AURA PRECINCTS 3-5

STORMWATER QUALITY MANAGEMENT PLAN

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

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SUMMARY

Precincts 3-5 of the Aura masterplan development covers 134ha of industrial, commercial, arterial road, sports field, linear park land uses, Bells Creek Arterial and various environmental buffer zones. The site drains in two directions. The majority of the site (125 ha) drains southwards into Bells Creek North and a small portion of the site flows into Lamerough Creek to the north. The two receiving waterways have different stormwater quality objectives.

The area of Precincts 3-5 draining southwards, flows into a State Government declared High Ecological Value area (Pumicestone Passage) as well as Ramsar listed wetlands. Consequently requirements for comprehensive stormwater quality improvement from the site are imperative. Stormwater quality objectives for development runoff from Aura have been determined as part of a wider water quality assessment of Bells Creek and Pumicestone Passage.

The area draining northwards into Lamerough Creek (9.6ha) does not require the same level of stormwater pollutant reduction. This area is, however, required to provide stormwater quality treatment to levels defined by State Planning Policy.

This document describes the stormwater quality management strategy for Aura Precincts 3-5 to meet required stormwater quality objectives.

<u>Area draining south (>90% of site)</u>

This strategy proposes a comprehensive combination of treatment systems responding to the very high value receiving waters. Vegetated swales convey flows to the south and two wetland and bioretention treatment systems at the southern edge of the development to provide the majority of treatment. In addition, rainwater tanks are used on allotments for water reuse in toilets and outdoor demands. These systems combined provide required stormwater treatment prior to discharge into Bells Creek North.

The treatment systems have been all be located within the constraints of site levels, available space and requirements for environmental buffers (e.g. avoid frog habitat and frog zone).

The treatment strategy meets the requirements for stormwater quality improvement to ensure there are no adverse impacts on Bells Creek and Pumicestone Passage. This includes reducing annual pollutant loads by more than the required 95% for total suspended solids (TSS), 89% for total phosphorus (TP) and 68% for total nitrogen (TN) from developed areas. These stormwater objectives were established as part of the stormwater planning and waterway modelling for the whole Aura development as documented in *Aura Development Stormwater Quality Management Plan* (DesignFlow & BMT, 2019).

<u>Area draining north (<10% of site)</u>

The area draining northwards will be treated using rainwater tanks, at-source bioretention systems within allotments and along the roads and a vegetated swale. The stormwater treatment strategy achieves the required annual pollutant reduction of 80%, 60% and 45% for TSS, TP and TN.

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1 Introduction

The Aura development site has been the focus of extensive water quality and stormwater quality management investigations over the last 10 years. This work has established the water quality characteristics of the receiving waterways (i.e. Bells Creek), monitored the quality of stormwater quality exiting the site, completed extensive catchment and receiving waterbody modelling, established water quality objectives and defined stormwater treatment strategies to meet these objectives. These requirements are now included in Federal and State Government approvals for the site.

This report focusses on Precincts 3-5, approximately 134 hectares of land including industrial, commercial, and sports field land uses as well as a section of the Bells Creek Arterial road and areas of buffers and environmental zones adjacent to Bells Creek North.

This report presents a SQMP for Precincts 3-5 of Aura reflecting recent investigations and consideration of site constraints and proposed development land uses and levels. The strategy ensures the stormwater quality objectives for Aura are achieved using treatment measures that respond to the site constraints while providing flexibility through future detailed design.

The treatment strategy for Precincts 3-5 is consistent with the stormwater objectives, planning and modelling documented in *Aura Development Stormwater Quality Management Plan* (DesignFlow & BMT, 2019) and recently approved by Economic Development Queensland (EDQ). This report defines stormwater management objectives for the Aura development (i.e. reduction in annual pollutant loads by the required 95% for total suspended solids, 89% for total phosphorus, and 68% for total nitrogen from developed areas) to ensure no adverse impacts to Bells Creek and Pumicestone Passage. The stormwater treatment strategy for Precinct 3-5 ensures these objectives are achieved.

1.1 Precincts 3-5 development

Precincts 3-5 is located in the north of the Aura development site and is directly west of Precinct 2 (Figure 1).

Areas covered in this SQMP include approximately (Figure 2):

- 65 hectares of industrial land
- 16 hectares of commercial land
- 17 hectares of arterial road (Bells Creek Arterial)
- 11 hectares of waterways and linear park
- 8 hectares of sports field
- 17 hectares of linear park, buffers and environmental zones adjacent to Bells Creek North.

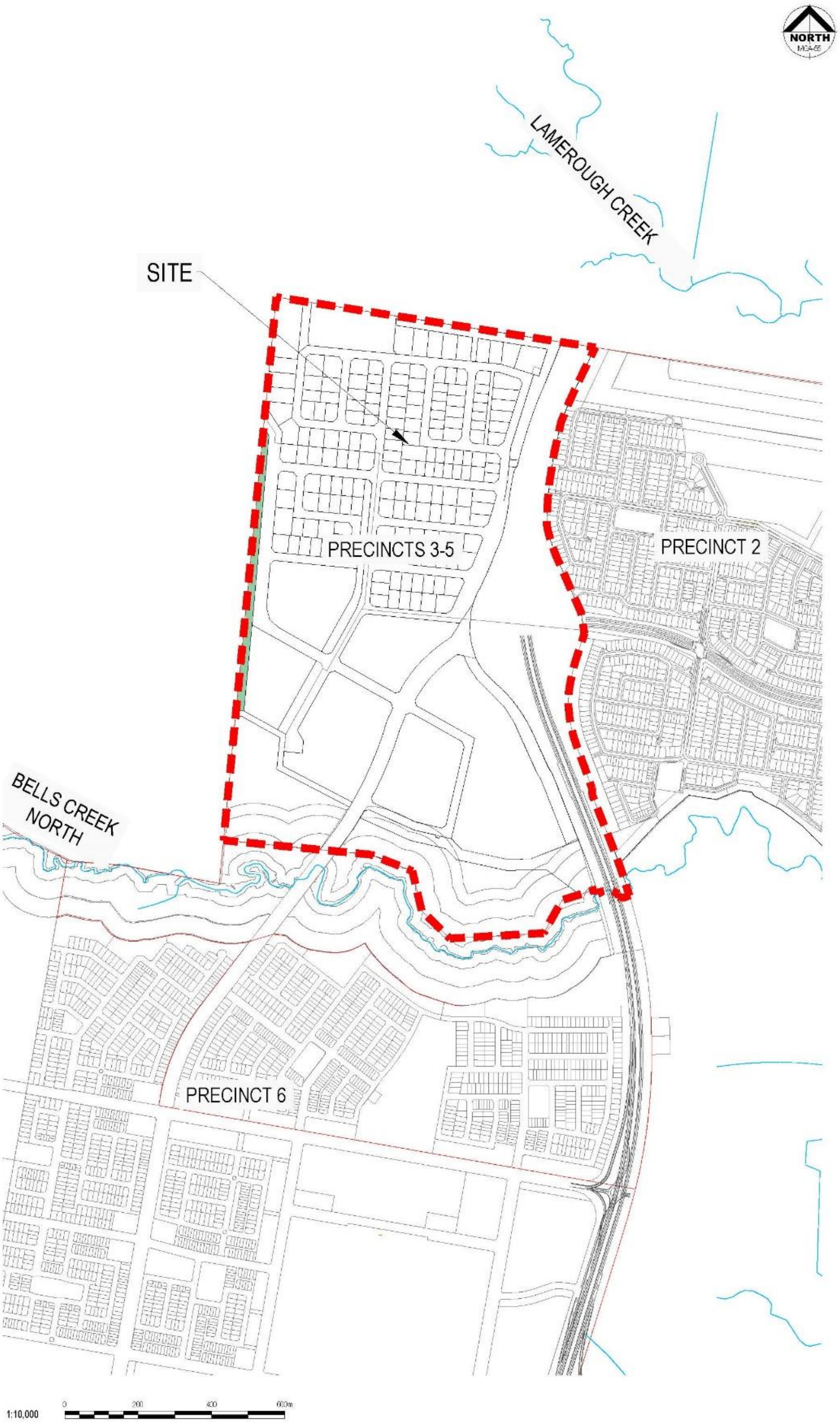

Figure 1 Aura Precincts 3-5 Location

Figure 2 Aura Precincts 3-5 Development

2 Site Characteristics

The description of the site presented here relates to elements that affect the stormwater quality management strategy for Precincts 3-5. More thorough site descriptions of soils, geology, climate, vegetation and habitats are not replicated as these are covered in other reports relating to the site.

2.1 Current land use

Precincts 3-5 cover approximately 135 hectares of predominantly cleared grazing land. The area is bordered by Bells Creek North to the south, Precinct 2 to the east, Lamerough Creek to the north and bushland and pine forest to the west (Figure 3).

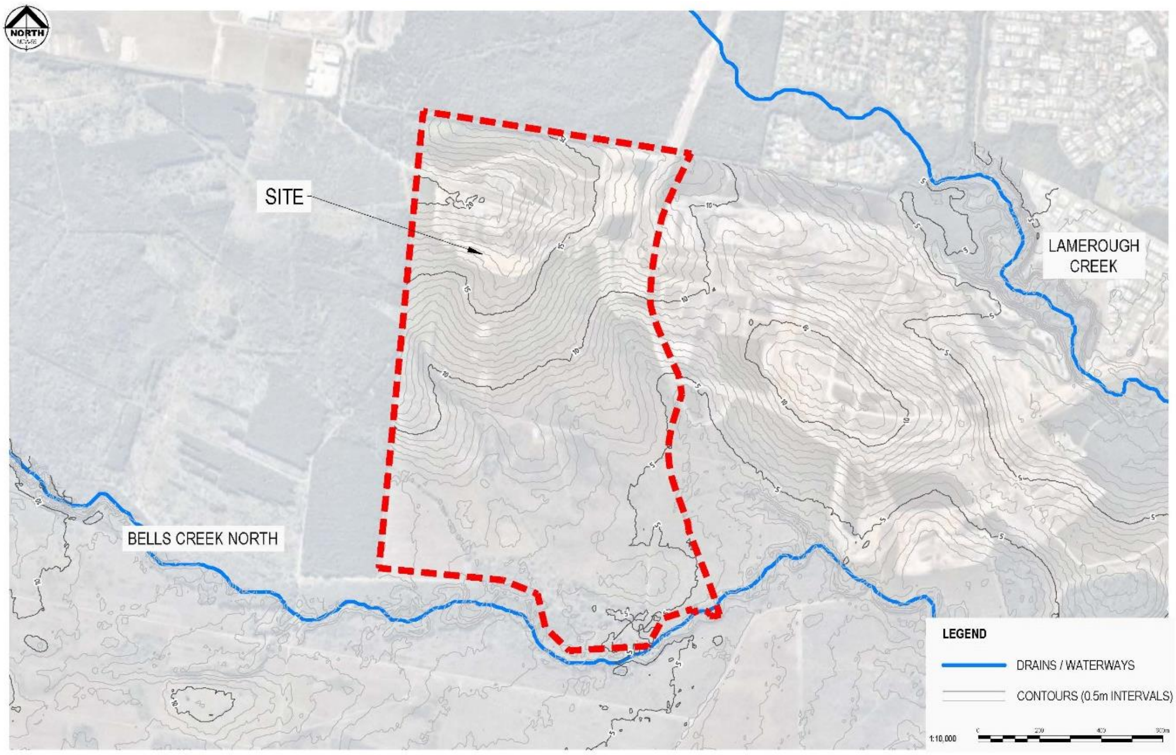

Figure 3 Existing land use, topography and drainage

2.2 Topography and drainage

The majority of the site (~90%) slopes generally from north to south into Bells Creek North. Approximately 10% of the area drains northwards and flows into Lamerough Creek.

The site generally has mild grades (from approximately RL 20m AHD in the north to 5m AHD in the south). The mild grades offer some potential to redirect flows across catchments where it suits the overall stormwater management approach.

Bells Creek North has water levels of approximately RL 6m AHD at the western edge and RL 3.5m AHD at the eastern edge of the development area. These levels are a critical consideration when establishing the stormwater network layout and operation of treatment devices discharging into Bells Creek North.

Using this information in the development of the stormwater treatment strategy a catchment plan was developed.

2.3 Bells Creek North

Bells Creek North (a tributary of Bells Creek) is a healthy waterway which supports a range of wetland and riparian flora and fauna (see photo below). The condition of the creek, including water quality, has been extensively monitored and presented in other reports and is not covered here.

The total catchment of Bells Creek including the Aura development is 4,630ha . Precinct 3-5 form approximately 125ha of this catchment with commercial, industrial and road land uses (this represents 2.7% of the total Bells Creek catchment). The context of Precincts 3-5 in the wider Bells Creek catchment is shown in Figure 4.

Protection of Bells Creek and the downstream Pumicestone Passage are a critical component of the Aura development and stormwater runoff from the whole area is required to meet a general "no worsening" water quality concentration condition in Pumicestone Passage . This is discussed further with regard to the stormwater treatment objectives (Section 3).

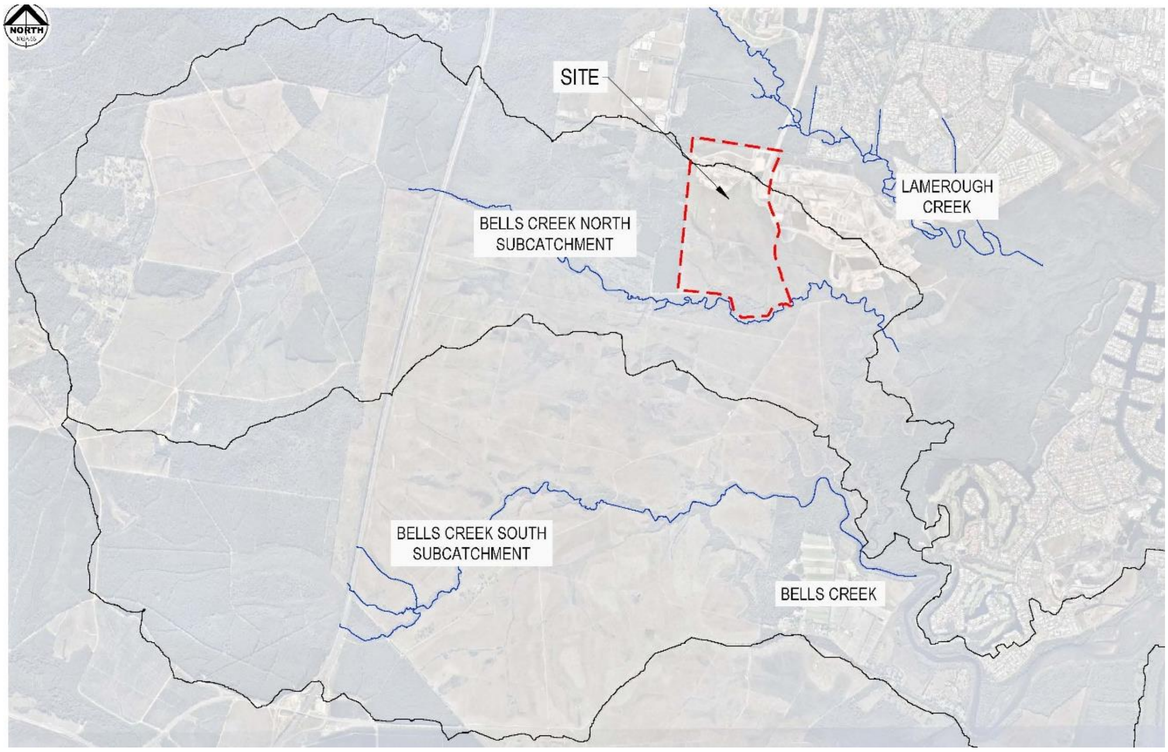

Figure 4 Bells Creek Catchment

2.4 Frog habitat

Frog habitat has been identified across the Aura development for the following frogs which have federal or state significance:

- Wallum Sedgefrog
- Wallum Froglet
- Wallum Rocket Frog.

Management of the Wallum Sedgefrog is to occur in accordance with the approved *Caloundra South Wallum Sedge Frog Management Plan*. Some Sedgefrog habitat areas within the development footprint will be removed and compensatory Sedgefrog habitat areas recreated within the Aura development site (typically within frog zones and buffers as per Section 2.5).

The Wallum Froglet and Wallum Rocket Frog will be managed in accordance with the *Caloundra South Acid Frog Management Plan*, the requirements of which are very similar to the Wallum Sedgefrog outlined above.

2.5 Waterway and frog buffers

To preserve and enhance the riparian function of Bells Creek and meet the requirements of the *Caloundra South Wallum Sedge Frog Management Plan* and *Caloundra South Acid Frog Management Plan*, the development edges in Precincts 3-5 are required to incorporate the following:

- 25m wide riparian buffers from top of waterway banks (for preservation and rehabilitation of riparian vegetation)
- 50m width Frog Zone (for creation of Wallum Frog habitat)
- 50m Frog Buffer (buffer to the Frog Zone and additional space for creation of Wallum Frog Habitat).

The Frog Buffer can incorporate some stormwater management as per *Caloundra South Wallum Sedge Frog Management Plan* and details of permitted encroachment into the frog buffer is described in Section 5.3.4.

3 Stormwater Quality Objectives

3.1 Bells Creek Catchment

The majority of Precinct 3-5 drains to Bells Creek. There are several fundamental drivers for managing stormwater quality from Aura.

The adjacent sections of Pumicestone Passage which receive runoff from the site have been defined as having High Ecological Value (HEV) status in the *Environmental Protection Policy (EPP) – Water* (2009). Water quality objectives that accompany HEV status are of the nature of 'no worsening', but more specifically are quantified as maintaining existing water quality (20th, 50th and 80th percentiles) in the receiving waterway (Department of Environment and Heritage Protection).

Pumicestone Passage and the estuarine sections of Bells Creek have also been defined as having Ramsar wetland status. The associated significance criteria which accompany this designation include:

- Areas of the wetland being destroyed or substantially modified
- A substantial and measurable change in the hydrological regime of the wetland (e.g. volume, timing, duration and frequency of surface and groundwater flows)
- The habitat or lifecycle of native species being seriously affected
- A substantial and measurable change in the water quality of the wetland that may adversely impact on biodiversity, ecological integrity, social amenity or human health
- An invasive species that is harmful to the ecological character of the wetland becoming established, or an existing invasive species spreading.

With such significant high value environmental areas downstream of Aura, considerable investigation and planning has gone into protecting these areas from the impacts of urbanisation as outlined in a range of previous reports (not reproduced here). These reports have attempted to establish load base stormwater quality design objectives which will ensure the 'no worsening' receiving water quality requirement is achieved.

Objectives that are applied to Precincts 3-5 are based on recent catchment and waterway modelling completed for the Bells Creek catchment and Aura development site presented in *Aura Development Stormwater Quality Management Plan* (DesignFlow & BMT, 2019). The stormwater load based reduction targets are presented in Table 1. These exceed *State Planning Policy* requirements, reflecting the significance of the receiving waters. These objectives apply to stormwater runoff from development areas or landuses only and exclude excludes waterway and frog buffers, Environmental Protection Zone, undeveloped areas and stormwater treatment systems, which do not required stormwater treatment.

Table 1: Stormwater quality design objectives – Bells Creek Catchment

Pollutant	Objective - Minimum reduction in mean annual load from unmitigated development area[1]
Total Suspended Solids	95%
Total Phosphorus	89%
Total Nitrogen	68%
Gross Pollutants	90%

3.2 Lamerough Creek Catchment

The far northern part of Precincts 3-5 drains to Lamerough Creek. For this portion of the development the State Planning Policy, and relevant objectives in the Sunshine Coast City Plan, have been applied as per Table 2.

Table 2: Stormwater quality design objectives – Lamerough Creek Catchment

Pollutant	Objective - Minimum reduction in mean annual load from unmitigated development area
Total Suspended Solids	80%
Total Phosphorus	60%
Total Nitrogen	45%
Gross Pollutants	90%

[1] Objectives apply to development areas. This excludes waterway and frog buffers, Environmental Protection Zone, undeveloped areas and stormwater treatment systems.

4 Stormwater Quality Management Strategy

This section provides an overview of the stormwater design philosophy and describes the treatment systems proposed for Precincts 3-5.

4.1 Design principles

To develop a robust stormwater treatment strategy, a number of principles were applied for managing stormwater quality. These include:

1. Flexibility – The stormwater treatment strategy will have flexibility and redundancy to allow adjustment in response to site constraints and issues identified as part of future design. This allows the design to be modified during detailed design if an unforeseen constraint is identified.
2. Avoid double treating – As much as practically possible, stormwater that has been "treated" in a wetland or bioretention system should not flow into a downstream treatment, but rather be discharged to the receiving waterway.
3. Identify end-of-line treatment opportunities – Explore all "end-of-pipe" treatment systems initially. Treatment systems are located along the southern perimeter of the development and need to work within the constraints of areas for frog habitat, buffer and existing Bells Creek North levels. This approach reduces the number of treatment devices needing maintenance and increases opportunities for adaptive management.
4. At-source treatments – Tanks are to be provided on all lows for water conservation and gross pollutant traps to manage litter from the industrial/commercial landuses. At-source biopods (bioretention) are proposed for the northern catchment only where end-of-line treatment is not feasible due to space and level constraints.
5. Frogs – Ensure the requirements of the *Caloundra South Wallum Sedge Frog Management Plan* and *Caloundra South Acid Frog Management Plan* are achieved.
6. Match catchments, levels and drainage to end-of line treatments– Consideration of slopes and drainage requirements resulted in a portion of the northern part of the area to be directed to Lamerough Creek with the remainder flowing to Bells Creek North. Capacity restrictions prevent high flows being directed to Lamerough Creek, therefore, the conveyance network accounts for the northern area high flows being directed to Bells Creek North.

4.2 Stormwater treatment strategy

A concept layout for the stormwater treatment strategy for Precincts 3-5 is presented in Figure 5. It shows how stormwater is directed to the two receiving waters (Lamerough Creek and Bells Creek North) and the interactions of biopods (Lamerough Creek only), swales, wetlands and bioretention with flows, overflows and treated water.

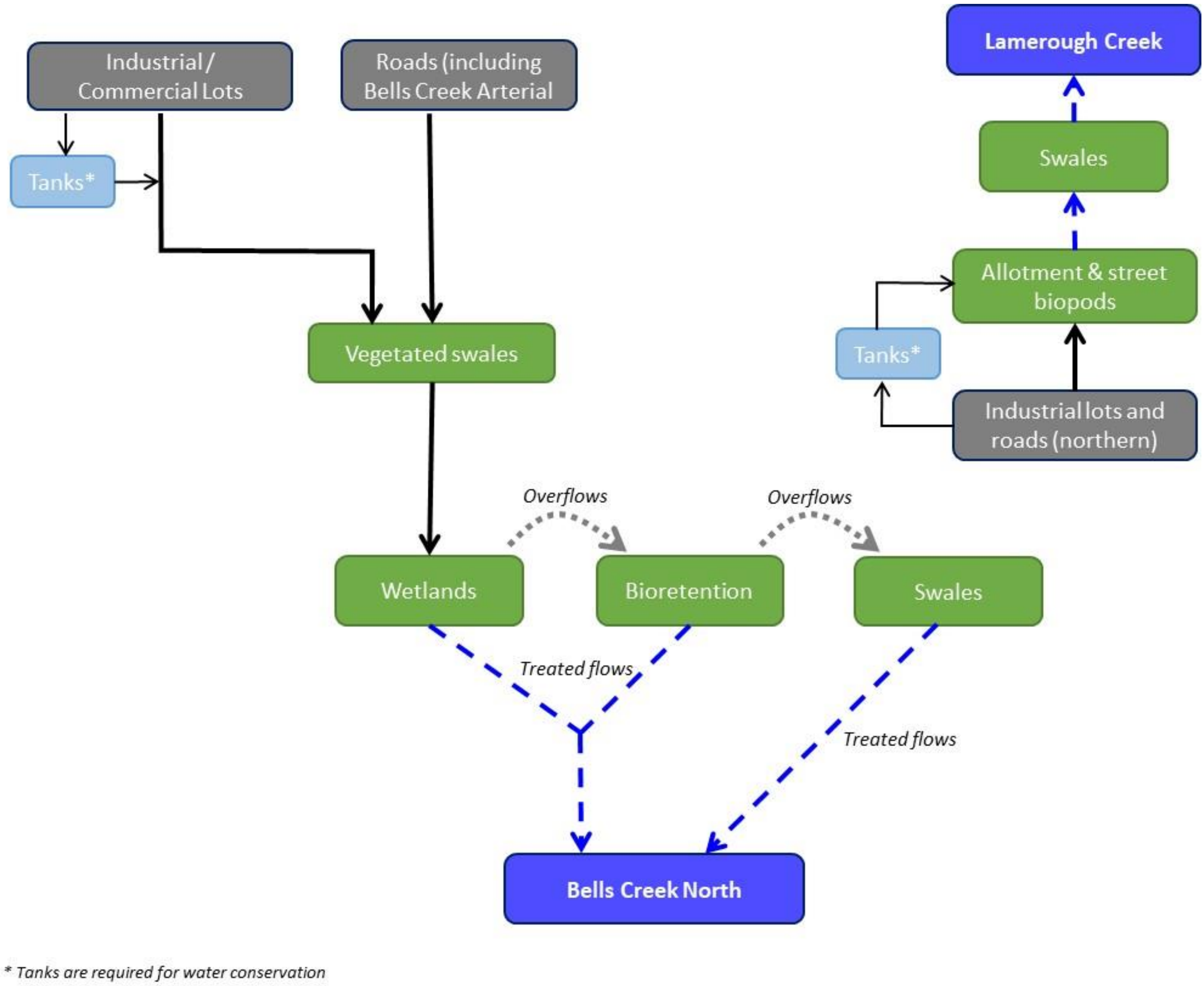

Figure 5 Stormwater treatment train flow diagram

The strategy adopts a similar approach to that taken in previous precincts of Aura. The same suite of stormwater treatment measures are used (i.e. rainwater tanks, biopods, end-of-line bioretention and wetland systems and vegetated swales in various forms). For Precincts 3-5, the treatment measures have been applied responding to proposed land uses and the constraints of the site while providing flexibility to achieve the stormwater quality objectives.

Important aspects of the treatment strategy are:

1. **Tanks** are included in the strategy and will provide a water conservation function. To be conservative in the assessment of stormwater loads for Precinct 3-5, the stormwater quality benefits of tanks have not been included in the MUSIC modelling and sizing of the stormwater treatment systems. This results in slightly oversized stormwater treatment systems thus ensuring resilience in the stormwater treatment strategy should the water demands on tanks be less than anticipated (refer to Section 6).
2. **Biopods in the Northern Catchment** are required to treat all stormwater runoff from the allotments and roads. These are to be sized at 1.35% of the allotment or road catchment. The allotment bipods will be privately owned and the road bipods will he Council owned.
3. **Vegetated swales** throughout the development will convey the majority of runoff southwards and direct flows into the end-of-line treatment systems adjacent to Bells Creek North.
4. **End-of-line treatment systems** (i.e. combined sediment basins, wetlands and bioretention systems have been sized to achieve the stormwater quality objectives in combination with upstream swales. Based on concept layouts (Section 5) there is suitable space having given consideration to other land requirements (e.g. frog zones).

Figure 6 presents the proposed catchment areas draining to the treatments and Figure 7 shows a summary of the overall treatment strategy, including the location and sizes of the end-of line treatment systems at the southern edge of the development layout. The exact location for biopods (for allotments and roads in Lamerough Creek catchment) is subject to detailed design. Design principles for biopods are described in Section 5.

Table 3 presents catchment and treatment size details for the proposed treatment systems.

Note:

- The sizes nominated in Table 3 for treatment areas are the wet areas of wetlands (i.e. normal water level) and the filter area surfaces of bioretention basins. They do not include land for required batters, access tracks etc. Total land requirements have been considered carefully when developing the concept layouts and are included in those diagrams (Section 5.4).
- The end-of-line treatment systems include a <u>safety factor</u> in the design given the industrial and commercial landuse in precinct 3-5 and the associated risk to Bells Creek. The sensitivity testing completed in MUSIC illustrates the bioretention filter media area can be reduced (due to blockage or other failure) by 30% and still achieve the stormwater quality objectives.

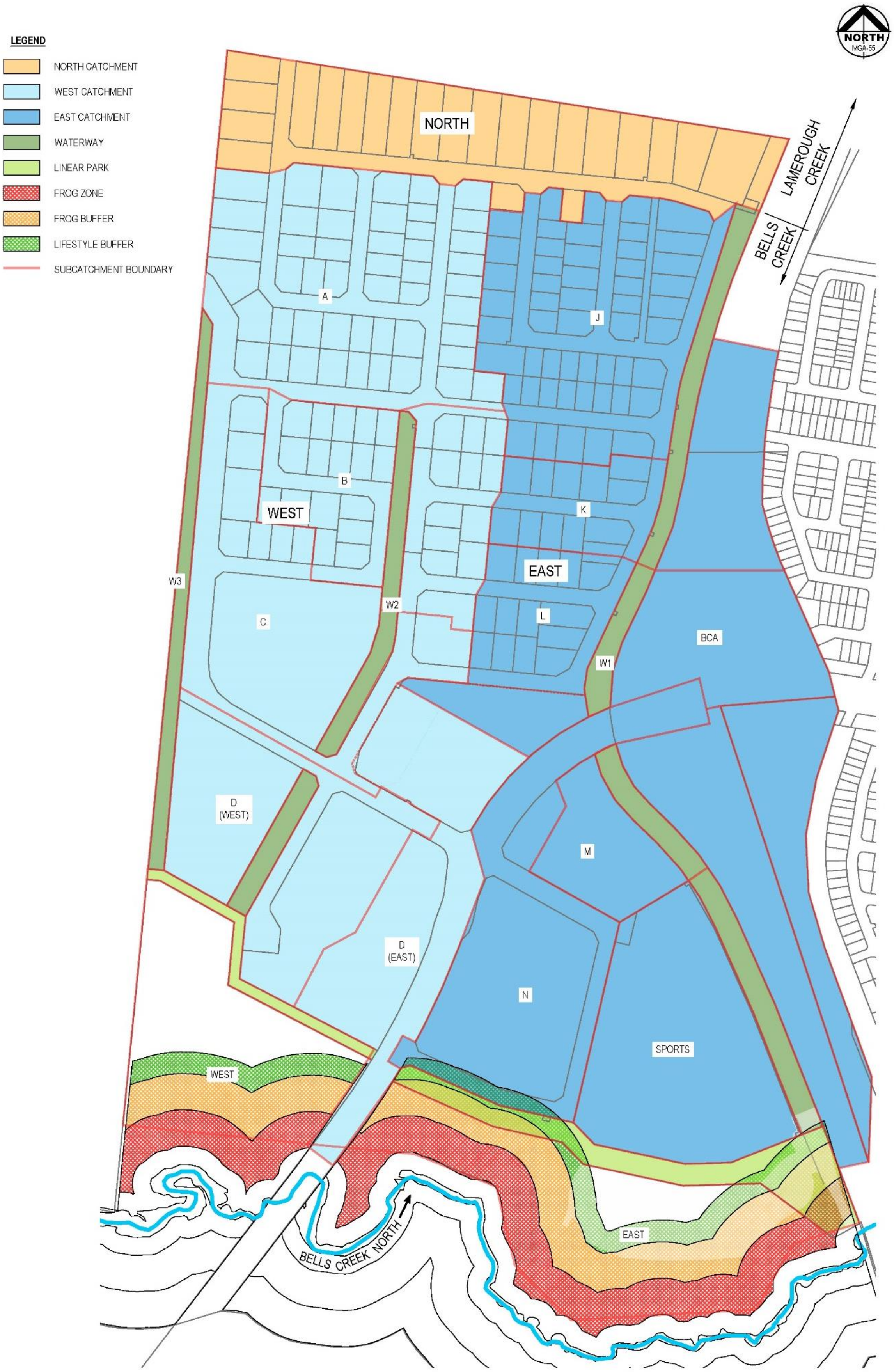

Figure 6 Proposed catchments for treatment in precincts 3-5

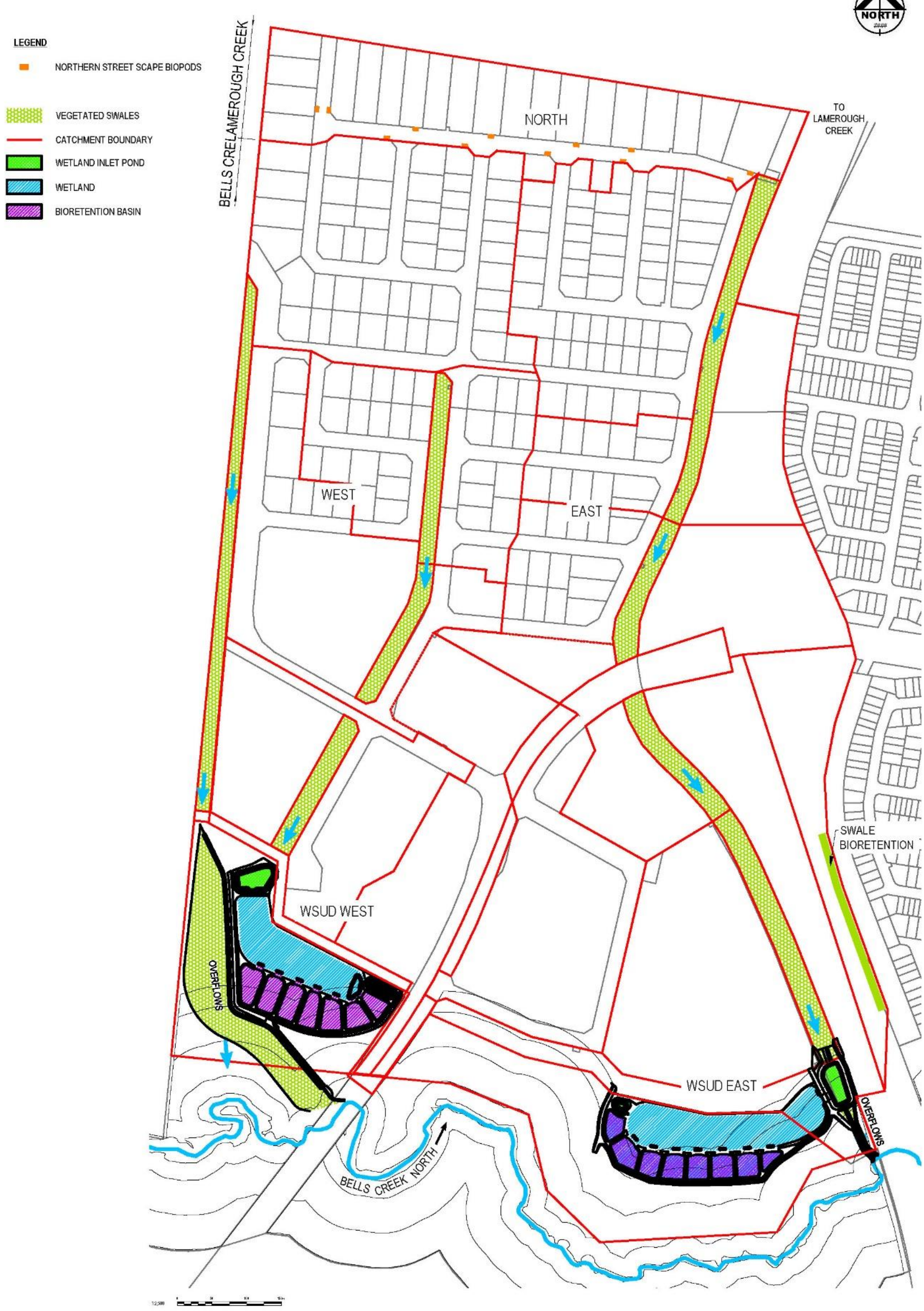

Figure 7 Summary of the stormwater treatment strategy for Precincts 3-5

Refer to Figure 6 for the location of specific catchments within Precincts 3-5.

Table 3 Stormwater catchments and treatment system areas for Precincts 3-5

CATCHMENT ID	Area ha	Allotment biopods m^2	Street biopods m^2	Wetland inlet pond m^3	Wetland m^2	Bioretention basin m^2
WEST CATCHMENT						
A - industrial	12.23					
B - industrial	7.14					
C - industrial	8.82					
C - commercial	1.40					
D -industrial	10.53					
D - commercial	1.75					
Linear park	0.67					
Road (Aura Bde)	1.76					
Swale	3.74					
Buffers and WSUD	6.99					
TOTAL - WEST	**55.03**			**2,596**	**11,400**	**8,086**
EAST CATCHMENT						
J - industrial	10.11					
K - industrial	2.85					
L - industrial	3.48					
L - commercial	1.35					
M - commercial	3.48					
N - commercial	6.08					
Road (BCA, Aura Bde)	18.87					700#
SPORTS	7.74					
Linear park	1.83					
Swale	4.14					
Buffers and WSUD	9.9					
TOTAL EAST	**69.83**			**2,400**	**14,800**	**7,700**
NORTH CATCHMENT						
North - industrial	9.59	540	239			
TOTAL NORTH	**9.59**	**540**	**239**			
TOTAL P3-5	**134.5**					

 # Bioswale on east side of BCA

4.3 Summary of proposed stormwater treatment measures

The table below briefly describes the stormwater treatments measures adopted for Precincts 3-5. Many have been applied to other precincts of the Aura development.

Table 4 Summary of Stormwater Treatment Measures for Precincts 3-5

Measure	Description
Education and Awareness	Education of stormwater management approaches at Aura will be built into community communication through signs, kerb messages and other media. While education can play a role in reducing pollutants reaching waterways, the benefits of education on reduced pollutant loads have not been included in the MUSIC modelling assessment.
Rainwater Tanks	As part of Stockland's water conservation policy rainwater tanks accepting runoff from at least 50% of roof areas are proposed for all properties. Tanks are to be sized at 1.0KL per toilet or urinal with a minimum 5 KL size, and water from the tanks is to be plumbed to indoor non-potable and outdoor uses. While the tanks serve an important water conservation role they also contribute to reducing stormwater pollutant export. However, given the high variability in tank demand for commercial and industrial land uses, tanks have not been included in the MUSIC modelling of the stormwater pollutant reduction (Section 6).
Biopods (Streetscape raingardens) Lamerough Creek Catchment Only	Biopods (referred to as streetscape raingardens in previous stormwater strategies) have formed an important part of the stormwater strategy for the Aura site and have been implemented as part of earlier Precincts including Bells Reach and Precinct 2. The systems work by receiving runoff from the kerb in set down areas in the road verge. Stormwater then percolates through a vegetated soil matrix that promotes fine filtration and biological uptake of pollutants. Treated water is collected at the base and discharged into the stormwater system. The street biopods are assumed to have 200mm ponding depth. Biopods are proposed for the roads in the northern catchment of Precincts 3-5 that drain to Lamerough Creek, sized at 1.35% of their catchments.
Biopods (allotment raingardens) Lamerough Creek Catchment Only	Biopods are proposed for the allotments in the northern catchment which drains to Lamerough Creek as indicated in Figure 7. The systems work by the ground levels of the lots to be formed to direct all runoff to biopods. Stormwater then spreads over the biopod surface and is allowed to pond by up to 200mm before percolating through a vegetated soil matrix. The biopods are sized to be 1.35% of the whole lot and pond up to 200mm. Biopods will provide effective capture of gross pollutants (i.e. litter), sediment and nutrients and also any oil that may be in stormwater runoff (very low risk of oil contamination and biopods will manage).
Gross pollutant management	Where allotments do not have biopods, then gross pollutant management will be provided on the allotment for all ground level runoff to remove litter and other gross pollutants prior to discharge from the allotment. No specific oil management is required because the risk of oil is very low and suitable treatment of oil will be provided in the end-of-line wetland and bioretention systems. The design of high risk landuses such as service stations must occur in accordance with Council and State Government policy. Structural separation (installation of bunds and rooves/canopies) of high pollutant generating operations, such has fuel bowsers and car wash areas on the lot, must be adopted to effectively exclude these areas from stormwater runoff.

Measure	Description
Constructed Wetlands	Two constructed wetlands are proposed at southern perimeter of Precincts 3-5. The wetlands will receive flows from vegetated swales, hold water for treatment for approximately 3 days with overflows being transferred to adjacent bioretention basins. Constructed wetland systems are shallow extensively vegetated water bodies that use enhanced sedimentation, fine filtration and pollutant uptake processes to remove pollutants from stormwater. Water levels rise during rainfall events (by up to 350mm) and outlets are configured to slowly release flows, typically over two to three days, back to dry weather water levels. Wetlands consist of an inlet zone (sediment basin to remove coarse sediments), a macrophyte zone (a shallow heavily vegetated area to remove fine particulates and facilitate the uptake of soluble pollutants) and a high flow bypass (to protect the macrophyte zone). The proposed operation of the wetlands and interaction with the subsequent bioretention basins is described in Section 5. Treated flows from the wetlands will be discharged to Bells Creek North. Overflows from the wetland will enter bioretention basins located immediately around the wetland perimeter to receive further treatment. During large events, overflows from the inlet pond will drain via overflow swales to Bells Creek North. The wetlands will all be designed in accordance with the WSUD Technical Design Guidelines for SEQ (Water by Design).
Bioretention Basins	Bioretention basins are proposed to receive stormwater that overflows from the wetlands at the southern edge of Precincts 3-5. There are a number of advantages in considering the bioretention systems in this manner: • bioretention systems accept untreated stormwater thus avoiding double treating stormwater • bioretention systems do not receive regular "trickle' flows (that can cause algal growth and block their surface) • allows the bioretention basins to be positioned higher than the wetland normal water level. This approach minimises the head required to operate the wetland and bioretention treatment combination and thus reduces the level the development pad is required to be lifted to enable free draining to and from the treatment systems. Treated flow that collects in the underdrainage pipes will combine with treated water from the wetlands and discharge into Bells Creek North (or be diverted for harvesting). Design of the bioretention systems will occur in accordance with Bioretention Technical Design Guideline (Water by Design).
Overflow Swales	Overflows (i.e. high flow bypass flows) from the wetland and bioretention systems will be directed to wide shallow vegetated areas that will convey flows to Bells Creek North. The areas will act to filter the overflows and slow flows down before entering the creek. The systems will essentially act like occasional flowing wide swales.

5 Design Principles

5.1 Rainwater Tanks

Rainwater tanks are an important part of Stockland's water conservation and stormwater management strategy for Aura. Table 5 summaries the proposed tank approach for Precincts 3-5 which is consistent with the tank approach outlined in *Aura Development Stormwater Quality Management Plan* (DesignFlow & BMT, 2019). These have been written into the Plan of Development for Precincts 3-5 to ensure compliance with this Stormwater Quality Management Plan.

Table 5: Rainwater tank approach for Precinct 11-14

Landuse	Roof Area	Tank size (minimum)	Tank Connections / Fixtures / Uses
All non-residential uses including but not limited to: • Commercial • Retail • Industrial • School • Community	50% roof <u>must</u> connect / drain to tank If multiple buildings then 50% of total roof area must connect / drain to tank	1KL per toilet or urinal or 25kL/ha Minimum 5 KL size	Tanks <u>must</u> be connected to and supply water to all non-potable uses and fixtures including but not limited to: • Toilets (all toilets) • Urinals (all urinals) • Laundry cold (all taps in laundry) • Outdoor taps (all outdoor taps)

5.2 Biopod Design Principles (Lamerough Creek Catchment)

Biopods are to be used in the following locations and with the nominated sizes and average ponding depths across Precincts 3-5 (refer to Figure 7 and Table 3):

1. Allotments in the northern catchment (1.35% of the allotment area – 200mm average ponding depth)
2. Roads in the northern catchment (1.35% of the contributing catchment – 200mm ponding depth)

The detailed design for each biopod will be developed during further stages of design. Stockland has extensive experience on other Precincts of Aura in delivering biopods in different locations. While the particular aspects of the biopods will differ between the locations (e.g. in a car park compared to within an allotment) the operating principles are all similar and council's requirements will be accommodated.

Important design considerations will include:

- Biopod filter media minimum width of 1.0m
- Batters of 1 in 2 or flatter
- Consider one-way cross-fall pavement for streets
- Locate biopods to avoid driveways and parking areas
- No conflict with services other than sewer which may pass under a biopod, with correct protection.
- Avoid interaction of pedestrians and trip hazards with the bipods as much as possible.

* Where possible moving pedestrian pathways and non-compatible services to the opposite verge from the biopod to create space where required.
* Where it is not possible to pedestrian pathways away from biopods, small vertical walls may be adopted in accordance with *Bioretention Technical Design Guideline* (Water by Design, 2014). In this case suitable balustrade will be installed to minimize hazards of pedestrians or bicycle riders falling into basin.

There are many variations of biopod designs but the proposal for Precincts 3-5 will be to create systems similar to other areas of Aura so that maintenance can be streamlined. Some examples in the photos below show variations in biopod type.

Photo: Linear Car Park Biopod

Photo: Biopods at end of parking bays

Photo: Example of biopod (Aura Precinct 2)

5.3 Wetland and Bioretention System Design

Designs for the end-of-line treatment systems (i.e. constructed wetlands, bioretention basins and overflow swales) involved a number of steps:

1. Resolving the function of the treatment systems (i.e. how they interact hydraulically to maximize treatment performance)
2. Identifying available space for treatment adjacent to Bells Creek North and accommodating the required buffers
3. Ensuring there is sufficient space for the contributing catchments
4. Completing MUSIC modelling to confirm treatment performance
5. Completing survey of creek levels (top of bank and standing water level)
6. Defining operating levels in the wetlands and bioretention systems (using discharge levels into the creek)
7. Optimising the swale levels and associated earthworks in the development.

The following sections summarise the considerations and findings of this process.

5.3.1 Treatment system operation

The wetland and bioretention treatment systems receive flows for the swales running southwards in the development (Figure 7). As flow enters the treatment systems it follows the sequence below (refer to Figure 8):

- Inlet pond - Flows from the swales enter an inlet pond where coarse sediment will settle out and low flows will pass via a pit/pipe system to the wetland.
- Wetland - Flows enter the macrophyte zone of a wetland for treatment. The wetland will treat base flows and small storm events with treated flows discharged to Bells Creek North. Wetlands will typically have a 48-72hr notional detention time (in this case we have adopted 72hr notional detention time) and a maximum depth of 350mm above normal water level (when bioretention is fully engaged) which will drain back to 50-100mm depth quickly.
- Bioretention – During rainfall events, the wetlands begin to fill and as water levels increase by more than 50mm they will overtop weirs into adjacent bioretention basins. As flow increases water ponds over the bioretention by up to 300mm. The ponded water is combined with that over the wetland. As a storm ends, water then flows through the bioretention media (the majority) and through the wetland outlet. Treated flows from the bioretention basins will be discharged to Bells Creek North.
  The bioretention basins are divided into "cells" to provide management flexibility, promote better flow spreading and allow easier construction and maintenance).
- Overflow swales – The vast majority of stormwater will pass through the wetland and bioretention system to achieve the performance objectives listed in Section 3. Large storm events will overflow a weir in the inlet pond and pass through an overflow swale which will be vegetated. The swale will promote sedimentation and filtration of sediment and particulate phosphorus and discharge large flow events to the creek.

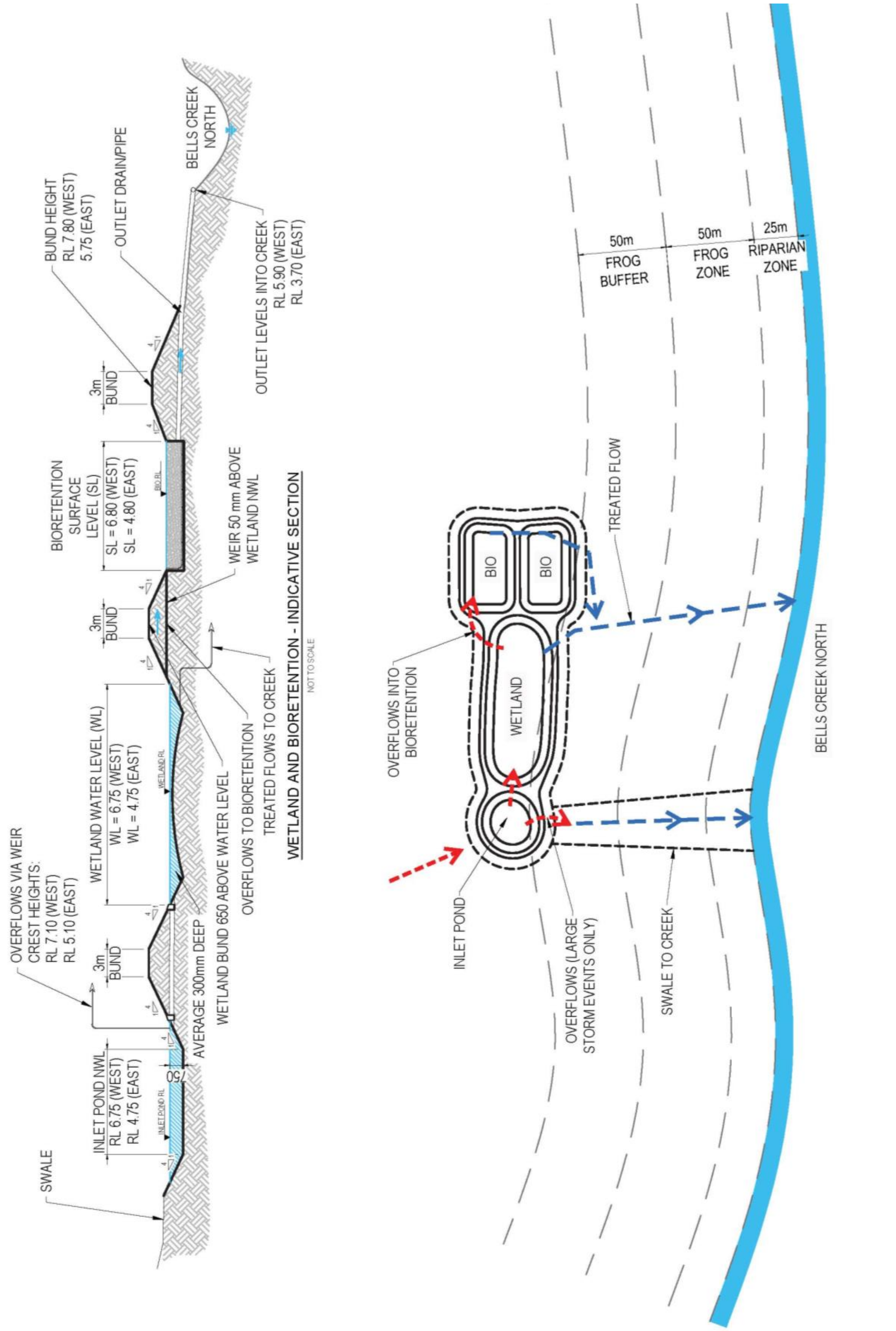

Figure 8 Function and operating levels wetland and bioretention treatment systems

5.3.2 Operating levels

A critical consideration of the end-of-line treatment systems is the operating levels and how the systems will discharge into Bells Creek North. Figure 8 provides a conceptual cross section through the wetlands and bioretention systems to illustrate how water will move through the systems and drain freely into the adjacent creek.

It shows there is 1-2-1.5m between the outfall levels in the creek to the swale invert entering the wetlands. Survey of the creek standing water level and top of bank was completed as part of the conceptual design to define outfall levels, which have been set above the standing water and low flow levels in the creek.

5.3.3 Location and size

The end-of-line wetlands and bioretention systems have been carefully located considering the constraints including:

- Existing Wallum Sedgefrog habitat (no stormwater management allowed)
- Riparian buffer of 25m (no stormwater management allowed)
- Frog zone of 50m (no stormwater management allowed)
- Frog buffer of 50m (stormwater management allowed) following appropriate criteria (Section 5.3.4)
- Existing vegetation
- Existing drainage
- Parkland, following appropriate criteria (Section 5.3.5)
- Suitable discharge points for treated stormwater.

Sufficient space for the treatment areas as well as batters and access tracks etc. have been provided. In addition, consideration of flood levels of Bells Creek North and requirements for pedestrian paths have influenced their proposed locations.

5.3.4 Frog buffer considerations

Stormwater treatment systems are located in parts of the frog buffer ensuring the following criteria are met (developed in consultation with Australian Wetlands Consulting):

1. No more than 40% of the Frog Buffer can be used for stormwater management devices, including drainage channels. Stormwater management devices must be placed uniformly along the length of the Frog Buffer to ensure no restriction to the overall connectivity of Wallum Sedgefrog (WSF) habitat within the Frog Zone and Frog Buffer.
2. Where stormwater management is located within the Frog Buffer, an average minimum set back of 20m is required between all the edges of each stormwater management measure and the Frog Zone boundary. This set back distance does not apply to stormwater outlet drainage channels.
3. The final locations of the stormwater management devices will be determined during detailed design. The location will consider the proposed WSF breeding ponds, foraging habitat and overall habitat connectivity to ensure compliance with Key Performance Criteria 5, listed in Table 6.2a within the *Wallum Sedgefrog Management Plan* and Table 8.2a within the *Acid Frog Management Plan*.

5.3.5 Parklands considerations

Stormwater treatment systems have been placed in parklands in accordance with the *Caloundra South Infrastructure Agreement*:

1. Land provided for stormwater treatment facilities for the park are to have a minimal impact on the park's functionality.
2. Max. 5% of total park area for stormwater treatment
3. Where possible, stormwater treatment facilities are to be integrated with planting areas and form part of the overall vegetated area.
4. 30% of the parkland area can be below the 5yr ARI
5. Max grade 1:4, 1:6 preferred for maintenance requirements.

5.4 End-of-line concept designs

Proposed sizes, shapes and configurations for wetland and bioretention systems were resolved by considering available areas for the treatment systems, catchments, required treatment areas and surveyed outfall levels. The operational principles as shown in Figure 8 were applied to develop the concepts.

Figure 9 (west) and Figure 10 (east) show the concepts for the two end-of-line systems. They show sizes, shapes, earthworks and levels for each system. They demonstrate how the proposed system can feasibly fit within the available space and operate hydraulically with the levels of the area and Bells Creek North.

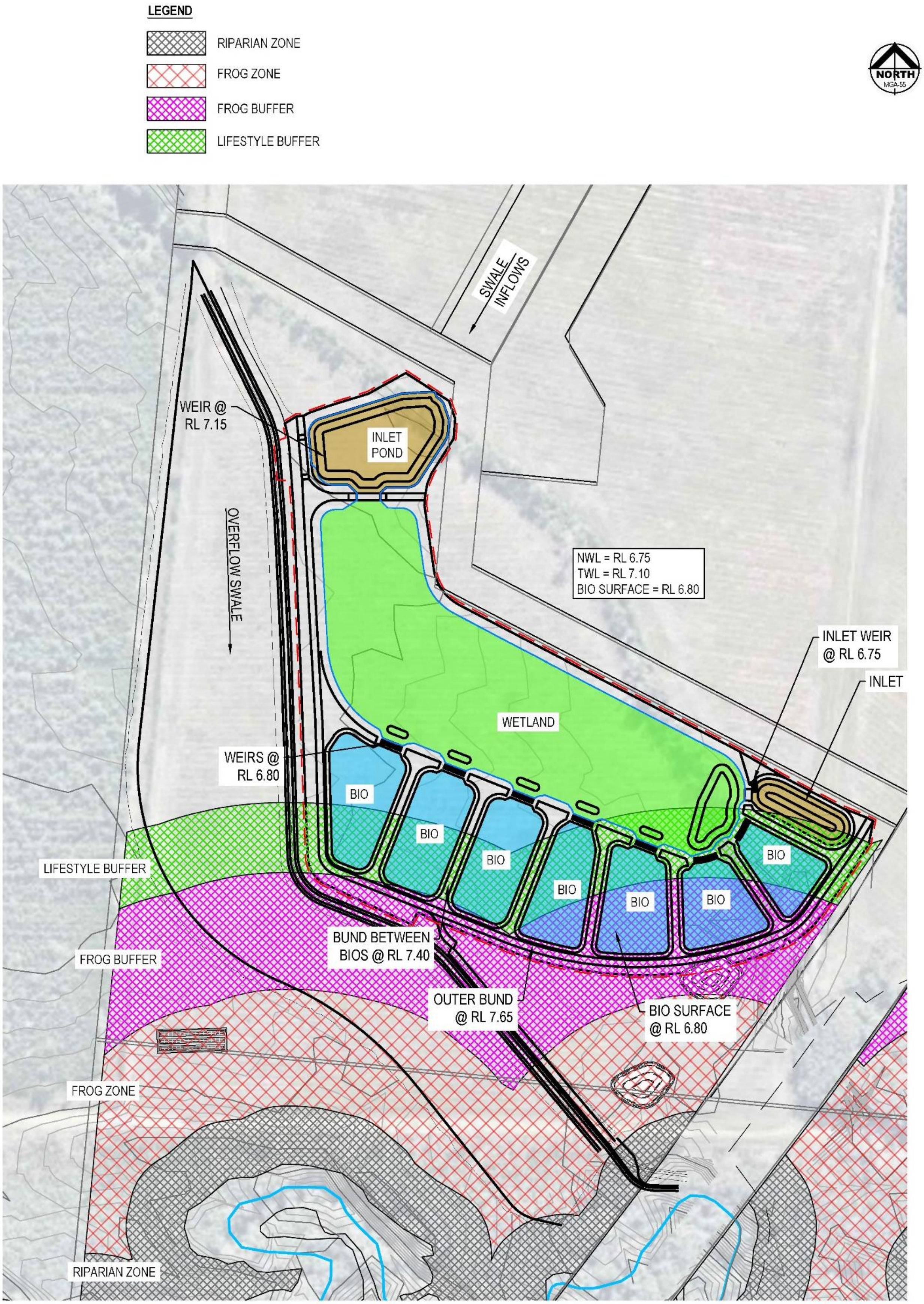

Figure 9 Western end-of-line treatment system concept

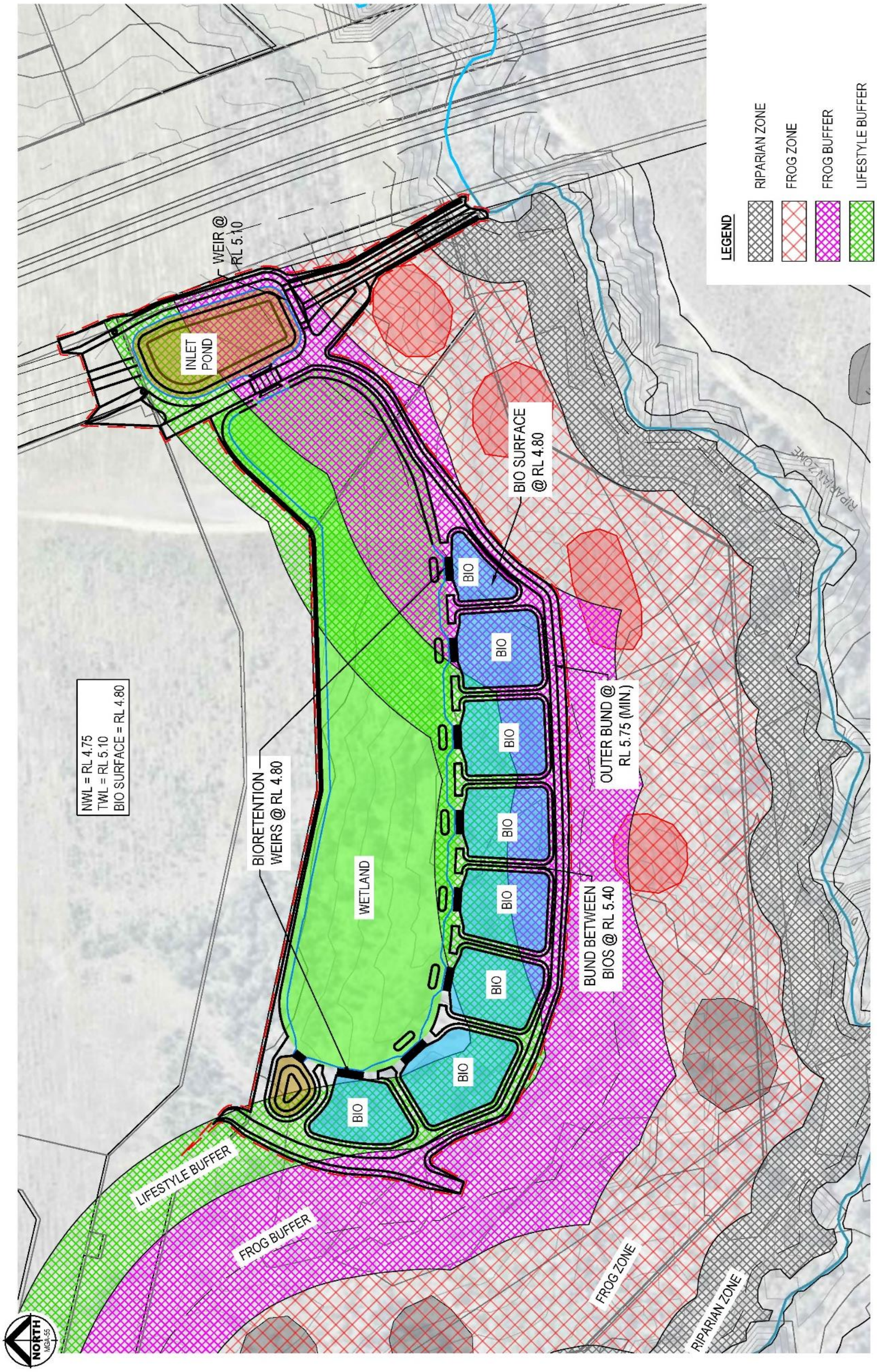

Figure 10 Eastern end-of-line treatment system concept

5.5 Stormwater harvesting for the sports field

The eastern treatment system is located adjacent to proposed sports fields. An opportunity to use a stormwater harvesting scheme to supply irrigation was identified. This will need to be worked through with Council further and is presented here as an opportunity only (i.e. it is not relied upon to meet required stormwater treatment targets).

The system would direct treated water from the eastern treatment system (from both wetlands and bioretention systems) to a storage tank for subsequent reuse.

The tank (most likely to be located underground) would then be used to supply irrigation water following some additional disinfection. The location of the infrastructure will be confirmed during if the scheme proceeds and required components would be:

- Pumping station to transfer treated water to a storage tank (including pump, power and control systems) – e.g. 10 L/s pump rate
- Pipe connection to the storage tank
- Storage tank (most likely underground) – approximately 800m^3 of storage
- Irrigation pump station (including filter, disinfection (e.g. UV), pump, power, controls and mains water back up)
- Dedicated irrigation supply pipes (with back-flow prevention to mains water supply).

The harvesting system will meet approximately two thirds of the sports field irrigation demand of 40 ML/year.

This is a conservative irrigation demand because it is assumed the sports fields will be of high quality and therefore require considerable irrigation (e.g. 800mm/year).

To pursue this opportunity, Stockland have committed to working with Council to develop a business case for the harvesting scheme and provide other details to enable council to assess its merits.

6 Performance Assessment (MUSIC modelling)

6.1 MUSIC modelling approach

MUSIC modelling was undertaken to quantitatively assess the performance of the proposed stormwater strategy. MUSIC version 6.2.1 was used for the assessment and the parameters have been established in accordance with the *MUSIC Modelling Guidelines* (Water by Design, 2018).

6.1.1 Model structure

The Precincts 3-5 MUSIC model layout is shown in Figure 11. Details of the modelling assumptions, parameters and results are provided below.

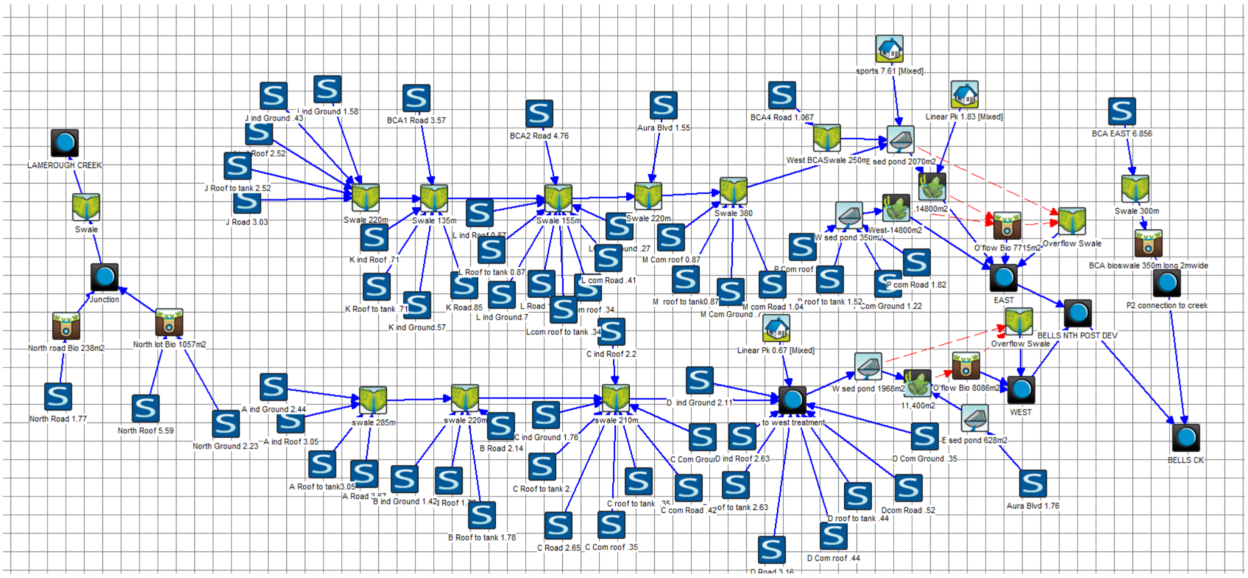

Figure 11 Precincts 3-5 MUSIC model layout

Table 6 provides a summary of the meteorological data on which the model is based.

Table 6 Meteorological and rainfall runoff data

Input	Data used in modelling
Rainfall station	40496 Caloundra (Updated)
Time step	6 minute
Modelling period	1997 – 2009
Mean annual rainfall	1,570 mm (for the period used)
Mean annual evapotranspiration	1,628 mm
Rainfall runoff parameters	Per SEQ MUSIC Guidelines
Pollutant export parameters	Per SEQ MUSIC Guidelines

6.1.2 Catchments

The stormwater catchments presented in Figure 6 were used and the various land uses (residential, commercial or parkland) within these catchments were measured. The model uses split land uses.

The overall catchment areas and land use types are presented in Table 3 and details of the split catchments are shown in Table 7.

Table 7 Catchment land use area MUSIC details

CATCHMENT ID	Area ha	Ground level ha	Roads ha	Roof ha	Open space ha
WEST CATCHMENT					
A - industrial	12.23	2.45	3.67	6.12	
B - industrial	7.14	1.43	2.14	3.57	
C - industrial	8.82	1.76	2.65	4.41	
C - commercial	1.40	0.28	0.42	0.70	
D -industrial	10.53	2.11	3.16	5.27	
D - commercial	1.75	0.35	0.53	0.88	
Linear park	0.67				0.67
Road (Aura Bde)	1.76		1.76		
TOTAL - WEST	**44.30**				
EAST CATCHMENT					
J - industrial	10.11	2.02	3.03	5.06	
K - industrial	2.85	0.57	0.86	1.43	
L - industrial	3.48	0.70	1.04	1.74	
L - commercial	1.35	0.27	0.41	0.68	
M - commercial	3.48	0.70	1.04	1.74	
N - commercial	6.08	1.22	1.82	3.04	
Road (BCA, Aura Bde)	18.87		9.44		9.44
SPORTS	7.74				7.74
Linear park	2.81				2.81
TOTAL EAST	**56.77**				
NORTH CATCHMENT					
North - industrial	9.59	2.23	1.77	5.59	
TOTAL NORTH	**9.59**				
TOTAL P3-5	**110.7**				

6.2 Treatment systems

A summary of the treatment system sizes is shown in Table 3 and the characteristics for MUSIC modelling purposes of each treatment system are summarised below.

6.2.1 Tanks

Rainwater tanks were not included in the MUSIC model for Precinct 3-5. Although the tanks are to be installed on the lots in accordance with this strategy and will provide a water quality benefit, the tanks were not included in the MUSIC model given the variable demand on the tanks in industrial and commercial landuses. This is a conservative approach and ensures the end of line treatment systems are likely oversized.

6.2.2 Swales

The swales are represented in MUSIC using the preliminary design for the swales (Calibre Consulting, 2016).

Typical characteristics include:

- Slopes between 0.2 – 0.75%
- Base width 2m – 13m
- Top width 22m – 30m
- Depth = 1.5 – 2.2m
- Vegetation height = 300mm.

6.2.3 Biopods

Biopods all have the same characteristics of:

- Saturate hydraulic conductivity of 200mm/hour
- Filter depths of 400mm
- No exfiltration (lined bases with underdrains)
- Use vegetation with effective nutrient removal.

For the MUSIC modelling, only the northern catchment included the biopods in the model as these are required to achieve the stormwater quality objectives for Lamerough Creek. The biopods have not been included in the MUSIC modelling for the East and West catchments draining to Bells Creek which is a conservative approach.

Model of the biopods adopted parameters in accordance with the *MUSIC Modelling Guidelines* (Water by Design, 2018). The only variation from the *MUSIC Modelling Guidelines* (Water by Design, 2018) is the bioretention media specifications for Ortho-P of 20mg/kg and TN of 400mg/kg which have been justified previously by BMT WBM and previously accepted by EDQ reviewers.

6.2.4 Wetland systems

Wetlands were modelled in accordance with the *MUSIC Modelling Guidelines* (Water by Design, 2018). The inlet pond volume was defined through design with a notional depth of 1.5m. Weir and bypass flows were directed to the bioretention basins and treated pipe flows bypass the bioretention.

6.2.5 Bioretention basins

The bioretention basins were modelled to only receive overflows from the wetlands with the adopted parameters in accordance with the *MUSIC Modelling Guidelines* (Water by Design, 2018). The only variation from the *MUSIC Modelling Guidelines* (Water by Design, 2018) is the bioretention media specifications Ortho-P of 20mg/kg and TN of 400mg/kg which have been justified previously by BMT WBM and previously accepted by EDQ reviewers.

The extended detention depth above the bioretention basins is configured to include the ponding depth above the wetlands once the wetlands spill into the bioretention basins. This is because the two systems will 'share' this ponded water and the bioretention basins will draw down much faster than the wetland systems, hence the vast majority of ponded water will filter through the bioretention media.

6.2.6 Overflow swales

The swales that take untreated overflows from the end-of-line treatments and the swales have the following characteristics:

- Length = 100m
- 0.2% bed slope
- Base width = varies 8m
- Top width = varies 40m
- Depth = 500-700mm
- Vegetation height = 250mm
- Exfiltration = 0 mm/hour

6.3 Results

The results of the MUSIC modelling for flow entering Bells Creek North from Precincts 3-5 using the proposed strategy are shown in Table 8.

The results demonstrate that the proposed stormwater strategy achieves the stormwater quality load reduction objectives as outlined in Section 3. In reality the water quality performance for Bells Creek North should be greater than that presented in Table 8 due to the influence of tanks which were not included in the modelling.

Table 8 MUSIC modelling results for Bells Creek Catchment

Parameter	Unmitigated	Mitigated	% Removal
Flow (ML/yr)	1,240	1,160	7%
TSS (kg/yr)	280,000	8,320	97%
TP (kg/yr)	538	47	91%
TN (kg/yr)	3,000	929	69%
Gross Pollutants (kg/yr)	25,500	0	100%

The results of the MUSIC modelling for flows directed to Lamerough Creek from Precincts 3-5 are showncool in Table 9. The results demonstrate that the proposed stormwater strategy achieves the stormwater quality load reduction objectives as outlined in Section 3.

Table 9 MUSIC modelling results for Lamerough Creek Catchment

Parameter	Unmitigated	Mitigated	% Removal
Flow (ML/yr)	132	128	3%
TSS (kg/yr)	16,900	3,320	80%
TP (kg/yr)	41.2	15.3	63%
TN (kg/yr)	305	162	47%
Gross Pollutants (kg/yr)	2,850	0	100%

6.4 Sensitivity Testing

To assess the robustness of the stormwater quality strategy to achieve or failure the following sensitivity tests were completed.

1. Sediment basin highflow bypass

The highflow bypass in the sediment basin was set to 3.2m^3/s for the eastern system and 9m^3/s in the western system to match the detailed design. Flows above this bypass the wetland and biorerention system via a secondary link. The results are provided in Table 10 and show the stormwater quality objectives are still achieved. Further testing found that the highflow bypass on both the eastern and western system could be reduced to approximately 2m^3/s and still achieve the objectives. Bypass rates below 2m^3/s result in a reduction in performance below the objectives.

Table 10 MUSIC modelling results for Sensitivity Test 1

Parameter	Unmitigated	Mitigated	% Removal
Flow (ML/yr)	1,240	1,160	7%
TSS (kg/yr)	280,000	8,390	97%
TP (kg/yr)	538	47	91%
TN (kg/yr)	3,000	929	69%
Gross Pollutants (kg/yr)	25,500	0	100%

2. Highflow bypass on the wetlands

The highflow bypass in the wetlands was set to $1m^3/s$ to assess whether the wetland provides any treatment in large flows (i.e. the wetland is designed to manage low flows and provide a buffer storage). The results are provided in Table 11 and show the stormwater quality objectives are still achieved

Table 11 MUSIC modelling results for Sensitivity Test 2

Parameter	Unmitigated	Mitigated	% Removal
Flow (ML/yr)	1,240	1,160	7%
TSS (kg/yr)	280,000	8,320	97%
TP (kg/yr)	538	47	91%
TN (kg/yr)	3,000	929	69%
Gross Pollutants (kg/yr)	25,500	0	100%

3. Western Sediment basin direct to bioretention

There is small sediment basin in the western end-of-line system which short circuits the wetland and likely drains directly to the biorerention treatment. The MUSIC model was updated to simulate this process. The results are provided in Table 12 and show the stormwater quality objectives are still achieved

Table 12 MUSIC modelling results for Sensitivity Test 3

Parameter	Unmitigated	Mitigated	% Removal
Flow (ML/yr)	1,240	1,160	7%
TSS (kg/yr)	280,000	8,320	97%
TP (kg/yr)	538	47	91%
TN (kg/yr)	3,000	929	69%
Gross Pollutants (kg/yr)	25,500	0	100%

4. Sensitivity tests 1-2-3

All three sensitivity tests were applied with the results in Table 13 showing the stormwater quality objectives are still achieved.

Table 13 MUSIC modelling results for Sensitivity Test 1-2-3

Parameter	Unmitigated	Mitigated	% Removal
Flow (ML/yr)	1,240	1,160	7%
TSS (kg/yr)	280,000	8,390	97%
TP (kg/yr)	538	47	91%
TN (kg/yr)	3,000	929	69%
Gross Pollutants (kg/yr)	25,500	0	100%

5. Reduction in Bioretention Filter Media Area

The area of the filter media was reduced by 10%, 20% and 30% in the end-of-line treatment system to similar blockage or failure of the bioretention filter media. The results are presented in the tables below and illustrate the stormwater quality objectives are still achieved. The illustrates there is safety factor within the end-of-line systems of up to 30%.

Table 14 MUSIC modelling results for reduction in bioretention filter media area of 10%

Parameter	Unmitigated	Mitigated	% Removal
Flow (ML/yr)	1,240	1,160	7%
TSS (kg/yr)	280,000	8,390	97%
TP (kg/yr)	538	48	91%
TN (kg/yr)	3,000	942	69%
Gross Pollutants (kg/yr)	25,500	0	100%

Table 15 MUSIC modelling results for reduction in bioretention filter media area of 20%

Parameter	Unmitigated	Mitigated	% Removal
Flow (ML/yr)	1,240	1,160	7%
TSS (kg/yr)	280,000	8,400	97%
TP (kg/yr)	538	49	91%
TN (kg/yr)	3,000	946	68%
Gross Pollutants (kg/yr)	25,500	0	100%

Table 16 MUSIC modelling results for reduction in bioretention filter media area of 30%

Parameter	Unmitigated	Mitigated	% Removal
Flow (ML/yr)	1,240	1,160	7%
TSS (kg/yr)	280,000	8,780	97%
TP (kg/yr)	538	50	91%
TN (kg/yr)	3,000	959	68%
Gross Pollutants (kg/yr)	25,500	0	100%

7 Conclusions

This report describes a Stormwater Quality Management Plan for Precincts 3-5 of Aura. It comes as a results of thorough assessments of constraints to stormwater treatment measures.

Precincts 3-5 drain to two catchments, Bells Creek North (>90% of the area) and Lamerough Creek. The two receiving waters have different discharge requirements, with Bells Creek North requiring more stringent stormwater quality improvement because of the sensitive receiving environment of Bells Creek and Pumicestone Passage.

The strategy provides a comprehensive stormwater treatment strategy which reflects the high valued receiving waters (i.e. Bells Creek). It includes using rainwater tanks, at source biopods (for Lamerough Creek catchment), vegetated conveyance swales and an innovative combination of end of line wetland and bioretention basins.

Principles of the strategy focus on not treating already treated water and providing flexibility in the treatment train to adjust the design in response to constraints and other design requirements. The proposal takes advantage of available areas at the southern perimeter of the site adjacent to Bells Creek North and gives careful consideration of the existing levels within the creek.

The treatment strategy meets the requirements for stormwater quality improvement for the two separate receiving waterways. The measures proposed here will help to ensure there are no adverse impacts on Bells Creek and Pumicestone Passage. This includes reducing annual pollutant loads by more than 95% for suspended solids, 89% for total phosphorus and 68% for total nitrogen from the developed areas of the site draining to Bells Creek North.

8 References

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