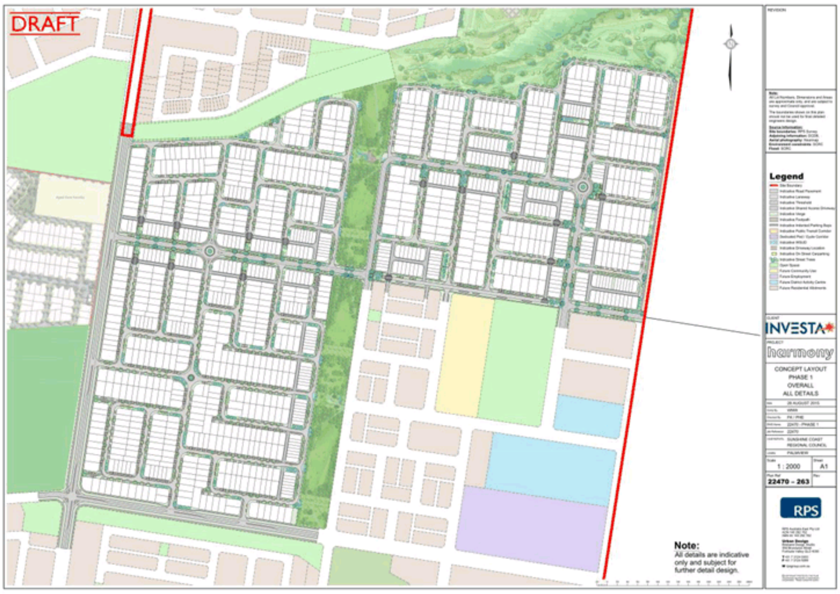

Figure 2.2 – Proposed Landuse

2.1.3 Topography & Hydrology

The site is located on low-lying land adjacent to Sippy Creek and the Mooloolah River and forms part of the lower coastal floodplain of the Mooloolah River. The topography across most of the site is very flat with typical slopes of between 0.5 and 1%.

Under existing conditions, rainfall runoff occurs via sheet flow across much of the site before entering either shallow man-made drains or more natural vegetated channels. There is one major drainage channel through the northern portion of the site which discharges through a vegetated drainage corridor to Sippy Creek and then to the Mooloolah River. Two major drainage channels exist through the southern portion of the site which drain to the Mooloolah River. These southern drainage lines also receive flows from small external catchments located west of the Bruce Highway. These existing topographic and drainage features are shown in Figure 2.3 along with the landuse plan from Structure Plan Map OPM P3 (refer Appendix A).

The low relief topography of the Harmony site and that of the surrounding receiving environment, requires careful consideration of the site bulk earthworks strategy and urban drainage solutions to avoid the creation of expensive, low gradient, large diameter pipe drainage networks. Further, the treatment of urban stormwater to current best practice environmental standards before discharge to receiving environments can become problematic in such low relief topography, particularly if un-treated stormwater is conveyed within deep, large diameter pipe drainage systems that have difficulty finding a free draining outfall to the local waterways.

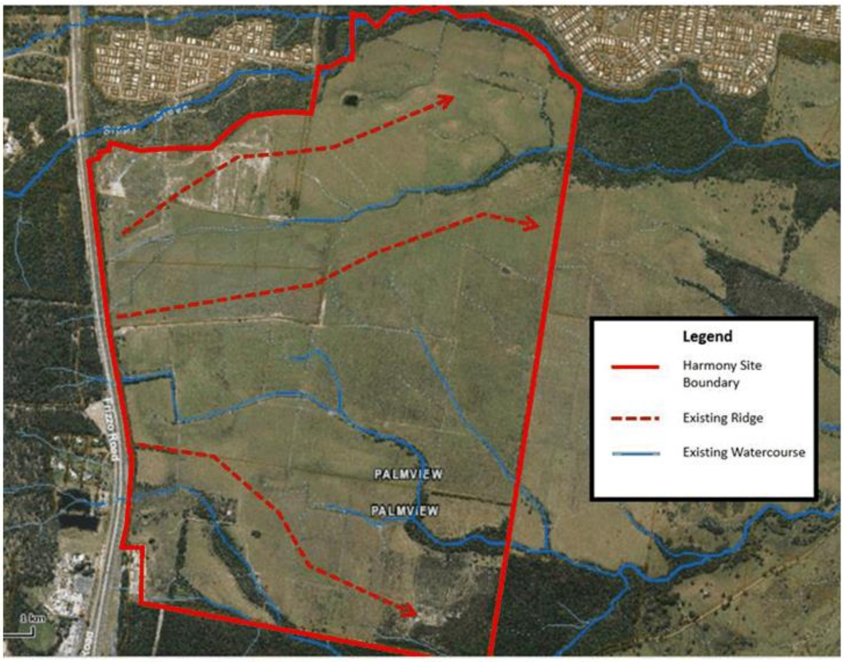

Figure 2.3 – Existing Topographic and Drainage Features

2.1.4 Flooding

The existing extent of flooding is shown in the Palmview Structure Plan Map OPM P2(a) (refer Appendix A) which demonstrates that the Harmony development area is relatively unconstrained by regional flooding compared to the other areas of the Palmview Structure Plan Area. The exception to this is the Northern and Eastern edges of the Harmony site, which are impacted by Sippy Creek flooding. Stormwater management infrastructure proposed in this area will need to take care that flooding impacts, such as frequency, inundation depth and flood velocity, are not going to have an unreasonable impact on system performance and maintenance requirements.

2.1.5 Soils

The Horticulture Land Suitability Study Sunshine Coast Southeast Queensland (Capelin, 1987) indicates that the site soils are a mosaic of humic gleys and gleyed podzolic soils. Humic gleys are acid to neutral soils with a dark organic A horizon grading into grey mottled heavy clay B horizons. Gleyed podzolic soils are poorly drained, acid soil with texture contrast profiles of brownish-grey A horizons, pale A2 horizons and grey and yellow mottled clay B horizons.

Capelin (1987) indicates that these soils may be poorly draining which would limit the infiltration capacity of stormwater treatment systems thus requiring the use of underdrainage systems, in treatment systems such as bioretention.

2.1.6 Landscape Character

The low relief topography, lack of natural water features and limited tree cover on the site provides limited natural assets for new residents to enjoy. There is significant scope therefore for WSUD facilities to be integrated throughout the public realm to add diversity and interest to the landscape character of the Harmony development.

2.2 Climate

The climate of the region is considered to be sub-tropical having warm summers, mild winters and a large rainfall average (Table 2.1). The Sunshine Coast has a humid, subtropical climate typified by hot, wet summer periods (November to April) and cool, dry winters from May to October. Annual rainfall is typically around 1600mm, however extreme wet (~2000 mm 90%ile) and dry rainfall (~1000mm 10%ile) years have been experienced.

Rainfall is highly seasonal, with 65% of rainfall falling in the summer months (CCC, 2003). The evapotranspiration information infers that natural aquatic ecosystems typically experience drying conditions (evapotranspiration greater than rainfall) through spring and early summer.

Table 2.1 - Summary of average climatic conditions for the Palmview climatic region

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Rainfall (mm)	174	202	208	173	170	102	89	61	54	81	113	147	1578
Mean PET (mm)	198	155	160	121	86	73	74	91	118	160	180	201	-
Mean maximum temperature (°C)	27.6	27.2	26.4	24.6	22.2	19.8	19.3	20.3	22.3	24.1	25.4	27.0	23.8
Mean minimum temperature (°C)	21.4	21.2	19.9	17.4	14.9	11.7	10.8	11.6	13.9	16.5	18.5	20.3	16.5

(Source: http://www.bom.gov.au/climate/averages/tables/cw_040040.shtml and PET values from Climate Atlas of Australia)

This climate would support implementation of current best practice water cycle management technologies that utilise vegetative systems to promote the interception, adsorption and biological processing of water borne pollutants.

2.3 Receiving Environments

The northern-draining portions of the Harmony development site drain directly into the Sippy Creek riparian corridor, while southern-draining portions of the site enter local waterways which ultimately flow to the Mooloolah River. Sippy Creek runs east from the Mooloolah Range, along the southern boundary of the existing Bellflower and Chancellor Park Estates, and joins the Mooloolah River at Palmview. The creek and tributaries are predominantly lowland fresh waters meandering through alluvial floodplains.

The Maroochy Shire State of Waterways Report 2005-07 describes Sippy Creek as being in reasonable condition and had a waterway score of B+ in the location of the Harmony Site. The report identifies the main threats to waterway health being weed invasion, sediment and nutrient runoff from new residential developments and pollution runoff from existing urban areas.

More recently, annual reporting by Healthy Waterways as part of the Environmental Health Monitoring Program (or HWW Report Card) identified a report card grade of C- for the freshwater catchments of the Mooloolah River (including Sippy Creek). This is a concerning decline, with particularly poor scores achieved in relation to nutrient cycling indicating low assimilative capacity for additional nutrient inputs.

2.3.1 Ecology and Biodiversity

A number of vegetation communities are identified in Vegetation Management Act (VMA) Regional Ecosystem Mapping along Sippy Creek and further downstream in the Mooloolah River National Park. The following regional ecosystems have been mapped along the Sippy Creek Riparian Corridor:

- 12.3.2 100 *Eucalyptus grandis* tall open-forest on alluvial plains
- 12.3.5 100 *Melaleuca quinquenervia* open-forest on coastal alluvial plains
- 12.9-10.4 *Eucalyptus racemosa* woodland on sedimentary rocks
- 12.3.13 Palustrine wetland (e.g. vegetated swamp)

2.3.2 Environmental Values

The '*Mooloolah River environmental values and water quality objectives Basin No. 141 (part), including all tributaries of the Mooloolah River*' (DERM, 2010) document sets environmental values and water quality objectives for waters in the Mooloolah River catchment. The Sippy Creek waterway, in the location of the Harmony, is identified as 'Lowland freshwaters' at the northern western site extent and transitions to 'Wallum / tannin freshwaters' towards the downstream sections of the site. The Mooloolah River in the vicinity of Harmony is identified as 'Wallum / tannin freshwaters'.

The environmental values identified for protection for the Sippy Creek Catchment ('other freshwater tributaries' as per Table 1, on Page 10 of the Mooloolah River environmental values and water quality objectives Basin No. 141 (part), including all tributaries of the Mooloolah River) are:

- Aquatic ecosystems
- Irrigation
- Farm Supply/use
- Stock water
- Human consumer
- Primary recreation
- Secondary recreation
- Visual recreation
- Cultural and spiritual values.

2.3.3 Water Quality Objectives

Water Quality Objectives (WQOs) are defined in the Environmental Protection (Water) Policy 2009 for the Mooloolah River catchment as long-term goals for water quality management. The WQOs identified for the water types applicable to the Harmony Site ('Lowland freshwaters' and 'Wallum / tannin freshwaters') are identified in Table 2.2.

Table 2.2 - Water quality objectives for Mooloolah River and Tributaries (DERM, 2010).

Water area/type (refer Plan WQ1412)	Management intent (level of protection)	Water quality objectives to protect aquatic ecosystem EV
Lowland freshwater (comprising lowland streams, and coastal streams)	Aquatic ecosystem – moderately disturbed	• turbidity: <10 NTU • suspended solids: <6 mg/L • chlorophyll a: <5 µg/L • total nitrogen: <500 µg/L • oxidised N: <60 µg/L • ammonia N: <20 µg/L • organic N: <420 µg/L • total phosphorus: <50 µg/L • filterable reactive phosphorus (FRP): <20 µg/L • dissolved oxygen: 85 – 110% saturation • pH: 6.5 – 8.0 • secchi depth: n/a • conductivity: 500 µS/cm
Wallum/tannin stained streams	Aquatic ecosystem – Moderately disturbed	• turbidity: <20 NTU • suspended solids: <6 mg/L • chlorophyll a: <5 µg/L • total nitrogen: <500 µg/L • oxidised N: <60 µg/L • ammonia N: <20 µg/L • organic N: <420 µg/L • total phosphorus: <50 µg/L • filterable reactive phosphorus (FRP): <20 µg/L • dissolved oxygen: 85 – 110% saturation • pH: 5.0 –7.0 • secchi depth: n/a • conductivity: 500 µS/cm

3 Statutory Requirements

The key policy document guiding the implementation of Water Sensitive Urban Design is the State Planning Policy (DSDIP, 2014) and specifically the State Interest: Water Quality. The SPP requirements have been applied in a local context through the Sunshine Coast Planning Scheme 2014 (SCC, 2014) through the Stormwater Management Code, Palmview Structure Plan Area Code and associated Planning Scheme Policies (PSPs).

3.1 State Planning Policy

The State Planning Policy articulates the State Interest in relation to Water Quality and puts in place matters which must be addressed when a local government makes or amends a planning scheme and also has interim development assessment provisions which apply until such time as a local government planning scheme adequately reflects the SPP. As the Sunshine Coast Planning Scheme adequately reflects the SPP, it has no further relevance in the assessment of development applications. For completeness, Table B of Appendix 3 of the SPP is provided below which sets the quantitative targets for stormwater management for Queensland Local Government Areas.

Table B: Post construction phase—stormwater management design objectives

Application

(a) Applies to western Queensland and Cape York/ Far North Queensland, for population centres greater than 25,000 persons, and
(b) For all other climatic regions with population centres greater than 3000 persons.

Climatic region (Refer SPP Interactive Mapping System)	Design objectives Minimum reductions in mean annual load from unmitigated development (%)				Application
	Total suspended solids (TSS)	Total phosphorus (TP)	Total nitrogen (TN)	Gross pollutants >5 mm	
South East Queensland	80	60	45	90	Development for urban purposes within population centres greater than 3000 persons.
Central Queensland (south)	85	60	45	90	As above.
Central Queensland (north)	75	60	40 #	90	As above. # Mackay Regional Council has adopted a 35% reduction for TN.
Dry Tropics	80	60 #	40	90	As above. # Townsville City Council has adopted a 65% reduction for TP.
Wet Tropics	80	60	40	90	As above.
Cape York/FNQ	80	60	40	90	Development for urban purposes within population centres greater than 25,000 persons.
Western Queensland	85	60	45	90	As above.
All	N/A	N/A	N/A	N/A	Excludes development that is less than 25% impervious. In lieu of modelling, the default bio-retention treatment area to comply with load reduction targets for all Queensland regions is 1.5% of the contributing catchment area.
	Waterway stability management • Limit the peak 1-year ARI event discharge within the receiving waterway to the pre-development peak 1-year ARI event discharge.				Catchments contributing to un-lined receiving waterway. Local government may not require compliance if the waterway is degraded. For peak flow for the 1-year ARI event, use co-located storages to attenuate site discharge rate of stormwater.

3.2 Sunshine Coast Planning Scheme

Stormwater management provisions are covered by both the Palmview Structure Plan Code and the Stormwater Management Code. The two codes work together, with the former setting the policy stance for how stormwater management is expected to be specifically addressed within the Palmview Structure Plan Area, while the latter sets engineering performance outcomes and targets which must be achieved.

Palmview Structure Plan Code and PSP

The Palmview Structure Plan Code addresses stormwater requirements in ***Table 10.3.4.1 – Performance Outcomes and Acceptable Outcomes for the Development of Infrastructure and Services***. Stormwater Infrastructure requirements are covered by PO24-28, with key notable aspects summarised as follows:

- PO24(b) recognises the need to balance WSUD with maximising developable area and compact development
- PO24(d) identifies that WSUD is to be integrated into the overall urban design including streets and open space
- PO24(f) identifies that localised WSUD solutions are preferred over regional
- Defers to the PSP for Development Works for specific targets and standards

The same table addresses urban open space standards and notably identifies in PO31 and AO31.2 that soft elements of WSUD are appropriate low-impact uses within district and regional parks.

The other notable aspect of the Structure Plan Code and PSP in relation to stormwater is the location and provisions of the environmental transition zones. These areas are show diagrammatically in Map OPM P12 (refer Appendix A). Table 10.4.3.4 PO9 (b) (ii) specifically notes that WSUD infrastructure is appropriate for location in this zone.

The soft elements of WSUD proposed across the Harmony development consist of grass swales, bioretention and wetlands. These elements are proposed within the environmental transition areas of the non-urban open space infrastructure area in accordance with the Palmview Structure Plan Table 10.3.4.3A as well as the district and regional recreational parks in accordance with the Palmview Structure Plan acceptable outcome AO33.2. The total unconstrained area provision for the urban open space infrastructure network shall be delivered in accordance with OPM P11.

Stormwater Management Code and Development Works Planning Scheme Policy

The Stormwater Management Code contains a range of provisions with key points of note summarised as follows:

- PO2 requires that stormwater is discharged to a lawful point of discharge
- PO6 requires that waterway stability is preserved
- PO7 requires that frequent flow management objectives are met
- PO9 requires that pollutant load reduction objectives are met

The PSP for Development Works provides the quantitative triggers for application of these objectives and the numerical values associated with the objectives. In the case of the pollutant load reduction targets and waterway stability targets these objectives are identical to the SPP targets identified in Section 3.1.

3.3 Application of Objectives

The pollutant load reduction objectives have been derived based on the limit of cost-effective treatment using conventional stormwater treatment technologies. Due to this, it is generally not effective to over-treat some internal site catchments to compensate for under-treatment in other areas. As such, it is proposed that the pollutant load reduction objectives will be achieved for each urban development stage. This will be demonstrated with each reconfiguration of a lot application for each stage where detailed locations and sizing of treatment devices consistent with the Strategy document will be provided.

3.4 Summary of Design Objectives

Based on the statutory requirements and site context discussed in the preceding sections, the Stormwater Quality Design Objectives are summarised in Table 3.1.

Table 3.1 – Summary of Stormwater Quality Design Objectives

Type of Objective	Design Criteria	Application	Methodology
Stormwater Quality	Minimum reductions in mean annual loads compared to unmitigated development: ▪ Total Suspended Solids (TSS): 80% ▪ Total Phosphorus (TP): 60% ▪ Total Nitrogen (TN): 45% ▪ Gross Pollutants >5mm: 90%	All urban development areas of the site where the local catchment fraction impervious exceeds 25%	Compliance to be quantitatively demonstrated with each REC application based on MUSIC modelling

4 WSUD Guiding Principles

A number of conceptual design principles were established in earlier versions of this strategy document to inform the stormwater design and WSUD strategy. However many of these principles were rejected by Council and subsequently the following two guiding principles were negotiated and agreed between Investa and Council, which now form the guiding principles for the document:

- End-of-line devices are preferred, however are to be located in environmental transition areas not co-located with urban open space; and
- At-source treatment is acceptable when the above is not achievable, however one-way crossfall roads are only acceptable on the lowest-order roads

The Conceptual Design Guidelines for Water Sensitive Urban Design (Water by Design, 2009) outlines the range of current best practice structural stormwater management technologies and identifies considerations relevant to their use. Based on the site constraints and opportunities and the above directive, the following technologies were determined to be most appropriate for consideration for use within the Harmony development area:

- ***At-source/streetscape bioretention (biopods and bioswales):*** The flat topography combined with restricted land availability (when not adjacent to a linear open space edge) makes this technology highly appropriate for the central areas of the site

- ***Constructed Wetlands:*** The flat topography makes this technology highly appropriate in locations where ecological enhancement is required and space is not restricted

- ***End-of-line Bioretention Basins:*** Opportunities may exist for this technology where adequate fall exists, though the flat topography and lack of significant ecological benefits from this technology mean it has less applicability than the first two options

The following section describes how these identified technologies have been spatially allocated within the development footprint based on consideration of the guiding principles defined above.

5 Strategy Development

Informed by knowledge of the site characteristics and the guiding principles for the project, an overall strategy for WSUD has been developed. The development area was initially discretised into indicative sub-catchment areas based on the existing site topography and the development footprint identified in the Structure Plan maps. Figure 5.1 identifies the indicative subcatchment areas along with open space areas from Structure Plan Map OPM P4 and existing major drainage lines. Note that sub-catchments are indicative as they are based on existing topography and the WSUD strategy developed in this Section will inform the final earthworks design and final site sub-catchments.

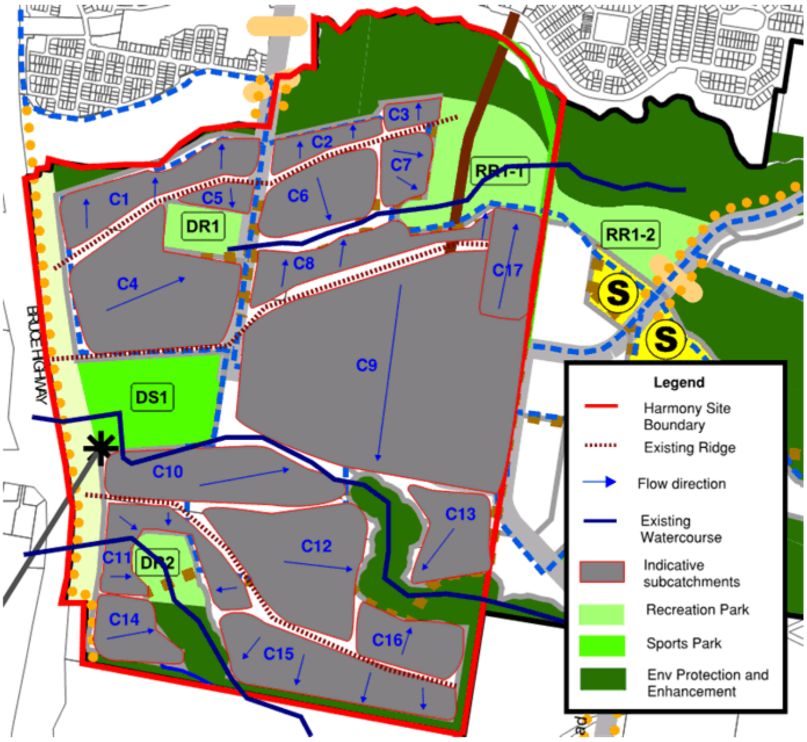

Figure 5.1 – WSUD Strategy Sub-catchments

For each of the subcatchments a process was followed of identifying opportunities and constraints in order to derive the water quality management strategy for each area which best achieves the guiding WSUD principles defined in Section 4.0. This process is documented in Table 5.1

Table 5.1 – Water Quality Management Strategy Development

Subcatchment ID	Opportunities	Constraints	Strategy Outcome
C1, C2, C3	• Drain to environmental transition area which allows co-location of WSUD infrastructure • Wetlands can enhance ecological outcomes of this area and integrate with riparian buffer	• Flat topography prevents use of end-of-line bioretention	• Provide end-of-line constructed wetlands to treat these subcatchments, located in environmental transition area • Earthworks design to move ridgeline which defines southern extent of these sub-catchments to the south as far as practicable in order to maximise opportunity for enhanced environmental transition area
C4, C5		• Drains to district recreation park DR1, so no opportunity exists to integrate end-of-line WSUD • Flat topography and lack of fall to receiving waterway prevents use of end-of-line bioretention	• Provide at-source biopods to treat this subcatchment
C6	• Existing drainage channel at southern extent of subcatchment provides outlet for stormwater system, minimising pipe network and stormwater infrastructure costs	• Flat topography prevents use of end-of-line bioretention • Absence of open-space in which to integrate wetlands	• Provide at-source biopods to treat this subcatchment • Retain/enhance existing drainage channel which defines southern boundary of this sub-catchment for flow conveyance and to minimise stormwater infrastructure costs
C7	• Environmental transition zone exists at northern and eastern fringe of regional recreation park RR1-1	• Regional flooding and flat topography prevents use of end-of-line bioretention	• Provide constructed wetland integrated within environmental transition zone at fringe of regional park RR1-1
C8	• Existing drainage channel at northern extent of subcatchment provides outlet for stormwater system, minimising pipe network and stormwater infrastructure	• Flat topography prevents use of end-of-line bioretention	• Provide at-source biopods to treat this subcatchment • Retain/enhance existing drainage channel which defines northern boundary of this sub-catchment for flow conveyance and to minimise stormwater infrastructure costs

	costs		• Earthworks design to move ridgeline which defines southern extent of this sub-catchment to the south as far as practicable in order to reduce maximum flow length for C9 and hence minimise stormwater infrastructure costs
C9		• Flat topography and long distance to outlet to open channel. Risk of large diameter, deep and expensive pipe network if flow lengths not minimised • Large catchment, would result in very large end-of-line device • Absence of open-space in which to integrate wetlands	• Provide at-source biopods and bioswales to treat this subcatchment • Earthworks design to move ridgeline which defines northern extent of this sub-catchment to the south as far as practicable in order to reduce maximum flow length for C9 and hence minimise stormwater infrastructure costs • Earthworks and urban design to minimise length of pipe network in order to minimise infrastructure costs • Consider incorporation of north-south open channel for conveyance of high-flows to minimise pipe costs
C10	• Existing drainage channel at northern extent of subcatchment provides outlet for stormwater system, minimising pipe network and stormwater infrastructure costs	• Flat topography prevents use of end-of-line bioretention • Absence of recreation open-space in which to integrate wetlands	• Provide at-source biopods to treat this subcatchment • Retain/enhance existing drainage channel which defines northern boundary of this sub-catchment for flow conveyance and to minimise stormwater infrastructure costs
C11	• Environmental transition zone exists around edge of DR2		• Provide constructed wetlands or bioretention integrated within environmental transition zone to treat this subcatchment
C12	• Discharges to environmental transition area which provides an opportunity to incorporate end-of-line device(s) if adequate space available	• Flat topography and long distance to outlet to open channel. Risk of large diameter, deep and expensive pipe network if flow lengths not minimised • Large catchment, would result in very large end-of-line device with inadequate space available to incorporate	• Provide at-source biopods to treat this subcatchment • Consider use of passive street tree irrigation in preference to mid-block bioretention on collector roads • Earthworks and urban design to minimise length of pipe network in order to minimise infrastructure costs • Consider incorporation of east-west open channel or flow path for conveyance of high-flows to minimise pipe costs
C13, C14, C15,	• Drain to environmental transition areas	• Flat topography may prevent use of	• Provide end-of-line constructed wetlands or bioretention

C16	which allows co-location of WSUD infrastructure • Wetlands can enhance ecological outcomes of this area and integrate with riparian buffer	end-of-line bioretention • Layout lends itself to smaller distributed end-of-line systems which would be of a scale more appropriate for bioretention than wetlands	basins to treat these subcatchments, located in environmental transition area. Determination of bioretention viability to be undertaken with concept design based on availability of adequate fall
C17	• Environmental transition areas located immediately to the north of this catchment	• Local Public Transport Corridor along the eastern boundary limits the opportunity to incorporate at-source devices	• Provide end-of-line constructed wetlands or bioretention basins to treat these subcatchments, located in environmental transition area. Determination of bioretention viability to be undertaken with concept design based on availability of adequate fall

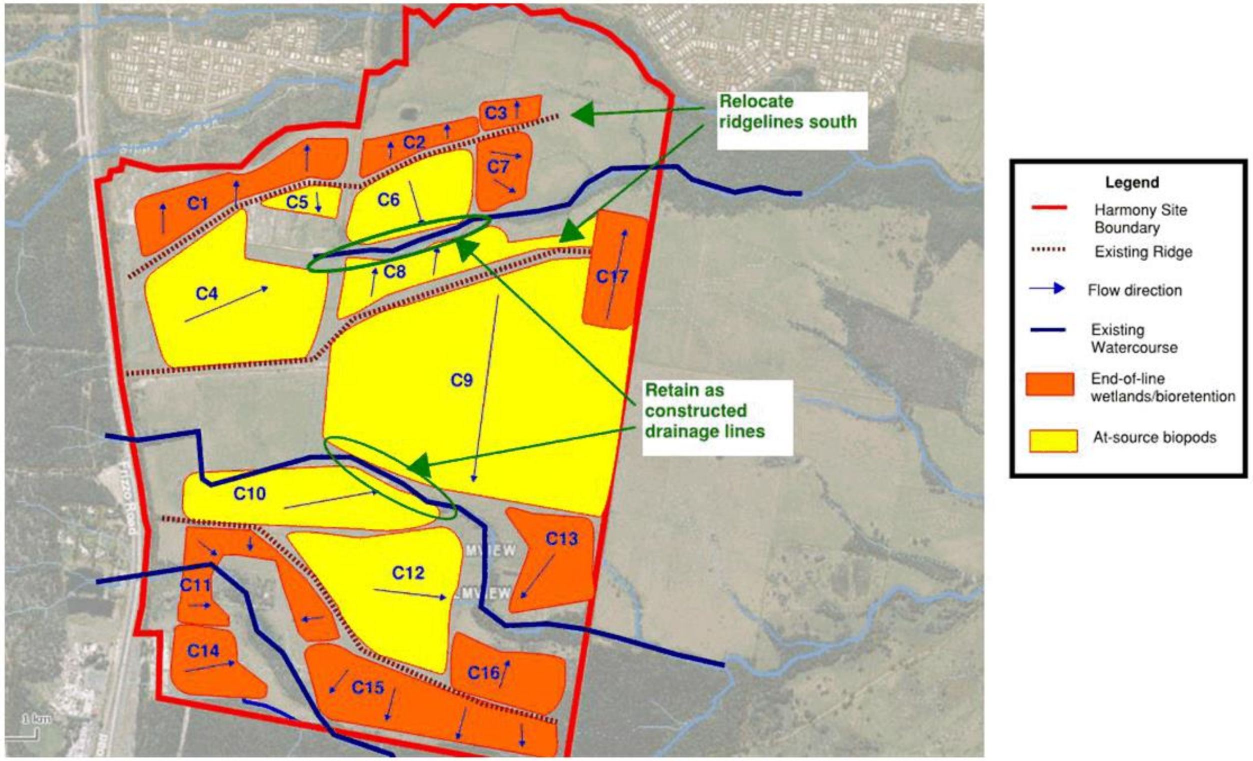

Figure 5.2. – WSUD Strategy for Harmony

6 Conceptual Design

6.1 At-Source Strategy Elements

At-source stormwater treatment (biopods) within residential streets was pioneered in Australia locally at Bellvista Estate from 2006. Since that time there have been many further examples locally of at-source treatment approaches, which have been implemented with varying levels of success. From this considerable evidence base, we believe a number of conclusions can be drawn:

1. Earthworks and urban design needs to facilitate consolidated biopod outcomes and eliminate mid-block devices where-ever possible. Mid-block devices are generally small, expensive and undesirable to residents due to being located in the frontage of properties and constrained in length due to driveway cross-overs
2. Amenity is enhanced by providing trees and shrubs adjacent to or within biopods. This is evidenced by the early Bellvista biopods which included these elements and are considered to have enhanced amenity compared to later versions which have only macrophyte planting.
3. Pedestrian safety needs to be carefully considered in design. Engineered 'retro-fits' to address this issue (such as raised concrete refuge strips and handrails adjacent to paths) have added significant cost and detracted from amenity

Based on the above conclusions and a desire to produce a superior streetscape amenity outcome for Harmony, an evolved biopod concept has been developed. The key features of this concept are:

- **One-way crossfall pavement** on local access streets. This allows the biopod to be consolidated on one verge and hence provides a larger area for landscape embellishment making tree and shrub planting more viable. This also leaves the other verge completely unconstrained for pedestrian movement.
- **7.5m pavement width** on access streets narrowing to 6m adjacent to the biopod. This wider pavement width is necessary to accommodate the on-street parking requirements of the Structure Plan.
- **Enhanced landscape outcomes,** by providing flush kerb and a landscaped refuge strip for pedestrians. This allows elimination of the raised concrete refuge strip and concrete kerb turn-out with the effect of significantly 'softening' the streetscape.

These features are shown in Figures 6.1 and 6.2 which have been prepared by Calibre and RPS respectively.

While this evolved biopod concept/configuration will be used extensively throughout the estate, it is but one of a range of at-source elements which will be selected and optimized for each stage based on the specific constraints and opportunities. For example, within the Display Village area of the development there is a need to create an 'a-typical' urban design layout to facilitate the function of building display. In areas such as this a range of alternative at-source measures may be used in addition to the evolved biopod concept described above.

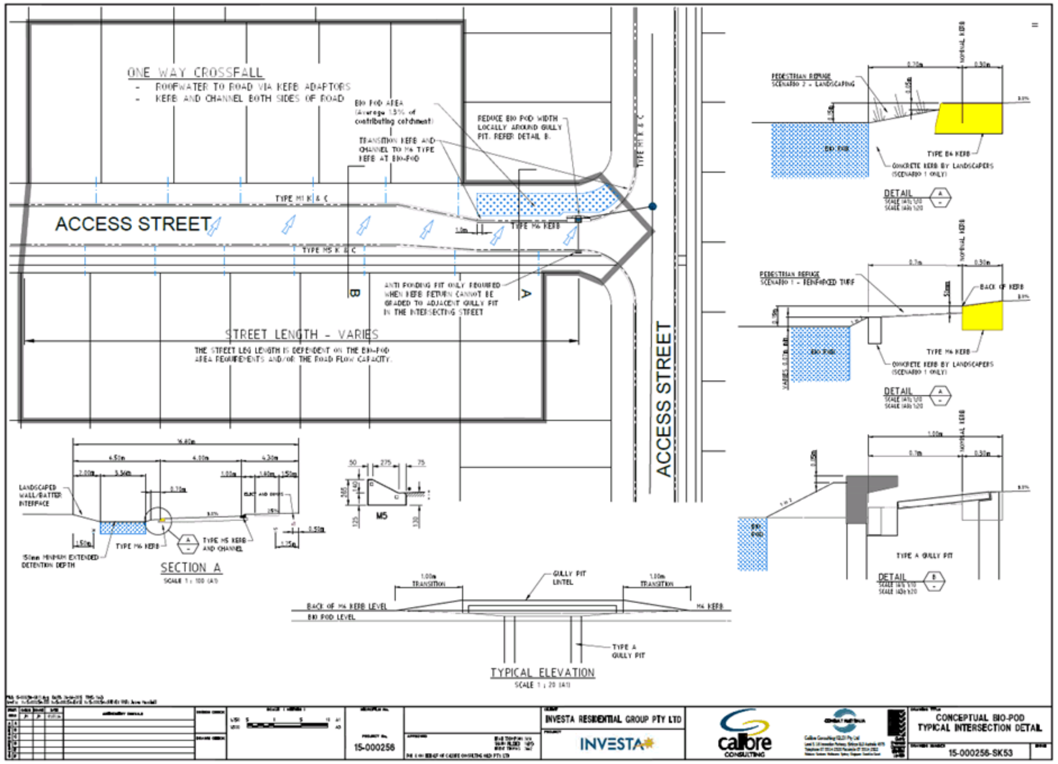

Figure 6.1 – Biopod Concept Engineering Drawing by Calibre Consulting

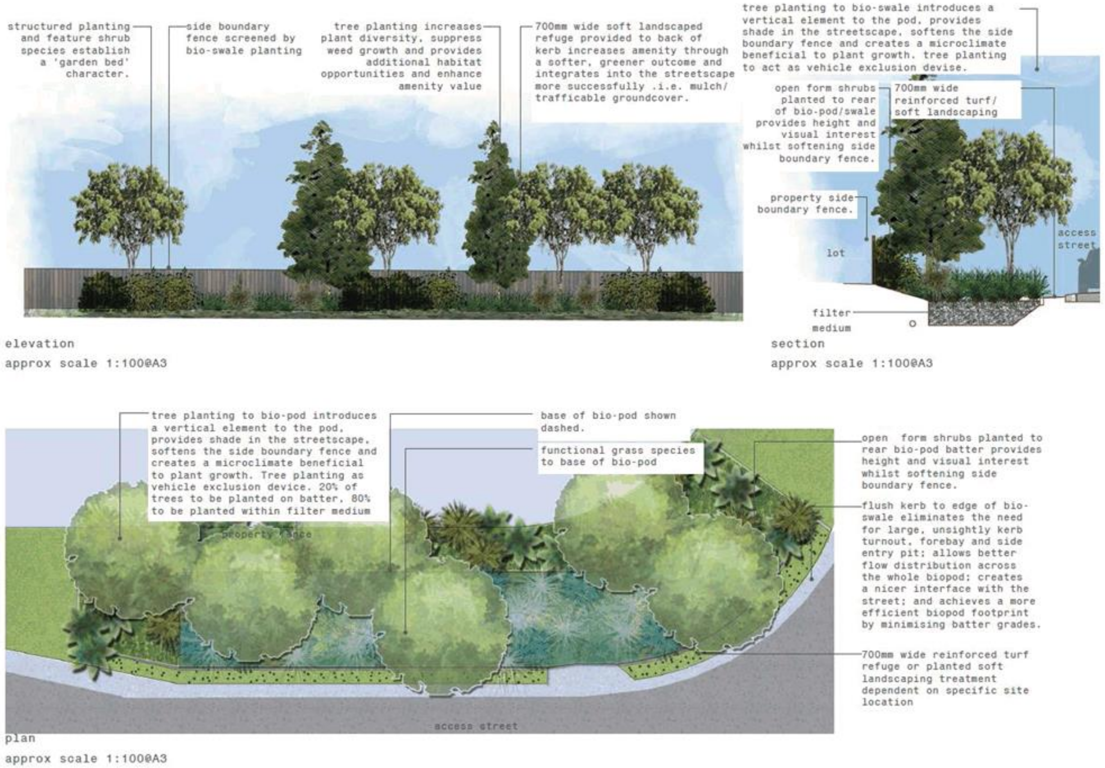

Figure 6.2 – Biopod Concept Landscape Drawing by RPS

This enhanced biopod concept was workshopped with Council officers and a range of issues were identified requiring further investigation as follows:

1. Compliance with QUDM minor/major event criteria
2. Risk of aqua-planing due to transverse flow from high-side roofwater connections across the pavement
3. Risk of seepage flows and 'sliming' of the pavement due to roofwater connections on the high side of the road
4. How pedestrian refuge has been accommodated
5. Justification for the nominated pavement width and interaction with on-street parking

Each of these issues is discussed in turn.

6.1.1 Compliance with QUDM minor/major event criteria

The roadway flow width limitations have been assessed in accordance with QUDM Tables 7.4.1 and 7.4.2 for the minor and major storm events respectively. This specific criteria has been adopted to determine what maximum street leg lengths can be achieved before the stormwater runoff is required to be collected and piped via an underground pipe network. Figure 6.3 outlines the flow depth and width limitations which can be accommodated for an Access Street having a street length of 110m and a longitudinal grade of 0.5%.

Street leg lengths have been used to inform the urban design and are generally limited to a maximum 110m when earthworks grading allows. Street lengths greater than 110m can still be achieved however when a localised high-point is able to be introduced along the street to split the catchment into two smaller areas i.e. the street will fall in both directions and limit the total flow length. Opportunities also exist to have longer street leg lengths where only a single side of the street contributes to the street catchment (e.g. Access Street fronting park or drainage reserves). An example of these situations are demonstrated in Figure 6.4 and supported by the stormwater drainage capacity calculations.

6.1.2 Risk of aquaplaning

A risk assessment was undertaken by Calibre Consulting based on the following:

- An aquaplaning assessment has been conducted at the sag of 2 1-way crossfall intersecting streets
- The aquaplaning assessment has been undertaken in accordance with Transport of Main Roads Road Drainage Design Manual – Chapter 11
- A copy of the aquaplaning potential assessment is shown predicting a maximum depth of 2.18mm – indicating that aquaplaning is highly unlikely

A copy of the aquaplaning assessment is provided as Figure 6.5.

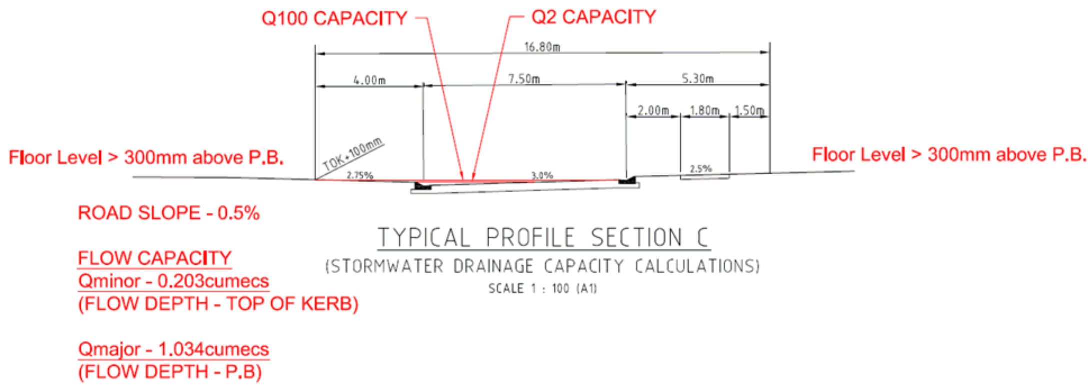

Table 7.4.1 – Roadway flow width[1] limitations during MINOR STORM for 'longitudinal' flow

Site condition	Major road	Minor road
Normal situation	Parking lane width (usually 2.5 m) or breakdown lane width[2]	(i) Full pavement width with zero depth at crown (ii) Where one way crossfall exists (i.e. no crown), flow width is limited to the high side of road pavement, but not above top of kerb on low side
Where parking lane may become an acceleration, deceleration or turn lane	1.0 m	Not applicable
Where road falls towards median	1.0 m	Not applicable
Pedestrian crossings or bus stops	0.45 m	0.45 m
At intersection kerb returns (including entrances to shopping centres and other major developments)	1.0 m[3] [4]	1.0 m[3] [4]
Vehicular safety	Flow depth and depth*velocity limits as per major storm	

Table 7.4.3 – Roadway flow depth and velocity limitations during MAJOR STORM for 'longitudinal' flow

Site condition	Flow depth and width limits
Where floor levels of adjacent buildings are above road level	• Total flow is contained within road reserve • Minimum freeboard of 300 mm to floor level of adjacent buildings
Where floor levels of existing adjacent buildings are below, or less than 300 mm above, the top of kerb; and there is at least 100 mm fall on footpath towards the kerb	• Maximum flow depth of 50 mm above top of kerb
Where floor levels of existing adjacent buildings are below, or less than 300 mm above, the top of kerb; and there is less than 100 mm fall on footpath towards the kerb	• Maximum flow depth at top of kerb
Vehicle safety: Flow conditions at kerb for flow along a road(no risk to life)	• Maximum flow depth, $d_g \leq 250$ mm • Depth*velocity product, $d_g.V_{ave} \leq 0.6$ m^2/s
Vehicle safety: Flow conditions at kerb for flow along kerb (potential risk to life)	• Maximum flow depth, $d_g \leq 250$ mm • Depth*velocity product, $d_g.V_{ave} \leq 0.4$ m^2/s

Figure 6.3 – Flow Capacity Calculations by Calibre Consulting

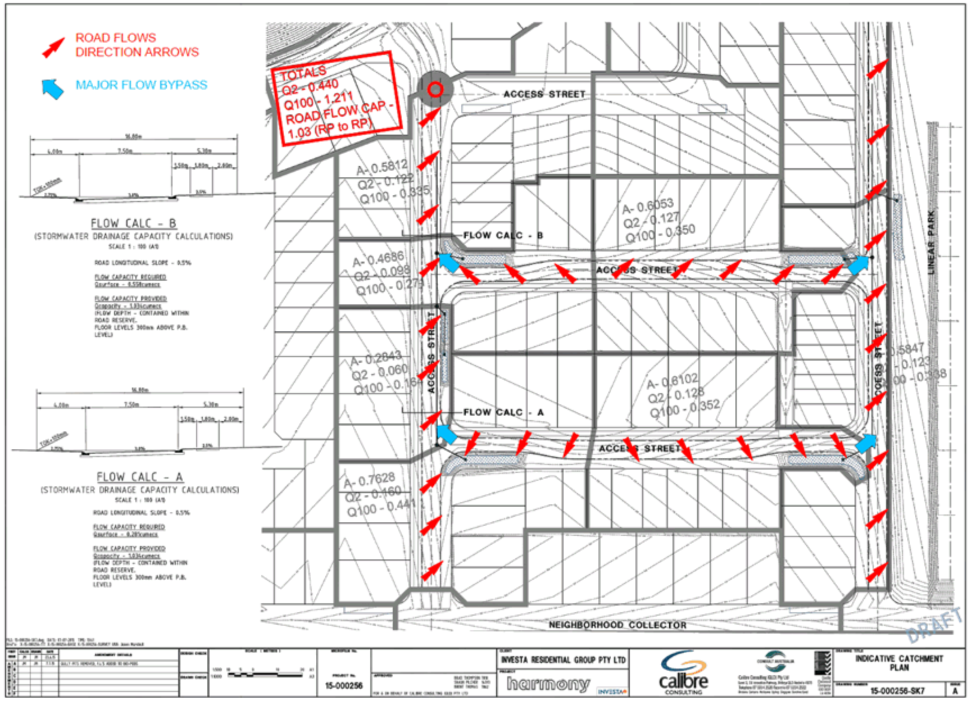

Figure 6.4 – Sample Layout and Drainage Calculations by Calibre Consulting

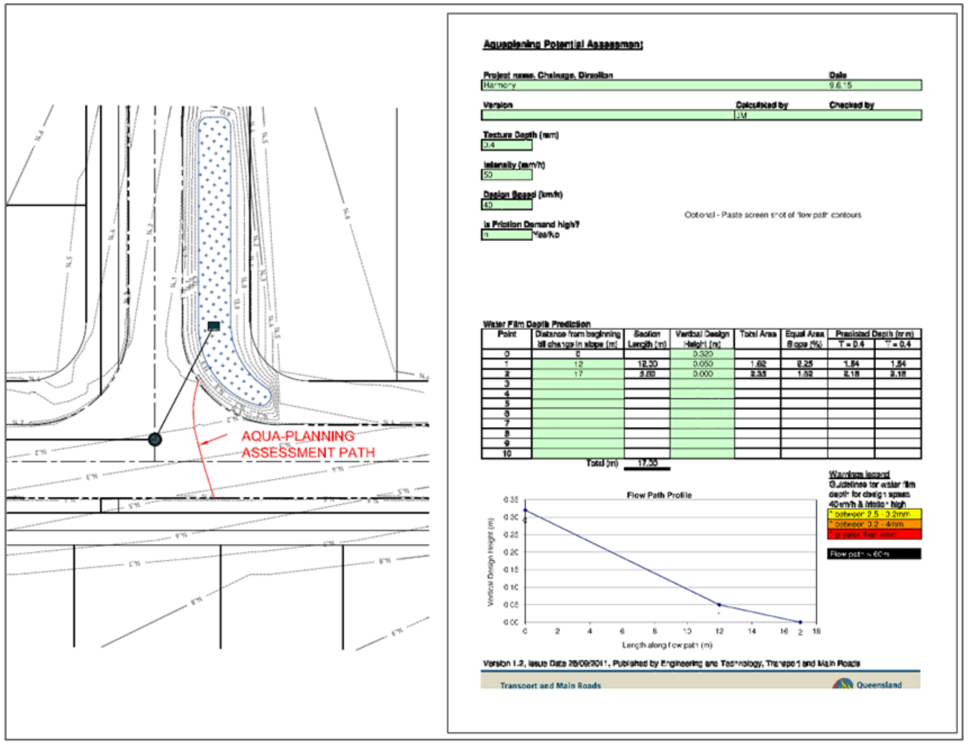

Figure 6.5 – Aquaplaning Calculations by Calibre Consulting

6.1.3 Risk of seepage flows

Seepage has been addressed by provision of a standard M1 kerb-and-channel profile on the high-side of the pavement (rather than an edge restraint or kerb-only). This will allow seepage flows to be collected in the channel and conveyed longitudinally to either an anti-ponding pit at the end of the street or graded to a side-entry pit on the intersecting road. The capacity of the channel is very low and will not significantly affect the MUSIC modelling results, although this flow bypassing the biopods will be modelled. This is shown diagrammatically in Figure 6.1.

6.1.4 Pedestrian refuge

There appeared to be broad acceptance from the Council Officers present at the workshop that there was no need for provision of linear movement on the verge containing the biopod if there was a constructed footpath on the opposing verge. This position is consistent with the position adopted by Council on all previous estates incorporating biopods on the Sunshine Coast. However Council Officers appeared to be of the view that a 'refuge' area between the kerb and the top of batter of the biopod was required in all situations.

In response to this feedback, the biopod concept section provided in Figure 6.6 contains sufficient width to incorporate a refuge area. The form of the refuge is extremely important in terms of streetscape outcomes. The approach taken at many estates to provide this refuge as a raised concrete plinth (refer Photo 1) has created undesirable streetscape outcomes because:

- It requires a discrete kerb turnout for flows to enter the biopod (as opposed to kerb breaks or flush kerb) which in turn drives provision of a forebay – both of which further add to the harsh concrete look and feel of the biopods
- The concrete plinth creates legibility issues as pedestrians/residents become confused about whether it is meant to be a footpath, bin pad or mountable area for parking;
- The plinth, turnout and forebay are ugly and detract from streetscape outcomes; and
- The heavy use of concrete increases total lifecycle costs significantly and unnecessarily, including both establishment cost to the developer and replacement cost to Council

Photo 1 – Traditional concrete refuge plus kerb turn-out and forebay (Britinya) – not a desired outcome

The approach adopted in Figure 6.2 is to provide a 700mm wide soft landscape strip to back of flush kerb. We believe this is a better approach compared to a raised concrete plinth because:

- The flush kerb proposed eliminates the need for large unsightly kerb turn outs, forebays and side entry pits.
- Flush kerb allows better flow distribution across the whole of the bio-pod/swale.
- The flush kerb and soft landscape refuge strip achieves a more efficient bio-pod/swale footprint by minimising batter grade.
- The soft landscape refuge increases amenity through a softer, greener outcome and integrates into the streetscape more successfully.
- The soft landscape refuge supports the 'garden bed' desired visual outcome, creating a landscape feature out of the bio pods/swale.

6.1.5 Pavement Width and On-Street Parking

The wider 7.5m pavement width for access streets is required due to the on-street parking requirements under the Structure Plan. On-street parking requirements have been calculated based on Planning Scheme Schedule 6 SC6.17P Table:

- 2 spaces per 3 dwellings
- 1 space per 2 dwelling houses on small lots (<300m²)
- At least 75% within 25m
- 100% within 40m

Figure 6.6 demonstrates on-street parking allocation for a typical access street and how a 6.0m pavement is insufficient and must be increased to 7.5m. The narrower pavement (6.0m) is however adopted adjacent to the biopod at the entrance to the local access streets and provides strong visual cues that parking in this location is not encouraged. In relation to collector roads, the intention is again to minimise parking conflicts with biopods by consolidating biopods at the build-outs which define the start and end of indented parking bays and where additional biopods are required based on the contributing catchment area, utilizing passively-irrigated-street trees in preference to mid-block biopods

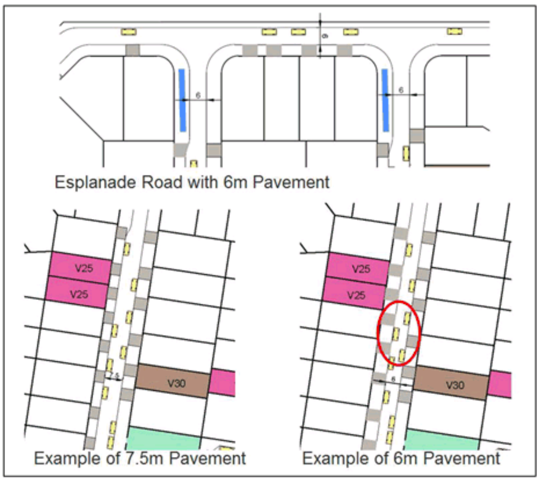

Figure 6.6 – On-Street Parking Analysis by RPS

28 | WSUD Strategy for Harmony

6.1.6 Spatial Allocation

Although all engineering performance criteria have been addressed, Council have indicated that they will not support the one-way crossfall concept on higher-order streets. For this reason a two-way crossfall road will be implemented on all collector roads and on access streets having larger traffic volumes. The roads which will be retained as a traditional crowned road within the initial land release areas are shown in Figure 6.8.

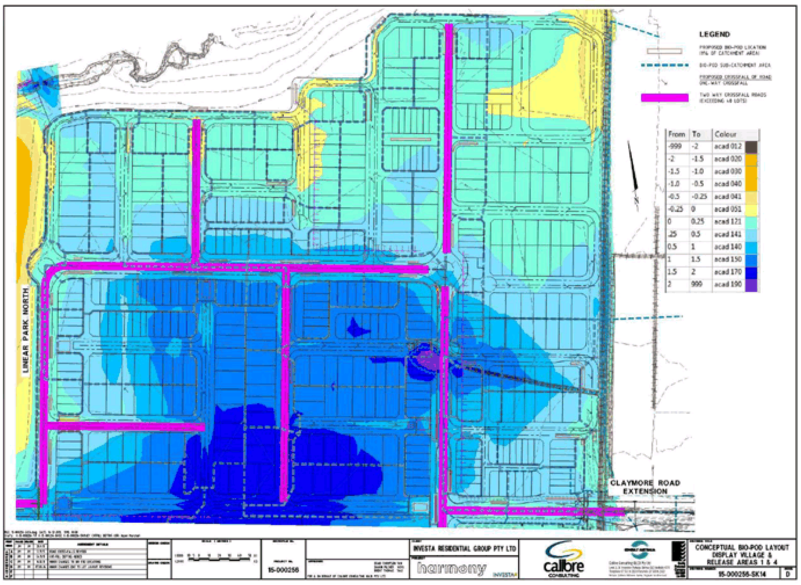

Figure 6.8 – Crowned Roads

6.2 End-of-line Strategy Elements

The end-of-line strategy elements considered are constructed wetlands and bioretention basins. There are two key considerations impacting the selection of either technology being scale and grade.

6.2.1 Grade

Constructed wetlands are often the only feasible end-of-line technology for flat topography. This is because the wetland features an inlet pond at the start of the device which allows the incoming pipe from the stormwater drainage network to be submerged. Although the wetland outlet should generally have at least 300mm fall to the normal dry-weather receiving water level, the actual pipe discharging to the inlet pond may have an invert level approaching that of the receiving water level (subject to HGL analysis and adequate drainage performance). Thus **constructed wetlands can often be design to be neutral** in terms of the overall effect on the fill levels and required outlet levels of the stormwater drainage network.

Bioretention basins are a different matter, with key bioretention components shown in Figure 6.9. The pipe outlet from the stormwater drainage network is required to be free-draining and discharge to the surface of the bioretention basin filter media (preferably 200mm above filter media surface). Filter media incorporating trees is required to have a minimum depth of 700mm and is followed by an additional width of 300mm for the transition and drainage layers. The subsoil drains require an outlet which is at least 300mm above the normal dry-weather receiving water level in order to ensure free-draining. The consequence of this is that provision of a bioretention basin which incorporates trees requires a **minimum of 1.5m of fall between the invert of the outlet pipe from the stormwater network and the receiving water level.**

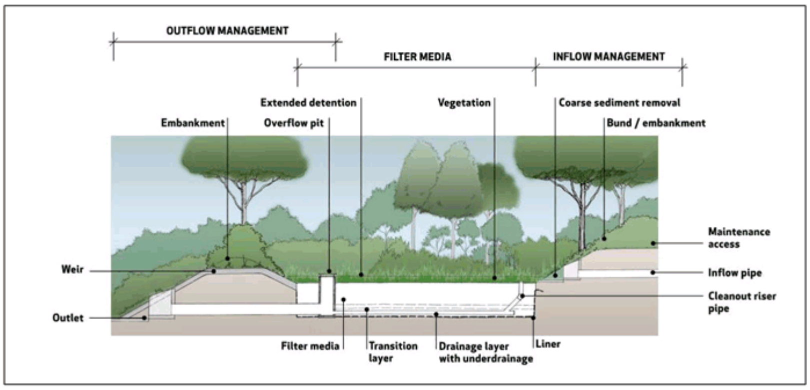

Figure 6.9 – Bioretention components (source: Water by Design, 2012)

6.2.2 Scale

Due to constructability limits, bioretention basins are limited in scale to a filter media area of 800m^2 corresponding to a contributing catchment area of approximately 6Ha. Although multi-cell bioretention basins can be constructed in order to service larger catchments, this is generally undesirable compared to provision of a constructed wetland as:

- Multi-cell bioretention introduces additional complexity in terms of flow distribution – both to the cells and within the cells
- Larger bioretention basins servicing larger catchments generally correspond to longer runs of stormwater pipe network and on flat topography this results in deep outlets. Even if adequate fall exists to drain the bioretention device effectively, this results in a system which is deep and visually isolated from the surrounding landscape, leading to detrimental amenity outcomes
- At this scale wetland offer a more diverse range of habitats and enhanced ecological outcomes.

Conversely, wetlands are not subject to the same size limitations and can serve very large catchment areas. Wetlands can be designed down to a micro-scale servicing small catchment areas, though few local examples exist.

Based on the above considerations of scale and grade, bioretention basins will generally only be preferred over constructed wetlands where adequate fall exists and where system size can be kept below 800m^2. Such situations are likely to be limited to the Southern area of the site where grade is more significant and the occurrence of more frequent open drainage channels within the urban form provides opportunities to keep runs of stormwater short and basin surface levels closer to that of the surrounding open space.

6.2.3 Sizing

Indicative sizing for bioretention and wetland devices has been derived by developing performance curves using the software MUSIC. A model was created based on 6min rainfall data for Caloundra WTP for the period 1/1/1997-31/12/2006 using a lumped catchment approach. A fraction impervious of 60% was adopted, reflecting the typical density of 18 dwellings/ha across the Palmview Structure Plan Area. Rainfall-runoff and pollutant-export parameters were specified consistent with the *MUSIC Modelling Guidelines* (Water by Design, 2010).

Varying bioretention and wetland sizes were then run through the model in order to establish the minimum size requirements to achieve the required pollutant load reduction targets. For bioretention devices the limiting pollutant was fund to be TSS, while for wetlands the limiting pollutant was TN.

The resulting curves are provided as Figures 6.10 and 6.11. From these figures it can be determined that:

- Minimum filter media area requirement for at-source bioretention (biopods) is 1% of the contributing catchment area
- Minimum filter media area requirement for end-of-line bioretention basins is 0.9% of the contributing catchment area
- Minimum macrophyte zone area for constructed wetlands is 7% of the contributing catchment area

These sizing's can be used in initial planning for the spatial allocation of these devices, however it should be noted that additional space must be allowed for batters (all devices) and inlet zones and high-flow by-pass channels (wetlands only).

In addition, where bioswales are used instead of biopods (1m bioretention width overlaid with nominal swale) the required size is less than 2% of the contributing catchment area.

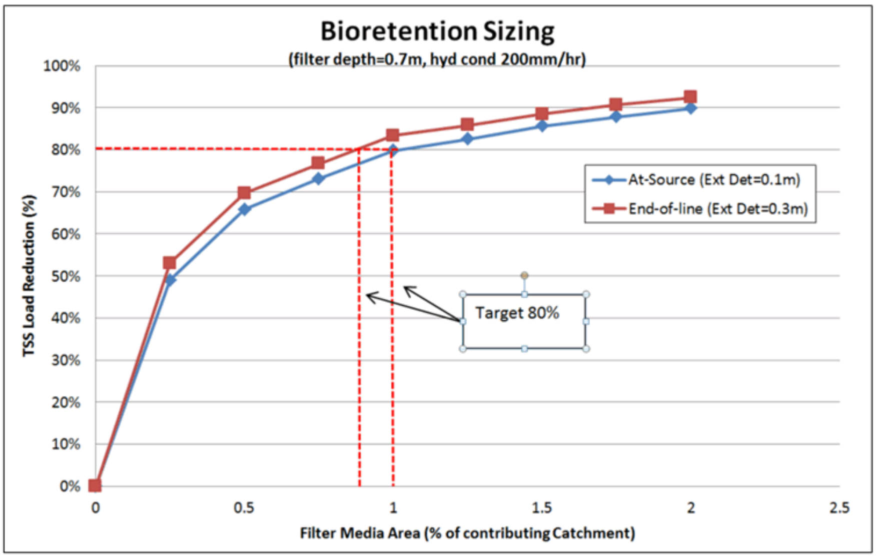

Figure 6.10 – Bioretention Filter Media Area Size Requirements

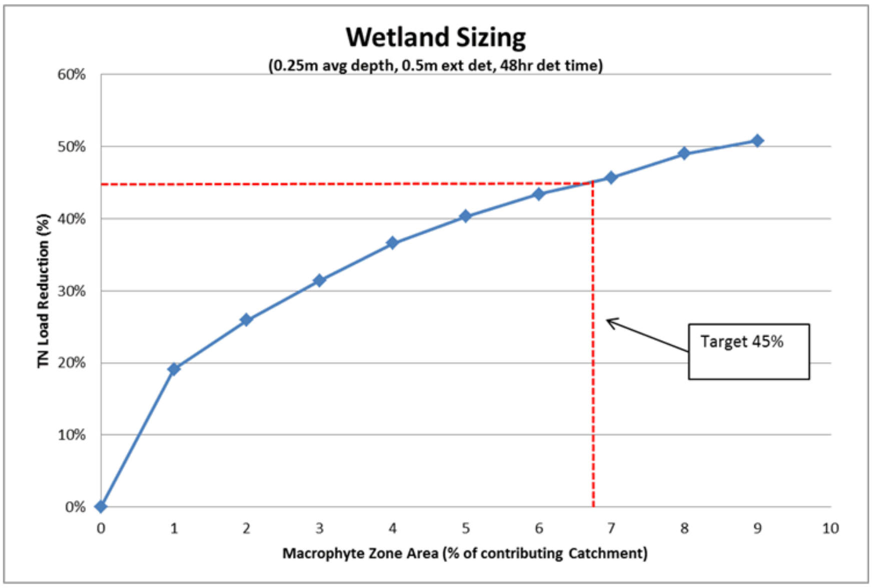

Figure 6.11 – Wetland Macrophyte Zone Size Requirements

7 Detailed Design and Sequencing of WSUD Infrastructure

This strategy is the first step in what will be a process spanning many years in order to see the successful design and delivery of water sensitive urban design throughout the Harmony Estate. It is therefore important to understand how further design work will be tied to future applications and the intended sequence of delivery of infrastructure for the project.

Future Planning

The following is the intended triggers and scope for further detailed Stormwater Management Plan reporting and detailed concept design:

- MUSIC modelling will be undertaken and reported in conjunction with **each** future reconfiguration of a lot application, demonstrating how the pollutant load reduction objectives are met for that stage. The application will also be accompanied by detailed concept design information for the water quality treatment devices proposed for the stage, include the spatial allocation and sizing for each device.
- Runoff-routing modelling will be undertaken in conjunction with the **first** future reconfiguration of a lot application for a stage contributing to each site release point. The modelling will develop the storage design required to ensure the applicable waterway stability and/or flood detention objectives associated with that release point are achieved.

Delivery of Infrastructure

The following is the intended sequence of on-ground delivery of infrastructure:

- **At-source bioretention:** Will be delivered progressively with each development stage
- **Regional end-of-line bioretention or Wetlands**: Will be designed and constructed with the first stage contributing flow to these device locations. However the devices will remain in a protected temporary unvegetated state until construction is completed in that catchment.
- **Detention storage**: The storage required to achieve either the waterway stability or flood detention objectives will be constructed in conjunction with the first development stage within that catchment. If this stage occurs ahead of the road link or other infrastructure necessary to form the final storage solution then a temporary solution achieving the same outcome will need to be implemented.

8 References

Department of State Development, Infrastructure and Planning. (2014). *State Planning Policy*

Department of Natural Resources and Water. (2013). *Queensland Urban Drainage Manual*

Sunshine Coast Council (2014) *Sunshine Coast Planning Scheme 2014*

Water by Design (2007) *Water Sensitive Urban Design – developing design objectives for urban development in South East Queensland*

Water by Design (2009) *Concept Design Guidelines for Water Sensitive Urban Design*

Water by Design (2010a) *Multiple Uses of Open Space Discussion Paper*

Water by Design (2010b) *MUSIC Modelling Guidelines*

Water by Design (2011) *Framework for the Integration of Flood and Stormwater into Open Space*

Water by Design (2014a) *Sketch designs*

Water by Design (2014b) *Living Waterways*

Appendix A – Palmview Structure Plan Maps