AURA PRECINCT 15

STORMWATER QUALITY MANAGEMENT PLAN

VERSION 3

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

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SUMMARY

This document describes a stormwater quality management strategy for Aura Precinct 15 to meet required stormwater quality objectives.

The document supersedes *Aura Precinct 15 Retirement Living Site and Surrounds Stormwater Quality Management Plan (*DesignFlow, 2021) and should be read with the approved *Aura Precinct 11-14 Stormwater Quality Management Plan* (DesignFlow, 2020) which provides the stormwater quality management strategy for the catchments to the north of the Precinct 15.

This stormwater quality management strategy covers 211ha of Aura including the 20ha Land Lease Community Site. The development includes the creation of residential dwellings (~1250-1300 dwellings), over 50's living, small commercial, community, school, sports fields and recreational park land uses. An additional 10.57ha of Bruce Highway catchment is also considered in the modelling with two options presented for either bypassing or treating these flows.

The site drains in south east via sheet flows onto the floodplain of Bells Creek South. All runoff from the site flows into a State Government declared High Ecological Value area (Pumicestone Passage) via Bells Creek which is a Ramsar listed wetland. 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.

This strategy proposes a comprehensive combination of treatment systems responding to the very high value receiving waters. Treatment will occur via end of line sediment basins, wetland and bioretention basin integrated into linear open spaces and buffers between the development and Bells Creek South. In addition, rainwater tanks are used on most allotments for water reuse in toilets and outdoor demands. These systems combine provide required stormwater treatment prior to discharge into Bells Creek.

The treatment strategy for Precinct 15 meets the stormwater objectives established for the Aura development to ensure no adverse impacts to Bells Creek and Pumicestone Passage. This includes reducing annual pollutant loads by the required 95% for total suspended solids (TSS), 89% for total phosphorus (TP) and 68% for total nitrogen (TN). These stormwater objectives were established as part of the stormwater planning and waterway modelling for the whole Aura development as documented in the approved *Aura Development Stormwater Quality Management Plan* (DesignFlow & BMT, 2019). The treatment systems have been all be located within the constraints of site levels, available space and requirements for environmental buffers (e.g. frog habitat).

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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 Precinct 15 (referred to herein as "the site") as illustrated in Figure 1. This includes 211ha of residential dwellings, over 50's living, residential, commercial, school, sports fields and recreational parks as illustrated in Figure 2.

This report presents a SQMP for Aura Precinct 15 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 document supersedes *Aura Precinct 15 Retirement Living Site and Surrounds Stormwater Quality Management Plan* (DesignFlow, 2021) and should be read with the approved *Aura Precinct 11-14 Stormwater Quality Management Plan* (DesignFlow, 2020) which provides the stormwater quality management strategy for the catchments to the north of the Precinct 15.

The treatment strategy for Precinct 15 is consistent with the stormwater objectives, planning and modelling documented in the approved *Aura Development Stormwater Quality Management Plan* (DesignFlow & BMT, 2019). 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) to ensure no adverse impacts to Bells Creek and Pumicestone Passage. The stormwater treatment strategy for Precinct 15 ensures these objectives are achieved.

Figure 1 Aura Precinct 15 Site Location

Figure 2 Aura Precinct 15 Layout

2 Site Characteristics

The description of the site presented in this section relates to elements that affect the stormwater quality management strategy for Precinct. 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 Landuse, topography and drainage

The Precinct 15 site is located on cleared grazing land that is relatively flat with average grade of 1% grade even though the elevations on the site range between RL 8–30 m AHD.

The area is bordered by the Bruce Highway to the west, Bells Creek South to the east and Precinct 14 and CAMCOS to the north (Figure 3).

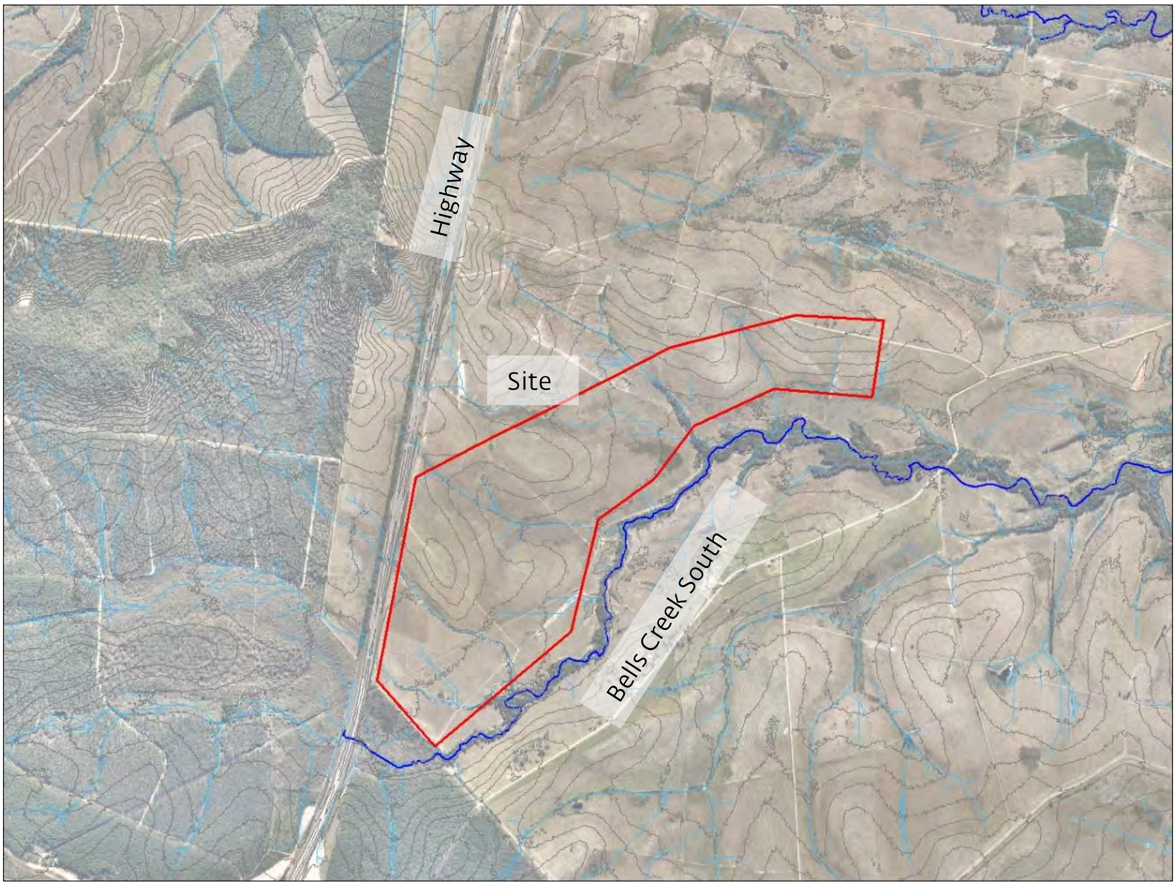


Figure 3 Existing land use, topography and drainage

The site drains in in a south easterly direction via sheet flow and a number of depressions to Bells Creek South. There is a number of external catchments along the Bruce highwater which enter the side most of which will be diverted south to reduce external flows entering Precinct 15. Some large catchments from Precinct 14 north of the site will also enter the site.

Planned earthworks as part of Aura will include reshaping the site to create a number of discharge points along the edge of Bells Creek South where water will be captured an treated in WSUD systems (including external catchments).

2.2 Bells Creek

Bells Creek has been modified previously but have regrown to healthy waterways that support a range of wetland and riparian flora (see photo below). The condition of the creeks, 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 15 site is approximately 211ha of this catchment (this represents 4.6% of the total Bells Creek catchment). The context of Precinct 15 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).

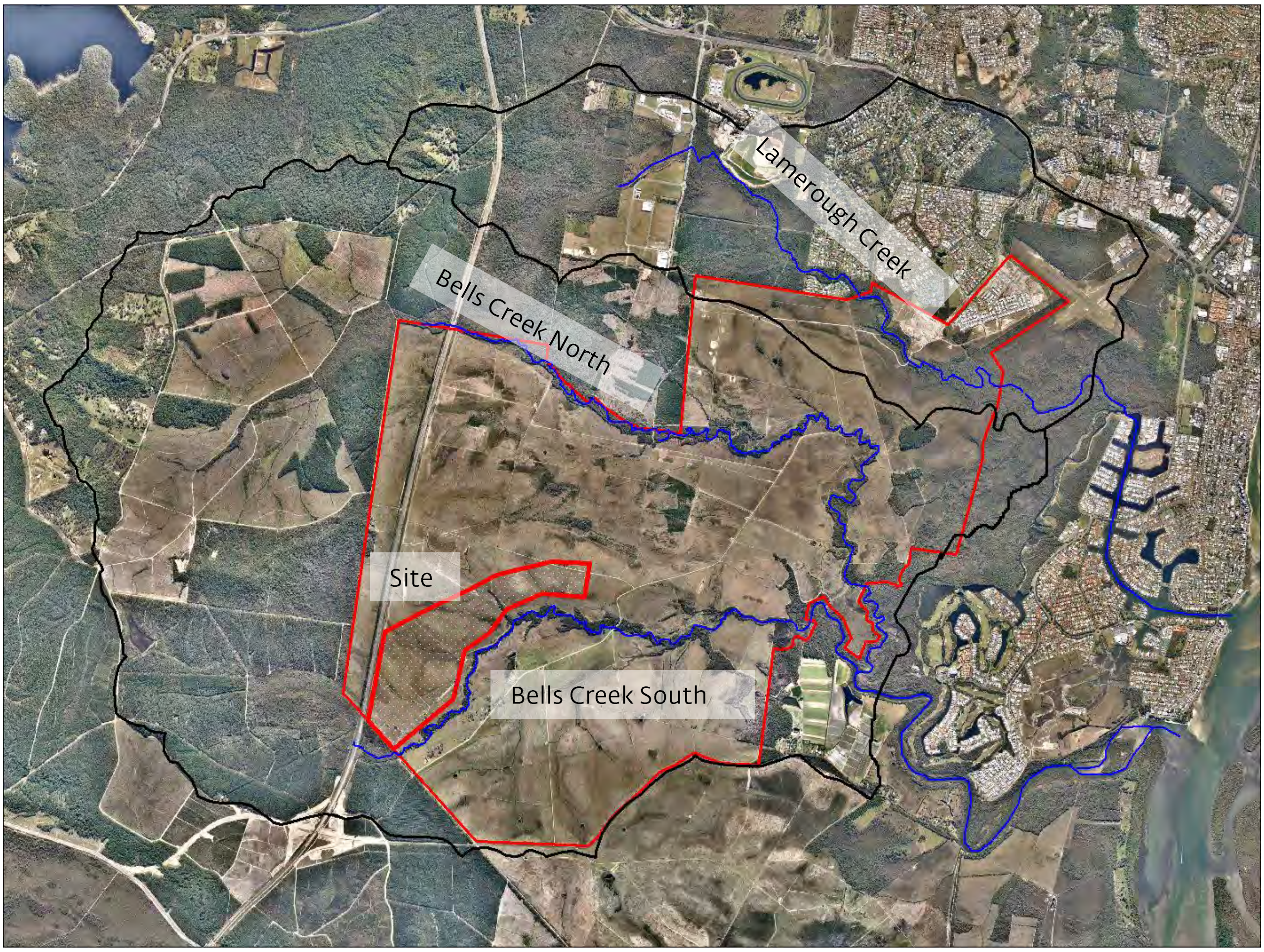


Figure 4 Bells Creek Catchment

2.3 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 2.4).

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.

2.4 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 Precinct 15 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 5.2.4.

3 Stormwater Treatment Objectives

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 Precinct 15 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.

Table 1: Stormwater quality design objectives

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

4 Stormwater Quality Management Strategy

This section provides an overview of the stormwater strategy and describes the treatment systems proposed for Aura Precinct 15.

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. 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. Frogs – Ensure the requirements of the *Caloundra South Wallum Sedge Frog Management Plan* and *Caloundra South Acid Frog Management Plan* are achieved.
5. Match catchments, levels and drainage to end-of line treatments– Consideration of slopes, drainage and earthworks requirements to ensure the correct catchment areas were drained to spaces that allowed suitably sited treatment system and also drainage can occur to these system to allow proper drainage into the creek or waterway following treatment.

4.2 Stormwater treatment strategy

A concept layout for the stormwater treatment strategy for the site is presented in Figure 5. It shows how stormwater is directed to Bells Creek South via tanks, GPTs, wetlands, bioretention and swales.

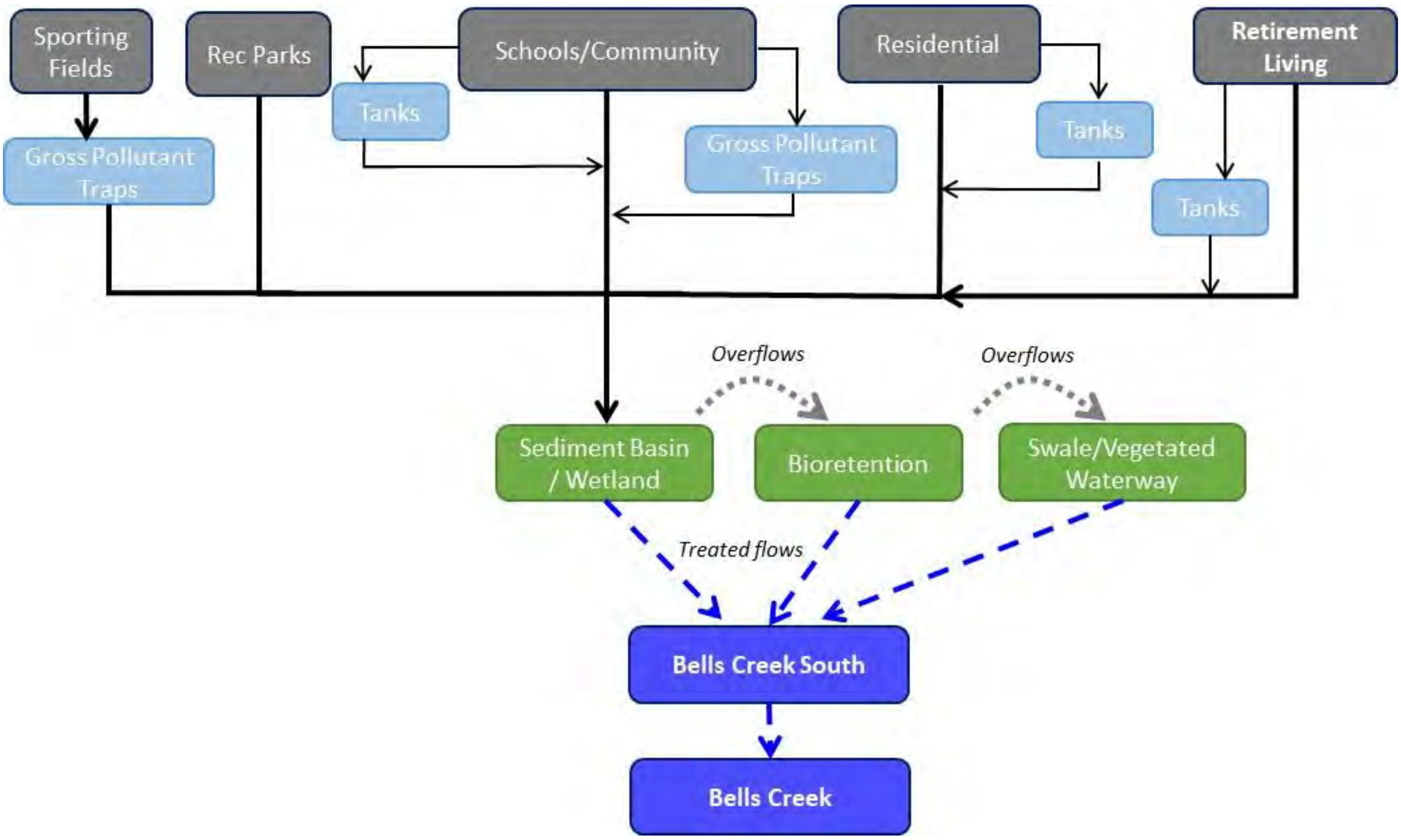


Figure 5 Stormwater treatment train flow diagram

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, gross pollutant traps, end-of-line bioretention and wetland systems and vegetated swales in various forms). For Precinct 15 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.

The stormwater treatment strategy includes:

1. **Tanks** are included in the strategy and will provide a water conservation function. The tanks are to be placed on retirement living, residential, commercial, community and school lots and plumbed for toilets and outdoor uses. These also contribute to Aura's water conservation initiatives. Refer to Section 5.1 for details.
2. **Gross pollutant traps** on lots for landuses which generate high volumes of litter (i.e. commercial, industrial, school, community facilities, child car and sporting ovals)
3. **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 treatments. Based on concept layouts there is suitable space having given consideration to other land requirements (e.g. frog zones).
4. **Swales** will collect and convey flows from the end-of-line treatment systems and convey to Bells Creek South. The waterway will provide additional treatment of moderate to high flows.

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. Table 2 presents catchment and treatment size details for the proposed end of line treatment systems.

Importantly, there is a 10.57ha external Bruce Highway which enters the western edge of Catchment S3. Two options have been assessed for dealing with these flows:

1. Bypassing the 10.57ha Bruce Highway catchment to Bells Creek
2. Treating the 10.57ha Bruce Highway catchment in WSUD S3

Treating the 10.57ha Bruce Highway catchment in WSUD S3 is recommended as it simplifies the drainage and provides additional removal of pollutants which would otherwise enter Bells Creek.

Note the sizes nominated in Table 2 for treatment areas are the wet areas of sediment basins, wetlands (i.e. normal water level) and the filter surface area 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 development layout for Precinct 15 and are presented in Appendix A. Refinement of the designs will occur through detailed as the catchments and earthworks of the development are developed.

Table 2 Stormwater catchments and treatment system areas for Precinct 15

Catchment ID	Area	Inlet Pond		Wetland	Bioretention
	(ha)	Volume (m3)	Area (m2)	(m2)	(m2)
S1	48.05	1920	1280	6200	10000
S2	90.73	3900	2600	9500	16000
S3*	32.54	900	600	3300	5800
S4a	12.85	750	500		2900
S4b	6				1800
S4c	11.45	750	500		2700
S5	20.27	1200	800	2000	5000
Total	**221.889**	**9420**	**6280**	**21000**	**44200**

* Catchment S3 area in this table includes the external Bruce Highway catchment of 10.569ha

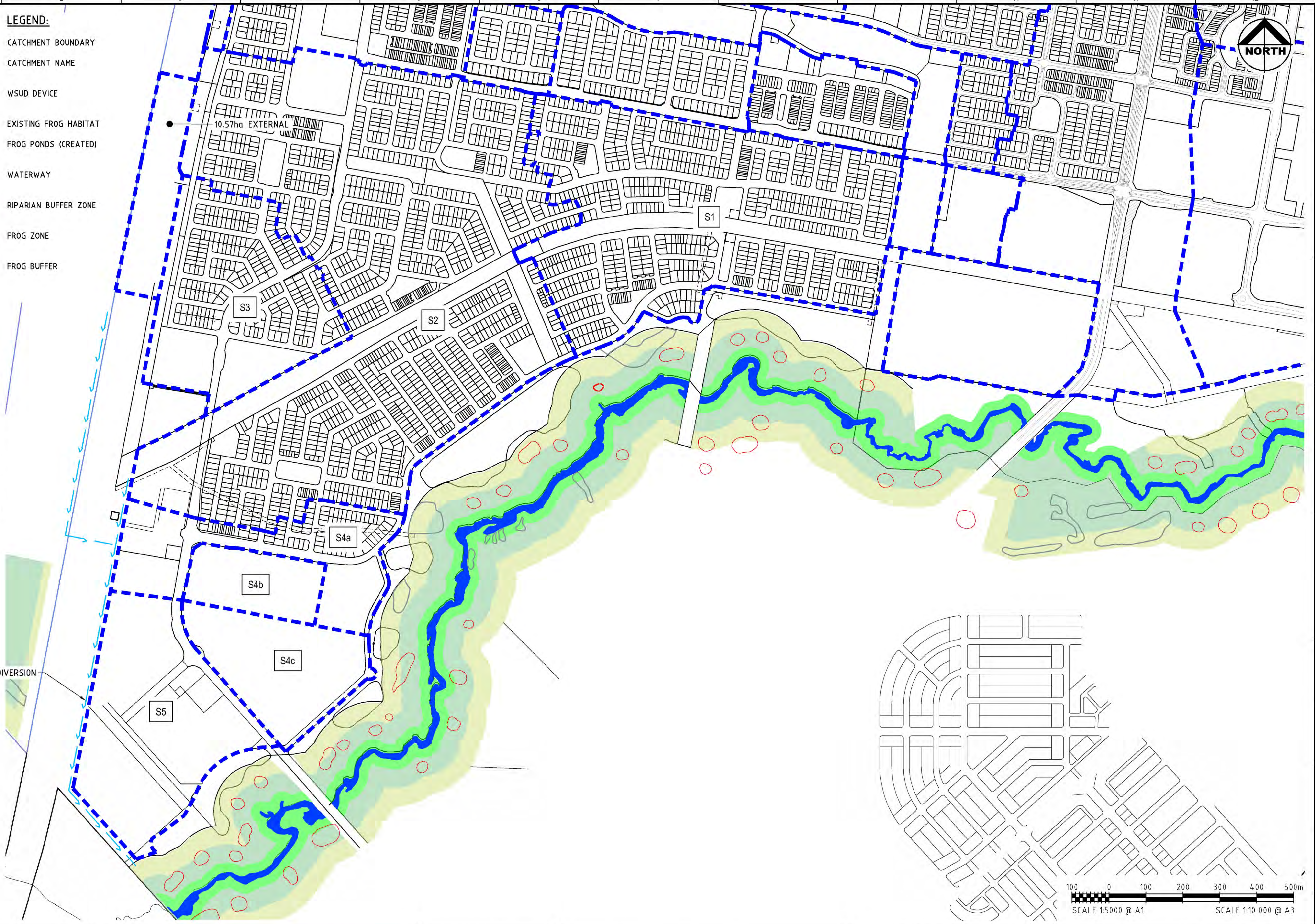
LEGEND:

- CATCHMENT BOUNDARY
- C5 — CATCHMENT NAME
- WSUD DEVICE
- EXISTING FROG HABITAT
- FROG PONDS (CREATED)
- WATERWAY
- RIPARIAN BUFFER ZONE
- FROG ZONE
- FROG BUFFER

CATCHMENT

ID	AREA(ha)
S1	48.05
S2	90.73
S3 *	32.50
S4a	12.85
S4b	6.0
S4c	11.45
S5	20.27

* S3 INCLUDES 10.57ha BRUCE HIGHWAY EXTERNAL CATCHMENT



REVISION	DESCRIPTION	INITS	DATE	INITS	DATE
C	CATCHMENTS AMENDED	SBY	15.09.22	SL	15.09.22
B	CATCHMENTS AMENDED	SBY	10.03.22	SL	10.03.22
A	PRELIMINARY ISSUE	SBY	23.02.22	SL	23.02.22
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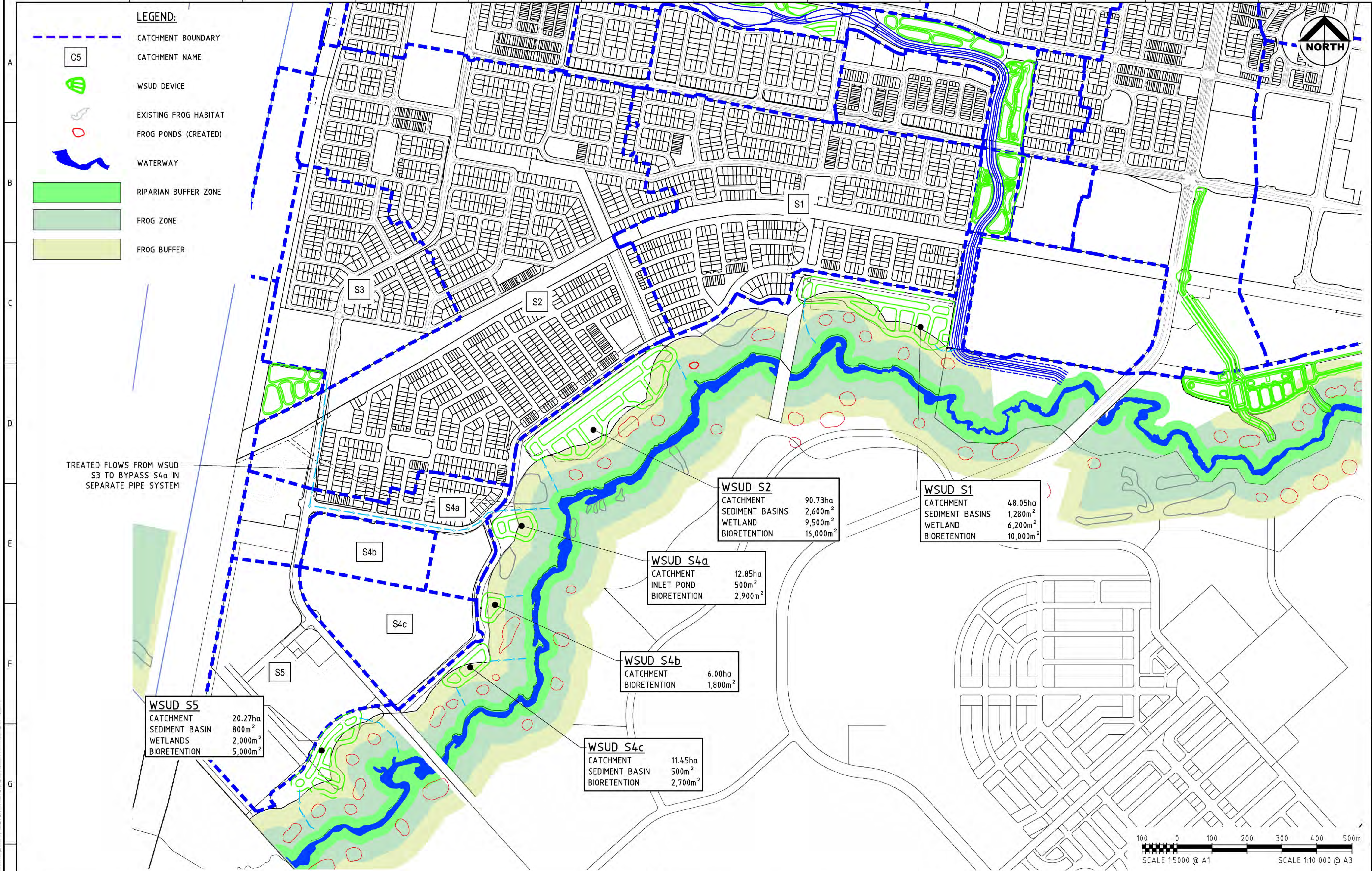
DRAWN: SBY — DATE: 15.09.22
DESIGNED: SL — DATE: 15.09.22
SCALE: A1

PROJECT: AURA - STORMWATER PLANNING
DRAWING TITLE: AURA MASTER CATCHMENTS PRECINCT 15 SITE
PROJECT No: 4419
DRAWING No: FIGURE 6
REVISION: C



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C	CATCHMENTS AMENDED	SBY	15.09.22	SL	15.09.22
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PROJECT: AURA - STORMWATER PLANNING
DRAWING TITLE: AURA MASTER STORMWATER TREATMENT STRATEGY PRECINCT 15 SITE
PROJECT No: 4419
DRAWING No: FIGURE 7
REVISION: C

4.3 Stormwater treatment measures

The table below briefly describes the stormwater treatments measures adopted for Precinct 15. Many have been applied to other precincts of the Aura development.

Table 3 Summary of Stormwater Treatment Measures for Precincts

Measure	Description
Rainwater Tanks	As part of Stockland's water conservation policy and to reduce the volumes of stormwater requiring treatment, rainwater tanks are proposed for residential, commercial, industrial, community and school land uses. Water from the tanks is to be plumbed for toilet, cold laundry tap, outdoor uses and suitable non-potable demands. While the tanks serve an important water conservation role they also act to reduce the volume of stormwater (and associated pollutants) from reaching downstream waterways. Section 5.1 outlines the proposed tank implementation for Precinct 15.
Gross Pollutant Traps	Commercial, industrial, school, child care, community and sporting parks are a significant source of litter and sometimes sediment at ground level. Runoff from the ground level area on these landuses will pass through gross pollutant traps prior to discharging from the lot. The GPTs will focus on litter and coarse sediment. The GPTs will be owned and managed by the lot owners other than for sporting parks where the GPTs will be owned and managed by Council. GPTs have not be included in the MUSIC model as the focus of these in Precinct 15 is litter and coarse sediment.
Constructed Wetlands	A constructed wetland is proposed to manage stormwater from the larger catchments in the site. The wetlands will receive flows from the drainage network hold water for treatment for approximately 2 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 wetland and interaction with the subsequent bioretention basins is described in Section 5.2. Treated flows from the wetland will be discharged to either Bells Creek North or South. 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. The wetland 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 as part of the end-of-line treatment systems. 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)

Measure	Description
	• minimises the hydraulic head required to operate the wetland and bioretention treatment combination and minimises the level the development pad is required to be lifted to enable free draining treatment systems • by combining the active storages of the wetlands and bioretention, much more water can be treated through the bioretention because of the relatively large areas of the wetlands and the faster treatment rates of bioretention. In this way, less water overflows the overall treatment systems. Treated flow that collects in the underdrainage pipes will combine with treated water from the wetlands and discharge into Bells Creek. Design of the bioretention systems will occur in accordance with *Bioretention Technical Design Guideline* (Water by Design).
Outlet Swales	All flows from the wetlands and bioretention systems will enter vegetated swale to the creek. For treatment flows, no further treatment will occur. For the occasional 'overflows' which are not fully treated in the wetland and bioretention systems, additional treatment will occur in swales while flowing to the outlet at Bells 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 4 summaries the proposed tank approach for Precinct 15 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 Precinct 15 to ensure compliance with this Stormwater Quality Management Plan.

Table 4: Rainwater tank approach for Precinct 15

Landuse	Roof Area	Tank size (minimum)	Tank Connections / Fixtures / Uses
Residential - Detached/attached dwellings (Lot >300m²)	50% roof area must connect / drain to tank	5kL per dwelling	Tanks must be connected to and supply water to all of the following: • Toilets (all toilets) • Laundry cold (all cold taps in laundry) • Outdoor taps (all outdoor taps)
Residential - Detached/attached dwellings (Lot = 225-300m²)	50% roof must connect / drain to tank	3kL per dwelling	Tanks must be connected to and supply water to all of the following: • Toilets (all toilets) • Laundry cold (all taps in laundry) • Outdoor taps (all outdoor taps)
Residential - Detached/attached dwellings (Lot <225m²)	No tanks		
Residential - Medium density dwellings	75% roof must connect / drain to tank If multiple buildings then 50% of total roof area must connect / drain to tank	1kL per dwelling	Tanks must be connected to and supply water to all of the following: • Toilets (all toilets) • Laundry cold (all taps in laundry) • Outdoor taps (all outdoor taps)
All non-residential uses including but not limited to: • Commercial • Retail • Industrial • School • Community	50% roof must 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 must 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 Wetland and Bioretention System Concept Designs

Conceptual design 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 and accommodating the required buffers and finding sufficient space within the proposed waterway flowing to the south
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 drainage levels and associated earthworks in the development.

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

5.2.1 Treatment system operation

The wetland and bioretention treatment systems receive flows from drainage pipes throughout the development (Figure 7). As flow enters the treatment systems it follows the sequence below (refer to Figure 8):

- **Inlet pond** - Flows from pipes 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 discharging directly downstream to Bells Creek. Wetlands will typically have a 48-72hr notional detention time and a maximum depth of 350mm above normal water level (when bioretention is engaged as well).
- **Bioretention** – During rainfall events, the wetlands begin to fill and as water levels increase by more than 50-100mm 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. 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.

The design of the treatment systems has undergone a conceptual design process to locate and size the systems in relation to the catchments, frog buffers and define design levels to ensure hydraulic function. Conceptual earthworks and cross sections are provided in Appendix A.

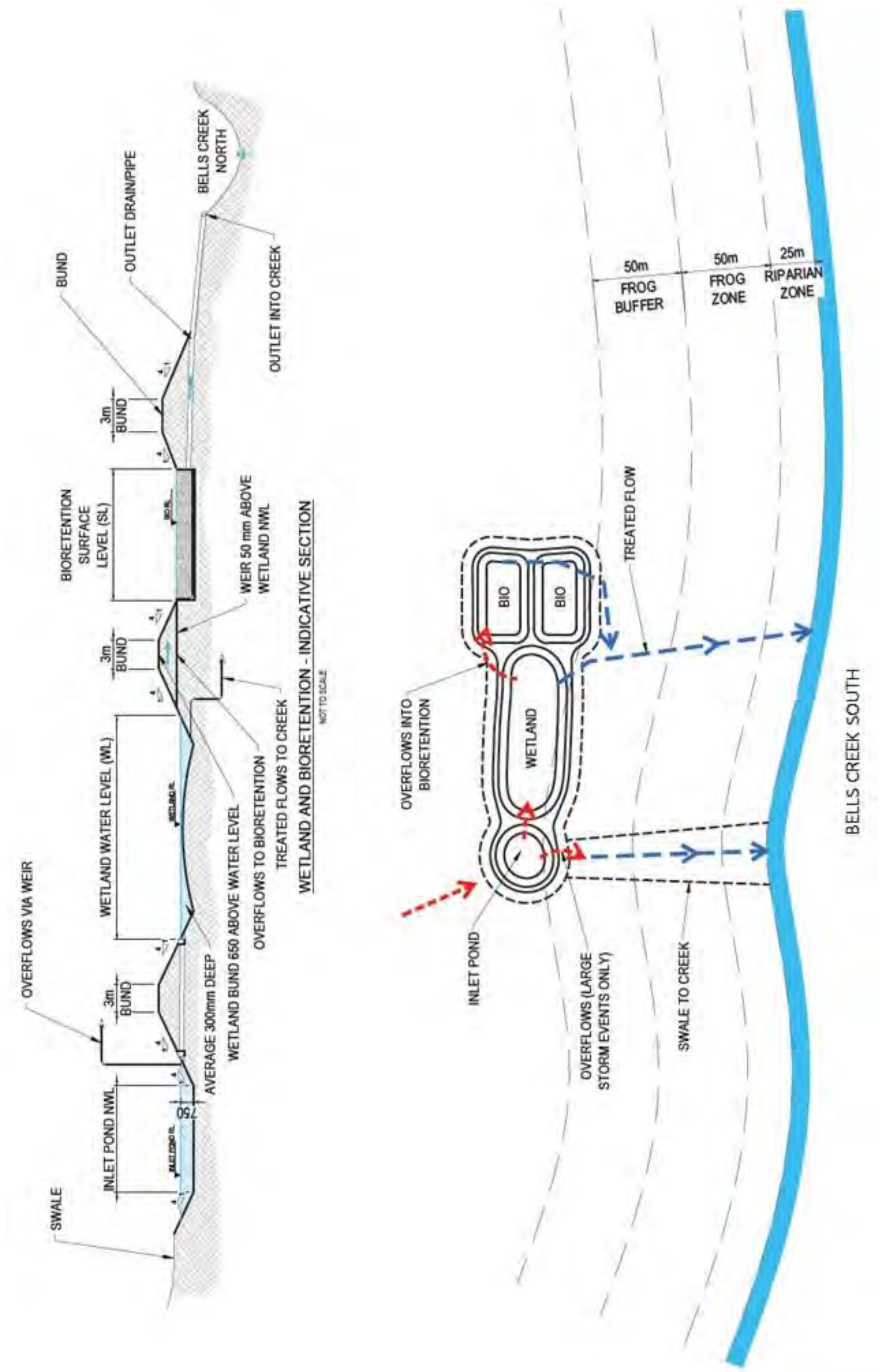

Figure 8 Function and operating levels wetland and bioretention treatment systems

5.2.2 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. 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 1-3-1.5m between the outfall levels in the creek / constructed waterway 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.

5.2.3 Location and size

The end-of-line inlet ponds (sediment basins), wetlands and bioretention systems have been carefully located considering the constraints including:

- Existing Wallum Sedgefrog habitat (no stormwater management allowed within 30m)
- Existing created frog ponds (no stormwater management allowed within 30m other than those agreed with frog consultant)
- 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 5.2.4)
- Existing vegetation
- Existing drainage
- Interaction with development edges to ensure there is space for the treatment systems
- Flood immunity requirements
- Parkland, following appropriate criteria (Section 5.2.5)
- Suitable discharge points for treated stormwater.

Sufficient space for the treatment areas as well as batters and access tracks etc. have been provided.

5.2.4 Frog buffer considerations

Stormwater treatment systems are to be 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 stormwater management measures must be set back 30m from the create Frog Ponds within the Frog Zone and Frog Buffer. Drainage channels and swales from the stormwater management measures to the creek can be closer than 30m.
4. 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*.

5.2.5 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.

5.2.6 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.

High level concept designs have been developed for all the end of line stormwater treatment systems to ensure there is enough space within the development layout (Appendix A). In particular, extensive refinement of the concept designs has been developed for the systems located in the centre of Precinct 15.

The conceptual design outcomes are reflected in the stormwater treatment locations and shapes presented in Figure 7. The stormwater treatment systems om Appendix A have been drawn to scale on this plan to match the areas defined in Table 2

The size and location of the stormwater treatment systems will 'evolve' in response to catchment changes or other constraints as part of design development and detailed design. There is sufficient redundancy and flexibility in the proposed designs to accommodate minor changes. On the basis of these concept designs, there is a high level of certainty that the proposed treatment strategy is feasible and can be implemented without changing the development layout. If there is a need to change the layout to allow for the stormwater strategy this will occur as part of future development approval variations.

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 6.3 was used for the assessment and the parameters have been established in accordance with the *MUSIC Modelling Guidelines* (Water by Design, Draft 2018).

6.1.1 Model structure

The Precinct 15 MUSIC model layout is shown in Figure 9. Details of the modelling assumptions, parameters and results are provided below.

Table 5 provides a summary of the meteorological data on which the model is based.

Table 5 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, so that particular areas could be directed to treatment while others may bypass (for example, roof runoff can be directed to tanks).

The details of the split catchments are shown in Table 6.

Note: The 10.57ha external Bruce Highway is included as Major Road in Catchment S3. Two options were assessed in the MUSIC modelling:

1. Bypassing the 10.57ha Bruce Highway catchment
2. Treating the 10.57ha Bruce Highway catchment in WSUD S3

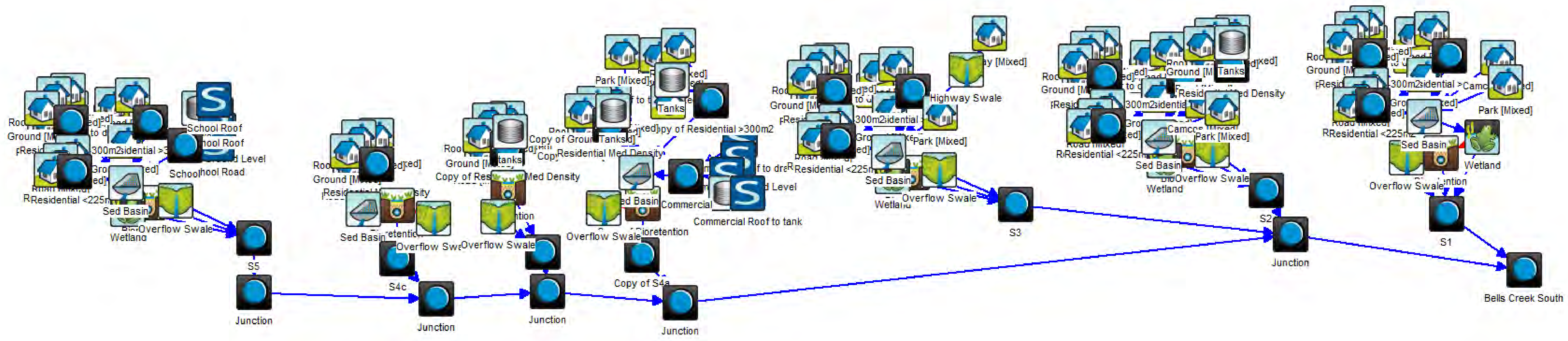

Figure 9 Precinct 15 MUSIC model layout

Table 6 Catchment land use area details

Catchment ID	Residential >300m²	Residential 225-300m2	Residential <225m2	Residential Medium Density	Commercial / Community	School	Major Road/Rail	Park	Total
	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)
S1	35.60	3.35	4.17				4.18	0.76	**48.05**
S2	58.07	5.49	6.83	0.48	0.32	2.50	5.90	11.14	**90.73**
S3	12.46	1.18	1.46				10.57	6.87	**32.54**
S4a	5.24			4.00	0.65			2.96	**12.85**
S4b				6.00					**6.00**
S4c				11.45					**11.45**
S5	12.87	1.28	0.42			5.70			**20.27**
Total	18.11	1.28	0.42	21.45	0.65	5.70	0.00	2.96	221.89

Note: The 10.57ha external Bruce Highway is included as Major Road in Catchment S3 in the table above.

Catchment ID	Residential >300m2				Residential 225-300m2				Residential <225m2			Residential Medium Density				Commercial / Community				School				Major Road	Park	Total
	Roof to tank (ha)	Roof to drain (ha)	Road (ha)	Ground (ha)	Roof to tank (ha)	Roof to drain (ha)	Road (ha)	Ground (ha)	Roof to drain (ha)	Road (ha)	Ground (ha)	Roof to tank (ha)	Roof to drain (ha)	Road (ha)	Ground (ha)	Roof to tank (ha)	Roof to drain (ha)	Ground (ha)	Road/Parkng (ha)	Roof to tank (ha)	Roof to drain (ha)	Ground (ha)	Road/Parking (ha)	(ha)	(ha)	(ha)
S1	6.229	6.229	8.899	14.238	0.628	0.628	0.837	1.256	1.624	1.041	1.499													4.180	0.760	**48.050**
S2	10.163	10.163	14.518	23.229	1.029	1.029	1.373	2.059	2.663	1.707	2.458	0.084	0.084	0.144	0.168	0.080	0.080	0.064	0.096	0.500	0.250	1.375	0.375	5.900	11.140	**90.730**
S3	2.180	2.180	3.114	4.983	0.221	0.221	0.294	0.442	0.571	0.366	0.527													10.569	6.870	**32.539**
S4a	0.917	0.917	1.310	2.096								0.700	0.700	1.200	1.400	0.163	0.163	0.130	0.195						2.960	**12.850**
S4b												1.050	1.050	1.800	2.100											**6.000**
S4c												2.004	2.004	3.435	4.008											**11.450**
S5	2.251	2.251	3.216	5.146	0.240	0.240	0.321	0.481	0.165	0.106	0.152									1.140	0.570	3.135	0.855			**20.270**
Total																										221.89

Note: The 10.57ha external Bruce Highway is included as Major Road in Catchment S3 in the table above.

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 Rainwater Tanks

Rainwater tanks were modelled in accordance with *MUSIC Modelling Guidelines* (Water by Design) based on the sizes defined in Table 4.

In this case tanks were modelled conservatively at 80% of the volume to allow for main water topup storage in the tanks at the request of Economic Development Queensland and the peer reviewer. Advice from Stockland is that in many situations main water backup for the tanks is being provided valves which switch to main supply (i.e. Rainbank style systems) rather than topping up the tank. In this case there is no loss of storage in the tank for mains water topup.

Given this advice, we conclude the modelling approach of using 80% of the tank volume for storage is conservative.

6.2.2 Inlet Ponds / Sediment Basins

The inlet area was generally set at a 0.25% of the catchment with a minimum of 300m², although some larger sediment basin areas were adopted to suit the layout of the particular WSUD system. To derive the volume a notional depth of 1.5m in larger systems (>500m²) and 1m for systems smaller (<500m²) given the average depth in smaller systems is reduce to the surrounding underway batters.

6.2.3 Wetland systems

Wetlands were modelled in accordance with the *MUSIC Modelling Guidelines* (Water by Design) and the description provided in Section 5.2. An extended detention depth of 50mm was adopted with weir and bypass flows were directed to the bioretention basins. Treated pipe flows bypass the bioretention and discharge to the receiving waterways.

6.2.4 Bioretention basins

The end of line 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). The only variation from the *MUSIC Modelling Guidelines* (Water by Design) 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.

6.2.5 Overflow swales

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

- Length = 50-100m for systems next to Bells Creek North and South. Up to 400m in length for reached of The Brook (Length has been set based on location. For example The Brook drainage corridor is 2.5km in length.)
- 0.1-0.2% bed slope
- Base width = varies
- Top width = varies
- Depth = 500-800mm
- Vegetation height = 250mm
- Exfiltration = 0 mm/hour

6.3 Results

The results of the MUSIC modelling for flow entering Bells Creek from Precinct 15 using the proposed strategy are shown in Table 7 and Table 8. The results in Table 7 include loads from development area without the external Bruce Highway catchment. The results demonstrate that the proposed stormwater strategy achieves the stormwater quality load reduction objectives as outlined in Section 3.

The results in Table 8 illustrate that when the additional Bruce Highway catchment is diverted into WSUD S3 then additional load is removed from the overall stormwater discharging to Bells Creek and the stormwater objectives are still generally achieved. This water quality benefit to Bells Creek combined with much simpler drainage design (i.e. no need to bypass the Bruce Highway flows around WSUD S3) supports the adoption of this approach (i.e. treating the external Bruce Highway catchment in WSUD S3).

Table 7 MUSIC modelling results (excluding Bruce Highway Catchment)

Parameter	Unmitigated	Mitigated	Removed	% Removed
Flow (ML/yr)	2,200	1,890	320	14.1%
TSS (kg/yr)	378,000	18,400	359,700	95.2%
TP (kg/yr)	782	80.8	701.2	89.7%
TN (kg/yr)	4,650	1,460	3,190	68.6%
Gross Pollutants (kg/yr)	45,400	0	45,400	100%

Table 8 MUSIC modelling results (including Bruce Highway Catchment)

Parameter	Unmitigated	Mitigated	Removed	% Removed
Flow (ML/yr)	2,270	1,950	310	14.1%
TSS (kg/yr)	398,000	19,500	377,600	95.1%
TP (kg/yr)	815	85.5	729.8	89.5%
TN (kg/yr)	4,780	1,530	3,270	68.3%
Gross Pollutants (kg/yr)	46,100	0	46,200	100%

6.4 Sensitivity test

The arrangement of WSUD system S1, S2 and S5 involves two sediment basins at either end of the treatment systems (refer Appendix A). These sediment basins will accept flows from sub-catchments with each of these broad catchments. To test the performance of this arrangement, the MUSIC model was split for S1, S2 and S5 to include the following:

- Split sub-catchments (i.e. S1 was split into S1a and S1b)
- Two separate sediment basins (to match the split sub catchments)
- Two wetland systems (to match the split sub catchments)

The details of the catchments and treatment systems for WSUD S1, S2 and S5 are provided in Table 9 with the catchment split and associated sediment basins and wetlands provided in red.

Table 9 Catchment, sediment basin and wetland split for WSUD S1, S2 and S5

Catchment ID	Area	Inlet Pond		Wetland	Bioretention
	(ha)	Volume (m3)	Area (m2)	(m2)	(m2)
S1	48.05	1920	1280	6200	10000
S1a	16.50	750	500	3100	no change
S1b	31.55	1170	780	3100	no change
S2	90.73	3900	2600	9500	16000
S2a	53.73	2310	1540	5626	no change
S2b	37.00	1590	1060	3874	no change
S3*	32.54	900	600	3300	5800
S4a	12.85	750	500		2900
S4b	6				1800
S4c	11.45	750	500		2700
S5	20.27	1200	800	2000	5000
S5a	9.00	533	355	888	no change
S5b	11.27	667	445	1112	no change
Total	360.669	15240	10160	36700	44200

* Catchment S3 area in this table includes the external Bruce Highway catchment of 10.569ha

The results of the MUSIC modelling with the split catchment and sediment basin – wetland configuration is provided in Table 10 and Table 11. The results demonstrate that the proposed stormwater strategy achieves the stormwater quality load reduction objectives as outlined in Section 3.

Table 10 Sensitivity results - Split Catchment (excluding Bruce Highway Catchment)

Parameter	Unmitigated	Mitigated	Removed	% Removed
Flow (ML/yr)	2,200	1,890	320	14.1%
TSS (kg/yr)	380,000	18,600	361,400	95.1%
TP (kg/yr)	787	82.3	704.7	89.5%
TN (kg/yr)	4,670	1,460	3,210	68.7%
Gross Pollutants (kg/yr)	45,400	0	45,400	100%

Table 11 Sensitivity results - Split Catchment (including Bruce Highway Catchment)

Parameter	Unmitigated	Mitigated	Removed	% Removed
Flow (ML/yr)	2,270	1,950	310	14.1%
TSS (kg/yr)	399,000	19,800	379,200	95.0%
TP (kg/yr)	821	86.7	734.3	89.5%
TN (kg/yr)	4,800	1,530	3,270	68.1%
Gross Pollutants (kg/yr)	46,400	0	46,400	100%

6.5 Potential future refinement to modelling

The MUSIC modelling presented in the previous sections adopts parameters in accordance with the *MUSIC Modelling Guidelines* (Water by Design). Recent research (Lucke, 2018) indicates the concentration of pollutants being generated on urban land uses in Queensland may be lower than those recommended in MUSIC Modelling Guidelines (Water by Design). If this is correct, then the MUSIC models for Aura may be over-estimating pollutant loads from the development to Bells Creek. Stockland are awaiting the results of current research which involves a comprehensive review of all available stormwater quality data across Australia. If this research work finds that lower MUSIC pollutant export parameters are justified, then this will be adopted for Aura subject to agreement with Economic Development Queensland.

The stormwater treatment objectives (% load removal) presented in Section 3 were established as part of the Aura Development Stormwater Quality Management Plan (DesignFlow & BMT, 2019). The modelling which underpins Aura Development Stormwater Quality Management Plan (DesignFlow & BMT, 2019) establishes the allowable pollutant loads (kg/yr) which can be discharged to bells Creek from Aura. These loads were converted to % load removal to be consistent with previous compliance requirements for Aura. However, these objectives can be defined as allowable pollutant loads (kg/yr) rather than % removal. Stockland are planning to update the Aura Development Stormwater Quality Management Plan (DesignFlow & BMT, 2019) to present the objectives as both % load removal and allowable pollutant loads (kg/yr).

7 Conclusions

This document describes a stormwater quality management strategy for Aura Precinct 15 designed to meet required stormwater quality objectives.

This stormwater quality management strategy covers the 211ha area of Precinct 15 including the 20ha Land Lease Community. The development includes the creation of over 50's village, residential, small commercial, community, school, sports fields and recreational park land uses as well as a number of drainage corridors. An additional 10.57ha of Bruce Highway catchment is also considered in the modelling with two options presented for either bypassing or treating these flows.

This strategy proposes a comprehensive combination of treatment systems responding to the very high value receiving waters. It includes using rainwater tanks, gross pollutant traps and an innovative combination of precinct scale wetland and bioretention basins and a vegetated conveyance waterway. The treatment systems have been all be located within the constraints of site levels, available space and requirements for environmental buffers (e.g. frog habitat).

The treatment strategy meets the stormwater objectives for the Aura development, as defined in *Aura Development Stormwater Quality Management Plan* (DesignFlow & BMT, 2019), to ensure there are no adverse impacts on Bells Creek and Pumicestone Passage. This includes reducing annual pollutant loads by the required 95% for total suspended solids (TSS), 89% for total phosphorus (TP) and 68% for total nitrogen (TN).

8 References

Corrs Chambers McGrath (2015) *Caloundra South Infrastructure Agreement*

DesignFlow (2020) *Aura Precincts 11-14 Stormwater Quality Management Plan*

DesignFlow & BMT (2019) *Aura Development Stormwater Quality Management Plan*

Stockland (2017) *Caloundra South Wallum Sedge Frog Management Plan*

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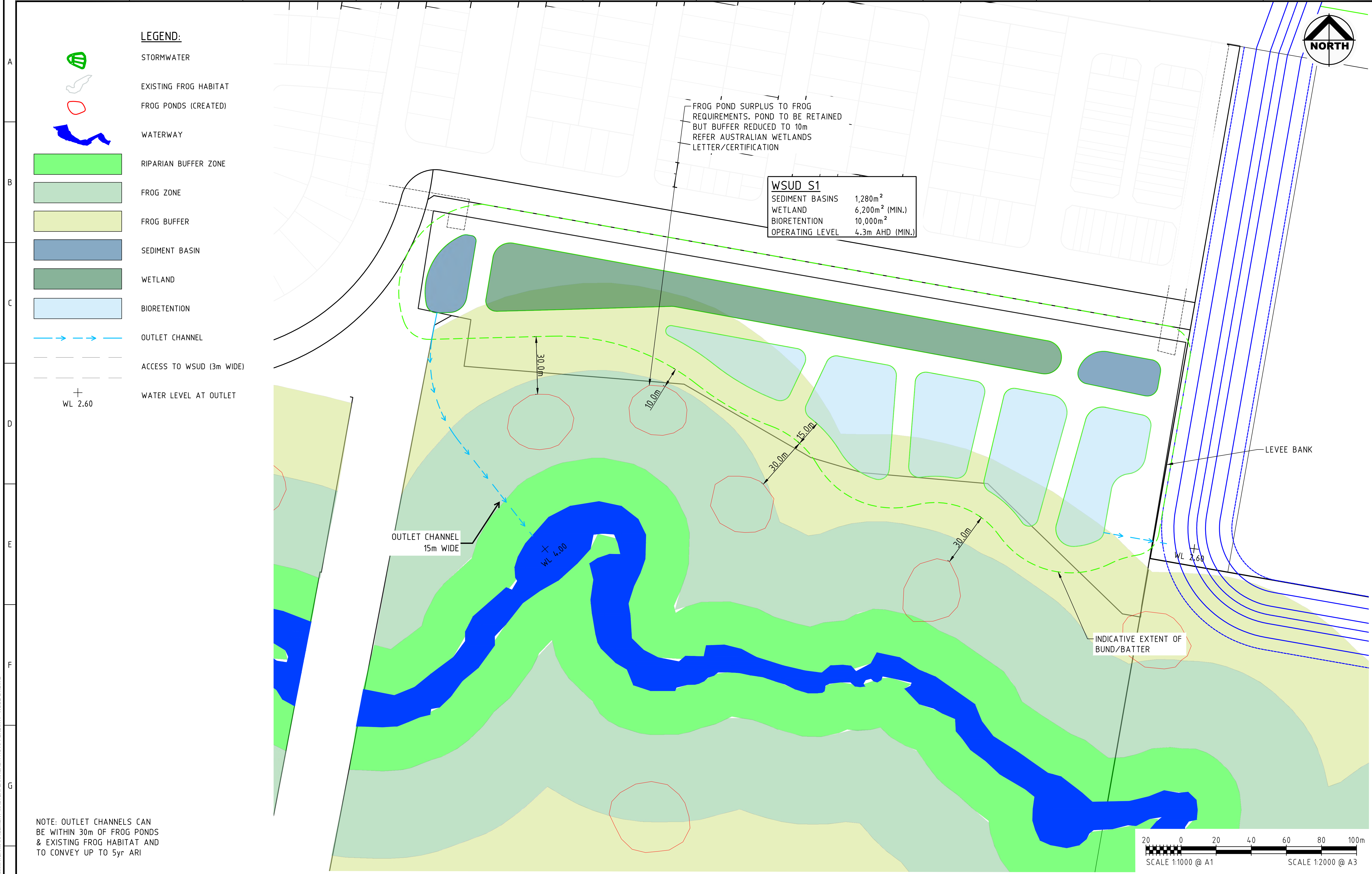
Appendix A: WSUD Concepts



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B	UPDATED PRELIMINARY DESIGN	SBY	09.06.22	SL	09.06.22
A	PRELIMINARY ISSUE	SBY	23.02.22	SL	23.02.22

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DRAWN	SBY — DATE 09.06.22
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PROJECT	AURA - STORMWATER PLANNING
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PROJECT No	4419
DRAWING No	APPENDIX A
REVISION	B

XREF:
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NOTE: OUTLET CHANNELS CAN BE WITHIN 30m OF FROG PONDS & EXISTING FROG HABITAT AND TO CONVEY UP TO 5yr ARI

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PROJECT No: 4419
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REVISION: B

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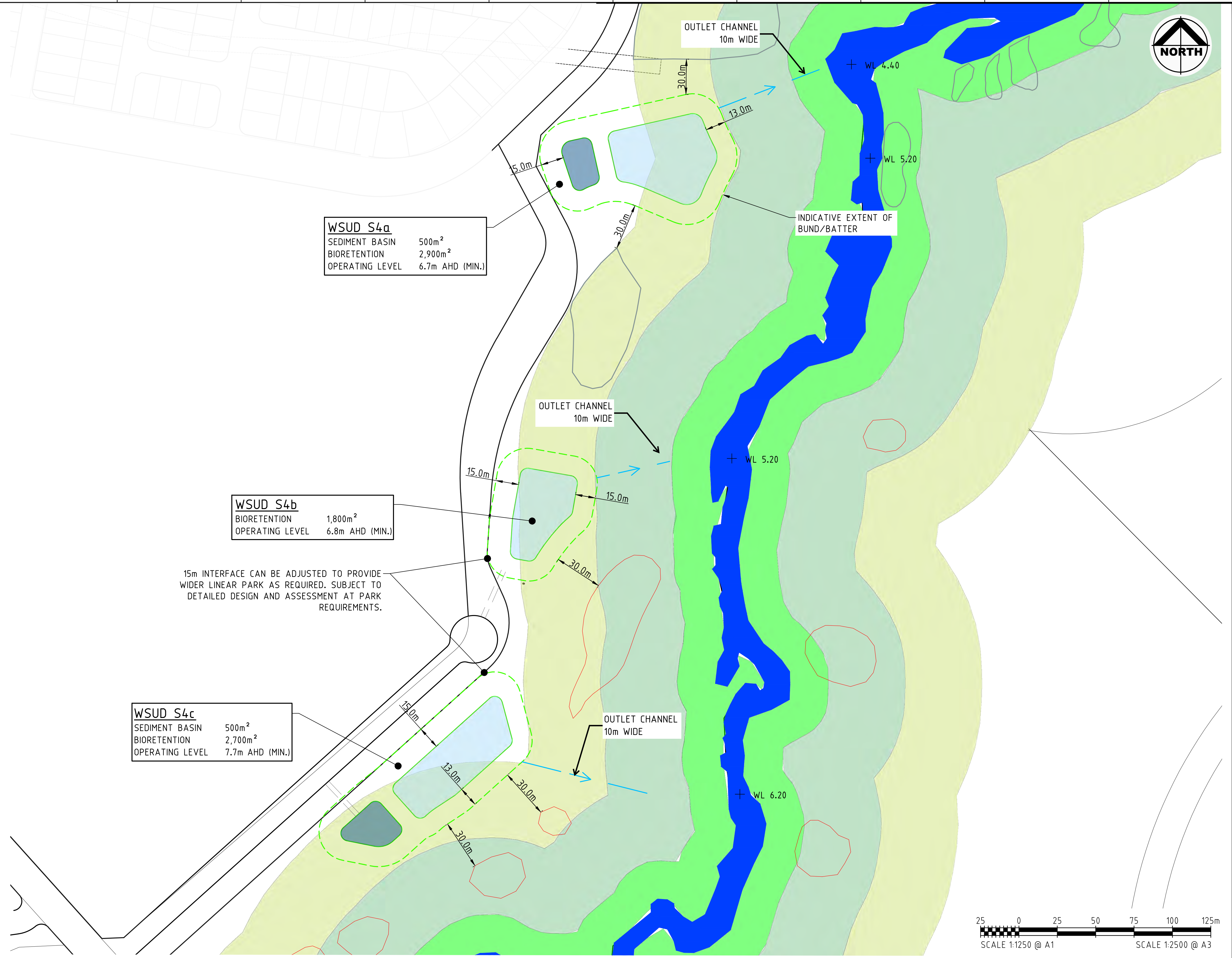
LEGEND:

- STORMWATER
- EXISTING FROG HABITAT
- FROG PONDS (CREATED)
- WATERWAY
- RIPARIAN BUFFER ZONE
- FROG ZONE
- FROG BUFFER
- SEDIMENT BASIN
- WETLAND
- BIORETENTION
- OUTLET CHANNEL
- ACCESS TO WSUD (3m WIDE)
- WATER LEVEL AT OUTLET (WL 2.60)



NOTE: OUTLET CHANNELS CAN BE WITHIN 30m OF FROG PONDS & EXISTING FROG HABITAT AND TO CONVEY UP TO 5yr ARI

25 0 25 50 75 100 125m

SCALE 1:1250 @ A1 SCALE 1:2500 @ A3

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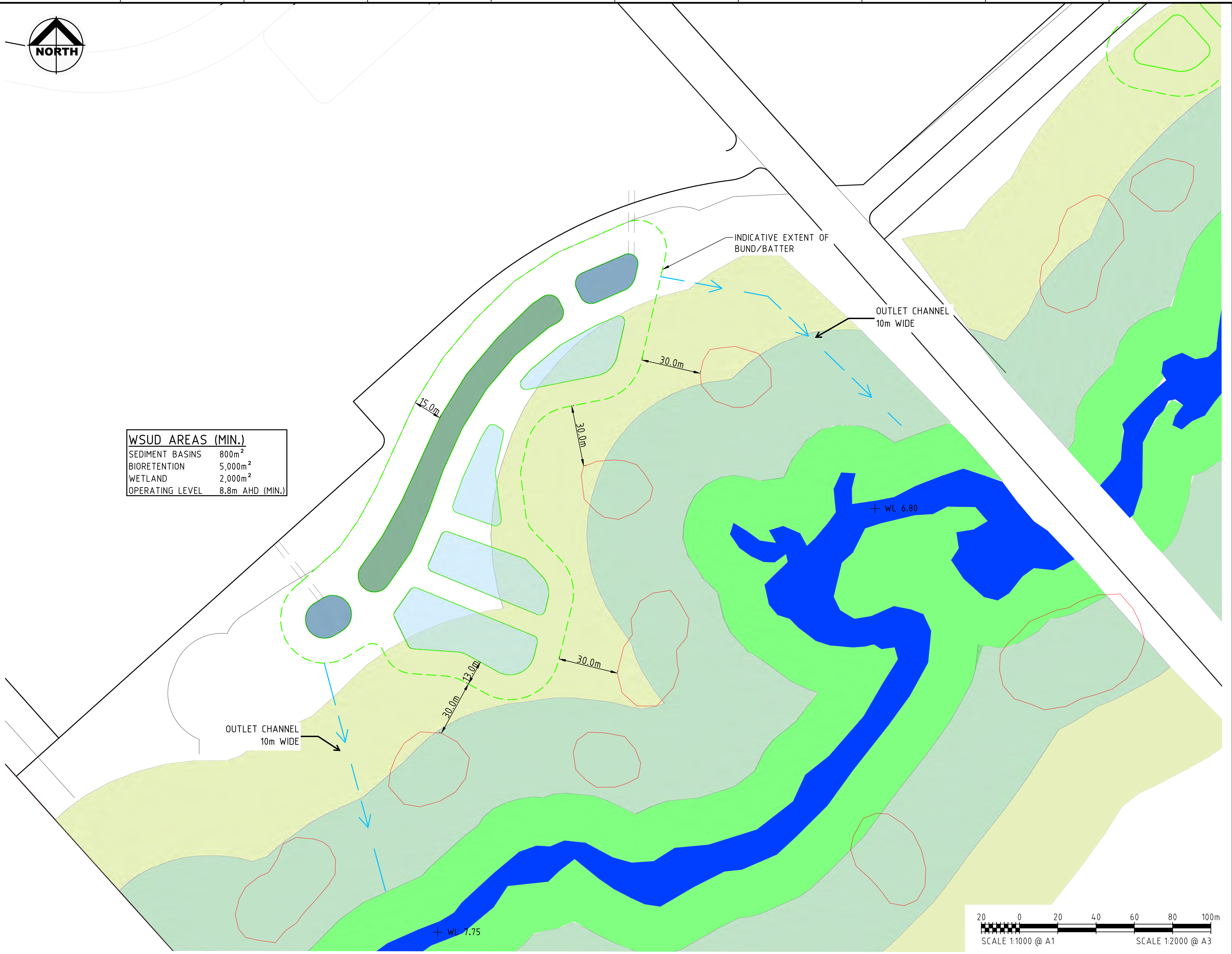
PROJECT No	4419
DRAWING No	APPENDIX A
REVISION	B

LEGEND:

- STORMWATER
- EXISTING FROG HABITAT
- FROG PONDS (CREATED)
- WATERWAY
- RIPARIAN BUFFER ZONE
- FROG ZONE
- FROG BUFFER
- SEDIMENT BASIN
- WETLAND
- BIORETENTION
- OUTLET CHANNEL
- ACCESS TO WSUD (3m WIDE)
- WL 2.60 — WATER LEVEL AT OUTLET

NORTH

WSUD AREAS (MIN.)	
SEDIMENT BASINS	800m²
BIORETENTION	5,000m²
WETLAND	2,000m²
OPERATING LEVEL	8.8m AHD (MIN.)



NOTE: OUTLET CHANNELS CAN BE WITHIN 30m OF FROG PONDS & EXISTING FROG HABITAT AND TO CONVEY UP TO 5yr ARI

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DRAWING No	APPENDIX A
REVISION	B

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