Sunshine Coast COUNCIL

Flooding and Stormwater Management Guidelines

Version 1 – September 2020

FOREWORD

THE FLOODING AND STORMWATER MANAGEMENT GUIDELINES AIM TO SUPPORT THE CODES AND POLICIES THE *SUNSHINE COAST PLANNING SCHEME 2014* BY PROVIDING ADDITIONAL DETAIL AROUND HOW STORMWATER QUALITY, QUANTITY AND DRAINAGE AND FLOODING ISSUES ARE TO BE MANAGED.

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This document was prepared in conjunction with the following organisation:

SWITCHBACK CONSULTING

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Contents

1 Introduction

1.1 Purpose of the Guidelines

One of the things that make the Sunshine Coast great is the range of high-quality aquatic receiving environments in close proximity to the towns and villages of the region. These environments are valued by residents and tourists alike, and contribute significantly to the sustainability of the local economy.

However, retaining this natural capital is not without challenge. The Sunshine Coast is in a sub-tropical climatic region and is subject to significant rainfall events from time to time. As can be seen in Figure 1, many of our population centres and future growth areas are close to water and are susceptible to flooding from streams and rivers or the ocean through storm tide. The growth of the region creates prosperity but also puts increasing pressure on our waterways through increased runoff and pollution.

Through the *Sunshine Coast Planning Scheme 2014*, Sunshine Coast Council has articulated how sustainable development is to occur in the region and have put in place policies to preserve the natural quality of our waters and protect residents from the potentially damaging effects of flooding.

These guidelines support the codes and polices of the planning scheme by providing additional detail around key issues. The aim of the guideline is to assist applicants to make better applications and through this achieve faster approvals and better on-ground outcomes for the community.

1.2 Future Climate Considerations

Rainfall estimation is a key input into all aspects of flooding and stormwater management and is discussed within each Section of these guidelines. The way in which climate change is accounted for is therefore a key consideration.

In general, the assessments required by these guidelines are to be based on future climate and are to incorporate climate change allowances at year 2100 (0.8m sea level rise and 20% increase in rainfall intensity[1]). This is specifically required for estimation of design flood levels, assessment of flood risk, and infrastructure sizing/design including urban drainage design.

The exceptions to the need to account for future climate are as follows:

- Flood impact assessment is to be based upon a current climate condition except that an additional assessment of impacts for the 1 in 100 AEP future climate event is also required;
- Sizing of stormwater quality treatment trains is based on historical rainfall records and hence is based on current climate; and
- Compliance against the Waterway Stability objective is to be based on current climate.

[1] Increased rainfall intensity allowance is based on the Intergovernmental Panel on Climate Change 5th Report (scenario RCP 8.5) based on current tends of CO_2 emissions. SCC considers it prudent to adopt this scenario until such time as international efforts to reduce CO_2 emissions are effective

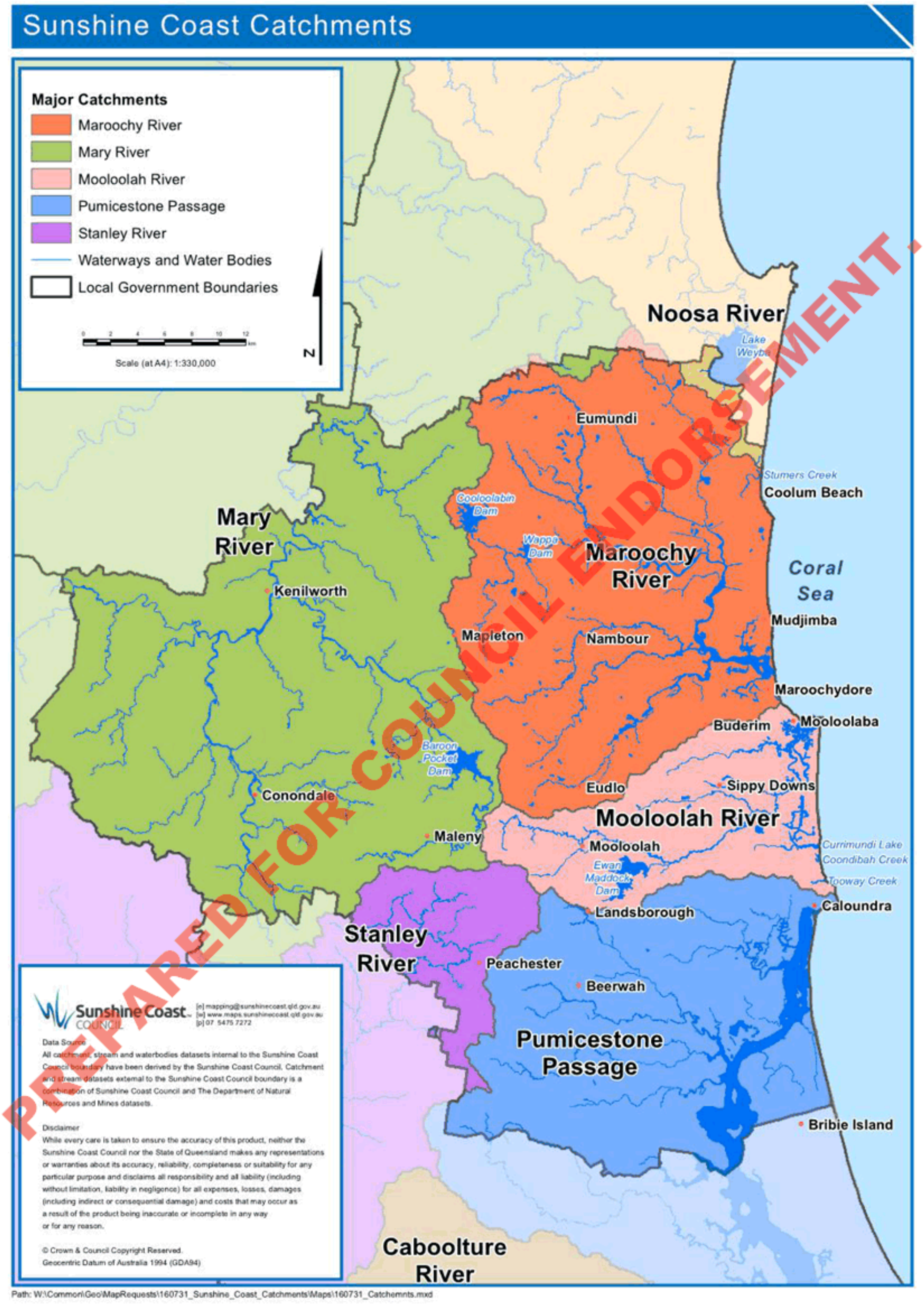


Figure 1 Catchments of the Sunshine Coast Local Government Region

2 Issues Addressed Through the Guidelines

The purpose of this section is to clearly articulate Council's policy position on flooding and stormwater issues and provide a guide as to how each issue is documented in the Planning Scheme and Guidelines.

The long-term vision for flooding and stormwater is set through Council's *Environment and Liveability Strategy*, which sets the following outcome for 2041:

Flood risk is managed for community wellbeing, facilitated by an integrated stormwater network that contributes to waterway health.

This outcome or long-term vision is to be achieved through the following three key policy positions:

6.1 - Flood risk is managed for the wellbeing of our communities:

a) Development will be provided with acceptable flood risk and will not burden emergency services

b) Flood immunity (from rainfall induced flooding) of existing communities is improved through the exploration of effective flood mitigation measures where practical

c) Disaster management activities cater for our communities before, during and after events

d) Flood risk information is made available in a form that is easily understood

e) Insurance affordability is promoted through the provision of information to industry

6.2 - Flooding and stormwater assets are effective and responsive to a changing environment:

a) Infrastructure is designed to be effective until the end of its design life

b) Infrastructure that is a burden or liability for Council is avoided

c) Accurate and current models, mapping and other corporate datasets inform the understanding of flood risk and stormwater network effectiveness

d) Performance and condition of assets is monitored to ensure effectiveness

e) Land for stormwater management purposes is appropriately located and designated

6.3 - Flooding and stormwater management protects the natural and built environment:

a) Flood plains are protected for their intrinsic environmental, social and economic values

b) Development in the flood storage preservation area only occurs where there is overriding community need with acceptable associated impacts and minimal alteration to the floodplain

c) Development ensures that areas of community isolation are not created

d) Stormwater quality treatment is provided to protect receiving waters and the health of our community

e) Stormwater treatment is complementary and integrated within the public realm, using natural processes to the greatest extent possible

f) Flood conveyance pathways are protected or enhanced

g) Natural waterways are not diverted

There is a range of documents which Council relies on to deliver these policy positions relating to flooding and stormwater management. At the planning scheme level, there are the codes and planning scheme policies (PSP's), which include:

- Stormwater Management Code
- Flood Hazard Overlay Code
- Planning Scheme Policy for Development Works
- Planning Scheme Policy for the Flood Hazard Overlay Code

Table 1 provides a summary of flooding and stormwater issues and where in the Planning scheme such issues are addressed along with the linkages to the policy positions in the *Environment and Liveability Strategy*. This summary is provided using everyday language and the specific planning scheme reference should be referred to for the exact requirements.

In simple terms, the planning scheme stipulates what outcomes development needs to achieve. These guidelines assist and support the planning scheme by providing additional information on how to achieve these outcomes.

Wherever possible, industry guidelines are referred to within this document and form the default position for design unless alternate or additional requirements are specified. This has been done to avoid duplication and provide an approach consistent with other local government areas.

Source: *Water Sensitive Designs* (Healthy Waterways Ltd, 2014)

Table 1 Summary of Flooding and Stormwater Management Policy Positions and Planning Scheme References

Issue	*Environment and Liveability Strategy*	Sunshine Coast Planning Scheme 2014 Requirements	Flooding and Stormwater Management Guidelines Content
Stormwater Quality and Environmental Flows – Primary Code: Stormwater Management Code (SMC) and Planning Scheme Policy for Development Works (PSPDW)			
Open space integration	Policy Position 6.2(e), 6.3(e)	PSPDW SC6.14.3.6 specify performance standards for stormwater in parks, including: • Only areas above the 5%AEP inundation level from regional and local flooding (including stormwater treatment and detention facilities) may be considered for credit towards LGIP trunk open space network or minimum land required for non-trunk open space (i.e. local recreation park) • Infrastructure (BBQ, playground) above 1 in 100 AEP	Contains design advice on achieving good integration of stormwater into open space
Land Dedication – reserves, easements, freehold	Policy Position 6.2(e)	PSPDW SC6.14.3.4 (6)-(15) define requirements for reserves and easements Default position is reserve. Easement accepted where: • Rural land • Rural Residential and drains <5Ha • Urban and drains <1Ha of non-Council land Inter-allotment drainage in easement vested in favour of upstream property owner	Nil
Performance of proprietary products and emerging technologies	Policy Position 6.3(d)	PSPDW SC6.14.3.8 Documents the certification required for products which remain in private ownership and the testing required to verify the performance of proprietary products (GPTs) and emerging technologies proposed as donated infrastructure	Restates PSPDW position
Tailwater levels (gw, tidal, drainage impacts, climate change)	Policy Position 6.2(a)	Stormwater Management Code (SMC) PO2 requires a drainage system to be provided for development which considers climate change PSPDW SC6.14.3.3 requires drainage design to include 20% increased rainfall intensity and 0.8m increase in sea level	Provides background to adopted climate change parameters and links for IFD estimation
Environmental Flows and Waterway stability	Policy Position 6.3(d)(g)(e)	SMC PO6 requires channel erosion be controlled by limiting post-development changes in flows PSPDW SC6.14.3.7 provides objectives and application for waterway stability, consistent with the SPP. SMC PO7 and PO8 require that low-flow/frequent flow hydrology be maintained to protect in-stream ecology PSPDW SC6.14.3.7 notes assessment of frequent-flow hydrology will not normally be required except in specific circumstances where derivation of site-specific objectives will be required	Provides detailed guidance on how to demonstrate compliance with waterway stability objective

Issue	***Environment and Liveability Strategy***	**Sunshine Coast Planning Scheme 2014 Requirements**	**Flooding and Stormwater Management Guidelines Content**
Stormwater Quality Objectives and Compliance	Policy Position 6.3(d)(g)(e)	SMC PO9 and AO9.1, AO9.2 requires development achieve pollutant load reduction targets and such targets are met prior to entering a waterway/wetland buffer or a constructed waterbody PSPDW SC6.14.3.8 Quantifies the stormwater quality design objectives and provides criteria for when such objectives apply	A number of compliance approaches are documented on how to demonstrate compliance with the stormwater quality design objective.
Stormwater Quality Treatment Devices	Policy Position 6.3(d)(g)(e)	No specific design details on stormwater quality treatment devices are provided	Detailed design guidance is provided for a range of technologies, including standard drawings for streetscape bioretention devices (biopods)
Stormwater Harvesting		SMC PO13-PO15 provide requirement for developments which choose to incorporate stormwater harvesting. For systems donated to Council, AO15.1 requires an over-riding community benefit to establish the scheme and AO15.2 requires a secure on-going funding source. PSPDW SC6.14.3.9 reflects and restates the above requirements	Nil
Construction and establishment	Policy Position 6.3(d)(g)	SMC PO16 AO6.1 and AO6.2 requires construction methods in accordance with PSPDW and timing of construction to minimise risks SMC PO17 requires vegetated systems be established during the maintenance period PSPDW SC6.14.11 contains specifications for construction tolerances, testing, inspections and certifications which covers WSUD infrastructure	Nil
Constructed waterbodies	Policy Position 6.2(b)	SMC PO18-PO22 have specific requirements for constructed waterbodies, which include: • That new waterbodies are avoided • That waterbodies achieve EVs and WQOs • That waterbodies have secure on-going funding sources • That they are not used as stormwater treatment devices • That they provide multiple benefits and do not pose healthy, safety or aesthetic risks PSPDW SC6.14.9 comprehensively addresses the requirements for constructed waterbodies	Nil
Reporting requirements for Stormwater Management Plans	Policy Position 6.2(c)	Nil	Reporting template for stormwater management plans provided as Appendix 1

Issue	*Environment and Liveability Strategy*	Sunshine Coast Planning Scheme 2014 Requirements	Flooding and Stormwater Management Guidelines Content
Off-site Solutions	Policy Position 6.3(d)	Nil	Off-site solutions are identified as a possible compliance approach through infrastructure agreements, however Council does not currently support Council delivered off-site solutions.
Stormwater Quantity and Drainage – Primary Code: Stormwater Management Code (SMC) and Planning Scheme Policy for Development Works (PSPDW)			
Vegetated channel design details	Policy Position 6.2(a)(b), 6.3(e)(f)(g)	SMC PO3 and AO3.1-3.3 mandate use of natural channel design which supports landscape, passive rec and ecological functions SMC PO4 requires stormwater infrastructure to be designed to minimise maintenance costs PSPDW SC6.14.3.3 contain requirements for open channels, which include: • Must comply with BCC Natural Channel Design Guidelines • Channel works/rehabilitation not to be included in stormwater quality load reduction calculations • Designed with min 'n' of 0.15 with sensitivity +/- 50% to check for freeboard and scour effects • Requirements for safety and maintenance berms	Further discussion on the common problems of vegetated channels plus design approaches and planting palettes are provided
Lawful Point of Discharge (LPoD)	Policy Position 6.1(b)	Stormwater Management Code (SMC) PO2 and AO2.1 require LPoD to be met. PSPDW SC6.14.3.4 defines requirements for LPoD.	Contains a comprehensive discussion on the background of the 2-point test relating to Lawful Point of Discharge as well as checklists and requirements for addressing each point
Detention – when required	Policy Position 6.1(b)	PSPDW SC6.14.3.5 Table SC6.14.3B contains criteria for when peak flow management objectives are triggered.	
Detention – implementation (ownership, form, integration with WSUD)	Policy Position 6.2(a)(b)(e)	PSPDW SC6.14.3.5 contains design requirements for detention basins	Provides further advice on detention for in-fill situations and preferred arrangements when open detention basins not feasible
Drainage Design	Policy Position 6.1(a)(b), 6.2(a)(b)(e)	Stormwater Management Code (SMC) PO2 requires a drainage system to be provided for development which considers climate change and achieves LPOD PSPDW SC6.14.3.3 covers drainage design requirements in detail.	Includes advice on determining design rainfall intensities and additional advice on design of vegetated channels

Issue	*Environment and Liveability Strategy*	Sunshine Coast Planning Scheme 2014 Requirements	Flooding and Stormwater Management Guidelines Content
Flooding – Primary Code: Flood Hazard Overlay Code (FHOC) and Planning Scheme Policy for Flood Hazard Overlay Code (PSP FHOC)			
Loss of Flood Storage – specifically infill	Policy Position 6.3(a)(b)(c)	FHOC Table 8.2.7.3.1 PO4 and AO4.1 requires that any filling for accepted development within the flood and inundation area does not result in net filling on the site FHOC Table 8.2.7.3.2 PO2 requires that physical alteration of land within the flood and inundation area does not occur except in specific circumstances. PO9 and AO9.1 requires that any filling for assessable development within the flood and inundation area is offset by providing compensatory flood storage within the site.	Additional discussion is provided on the circumstances when preservation of floodplain storage is or is not required. Requirements for how to calculate flood storage are also provided.
Acceptable or Tolerable risk to people or property	Policy Position 6.1(b)	SPP2017 Assessment benchmark (3) of the State Interest for Natural Hazards, Risk and Resilience requires that development mitigates risk to people and property to an acceptable or tolerable level. This State Interest is not currently fully reflected in the Planning Scheme so the SPP2017 becomes the assessment benchmark.	Includes detailed guidance for determining whether risk to people and p[property should be deemed acceptable or tolerable for a range of AEPs.
Acceptable or Tolerable levels of impacts	Policy Position 6.1(b)	FHOC PO9 and AO9 – require no offsite changes based on current climate and future climate at 2100	Includes detailed guidance for determining whether changes caused off-site are either acceptable or tolerable. Requirements include analysing impacts for a range of AEP based on current climate and only the 1%AEP for future climate
Addressing Residual Flood Risk	Policy Position 6.1(a), 6.3(c)	SPP2017 Assessment benchmark (3) of the State Interest for Natural Hazards, Risk and Resilience requires that development mitigates risk to people and property to an acceptable or tolerable level. This State Interest is not currently fully reflected in the Planning Scheme so the SPP2017 becomes the assessment benchmark. In addition to the above, FHOC Table 8.2.7.3.2 PO4 requires residual flood risk (up to the PMF or PMST) to be addressed. A range of requirements are provided through the acceptable measures including provision of either feasible evacuation or refuge strategies.	Includes discussion on the practical implementation of these requirements and the implications for development design.
Flood Immunity Requirements	Policy Position 6.1(a)	FHOC Table 8.2.7.3.1 PO1 and PO2 set flood immunity levels for floor levels and car parking respectively for dual occupancy and dwelling house FHOC Table 8.2.7.3.2 PO3, PO6, PO7 and PO8 specify flood immunity requirements for assessable development for development, essential network infrastructure, essential community infrastructure, and hazardous materials respectively	Nil
Levees	Policy Position 6.1(a)	PSP FHOC prohibits use of levees for achievement of flood immunity standards	Nil

Issue	*Environment and Liveability Strategy*	Sunshine Coast Planning Scheme 2014 Requirements	Flooding and Stormwater Management Guidelines Content
Climate Change	Policy Position 6.2(a)	PSP FHOC – requires 0.8m sea level rise. Design rainfall intensities required to be increased by 20%	These requirements are restated in the guidelines
Technical modelling requirements	Policy Position 6.2(c)	Nil	The guidelines contain requirements for: • Hydrology model: software, sub-catchment delineation, assumptions • Hydraulics model: software, steady/unsteady, 1D/2D, roughness • Calibration/validation • Temporal patterns • Design loss rates • Design rainfall • Climate change parameters • Boundary Conditions – joint probabilities • Sensitivity analysis
Flood Impact Reporting Requirements	Policy Position 6.2(c)	Nil	The guideline contains a template for flood hazard assessment report and flood hazard mitigation report

3 Stormwater Quality

Our beaches, estuaries and local streams underpin the lifestyle aspirations of residents and is a key economic base of our tourism industry.

The land development industry is also a key part of the Sunshine Coast economy and it is vital that land development occurs in ways which are sustainable and which preserve the quality of our waterways.

The following sections support the codes and policies specified in the *Sunshine Coast Planning Scheme 2014*, by providing additional guidance on key issues relating to stormwater quality management. In addition, Appendix 1 contains a reporting template for the preparation of Stormwater Management plans (SWMP) to support development applications.

3.1 Guiding Documents

The primary technical resources for designing stormwater quality management systems are noted below and are to be followed unless superseding requirements are noted in this guideline or the Planning Scheme.

3.1.1 Concept Design

Conceptual design of water sensitive urban design treatment measures is to be undertaken in accordance with the *Concept Design Guidelines for Water Sensitive Urban Design* (Water by Design, 2009). MUSIC modelling supporting concept development is to be undertaken in accordance with the latest version of the *MUSIC Modelling Guidelines* (Water by Design, 2010)

3.1.2 Detailed Design

Detailed design of water sensitive urban design treatment measures is to be undertaken in accordance with the latest version of the following:-

- *Water Sensitive Urban Design Technical Design Guidelines for South-East Queensland* (Water by Design, 2006), including the *Bioretention Technical Design Guideline* (Water by Design, 2014) and Wetland Technical Design Guidelines (Healthy Land and Water, 2017);
- IPWEAQ Standard Drawings DS-070 to DS-080 and
- Specific Council requirements detailed in this guideline.

3.1.3 Construction, Establishment and Handover

The construction, establishment and handover of water sensitive urban design treatment measures is to be undertaken in accordance with the latest version of the following:-

- *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands* (Water by Design, 2010)
- *Maintaining Vegetated Stormwater Assets* (Water by Design, 2012)
- *Transferring Ownership of Vegetated Assets* (Water by Design, 2012)

3.2 Stormwater Quality Compliance Approaches

The stormwater quality design objectives and their application are detailed in the *Planning Scheme Policy for Development Works*, and require the following pollutant load reductions relative to an unmitigated development case:

- Total Suspended Solids (TSS): 80%
- Total Phosphorus (TP): 60%
- Total Nitrogen (TN): 45%
- Gross Pollutants: 90%

For development which falls outside the triggers identified in the *Planning Scheme Policy for Development Works*, there is no requirement to demonstrate compliance with these objectives provided that ***alternative management measures*** are implemented.

For development which is triggered, there are a number of approaches promoted within the industry to demonstrate compliance with the stormwater quality design objectives. ***Not all of these are accepted by Council***; however, each compliance approach and its applicability is briefly described below:

- **On-Site Stormwater Treatment** - A range of stormwater treatment measures and technologies can be adopted within developments and streetscapes that will fully achieve the stormwater quality design objectives on-site. Compliance is usually demonstrated either through MUSIC modelling or by implementing *Complying Solutions*

- **Living Waterways** – is a flexible environmental management approach that assists practitioners and government to deliver water management systems which are integrated with outdoor spaces that are socially, economically and environmentally sound. It does this through a subjective scoring system which encompasses and incentivises the broader objectives of WSUD. ***The Living Waterways approach is currently not accepted by Council.***
- **Off-site stormwater solutions (off-site solutions)** - is the consideration of locally applied alternative solutions that achieve an equivalent or improved water quality outcome to the stormwater management design objectives of the State Planning Policy. It is possible for this concept to be applied between multiple developers (in the same catchment) where it can be demonstrated that the combined outcome is equivalent to the outcome required of the individual sites (together) regardless of whether a particular site has satisfied the objectives. This could be done as an infrastructure agreement and would be considered by Council as part of the development application. The concept of off-site solutions have also been presented a voluntary mechanism for local governments to collect a fee from developers in lieu of managing stormwater on-site. This money is then used by the local government to implement stormwater solutions off-site. This concept transfers developer responsibility to Council and creates a significant administrative burden for Council. At this time, this off-site solutions concept is not able to be supported and this compliance approach is not applicable.
- **Reducing imperviousness** - may assist in minimising stormwater runoff and reducing stormwater management requirements. In order to encourage low impact design that minimises stormwater runoff, MCU developments with less than 25% effective imperviousness are excluded from achieving the stormwater quality design objectives

Detailed guidance on the application of alternative measures and each of the applicable compliance approaches is provided below.

Although there is an apparent emphasis on quantitatively meeting design objectives, of equal or greater importance is developing good concept designs which are low maintenance and which deliver multiple benefits such as high amenity. Concept designs must be developed in conjunction with each of the compliance approaches discussed below, and should be based on the *Concept Design Guidelines for Water Sensitive Urban Design* (Water by Design, 2009). The remaining Sections of Chapter 3 also provide guidance on design.

3.2.1 Alternative management measures for stormwater quality management

Alternative management measures are applicable only when the development is exempt from complying with stormwater quality design objectives, as defined by the triggers in the *Planning Scheme Policy for Development Works Table SC6.14.3E*. Further, developments are only exempt from complying with stormwater quality design objectives if the alternative measures are complied with. If the alternative measures are not complied with then stormwater quality design objectives still apply to the development.

Alternative management measures are defined in the *Planning Scheme Policy for Development Works Table SC6.14.3E*. The stormwater harvesting tanks required by the alternative management measures (other than those required to provide full potable supply in non-reticulated area) are to be provided as follows:

- Tank sized as 1kL per 25m^2 of communal landscaped area;
- Minimum 50% of roof area connected to tank; and
- Installed in accordance with the QDC MP4.2 or 4.3 as applicable

3.2.2 On-Site Stormwater Treatment

This is the traditional approach to achieving compliance, whereby a stormwater treatment train is implemented within the development to meet the stormwater quality design objectives. Compliance may be demonstrated through either:

- Deemed-to-Comply Solutions (or *Complying Solutions*) - The default deemed-to-comply solution for all Queensland regions is to provide a bioretention device with filter area equivalent to 1.5% of the development site area. Minimum filter media depth is 0.5m and minimum extended detention depth 0.1m (at-source) or 0.3m (end-of-line); or
- Numerical Modelling - The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) is widely adopted for this purpose. Modelling should be undertaken in accordance with the latest version of the *MUSIC Modelling Guidelines* (Water by Design, 2010) using the split land use approach

3.2.3 Reducing Imperviousness

The benefits of low-impact design are well recognised, however traditional compliance methodologies such as through MUSIC modelling have often disadvantaged such approaches due to requirements for infiltrated flows to be accounted for in the pollutant export from the site.

Approaches to impervious area management such as the use of porous pavements, green roofs and stormwater harvesting and reuse reduce the effective imperviousness of a site. If the effective imperviousness is reduced to below 25% then the stormwater quality design objectives do not apply and compliance is achieved.

A reduction of impermeable area to less than 25% of site area may be demonstrated either subjectively (for small sites <3000m^2) by applying BMP's to all impermeable site surfaces, or quantitatively through water balance modelling which shows that mean annual runoff volume (MARV) from the developed site is less than that predicted from an equivalent site with 25% imperviousness.

3.3 Open Space Integration

Stormwater treatment is to be complementary and integrated within the public realm, using natural processes to the greatest extent possible.

Land within parks or amenity reserves that is below the 5% AEP flood level and/or required for stormwater management devices such as bioretention basins, wetlands, detention basins, GPT's and pipes should be designated for a stormwater purpose.

When land that is designated for a stormwater purpose is co-located with adjacent open space areas including parks and riparian buffers, it must be thoughtfully integrated in order to maximise the overall benefits including amenity and ecological enhancement. Land designated for a stormwater purpose is to be located outside of the required riparian buffer areas and is separate from the minimum land required for open space.

Key considerations for complementary co-location of stormwater with open space is avoiding fragmentation, minimising level differences and reducing the hazard associated with the stormwater function to eliminate the need for fencing or retaining walls. Council's Open Space Landscape Infrastructure Manual (LIM) provides further guidance on demonstrating effective and complementary co-location of stormwater with open space.

Figures 2 and 3 show examples of poor and good complementary co-location with open space respectively. If the design would result in a deep stormwater device (relative to adjacent open space levels) and would require either extensive batters or significant retaining walls, then the development layout and stormwater concept design should be revised to either reduce flow path lengths or incorporate treatment closer to the source.

Open space areas are to be protected from utility encroachment. In situations where new development is delivered adjacent to existing open space, and has need to connect stormwater discharging from the new development to a receiving waterway, every effort should first be made to avoid direct connection through the open space. In circumstances where this is unavoidable and the open space use is compromised, the land associated with the works shall be redesignated for a stormwater purpose and Council shall be compensated for the loss to the Open Space Network.

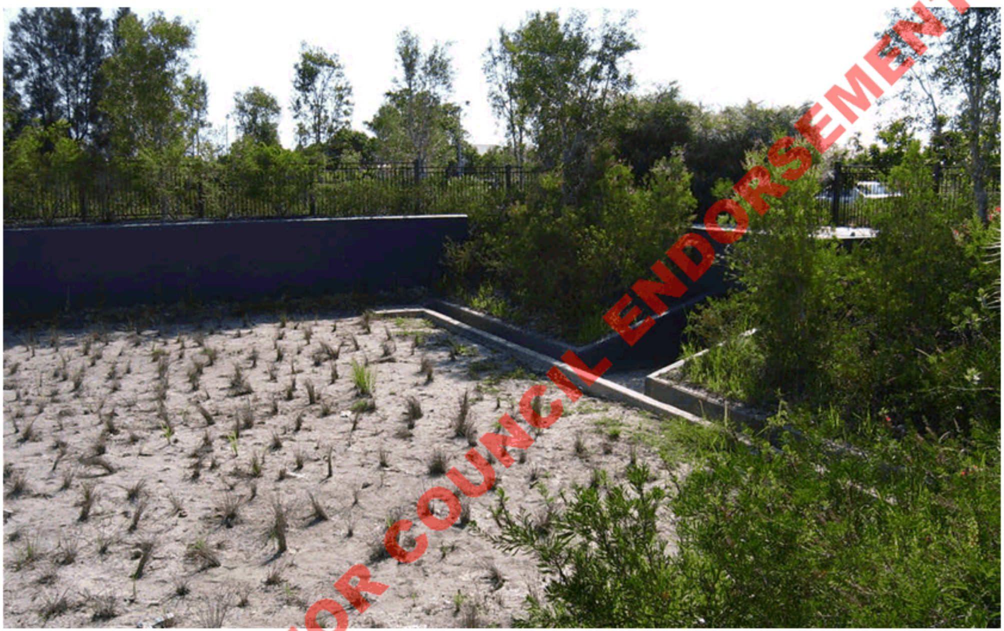


Figure 2 Poorly integrated bioretention basin (source: Switchback 48 Consulting)

Figure 3 Complementary co-location of bioretention basin (source: Sunshine Coast Council)

3.4 Requirements for Specific Technologies

3.4.1 Swales

Swales are not to be used for urban development where driveways are required to cross the swale.

Swales are to be designed to ensure that the depth-velocity limit of $0.4m^2/s$ is not exceeded for all flows up to the major flow event (or in the case of inter-allotment drainage, the design event).

Alongside roadway pavements, the swales must be sized so that the major/minor event criteria of *QUDM* (IPWEA, 2016) are achieved.

3.4.2 Streetscape Bioretention

Due to the flat topography of the coastal plain of the Sunshine Coast, streetscape (or at-source) bioretention devices have become an increasingly common feature of subdivisions since 2006. This section details Council's expectations for design of streetscape systems and provides standard cross-section details and typical layouts for common applications.

The performance requirements which all streetscape proposals must achieve are as follows:

- Maximum desirable density of one bioretention device per 6 lots and minimum device area of $20m^2$. This density may only be exceeded where specific engineering constraints exist and the remaining performance requirements are met
- Minimum filter media width of 1.5m
- No bioretention devices located between driveways for lot frontages less than 10m and preferably no devices on any lot frontage (i.e. located only on secondary frontage of corner lots)
- Filter media offset minimum of 1m from back of kerb
- 1m wide unvegetated strip behind back of kerb
- Maximum 1:2 vegetated batter from footpath to top of filter media
- Must not be reliant on fencing or other physical barriers to address safety risks
- Safe intersection sight distances and pedestrian movement along the road verge must not be impeded

A combination of both good engineering and good urban design are required in order to achieve the above performance criteria. For this reason, all proposals incorporating streetscape bioretention (or biopods) must include sufficient engineering detail with the REC application to enable a lot layout to be approved. Urban design approaches which support achievement of good biopod designs are discussed below.

Standard drawings for biopods are provided in Appendix 4 and include 2 types of biopods. Biopod Type 1 is the preferred detail and is based on the use of a side entry pit. Biopod Type 2 is based on a field inlet and is only to be accepted in constrained situations where provision of a side entry pit is impractical (such as where driveway conflicts occur).

Urban Design Approach 1 – Biopods clustered at intersections

The basic planning approach for implementing biopods on flat sites is documented in *Concept Design Guidelines for Water Sensitive Urban Design* (Water by Design, 2009) and is shown in Figure 4. The approach is to grade access streets or places towards the intersection and limit the leg length to the maximum available before a stormwater inlet is required in order to meet the minor flow criteria of *QUDM* (IPWEA, 2016).

The biopods are located at the intersection where an entry to the underground stormwater system is required. The lots at the end of the access street adjacent to the biopod are turned to access off the intersecting street so the biopods are adjacent to the long-axis of the lots (i.e. do not interfere with lot access). A real-world example of this approach is shown in Figure 5.

A variation of this approach is to incorporate a 1-way crossfall rather than a centrally crowned access street. This allows for a halving of the number of biopods and provides one verge unconstrained for pedestrian access and services. A real-world example is shown in Figure 6 and typical details are provided in Appendix 4.

Urban Design Approach 2 – Biopods with pedestrian links

An alternative approach to having biopods at intersections is to locate them adjacent to pedestrian linkages. This achieves better outcomes to the above approaches as the verge and lots of the access streets are unencumbered, however opportunities to incorporate this approach are generally fewer. Real-world examples of this approach based on a crowned street and a 1-way crossfall street are provided in Figures 7 and 8 respectively.

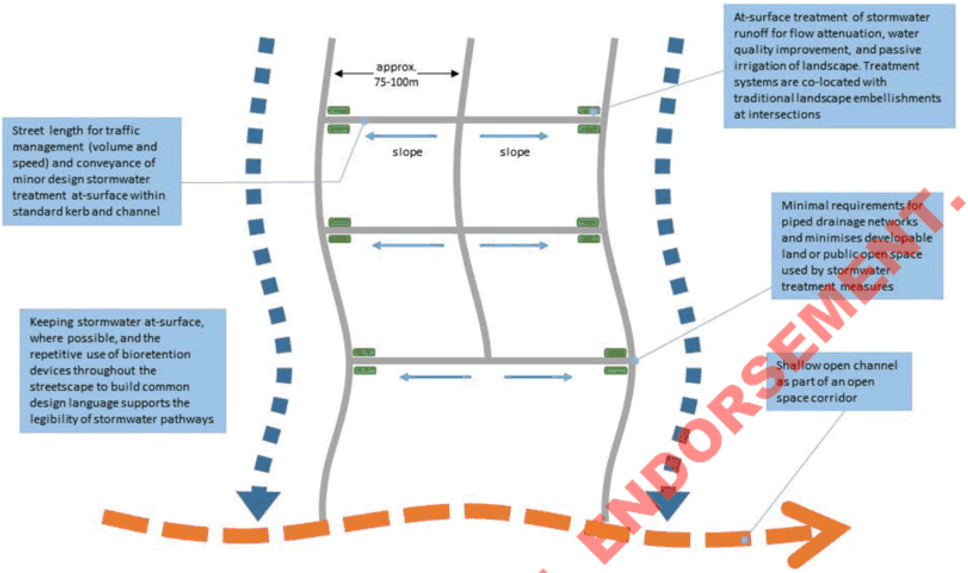


Figure 4 Model Street Layout for Biopods on Flat Sites (source: Concept Design Guidelines for Water Sensitive Urban Design (Water by Design, 2009))

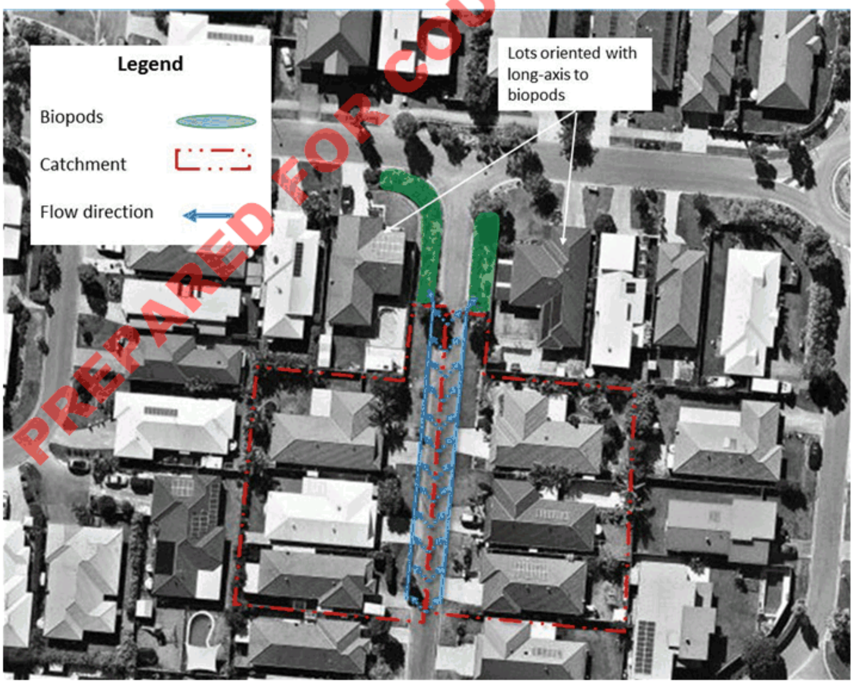


Figure 5 Biopod Locations for Centrally Crowned Access Street

Figure 6 Biopod Locations for Access Street with 1-Way Crossfall

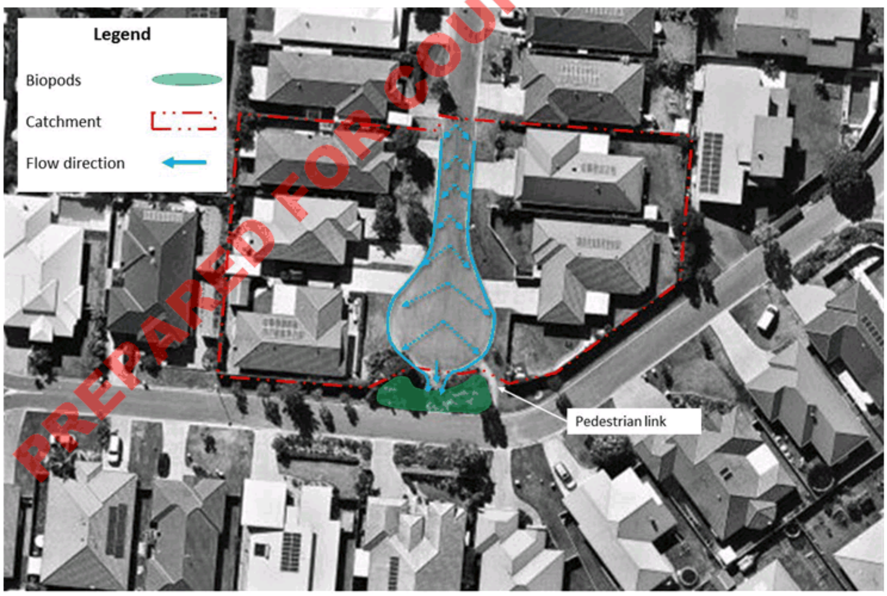


Figure 7 Biopod Located with Pedestrian Link (Crowned Road)

Figure 8 Biopod Located with Pedestrian Link (1-Way Crossfall)

3.4.3 Bioretention Systems (including streetscape)

All bioretention systems are required to achieve the following minimum performance requirements in addition to the requirements of the *Bioretention Technical Design Guidelines* (Water by Design, 2014):

- all bioretention systems are provided with a subsurface drainage system irrespective of the hydraulic conductivity of the underlying soils;
- subsoil pipes are to be minimum 100mm diameter uPVC pipe and slotted pipe is to be proprietary manufactured product not slotted on site;
- all bioretention devices with the exception of roadside at source devices are provided with an overflow pit within the device;
- bioretention devices treating catchments >0.5ha are provided with pre-treatment incorporating either a swale or coarse sediment forebay or GPT if high gross pollutant load;
- bioretention devices treating catchments >5ha are provided with pre-treatment incorporating either a sediment basin or GPT followed by sediment basin if high gross pollutant load;
- do not conflict with other infrastructure including minimum offsets to underground services;
- bioretention swales are required to achieve the same minimum design objectives as conventional swales; and
- retaining walls are to occupy a maximum of 50% of the device perimeter and the use of fencing to address safety is to be avoided in preference to other means

Streetscape at-source bioretention is to meet the performance requirements noted in Section 3.4.2. Bioretention tree pits are required to achieve the following minimum performance requirements:

- allow for unimpeded access for pedestrians along the road reserve;
- only implemented in high density urban and constrained environments where required to achieve streetscape requirements;
- to not be reliant on safety fencing to address safety risks;
- to have sufficient depth to prevent tree roots from entering the subsurface pipes, with minimum filter media depth of 0.7m;
- to include measures to protect the road pavement from tree roots and seepage from the tree pits; and
- maximum of 1 tree per 20m^2 of filter media and planted as tube stock.

Landscaping of bioretention devices which are proposed as public infrastructure are required to follow a standard palette in order to simplify Council's maintenance requirements and maximise the opportunities for successful functioning of the device.

Filter Media

The specification for the filter media is to be in accordance with FAWB (2009) as amended by Water by Design (2014a). The complete specification is provided below:

- Hydraulic conductivity 100-300mm/hr
- Organic matter >3%
- pH 5.5-7.5
- Electrical conductivity (1:5) <1.2dS/m
- Orthophosphate <80mg/kg
- Total Nitrogen <1000mg/kg
- PSD
    - Clay+silt 2-6%
    - Very fine sand 5-30%
    - Fine sand 10-30%
    - Medium to coarse sand 40-60%
    - Coarse sand 7-10%
    - Fine gravel <3%

Landscaping – Bioretention Filter Media/Base

Experience of many systems on the Sunshine Coast has shown that *Lomandra spp.* are often the only surviving macrophyte after several growing seasons. For this reason, the landscaping of the bioretention basin surface is to include at least 1 *Lomandra spp*. per m^2 The following additional functional species may also be provided, to achieve an overall minimum planting density of 6 plants/m^2

- *Ficinia nodosa*
- *Juncus usitatis*
- *Lomandra longifolia*
- *Lomandra hystrix*
- *Ghania sieberiana*
- *Ghania aspera*
- *Juncus kraussii*
- *Melaleuca quinquinervia* (max 1 plant per 20m^2)

Landscaping – Bioretention Batters

Landscaping for bioretention basin batters is to include a mixture of the following species at a suitable density and ensuring the species that are taller and/ or have longer denser leaf growth are planted towards the top of the batter:

- *Carex appressa;*
- *Ficinia nodosa;*
- *Juncus usitatis;*
- *Lomandra longifolia;*
- *Ghania sieberiana;*
- *Banksia robur;*
- *Dianella brevipendunculata;*
- *Themada triandra;*
- *Cymbopogan refractus;*
- *Melaleuca thymifolia;*
- *Nandina domestica; and*
- *Acmena Allyn Magic.*

For streetscape devices, taller species should not be planted on the kerb-side batter and the species selected should be considerate of soil conditions, sight line visibility and CPTED strategies.

Mulch is to be provided in accordance with the *Water by Design Construction and Establishment Guidelines* Section 3.6.4 Mulching.

Community Education

Signage, consistent with the design standard provided in Appendix 5, is to be provided with the delivery of bioretention systems.

3.4.4 Wetlands

All wetland systems are required to achieve the following performance requirements:

- due to wet summers experienced on the Sunshine Coast, maximum notional detention time of 48 hours;
- vegetation design must carefully consider the longevity of species and risks associated with bird populations such as swamp hens and sacred ibis.

3.4.5 Sediment basins

Sediment basins are to be used to pre-treat stormwater prior to entering wetlands or large bioretention systems. Sediment basins shall not be either undersized or oversized for the catchment area draining to the basin.

All sediment basins are required to achieve the following performance requirements:

- sized according to the 63% AEP design operation flow;
- sized to capture a target particle size of 0.125mm;
- sediment storage volume sized for 5 year clean out frequency; and
- Provided with concrete base and concrete maintenance access

3.4.6 Infiltration systems

Generally, infiltration systems are used where stormwater discharge is to a natural system and groundwater recharge and maintaining pre-development runoff volume is required. Stormwater quality design objectives shall be achieved prior to stormwater entering an infiltration device. An exception to this are source controls which replace impervious areas (such as porous pavements).

3.4.7 Sand filters

Sand filters operate in a similar way to bioretention systems, with the exception that stormwater passes through a filter media (typically sand) that has no vegetation growing on the surface. The absence of vegetation and the associated biologically active soil layer typically created around the root zone of vegetation planted in bioretention systems means sand filters have an increased maintenance requirement and reduced stormwater treatment performance compared to bioretention systems.

Sand filters have essentially been replaced by proprietary media filtration systems and shall only be considered for re-development situations where the surrounding urban environment is already developed and site conditions limit the use of bioretention systems.

3.4.8 Gross Pollutant traps (GPT's)

GPTs are only required for types of development which create high gross pollutant loads. GPTs are to be designed and constructed so that:

- dry sump GPTs are preferred where possible due to concerns for anaerobic decomposition that can occur in wet sump GPTs, particularly when then are no downstream treatment devices capable of effectively removing dissolved nutrients;
- the required maintenance methods must be compatible with common practices amongst the industry and not rely on specialised equipment;
- the GPT is located in an accessible location (not in swampy areas, at the bottom of embankments or other inaccessible locations);
- the GPT is not located near electrical equipment or where a voltaic cell can occur;
- the GPT can be fitted with a suitably designed lockable access cover approved by Council that prevent entry of unauthorised persons;
- re-suspension of captured pollutants during flows in excess of the SQID design event is prevented;

- a minimum of 90 percent of pollutants re-suspended by back flushing is recaptured;
- grills/mesh have a self-cleansing mechanism to prevent blockage;
- the GPT does not create surcharge at the pit/manhole immediately upstream of the GPT, unless there is an acceptable overland flowpath or high flow bypass;
- the GPT can be suitably located in public road, park or drainage reserve;
- where located in public open space the exposed concrete is embellished to better integrate into the environment, without compromising access or performance;
- the GPT can be hydraulically isolated during cleanout;
- when located in areas where tidal backflow is present, the downstream drain includes provision of a tide gate of other means to prevent tidal inflow (subject to hydraulic analysis to ensure no unacceptable upstream surcharge);
- any proprietary products are to be designed and installed in accordance with the manufacturer's guidelines; and
- it is preferred that GPTs are located adjacent to a sewer access point, so that any water that collects in the GPT can be pumped directly to the sewer as trade waste (at clean-out).

3.4.9 Gully Pit Baskets

Gully pit baskets are used as part of the pre-treatment (removal of gross pollutants and coarse sediment) within the overall treatment system in areas of high gross pollutant load where enclosed minor stormwater systems (that is, piped drainage systems) are installed. Gully pit baskets can also be used in existing enclosed minor stormwater systems, where there is sufficient hydraulic capacity for the installation.

The gully pit basket should not be used in retrofit situations where the existing systems inlet capacity is insufficient.

Gully pit baskets are to be designed and constructed so that:

- gross pollutants for the design event are captured prior to entry to the minor stormwater system;
- sufficient overflow capacity is provided so that the minor storm event enters the minor stormwater system when the gully pit GPT is fully blocked. In certain circumstances, this will mean that additional gully pits will need to be installed;
- any proprietary products are designed and installed in accordance with the manufacturer's guidelines;
- the pollutant collection chamber is free draining to prevent anaerobic decomposition of collected matter. Anaerobic decomposition may be a source of odour and polluted leachate;
- the grates of the gully pit basket are to be lockable such that a member of the public cannot access the pollutant collection chamber, but so that Council maintenance crews can easily clean utilising a vacuum truck or a vacuum street cleaner; and
- for work, health and safety reasons manual lifting or cleaning of gully pit baskets can be minimised through appropriate design and development.

3.4.10 Media Filtration Devices

Media Filtration devices use engineered filter media to remove total suspended solids and nutrients amongst other pollutants. Refer to Section 3.5 regarding accepted pollutant removal efficiencies for media filtration devices. The typical arrangement of these systems is a number of cartridges containing the engineered filter media located in an underground vault.

Pre-treatment of stormwater to remove gross pollutants and coarse sediment is required prior to stormwater entering these devices.

Council has a number of concerns relating to the use of media filtration devices for stormwater treatment. These include:

- they may have considerably higher whole of life cycle costs than other treatment devices which use natural processes, such as bioretention devices;
- they provide none of the amenity and biodiversity benefits afforded by vegetated devices which use natural processes; and
- there are no guarantees that the consumable components of these devices

will be available, or affordable, for the life of the asset.

Performance Outcome PO10 of the Stormwater management code requires that treatment systems that use natural processes and materials are integrated into the development whenever practicable, taking into account the whole of life cycle cost to enhance biodiversity and landscape benefits. Media filtration devices are therefore suitable for use only where they will **remain as private assets** and only if all of the following criteria are met:

- use is within the high density residential zone, centre zone, or industrial zone development; and
- constrained site where at source or end of line bioretention is not practicable and bioretention unfeasible based on the Concept Design Guidelines for Water Sensitive Urban Design (Water by Design, 2009).

Within these limited zones with respect to determining whether a bioretention system is practicable or not the following sites are considered to have a more limited ability to integrate bioretention devices and use of bioretention may not be practicable;

- sites being re-developed (brownfield); or
- smaller sites (<2,500m2); or
- sites with an allowable site cover of buildings greater than 70%; or
- sites which are required to achieve an activated street frontage; or
- sites with limited available fall (<1m) to the invert of the existing trunk stormwater network.

Where media filtration devices are approved, certainty must be given that the devices will be maintained so that they continue to achieve the claimed pollutant removal performance for the life of the development. This will be achieved through reasonable and relevant conditions of approval and prior to the commencement of use of any development which incorporates media filtration devices the site operator or body corporate must enter into a supply agreement for the maintenance and replacement of the media filtration device for a minimum period of 10 years.

3.5 Emerging and Proprietary Technologies

Sunshine Coast Council encourages innovations in stormwater management which will deliver better overall outcomes to the community, including improved water quality outcomes, reduced maintenance needs and improved amenity. However, these innovations need to be measured against fair and consistent performance requirements and remain consistent with the intent of Environment and Liveability Strategy policy for stormwater treatment to use natural processes to the greatest extent possible.

The Planning Scheme Policy for Development Works specifies the circumstances where Council will consider proprietary and/or emerging technologies either for use in private developments or as contributed public assets.

The Stormwater Quality Improvement Device Evaluation Protocol (SQIDEP) of Stormwater Australia is the basis for demonstrating performance claims of treatment devices that are to remain in private ownership, whereas for treatment devices that are proposed to be contributed public assets a three stage process has been outlined in Council's Planning Scheme Policy for Development Works. These stages include laboratory testing, field testing within the Sunshine Coast Council Local Government Area and an independent expert peer review. The information collected from these stages of testing are intended to provide greater confidence to Council of the asset's maintenance needs and costs in a local context, minimising council's risk to an unexpected burden or liability.

3.6 Designing for Maintenance

The design of stormwater assets, including stormwater treatment devices and vegetated channels need to carefully consider future maintenance requirements and minimise the future maintenance burden on Council.

There are two key aspects to consider in designing for maintenance:

1. Providing adequate access so the intended maintenance activities can be safely carried out; and

2. Ensuring the design and materials specified does not result in unnecessarily intensive, onerous or risky maintenance

3.6.1 Access

Suitable access tracks need to be provided from the road to the location of high-maintenance areas which include GPTs, sediment basins and coarse sediment forebay and inlet ponds to end-of-line bioretention and wetland devices.

Access tracks for GPT's (where not serviced directly from the roadway) and sediment basins or forebays associated with end-of-line bioretention basins should have the following characteristics:

- Minimum width of 2.5m
- Constructed of concrete in accordance with standard drawing SEQ R-051
- Include provision for turning and stockpiling of material as required
- Provide a lockable gate to restrict public access

For longer access tracks which are on flatter grades, gravel or reinforced turf may be suitable for part or all of the access track. Reference should be made to Figure 34 of the *Bioretention Technical Design Guidelines* (Water by Design, 2014).

Access to the permitter of devices should also be provided to facilitate less intensive maintenance activities. The *Bioretention Technical Design Guidelines* (Water by Design, 2014) provides further requirements on permitter access including advice on retaining walls.

Access to constructed wetlands requires special considerations and should be provided in accordance with Section 3.6 of the *Wetland Technical Design Guidelines* (Water by Design, 2017).

3.6.2 Materials and Planning

When designing stormwater systems, careful consideration should be made of the maintenance activities likely to be required. For all vegetated stormwater assets, which are proposed to be dedicated to Council, a Maintenance Report is required to be submitted and prepared in accordance with the template provided in Appendix 6.

Maintenance Reports are required to identify the following, including provisions of plans:

- Proposed maintenance activities required for each component of the system
- Access locations for each maintenance activity
- For each activity:
  - Machinery/equipment required
  - Personnel required
  - Frequency and duration of activity

Designs should minimise the need for herbicide sprays. This is because application of herbicides can often result in the deterioration of non-weed species and compromise the function of vegetated stormwater assets.

A common example of poor maintenance considerations is excessive use of rock armouring. Dumped rock can accumulate sediment and weeds and lead to frequent maintenance for weed removal to meet community expectations. Less maintenance-intensive design alternatives should be considered such as use of dense plantings.

Proposed stormwater assets that include an onerous requirement to have specialised equipment unique to a device may be rejected.

3.7 Construction-Phase Water Quality

SCC requirements for the management of water quality impacts during development construction through Erosion and Sediment Control (ESC) is documented in the *Planning Scheme Policy for Development Works (PSPDW)*.

The State Planning Policy 2017 (SPP 2017) introduced new design objectives for the construction-phase which are reflected in the *PSPDW*. SCC have also provided guidance to industry on how to address these requirements through the document titled *Stormwater Management Requirements for Construction Sites – Changes resulting from the commencement of the SPP 2017* (SCC, 2017a).

4 Stormwater Quantity and Drainage

Stormwater quantity management is essential for the protection of people and property as well as enhancing convenience and amenity during rainfall events.

The following sections support the codes and policies specified in the *Sunshine Coast Planning Scheme 2014*, by providing additional guidance on key issues relating to stormwater quantity management. In addition, Appendix 1 contains a reporting template for the preparation of Stormwater Management Plans (SWMP) to support development applications.

4.1 Guiding Documents

The primary technical resources for design of stormwater drainage systems are noted below in order of precedence and are to be followed unless superseding requirements are noted in this guideline or the Planning Scheme:

- *A Review of Simple Peak Flow Estimation Methods for use on the Sunshine Coast following the release of ARR 2016* (SCC, 2018a)
- *Application of Design Temporal Patterns on the Sunshine Coast* (SCC. 2018b).
- *Queensland Urban Drainage Manual, Fourth Edition* (*QUDM*) (IPWEAQ, 2016)
- *Australian Rainfall and Runoff* (Engineers Australia, 2019)

4.2 Stormwater Drainage System and Lawful Point of Discharge

Issues surrounding lawful point of discharge are often cited as amongst the most confusing and frustrating for applicants and engineers alike. This section seeks to clarify Council's expectations regarding this issue.

Council's overall objectives for a stormwater drainage system within a development site can be summarised as follows:

1. Objective (1): That the development site is provided with appropriate and reliable stormwater infrastructure to ensure the site is adequately drained in order to provide convenience and safety;
2. Objective (2): Where the development site relies on infrastructure or waterways which traverse downstream land to achieve Objective (1), that an appropriate on-going right to discharge is in place over the downstream land; and
3. Objective (3): That development does not cause unacceptable impacts to infrastructure or property external to the development site

Each of the above objectives are separate tests which Council will apply in order to determine whether PO2 of the Stormwater Management Code has been achieved.

Together, Objective (2) and Objective (3) can be considered to cover the range of issues known traditionally as 'lawful point of discharge' as used in the Acceptable Outcomes of the Stormwater Management Code. The term 'lawful point of discharge' has limited further use in this document and instead consideration is given for each of the Objectives stated above.

The guidance provided in this Section is considered to be consistent with the intent of *QUDM* V4 (IPWEAQ, 2016) in relation to Lawful Point of Discharge but expands the tests of that document, which do not adequately consider the consequences of downstream blockage.

4.2.2 Objective 1 – Drainage System Design

The design of the street drainage system and roof and allotment drainage is to be undertaken in accordance with the requirements of the Planning Scheme Policy for Development Works, the specific guidance provided in this document and *QUDM* V4 (IPWEAQ, 2016).

The following specific levels of roof and allotment drainage are required for assessable development:

- Level 0 and Level 1 – Not accepted for use on the Sunshine Coast in any circumstance
- Level 2 – Not generally accepted. May be considered based on specific site circumstances for low density residential land uses
- Level 3 – Minimum level for low and medium density residential land uses
- Level 4 or 5 (scale dependent) – Minimum level for high density residential, central business, commercial and industrial land uses

In addition to the above, the use of pumped drainage systems will not be accepted due to the risk and consequences of failure and the on-going maintenance required for the system to function.

The implications of the above requirements are that where the development involves land which falls away from the road or other Council-controlled land (eg. drainage reserve), there will be a need for an inter-allotment drainage system which **directly connects to the public trunk drainage network** in order to achieve the requirements for Level 3, 4 or 5 systems.

In many cases this connection will need to traverse downstream private land. Where this occurs, in accordance with the *Planning Act 2016* (Qld) the downstream land is ordinarily required to form part of the development application and owners permission included with the application.

As a minimum, the connection through downstream private land from a development site to the trunk public drainage network is required to be an underground pipe no smaller than 300mm in diameter. Larger pipe sizes and possibly overland flow channels may also be required subject to the requirements of the PSPDW and QUDM V4.

It is important that direct underground connections are provided in order to achieve a properly implemented drainage system rather than adopting other approaches such as level-spreaders or infiltration systems which are not recognised as components of Level III – V systems. Such approaches are unable to mitigate the many effects of altered hydrology (such as increased frequency and duration of discharge) which can significantly affect the amenity and enjoyment of downstream owners and are therefore not accepted.

4.2.3 Objective 2 – Discharge Rights

The purpose of this objective is **to ensure that the development has an on-going right to discharge stormwater so that the development is certain to be able to be adequately drained in perpetuity**.

In the absence of Riparian Rights, there is no common law obligation on a downstream landowner to accept stormwater from an upstream property and they are within their common law rights to take reasonable measures to restrict the flow of stormwater (either overland or within a pipe/channel) onto their land – even where this causes ponding on the upstream property. The implication of not ensuring that this Objective is met may be that Council is forced in the future to compulsorily acquire an easement or drainage reserve over a downstream property in order to re-establish a flowpath if the downstream landowner decides to block it. Or the development may not be able to undertake maintenance on a piece of downstream infrastructure required for the development site drainage.

Where infrastructure (new or existing) is identified as being required through downstream private land in order to meet Objective (1), then either an easement or drainage reserve through this land is required in all circumstances. The easement dimensions are to be in accordance with QUDM V4. The vast majority of MCU and RAL applications within the urban footprint that fall away from the public roadway will require both a pipe connection and easement through adjoining downstream land and this should be considered as the default position.

In rare instances, neither a pipe connection nor an easement may be required over downstream land. The applicant in these instances will need to demonstrate how Objectives (1) and (2) are achieved. The instances where this is able to be demonstrated will be rare. Specific situations where this may be appropriate are:

1. Where the development internal drainage system discharges directly to

a waterway defined under the Water Act 2000; or

2. Where the development internal drainage system discharges directly to a tidal waterway defined under the Coastal Protection and Management Act 1995 [2]; or
3. Where the development discharges to a defined gully which the Planning Scheme shows mapped as being subject to protected vegetation; and
4. Where the applicant demonstrates that there are no lawful works a downstream owner could undertake to block the gully/waterway or that the consequences of a lawful blockage are negligible.

Although they may seem innocuous, situations of development discharging onto low-relief rural land have been some of the most problematic and litigious for Council. The downstream land use does not change the need to comply with the above principles.

4.2.4 Objective 3 - Worsening or Nuisance

Achieving this Objective does not negate the need to comply with Objective (1) and Objective (2). Each objective is a discrete requirement, though the solution to one objective may also contribute to the achievement of the others.

As "no change" is not an achievable outcome in most circumstances, it is necessary to determine if each change is likely to result in an unacceptable impact.

An impact will be deemed unacceptable where:

- A site discharges to public infrastructure and the discharge will reduce the standard of service of that infrastructure; or
- A site discharges through private property and results in an unreasonable loss of enjoyment to the property that can be substantiated (i.e. actionable nuisance).

The following checklist is provided to assist in determining the risk of an unacceptable impact occurring:

1. Determine if/what physical **changes** in discharge will result from the development compared to the "natural" case, e.g.:
   I. More concentrated discharge or change in discharge locations
   II. More/less frequent discharge
   III. Change in duration of discharge
   IV. Changed discharge volume
   V. Change in peak discharges
   VI. Change in velocity
2. For each physical change in discharge, will the change result in a measurable/noticeable **impact** (effect) on public infrastructure or on downstream private property given the specific physical characteristics of the downstream land and drainage system? E.g.:
   I. Erosion, scour or damage
   II. Greater frequency of inundation of land
   III. Increased duration of inundation of land
   IV. Increased extent of inundation of land
   V. Increased depth/level of inundation of land
   VI. Lower standard of service of infrastructure

The answers to the above questions then feed into the following decision process:

[2] Tidal waters under this exemption are to have minimum dimensions of more that 1m depth and cross sectional area $2.5m^2$

- **If there is no physical change then there can be no impact and no actionable nuisance.** Development which does not alter the physical form of the land from "natural" conditions will not give rise to an actionable nuisance.
- **If there is a physical change but no impact, then there can be no actionable nuisance.** Example – an industrial site is developed and discharges into a piped underground inter-allotment drainage system which has adequate capacity for the developed site flows. No actionable nuisance will occur and no mitigation measures necessary. However, in such a situation consideration needs to be given to the entire downstream network and the potential for any impacts at all downstream locations not just immediately downstream of the site.

  In situations where flow is increased and is accepted by Council, but later flows into a system controlled by another statutory authority, then Council will require evidence of permission from that statutory authority.
- **If there is a physical change which will cause an impact with a significant cost to the downstream landowner (either in terms of damage to their land or cost to mitigate or rectify) then it is likely that an actionable nuisance will occur. This presents an unacceptable level of impact and options to mitigate the impact are required to be implemented.** Example – A pre-development drainage system through downstream land has adequate capacity to accept the natural site flows. Following development, the peak discharges will increase to beyond the capacity of the downstream system, causing additional extent, duration and depth of inundation. Implementation of mitigation measures such as a detention basin to reduce flows to below the system capacity would be required, or the downstream drainage system capacity may need to be increased.

4.2.5 A Word About Construction

An additional aspect of nuisance which is often overlooked is the construction phase of a development. There are situations where the ultimate drainage system will successfully mitigate impacts but interim nuisance may occur during construction.

Examples include when lots fall away from an internal road and towards existing residences. The road and inter-allotment drainage system will protect the downstream residences once all operational and building works are complete, however there may be phases of construction when runoff is increased to the existing residences. This issue is often compounded by poor erosion and sediment control which results in the transport of sediment as well as increased flow to downstream lots.

For these reasons it is critical that both the ultimate developed site plus interim construction phases are considered and accounted for when developing a solution which achieves lawful point of discharge.

4.3 Requirements for On-Site Detention

Provision of on-site detention (OSD) storage within a development site will often be a component of the development demonstrating that it will not cause unacceptable impacts to infrastructure or property external to the development site.

For on-site detention storage proposed as donated infrastructure, these basins should be provided as open, dry basins. WSUD infrastructure such as bioretention or wetlands may be incorporated within the floor of the detention basin to minimise the overall footprint required for stormwater management, provided that the extended detention of such devices are not included in any detention calculations.

In some situations, such as small in-fill subdivisions, it may not be practical to provide detention storage as an open, dry basin. In these situations, the following approaches should be followed, in order of preference:

1) Investigate capacity of downstream drainage network and options to upgrade capacity to avoid the need for on-site detention;
2) Provide distributed detention storage below ground within each lot and

connected to the inter-allotment drainage system; or

3) Provide a combined detention storage below ground near the outlet of the site. The storage is to be located in private land and maintained by body corporate.

Options 2 and 3 are restricted in their permissible applications because of concerns for the bypass of the storage by flows exceeding the capacity of the piped drainage system. The drainage upstream of the underground storage should therefore be designed to ensure the 1 in 100 AEP flows are captured.

In no circumstances will above-ground detention storage within lots, such as modified rainwater tanks, be approved for subdivisions for the purpose of on-site detention (noting approval of rainwater tanks is however encouraged for water quality and water supply benefits). This is due to the difficulty of ensuring the storage is correctly provided and installed with later building works and the risk of future interference with the storage such as to create permanent storage for water reuse.

Greater flexibility is available for MCU developments, though the detention storage will need to be installed and fully operational prior to the commencement of the use. This flexibility is available as the conditions on the MCU approval persist after the use has commenced so provide on-going certainty. The compliance process also requires Council inspections prior to commencement of use.

The design of detention systems is required to consider events between the 63% AEP (1yr ARI) and the 1 in 100 AEP current climate, however impact assessment will also seek to ensure that impacts remain acceptable under future climate conditions.

Detention sizing using hydrological models requires that those models appropriately reflect the changes associated with urbanisation. The consideration of urbanisation should not be limited to loss based methods. Urbanisation should also affect the timing of runoff and manifest as a change in peak flow. Modelled estimates that incorporate urbanisation should be compared with SCC (2018a) *A Review of Simple Peak Flow Estimation Methods for use on the Sunshine Coast following the release of ARR 2016*.

4.3.1 Deemed-to-Comply Approach

A simplified deemed-to-comply approach may be adopted for sites which are:

- less than 2Ha in area; and
- fall to the street frontage; and
- which discharge directly to piped trunk stormwater infrastructure, and
- are not located within a master drainage study area; and
- show no evidence of the trunk network having capacity issues.

The design recommendations in Section BN5.5.2(p) of *QUDM* (IPWEA, 2016b) should be referred to.

1) Size the on-site detention outlet based on the pre-development peak flow (Qo) at the boundary of the site using SCC (2017a) document: *A Review of Simple Peak Flow Estimation Methods for use on the Sunshine Coast following the release of ARR 2016*. A sheet flow method is to be used for pre-development conditions that are rural or grassed, channel flow for pre development conditions that have a higher percentage of urbanisation. The outlet arrangement shall be designed for the following design event:

   a. Pipe: Future climate 10% AEP storm event.

   b. Orifice Plate: Current climate 10% AEP storm event.

Details of the OSD pit and orifice general arrangement are provided in Appendix 2 and in the Fact Sheet: *OSD Tank Orifice Plate Sizing* (SCC, 2018).

2) Determine required detention storage volume based on the pre and post-development conditions identified in Table 2

Table 2 Deemed-to-comply detention storage volumes (m^3/Ha)

Pre-development condition	**Post-development condition**	
	Low Density (fi<60%)	Medium density (fi>60%)
Rural/grassed	330	420
Urban	NA	90

The above procedures are intended to simplify calculations for small low-risk developments and should not be used where there is any risk of impacts to private property or in locations where existing flood storage occurs, such as in locations that are subject to a downstream hydraulic constraint.

In addition, OSD considerations are to ensure that adequate overland flow paths are provided to account for potential blockage of pipe networks and surcharge of the underground detention storage.

4.3.2 Ensemble Storms Approach

In situations where the deemed-to-comply approach is not applicable then an ensemble storms analysis is required.

Table BN 5.2.1 of the *QUDM* (IPWEA, 2016b) edition background notes lists a number of problems that can result from the use of detention basins.

As such, detention basins should only be used where there is a specific issue required to be addressed, and not just as a matter of course on all development sites. Detention basins may be necessary to prevent an actionable nuisance from occurring where the analysis required by Section 4.2.4 indicates that increased peak flows may impact downstream land or infrastructure. In such circumstances, detention basins are to be sized to ensure that peak flows are not increased over a wide range of design storm durations. This concept is shown for a given event probability in Figure 9.

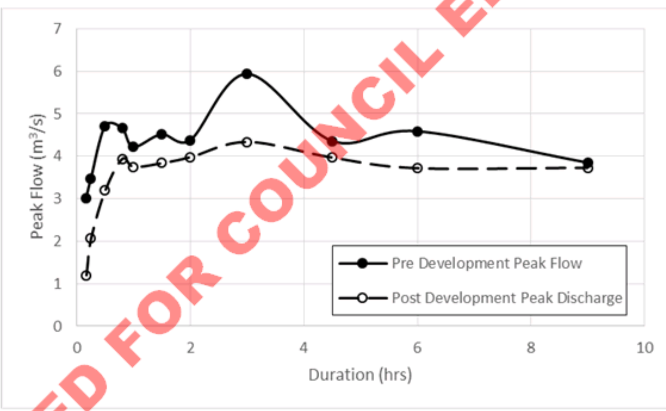


Figure 9 Detention Basin Storm Duration Consideration

Detention basins must therefore be sized in the following manner:

Sizing Methodology

1) Determine pre and post-development peak 1 in 100 AEP inflows for model validation as per *A Review of Simple Peak Flow Estimation Methods for use on the Sunshine Coast following the release of ARR 2016* (SCC, 2018a)
2) Develop a hydrologic model with appropriate sensitivities to urbanisation, as informed by estimates from Step 1.
3) Determine pre-development inflows from the hydrologic model, using ensemble temporal patterns with pre-burst rainfall and ARR Datahub Initial Loss and Continuing Losses. This is to be done for the range of
    a. Durations: 0.167, 0.25, 0.5, 0.75,1,1.5.2,3,4.5,6,9,12,18,24
    b. AEPs: 63%, 39%, 18%, 10%, 5%, 2, 1%.

   For each AEP and duration combination calculate the average (or rank 6) peak flow across all 10 ensembles. Prepare a critical duration analysis table of AEP vs duration.

Table 3 Example of Pre-Development Peak Inflows Critical Duration Analysis Results

	Duration													
ARI	0.167	0.25	0.5	0.8	1	1.5	2	3	4.5	6	9	12	18	24
1	0	0	0.5	0.77	0.91	1.15	1.2	1.38	1.48	1.07	1.03	0.8	0.64	0.77
2	0	0.41	1.03	1.26	1.41	1.54	1.58	1.76	1.94	1.49	1.38	1.11	1.07	1.07
5	0.9	1.45	2.03	2.07	2.3	2.27	2.28	2.39	2.74	2.13	1.97	1.62	1.56	1.58
10	1.74	2.15	2.93	2.98	2.72	2.75	2.85	3.26	3.15	2.84	2.27	2.05	1.38	1.71
20	2.44	2.87	3.62	3.66	3.25	3.32	3.38	3.87	3.76	3.4	2.77	2.49	1.68	2.1
50	2.76	3.17	4.25	4.15	3.73	3.95	3.83	5.14	3.78	3.97	3.35	3.17	2.36	2.11
100	3.02	3.47	4.71	4.66	4.22	4.52	4.38	5.94	4.36	4.59	3.85	3.67	2.73	2.46

4) Create a Post Development version of the hydrologic model and repeat the ensemble analysis returning peak discharges but limiting the maximum duration to twice the critical duration of pre-development inflows, or 3hrs (whichever is the greater). Prepare a critical duration analysis table, similar to Step 3, from the average of the ensemble peak discharge results for each AEP/duration combination.

   In the example shown in Table 3 the critical duration of pre-development inflows is 4.5hrs, thus the post development situation is limited to 9hrs (as shown in Table 4).

Table 4 Example of Post-Development Peak Inflows Critical Duration Analysis Results

	Duration									
ARI	0.167	0.25	0.5	0.8	1	1.5	2	3	4.5	6	9
1	0	0	1.22	1.45	1.72	2.25	1.71	2.12	2.04	1.61	1.53
2	0	1.19	2.46	2.13	2.38	2.86	2.26	2.8	2.94	2.12	2.06
5	2.59	3.53	4.31	3.66	3.82	3.85	3.22	3.71	3.98	2.97	2.92
10	4.73	4.67	4.96	4.53	4.2	3.82	4.32	4.42	5.03	3.92	3.72
20	6.06	5.75	6.16	5.34	5.03	4.7	5.11	5.25	5.95	4.69	4.48
50	6.98	7.02	7.14	6.63	5.6	5.56	5.21	8.28	5.77	5.83	4.93
100	7.7	7.71	7.95	7.45	6.3	6.32	5.94	9.5	6.64	6.73	5.69

5) Add the detention basin to the hydrologic model.

   Set up a Storage Curve that has a 1 in 100 AEP detention storage initially sized using Figure 10. The 1 in 100 AEP detention storage is defined as the storage volume (m³) between the invert level of the lowest outlet and the level that produces a discharge equivalent to the 1 in 100 AEP pre development inflow. Qi in Figure 10 is the 1 in 100 AEP post development peak flow from Step 1.

For Qi < 50m³/s; Vol (m3/Ha) = 0.0014Qi³ – 0.4116Qi² + 32.834Qi +197.43

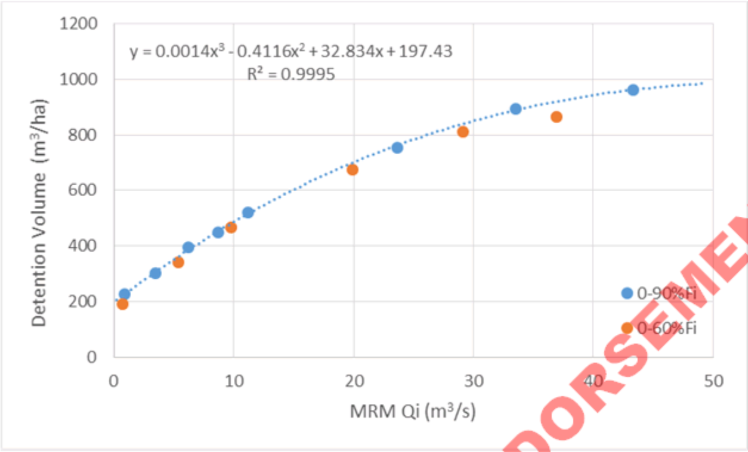


Figure 10 Initial Detention Volume Sizing (1 in 100 AEP)

6) Set up outlets.
It is suggested that outlets be sized to convey all flows up to and including the 1 in 100 AEP, and that the spillway is designed for larger events.

The hydrologic model must adopt hydraulic formulas that appropriately consider whether small or large orifice equations apply. In addition the modeller must consider the likelihood of the orifice being outlet controlled by an elevated downstream water level.

It is suggested that the level between the invert of the lowest outlet and the spillway be divided equally into three and that stage outlets are initially sized for the first stage to take the 63% (1yr ARI) pre development peak flow, the second stage to take the 10% AEP pre development peak flow and the third stage to take the 1 in 100 AEP pre development peak flow.
This should serve to create a Storage vs Discharge rating that approximates a linear relationship, as seen in the example of Figure 11.

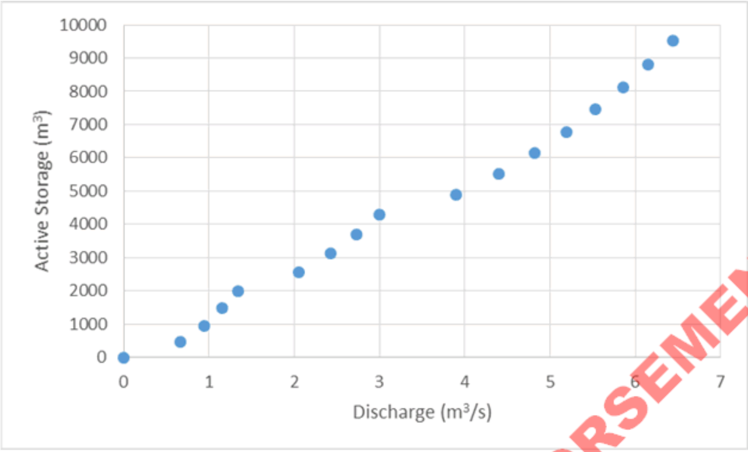


Figure 11 Example Storage-Discharge relationship

7) Rerun the hydrologic model ensemble analysis for the post-development scenario, returning peak discharges from the detention basin, for the same durations and AEPs as Step 3.
Prepare a critical duration analysis table, similar to Step 3 from the average of the ensemble peak discharge results for each AEP/duration combination.

Table 5 Example of Post-Development Peak Discharges Critical Duration Analysis Results

	Duration										
ARI	0.167	0.25	0.5	0.8	1	1.5	2	3	4.5	6	9
1	0	0	0	0.3	0.64	0.95	1	1.18	1.1	0.91	1.03
2	0	0	0.57	0.89	1.04	1.16	1.21	1.58	1.35	1.13	1.29
5	0.1	0.67	1.23	1.53	1.86	1.84	1.98	2.19	2.27	1.73	1.99
10	0.7	1.05	2.05	2.32	2.31	2.33	2.45	2.62	2.62	2.48	2.19
20	1.05	1.42	2.56	2.8	2.66	2.73	2.77	2.98	2.99	2.84	2.56
50	1.13	1.78	2.85	3.21	3.1	3.15	3.22	3.79	3.23	2.96	3.09
100	1.2	2.07	3.2	3.94	3.75	3.84	3.98	4.34	3.97	3.72	3.73

8) Subtract the table of results from step 6 from the table of results from step 3.
9) Check to ensure that differences are acceptable.
Acceptable differences are:
   a. <= than 2% of the pre-development flow for the same duration-AEP event, OR
   b. <= or 0.5% of the 1 in 100 AEP pre-development peak inflow, OR
   c. <= 0.01 m3/s.

Table 6 Example of Final Critical Duration Analysis Pre and Post Development Differences (m^3/s)

	Duration										
ARI	0.167	0.25	0.5	0.8	1	1.5	2	3	4.5	6	9
1	NA	NA	-100.0%	-61.0%	-29.7%	-17.4%	-16.7%	-14.5%	-25.7%	-15.0%	0.0%
2	NA	-100.0%	-44.7%	-29.4%	-26.2%	-24.7%	-23.4%	-10.2%	-30.4%	-24.2%	-6.5%
5	-88.9%	-53.8%	-39.4%	-26.1%	-19.1%	-18.9%	-13.2%	-8.4%	-17.2%	-18.8%	1.0%
10	-59.8%	-51.2%	-30.0%	-22.1%	-15.1%	-15.3%	-14.0%	-19.6%	-16.8%	-12.7%	-3.5%
20	-57.0%	-50.5%	-29.3%	-23.5%	-18.2%	-17.8%	-18.0%	-23.0%	-20.5%	-16.5%	-7.6%
50	-59.1%	-43.8%	-32.9%	-22.7%	-16.9%	-20.3%	-15.9%	-26.3%	-14.6%	-25.4%	-7.8%
100	-60.3%	-40.3%	-32.1%	-15.5%	-11.1%	-15.0%	-9.1%	-26.9%	-8.9%	-19.0%	-3.1%

10) Repeat steps 8 and 9 to optimise the orifice settings and storage size.

Failure Impact Assessment

As detention basins are effectively dams. The Statutory requirements of the *Water Supply (Safety and Reliability Act) 2008* apply. Where it is considered that the failure of a detention basin may have a population at risk of 2 or more persons, a failure impact assessment of the detention basin is required to determine the downstream impact of a failure of the asset that releases the full volume over a period of 30 minutes. The requirement for the failure impact assessment is purely based on population at risk and not height or volume of the detention basin.

Where a failure impact assessment confirms a PAR of 2 or more persons the design will not be accepted by Council. The applicant will be able to resubmit once they have consulted with the regulator of the *Water Supply (Safety and Reliability Act) 2008* and the construction standard for failure immunity has been determined.

Advice from the regulator indicates that the minimum design standard required for failure immunity is a 1 in 2000 AEP, but the specifics of a given situation may require a higher standard.

For basins with a population at risk of less than 2 the design failure immunity shall be based upon the severe storm.

4.3.3 Freeboard Requirements

The floor levels of buildings or lots adjacent to detention storages should be set at least 300mm above the calculated 1 in 100 AEP (at 2100) drainage flood level. In addition the floor level must be above flood levels from the following sensitivity analyses:

- A Severe Storm that is the defined flood event with 100% structure blockages.
- A Severe Storm that is the 1 in 2000 AEP event.
- The defined flood event with roughness values reflective of unmaintained channels/site areas.

4.4 Waterway Stability

The waterway stability objective is defined in the *Planning Scheme Policy for Development Works* as limiting the post-development peak 63% AEP event discharge within the receiving waterway to the pre-development peak 63% AEP discharge, and is only applicable when runoff from the site passes through or drains to natural channels, non-tidal waterways or wetlands

As it is the flow within the receiving waterway that is the critical consideration, this objective should not be applied when the development site is only a small portion (<5%) of the catchment and there is limited potential for further development within the catchment.

Compliance with the objective is demonstrated through hydrologic calculations, with the level of complexity appropriate to the catchment context and scale of development. The following compliance methodology has been adapted from the *Gold Coast City Council Planning Scheme* (2016) and *Healthy Waterways* (2006).

The compliance method is selected based on the available options listed in Table 7. The application of each compliance method is documented in Table 8.

These methods are derived from case studies using *Erosion Potential Index* (EPI) and represent simplified approaches. An analysis using an EPI threshold of <10% change may be used in lieu the methods described below, however significantly greater data and computation would be required.

Table 7 Selection of Waterway Stability Compliance Methods

Development Scenario	**Method**		
	A	**B1**	**B2**
Small development (≤1.25Ha)	✓	✓	×
Larger development (>1.25Ha)	×	✓	×
Development with a natural waterway within the site.	×	×	✓

Table 8 Waterway Stability Compliance Methods

Method A – Deemed to Comply Calculation of detention storage to manage peak 1yr ARI flow at boundary of site	A simple method which can be used when runoff-routing modelling is not required for the development for any other purpose 1) Calculate the desired peak outflow (Qo) for the 1 year ARI (63%AEP) storm event at the boundary of the site using the Sunshine Coast Rational Method calculated as per *A Review of Simple Peak Flow Estimation Methods for use on the Sunshine Coast following the release of ARR 2016* (SCC, 2018a). For this calculation the predevelopment form of the equation is to be use a sheet flow method with a surface type of Densely Grassed (unless otherwise agreed). This ensures the storage is sized to restore 1 year flows to rural or forested conditions. 2) Determine required detention storage volume from the following equation (derived from Healthy Waterways, 2006) Storage Volume (m^3/ha) = 152 + 0.83 x fi Where fi = fraction impervious (%) 3) Size detention storage outlet to restrict discharge from the detention basin to the desired peak outflow (Qo) using the small orifice equation. Otherwise other standard calculations for outlet may be used. $Qo = C.A (2.g.h)^{0.5}$ C = 0.6 (orifice discharge coefficient) A = orifice area (m^2) g = 9.81m^2/s (gravity) h = hydraulic head above centroid of orifice (m), or the downstream tail water level, whichever is greater. Note: For the small orifice equation to be accurate the ratio of h (m) to orifice diameter (m) should be greater than 2 otherwise hydraulic equations relevant to flow through a large orifice should be used.

Method B1 – Hydrologic modelling to manage peak 1year ARI flow at boundary of site	This method involves hydrologic modelling calibrated to peak flows determined in accordance with *A Review of Simple Peak Flow Estimation Methods for use on the Sunshine Coast following the release of ARR 2016* (SCC, 2018a) and *QUDM* (IPWEA, 2016) to ensure the peak 1 year pre development ARI (63%AEP) storm event flow does not increase **at the boundary of the site**. The modelling must: 1) Use SCC (2018a) with a surface type of 'densely grassed' for pre-development (unless otherwise agreed) to determine the 1year ARI (63%AEP) peak flows that represents rural or forested conditions. 2) Develop a predevelopment hydrological model that uses channel routing and not a channel time lag methodology. The hydrological model must undertake a critical duration methodology that uses a number of durations from 0.25hrs to 3hrs. The hydrologic model should adopt ensemble temporal pattern methodology (refer Section 4.6.3) and the critical duration of ensemble averages or the ensemble rank 6 event should be identified. 3) Losses should be applied to the design rainfall such the critical duration peak flow matches the 1 year ARI (63% AEP) pre development peak flow from Step 1. 4) Modify the hydrological model to represent the developed condition with a detention basin and an outlet designed to match the 1 year ARI (63% AEP) peak flow from Step 1 when the basin full, ie at spillway level. 5) Repeat the critical duration analysis with the model representing the developed condition (all durations, do not only adopt the pre-development critical duration), iterating an increasing size of the detention basin until such time that the discharge does not exceed the predevelopment inflow for any duration (duration limited to twice the duration of predevelopment inflows).
Method B2 – Hydrologic modelling to manage 1 year ARI flows within the receiving waterway	This method applies in situations where the development contains an existing waterway within the development. The same methodology applies as Method B1, except that **the focal location is the receiving water way within the Development Site**. In some cases it is not practically possible to achieve an outcome where the predevelopment 1 year ARI (63%AEP) peak flow is preserved within the waterway. In these cases an assessment of the changes in flow velocity and bed shear stress needs to be undertaken to determine the required management strategy for any erosion potential. The analysis then reverts to Method B1 where the focal location is the boundary of the development site.

4.5 Frequent Flow Hydrology

Preventing changes in frequent flows may be critically important for high value waterways with little existing catchment imperviousness. This is best achieved by not developing in such catchments and will be a key consideration for Council when designating land for urban purposes.

Frequent flow objectives will not be routinely or broadly applied to development applications due to the difficulty of achieving the objectives and the limited benefits derived for catchments which already have significant imperviousness.

However, proposals which seek to increase imperviousness in the catchment of high value waterways with low existing imperviousness, will be subject to considerable scrutiny. Such proposals will be required to derive site-specific objectives which relate to the individual characteristics of the receiving environment.

For example, proposals which discharge to a high value wetland which is sensitive to changes in runoff volume would need to demonstrate no change in mean annual runoff volume. Other parameters such as number of surface flow days and baseflow proportion and rate may also be critical depending on the receiving environment.

4.6 Drainage Design Requirements

The design of urban drainage systems is to be undertaken in accordance with *QUDM* (IPWEA, 2016) as modified by the *Planning Scheme Policy for Development Works.* Issues covered by the planning scheme policy requiring further explanation are discussed below.

4.6.1 Rainfall Intensity

Design rainfall intensities are to be obtained at the specific location being analysed and are to be in accordance with BoM and ARR recommendations. Intensity-frequency-duration (IFD) data can be generated for specific locations at the following address: http://www.bom.gov.au/water/designRainfalls/ifd/

The Bureau of Meteorology currently provides two estimates of IFD data: the older ARR1987 and new ARR2019 estimates.

The Bureau of Meteorology cautions against the use of ARR2019 IFD data with the rational method. However, SCC (2018a) has concluded that they are suitable for use with the rational method on the Sunshine Coast. For this reason, only ARR2019 IFD data should be used in both drainage design and flood estimation.

In order to account for the effects of climate change, adopted current climate rainfall intensities should be increased by 20%.

4.6.2 Rational Method

Council supports the continued use of the Rational Method in appropriate situations such as urban drainage design. SCC have developed a specific methodology for the Sunshine Coast (the Sunshine Coast Rational Method) which addresses many of the concerns raised in ARR2019.

The Sunshine Coast Rational Method is documented in *A Review of Simple Peak Flow Estimation Methods for use on the Sunshine Coast following the release of ARR 2016* (SCC, 2018a) and is to be used in place of the *QUDM* rational method.

It is desirable that Sunshine Coast Rational Method is used to calibrate flood models. It is recommended that calibration be based on natural catchment conditions as the Sunshine Coast Rational Method has the highest confidence in deriving estimates for this condition based on the data used to develop the method.

4.6.3 Rainfall Temporal Patterns

Sunshine Coast Council has undertaken a review of the ARR2019 ensemble temporal patterns. This is documented in *Application of Design Temporal Patterns on the Sunshine Coast* (SCC, 2018b).

In simple terms this document recommends ARR ensemble patterns for investigations that only require hydrological modelling, but investigations that require hydraulic modelling single representative temporal patterns are considered appropriate.

Two single representative temporal patterns are considered acceptable for drainage design involving hydraulic analysis. The Median Intensity Storm (MIS) which is a temporal pattern derived from the median intensity of the 10 ARR2019 ensemble temporal patterns, and the Median Intensity Duration Independent Storm (MIDIS). Both patterns should provide similar peak flows/levels.

Details on the derivation of MIS and MIDIS temporal patterns are provided in SCC (2018b).

When assessing duration of inundation to ensure that a minor road does not have more than 6hrs of inundation, the practitioner should either;

a) If using the MIS temporal pattern. Determine the duration of inundation from the 1 in 100 AEP event for the critical duration event and the event that has a duration 50% longer than the critical duration.

b) If using the MIDIS temporal pattern, the hydrograph at the location of interest should be filtered to remove excess volume in the base of the hydrograph prior to assessing duration of inundation. A filtering method is provided in *Application of Design Temporal Patterns on the Sunshine Coast* (SCC, 2018b).

In situations where the drainage model adopts boundary conditions extracted from Council's regional flood model, it will be necessary to adopt the same temporal pattern as that which has been applied in the regional model.

For analyses that only require hydrological modelling, ensemble temporal patterns should be adopted in accordance with the method prescribed in ARR.

It should be noted when using ARR ensemble or the MIS temporal patterns the critical duration may be different for pre-development and post-development scenarios, and should be calculated separately for each situation.

4.6.4 Tailwater Levels

Tailwater levels for HGL calculations for design of the Minor/Major drainage system are to be based on the requirements of *QUDM* (IPWEA, 2016) except as tidal boundary conditions are to be increased by 0.8m to account for future sea level rise due to climate change.

Tailwater levels for the design of stormwater quality treatment devices such as bioretention basins and constructed wetlands are to be in accordance with Table 7 of the *Bioretention Technical Design Guidelines* (Water by Design, 2014). These levels are intended to ensure the treatment devices are free-draining during normal operational conditions.

4.6.5 Lot Table Information

Council requires that a table is provided in conjunction with each survey plan submitted for endorsement, which lists the design flood levels and minimum lot fill levels based on both waterway flooding and also the major event associated with the urban drainage network. Appendix 3: *Reporting Template for Flood Hazard Assessments* has further details on the requirements of this table.

A version of this table is also to be provided with each Operational Works application involving drainage works, in order to verify that the lot levels have been set at a sufficient elevation to ensure the final building floor levels will achieve the required freeboard.

The lot table information needs to account for any additional freeboard required as a result of the Severe Storm Assessment (refer Section 4.6.7).

The information provided in the table is used by Council to respond to flood search requests. Flood information searches are used by Building Certifiers and provide the information required to satisfy the Queensland Development Code Mandatory Part 3.5, namely minimum floor levels for dwellings. Drainage levels are also relevant to ensure compliant driveway outcomes on blocks that slope downward from the road. It is therefore critical that the RPEQ certifying the table is satisfied that the information has been derived using suitable modelling techniques and is fit for purpose.

4.6.6 Modelling Methodology

Two-dimensional (2D) modelling capabilities in conjunction with unsteady flow hydrology are incorporated into some modern software packages and should be considered as the default approach to modelling the surface flows component of the major event. This approach is particularly important in the following circumstances:

- Flat terrain
- Complex flowpaths
- Significant storage effects

Where a 2D approach is coupled with a One-dimensional (1D) approach for the channel and pipe flow, care should be taken to ensure that the interface between the 2D domain and the 1D elements accurately represents the capture of flow.

Areas of the 2D grid available for conveyance and storage should exclude private lots as the conveyance and storage of these areas may be compromised in the future by lawful works such as solid fencing and landscaping.

Simpler modelling approaches may be appropriate and may be accepted by Council in specific situations. Prior approval from Council is to be sought when differing from the above approach and is to be justified based on the specific flow characteristics and topography of the situation being modelled

4.6.7 Severe Storm Assessment

A severe storm impact assessment is to be undertaken and is to seek to ensure that the design does not introduce any new hazardous conditions for:

- the 1 in 100 AEP future climate design event with 100% blockages applied to structures, and
- the 1 in 2000 AEP design event with design blockages.

Hazardous conditions to be avoided for the above events include the following:

- Flood levels remain below finished floor levels
- Flood levels are no more than 200mm above lot building pad levels
- No unintended overland flowpaths
- No flood hazard category greater than **H3** within roadways (refer Table 9)

The severe storm assessment will usually be submitted with the Operational Works Application for drainage works, however a preliminary version may be requested by Council as part of a reconfiguration of a lot or material change of use application where it is determined that the outcome of the severe storm assessment may significantly alter layout. Such instances include developments which place an over-reliance on the underground drainage network.

4.6.8 Constructed Channels

Traditional hard-lined constructed channels have been shown to lead to a range of issues such as exacerbation of downstream flooding, increased erosion of downstream soft-lined or natural waterways and water quality impacts such as increased temperatures. Such channels also fail to deliver ecological benefits for aquatic or terrestrial fauna and have little aesthetic appeal. For these reasons, vegetated channels are the outcome sought by the planning scheme for new development.

However, constructed vegetated channels on the Sunshine Coast have often suffered a range of issues as follows:

- Odours and algal growth in formalised pools or poorly drained sections;
- Excessive weed growth over rock;
- Inappropriate vegetation (such as turf on flat grades) leading to impractical maintenance requirements;
- Inadequate or absent maintenance access; and
- Erosion and failure of the channel due to inadequate armouring for the flow conditions

Extensive guidance on the design of open channels is provided in both the *Natural Channel Design Guidelines* (BCC, 1999) and *QUDM* (IPWEA, 2016), however the issues identified above have arisen due to either inappropriate or inconsistent application of the principles adopted in these guidelines and due to gaps in these guidelines.

The *Planning Scheme Policy for Development Works* therefore provides specific advice on the types of channels considered appropriate for the Sunshine Coast and the specific features which must be incorporated in design.

Essentially open channels should be provided as densely vegetated channels which avoid use of concrete or bare rock and should include frequent tree planting in order to achieve a canopy to shade weeds and reduce water temperatures. Examples of poor open channels and better open channels on the Sunshine Coast are provided in Figures 11 and 12 respectively.

Specific advice on landscape species considered suitable for use in constructed channels include:

- *Schoenoplectus mucronatus*
- *Elocharis dulcis*
- *Schoenoplectus litoralis*
- *Shoenoplectus validis*
- *Bulboshoenus fluviatalis*
- *Ficinia nodosa*
- *Baumea rubiginiosa*
- *Gahnia sp.*
- *Lomandra hystix* (batter)
- *Melaleuca sp.* (Tree – within channel)
- *Casurina sp.* (Tree – batter)

Figure 12 Poor Open Channel –Ponding, odour, weed incursion, unable to be maintained (source: Switchback Consulting)

Figure 13 Better Open Channel –Free draining, densely planted, coir mat stabilisation during establishment, shading (source: Switchback Consulting)

5 Flooding

5.1 Guiding Documents

The primary technical resources for the hydrologic and hydraulic aspects of flood investigations and flood hazard assessments are noted below and are to be followed unless superseding requirements are noted in this guideline or the Planning Scheme:

- *Australian Rainfall and Runoff: A Guide to Flood Estimation* (Commonwealth of Australia, 2019)
- *Application of Design Temporal Patterns on the Sunshine Coast* (SCC, 2018b).

Where the assessment involves an urban drainage system the above resource may be supplemented by the following:

- *Queensland Urban Drainage Manual V4* (IPWEAQ, 2019)

5.2 Flood Immunity

Minimum flood immunity level for different categories of development are specified in the *Flood Hazard Overlay Code*. This is achieved by specifying a Defined Flood Event (DFE) and freeboard for each development category.

Flood immunity requirements are also specified for different classes of roads. In addition to flood immunity, changes in time of inundation may be a relevant consideration when assessing impacts to roads. Section 5.6.2 provides specific guidance on temporal pattern requirements when assessing duration of inundation.

5.2.1 Freeboard Requirements

The floor levels of buildings or lots adjacent to detention storages and flood flowpaths should be set at least 500mm above the calculated 1 in 100 AEP (at 2100) flood level. In addition, the floor level must be above flood levels from the following sensitivity analyses reflective of severe storm or severe blockage conditions:

- The 1 in 500 AEP event (regional flooding) or the 1 in 2000 AEP event (local flooding).
- The defined flood event with 100% structure blockages.
- The defined flood event with roughness values reflective of unmaintained channels/site areas.

5.2.2 Safe Refuge from Flooding

A safe refuge from flooding is to have a floor level immunity from the Probable Maximum Flood or the Probable Maximum Precipitation Design Flood. It must also be designed to withstand the hydrostatic forces of the flood adopted for the specification of floor level immunity.

In addition, a building that is to be designed for the purposes of a safe refuge in a flood event, where the duration of refuge is 18 hours or greater is to satisfy Council's requirements for a tier 1 evacuation centre. *Preferred Sheltering Practises for Emergency Sheltering in Australia* (Red Cross, 2015) provides details of the standards for such a facility.

5.3 Floodplain Storage

The protection of floodplain storage is an important principle of floodplain management. This is because a single development in isolation may not cause off-site impacts, but cumulatively a number of developments in combination which result in reductions in floodplain storage may have an unacceptable impact.

The Sunshine Coast Planning Scheme 2014 includes PO1 and PO2 of the Flood Hazard Overlay Code which provide strict protections of the landform within the floodplain except in certain specific situation.

Development within the floodplain which meet the above exception requirements must demonstrate that flood storage is preserved within the development site. This will usually be achieved by undertaking compensatory cut earthworks to offset the effect of filling to achieve flood immunity.

The exception to the above is redevelopment or infill development within the urban footprint of existing coastal communities where it will be necessary to allow these communities to fill in response to climate change. This is likely to be important to a future Council Coastal Hazard Adaptation Strategy. In these areas it is accepted that flood storage will not be preserved, however strategies to minimise loss of floodplain storage should still be pursued to the extent practicable.

In all situations the actual flood impacts of a development must be mitigated to acceptable or tolerable levels regardless of whether or not loss of floodplain storage is permitted.

In order to demonstrate that floodplain storage has been preserved, the following is required:

- Areas of cut intended as compensatory storage must be free draining (i.e. must be available to store flood waters at the start of an event). For example, the water volume in a dam is not effective flood storage; and
- Cut and fill volumes are to be calculated at regular depth increments for each of the nominated AEPs up to the DFE. It must be shown that the equivalent or greater storage is available at each depth increment up to the design flood level for each AEP when compared to the existing case.
- Compensatory earthworks are to achieve a balance of the active storage above 1.5mAHD. Elevations below this level are assumed to be dead storage lost to future permanent inundation (as defined by a mean high water springs tide level of 0.7mAHD with 0.8m sea level rise).

In flat floodplain areas with low existing immunity these requirements may be difficult to achieve. In such circumstances the appropriateness of developing in this location should be considered and the proposal may need to be significantly reduced in scale.

5.4 Acceptable and Tolerable Flood Risk

The *State Planning Policy* (DILGP, 2017) requires that the risks from natural hazards are either avoided or mitigated to acceptable or tolerable levels (Assessment Benchmark (3) of the *Natural Hazards, risks and resilience State Interest*).

When the flood hazard can be avoided such as in the case of a rural property which is partially inundated during a flood any building must be located on the flood free portion of the site rather than filling the area subject to flooding to mitigate the flood hazard. This principle must be applied to all development with avoidance of the flood hazard always given priority over mitigation of the flood hazard.

'Tolerable' risk is a concept which can only be meaningfully applied to existing communities so design of new development must focus on achievement of acceptable risk.

An 'acceptable' risk goes beyond that which is merely tolerable and is the risk which is appropriate when designing new development.

The following methodology is provided to demonstrate compliance with Assessment Benchmark (3) of the *Natural Hazards, risks and resilience* State Interest of the *SPP2017* and is based upon the qualitative risk matrix approach of *Managing the Floodplain: A Guide to Best Practise in Flood Risk Management* (AIDR, 2017b):

1. Calculate the hydraulic hazard based on the categories in Table 9 which are derived from *Guideline 7-3 Flood Hazard* (AIDR, 2017c), future climate flood events for the 10%AEP, 1 in 100 AEP, 1 in 2000 AEP and the PMF.
2. The Hydraulic Risk should then be determined as acceptable or unacceptable from Table 10, the Hydraulic Risk Matrix. The overall hydraulic risk is the worst risk rating for any of the flood likelihoods investigated

Acceptable Hydraulic Risk is therefore the avoidance of Unacceptable Hydraulic Risk. Interpreting the Hydraulic Risk Matrix for new development, this means:

- locating development such that H5 and H6 flood hazards are avoided for all flood likelihoods
- ensuring that a 1 in 100 AEP flood immunity is achieved as a minimum for all development, and
- ensuring that depths of inundation greater than 0.5m are avoided for the 1 in 2000 flood likelihood.

For developments which fall into the unacceptable risk category and involves permanent residency or is subject to flash flooding from a riverine or creek source (i.e. inundation of the site within 6 hours of the commencement of an event), additional mitigation measures are required to be implemented until an acceptable level of risk is achieved.

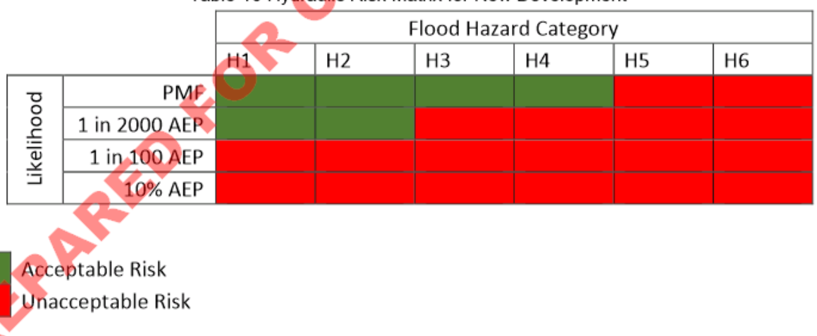
Such measures may have implications for off-site flood impacts and therefore determination of risk and impacts will be an iterative process until both issues are satisfactorily addressed.

For all other development, an alternative solution may be proposed which demonstrates an acceptable risk level. This may be achieved by providing a Flood Emergency Management Plan, prepared in accordance with the template in Appendix 7 that achieves an evacuated site prior to the realisation of the threat.

Table 9 Flood Hazard Classifications

Flood Hazard Category	Description	Depth-Velocity Limit	Depth Limit	Velocity Limit
H1	Generally safe for vehicles, people and buildings	≤ 0.3 m²/s	≤ 0.3 m	≤ 2.0 m/s
H2	Unsafe for small vehicles.	≤ 0.6 m²/s	≤ 0.5 m	≤ 2.0 m/s
H3	Unsafe for vehicles, children and the elderly	≤ 0.6 m²/s	≤ 1.2 m	≤ 2.0 m/s
H4	Unsafe for vehicles and people.	≤ 1.0 m²/s	≤ 2.0 m	≤ 2.0 m/s
H5	Unsafe for vehicles and people. All building types vulnerable to structural damage	≤ 4.0 m²/s	≤ 4.0 m	≤ 4.0 m/s
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure	> 4.0 m²/s	> 4.0 m	> 4.0 m/s

Table 10 Hydraulic Risk Matrix for New Development



In addition to the above quantitative risk assessment approach, the Flood Hazard Overlay Code provides a number of prescriptive outcomes to manage risk by:

- Specifying minimum lot, floor and infrastructure levels for different development categories based on a nominated DFE; and
- Requiring that safety is addressed for events which exceed the DFE (the residual flood risk) through either refuge or evacuation strategies.

These requirements can often be achieved through filling and/or built-form design, with the Council publication titled *Guidelines for Improving Flood Resilience for New Development* (SCC, 2016) providing examples of how flood risk can be addressed for common categories of development.

It is however acknowledged that not all development fits neatly into the above methodology and developments which do not incorporate either a residential component or any permanent buildings may wish to propose alternative measures. Such proposals should address the code performance outcomes based on the specific characteristics of the flood risk.

5.5 Acceptable and Tolerable Flood Impacts

Development may cause off-site impacts to flooding characteristics due to either changes in flood storage or changes in flood conveyance within the development site. Regardless of whether reductions in flood storage are permitted, the actual flood impacts due to both changes in storage and changes in conveyance must be assessed and mitigated to acceptable levels.

Traditionally impact assessments have focused solely on changes in peak water surface levels (WSL); however consideration of all flooding characteristics which have potential to cause an actionable nuisance to external land is required. As per Section 4.2.4, the characteristics to be assessed include:

- Changes to peak water surface levels
- Changes to times and durations of inundation
- Changes in extent or location of inundation
- Changes to velocities which could cause scour or erosion
- Changes to water quality

Council considers that the following default tolerances are an appropriate demonstration of no actionable nuisance (or non-worsening) and therefore constitute **Acceptable Impact**. These tolerances are largely defined by the numerical accuracy of the tools used to assess impact:

Afflux Tolerances

1. The change predicted is of a magnitude which is within the limits of accuracy of the modelling software. In the case of peak WSL this is +/-10mm; or
2. The change is entirely confined within an area which has no potential to worsen the use or enjoyment of the land. An example would be an impact which causes peak levels in a downstream drainage channel to increase, however the flow is still entirely contained in the channel and freeboard is maintained

Hydrology Tolerances

In situations where the use (current or future) on properties external to the proposed development is sensitive to changes in flow characteristics, pre and post development hydrographs are to be considered, both in visually as a hydrograph comparison and statistically.

Acceptable impact tolerances for changes in hydrology are:

1. Absolute and % change in timing, (Threshold for acceptance: no reduction in timing of when the hydrograph rising limb exceeds a consequential flood level is acceptable. In simple terms this could be presented as timing of the peak OR it could be presented as timing to when the threshold for inundation occurs, i.e. of a private land or roads). Note: it is assumed that any increase in timing of the peak is either beneficial or is a factor in coincident flooding that will be an issue for peaks.
2. Absolute and % change of duration of inundation (DoI) above an exceedance threshold (private land flooding, road inundation), (Threshold for acceptance: < 10min OR 10%, whichever is less)
3. Absolute and % change of lot coverage by the flood extent, (Threshold for acceptance: 1% for land that is sensitive to loss of enjoyment)
4. Absolute and % change in velocity (for velocities that have the potential for

scour), (Threshold for acceptance: 0.1m/s)

Impacts which do not meet the above criteria must be further mitigated. This mitigation could be in the form of additional engineered solutions until the default tolerances for acceptable impact are achieved. Another approach, limited to public infrastructure projects that do not have a development footprint that can accommodate impacts onsite, is to negotiate alternative tolerance criteria that are acceptable to the affected landowner.

5.6 Flood Hazard Assessments

The design flood levels and impacts associated with a development proposal are to be determined and assessed by preparing a **Flood Hazard Assessment Report** which is conducted in accordance with this guideline and follows the reporting template provided in Appendix 3. The hydrologic and hydraulic procedures used in the assessment are to be in accordance with the noted Guiding Documents, except as varied below.

5.6.1 Rainfall Intensity

Events up to the 1 in 2000 AEP

Design rainfall intensities are to be obtained at the specific location being analysed and are to be in accordance with BoM and ARR recommendations. Currently IFD data can be generated for specific locations at the following address: http://www.bom.gov.au/water/designRainfalls/ifd/

In order to account for the effects of climate change, adopted current climate rainfall intensities should be increased by 20%.

For larger catchment, spatial variability in the design rainfall across the catchment should be considered.

Probable Maximum Precipitation (PMP)

The Bureau of Meteorology provides two methods of PMP estimation relevant to the SEQ region. Generalised Short Duration Method (GSDM) and the revised Generalised Tropical Storm Method for longer durations. Both methods require determination for use with duration independent temporal pattern methods (refer to Section 5.6.2).

5.6.2 Rainfall Temporal Patterns

Sunshine Coast Council has undertaken a review of the ARR2019 ensemble temporal patterns. This is documented in *Application of Design Temporal Patterns on the Sunshine Coast* (SCC, 2018b).

In simple terms this document recommends ARR ensemble patterns for investigations that only require hydrological modelling, but for investigations that require hydraulic modelling single representative temporal patterns are considered appropriate.

Two single representative temporal patterns are considered acceptable for hydraulic estimation of peak level and hazard as part of a flood hazard assessment. The Median Intensity Storm (MIS) which is a temporal pattern derived from the median intensity of the 10 ARR2019 ensemble temporal patterns, and the Median Intensity Duration Independent Storm (MIDIS). Both patterns should provide similar peak flows/levels.

Details on the derivation of MIS and MIDIS temporal patterns are provided in SCC (2018b).

When assessing changes in duration of inundation, the practitioner should either;

c) If using the MIS temporal pattern. Determine the duration of inundation from the 1 in 100 AEP event for the critical duration event and the event that has a duration 50% longer than the critical duration.
d) If using the MIDIS temporal pattern, the hydrograph at the location of interest should be filtered to remove excess volume in the base of the hydrograph prior to assessing duration of inundation. A filtering method is provided in *Application of Design Temporal Patterns on the Sunshine Coast* (SCC, 2018b).

For impact assessment of changes in peak level, it is necessary to adopt a single temporal pattern. Depending on the size of the study area, and the importance of considering multiple focal locations, the critical location may vary, making it impractical to adopt critical duration approach for impact assessment. In such circumstances a MIDIS (duration independent) temporal pattern is appropriate.

In situations where the impact of changes in flow characteristics is required to be assessed, it is desirable to consider temporal patterns derived from ARR ensemble events in addition to the MIDIS or MIS. A limited selection temporal patterns taken from the 10 ensemble patterns is recommended. The selection should include short, moderate and longer duration events, with the longest duration preferably being double peak. The three ensemble temporal patterns should be selected from a hydrological analysis that provides the closest match to the MIDIS/MIS estimated peak flow (at AEP of interest). The focal location for this analysis should be at the downstream boundary of the development site

In situations where the flood model adopts boundary conditions extracted from Council's regional flood model, it will be necessary to adopt the same temporal pattern as that which has been applied in the regional model.

For analyses that only require hydrological modelling, ensemble temporal patterns should be adopted in accordance with the method prescribed in ARR.

When using ARR ensemble or the MIS temporal patterns for impact assessment of peak levels, the critical duration may be different for pre-development and post-development scenarios, and should be calculated separately for each situation.

5.6.3 Design Loss Rates

Where gauged site flood frequency analysis is available, it should be used to determine design loss parameters by calibrating the design continuing or proportional loss such that the modelled flows reasonably agree with the flood frequency information. This may be limited by the length of record or concern for the accuracy of the rating curve at the gauged location.

In circumstances where gauged data does not exist; the following approaches can be adopted (in order of preference):

a) Contact Council Customer Service Centre to ascertain whether design loss values are available from a relevant regional model.

b) Estimate a natural catchment flood frequency curve using *Simple Peak Flood Estimation on the Sunshine Coast* (Smythe, 2018a) and calibrate design losses for a version of the flood model that also represents the natural catchment condition. This method is not suitable for all locations. The restrictions on this method are outlined in the aforementioned document.

c) Apply ARR Data Hub loss values (noting Burst Loss = Storm Loss – Preburst)

Where DIS temporal patterns have been used a proportional loss approach should be always adopted. Loss values should be reduced log-linearly between the adopted value at the 1 in 100 AEP to 0 at the AEP of the probable maximum precipitation (PMP).

5.6.4 Direct Rainfall Modelling

Direct rainfall onto 2D hydraulic model domains may be used as an alternative to hydrologic modelling, if validation of the approach is provided by means of calibration to a range of historical events over a number of locations upstream and downstream of the subject location. If no calibration data exists, comparison must be undertaken against an industry standard hydrologic model of the same or similar catchment. The validation must demonstrate adequate performance at a range of locations throughout the catchment in terms of peak flows, travel times and hydrograph shape.

Results of direct rainfall 2D hydraulic modelling must be filtered in accordance with the Fact Sheet for Rainfall on Grid Output Filtering (SCC, 2018c)

5.6.5 Boundary Conditions

Design boundary conditions should be sought from Council in the first instance to ensure integration with the wider regional model, where appropriate.

Where Council is unable to provide boundary conditions, it is the responsibility of the applicant to determine appropriate boundary conditions for the hydraulic model. These will depend upon the configuration and extent of the model. Typically, the downstream boundary condition is based on:

- normal flow depth;

- an analytically-derived rating curve for a downstream hydraulic structure, such as a culvert crossing, or
- a tailwater level from the receiving water, such as a tide level or design flood level in a downstream waterway.

In calculating normal flow depth, an appropriate bed slope should be determined from a longitudinal profile over a sufficient channel length to be representative of the reach of interest. The calculated bed slope should be checked against values obtained from topographic maps to ensure that the results are consistent.

It may be necessary to consider coincident flooding. This occurs when the location of interest is potentially affected by local and regional waterways with significantly different hydrologic response times (such as a small creek discharging into a major river) one rainfall pattern will produce floods of different recurrence interval in each system.

These differences are automatically taken into account by simulating the hydrologic response of the entire catchment and estimating flood levels using an unsteady hydraulic model.

In the absence of more detailed information, suitable event combinations, based on the ratio of the local to regional catchment area, may be obtained from Table 11.[3]

Table 11 Event Combinations for Local and Regional Flooding

Ratio of Local to Regional Catchment Area (A_L/A_R)	Event Combinations to Define 1 in 100 AEP Flood Level
< 0.001	39% AEP (Q2) + 1 in 100 AEP
0.001 – 0.01	18% AEP (Q5) + 1 in 100 AEP
0.01 – 0.1	5% AEP + 1 in 100 AEP
0.1 – 0.2	2% AEP + 1 in 100 AEP
> 0.2	1 in 100 AEP + 1 in 100 AEP

The 1 in 100 AEP flood level is the highest level resulting from:

- the smaller magnitude flood in the local system combined with the larger magnitude flood in the regional system; and
- the larger magnitude flood in the local system combined with the smaller magnitude flood in the regional system.

Peak levels and hydraulic impacts of development should be considered for both cases. Hydraulic impact analysis should also consider the situation where there is no coincident regional flooding.

5.6.6 Hydraulic roughness

It must be assumed that waterways will not achieve optimal maintenance. Similarly, it is reasonable to assume that flooding can occur towards the end of a maintenance cycle, or in periods of the years when regrowth is particularly aggressive. For these reasons, the design flood level for estimation of floor levels should be set using a conservative (high) Manning's n value, typically 0.12 for all riparian areas.

[3] Alternative event combinations may be acceptable with appropriate justification.

For inundated areas beyond the riparian buffer widths, lower Manning's n values of less than 0.12 must be supported by a landscape plan which confirms plant species, positions and densities and maintenance requirements.

For assessment of the impact of a development on flood levels and velocities, a representative Manning's n value should be selected based on accepted industry standards, such as Brisbane City Council's Natural Channel Design Guidelines, or taken from a Council calibrated flood study with a similar land use. A sensitivity analysis should be undertaken across the range of likely Manning's n values to assess the effect of channel roughness on flow velocity and flood level impacts.

5.6.7 Calibration

Where suitable data exists, the hydrologic model should be calibrated to match recorded flood events, or discharges from an existing Council flood study. Flows should also be entered to the hydraulic model to ensure that levels also match those determined by a Council flood study.

Where a model is calibrated to recorded data at another location substantially downstream of the area of interest, a check should be made that the model produces reasonable discharge estimates at the location of interest.

Where a Council flood study is not available for the area of interest Council should be contacted to determine the availability of historic flood levels or flow data to enable calibration to historic events.

If neither a Council study nor historic levels are available, then the methods of *A Review of Simple Peak Flow Estimation Methods for use on the Sunshine Coast following the release of ARR* 2019 (SCC, 2018a) should be applied to determine a peak flow estimate for validation of the design flows derived from modelling. It should also be noted that SCC (2018a) provides regional peak flow estimates from two methods; namely a *SCC Regional Flood Frequency Estimate* (RFFE) tool (for catchments >15km^2) and an adjusted Rational Method (The Sunshine Coast Rational Method) in combination with SCC time of concentration (ToC) estimates.

SCC (2018a) has also concluded that the ARR2019 RFFE does not perform well on the Sunshine Coast. The Sunshine Coast Rational Method approach can also be used in lieu of a hydrologic model where steady-state flow analysis is deemed appropriate, however SCC (2018a) does provide some limitations on use that must be observed.

5.6.8 Sensitivity Testing

Sensitivity for design peak WSL

Conservative assumptions regarding hydraulic roughness, tailwater boundary and structure blockages are generally adopted for determining peak WSL and setting development levels, as discussed earlier in this guideline.

Sensitivity testing should be undertaken to determine whether the development freeboard is exceeded based on:

- The peak water surface levels of the defined flood event with 100% structure blockages.
- The flood levels of the 1 in 500 AEP event (regional flooding) or the 1 in 2000 AEP event (local flooding).
- Roughness values reflective of unmaintained channels/site areas.

Sensitivity for impacts

Adoption of conservative assumptions for hydraulic roughness, tailwater boundary and structure blockages is appropriate for estimation of peak WSL but may mask the extent of flood impacts. For this reason, impact assessments should be run for a range of model assumptions relating to these parameters representing the full range of likely conditions. The combination of parameters yielding the greatest impact should be used for testing of mitigation measures and impact reporting.

5.6.9 Development Staging

Where a development is delivered in stages or where significant earthworks are proposed below the 1 in 100 AEP inundation level, the impact of any intermediate development stage or earthworks phasing must be assessed. The same requirements apply as for assessments undertaken for the ultimate landform.

6 Glossary

Acceptable Risk
Risk deemed appropriate for new development through a quantitative risk assessment process involving the calculation of hydraulic hazard

Annual Exceedance Probability (AEP)
Probability that an event of that magnitude will be exceeded in a given year

Australian Rainfall and Runoff (ARR)
Publication which has existed for many years and which documents the procedures for hydrologic and hydraulic analysis of flooding and drainage

Best Management Practice (BMP)
Range of structural and non-structural measures aimed at improving the quality of urban stormwater runoff

Biopod
Bioretention device located within the streetscape and small in scale with stormwater typically delivered at surface (i.e. not via a pipe)

Defined Flood Event (DFE)
The flood event selected for ensuring lot and/or floor level immunity for new development

Duration Independent Storm (DIS)
Rainfall temporal pattern which includes all storm durations within the one pattern for a given AEP

Gross Pollutant Trap (GPT)
Structural stormwater pollution control device which targets large-particle sized pollutants such as litter and coarse sediment

Intensity-Frequency-Duration Plot (IFD)
Method of documenting the probability of rainfall magnitudes occurring over various durations at a given location

Material Change of Use (MCU)
Type of development application which seeks to change the use of land from one type to another

Mean Annual Runoff Volume (MARV)
Annual rainfall multiplied by catchment area and a coefficient of runoff which varies by landuse (fraction impervious)

Model for Urban Stormwater Conceptualisation (MUSIC)
Modelling software used to aid in the concept design of stormwater treatment trains and to demonstrate compliance with design objectives

Off-Site Stormwater Solutions
Approach to achieving compliance with the stormwater design objectives, where-by a monetary payment is made by the developer to Council in lieu of achieving full compliance on-site

Probable Maximum Flood (PMF)
The largest flood that could conceivably occur at a particular location. This flood defines the floodplain by the maximum extent of land liable to flooding.

Probable Maximum Precipitation (PMP)
The largest rainfall that could conceivably occur at a particular location.

Queensland Urban Drainage Manual (QUDM)
Publication which has existed for many years and which documents the design procedures for urban drainage systems in Queensland (see also References)

Reconfiguration of a Lot (REC)
Type of development application which seeks to subdivide land into additional parcels and which usually results in donated infrastructure to Council

Severe Storm
The Severe Storm considers two design conditions. a) The 1 in 100 AEP design event at 2100 with 100% structure blockages, and b) The 1 in 2000 AEP design event with design blockage assumptions.

Stormwater Management Plan (SWMP)
Report that documents strategies for managing stormwater quality and quantity issues associated with development and usually submitted in support of a development application

Water Sensitive Urban Design (WSUD)
Holistic approach to development planning which considers all aspects of the water cycle

Water Surface Level (WSL)
The calculated elevation of the flood or drainage water surface for a specific event AEP or scenario

7 References

Australian Institute of Disaster Resilience. (2017a) *Evacuation Planning*. Australian Disaster Resilience Handbook Collection. Handbook 4

Australian Institute of Disaster Resilience. (2017b) *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*. Australian Disaster Resilience Handbook Collection. Handbook 7.

Australian Institute of Disaster Resilience. (2017c) *Flood Hazard*. Australian Disaster Resilience Handbook Collection. Guideline 7-3

Brisbane City Council. (1999). *Natural Channel Design Guidelines*

Department of Infrastructure Local Government and Planning. (2017). *State Planning Policy*

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), Commonwealth of Australia (Geoscience Australia) (2019) *Australian Rainfall and Runoff: A Guide to Flood Estimation*

Gold Coast City Council. (2016). *Planning Scheme Policy 6.9 – Land Development Guidelines*

Healthy Waterways Ltd. (2014c). *Living Waterways*

Department of Energy and Water Supply (DEWS). (2013). *Queensland Urban Drainage Manual, Third Edition - Provisional*

Institute of Public Works Engineering Australasia. (2016a). *Queensland Urban Drainage Manual, Fourth Edition*

Institute of Public Works Engineering Australasia. (2016b). *Queensland Urban Drainage Manual, Background Notes*

Red Cross Australia. (2015) *Preferred Sheltering Practises for Emergency Sheltering in Australia*

Stormwater Australia (2018) *Stormwater Quality Improvement Device Evaluation Protocol, Field Monitoring (v1.3)*

Sunshine Coast Council. (2016). *Guidelines for Improving Flood Resilience for New Development*

Sunshine Coast Council. (2017a). *Stormwater Management Requirements for Construction Sites – Changes resulting from the commencement of the SPP 2017.*

Sunshine Coast Council. (2018a). *A Review of Simple Peak Flow Estimation Methods for use on the Sunshine Coast following the release of ARR 2016*

Sunshine Coast Council. (2018b). *Application of Design Temporal Patterns on the Sunshine Coast.*

Sunshine Coast Council (2018c) *Fact Sheet: OSD Tank Orifice Plate Sizing.*

Sunshine Coast Council (2018d) *Fact Sheet: Rainfall on Grid Output Filtering.*

Sunshine Coast Council. (Online). *LIM – Open Space Landscape Infrastructure Manual*

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

Water by Design. (2006b). *Water Sensitive Urban Design –Developing design objectives for water sensitive urban development in South East Queensland*

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

Water by Design. (2010a). *MUSIC Modelling Guidelines*

Water by Design. (2010b). *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands*

Water by Design. (2012c). *Maintaining Vegetated Stormwater Assets*

Water by Design. (2012d). *Transferring Ownership of Vegetated*

Water by Design. (2014a). *Bioretention Technical Design Guideline*

Water by Design. (2014b). *Water Sensitive Designs*

Water by Design. (2017) *Wetland Technical Design Guidelines*

Appendix 1 – Reporting Template for Stormwater Management Plan

Stormwater Management Plans (SWMP) will usually be submitted in support of a planning application (REC or MCU) and are required to include sufficient level of detail to show that the proposed development layout is viable and can physically accommodate the proposed stormwater management measures. The SWMP must also provide sufficient detail that the engineering design and OPW application can progress.

The required structure and content of a SWMP is summarised in the below reporting template. Additional sub-headings to those nominated may be used.

This reporting template should be considered in conjunction with this guideline as well as the **Stormwater Management Code** and Planning Scheme Policy for Development Works.

Document details and certification

Details of the authorship of the Stormwater Management Plan should be provided. The report must be certified by an RPEQ with experience in drainage design and stormwater management. An appropriate way to present this information may be in tabular form.

Example:

Report Title:	Stormwater Management Plan for Proposed Maroochy Woods Development, Maroochy Road, Maroochydore
Affected Properties:	
Street Address	15-35 Maroochy Rd, Maroochydore
RP Description	Lots 1,2 & 7 on RP 123456
Prepared For:	Maroochy Development Company Pty Ltd
Date:	7 Sept 2013
Revision No.	3
Report Status:	Draft/Final
Prepared By:	
Name	Bob Jones
Qualifications	BE
Company	Water Consultants Pty Ltd
Phone No.	5555 1234
Certified By:	
Name	John Smith
Qualifications	BE, Msci
Company	Water Consultants Pty Ltd
Phone No.	5555 1234
Industry Accreditation	RPEQ No. 1234
Signature	

Executive summary

The summary provides a brief (1-2 page) overview of the development proposal, the findings and the associated recommendations and conclusions.

1 Introduction

Include the sites address, real property description, type of application and a description of the proposed development including a figure. Any previous reports, approvals or strategies and their relevance should be noted and discussed.

2 Existing Conditions

A description and accompanying figure is to be provided illustrating the existing site topography, drainage patterns and discharge points from the site, external catchments, and vegetation.

The broader context of the catchment including downstream receiving environments and extent of current and future development should also be discussed, as should whether lawful point of discharge currently exists.

3 Design Objectives

A review of the Planning Scheme Design Objectives as well as a review of any State or National requirements is to be undertaken. A summary of the objectives and the point at which they are to be achieved is to be provided. Objectives to be discussed include:

- Stormwater quality design objectives
- Waterway stability design objectives
- Stormwater quantity objectives for lawful point of discharge (eg. Peak flow management)
- Whether frequent flow objectives are required and their derivation

4 Stormwater Strategy

Describe the opportunities and constraints and the selected strategies for achieving compliance with each of the design objectives. This is to include a plan or series of plans which shows that the spatial and level constraints/requirements associated with each strategy element has been catered for in the development layout and clearly identifying proposed site catchments and release points.

5. Stormwater Quality

The compliance methodology selected (i.e. on-site (MUSIC modelling or Complying Solutions), reduced imperviousness) is to be noted and supporting assumptions and calculations demonstrating compliance provided.

The concept design parameters adopted are to be summarised and additional plans may be necessary to show how the devices fit spatially within the development layout. This is particularly relevant for streetscape solutions where a level of detail commensurate with preliminary engineering/OPW design will be required.

6. Stormwater Quantity

This section includes both flow mitigation required to meet the waterway stability objective and any mitigation required to achieve no actionable nuisance downstream of the site.

All hydrologic modelling assumptions are to be clearly noted and justified. Both parts of the *QUDM* (DEWS, 2013) 2-point test for Lawful Point of Discharge are to be discussed and requirements for easements or other external works detailed. Details of proposed storages (stage-volume) and outlet structures (RLs and sizes) are to be listed.

7. Detailed Design and Staging

Specific issues relating to the detailed design of measures or the timing of delivery of strategy components (where a development is staged) should be discussed. How construction will be managed to prevent interim stormwater quantity or quality impacts and the conversion of construction-phase ESC controls to operational-phase controls should be detailed.

8. Conclusion

Summarise strategy and any key issues for detailed design

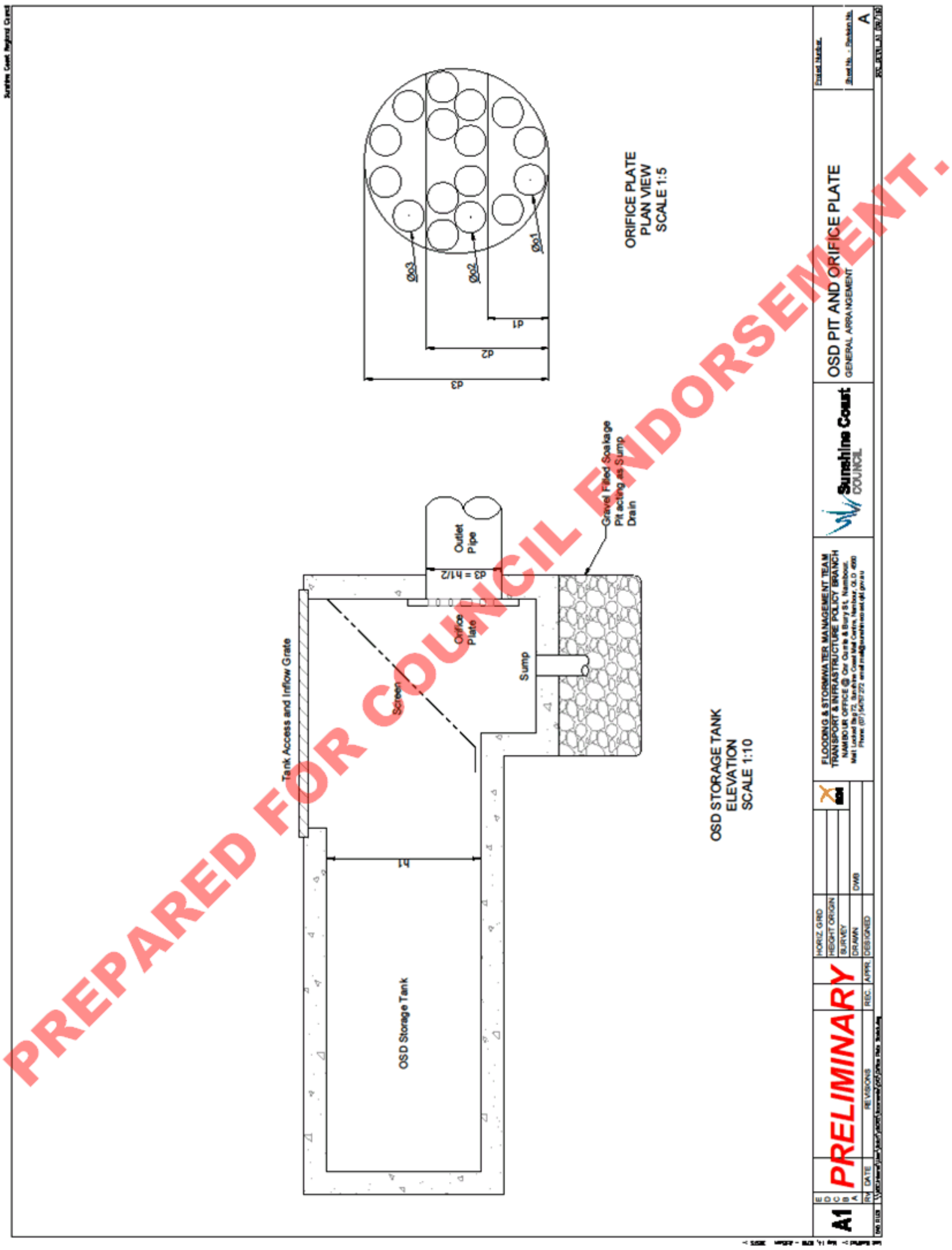
References

Include all references used in the report

Appendices

Include supporting calculations or figures include preliminary engineering plans or earthworks designs

Appendix 2 – OSD Pit and Orifice Plate General Arrangement



Appendix 3 – Reporting Template for Flood Hazard Assessment

This reporting template should be considered in conjunction with this guideline as well as the **Flood Hazard Overlay Code** and associated planning scheme policy.

Document details and certification

Details of the authorship of the Flood Hazard Assessment Report should be provided. The report must be certified by an RPEQ with experience in Flood Modelling and Management. An appropriate way to present this information may be in tabular form.

Note: It is a requirement of the Act that professional engineering services in Queensland are carried out by a RPEQ, or alternatively by a person who carries out the services under the direct supervision of a RPEQ who is ultimately responsible.

Example:

Report Title:	Flood Hazard Assessment and Mitigation Report for Proposed Maroochy Woods Development, Maroochy Road, Maroochydore
Street Address	15-35 Maroochy Rd, Maroochydore
RP Description	Lots 1,2 & 7 on RP 123456
Prepared For:	Maroochy Development Company Pty Ltd
Date:	7 Sept 2016
Revision No.	3
Report Status:	Draft/Final
Prepared By:	
Name	Bob Jones
Qualifications	BE
Company	Water Consultants Pty Ltd
Phone No.	5555 1234
Certified By:	
Name	John Smith
Qualifications	BE, Msci
Company	Water Consultants Pty Ltd
Phone No.	5555 1234
Industry Accreditation	RPEQ No. 1234
Signature	

RPEQ Certification

The certifying RPEQ must sign a statement of certification, which is to be included inside the front cover of the report.

The statement of certification must take the following form, with details for any statements answered 'No' to be provided on a separate sheet at the end of the certification:

I [Name of RPEQ,] certify that this flood hazard assessment has been undertaken in accordance with Council requirements and that the following statements are true:

Mechanisms of Flooding	Y	N
This flood assessment has considered whether the following mechanisms of flooding are relevant to the site. • Flooding from a regional catchment • Flooding from a local area catchment • Flooding from a storm tide event Flood mapping and impact mapping has been included in this report for all relevant flood mechanisms.	❑	❑
The flood assessment has specifically included boundary conditions that represent backflow flooding of the local stormwater network from a regional event.	❑	❑
Methodology		
This flood assessment has incorporated hydrology and hydraulic methodology in accordance with the Sunshine Coast Council Flooding and Stormwater Management Guidelines (2020)	❑	❑
Flood Analyses		
Flood modelling has been completed for a base case and developed case, for the 63%AEP (Q1), 39% AEP (Q2), 10% AEP, 1 in 100 AEP, 1 in 2000 AEP and the PMF current climate and 1 in 100 AEP future climate (at 2100) flood events. Flood mapping has been produced and included in this report for the following parameters, water surface level, depth, velocity and hazard. Flood level hydrographs are produced at relevant locations to demonstrate that nuisance changes to inundation times are not created and that maximum inundation times for roads are not exceeded. This information has been used to demonstrate that this development design produces acceptable flood impacts in accordance with default tolerances prescribed in the SCC Flooding and Stormwater Management Guidelines (2020)	❑	❑
Afflux mapping has been produced for the 63%AEP (Q1), 39% AEP (Q2), 10% AEP and 1 in 100 AEP current climate flood events and the 1%AEP future climate (2100) event. This information has been used to demonstrate that this development design produces acceptable flood impacts in accordance with default tolerances prescribed in the SCC Flooding and Stormwater Management Guidelines (2020)	❑	❑
Where the use (current or future) on properties external to the development is sensitive to changes in the flow characteristics (timing, duration of inundation, frequency, location, extent, scour velocity and water quality) from the development site, then the relevant characteristics (for which there is a sensitivity) have been	❑	❑

assessed. This may be done through the use of continuous simulation modelling (where a hydrologic model can be used) or through the use of ARR ensemble temporal patterns in a manner that provides an appropriate consideration of temporal variability. Consideration has been given to the relevance of events more frequent than 1EY and analysed as necessary.		
Provision of specification to manage flood consequence and protect property		
Pad levels for essential network infrastructure within a site (e.g. electricity, water supply, sewerage and telecommunications) have been specified in this report, in accordance with the flood immunity requirements of Table 8.2.7.3.3 of the Sunshine Coast Planning Scheme Flood Overlay Code.	❑	❑
Where the development design has a need for materials with high water resistance to improve the flood resilience of infrastructure, details of the specific requirements have been provided in this report.	❑	❑
Where the development design incorporates essential community infrastructure, floor levels for this infrastructure have been specified in this report, in accordance with the flood immunity requirements of Table 8.2.7.3.3 of the Sunshine Coast Planning Scheme Flood Hazard Overlay Code. To demonstrate that the essential community infrastructure will be able to function effectively during and immediately after flood events, it has been demonstrated that access to this infrastructure is in accordance with the requirements for evacuation routes as prescribed in the planning scheme policy for the Flood Overlay Code.	❑	❑
The development design provides flood immunity to the DFE for the protection of property. Pad levels and Floor levels have been specified for each lot as part of the lot table information, with consideration of the freeboard requirements that vary depending on the mechanism of flooding.	❑	❑
Where the development design has a need for unenclosed car parks, the level of the carpark has been specified such that it provides: • flood immunity for the 10% AEP, • a flood depth no greater than 250mm in the 1 in 100 AEP to 250mm, and • a velocity no greater than 2.0m/s, and • a depth x velocity ratio no greater than 0.4m^2/s;	❑	❑
Where basements form part of the development design, the report has specified the provision of waterproofed perimeter walls, air vents and has specified the level of entry/exit ramps on the basis that are at least above the 1%AEP flood level plus freeboard (at 2100);	❑	❑
Where the development design incorporates lots requiring driveways with a downhill slope; For each relevant lot, the need for a raised entry ramp from the roadway (to satisfy the requirements of *QUDM* (IPWEA, 2016) for containment of flood flows) has been noted in the comments field (Column 14) of the lot table information.	❑	❑
It has been demonstrated, using the methodology prescribed in the Sunshine Coast Council Flooding and Stormwater Management Guidelines, that the development design provides acceptable flood risk.	❑	❑

Protection of Life		
The development design has provided for residual flood risk beyond the DFE, for the protection of life.	❑	❑
For events other than storm tide, the development design does not rely on evacuation routes to offsite locations that are shown to be flood affected in DFE mapping. This requirement is for the purpose of managing the residual flood risk beyond the DFE for the protection of life.	❑	❑
The development design has provided a direct route to enable progressive evacuation to safe refuge above the level of the PMF	❑	❑
The development design does not rely on the assistance of emergency services personnel, to manage residual risk beyond the DFE for the protection of life (i.e. development does not place additional demands on emergency services)	❑	❑
The development design ensures that public safety and the environment are not adversely affected by the detrimental impacts of floodwater on hazardous materials manufactured or stored in bulk during the DFE or DSTE;	❑	❑
Where the development design included a detention basin, the population at risk downstream has been determined and documented. A failure impact assessment has been completed when the population at risk is 2 persons or more.	❑	❑
Floodplain Storage and Waterway Conveyance Protection	❑	❑
Floodplain storage and waterway conveyance have been considered in accordance with the requirements of the Sunshine Coast Planning Scheme	❑	❑
Queensland Development Code requirements	❑	❑
Lot table information has been provided to satisfy the requirements of the Queensland Development Code (MP3.5)	❑	❑

Signature as evidence of Certification: ______________________________
Name of RPEQ (Printed in Full): ______________________________
RPEQ Licence Number: ______________________________
Date: ______________________________

Executive summary

The summary provides a brief (1-2 page) overview of the development proposal, the findings and the associated recommendations and conclusions.

1 Introduction

The introduction should give an overview of the proposed development application and any relevant background information. The scope of studies presented in the report should also be outlined. It may be appropriate to include a locality plan showing the location of the proposed development site.

2 Available data

Provide a summary of the sources of data used for the investigation. An appropriate way to present this information may be in tabular form, an example of which is shown below.

At the commencement of any hydrologic investigation, applicants are encouraged to contact Council's Customer Service Centre to determine whether Council holds existing information that may be of relevance. Applicants should be aware of Council's "Hydrologic Data Policy" which applies to any hydrologic information provided by Council. This includes extractions from regional flood models. Please note that fees apply.

The applicant should also contact Council's Customer Service Centre to determine whether historical flood levels are available in the area of interest. Council records such levels along waterways after major flood events and has a regional network of maximum height gauges. This data may be useful in the calibration of hydraulic models.

Example:

Table 1 Source data

Data	Source	Comments
Catchment boundaries	Determined from ALS	
Topographic Information	2014 ALS	
Hydraulic structure details	MSC hydraulic structure reference sheets: • Maroochy Rd Culvert crossing • Smith Rd culvert crossing	
Land use	SCRC Planning Scheme	
Historical flood levels	SCRC Advanced Flood Search Certificate No:12345	Peak flood levels for 1989 flood event
Existing SCRC Flood Studies	Smith Creek Flood Study, June 2003	
Historic Rainfall data	BoM	Daily rainfall, Station No. 040282

		Pluviometer data, Station No. 040111
Streamflow data	DNRM Water Monitoring Portal	Daily volumes, Station No. 141003
Design Rainfall Data	BoM	2016 IFD at 4 locations within model extent
Site photographs	Taken by Water Consultants Pty Ltd, 7 July 2018	Site photographs for pre-development conditions

3 Catchment drainage characteristics

This section provides a general description of the catchment, including how existing catchment naturally drains. The proposal for the developed catchment should be described, clearly articulating how the drainage and overland flow paths within the catchment are intended to change.

This section of the report should include a plan showing flow paths and the boundaries of relevant catchment areas under existing and developed site conditions. For ease of checking, plans should be prepared to an appropriate engineering scale (e.g. 1:1000 or 1:5000).

4 Previous studies

A number of flood investigations have been undertaken of waterways draining the Region. The applicant should contact Council's Customer Service Centre to determine if previous flood investigations have been undertaken in the vicinity of the proposed development. Applicants should be aware of Council's "Hydrologic Data Policy" which applies to any hydrologic information provided by Council. This policy requires applicants to make their own assessment of the applicability of existing studies.

5 Model setup

Hydrology

Applicants should undertake hydrologic modelling using industry-accepted software. Council is unable to recommend any particular software, however, checking of results will be expedited if applicants use software currently employed by Council. Details of Council's current hydrologic modelling software may be obtained through the Customer Service Centre.

The following should be documented:

- Model software - Details of the adopted model software should be documented in this section, including software version number.
- Model setup - Describes detail of the model setup undertaken for the existing and post-development catchment conditions
- Subcatchment delineation - Provide a plan showing the configuration of the model, in particular the extent of sub-catchments and the location of the proposed development. Discharges at locations of interest should not be obtained from the output at a single sub-catchment. Where distinct areas of different land use occur within a catchment, the catchment sub-division should reflect land use boundaries wherever possible.
- Summary details of the model, such as sub-catchment areas, fraction imperviousness, catchment lag and routing parameters, should be presented in tabular form, in sufficient detail that a model could be developed from the supplied data.

- Rainfall design intensities and temporal patterns – Provide details of the adopted design rainfall intensities and temporal patterns and details of any historic rainfall events used for either calibration or validation. DIS temporal patterns are to be used for peak WSL estimation however use of alternate temporal patterns (available from Council) may be required in addition if the impact assessment needs to consider the timing of hydrographs

Hydraulics

Applicants should undertake hydraulic modelling using industry-accepted software. Council is unable to recommend any particular software, however, checking of results will be expedited if applicants use software currently employed by Council. Details of Council's current hydraulic modelling software may be obtained through the Customer Service Centre.

The following should be documented:

- Model software - Details of the adopted model software should be documented in this section, including software version number.
- Model setup - Provide an overview of the method of analysis used to estimate design flood levels and justification for selection of steady or unsteady flow and whether a one or two-dimensional model
- Note that Council has two-dimensional regional models of the Maroochy and Mooloolah rivers and Pumicestone creeks catchment. Extractions from these models may, at Council's discretion, be made available to consultants, where appropriate noting that fee's will apply. Contact Councils Customer Service Centre for more details.
- Inflow points - Provides detail on how the inflows from the hydrological model are integrated into the hydraulic model.
- Topography - Provide a plan showing the location and extent of cross-sections, or the arrangement and extent of the two-dimensional grid used in the model. Data used in deriving model cross-sections or the two-dimensional grid should be specified in the source data table (See Table 1. **(Source data)**). Where two-dimensional grid data (ALS – aerial laser survey) is used, then a plan must be provided of the **difference between pre and post development ground levels**.
- Structures - Provide a plan showing the location of structures that are included in the hydraulic model setup. State blockage assumptions based on ARR2019 guidance and document sensitivity testing
- Hydraulic roughness – Provide a plan showing how hydraulic roughness has been applied spatially in the model. Include details of any sensitivity testing of roughness parameters
- Boundaries - Provides details on the Boundary Conditions that were adopted in preparation for model calibration.
- Floodplain storage – Provide earthworks plans and tables of storage volume calculations at each RL demonstrating whether flood storage has been preserved or lost at the site. Where compensatory earthworks are proposed to preserve flood storage such earthworks must maintain their storage function in all circumstances. That is, they cannot fill with water, or any other material, and lose their flood storage capacity.

6 Calibration

This section is to detail the calibration of the hydrologic and hydraulic models. The method of calibration is to be stated and justified based on the availability of existing Council model results, recorded historic flows and/or levels or use of flood frequency analysis.

Commentary should be provided on the quality of the calibration and the confidence in the calibrated model for design flood estimation. The quality of the calibration should be informed by some form of goodness of fit qualification, between modelled and observed flood data.

The parameters derived from the calibration of the hydrologic and hydraulic models should be clearly tabulated in this section of the report.

7 Design Flood Events

Mechanism of Flooding

The investigation should consider whether Storm Tide, Regional Catchment and Local Area Catchment flooding are relevant to the site. This assessment must also consider the climate change. Analysis is required for all flood mechanisms that affect the site.

Existing catchment

Provide mapping for the pre-development catchment condition of WSL, depth, velocity and hazard (using the methodology of the Floodplain Management Guidelines of Australia). This mapping should be provided for the following events: 63%AEP (Q1), 39% AEP (Q2), 10% AEP, 1 in 100 AEP, 1 in 2000 AEP and the PMF for current climate and 1%AEP future climate (2100).

Comparison of design event results with historic observation

Where historic observations are available within the catchment of interest, the probability of the historic event should be notionally considered in relation to the design flood levels. Where the historic information indicates a degree of confidence in the design flood levels, this should be documented. Similarly, where the historic information does not indicate agreement, documentation should be provided to explain why the difference is accepted.

Developed catchment

Provide mapping for the developed catchment condition of WSL, depth, velocity and hazard (using the methodology of the Floodplain Management Guidelines of Australia). This mapping should be provided for the following events: 63%AEP (Q1), 39% AEP (Q2), 10% AEP, 1 in 100 AEP, 1in 2000 AEP and the PMF for current climate and 1 in 100 AEP future climate (2100).

Impacts of development (afflux and hydrology)

Provide afflux mapping (water level difference between the pre-development and post-development) for the following events: 63%AEP (Q1), 39% AEP (Q2), 10% AEP, 1 in 100 AEP, 1 in 2000 AEP and the PMF for current climate and the 1 in 100 AEP for future climate.

Where there are potential changes to velocities or times of inundation then impact plots showing differences between pre and post-development velocities may be required. It may also be necessary to extract level hydrographs at specific locations to assess changes in duration of inundation.

Demonstrate acceptable impacts have been achieved for the development, in accordance with section 5.5 of the Sunshine Coast Council Flooding and Stormwater Management Guidelines (2020)

Demonstrate the risk to people and property is Acceptable

Demonstrate that the development design provides an acceptable flood risk in accordance with the methodology identified in the Sunshine Coast Council Flooding and Stormwater Management Guidelines, Section 5.4 (Acceptable Flood Risk)

Climate Change

The Defined Flood Event is based on a future planning horizon (2100). Therefore, all design flood levels and infrastructure sizing are required to incorporate climate change allowances. (0.8m sea level rise and 20% increase in rainfall). Flood impact assessment is based upon a current climate condition expect that an additional assessment of the impact for the 1%AEP future climate event is also required.

8 Consideration of flood consequence

Discuss how flood consequences are managed by the design of the development. In particular, consider whether:-

(a) essential network infrastructure within a site (e.g. electricity, water supply, sewerage and telecommunications) maintains effective function during and immediately after flood and storm tide inundation events;
(b) building materials used have high water resistance and will improve the resilience of a building during and after a flood or storm tide event. (Council can provide further guidance materials: Flood Resilience Implementation Guideline for New Development);
(c) community infrastructure is able to function effectively during and immediately after flood events;
(d) development does not compromise the safety of people resulting from flooding, including the residual flood or storm tide inundation risk associated with events exceeding the DFE or DSTE. Is a direct route to enable progressive evacuation to safe refuge above the level of the PMF available? Is there enough time required for evacuation between the DFE being exceeded and the peak of the PMF?;
(e) development ensures that public safety and the environment are not adversely affected by the detrimental impacts of floodwater on hazardous materials manufactured or stored in bulk during the DFE or DSTE;
(f) car parks achieve flood immunity for the 10% AEP and limit the extent of flooding at the 1 in 100 AEP to 250mm, velocity to 2.0m/s and depth x velocity ratio to 0.4m^2/s;
(g) basements are provided waterproofed perimeter walls, air vents and entry/exit ramps that are at least 500mm above the 1%AEP flood level (at 2100) or alternate solutions delivering the same level of protection are provided;
(h) driveways that with a downhill slope have a raised entry ramp from the roadway, as per the requirements of *QUDM* (IPWEA, 2016) to contain flood flows; and
(i) backflow flooding of the local stormwater network from a regional event will be problematic under current or future climatic conditions.

9 Sensitivity Testing

Document the results of all sensitivity testing relating to both design WSL and impact assessments

At a minimum, sensitivity analyses that inform floor levels shall consider

Regional Catchment Flooding

- 1 in 500 AEP Design Flood Event (Severe Storm)

Local Area Flooding

- 1 in 2000 AEP Design Flood Event (Severe Storm)

Regional and Local Area Flooding

- Blockages: No Blockages and 100% Blockages
- Boundary Conditions: Backwater flooding and free draining conditions.

- Manning's Roughness: Channel roughness 50% higher to check for inundation of properties associated with unmaintained channels and 50% lower to check for scour of the channel due to higher velocities.

10 Conclusions and recommendations

This section should summarise the main findings of the report and make any recommendations arising from these findings. These recommendations should include specific details of floor or pad levels relevant to key infrastructure, as per the requirements of the certification statement, to be provided at the front of the report.

11 Qualifications and limitations

Detail any specific qualification and limitations that are relevant to the methodology, conclusions or recommendations of the report.

12 References

Provide a list of documents referred to in the study. Where a reference document is not widely available a copy of the document or the relevant section should be included as an Appendix.

Appendix A: Lot table information

In areas that are within the declared Flood Hazard Area, Council is required by the Queensland Development Code (QDC MP3.5) to provide level and velocity information to building certifiers for the purpose of ensuring compliant construction. This information needs to consider flood mechanisms from both Riverine (water rising from Rivers and Creeks) and Drainage (water travelling overland enroute to a River or Creek).

PMF information is also sought to ensure that safe refuge and building stability can be considered in the construction of the dwelling.

This flood level information is provided by Council on a Flood Information Search.

Flood modelling that is undertaken for the purposes of Development Assessment will be the best information available representing the developed catchment configuration.

It is therefore necessary that a lot table be provided to Council at Plan Seal so that it can inform the construction of dwellings on lots as per the requirements of the Queensland Development Code.

The lot table is to summarise the level and velocity information discussed above as well as the required minimum lot and floor levels. This should be provided based on the template provided below. The minimum lot and habitable floor level requirements of the Planning Scheme differ with the type of development. **Table 8.2.7.3.3 (Flood levels and flood immunity requirements for development and infrastructure)** of the **Flood hazard overlay code** provides the specific requirements for setting minimum floor level based on the type of development.

As this information is also required in a tabulated electronic format for upload in to Council systems, an Excel template can be obtained from Council. Please contact Council's Customer Services Centre. This information will be provided on Council Flood Information Searches until such time as Council is able to revise and re-run the regional and local area flood model with ALS that represents the developed catchment.

General Notes and Assumptions

Column 1: Lot number

Column 2: Y/N box to identify whether the building floor level will be below the road level

Column 3: Developed DFE level (Regional)

Column 4: Developed DFE level (Local Area)

Column 5: Developed 1 in 2000 AEP Design Event level (Local Area, with design structure blockages)

Column 6: Developed 1 in 100 AEP 2100 Design Event level (Local Area with 100% structure blockages)

Column 7: Developed Severe Storm (Local Area) – greater of Column 5 and 6

Column 8: Developed Severe Storm 1 in 500 AEP Event (Regional)

Column 9: Largest Sensitivity Analysis Flood Level

Column 10: Note indicating which of the Sensitivity Analysis produces the Largest Flood Level.

Column 11: Developed PMF level (Regional)

Column 12: Developed PMF velocity (Regional)

Column 13: Minimum floor level

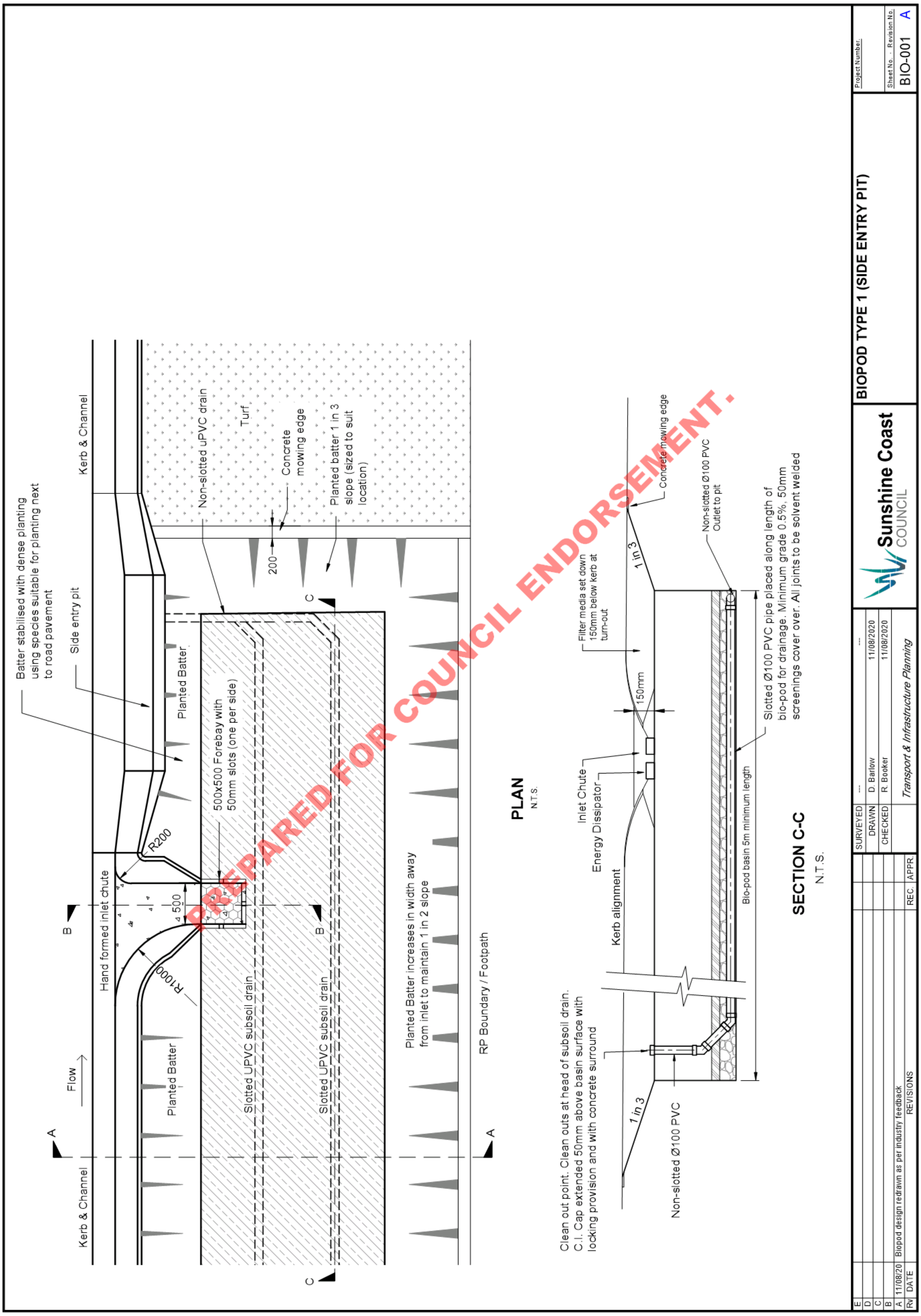
Column 14: Minimum building pad level

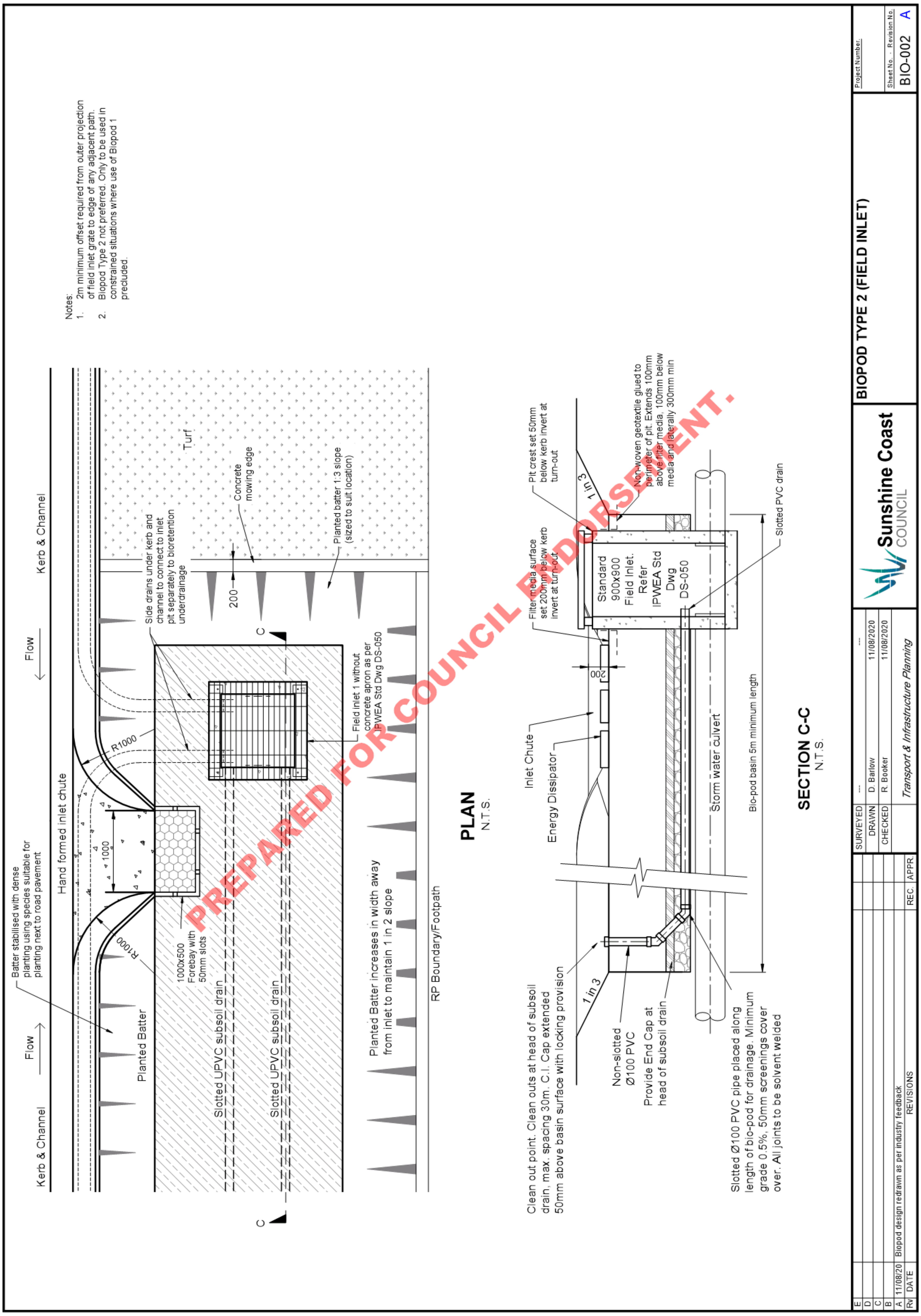
Column 15: Stage number

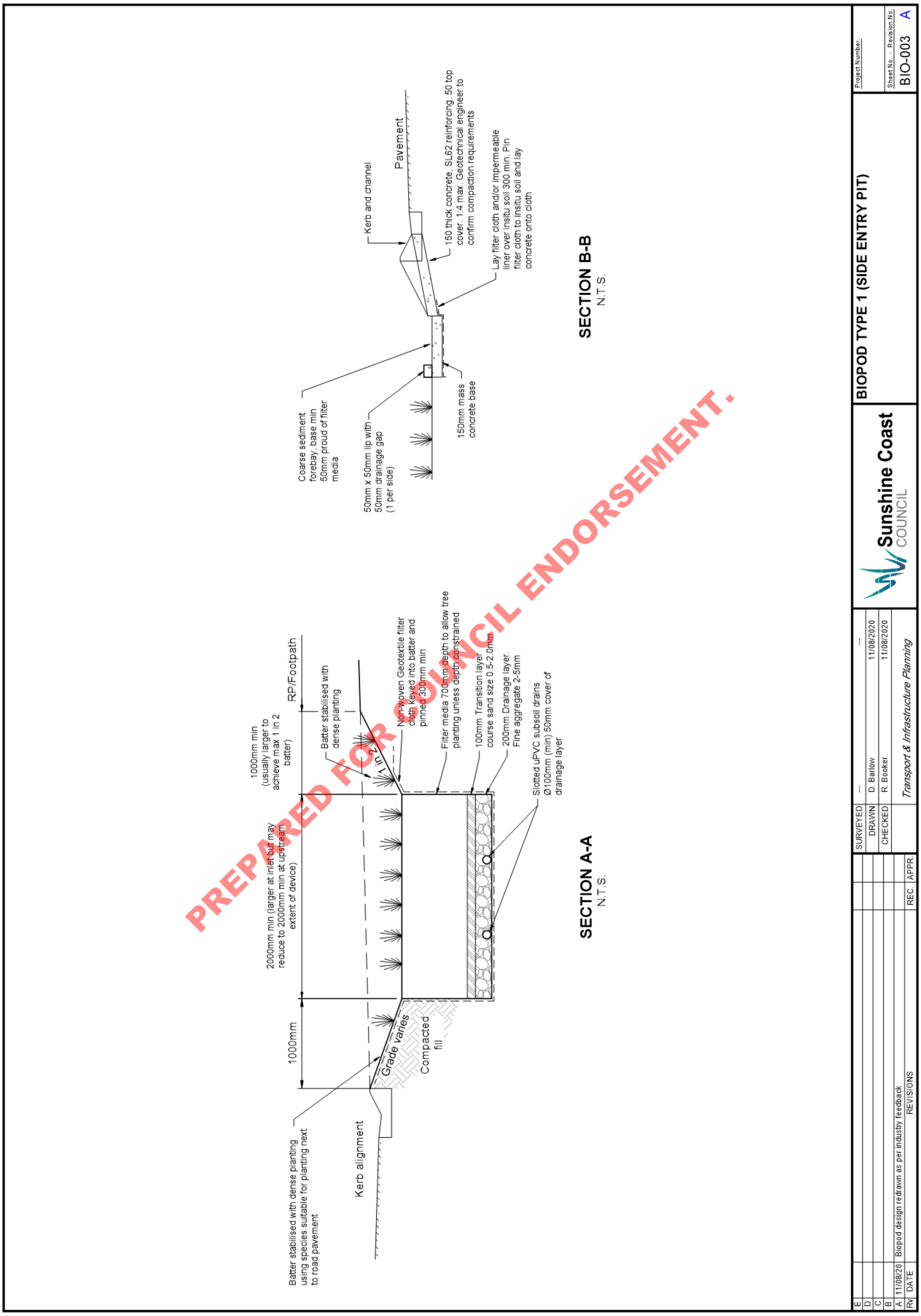
Column 16: Survey plan number

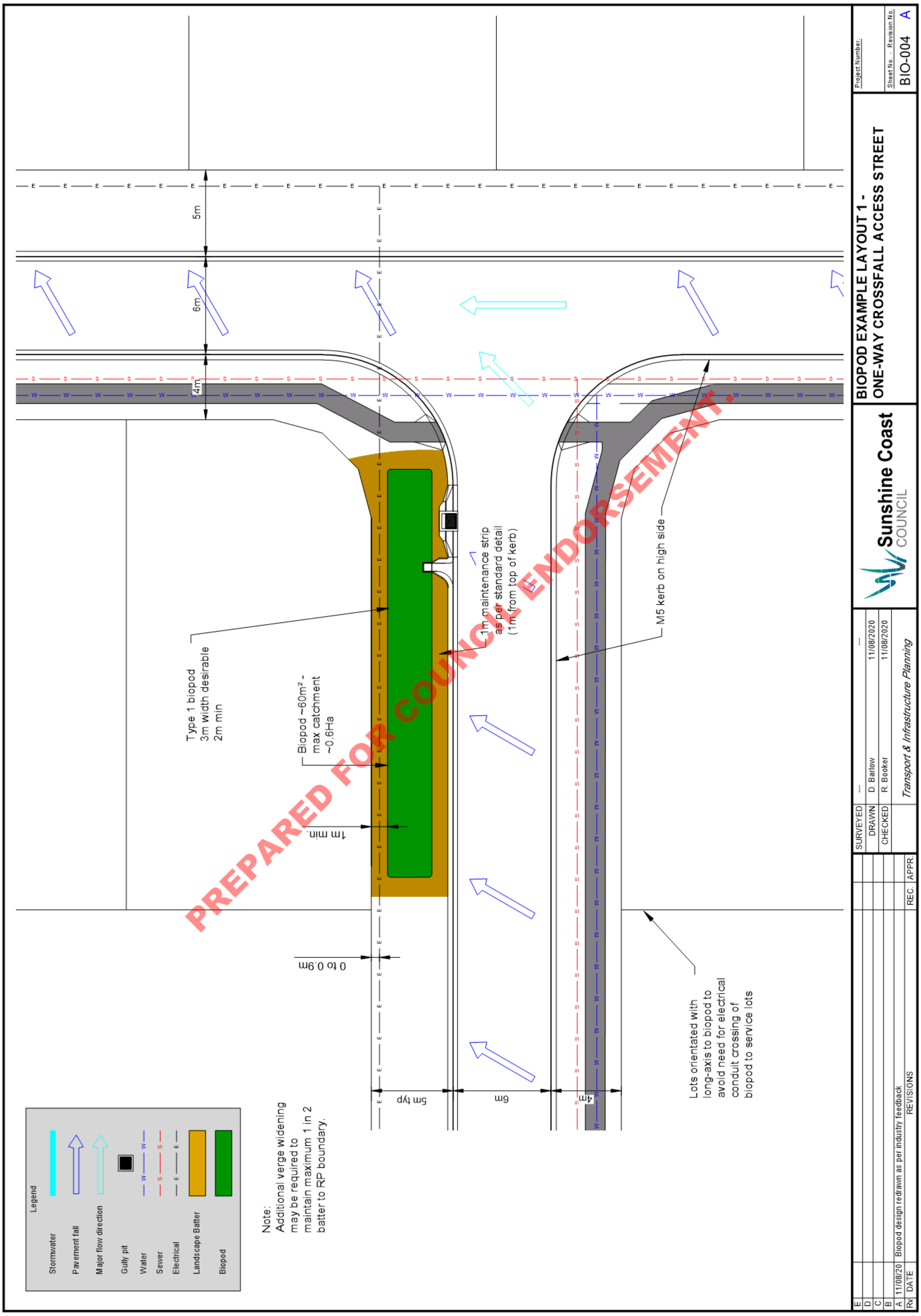
Column 17: Comments specific to lot.

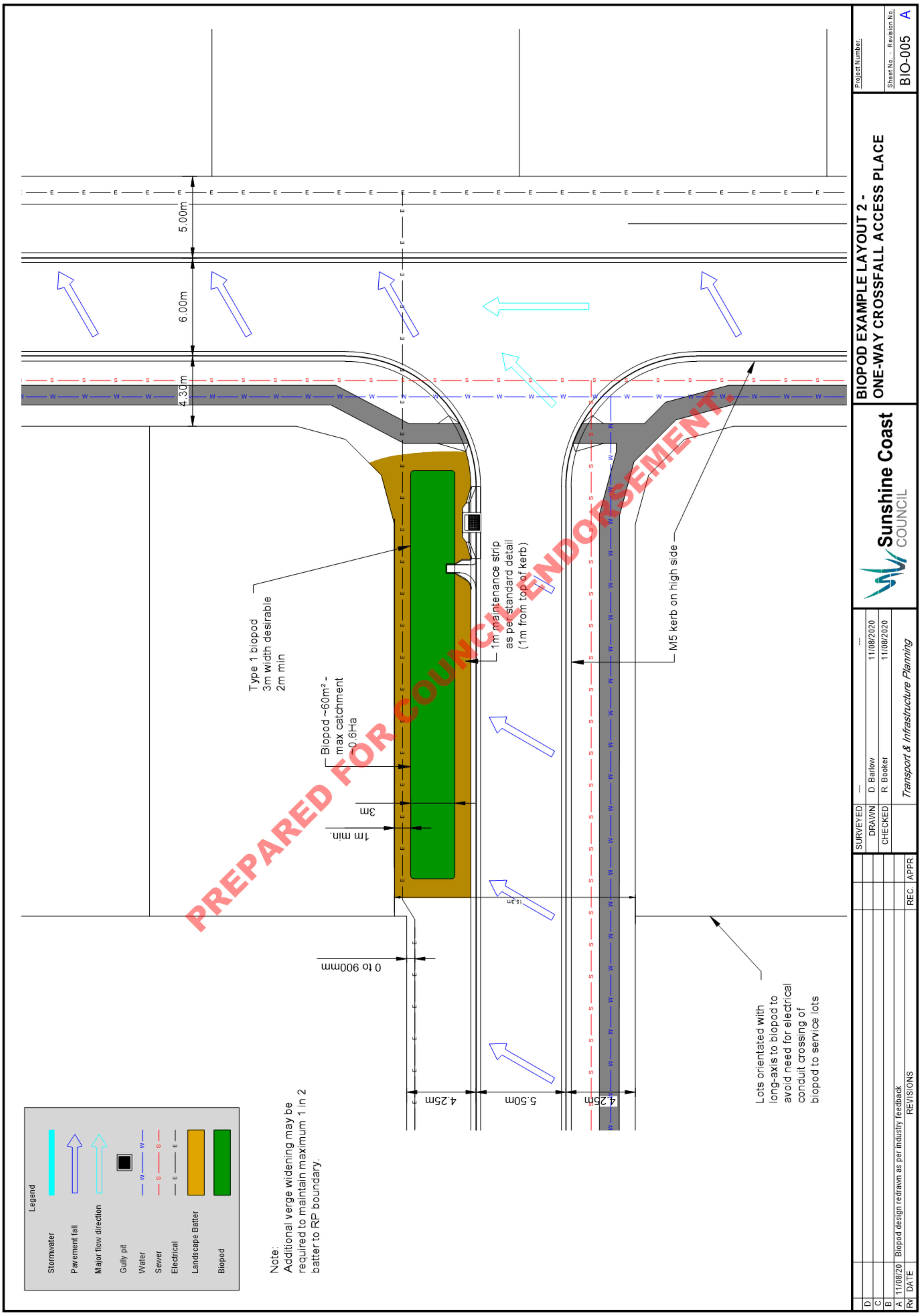
Appendix 4 – Biopod Standard Details and Layouts

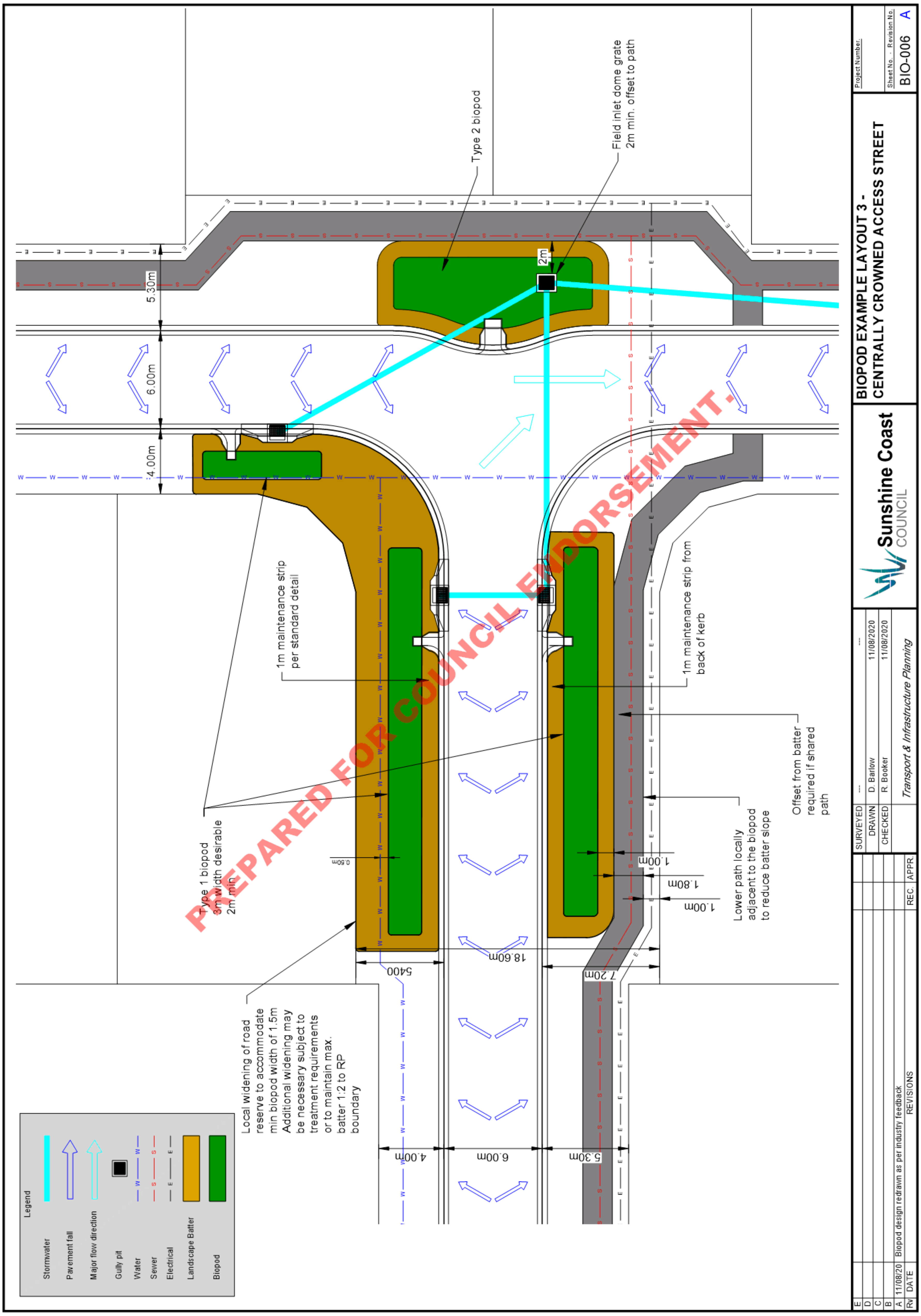

Batter stabilised with dense planting using species suitable for planting next to road pavement
Side entry pit
Kerb & Channel
Non-slotted uPVC drain
Turf
Concrete mowing edge
Planted batter 1 in 3 slope (sized to suit location)
200
Planted Batter
500x500 Forebay with 50mm slots (one per side)
R200
Hand formed inlet chute
500
R1000
Flow
Planted Batter
Slotted UPVC subsoil drain
Slotted UPVC subsoil drain
Planted Batter increases in width away from inlet to maintain 1 in 2 slope
RP Boundary / Footpath
PLAN
N.T.S.
PREPARED FOR COUNCIL ENDORSEMENT.
Clean out point. Clean outs at head of subsoil drain. C.I. Cap extended 50mm above basin surface with locking provision and with concrete surround
1 in 3
Non-slotted Ø100 PVC
Kerb alignment
Energy Dissipator
Inlet Chute
150mm
Filter media set down 150mm below kerb at turn-out
1 in 3
Concrete mowing edge
Non-slotted Ø100 PVC Outlet to pit
Bio-pod basin 5m minimum length
Slotted Ø100 PVC pipe placed along length of bio-pod for drainage. Minimum grade 0.5%, 50mm screenings cover over. All joints to be solvent welded
SECTION C-C
N.T.S.
A 11/08/20 Biopod design redrawn as per industry feedback
Rv DATE REVISIONS REC APPR
SURVEYED ---
DRAWN D Barlow 11/08/2020
CHECKED R Booker 11/08/2020
Transport & Infrastructure Planning
Sunshine Coast COUNCIL
BIOPOD TYPE 1 (SIDE ENTRY PIT)
Project Number
Sheet No. Revision No.
BIO-001 A

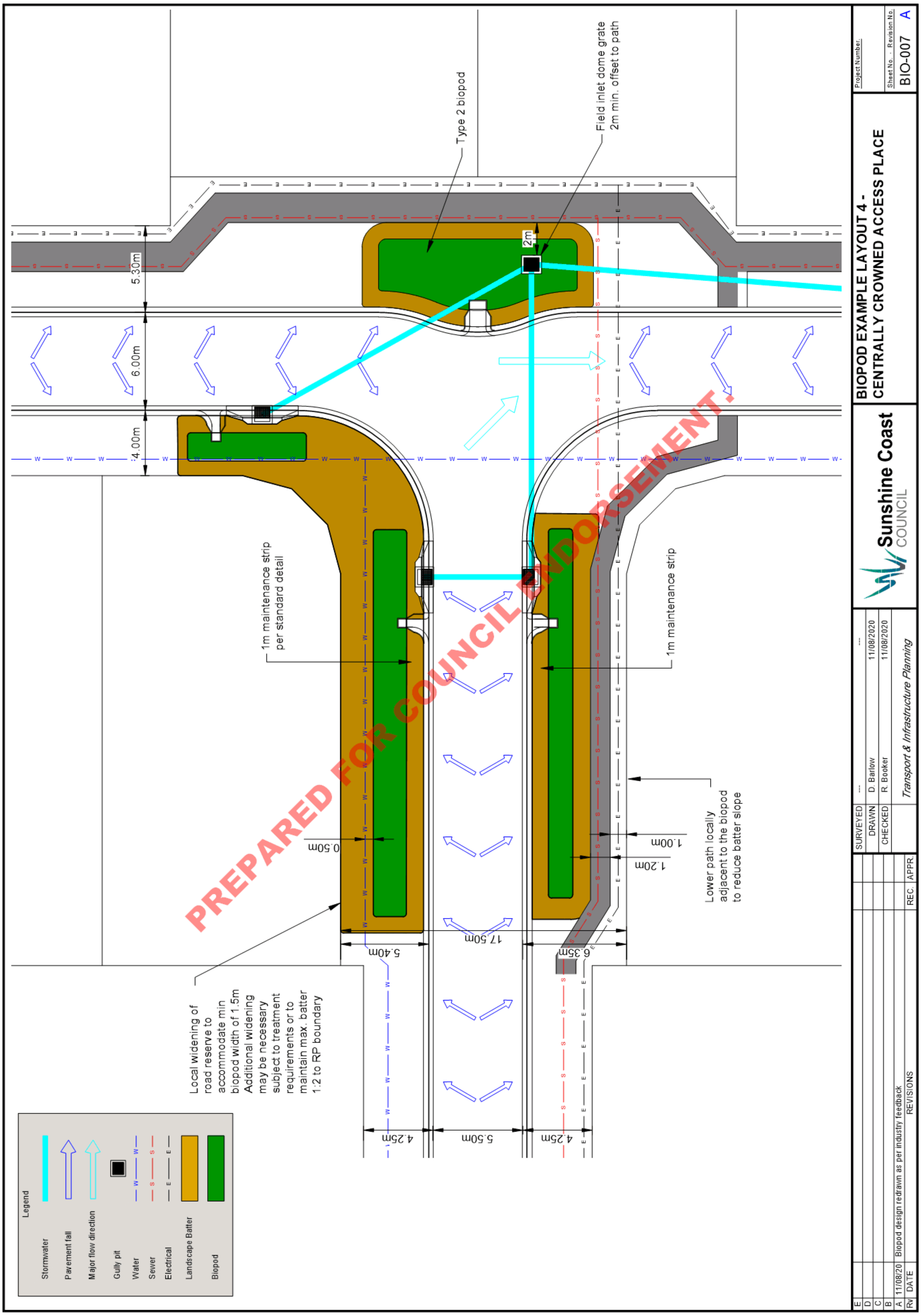

Notes:
1. 2m minimum offset required from outer projection of field inlet grate to edge of any adjacent path.
2. Biopod Type 2 not preferred. Only to be used in constrained situations where use of Biopod 1 precluded.
Kerb & Channel
Flow
Hand formed inlet chute
Batter stabilised with dense planting using species suitable for planting next to road pavement
Planted Batter
R1000
1000
1000x500 Forebay with 50mm slots
Side drains under kerb and channel to connect to inlet pit separately to bioretention underdrainage
Slotted UPVC subsoil drain
Field inlet 1 without concrete apron as per IPWEA Std Dwg DS-050
Turf
Concrete mowing edge
200
Planted batter 1:3 slope (sized to suit location)
Planted Batter increases in width away from inlet to maintain 1 in 2 slope
RP Boundary/Footpath
C
PLAN
N.T.S.
Clean out point. Clean outs at head of subsoil drain, max. spacing 30m. C.I. Cap extended 50mm above basin surface with locking provision
1 in 3
Non-slotted Ø100 PVC
Provide End Cap at head of subsoil drain
Slotted Ø100 PVC pipe placed along length of bio-pod for drainage. Minimum grade 0.5%, 50mm screenings cover over. All joints to be solvent welded
Energy Dissipator
Inlet Chute
Storm water culvert
Bio-pod basin 5m minimum length
Filter media surface set 200mm below kerb invert at turn-out
Pit crest set 50mm below kerb invert at turn-out
Standard 900x900 Field Inlet. Refer IPWEA Std Dwg DS-050
Non-woven geotextile glued to perimeter of pit. Extends 100mm above filter media, 100mm below media and laterally 300mm min
Slotted PVC drain
SECTION C-C
N.T.S.
PREPARED FOR COUNCIL ENDORSEMENT.
E
D
C
B
A 11/08/20 Biopod design redrawn as per industry feedback
Rv DATE REVISIONS REC APPR
SURVEYED ---
DRAWN D Barlow 11/08/2020
CHECKED R Booker 11/08/2020
Transport & Infrastructure Planning
Sunshine Coast COUNCIL
BIOPOD TYPE 2 (FIELD INLET)
Project Number:
Sheet No. Revision No.
BIO-002 A

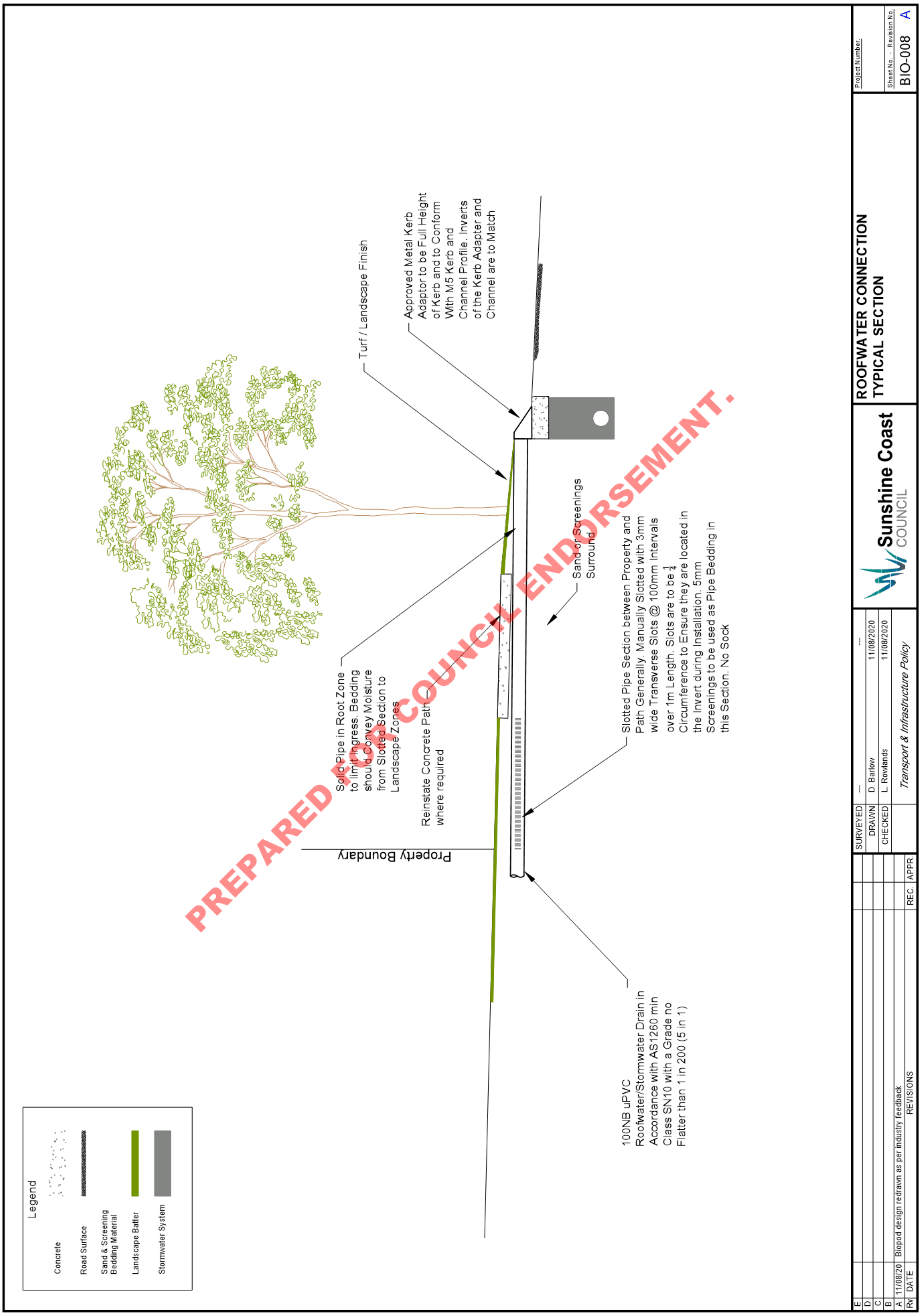

SECTION A-A
N.T.S.
SECTION B-B
N.T.S.
Batter stabilised with dense planting using species suitable for planting next to road pavement
Kerb alignment
1000mm
Grade varies
Compacted fill
2000mm min (larger at inlet but may reduce to 2000mm min at upstream extent of device)
1000mm min (usually larger to achieve max 1 in 2 batter)
RP/Footpath
Batter stabilised with dense planting
1 in 2
Non-woven Geotextile filter cloth keyed into batter and pinned 300mm min
Filter media 700mm depth to allow tree planting unless depth constrained
100mm Transition layer course sand size 0.5-2.0mm
200mm Drainage layer. Fine aggregate 2-5mm
Slotted uPVC subsoil drains Ø100mm (min) 50mm cover of drainage layer
Coarse sediment forebay, base min 50mm proud of filter media
50mm x 50mm lip with 50mm drainage gap (1 per side)
150mm mass concrete base
Kerb and channel
Pavement
150 thick concrete, SL62 reinforcing, 50 top cover. 1:4 max. Geotechnical engineer to confirm compaction requirements
Lay filter cloth and/or impermeable liner over insitu soil 300 min. Pin filter cloth to insitu soil and lay concrete onto cloth
PREPARED FOR COUNCIL ENDORSEMENT.
BIOPOD TYPE 1 (SIDE ENTRY PIT)
Sunshine Coast COUNCIL
Project Number.
Sheet No. Revision No.
BIO-003 A
SURVEYED ---
DRAWN D Barlow 11/08/2020
CHECKED R Booker 11/08/2020
Transport & Infrastructure Planning
A 11/08/20 Biopod design redrawn as per industry feedback
Rv DATE REVISIONS REC. APPR.


5m
6m
4m
Type 1 biopod
3m width desirable
2m min
Biopod ~60m² -
max catchment
~0.6Ha
1m maintenance strip
as per standard detail
(1m from top of kerb)
M5 kerb on high side
1m min.
0 to 0.9m
5m typ
6m
4m
Lots orientated with
long-axis to biopod to
avoid need for electrical
conduit crossing of
biopod to service lots
Note:
Additional verge widening
may be required to
maintain maximum 1 in 2
batter to RP boundary.
Legend
Stormwater
Pavement fall
Major flow direction
Gully pit
Water
Sewer
Electrical
Landscape Batter
Biopod
PREPARED FOR COUNCIL ENDORSEMENT.
A 11/08/20 Biopod design redrawn as per industry feedback
Rv DATE REVISIONS REC APPR
SURVEYED ---
DRAWN D Barlow 11/08/2020
CHECKED R Booker 11/08/2020
Transport & Infrastructure Planning
Sunshine Coast COUNCIL
BIOPOD EXAMPLE LAYOUT 1 -
ONE-WAY CROSSFALL ACCESS STREET
Project Number
Sheet No. Revision No.
BIO-004 A


BIOPOD EXAMPLE LAYOUT 2 -
ONE-WAY CROSSFALL ACCESS PLACE
Project Number.
Sheet No. - Revision No.
BIO-005 A
Sunshine Coast COUNCIL
SURVEYED ---
DRAWN D Barlow 11/08/2020
CHECKED R Booker 11/08/2020
Transport & Infrastructure Planning
A 11/08/20 Biopod design redrawn as per industry feedback
Rv DATE REVISIONS REC APPR
5.00m
6.00m
4.30m
Type 1 biopod
3m width desirable
2m min
Biopod ~60m² -
max catchment
~0.6Ha
3m
1m min.
1m maintenance strip
as per standard detail
(1m from top of kerb)
M5 kerb on high side
0 to 900mm
4.25m
5.50m
4.25m
Lots orientated with
long-axis to biopod to
avoid need for electrical
conduit crossing of
biopod to service lots
Note:
Additional verge widening may be
required to maintain maximum 1 in 2
batter to RP boundary.
Legend
Stormwater
Pavement fall
Major flow direction
Gully pit
Water
Sewer
Electrical
Landscape Batter
Biopod
PREPARED FOR COUNCIL ENDORSEMENT.

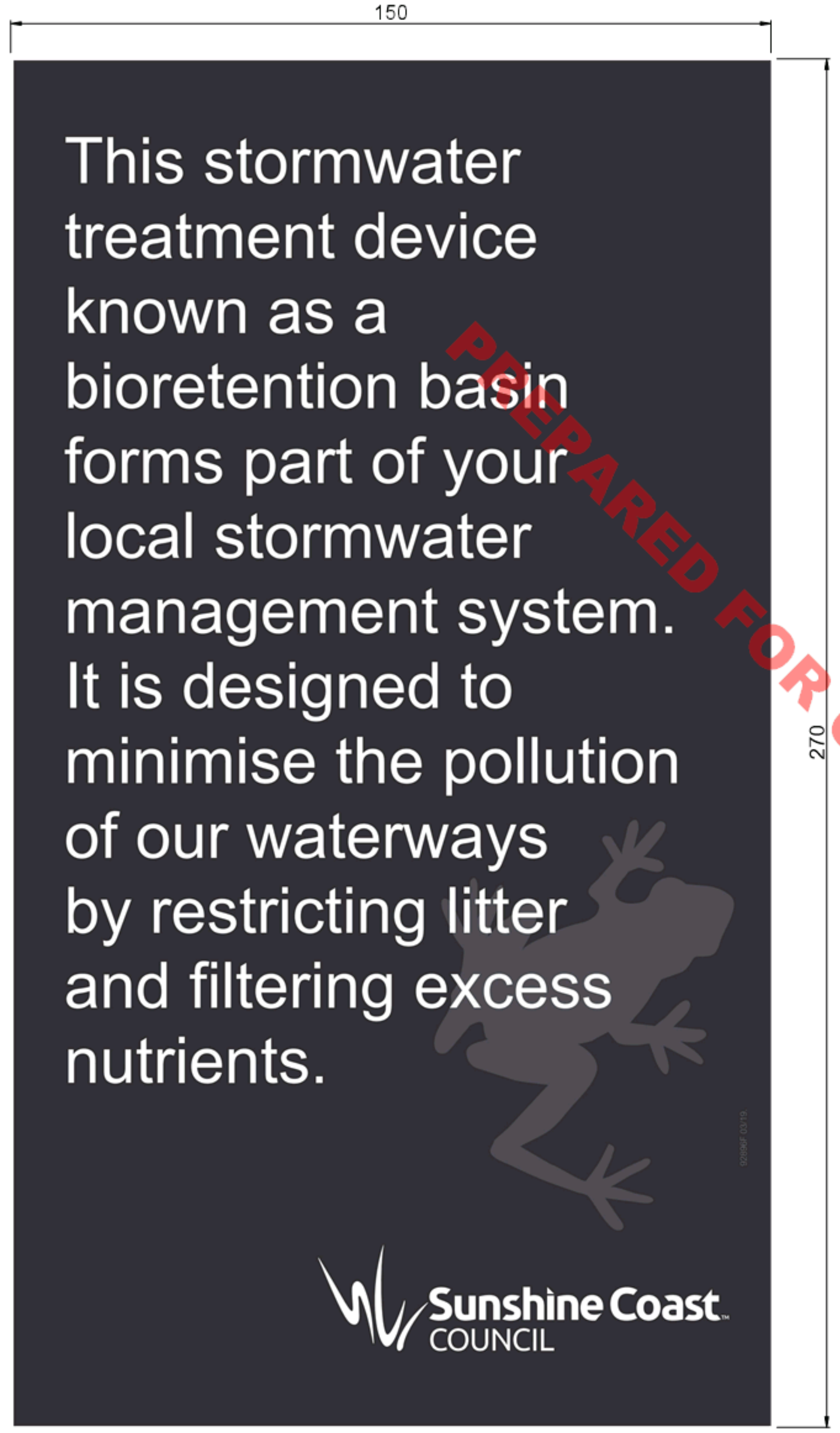

BIOPOD EXAMPLE LAYOUT 3 -
CENTRALLY CROWNED ACCESS STREET
Sunshine Coast
COUNCIL
Project Number.
Sheet No. Revision No.
BIO-006
A
Type 2 biopod
Field inlet dome grate
2m min. offset to path
2m
5.30m
6.00m
4.00m
1m maintenance strip
per standard detail
1m maintenance strip from
back of kerb
Offset from batter
required if shared
path
Lower path locally
adjacent to the biopod
to reduce batter slope
Type 1 biopod
3m width desirable
2m min
0.60m
1.00m
1.80m
1.00m
18.60m
5400
7.20m
Local widening of road
reserve to accommodate
min biopod width of 1.5m
Additional widening may
be necessary subject to
treatment requirements
or to maintain max.
batter 1:2 to RP
boundary
4.00m
6.00m
5.30m
PREPARED FOR COUNCIL ENDORSEMENT.
Legend
Stormwater
Pavement fall
Major flow direction
Gully pit
Water
Sewer
Electrical
Landscape Batter
Biopod
SURVEYED
DRAWN D Barlow 11/08/2020
CHECKED R Booker 11/08/2020
Transport & Infrastructure Planning
A 11/08/20 Biopod design redrawn as per industry feedback
Rv DATE REVISIONS REC APPR


BIOPOD EXAMPLE LAYOUT 4 -
CENTRALLY CROWNED ACCESS PLACE
Sunshine Coast COUNCIL
Project Number:
Sheet No. - Revision No.
BIO-007 A
SURVEYED ---
DRAWN D Barlow 11/08/2020
CHECKED R Booker 11/08/2020
Transport & Infrastructure Planning
A 11/08/20 Biopod design redrawn as per industry feedback
Rv DATE REVISIONS REC APPR
Type 2 biopod
Field inlet dome grate
2m min. offset to path
2m
5.30m
6.00m
4.00m
1m maintenance strip
per standard detail
1m maintenance strip
0.50m
1.00m
1.20m
17.50m
5.40m
6.35m
4.25m
5.50m
4.25m
Lower path locally
adjacent to the biopod
to reduce batter slope
Local widening of
road reserve to
accommodate min
biopod width of 1.5m
Additional widening
may be necessary
subject to treatment
requirements or to
maintain max. batter
1:2 to RP boundary
Legend
Stormwater
Pavement fall
Major flow direction
Gully pit
Water
Sewer
Electrical
Landscape Batter
Biopod
PREPARED FOR COUNCIL ENDORSEMENT.

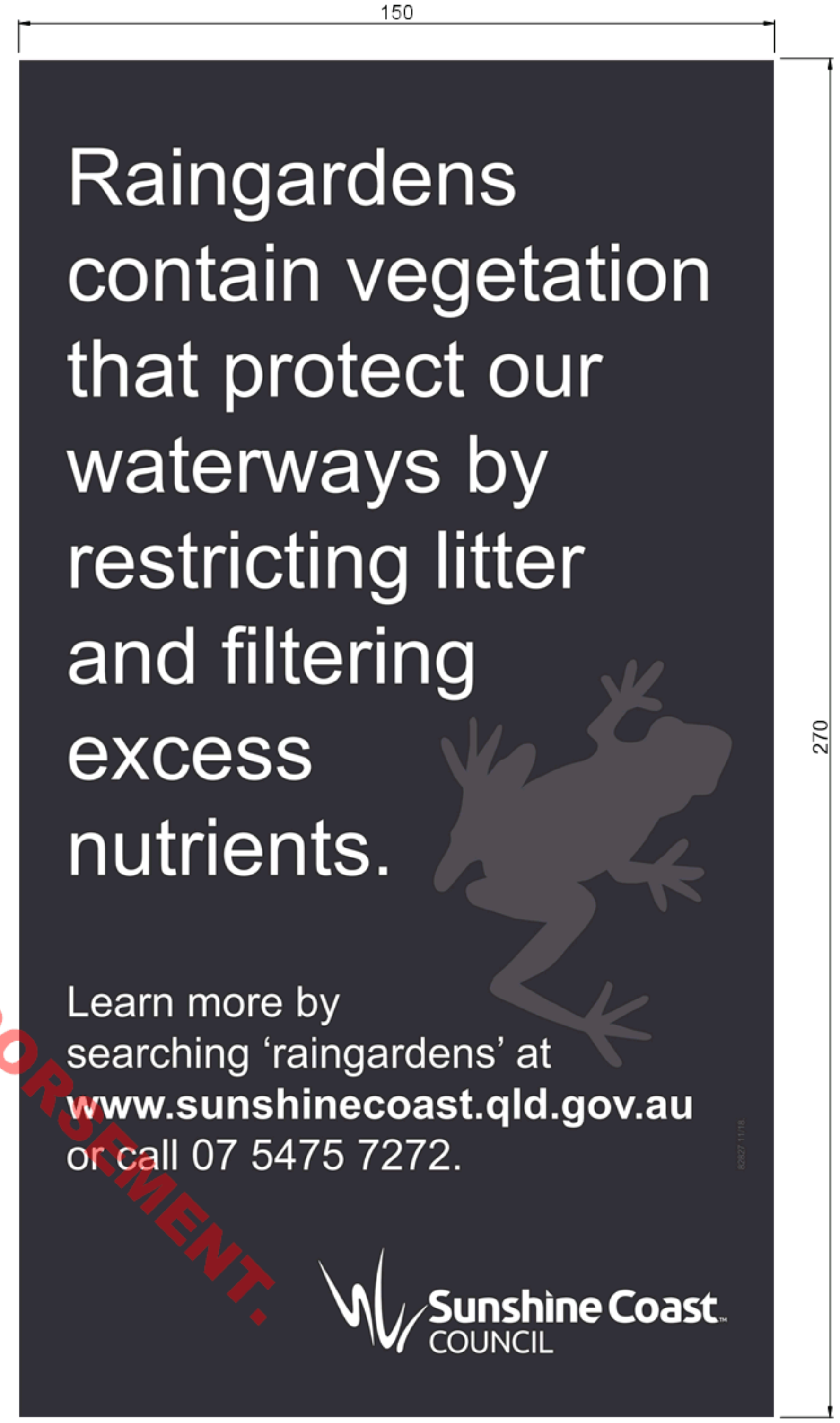

Turf / Landscape Finish
Approved Metal Kerb Adaptor to be Full Height of Kerb and to Conform With M5 Kerb and Channel Profile. Inverts of the Kerb Adapter and Channel are to Match
Sand or Screenings Surround
Slotted Pipe Section between Property and Path Generally. Manually Slotted with 3mm wide Transverse Slots @ 100mm Intervals over 1m Length. Slots are to be ¼ Circumference to Ensure they are located in the Invert during Installation. 5mm Screenings to be used as Pipe Bedding in this Section. No Sock
Solid Pipe in Root Zone to limit Ingress. Bedding should Convey Moisture from Slotted Section to Landscape Zones
Reinstate Concrete Path where required
Property Boundary
100NB uPVC Roofwater/Stormwater Drain in Accordance with AS1260 min Class SN10 with a Grade no Flatter than 1 in 200 (5 in 1)
PREPARED FOR COUNCIL ENDORSEMENT.
Legend
Concrete
Road Surface
Sand & Screening Bedding Material
Landscape Batter
Stormwater System
ROOFWATER CONNECTION
TYPICAL SECTION
Sunshine Coast COUNCIL
Project Number.
Sheet No. - Revision No.
BIO-008 A
SURVEYED ---
DRAWN D Barlow 11/08/2020
CHECKED L. Rowlands 11/08/2020
Transport & Infrastructure Policy
A 11/08/20 Biopod design redrawn as per industry feedback
Rv DATE REVISIONS REC APPR

Appendix 5 – Bioretention Standard Signage

Sunshine Coast Regional Council



BIORETENTION BASIN SIGN
NOT TO SCALE



RAINGARDEN SIGN
NOT TO SCALE

PREPARED FOR COUNCIL ENDORSEMENT.

A1	PRELIMINARY	HORIZ. GRID	
		HEIGHT ORIGIN	
		SURVEY	
		DRAWN	DWB
Rv DATE	REVISIONS REC. APPR.	DESIGNED	

GDA

FLOODING & STORMWATER MANAGEMENT TEAM
TRANSPORT & INFRASTRUCTURE POLICY BRANCH
NAMBOUR OFFICE @ Cnr Currie & Bury St, Nambour.
Mail: Locked Bag 72, Sunshine Coast Mail Centre, Nambour, QLD 4560
Phone: (07) 54757272 email:mail@sunshinecoast.qld.gov.au

Sunshine Coast COUNCIL

RAINGARDEN & BIORETENTION SIGNS
GENERAL ARRANGEMENT

Project Number.
Sheet No. - Revision No.
A

CAD FILES \\MSC.Internal\User\Data1\db042\Documents\CAD\RainGarden & BioRetention Signs.dwg
SCC_DETAIL_A1 (09/16)
Last Modified :- Apr 16, 2019 - 4:25pm XREFS :-

Appendix 6 – Maintenance Report Template

This reporting template is to be used for preparing a maintenance report for vegetated stormwater assets such as vegetated channels, swales, bioretention basins and wetlands. The report is intended to be read by Council maintenance staff after the asset has been handed over to Council (i.e. the asset is off-maintenance) so is to focus on long-term maintenance tasks rather than establishment.

The report should avoid large sections of text and should utilise drawings and tabular information to allow quick access to information by maintenance staff.

Detailed guidance on maintenance for different vegetated stormwater assets can be found in the Healthy Waterways (2012) publication titled *Maintaining Vegetated Stormwater Assets* and should be referred to when completing sections of the below template.

1. Site Location

A plan should be provided showing the location of the asset, including the nearest street intersection and the name of any park or reserve in which the asset is located

2. Functional Description

This section should include a brief description of the purpose and key design features of the asset and may include a schematic drawing showing the functional components. The full design drawings should be referenced and provided as an appendix to the report.

3. Maintenance Access

A plan is to be provided of the asset showing access to the asset from the nearest road and around/within the device. The Planning Scheme Policy for Development Works identifies minimum maintenance access requirements for different types of vegetated stormwater assets.

The plan is to identify the width and surface type (e.g. concrete, gravel, turf, etc.) of each access as well as the location of any access restrictions such as gates or removable bollards.

4. Surface and Horticultural Maintenance

A plan is to be provided of the asset showing each of the different functional surfaces of the asset, such as turf, filter media or batter. Surfaces should be categorised logically based on the function and the expected maintenance regime. The maintenance regime required for each surface type is to be summarised into Table 1, which is provided below along with information on Council's preferred methods, maintenance intervals and indicative rates for common activities.

Table 1 – Horticultural Maintenance Schedule (example)

Surface Type	Activities	Preferred Methods	Maintenance Interval	Area (m^2)	Rate ($/$m^2$, $/Lm)	Cost ($/yr)
Turf	Mowing	Flat-deck	Fortnightly Dec - April 3 weekly May to November	TBC	$0.0403/m2	TBC
Filter Media or planted channel invert	Weeding	hand pulling	3 weekly	TBC	$0.30/m2	TBC
Vegetated Batter	Weeding	Herbicide – foliar spray or rope-wick	3 weekly	TBC	$0.18 /m2	TBC
Loose Rock (unplanted)	Weeding	Herbicide – foliar spray or rope-wick	6 weekly	TBC	0.093/m2	TBC
Loose Rock (with pocket planting)	Weeding	hand pulling	6 weekly	TBC	0.36/m2	TBC
Open water	Weeding	Mechanical or hand removal of floating aquatic weeds	6 months	TBC	Mechanical $188/hr Hand $100/hr	TBC
macrophyte plantings (wetland, edges of open water)	Weeding	Hand pulling Cut-stump	6 months	TBC	Mechanical $188/hr Hand $100/hr	TBC

5. Drainage and Pollutant Maintenance

Non-horticultural maintenance activities will not all be undertaken at scheduled maintenance intervals. Some activities will be scheduled while others will be undertaken on a reactive basis when issues are observed. This balance between scheduling and monitoring has been consciously adopted to achieve the most cost-effective outcome for Council.

The activities which Council will undertake on a regular scheduled basis and those which will only be undertaken on a reactive basis are summarised below.

Scheduled maintenance activities:

- Sediment removal
- Litter removal

Monitoring and reactive maintenance activities:

- Unblocking inlets and outlets
- Managing mosquitos
- Managing birds
- Managing high or low water levels in a wetland

- Responding to spills of paint, fuel or concrete
- Replanting
- Managing excessive algal blooms in wetland or sediment basins
- Managing algae or moss on bioretention surfaces
- Storm damage assessments following events
- Green waste removal & notification of any dumping
- infrastructure repairs - caps , pipes, pits, fencing
- Council also undertakes quarterly scheduled condition assessments in addition to the above reactive monitoring

The maintenance activities which are to be scheduled (i.e. sediment removal, litter removal) are to be fully documented in the report and are to include a plan showing the location where the activities are to be carried out (eg location of sediment forebay, GPT etc) and the maintenance regime required for each activity is to be summarised into Table 2. The example provided for Table 2 below includes Council's required maximum maintenance intervals and indicative rates for each method of undertaking the activities.

Table 2 – Non-Horticultural Maintenance Schedule (example)

Activity	Location/Type	Maintenance Interval	Storage Volume or Area (m^3 or m^2)	Rate ($/$m^3$, $/$m^2$)	Cost ($/yr)
Sediment Removal	Forebay (at-source) Forebay (end-of-line) Sediment basin (wet) GPT	3 weekly 12 months 12 months 12 months	TBC	TBC	TBC
Litter Removal	Within vegetation (hand removal) In-pit basket Floating boom GPT	As per Table 1 3 months 12 months 12 months	TBC	TBC	TBC

6. Benchmark and Budget Allocation

The resulting overall maintenance cost should be compared against benchmark costing data (where available) such as the "Guide to the Cost of Maintaining Bioretention Systems" (Water by Design, 2015).

Where calculated maintenance costs exceed benchmark figures, the design should be revised based on utilising lower-cost surfaces or justification for the higher costs should be provided.

Appendix 7 - Flood Emergency Management Plan Template

This reporting template should be considered in conjunction with this guideline as well as the **Flood hazard overlay code and associated planning scheme policy**.

Provision of a Flood Emergency Management Plan may be an alternative solution for demonstrating that an ***acceptable level*** of flood risk is achieved to ensure the safety of people in all flood events as required by the Flood Hazard Overlay Code. It will not be acceptable to Council as an alternative to achieving the minimum levels for property and infrastructure specified by the Code and will only be considered as an alternative solution for safety where:

- The use does not involve permanent residential aspects; and
- The flooding characteristics are not flash flooding (defined as having a time to peak of less than 6 hours)

The completed Flood Emergency Management Plan is required to be registered with Council's Disaster Management Team.

Further guidance on developing evacuation plans can be obtained from *Evacuation Planning* (AIDR, 2017a).

Document details and certification

Details of the authorship of the Flood Emergency Management Plan should be provided and must be prepared by someone having not less than 5 years' experience in disaster management.

All flood modelling used to inform the plan must be undertaken and certified by an RPEQ with experience in Flood Modelling and Management.

Note: It is a requirement of the Act that professional engineering services in Queensland are carried out by a RPEQ, or alternatively by a person who carries out the services under the direct supervision of a RPEQ who is ultimately responsible.

Example:

Report Title:	Flood Emergency Management Plan for Proposed Maroochy Woods Development, Maroochy Road, Maroochydore
Street Address	15-35 Maroochy Rd, Maroochydore
RP Description	Lots 1,2 & 7 on RP 123456
Prepared For:	Maroochy Development Company Pty Ltd
Date:	7 Sept 2016
Revision No.	3
Report Status:	Draft/Final
Prepared By:	
Name	Bob Jones
Qualifications	BE
Company	Water Consultants Pty Ltd
Phone No.	5555 1234

Where flood modelling is documented in the report the additional certification is to be provided

Flood Modelling Certified By:	
Name	John Smith
Qualifications	BE, MSci
Company	Water Consultants Pty Ltd
Phone No.	5555 1234
Industry Accreditation	RPEQ No. 1234
Signature	

Executive summary

The summary provides a brief (1-2 page) overview of the development proposal, the findings and the associated recommendations and conclusions.

1 Introduction

The introduction should give an overview of the development and any relevant background information. It may be appropriate to include a locality plan showing the location of the proposed development site.

Any technical terms used in the document such as "DFE", "AEP" or "PMF" should be defined and explained for non-technical readers. As the document must be able to be read and followed by non-technical readers it may be appropriate to define terms such as "Minor", "Major" and "Extreme" flood events and then use these terms throughout the document.

2 Flooding Characteristics and Flood Information

a. Nature of Flood Threat

This section should qualitatively identify the sources of flooding and the risk this poses to the use. Considerations which should be discussed include:

- Sensitivities of the proposed use to flooding
- Degree of inundation of the use
- Inundation of the access routes between the use and flood-free refuge
- Sources of flooding: riverine, creek, stormwater drainage network or storm tide

Where there is more than one source of flooding, the plan should speak to each separately.

b. Flooding Constraints and Flood Risks

A quantitative description of the flooding constrains and risks is to be provided. The level of detail will depend on the nature of the use, site characteristics and proposed flood risk management strategies. As a minimum, the information provided should include:

- Flood level inundation maps for the DFE, 1 in 2000 AEP and PMF of the site and access routes linking the site to flood-free refuge
- An assessment of the flood warning time for the catchment response at the site and at any points in the access route liable to flood inundation

- Assessment of flood depths and time to/of inundation at specific reporting points such as roadway crossings of watercourses where access is most likely to be compromised during an event. Evacuation strategies are considered inappropriate where time to peak is less than 6 hrs and are subject to site and use-specific assessment where longer time to peak is involved

The flood warning time may be estimated using the SCC TTPP (Travel Time from Peak rainfall to Peak flow) equation provided in SCC (2018a).

c. Sources of Flood Intelligence

This section should list all available sources of flood information which can inform the management response during an event and identify any supplementary information needs for which monitoring systems need to be developed as part of the development proposal.

Available government data which should be listed in this section includes:

- Identify relevant water level and rainfall alert gauges operated by BoM
- Sunshine Coast Council Disaster Hub for consolidated listing of local and State roads closed plus BoM and Council current weather warnings http://disaster.sunshinecoast.qld.gov.au/

In developing the plan there are a range of technical industry guidelines which can be used including the Sunshine Coast Council (2016) publication titled *Guidelines for Improving Flood Resilience for New Development*

3. Flood Risk Management Strategy

a. Flood Risk Management Approach

This section is to document the proposed strategy components based on the understanding of the nature of the flood risk and flooding characteristics developed in the preceding sections. The strategies could include any combination of the following strategies depending on the feasibility and appropriateness for the site and use:

- Shelter in place (flood refuge)
- Evacuation
- Procedures specific to use

b. Triggers for Plan Activation

A staged approach to plan implementation is to be documented in order to minimise disruption during minor events whilst still ensuring safety during significant events. The plan implementation should move sequentially from monitoring through to preparation and implementation. Each stage in the plan activation process is to be clearly documented along with the quantifiable trigger initiating each stage and the data this trigger is to be based on.

The actions required during each stage of the plan should include any actions needed to make the site safe such as isolating power prior to leaving the site.

In developing each stage of the plan, the plan preparer should work backwards from the required outcome (e.g. residents fully evacuated from site to designated shelter location) and using realistic/conservative timeframes establish a corresponding trigger point to commence the action. The timeframes required will be dependent on considerations such as the landuse, site features/topography, training and skills of staff and any special needs of the resident population.

If the resulting trigger is impractical/unrealistic and would result in frequent disruption to the use of the site, then the plan should be revised or the proposed landuse may be inappropriate for the location.

c. Roles and Responsibilities

The responsibilities of each party during each part of the plan implementation is to be clearly documented along with performance measures to enable quantification of the success of these responsibilities having been fulfilled.

This information is to be provided in tabular form with names and phone numbers. The table is to be updated when there is any change in staff as well as being reviewed annually.

d. Assisted Mobility Requirements

For uses which may involve people with restricted mobility or special needs, this section is to document the measures which will be put in place to cater for those needs.

e. Medical Emergency Response

For strategies, which include a component of shelter-in-place, consideration is required for how to respond to a medical emergency during the period of isolation. The degree of response will depend on the nature of the use and the characteristics of the population which is isolated as well as the length of the period of isolation. The plan should assume a minimum period of isolation of 3 days.

f. Emergency Contacts

Emergency contacts during a flood emergency are to be listed and should include as a minimum the following public organisations:

- Emergency Services (Police/Fire/Ambulance): 000
- State Emergency Services (SES): 132 500
- Energex (For fallen power lines and electrical hazards): 13 19 62
- Unity Water (Sewer Overflows): 1300 086 489
- Sunshine Coast Council (Local Disaster Coordination Group) 5475 7272

g. Recovery

Flood recovery may be a significant undertaking depending on the use and nature of the flood risk. While the Plan primarily focuses on safety during an event, planning for Flood Recovery can significantly reduce the overall economic and social consequences of a flood event by allowing normal operations to recommence as soon as possible.

Specific strategies, procedures and responsibilities for dealing with the immediate aftermath of an event should be documented here with the aim on return the use to normal operation as soon as possible.

Advice for improving the resilience of development to flooding can be found in the Sunshine Coast Council (2016) publication titled *Guidelines for Improving Flood Resilience for New Development.*

4. Flood Risk Preparedness and Training

a. Education of Workers and Residents

This section is to document the education and training requirements for all people on the site, in order for the Plan to be able to be effectively implemented. The requirements will vary depending on the role each person or grouping of people is expected to fulfil during an event and also the strategies which have been adopted.

The potential scope of education and training includes:

- General flood safety and awareness training covering general principles such as not traversing flooded roadways, not touching fallen powerlines and providing emergency contact details
- Training on the specific responsibilities of their role under the Plan
- Specific training for those responsible for actively monitoring triggers for the Plan implementation. This may involve access to specific electronic systems or databases
- Evacuation drills (where evacuation forms part of the strategy)

b. Resource Requirements

The resources required will vary greatly with the strategy adopted. For strategies relying on shelter-in-place for able-bodied people and for brief periods of isolation then resources may be limited to simple first-aid kits and supplies for making isolation more comfortable such as water, torches and radios.

For uses with more sensitive populations and/or that involve evacuation procedures then resource requirements (both in terms of equipment and personnel) are likely to be far more intensive.

c. Management and Maintenance of Equipment and Buildings

Requirements for the servicing and maintenance of buildings and equipment required as part of the Plan strategies should be documented. The party responsible for maintenance and the expected frequency of maintenance intervals is also to be documented.

Buildings that are designed to be a safe refuge from flooding are to comply with the requirements of Section 5.2.2 of Council's Flooding and Stormwater Management Guidelines.

5. Documentation and Auditing

This section should document the required record-keeping, auditing and review required for the plan. The aim is to ensure that the plan remains relevant, accurate and is continuously improved based on experience.

Key requirements which should be included are:

- For the plan to be updated when staff change so names and phone numbers are current
- For the plan to be updated to reflect any changes to the physical or organisation features of the use
- For records to be kept of all training and maintenance undertaken to comply with the plan
- For records to be kept of actions taken during an event to comply with the plan and the effectiveness of such actions

An annual audit and review of the plan should be undertaken to ensure that the above requirements are being implemented. The annual review should also examine the frequency of activation of the plan and whether the triggers and actions are practical and effective.

Sunshine Coast COUNCIL

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