SPRINGWOOD COMMUNITIES

Springwood Urban Development

SPRINGWOOD PARK URBAN DEVELOPMENT

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Revision History

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APPENDICES

EXECUTIVE SUMMARY

A stormwater management strategy for the Springwood development has been prepared to apply a multi-objective approach to delivering sound environmental outcomes. This strategy adopts key objectives to minimise its environmental impact while also embracing the site's important attributes to take in opportunities for environmental enhancement. In this regard, this strategy is consistent with the following documents:

- Greening Australia (2019) Town of Gawler Biodiversity Management Plan, Draft 0.6, Town of Gawler (Note: Plan is not formally adopted and in Draft)
- Tonkin Consulting (2016) Gawler East Stormwater Instructure Study, Town of Gawler, Ref No. 20141387R001B
- Tonkin (2019) Gawler and Surrounds Stormwater Management Plan, Town of Gawler, Light Regional Council and Barossa Council, Ref. 20141387R006B (Note report is under consultation)
- EBS Ecology (2019) Springwood Flora and Fauna Assessment March 2019.

In addition to the above, this strategy has been developed to comply with Government Agency feedback following from direct engagement to define specific issues to be addressed by the strategy.

This strategy applies environmental stormwater management practices in the form of Water Sensitive Urban design (WSUD) to manage stormwater quality and frequent flow runoff from the proposed urban development. Refer to Table 1 for stormwater quality management summary. Given the challenging site, with all its encompassing physical and environmental constraints, this strategy has been developed using an iterative approach to resolve these issues at a master planning level. Therefore, this report should be considered with this context.

This strategy achieves stormwater quantity and quality standards while also ensuring that post development erosion risks would be appropriately addressed to protect and improve habitat values across the project. The strategy includes:

- Constructed wetland systems accommodating extended detention storages to treat and manage quality and quantity of stormwater
- Remediate Spring Creek at proposed wetland pools to improve the ecology & biodiversity and control in stream velocities post development. This includes the creation of a sequence of rock riffles and pools along the base of Spring Creek to ensure long term erosion stability and robustness when the adjacent catchment is developed. These techniques would be designed to mimic natural waterway design to include;
  - Incorporation of grade control structures (rock riffles)
  - Ensuring velocities are managed appropriately to prevent bed and bank erosion
  - Revegetation at proposed wetland pools to facilitate filtering, sediment deposition, nutrient uptake, erosion control, while also providing opportunities for increasing biodiversity and habitat value, and visual amenity
  - Supplementary vegetation planting within the existing marsh (zone B-C) using indigenous species (remnant species) to improve environmental value, mitigate flow velocity and improve the health of the marsh.
- The integration of the above features into passive recreation uses for the community benefit and visual interest

- Using the treatment train approach to stormwater management through the inclusion of:
  - Trash rack within Spring Creek to provide a regional scale trap to facilitate interception of debris and coarse sediments. This includes access for maintenance.
  - Wetland ponds, wetland systems, biofiltration basin, rain gardens and ecological sponge systems
  - Infiltration wells for rear of allotments (where these back onto gullies and Spring Creek). Infiltration wells are designed to cater for roof runoff only and incorporate trickle flow outlets to ensure storages are available to mitigate frequent rain events.
  - Linear wetland pools and reed beds (macrophyte zones) integrated into the base of Spring creek.
  - Each stormwater management system is designed to incorporate frequent flow management into their extended detention zone. This approach aims to release trickle flow over a 2 to 3-day period to reduce the responsiveness of the urban catchment to Spring Creek.
- Preservation of the Nationally Threatened iron-grass community and ensuring that the stormwater strategy does not encroach on this area through infrastructure that supports regeneration of this area.
- Preservation of remnant vegetation areas and faunal group habitats through additional planting with indigenous species of local provenance to enhance degraded areas.
- Protection of areas of high biological value, including the retention of trees and planting for appropriate regeneration, particularly as part of the waterway remediation and stormwater treatment elements.
- Mitigation of the 1% AEP post development flow from the overall proposed catchment down to the 1% AEP pre-development flow rate, with the resulting outcomes:
  - Storage volume = 18ML
  - The extent of inundation of the iron-grass community varies and is dependent upon where it occurs over the lower extents of its existing covered area
  - The extent of the iron-grass community varies between RL 58.50 to RL 73.00, with most of it lying above RL 63.00
  - No iron-grass communities are inundated for storms of less than 0.5 EY (equivalent to a 2-year ARI).
  - Duration of inundation is estimated at less than 2 hours for the 1% AEP post development storm event.
  - Peak 1% AEP storm event water level RL 65.9m AHD.
  - Storage is achieved within Spring Creek without the requirement to excavate or disturb the existing profile and vegetation. Noting that the disturbance is confined to the footprint of the new road crossing only
  - The culvert crossing would be designed using environmental principles and incorporate fish passage through the design of a partially submerged culvert.
  - The hydrology data and analysis are provided in Appendix D.
- An interim stormwater management strategy has been developed to suit the construction / implementation of Villages / Stages of development. The basis of this includes:
  - Using post development treatment systems as part of the construction phase sediment capture by excavating these systems for sediment capture, then reverting to post construction phase treatment systems.
  - Installation of a sedimentation basin (Basin A) within Spring Creek (located upstream of the marsh zone) which would intercept sediments during construction stages. This basin is provided as a last interception point.
  - SEDMP to be developed for each stage.

The overall stormwater management and treatment strategy for the development is included in Appendices A and B and summarised in Table 1 on the following page.

In summary, the proposed Stormwater Strategy for Springwood is intended to be part of the overall site master plan. Therefore, this report is high level however the approach has been formulated to be appropriately responsive to site constraints, gradients, physical features, and existing ecological values. This balance has produced a Stormwater Strategy that allows water to be treated to the required quality while value adding to the existing biodiversity value of regenerated and newly created habitat areas across the project.

Table 1: Stormwater Quality Management Summary

Sub Area Reference Number	Catchment sub area (Ha)	Treatment Measures	Stormwater Treatment Area (m^2)	Comments
1	1.73	Macrophyte Bed/Shallow Pond	400	Accommodate detention storage to 1%AEP
2	2.32	Wetland	500	Small scale wetland system
3	0.35	Precinct scale - Rain Garden	100	
4	0.21	Ecological Sponge	100	
5	0.3	Ecological Sponge	100	
6	1.26	Wetland Pond in Creek	250	Discharges directly to creek treatment system
7	0.3	Ecological Sponge	100	
8	1.25	Wetland Pond	200	
9	0.62	Macrophyte Bed/Shallow Pond	100	
10	0.23	Wetland pond	100	Discharges directly to creek treatment system
11	0.23	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
12	0.06	Macrophyte Bed/Shallow Pond in Creek	100	Roadway (only) discharges directly to creek treatment system
13	0.08	Wetland Pond in Creek	100	Discharges directly to creek treatment system
14	0.4	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
15	1.57	Wetland Pond	300	
16	0.37	Wetland Pond	100	
17	0.24	Wetland Pond in Creek	100	Discharges directly to creek treatment system
18	0.27	Macrophyte Bed/Shallow Pond in Creek	100	Discharges directly to creek treatment system
19	0.65	Wetland Pond	100	
20	0.31	Wetland Pond	100	
21	0.08	Wetland Pond	50	
22	2.24	Swale and Ecological Sponge	2 x 200	Linear system of swale and shallow marsh zones along the base of the escarpment
23	0.47	Wetland Pond	100	Tiered sequence of ponds
24	0.78	Wetland Pond	150	Tiered sequence of ponds
25*	0.49	No Treatment	-	Localised untreated catchment
26	0.62	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
27	0.76	Swale and Ecological Sponge	200	Linear system of swale and shallow marsh zones along the base of the escarpment
28	1.43	Wetland Pond	250	Tiered sequence of ponds
29	0.23	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
30*	0.43	No Treatment	-	Localised untreated catchment
31	2.55	Precinct scale - Rain Garden	400	
32	0.19	Ecological Sponge	100	
33	0.41	Ecological Sponge	100	
34	0.53	Ecological Sponge	100	
35	1.68	Wetland Pond	250	
36	0.4	Ecological Sponge	100	
37	0.237	Ecological Sponge	100	
38	0.23	Ecological Sponge	100	
39	0.31	Wetland Pond	100	
40	0.3	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
41	0.13	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
42	0.48	Ecological Sponge	100	
43	0.33	Precinct scale - Rain Garden	50	Combine with 44 if feasible
44	0.13	Precinct scale - Rain Garden	50	Combined with 43 if feasible
45	0.5	Ecological Sponge	100	
46	0.42	Ecological Sponge	100	
47	0.06	Ecological Sponge	50	

1 INTRODUCTION

1.1 BACKGROUND

Wallbridge Gilbert Aztec (WGA) was engaged by Springwood Communities to prepare a stormwater management strategy (strategy) for the proposed urban development at Gawler East (Springwood). The Springwood urban development (Development) is proposed on a rural parcel of land located on Calton Road (refer to Figure 1.1). The land is to be developed by Springwood Communities to comprise of urban development, which will consist of over 1400 allotments including commercial / town centre. A network of roadways and linked open space corridors, buffer zones and open spaces will be positioned throughout the Development. A first order tributary flows along the length of the development in an east / west alignment. The un named creek is referred to as Spring Creek for the purposes of this report.

WGA has prepared this strategy to be sensitive and responsive to local issues, to suit the physical nature of the site. This strategy applies methodologies to manage both the quantity and quality of stormwater from the proposed development.

The site features areas of high biological value, which this strategy considers to be highly sensitive by protecting, enhancing and remediating these important local environmental values. This follows an environmental study of the development areas that was undertaken by Kellogg Brown & Root Pty Ltd (KBR) over a 3-year period between 2008 – 2010 (KBR July 2010) and subsequently updated by EBS Ecology (2019) Springwood Flora and Fauna Assessment March 2019. These studies assessed and mapped the zones of the site that present an inherently high biological, ecological and habitat value. Following these studies, WGA undertook a detailed site walk along Spring Creek to identify its condition, opportunities and constraints, and its susceptibility to erosion risks.

The land area was the subject of previous stormwater management strategies from 2009 – 2014. This strategy draws on the previous work undertaken, with an updated strategy based strongly on employing a robust water sensitive urban design approach that considers the constraints, while also seizing on opportunities to enhance existing environmental values. It is also updated based on recent direct engagement with Council representatives and considers draft studies provided by Council. Refer to section 1.4 for the list of relevant documents considered in this strategy.

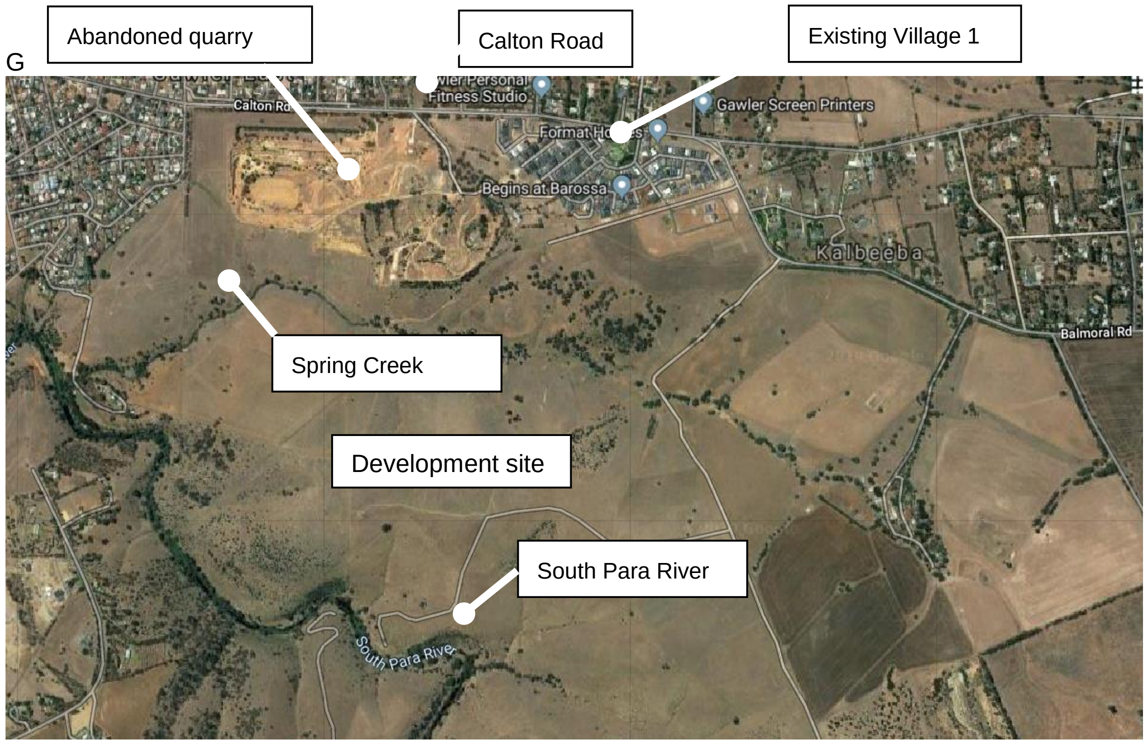

Figure 1.1: Site Location

1.2 SCOPE AND PURPOSE

The stormwater management strategy incorporates the principles of Water Sensitive Urban Design (WSUD). This strategy addresses the stormwater management requirements defined by Department of Environment and Water (DEW), Town of Gawler, The Barossa Council (Council) and by the Environment Protection Authority (EPA). These requirements apply to:

- Stormwater runoff volume and flow management;
- Quality of stormwater discharged; and
- The environmental aspects associated with stormwater, the receiving environment and its values.

These requirements have been defined through site investigations, and an engagement process with DEW, EPA and Gawler Council and therefore are specific to the Development.

The intent of this report is to provide the strategic basis for the multi-objective management of stormwater on the Development based on the following:

- A general overview of regional flood mitigation to manage post development flows to pre-development rates for the 1% AEP
- A general overview of the stormwater Internal network drainage design
- A general overview of WSUD and opportunities within the Development
- The management of stormwater within an overall risk management framework
- Selection of stormwater management techniques to deliver performance objectives and
- The staged implementation of the stormwater strategy.

The stormwater management strategy presented in this report is intended to demonstrate responsive performance outcomes. This is supported by preliminary calculations, modelling and a stormwater strategy layout. It has also been incorporated into the master plan that has been prepared for the Development by Tract.

This report summarises the investigation into developing opportunities for managing stormwater quantity and quality while ensuring that existing environmental values are protected and enhanced and degraded areas are remediated as part of the residential development. The scope of work included a desk top investigation, and from field verification with an Ecologist to identify opportunities, constraints and options for the environmental management of stormwater.

The key goals of this strategy are to manage the impacts downstream because of increasing stormwater runoff, incorporating treatment systems that will minimise the risk of potential adverse impacts on receiving environments, and sensitive habitat areas, while also ensuring that approaches result in an overall net benefit to the ecology and biodiversity of the area.

It is important to note that this report is a Strategy only, detailed design of individual stormwater management elements will be provided in a “Stormwater design report” for each individual land release through the life of the Development’s inception.

1.3 STORMWATER MANAGEMENT REQUIREMENTS AND REFERENCES

The following listed Authorities were engaged through several open meetings to discuss aspirations and specific requirements for the Development site. These have been outlined below.

Department of Environment and Water

A meeting was undertaken to define key issues, requirements as well as an understanding of the opportunities and constraints associated with the proposed development. There are several issues that are guided by DEW that must be considered in the context of this stormwater management strategy. In their response during the pre-lodgement engagement process, DEW identified their minimum requirements as follows:

- Stormwater treated to WSUD pollutant reduction targets;
- Sediment and other primary pollutants trapped and treated within the development;
- Erosion control through the management of flow velocities for low and high flows;
- Cautionary advice was given in relation to the positioning of stormwater treatment systems within the flood plain of South Para River due to the risk of damage during high flow events along this major river system;
- No discussion in relation to native vegetation as this will be referred to a different department; and
- Protect high value in stream habitat areas and provide opportunities to enhance existing environmental value.

These requirements define the approach taken for the stormwater strategy. Other management requirements are outlined in this strategy as deemed necessary to address any specific and identified risks in Section 3.

Environment Protection Authority

Three pre-lodgement engagement meetings were undertaken with the EPA Officers. The meetings were undertaken to define key issues, requirements, and discussions in relation to the site's constraints and existing environmental values. There are several issues that are guided by EPA that must be considered in the context of this stormwater management strategy. In their response during the pre-lodgement engagement process, the EPA identified their minimum requirements as follows:

- Stormwater treated to stormwater quality targets (see below for outline);
- Sediment and other primary pollutants trapped and treated within the development;
- Erosion control through the management of flow velocities for low and high flows;
- Stormwater treatment through Spring Creek is permitted, provided that all water targets are met upstream of the marsh zone;
- Interim stormwater management strategy to suit the staged implementation of the development;
- Water quality modelling to be reported at each of the following locations:
  - at each outlet into Spring Creek;
  - upstream of the creek marsh zone; and
  - overall development (western outlet – averaged result).

The EPA adopts the WSUD management approach which essentially define their requirements, which relate to management of both stormwater quantity and quality.

The EPA's minimum requirements are as follows:

- Run-off rates should not exceed the rate of discharge from the site that existed pre-development;
- Water quality treatment reduction targets of the typical urban average annual load as follows
  - Total Suspended Solids (TSS) 80%,
  - Total Phosphorus (TP) 60%,
  - Total Nitrogen (TN) 45%,
  - Retention of litter greater than 50mm for flows up to a 90% AEP peak flow,
  - No visible oils for flows up to a 90% AEP peak flow.
- Environment Protection Policy (Water Quality) 2015, under the Environment Protection Act, 1993.

Based on the EPP Water Quality (2015) for fresh water environments, the listed pollutant concentrations will be used as the limiting targets in the stormwater discharge. These are based on the general water quality criteria listed EPP (2015) and are listed below for reference.

EPP Water Quality (2015) Criteria

- Total Phosphorous = 0.5 mg/L
- Total Nitrogen = 5 mg/L
- Suspended Sediment = 20 mg/L

Town of Gawler

Further to the EPA and DEW requirements outlined above, there are several general Council aspirations. While here are no specific policies relating to stormwater management, through the engagement process the strategy has given due consideration of Council's feedback.

Following two pre-lodgement meetings with Gawler Council staff the following aspirations are listed below. These include:

- Run-off rates should not exceed the rate of discharge from the site that existed pre-development for 1% AEP;
- The Strategy should be prepared to be consistent with Council's stormwater management aspirations and draft biodiversity plan;
- Concerns raised about the removal of in stream vegetation for a proposed roadway crossing with culvert; and
- Stormwater treatment to meet WSUD targets.

1.4 REFERENCE DOCUMENTS

The following draft and non-finalised documents were provided by Council to provide consistency between the proposed Strategy and Council's aspirations. These are:

- Greening Australia (2019) Town of Gawler Biodiversity Management Plan, Draft 0.6, Town of Gawler (Note; This is a Draft)
- Tonkin Consulting (2016) Gawler East Stormwater Instructure Study, Town of Gawler, Ref No. 20141387R001B
- Tonkin (2019) Gawler and Surrounds Stormwater Management Plan, Town of Gawler, Light Regional Council and Barossa Council, Ref. 20141387R006B (Note this document is currently in consultation and not final)

The stormwater management strategy is developed to encompass the design criteria in accordance with the following recognised references:

- EPA Environment Protection Act 1993, (Water Quality) Policy 2015 (WQ EPP 2015)
- WSUD Engineering Procedures – Stormwater (2005)
- Australian Runoff Quality, Engineers Australia (2006), and
- Water Sensitive Urban Design - Greater Adelaide Region Technical Manual (Dec 2010).

These handbooks and guidelines are considered as Australian and South Australian standards and cover all aspects of stormwater management. This includes the design for major and minor storm flow, and stormwater quality improvement. The Stormwater Management Strategy adopts the design standards, principles and practices covered by the handbooks.

2 CATCHMENT OVERVIEW

2.1 EXISTING SITE AND CATCHMENTS

The site is located within both the Town of Gawler and Barossa Council, and lies to the east of the Gawler township, as shown in Figure 1.1. The site includes a central drainage tributary (first order) with small connected flow paths. For the purposes of this report, the central tributary is referred to as Spring Creek. To the south western side of the land lies the South Para River flanking the development site.

A cadastral and topographic map of 1:5,000 with 2 m contours for the region was obtained from Mapland to assess the catchments throughout the site area. Existing land use information was derived from site observations and inspection of aerial photography and field verification. The catchment areas generally comprise of cleared rural areas used predominantly for grazing and agriculture and a disused quarry. Numerous deep and shallow valleys intersect the site as well as major infrastructure including an above-ground 750mm diameter Barossa trunk water main, SEA Gas pipe line and major overhead electricity.

The site was previously used for sand mining, which is understood to have ceased operations in 2000. Because of the sand mining activities, the natural landscape has been modified significantly.

Numerous small valleys drain into Spring Creek that flows from East to West through the centre of the site. Land slope varies approximately from 5 - 11% on the upper slopes, to 15 - 25% within the lower valley areas near Spring Creek. The existing quarry is located within north-west portion of land.

Part of the southern land area drains directly into the South Para River via a steep valley. Land slope varies approximately from 8 - 11% on the upper slopes, to 15 - 30% within the lower valley areas.

2.2 SOILS AND GROUNDWATER SETTINGS

Regional soils

The Geological Survey of South Australia (1:100,000 Barossa sheet) indicates that upper natural soils around the site of the existing sand mine are likely to comprise Tertiary aged sands.

To the south of the sand mine the site is underlain at shallow depth by weathered bedrock (Woolshed Flat Slate), which contains seams of quartz. Majority of the site is underlaid with medium and high plasticity clay and sandy clay with calcareous pockets

Groundwater setting

There are 3 main north south trending faults over the Northern Adelaide Plains (NAP), the Para Fault occurs along the entire length of the eastern margin of the NAP and south passing through North Adelaide and extending offshore near Glenelg and Adelaide Airport. In the north-eastern quadrant of the NAP, south of Gawler township, the Para Fault splinters and a smaller fault, the Alma Fault trends due north to Roseworthy. The Redbanks Fault trends north-north east / south-south west, extending offshore from St Kilda and passing to the east of Virginia township and north through Redbank's township.

Figure 2.1 presents a representative cross section of the NAP

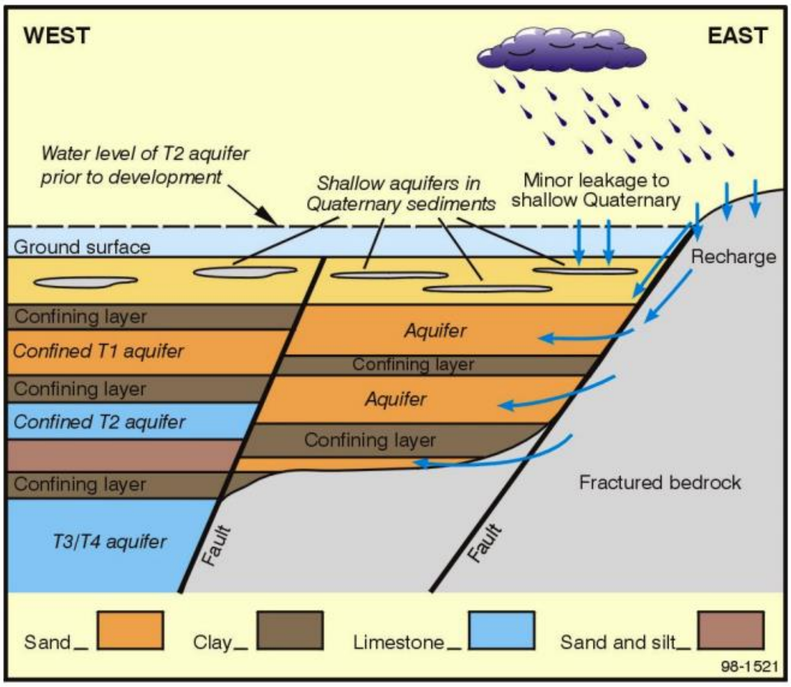

Figure 2.1: Cross Section of the Northern Adelaide Plains (source: Northern Adelaide Plains Water Allocation Plan)

The project site is located to the east of the Para Fault as depicted on the West to East Geological Cross Section presented in Figure 2.2. The local geology generally consists of Quaternary sediments overlying Fractured Rock of the Mount Lofty Ranges.

The Quaternary sediments in this location typically consist of Hindmarch Clay and / or sands and gravels of the Q1 Aquifer which is the primary target of the former quarry located to the north. The most transmissive sections of the Q1 Aquifer and areas of low salinity (400 to 1,500 mg/L (NABCWMB, 2000)) are usually located adjacent to major bedrock structures or surface drainage lines. This aquifer is not commonly used for commercial supplies due to low yields (NABCWMB, 2000). The thickness of the Quaternary sediments varies depending from 8 to 40 m depending (source: Water Connect Database accessed 15.05.2019). The underground water dependent ecosystems associated with the Little Para River environment include riparian communities dominated by river red gums and a diversity of in-stream vegetation. Other ecosystems dependent on underground water include fauna communities living in the shallow sand Q1 Aquifers and water course sediments (NABCWMB, 2000).

Underlying the Quaternary sediments is the Fracture Rock Aquifer, predominantly described as slate in this region (Source: Water Connect Database accessed 16.05.2019). The aquifer is brackish to saline in regions with yield between 4 and 10 L/s. The depth to groundwater ranges between 10 and 40 m below ground level depending on location.

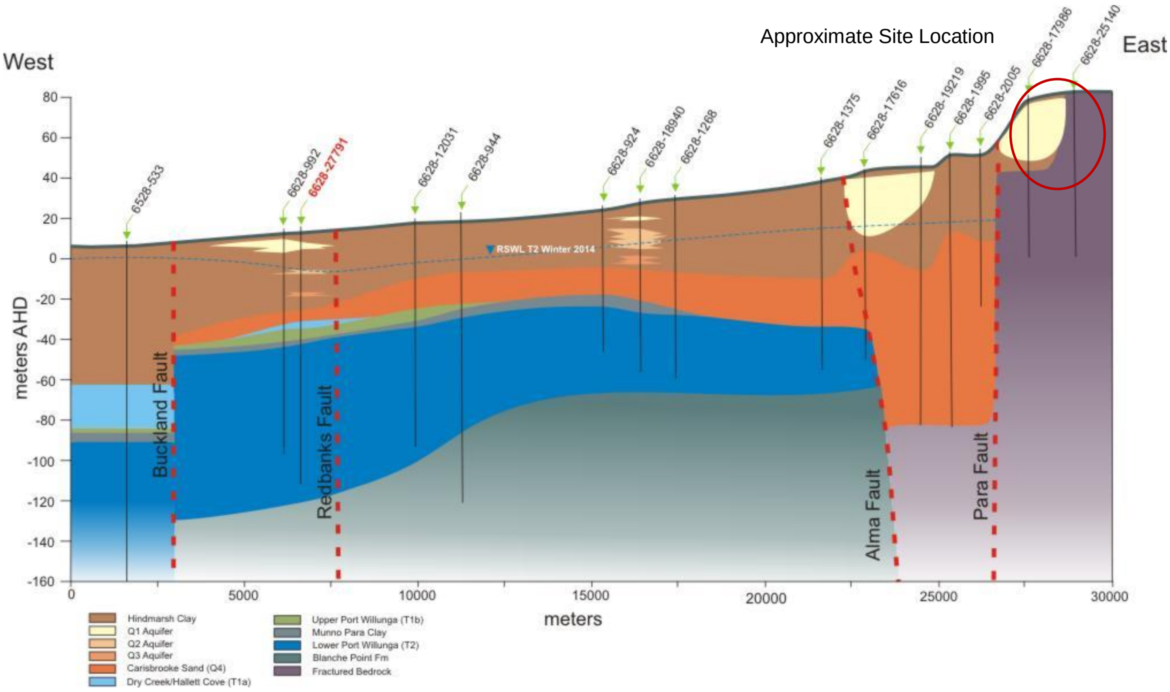

Figure 2.2: West to East cross section through northern NAP

Northern Adelaide and Barossa Catchment Water Management Board, 2000. Northern Adelaide Plains Prescribed Wells Area.

2.3 EXISTING KNOWN ASSETS

Given the rural nature of the locality, the site is not serviced by existing stormwater infrastructure. Several minor and major watercourses and valleys traverse the site. Generally, most of the site will eventually drain into the South Para River. However, smaller catchments have been identified which will drain through to existing adjacent Calton Road.

An assessment of existing site assets is discussed in WGA Infrastructure report (2019).

2.4 EXISTING VEGETATION AND ENVIRONMENTAL VALUES

A field assessment was undertaken by EBS Ecology (EBS) 2019 to identify native vegetation and sensitive areas of biological significance that should be avoided where possible. These key areas of remnant vegetation include:

- Mallee box;
- Flinders Ranges worm lizard;
- Iron grass;

- Eucalypts scattered along Spring Creek; and
- Marsh within Spring Creek along the western reach (west of the watermain crossing) comprising native sedge and reed species.

2.5 DEVELOPMENT OVERVIEW

The proposed development will comprise over 1400 allotments of mixed sized urban allotments and a town centre and significant open space over a total land area of 168.5 Hectares. Allotments include many super conventional lots, as well as conventional, traditional, courtyard, villa and terrace sized. The development will include a large network of open spaces, buffer zones and a wide central open space corridor along Spring Creek. There are proposed roadway corridors that are also incorporated into linear open spaces that will provide green corridors. These corridors will offer opportunities for integrated multi use spaces incorporating Water Sensitive Urban Design initiatives.

Figure 2.3 below depicting a preliminary site plan is provided as a guide only. It should be noted that this is subject to change.

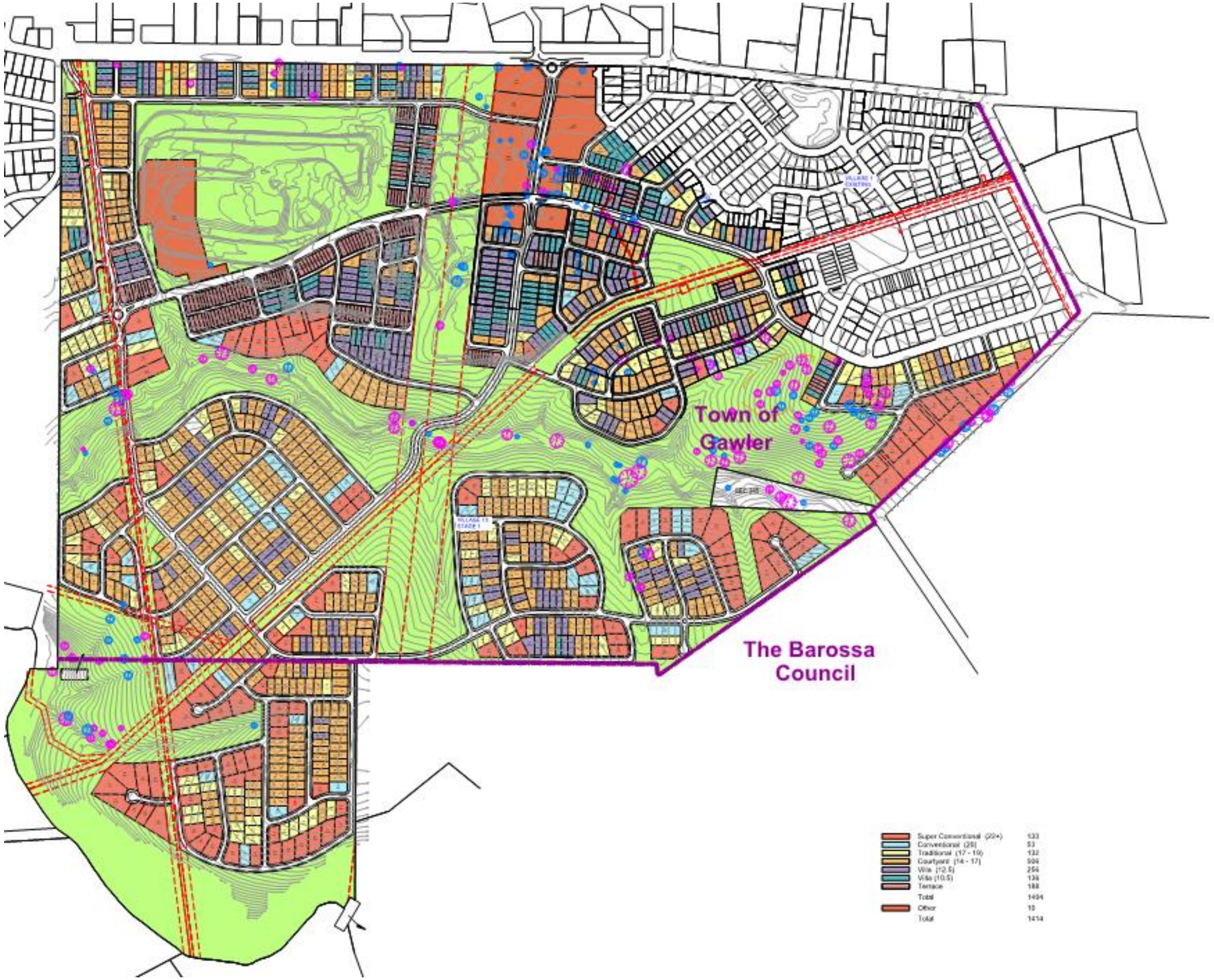

Figure 2.3: *Preliminary allotment layout*

3 IDENTIFICATION OF RISKS AND OPPORTUNITIES

3.1 RISK MANAGEMENT

This risk management process aims to determine the potential nature, scale and likelihood of any impacts on water quality, erosion and degradation of the receiving environment during the design, construction and operational phases of the development. This process is undertaken to assist in identifying appropriate management strategies to manage the project impacts, and / or determine if intervention is required to manage risks. The main steps in the risk management process are:

- Identify risks – as determined by the site and its characteristics;
- Analyse risks – how likely is it to happen, what are the likely consequences;
- Evaluate risks – against the likelihood and consequence matrix; and
- Treat risks – prioritise, address and mitigate identified risks through the adoption of mitigating strategies.

This Risk Management process covers the proposed development, with more detail focussed on using the proposed WSUD strategy to manage risks. The information sourced to inform this risk management process comes from site inspections and various technical reports / studies that have been undertaken for the site. These reports have been based on investigations relating to site characteristics including groundwater, vegetation, ecology, biodiversity, soils, and infrastructure. Following a review of these studies and the land area, the risk assessment has been prepared for each phase of the project. This is presented in Tables 3.2 to 3.4. The likelihood and consequence matrix are provided below in Table 3.1 for reference.

Table 3.1: Likelihood and Consequence matrix

	CONSEQUENCE		
LIKELIHOOD	**Low** Minor adverse social or environmental impact	**Medium** Measurable adverse environmental or social impact. Will result in annoyance or nuisance to community	**High** Significant damage or impact on environmental systems and local community
Low The event could occur only rarely, or is unlikely to occur	Low Risk	Low Risk	Medium Risk (could be high)
Medium The event will occur occasionally or could occur	Low Risk	Medium Risk	High Risk
High The event will occur often or is most likely to occur	Medium Risk	High Risk	High Risk

Table 3.2: Design phase risk management process

1. DESIGN PHASE							
ID	**Issue**	**Potential Impact**	**Likelihood**	**Consequence**	**Level of Risk**	**Response / Management Measure**	**Notes**
A	Flooding - local catchment	Increased flooding potential due to increased impervious areas	low	High	Medium	Drainage systems (including culverts, drainage networks, kerb and channel and open drains) shall cater for 20% AEP storm events, with a one in 1% AEP storm event checked for overland flooding through flow paths. The system shall have enough capacity to accommodate the design drainage flow in accordance with the drainage requirements and without causing damage or nuisance to adjacent landowners and properties.	Drainage network designed in accordance with Council standards
B	Increased erosion along watercourses	Scouring and erosion associated with increased velocities, peak, volume of water	High	High	High	Drainage outlets to incorporate rock pitching, energy dissipation and vegetation. The strategy aims to control velocities and stream power that is based on establishing a pool and riffle sequence and re-vegetation to restore natural waterway function and values. Target existing degraded sections and erosion hotspots using naturalistic design principles.	Outlets to be specially located to suit site conditions as part of design process. Incorporate pool and riffle sequence to control stream power and stabilise the bed. On site mapping has been undertaken to identify existing erosion and areas void of vegetation. A longitudinal section along the creek bed has been plotted to assess bed gradients. These areas have been targeted as part of the strategy for pool, rock riffles and wetland ponds and macrophyte zones.
C	Shallow ponding / stagnant water conducive to mosquito breeding within Watercourse	Nuisance issues, health risks to community	Low	Low	Low	Incorporate naturalistic design principles in waterway design to establish natural function, habitats and ecological values. These systems encourage natural predation of mosquitos and therefore it is not expected to pose a problem.	Rehabilitation design will be undertaken as part of detailed land division design process. Rehabilitation design will incorporate a pool and riffle sequence for stormwater treatment, erosion control and to stabilise the bed again stream power. The design will use best practice naturalistic design principles and will incorporate vegetation to create habitat and biodiversity values to encourage the survival of natural fauna.
D	Loss or removal of in stream vegetation	Increase erosion risk and loss of habitat	Medium	Medium	Medium	Retain all in stream and riparian native vegetation, including trees and understorey plants and ground covers. Enhance existing vegetation by planting additional to complement, protect and restore existing degraded areas. Watercourse works strategy is based on protecting native vegetation and only targets sections that are highly degraded, void of vegetation or that are weed infested.	A detailed walk along the watercourse was undertaken to identify sections and locations of native vegetation. These areas will remain undisturbed as part of the strategy. However where necessary erosion control measures will be provided.
E	Impacts to existing highly sensitive biological areas in-stream (reed beds)	Degradation of environmental values	Medium	High	High	Areas of high biological value have been extensively mapped and subsequent field inspections. These areas have been set aside to be protected and or enhanced by incorporating supplementary re-vegetation to enhance the protection zones.	Protect and enhance the existing environment values the basis of the stormwater management strategy
F	Impacts to iron grass community and to the worm lizard habitat	Inundation resulting from detention storage	Medium	High	High	The extent of iron grass community has been surveyed and mapped. Plotted onto the plan showing the detention storage extents. Refer to stormwater management strategy (plan). Areas containing exposed rock and cracks / fissures which are most likely to be habitat for the worm lizard are protected. No works occur near these valuable habitats. These areas are not inundated with water resulting from the detention storage.	Existing high value biological areas will be protected as part of the development and the stormwater management strategy
G	Waterway function – Spring Creek	Decrease in waterway function due to changes to hydrological regimes, sedimentation, erosion, water quality	High	High	High	The application of WSUD principles through the urban development will reduce the hydrological responsiveness of the catchment to the watercourse. The use of wetland ponds and systems and biofiltration basins will be designed to manage pre and post flow rates for the 90% AEP event. This ensures that all the frequent events are controlled within the catchment to limit the rate of flow through the watercourse. The watercourse will be remediated as part of the strategy to incorporate pool and riffle sequences and extensive revegetation to create a robust and environmentally sustainable environment. The design approach is sensitive to protecting existing environmental values, while using measures and techniques to rehabilitate existing areas that are eroded and void of vegetation.	Minor detention within the development is used to attenuate minor flows to enhance stormwater treatment. Trickle flows are released from treatment systems to reduce the connectivity of the catchment to the waterways.

H	Water Sensitive Urban Design - upper catchments	Runoff quality leads to long term water quality impacts to receiving environments	Medium	Medium	Medium	Project based treatment design using treatment train approach. The design and layout for stormwater treatment systems will follow the rationale and design features associated with artificial wetlands and naturalistic waterway design principles. The treatment flow adopted in the design will be based on a 90% to 63% AEP peak discharge rate from the Local catchment. Statistically this will allow for 98% of all annual rainfall and daily runoff events from the Local catchment to receive treatment to the best practice standards. Any flows of a higher rate above the 63% AEP would still pass through a stormwater treatment pond and receive some treatment. Treatment will achieve reductions in total pollutant load from the contributing roadway catchment. The EPA seeks the following pollutant reduction targets. -80% reduction of total suspended solids (TSS). -60% reduction of total phosphorus (TP). -45% reduction of total nitrogen (TN). -90% reduction of gross pollutants, and retention of litter greater than 50mm for up to the 90% AEP peak flow. -Oil and grease, no visible oils for flows up to the 90% AEP peak flow. Additionally, EPP Water Quality Criteria include: -Total phosphorous = 0.5 mg/L -Total nitrogen = 5 mg/L -Suspended sediment = 20 mg/L -Gross pollutants = Not specified (Adopt 100% removal)	**MUSIC modelling used to verify treatment systems adopted in design. Design demonstrates meets targets as specified Using best practice criteria for pollutant reduction targets and checked against EPA Water Quality Policy (2003)
I	Water Sensitive Urban Design - lower catchments	Steep topography limits the ability to treat runoff. Runoff quality leads to long term water quality impacts to receiving environments	Medium	Medium	Medium	Provide stormwater treatment where feasible out of the waterway corridor. Use waterway corridor to supplement treatment while also integrating wetland ponds and macrophyte zones into the watercourse as part of the rehabilitation. This approach aims to deliver an integrated solution based on the catchment constraints to provide a net overall benefit to the watercourse which is degraded.	**MUSIC modelling used to verify treatment systems adopted in design. Design demonstrates meets targets as specified Using best practice criteria for pollutant reduction targets and checked against EPA Water Quality Policy (2015)

Table 3.3: Construction phase risk management process

2. CONSTRUCTION							
ID	**Issue**	**Potential Impact**	**Likelihood**	**Consequence**	**Level of Risk**	**Response / Management Measure**	**Notes**
A	Sedimentation	Sedimentation impacts on receiving water quality: - increase in turbidity / total suspended solids / total dissolved solids - to aquatic ecosystems by reducing light and smothering organisms	High	medium	High	SEDMP Use treatment systems which are designed as part of operations phase as temporary sediment basins and flow control measures during construction. Incorporate sediment basins during construction phase Proposed sediment basin in Spring Creek as a last point of defence before flows head downstream	Develop a SEDMP using a risk-based approach due to steep topography
B	Vegetative matter	Increase in natural organic matter impacts on receiving water quality including: - increase in Nitrogen / Phosphorus and reduced oxygen levels - algae outbreaks and eutrophication - visual / surface scum	Low	Medium	Medium	SEDMP and as above	
C	Gross pollution (litter)	Impacts on receiving waters: - visual / aesthetics - decreased water quality	Medium	Low	Medium	Construction Environmental Management Plan (CEMP)and SEDMP as per above Waste recycling and reuse	
D	Accidental spills (including hazardous materials)	Impacts on receiving water quality: - increased toxicity - aquatic flora death / breakdown and increases in organic matter - aquatic fauna death / breakdown and increases in organic matter	Low	Medium	Medium	CEMP	
E	Hydrocarbons	Impacts to water quality including: - increased toxicity - algae outbreaks and eutrophication - visual / surface scum	Low	Medium	Medium	CEMP	
F	Accidental spills and/or release of contaminated soil into groundwater systems	Contamination of watercourse	Low	High	Medium	CEMP	
G	Temporary changes in direction and flow of surface water and groundwater	Pooling in undesirable areas, including excavations.	Low	Low	Low	CEMP	
H	Increased volume of surface water flow	Increased turbidity levels in receiving channels for excessive sediment accumulation within the bed of channel	High	Medium	High	CEMP Temporary drainage systems required during the construction of the works to direct flows into sediment traps and basins as part of SEDMP	Develop a SEDMP using a risk-based approach due to steep topography
I	Increased volume of surface water flow	Increased turbidity levels in receiving channels for excessive sediment accumulation within the bed of channel	Medium	Medium	Medium	CEMP Temporary drainage systems required during the construction of the works. Sedimentation basin to intercept all flows.	

Table 3.4: Operations (post construction) phase risk management process

ID	Issue	Potential Impact	Likelihood	Consequence	Level of Risk	Response / Management Measure	Notes
3. OPERATIONAL - POST CONSTRUCTION							
A	Urban stormwater pollution	Impacts to water quality including: - increased toxicity - accumulation in aquatic sediments	High	Medium	High	Project based stormwater treatment design e.g. drains, wetlands, treatment train approach. Maintenance and monitoring of system to achieve design outcomes.	
B	Hydrocarbons	Impacts to water quality including: - increased toxicity - algae outbreaks and eutrophication - visual / surface scum	medium	Medium	Medium	Design response. Stormwater treatment systems	
C	Sediment	Impacts on receiving water quality: - increase in turbidity / total suspended solids / total dissolved solids - to aquatic ecosystems by reducing light and smothering organisms - release of associated metals and nutrients.	Medium	Medium	Medium	Project based stormwater treatment design e.g. sediment ponds. Treatment systems	
D	Nutrients	Impacts on receiving water quality: - increase in Nitrogen / Phosphorus and reduced oxygen levels - aquatic flora death / breakdown and increases in organic matter - aquatic fauna death / breakdown and increases in organic matter	Low	Medium	Low	Design response. Stormwater treatment systems	
E	Vegetative matter	Increase in natural organic matter impacts on receiving water quality including: - increase in Nitrogen / Phosphorus and reduced oxygen levels - algae outbreaks and eutrophication - visual / surface scum	Low	Medium	Low	Maintenance Provision of a regional trash rack within Spring Creek	
F	Gross pollution (litter)	Impacts on receiving waters: - visual / aesthetics - decreased water quality	Medium	Low	Low	Maintenance Provision of a regional trash rack within Spring Creek	
G	Increased runoff volumes due to increased impermeable surfaces	Impact to flow regimes and function of receiving waters	High	Medium	High	Using WSUD techniques to slow rate of runoff through wetland ponds and systems and pool and riffle sequence in watercourse Revegetate watercourse with indigenous plant species to slow velocity and reduce stream power, protect from erosion, and restore habitat and environmental values	

3.2 STRATEGIES TO MANAGE RISK

The response measures are outlined in the Risk Management Tables 3.2 to 3.4 inclusive for the overall development is describe in more detail below. In addition to these management measures, the Construction Contractor will be required to prepare a Construction Environmental Management Plan (CEMP) including a Soil Erosion and Drainage Management Plan (SEDMP). These are further discussed in Sections 3.3 and 3.4.

Water Sensitive Urban Design (WSUD)

A design framework that uses the principles of WSUD to manage risks is a widely accepted approach to manage stormwater in an environmentally sensitive manner. In this regard the design of distributed WSUD elements throughout the development would incorporate a multi-objective approach to stormwater management that will also include infiltration measures where feasible. This main corridor would be interconnected with branches from the side roads also featuring green linkages. As part of this project a WSUD strategy will provide the approach to provide additional stormwater management benefits such as providing an additional buffer to the function of the wetland system. Such benefits will provide a robust and multi-barrier strategy centering on achieving higher levels of stormwater treatment and attenuation.

Principles within the WSUD framework are proposed for:

- Improving quality of stormwater runoff, and along the stormwater conveyance network;
- Managing the rates of runoff for regular rainfall events through attenuation via green systems (Frequent flow management);
- Managing the volume of runoff for < 90% AEP events where feasible through infiltration systems;
- Protection of existing downstream areas designated as high biological significance by creating opportunities for these values within the development’s green corridors as well as using WSUD within the open spaces to extend exiting vegetation groups;
- Enhancement in amenity, environmental values, habitat and biodiversity;
- Using operation phase WSUD system to operate during construction phase sediment basins;
- Protect Spring Creek from the high risk of erosion that will be a result of urbanisation by integrating rock riffle and pool sequences to control bed gradient and stream power;
- Sedimentation basin within Spring Creek as a major sediment interception point to protect downstream environmental values;
- Avoid works in areas identified as high environmental value and protection areas; and
- Adopt a sequence of wetland ponds within Spring Creek to manage velocities, provide additional treatment, and to provide opportunities for off-set planting.

3.3 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP)

The Constructor is expected to be prepare a CEMP which address construction phase work to mitigate the risks associated with construction. The CEMP is expected to have contents like that listed as follows:

OVERVIEW

INTRODUCTION

Project Scope

Purpose

ROLES AND RESPONSIBILITIES

PROJECT ENVIRONMENTAL PROCESS

Environmental Management System

Induction and Training

Contractor and Subcontractor Management

Communication

Feedback and Enquiries

Document Control

Monitoring, Inspection and Audits

Emergency Preparedness and Response

Incidents/non-Compliance Reporting

Reporting and Review

Environmental Control Planning

PROJECT ENVIRONMENTAL OBJECTIVES

KEY ENVIRONMENTAL RISKS AND CONTROLS

Noise and Vibration

Air Quality

Water Quality – Sediment, Erosion and Drainage Management

Waste Management

Dangerous Goods Storage

Energy Use and Greenhouse Gas Emission/Sustainability

The Construction Environment Management Plan will be prepared by the Construction Contractor (for each stage of the development) and will be prepared in consultation with Gawler and Barossa Council prior to construction. The CEMP will incorporate a SEDMP, which will form an important part of the site management during the construction phase. It is expected that the SEDMP will be developed using a risk-based approach that considers all contributing site physical factors that contribute soil erosion. The CEMP will be prepared by the Construction Contractor and therefore not covered in this report. A preliminary SEDMP is not covered in this report in detail, however guidance is provided in Section 3.4. Furthermore, the detailed engineering design of each stage will include the preparation of site specific SEDMP to provide guidance to Construction Contractor to plan and develop the CEMP.

3.4 MANAGEMENT OF CONSTRUCTION SEDIMENT LOADS

Overview and context setting

During the construction phase of the development a Soil Erosion and Drainage Management Plan (SEDMP) shall be implemented in accordance with the Environment Protection Act 1993. A plan will be prepared to meet the requirements in accordance with the Code of Practice for the Construction and Building Industry (1999) as part of the construction documentation for each development stage as they are implemented. This plan will be prepared and submitted as part of the Engineering approval process for each land release / stage.

The SEDMP encompasses surface stormwater management practices that shall be implemented during the construction phase by the constructor. The SEDMP provides a guide to the constructor to plan site management measures that should be implemented to prevent the mobilisation of sediment and pollutant exports during the construction stages. Whilst the site's conditions will change as the construction progresses, it is the environmental duty of the constructor to ensure that the site SEDMP is progressively maintained and upgraded to suit changing site conditions and stages of construction.

The SEDMP will be prepared to include several techniques to be implemented during the land division construction phase. Typical techniques include (but are not limited to), sediment traps / basins, silt fences, diversion swales to control site flow, single site access point with shaker pad, level spreaders, vegetative grass buffers and other measures as deemed necessary. It is noted that the SEDMP will not be limited to the adoption of sediment basins within development area, the SEDMP will require a sequence of management techniques to work collectively.

The Contractor shall consider other techniques that form part of the SEDMP strategy to address the following principal outcomes such as:

- The minimisation of cleared land to minimise exposure to wind and rain;
- Focussing efforts on minimising soil loss resulting from surface erosion;
- Minimise the generation of airborne dust and other potential nuisances to the environment and nearby residences; and
- Trap debris and vegetative matter and sediment at source and prevent is mobilisation downstream.

The interim construction phase sediment interception is based on construction of a temporary sedimentation basin online within Springwood Creek. The sedimentation basin would be constructed during the early phase of construction during the major earthworks and roadwork construction phases. This basin will provide protection to the downstream spring fed part of the creek and its remnant macrophyte beds. Refer to Section 8 for further discussion and sediment basin capture design.

The sedimentation basin will ensure that all site-generated runoff will pass through sediment interception system. Upon completion of the construction works, this sediment basin will be regraded and planted and landscaped in accordance with the design documentation to create a wetland pond to meet their ultimate operational function of stormwater treatment. This approach provides a fundamental SEDMP strategy that uses operational phase treatment systems, which would be adapted and used to facilitate construction phase sediment interception. All WSUD systems would be managed using this same approach whereby they function to intercept sediments during construction phase, then revert to their operation phase function of urban stormwater treatment.

The SEDMP will form a key component of the CEMP that will be developed and submitted prior to construction.

Development of the SEDMP during the design phase

During the design phase for each land release / development stage, the SEDMP would be developed to consider the following key points:

- Site and area characteristics;
- Soil types (in particular if dispersive characteristics have been identified);
- Land slope, and topography;
- Flow paths – to be considered as this needs to be managed on site;
- Sensitivity of receiving environments;
- Use where possible the design phase WSUD systems during construction phase. Upon completion of the construction these systems are completed to address operational phase stormwater treatment;
- Slope lengths – to minimise the potential for erosion; and
- Environmental assets and areas that may require specific protection (Trees and downstream Park).

General management approach – construction phase

The SEDMP would include, but not be limited to the implementation of the following techniques such as:

- Perimeter site fencing to compound;
- Flagging areas of the site that may be sensitive, need to be protected, or where vegetation (grass) should not be stripped;
- Bunting around trees and their root zones (tree protection zones) to be protected;
- Location of soil stockpiles at an appropriate location, away from flow paths, and protected to minimise mobilisation of airborne dust;
- Sediment traps, and incorporate debris traps;
- Sedimentation basin – a proposed wetland pond within Springwood Creek and other WSUD treatment systems could be excavated early and used to trap sediments and provide treatment of stormwater during the construction phase. (This is an example where construction phase treatment measures can revert to providing stormwater treatment for the life of the development. This approach is considered the appropriate and best means to facilitate construction phase treatment, to trap sediment load;
- Silt fences and hay bales;
- Diversion swales to control site flow around work sites;
- Single site access point with shaker pad and other measures as deemed necessary to prevent sediment entering Council roadways; and
- Dust management techniques, including:
  - cover stockpiles with mulch if they are to remain over the long term
  - maintain adequate moisture levels to all site access tracks and earthworks areas
  - adoption of a proactive approach to dust control by remaining informed of forecast weather conditions
- Hydro seeding and or hydro mulching areas left exposed for periods of time.

These elements will be considered, and where appropriate they would be included as part of the design of the SEDMP. This would be undertaken as part of the detailed design phase of each development stage and is therefore not part of this report.

Post Land Division Construction Phase SEDMP - private house building phase

It is widely acknowledged and understood that sediment loads and debris resulting from individual house building can be quickly conveyed via the stormwater network. These pollutant loads can be significant. However, the amount of pollution generated by individual house builders is highly dependent upon their level of compliance to the EPA Codes of Practice for building sites. This responsibility lies with the Builders of individual houses to be enforced by Council and the EPA.

This strategy is considered robust in that it will allow for some degree of management shortfall during the house building phase. The sedimentation basin has been developed to provide provisions to manage this issue to ensure that the impacts during the house building phase are appropriately addressed to prevent downstream impacts. In this regard, the provisions include:

- On line trash rack. This will trap debris, litter and coarse sediment; and
- Sedimentation basin located on line in Spring Creek is provided to trap primary sediments. The basin is designed to trap medium to finer sediment fractions. Refer to Section 8 for further detail.

Dust Control

During the land division construction phase of the development, an Environmental Management Plan (EMP) will be prepared by the constructor and implemented in accordance with the Environment Protection Act 1993 and its associated regulations (2009). The plan shall also be prepared to meet the requirements in accordance with the Code of Practice for the Construction and Building Industry (1999).

The contractor shall implement measures to minimise and manage nuisance issues associated with the mobilisation of dust resulting from earthworks and construction activities undertaken on the development site as part of the land division construction phase. Measures to control dust shall be implemented and maintained at all times. Measures will include but not be limited to the following:

- Minimise the area of land that is cleared and exposed to wind at any given time during the construction phase;
- Perimeter dust filter screen attached to fencing;
- Covering stockpiles with mulch;
- Maintain adequate moisture levels to all site access tracks and earthworks areas;
- Adopting a proactive approach to dust control by remaining informed of forecast weather conditions and preparing strategies in advance of high-risk days; and
- Hydro seeding areas left exposed for periods of time.

4 CATCHMENT HYDROLOGY

4.1 EXISTING CATCHMENT

The existing site catchment characteristics are described in Section 2. The pre-development flow rate at the 1% AEP storm event forms the basis of the permissible discharge rate from the development for the critical storm frequency.

4.2 REGIONAL STORMWATER MITIGATION

The following assessment considers the flows generated by the development site only and does not include the upstream rural catchment (621ha).

Pre-Development Flows

Pre-development flows from the site have been calculated using a flow-routing model using the DRAINS software package. The catchment plan is included as Appendix D. Rainfall data and temporal patterns for the site have been obtained from the *ARR Data Hub* website and the analysis has been undertaken using the 2016 ARR procedures. The model assumptions are summarised below:

- Effective Impervious Area Initial Loss 1mm
- Effective Impervious Area Continuing Loss 0mm/h
- Remaining Area Initial Loss 30mm
- Remaining Area Continuing Loss 2.7mm/h
- Development sub-catchments modelled with 5% impervious and 95% pervious with times of concentration of 10 minutes and 30 minutes, respectively.

The pre-development flow rate from the DRAINS modelling was calculated to be 13.2 m^3/s for the critical 2-hour storm for the 1% AEP event. DRAINS output has been included as Appendix D.

Post-Development Flows

DRAINS model assumptions are as listed in Section 4.2 with the following parameters altered for the development sub-catchments:

- Development sub-catchments modelled with 80% impervious and 20% pervious with times of concentration of 10 minutes and 30 minutes, respectively.

The post-development flow rate from the DRAINS modelling was calculated to be 24.8 m^3/s for the critical 30-minute event.

Regional Flood Detention Storage

A regional flood detention storage is proposed to manage the pre- and post-development flows for the proposed urban development catchment. The stormwater quantity management parameters for the total development are based on the fundamental requirement to manage the pre and post development flow rates leaving the site through Springwood Creek, prior to entering the South Para River. The preliminary size for flood detention storage has been determined on the basis to limit the critical peak flow from the proposed fully developed urban catchment for the 1% AEP Annual Exceedance Probability (AEP) outflow rate equivalent to a 1% AEP pre-developed flow rate.

The flood detention storage is to be located at the western (downstream) end of the Springwood Creek that bisects the proposed development site. A roadway crossing will be used to create the embankment for the flood storage, while a low flow pipe controls the rate of outflow.

A high-flow bypass pit with an oversized culvert will cater for the peak flows from the upstream rural catchment. Details will be confirmed as part of the detailed design.

The storage is shown on the overall stormwater management plan in Appendix A.

The outputs from the DRAINS modelling reveal the following results:

- Peak outflow from flood storage = 13.2 m^3/s
- Permissible outflow (1% AEP pre-development flow) = 13.2 m^3/s
- Peak inflow (1% AEP post development flow) = 24.8 m^3/s
- Peak water level RL 65.90 (Australian Height Datum) in 1% AEP event.
- Peak water level RL 63.10 (Australian Height Datum) in 20% AEP event.
- Peak detention storage volume = 18ML
- Duration of inundation = 1 to 6 hours
- Critical storm duration = 45 minutes (storm 1)

The hydrological input, output files and catchment plans are included in Appendix D.

A review of the impacts of the detention storage has on the iron-grass community has been carried out. The biological assessment and field survey to determine the extents of the iron-grass community have accurately plotted on the site plan. A comparison of the peak water level and duration of ponding relative to the iron-grass community has been undertaken for the peak storm event for the post development case. The following results and outcomes:

- The extent of the iron-grass community varies between RL 58.50 to RL 73.00, with most of it lying above RL 63.00

- No iron-grass communities are inundated for storms of less than 0.5 EY (equivalent to a 2-year ARI).
- Duration of inundation is estimated at less than 2 hours for the 1% AEP post development storm event.

The two major occurrences of the Iron Grass Community are located above top of the bank up the slope and will be unaffected by inundation even in the 1% AEP event. Cross sections showing a comparison between the existing iron-grass community and the maximum detention levels for various storm events have be plotted and included in Appendix B.

4.3 STORMWATER NETWORK DESIGN

This report is not intended to provide details or modelling associated with the internal stormwater network. The network design modelling, sizing calculations will be submitted as part of the Engineering design to be documented for each land release / stage.

Stormwater network design basis / strategy

The stormwater network would be designed using the minor and major design approach based on Town of Gawler's stormwater design requirements:

- Minor System (underground pipe system) 18% AEP
- Major System (overland flow)1% AEP

The underground pipe system will be been designed to accommodate flows with no surcharging. A minimum freeboard at pits for minor storms of 150mm would be adopted so that the hydraulic grade line (HGL) is at least 150mm beneath all pit openings.

Overland flow paths are to be accommodated within roadways to be contained within the respective road cross sections and or overland flow paths without inundation of adjoining allotments. Overland flow paths will enter many of the existing gullies and shallow valleys and these will drain into Springwood Creek. Particular attention will be applied during the detailed design phase to focus on ensuring that appropriate erosion control techniques are selected to control flow velocities within all existing natural flow paths. It is expected that such flow paths and associated erosion control measures will be designed to cater for the 1% AEP critical event flow rates. Refer to Figure 4.1 which shows general major flows paths to be incorporated within the development.

A trash rack is proposed to be located online within Springwood Creek to provide the ability to trap and intercept debris, litter and coarse sediments as a final line of defence to protect downstream spring fed waterway. This approach is to ensure and facilitate a robust approach to treatment and environmental protection by providing an opportunity for any debris that enters the upstream creek to be intercepted. Given that the trash rack will be located online, the treatment flow rate is expected to operate with the range of low flow flows (99% AEP to approximately 18% AEP) when the trash rack may become submerged. (NB: This is best guess assumption based on professional experience).

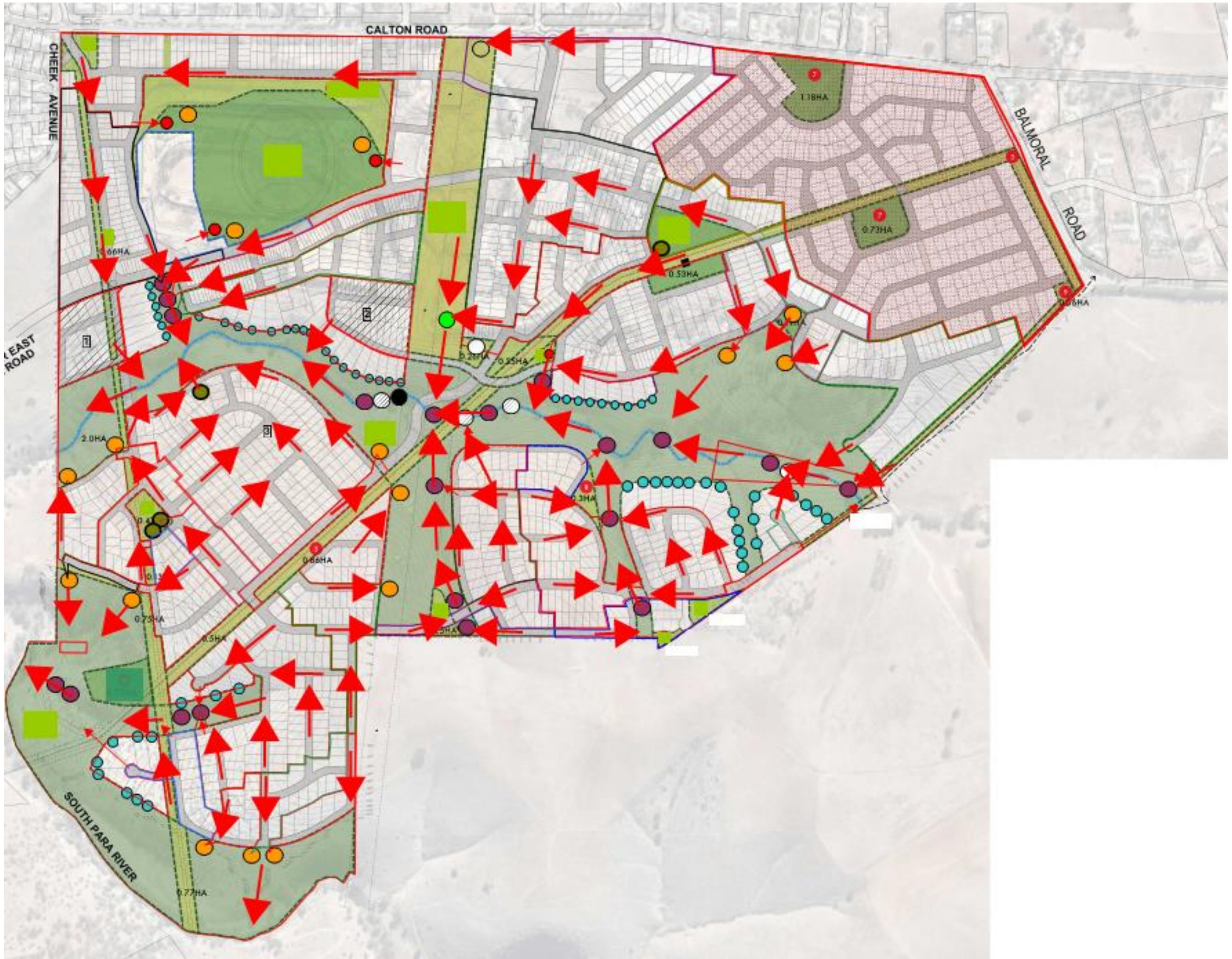

Figure 4.3 Major flow paths and regional detention storage.

5 STORMWATER TREATMENT SYSTEMS

5.1 SELECTION OF TREATMENT SYSTEMS

The Strategy is based on providing a mixed suite of stormwater treatment systems which have been selected and positioned based on the following approach:

- Consideration of land constraints;
- Consideration of environmental assets and areas to be protected;
- Creating sub catchments that are manageable in size;
- Selection of WSUD techniques that are robust, sustainable and contribute to ecosystem services; and
- Utilise soft engineering techniques that can provide a multi objective approach that will benefit the community and environment.

The strategy provides a variety of techniques that are selected for being robust and sustainable. Furthermore, these systems will each comprise densely vegetated water bodies and/or beds that will incorporate treatment processes including enhanced sedimentation, fine filtration, adhesion biological uptake, and chemical processes to remove pollutants from urban stormwater. Depending on where these systems are positioned, some of the WSUD systems are designed to provide infiltration into the underlying soils and or fractured rock profiles.

Refer to Appendix A and B for stormwater treatment system types and their locations. This Section should also be read with Section 7. The list of selected treatment systems is provided below.

- Precinct scale rain garden
- Biofiltration basin
- Wetland pond
- Macrophyte bed / shallow pond
- Ecological sponge (with infiltration wells)
- Wetland (with inlet pond)
- Vegetated swale
- Gross pollutant trap / trash rack
- Rear of allotment infiltration well

5.2 PRELIMINARY TREATMENT SIZING

For the purposes of master planning, the treatment systems have been sized using the percentage area method. This has been proven to be a reliable method of sizing the surface area of treatment systems such that will comply to treatment targets. Based on the complexity of the site, the treatment systems have been accolated to manage small sub catchments. This approach ensures that stormwater is generally managed at source, while more importantly, this ensures that the treatment systems will not be subjected to the erosive flows from bigger and rarer storm flow inputs.

A notional equivalent impervious area (EIA) fraction was adopted for:

- Urban 0.75
- Commercial 0.90

The above values are an upper bound value which is considered conservative given that there are large areas proposed with urban allotments larger than 700m2.Therefore the adopted values will provide a suitable estimate of treatment surface areas for each system. The nominated treatment areas are then evaluated using MUSIC modelling. A 2% of EIA was adopted to provide a notional treatment surface area for all systems.

Refer to Appendix d for the preliminary sizing calculations associated with the treatment systems for each sub catchment. Functional and detailed calculations for each treatment system including hydraulic control devices would be carried as part of future separate engineering design and subsequent development approval process.

5.3 MANAGEMENT OF STORMWATER DISCHARGE FROM TREATMENT SYSTEMS

The management of stormwater discharge from the treatment system will be controlled using:

- Discharge control pits with each incorporating a dual level discharge orifice to release:
  - Trickle flows – Frequent flow management (refer Section 5.4)
  - Porous rock weirs to disperse higher flow rates, and or to allow for slow leaky release of flows along Spring Creek
- Emergency spillway in the event that the outlet system becomes blocked and or when the system is exceeded by a larger storm event. Overtopping will occur at rock weirs / spillways

These aspects are associated with the detailed design of each treatment system which will be undertaken as part of the engineering design approval / assessment process.

5.4 FREQUENT FLOW MANAGEMENT

An important feature of the strategy is the management of frequent rainfall events in the order of less than and equal to the 63% AEP. It is widely understood that the stormwater generation and frequency of flows from the urban development in minor storm events will increase. This was of concern to DEW in terms of reducing the risk of erosion forming within Spring Creek.

The significance of this relates to the management and protection of waterway integrity / prevention of erosion from the impacts of frequent flows that will be generated from the development. It is not practical to remove or reduce volumetric discharge due to site constraints; however, techniques to reduce the impact of frequent flows have been considered and incorporated into the strategy through the following means:

- Use of rear of allotment infiltration wells within the development where technical feasible and such that they do not create problems to properties, asset and infrastructure;
- Ecological sponge systems – where feasible will be designed as unlined systems to allow for infiltration to subsoil layers;
- WSUD systems and green infrastructure that will reduce the responsiveness of the catchment to generate runoff and flows through the drainage network;
- All treatment system will include discharge control outlet systems to allow flows to be dissipated over a wider area (I.e. not at a single outlet point where feasible);
- Inclusion of detention storage (minor) into the treatment system to accommodate a 63% AEP, 30-minute storm runoff volume from its contributing sub catchment;
- It is widely acknowledged in Australian practice to consider management of an 80% - 63% AEP volumetric runoff volume is equivalent to managing 90% of all annual rainfall events; and
- The detention volume will be released and controlled over a 2-3-day period via porous rock weir and or a discharge control pit with level spreaders where feasible.

Importantly, the above points highlight the aim to maximize the potential to lengthen the catchment's response time to generate flow to the outfall into Spring Creek. It is further emphasised that there will be 3 separate outlets from the wetland system using soft engineering and environmental techniques to encourage infiltration and distribute trickle flows over a wider area and for all frequent rainfall events.

This strategy is aimed at ensuring the development would not cause a significant increase in the magnitude and frequency of erosion causing flows in minor storms. It is intended that the detailed design of each treatment system will incorporate the discharge control philosophy outlined in this Section.

6 STORMWATER QUALITY MODELLING

6.1 MUSIC MODELLING

This section summarizes the stormwater quality simulation carried out using MUSIC software and compares the outcomes to the EPA Water Policy (2015) and recognised Australian best practice guidelines for pollutant reduction targets as defined in the WSUD Guidelines for the Greater Adelaide Region (2013).

MUSIC modelling is utilised to conceptually confirm the required surface areas of the all treatment systems to ensure that the treatment requirements can be met for the overall development. MUSIC version 6.2 has been used to assess the performance of the strategy. The model layout has been shown in Figure 6.1 and shows that development area catchment has been included in the model to provide proof of concept that the treatment strategy will accommodate the immediate and future stages of development.

The assessment of the stormwater treatment performance and compliance is reported on the following basis:

- Point A – End of line: This provides an overall averaged indication of the compliance to treatment targets from the whole of development prior to South Para River
- Main outfalls: The MUSIC modelling results are reported at the main outlets into Springwood Creek.

Modelling Input Parameters

Development characteristics, site parameters and local climatic data sets have been entered the MUSIC model. Refer to Figure 6.1 for screen output of the model showing catchment nodes and treatment systems graphically displayed. The treatment elements associated with the strategy are all included in the model as per their adopted design configurations. MUSIC model uses climatic data comprising of daily rainfall interval and evaporation data from Rosedale (Turretfield Research Centre) (Station No 023343) from 1958 to 2010. This station was the closest available to Gawler East with a similar aspect in the ranges. The data is used to simulate the rainfall runoff on site and the subsequent treatment performance for the development strategy. The results and outcomes are presented in this Section.

The parameters entered MUSIC model for the source and treatment nodes are summarised in Table 6.1. It is noted that, the impervious fraction parameter for the urban source nodes have been selected to be conservative (I.e. higher than the proposed development density) and will therefore provide a margin of assurance that the strategy will be achieved.

Table 6.1 is not intended to provide details of each node within the model; instead it provides a general overview of the typical parameters used for the source and treatment nodes. It this case the source nodes are represented by “urban nodes”, and the treatment nodes are represented by, gross pollutant trap, vegetated swales, biofiltration and wetlands and the like. In is noted that the GPT treatment parameters are based on the Rocla CDS or Cleansall unit. However, for the purposes of modelling and performance, we have assumed that the GPT’s do not contribute to the reduction of Nutrients. Furthermore, the trash rack proposed online within Springwood Creek has been modelled on the basis that only small fraction of gross pollutants and sediments are trapped and therefore provides a conservative approach to modelling.

A screen copy of the model is provided in Figure 6.1.

Table 6.1: MUSIC Model parameters

Node Types	**Parameters**				
Urban	Soil storage capacity 40mm	1 mm depression storage	Typical impervious fraction 75% Urban 90% commercial	Stochastically generated pollutants	Initial storage capacity % of capacity 30%
Treatment	**Parameters**				
Vegetated Swale	Gradient 0.5%	Vegetation height 250mm	Base width varies 1 to 5m	Infiltration loss 3.6mm/hr	Batter varies 1 in 1 to 1 in 5 Depth varies 0.3 to 0.6m
GPT	Treatment flow to the 63% AEP	TSS removal rate 70%	TP removal rate ZERO	TN removal rate ZERO	Gross pollutant removal rate 90%
Trash rack (using GPT node)	Treatment flow to the 18% AEP	TSS removal rate 10%	TP removal rate ZERO	TN removal rate ZERO	Gross pollutant removal rate 90%
Wetland systems and ponds	Surface area (refer tables for each)	Permanent pool volume is averaged over the area assuming 350mm depth	Extended detention depth 500mm	Infiltration loss 3.6mm/hr	Detention time is approximately 48 – 72 hours
Bio filtration basins / rain gardens	Filter depth 500mm min	Unlined basin	Extended detention depth 200mm	Infiltration loss 3.6mm/hr	Includes Nitrogen effective removing planting

Infiltration Ephemeral Wetland ponds (Ecological sponge)	Typical surface area 100 to 300m^2	Permanent pool volume = 0m^3 and 0.0m depth	Extended detention depth 300mm	Infiltration loss 6mm/hr	Detention time is approximately 48 hours

It is noted that the input parameters for source nodes (urban catchments) are somewhat considered conservative. The equivalent impervious parameter has been selected to be deliberately high and averaged across all the urban areas across the development. Given that they are a considerable number of larger allotments proposed, the values adopted means that the results are considered conservative.

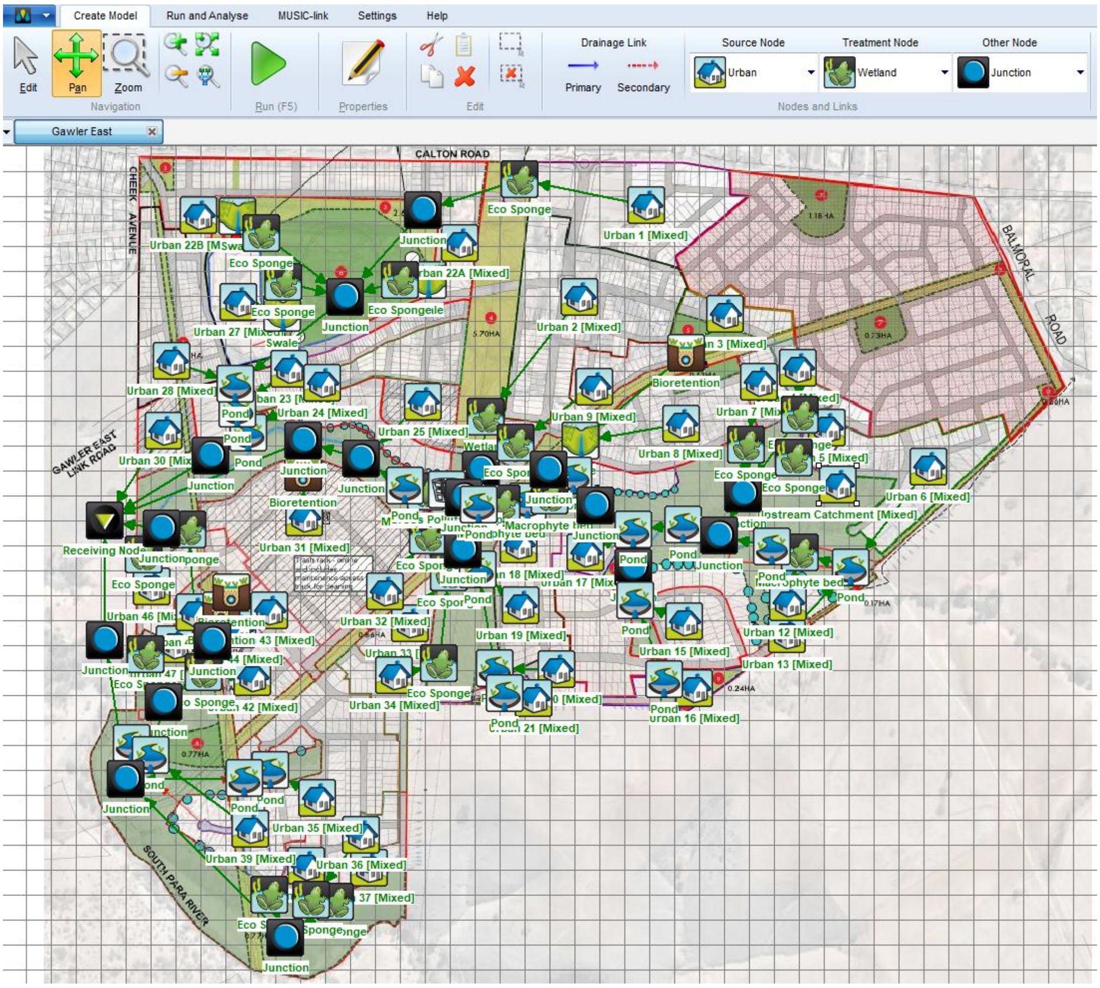

Figure 6.1: MUSIC model screen copy

6.2 TREATMENT REQUIREMENTS

The design of the site treatment system aims to treat stormwater in accordance with the standards as defined by:

- The South Australian EPA Water Quality Policy, EPP Water Quality (2015) (Based on fresh water environments); and
- WSUD best management practice pollutant reduction targets as defined in the WSUD Guidelines for the Greater Adelaide Region.

In addition to the above treatment policies, the EPA requires that all stormwater must be treated prior to entering the existing marsh / macrophyte lined creek downstream of the watermain crossing point. Refer to Section 6.3 for the locations where the results have been reported.

The pollutant treatment criteria are presented below, and these have been compared to the simulated results using MUSIC.

6.3 MODELLING RESULTS

The results presented in this section demonstrate water quality compliance in accordance with the target values specified. These are assessed against the standards defined in the tables below. These targets were entered in the model to enable a direct comparison to be made.

The results are reported at each outlet into Spring Creek as well as at:

- Node A – Downstream of the watermain crossing (upstream of the creek marsh zone)
- Node B – At the outlet from the development in Spring Creek

Refer to Figure 6.2 for the reported locations.

Figure 6.2: MUSIC modelling results - reported locations

In comparison to the EPP Water Quality limiting concentrations, the model results are presented in Table 6.2a and 6.2b and compared to the target values for each reported location.

Table 6.2a: Water Quality Results compared to EPP Water Quality parameters - Averaged

Pollutant Type	TP	TN	TSS	Gross Pollutants
Target value (mean) mg/L	**0.5**	**5**	**20**	**Not specified**
NODE B - End of development averaged across full development - Result value (mean) mg/L	0.091	1.02	15.8	-
NODE A- Upstream of Creek Marsh - Result value (mean) mg/L	0.0077	0.116	1.17	-
Outlet 1 - Result value (mean) mg/L	0.0027	0.0417	0.64	-
Outlet 2 - Result value (mean)mg/L	0.0189	0.309	2.72	-
Outlet 3 - Result value (mean)mg/L	0.0334	0.503	5.25	-
Outlet 4 - Result value (mean) mg/L	0.0228	0.369	2.9	-
Outlet 5 - Result value (mean) mg/L	0.0328	0.488	5.68	-
Outlet 6 - Result value (mean) mg/L	0.0045	0.0699	0.942	-
Outlet 7 - Result value (mean) mg/L	0.0129	0.209	1.9	-

Table 6.2b: Water Quality Results compared to EPP Water Quality parameters - Maximum

Pollutant Type	TP	TN	TSS	Gross Pollutants
Target value (maximum) mg/L	0.5	5	20	**Not specified**
NODE B - End of site outlet full development - Result value (maximum) mg/L	1.22	6.19	0.001	-
NODE A - Upstream of Creek Marsh - Result value (maximum) mg/L	0.369	4.17	108	-
Outlet 1 - Result value (maximum) mg/L	0.492	4.19	578	-
Outlet 2 - Result value (maximum) mg/L	0.262	3.99	171	-
Outlet 3 - Result value (maximum) mg/L	0.9	10.1	229	-
Outlet 4 - Result value (maximum) mg/L	0.0228	10.3	211	-
Outlet 5 - Result value (maximum) mg/L	0.41	4	158	-
Outlet 6 - Result value (maximum) mg/L	0.704	3.82	433	-
Outlet 7 - Result value (maximum) mg/L	0.328	3.7	141	-

The results were also compared to the WSUD Guidelines for the Greater Adelaide Region, which are based on recognised Australian best practice. These are presented in Table 6.3 along with the results achieved at each reported location.

Table 6.3: Water Quality Results compared to WSUD standards

Pollutant Type	TP	TN	TSS	Gross Pollutants
Target percentage reduction	60%	45%	80%	**90%**
NODE B - Overall / end of development - Resultant percentage reduction	82.7	76.2	91.1	96.6
NODE A - Upstream of Creek Marsh - Resultant percentage reduction	94.7	89.0	97.6	100
Outlet 1 - Resultant percentage reduction	93.7	91.1	93.9	100
Outlet 2 - Resultant percentage reduction	93.9	93.7	91.1	100
Outlet 3 - Resultant percentage reduction	75.6	42	91.5	100
Outlet 4 - Resultant percentage reduction	78.2	56.5	87	100
Outlet 5 - Resultant percentage reduction	79.4	63.2	88.1	100
Outlet 6 - Resultant percentage reduction	92.7	89.7	93.8	100
Outlet 7 - Resultant percentage reduction	87.8	75.8	94.5	100

Summary

The results summarised in Tables 6.2a, 6.2b and 6.3 demonstrate that the TSS, TP and TN reductions will meet the required performance criteria. These results have been met at all targets at each of the reported locations.

Whilst other pollutant loads are not considered due to the limitations of MUSIC, the software assumes that other pollutants would be effectively removed and or treated. The rationale is based on the premise that very fine pollutants are attached to other particulate pollutants such as TP and TSS. Therefore, while targeting TP and TSS, it is reasonable to expect that many more pollutants are in fact being removed, trapped and or treated.

It is brought to your attention that two small sub catchments (25 and 30) are not currently proposed to receive stormwater treatment. It is the intention that as part of the detailed design, a treatment system will be provided once further planning can be carried out.

In summary, the resultant pollutant concentrations attained from the simulations revealed that each fall within the average (mean) limits set by the EPA in South Australia in addition to complying with the best management performance targets from referenced codes and guidelines, therefore the treatment strategy is satisfactory.

7 WATER SENSITIVE URBAN DESIGN

7.1 OPPRTUNITIES FOR WSUD

It is recognized that Water Sensitive Urban Design (WSUD) embraces a range of measures that form part of ecologically sustainable development (ESD). WSUD can be designed into the development to create sustainable and resilient green spaces and expand, enhance and or contribute to environmental assets found within the development site. Such principles will also contribute to greening within the project's public areas to enhance liveability, greening, and water reuse through the provision of site-based soil infiltration approaches within the landscape.

The vision for the project seeks to consider the following key principles:

- Work within the limitation of WSUD and the steep topography;
- Seek opportunities to enhance existing and pre-European vegetation as part of WSUD;
- Utilise stormwater runoff from the new urban area to play a key role to sustain the landscape;
- Sustainable practices using green infrastructure at a multitude of scales;
- Creation of places for people that are comfortable and provide an element of protection and shelter from heat generated from hard surfaces as well as softening the hard-built form;
- A collaborative approach to design that seeks to integrate stormwater design as part of landscape architecture to create visual interest and interactive public spaces;
- Application of best practice that demonstrate sustainable outcomes to the wider community;
- Utilising practices that are innovative, practical, and maintainable and that are proven to be cost effective and delivering multiple outcomes as they relate to landscaping and stormwater management; and
- Incorporation of infiltration systems to provide onsite stormwater retention where feasible, encourage base flow along the riverine corridors and as a measure to contribute towards the reduction of directly connected stormwater outflow from the developed catchment.

As part of the planning process, key WSUD opportunities were identified in the following locations within the Development:

- Spring Creek – integrated pool and riffle sequence to control and prevent erosion, and larger online wetland pond systems to facilitate further stormwater treatment, as well as environmental remediation to re-establish a pre-European riverine environment.
- Local parks with precinct scale rain gardens.
- General open space areas (not formalised) feature the use of ecological sponges to encourage infiltration into underlying fractured rock and dissipation of small rainfall events.

- Gullies and shallow valleys – provide the opportunity to integrate wetland ponds and rock lined swales to slow urban inflow and control stormwater to prevent erosion.
- Residential allotments that back onto gullies, shallow valleys and Springwood Creek's escarpment offer the opportunity to include at source control measures such as infiltration wells at the rear of each allotment. These techniques will disconnect the urban catchment, encourage base flow and reduces the direct discharge into waterways.
- Precinct / local scale WSUD initiatives will be explored as part of other retail / commercial precincts of Springwood, such as within car parks and the like.

Other project-based opportunities in WSUD can be sought at multiple scales as part of the detailed design process. The best outcomes can be achieved when opportunities are explored through an integrated planning and design process. This development can present these opportunities and outcomes which will be explored during the detailed design phase.

The preliminary strategy for WSUD is presented in Figure 7.1.

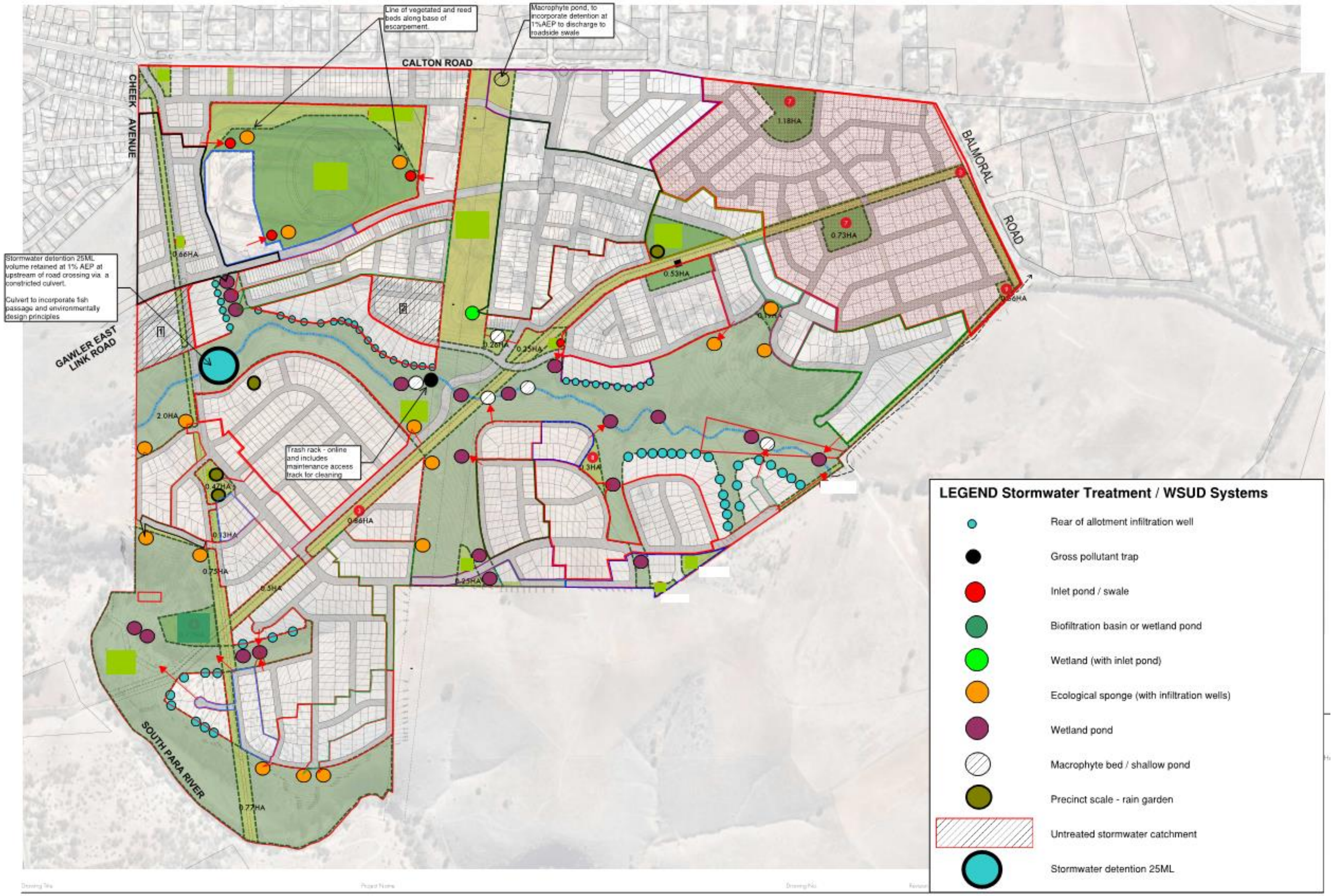

Figure 7.1: WSUD Strategy

7.2 WSUD SYSTEM PLANTING DESIGN APPROACH

The aim is to establish a functioning ecosystem while also meeting the requirements of stormwater treatment. The areas associated with the WSUD system will be subsequently revegetated with a range of indigenous flora species that will contribute to improvement of biodiversity values within Springwood. Plant associations that currently exist with Springwood will be further enhanced by these WSUD systems. As such this offers the opportunity to off-set any loss of native vegetation required as part of the development.

The vegetation of WSUD systems as well as the proposed remediation of the Spring Creek corridor with its pool and riffle sequences, and online stormwater ponds proposed within Spring Creek system are intended to provide a vegetation community of native vegetation that aims to remediate pre-European ecosystems and biodiversity. The revegetation design documentation will set out the vegetation communities for each zone associated with the stormwater strategy. These zones will correspond to the water appropriate and expected regimes, aspect and location within the open spaces of the development.

The approach to the stormwater management strategy is to coordinate with the proposed guidelines with the DRAFT Town of Gawler Biodiversity Management Plan and EBS Ecology (2019) Springwood Flora and Fauna Assessment March 2019, with the aim of delivering an integrated environmental outcome for Springwood. In this regard the provision of WSUD elements offers the opportunity to extend existing vegetation groups through biodiversity plantings within the treatment systems. This intent will be further pursued as part of the design phase implementation.

8 INTERIM ON-SITE MANAGEMENT

8.1 TEMPORARY ON-SITE STORMWATER MANAGEMENT

The implementation of the Development will be staged over several years. The construction of stages will follow the staging plan set out in Figure 8.1. However, this will be largely dependent upon the market and demand. This requires the implementation of urban development to be cognisant of the need to manage stormwater progressively to mitigate the risk of downstream impacts.

Following the sequence of implementation of each stage, there will be a trigger point where formalised measures to treat runoff from the site will become necessary. Indeed, much of the development will drain to temporary or partially completed treatment systems to prevent the risk of WSUD measures becoming damaged, clogged and or vegetation establishment becomes difficult due insufficient contributing catchment to sustain the plantings. These issues are not considered as part of this interim strategy as it is too detailed to consider this and would require an individual assessment of each catchment. Therefore, this interim strategy is high level and preliminary to inform master planning.

A suggested implementation strategy indicating management measures is provided in Table 8.1 below and refers to Figure 8.1.

Table 8.1: Stormwater management implementation sequencing

Village / Stage	Management measures
Each stage	Stormwater drains into individual WSUD systems. Consider partial construction depending upon catchment area contributing to each system.
Village Centre	Stormwater managed within proposed systems (Nodes 1 and 2)
Village 3	Stormwater to be managed effectively within several treatment systems constructed partially of fully (depending upon area of contributing catchments) Construct temporary **sedimentation basin A** in Spring Creek Construct 50% of the in-stream wetland ponds integrated as part of the rock riffle installations
Village 4	Stormwater to be managed effectively within several treatment systems constructed partially of fully (depending upon area of contributing catchments) Construct rock riffles along Spring Creek at the first stage of Village 4
Village 5	Stormwater to be managed effectively within several treatment systems constructed partially of fully (depending upon area of contributing catchments) Construct another 25% of the in-stream wetland ponds integrated as part of the rock riffle installations
Villages 6 & 7	Stormwater to be managed effectively within several treatment systems constructed partially of fully (depending upon area of contributing catchments)
Villages 8 & 9	Stormwater to be managed effectively within several treatment systems constructed partially of fully (depending upon area of contributing catchments)
Village 10	Stormwater to be managed effectively within several treatment systems constructed partially of fully (depending upon area of contributing catchments) Construct the regional trash rack at the first stage of Village 10 Construct the remaining 25% of in-stream wetland ponds and complete all temporary basins including Wetland Pond A

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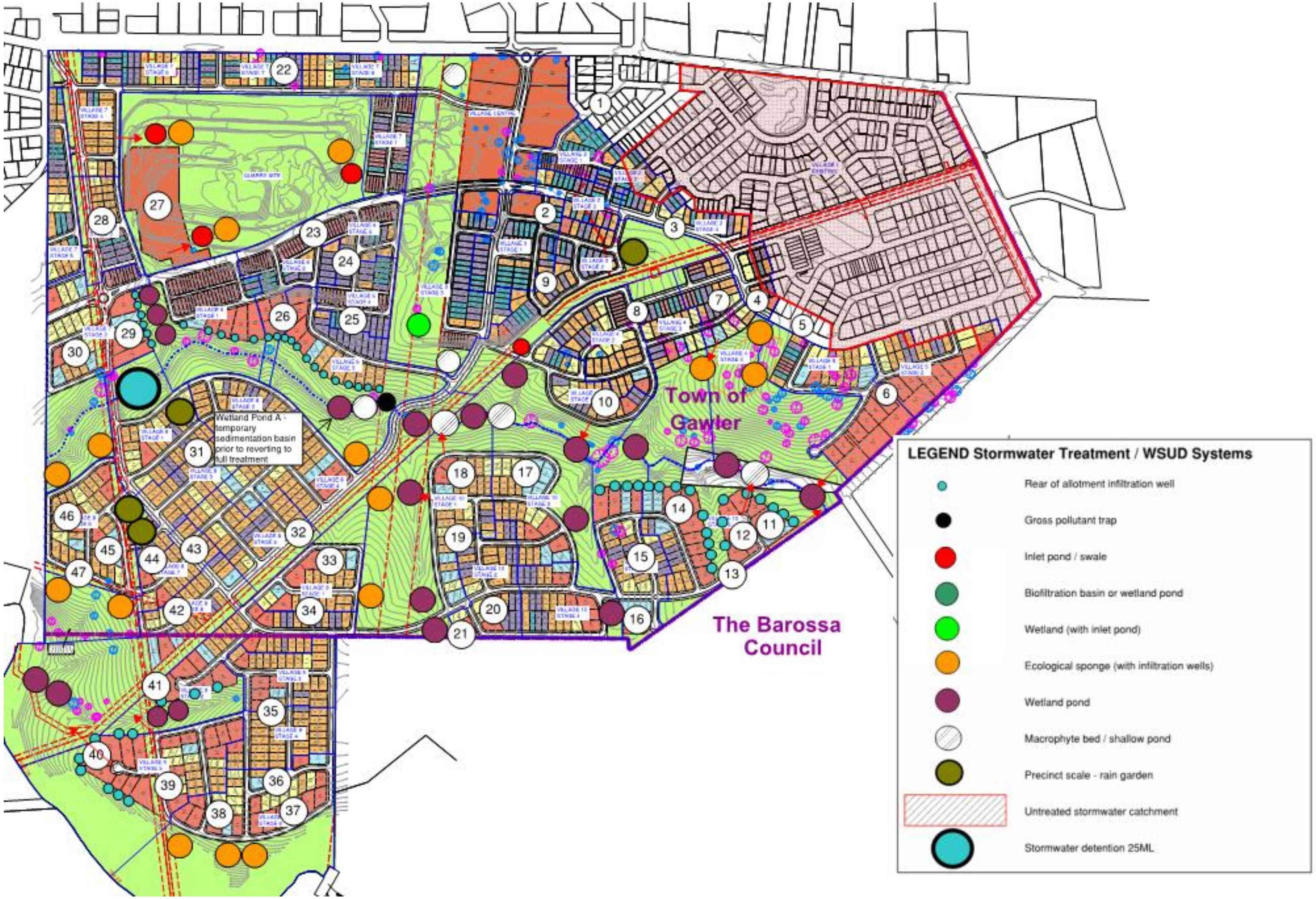
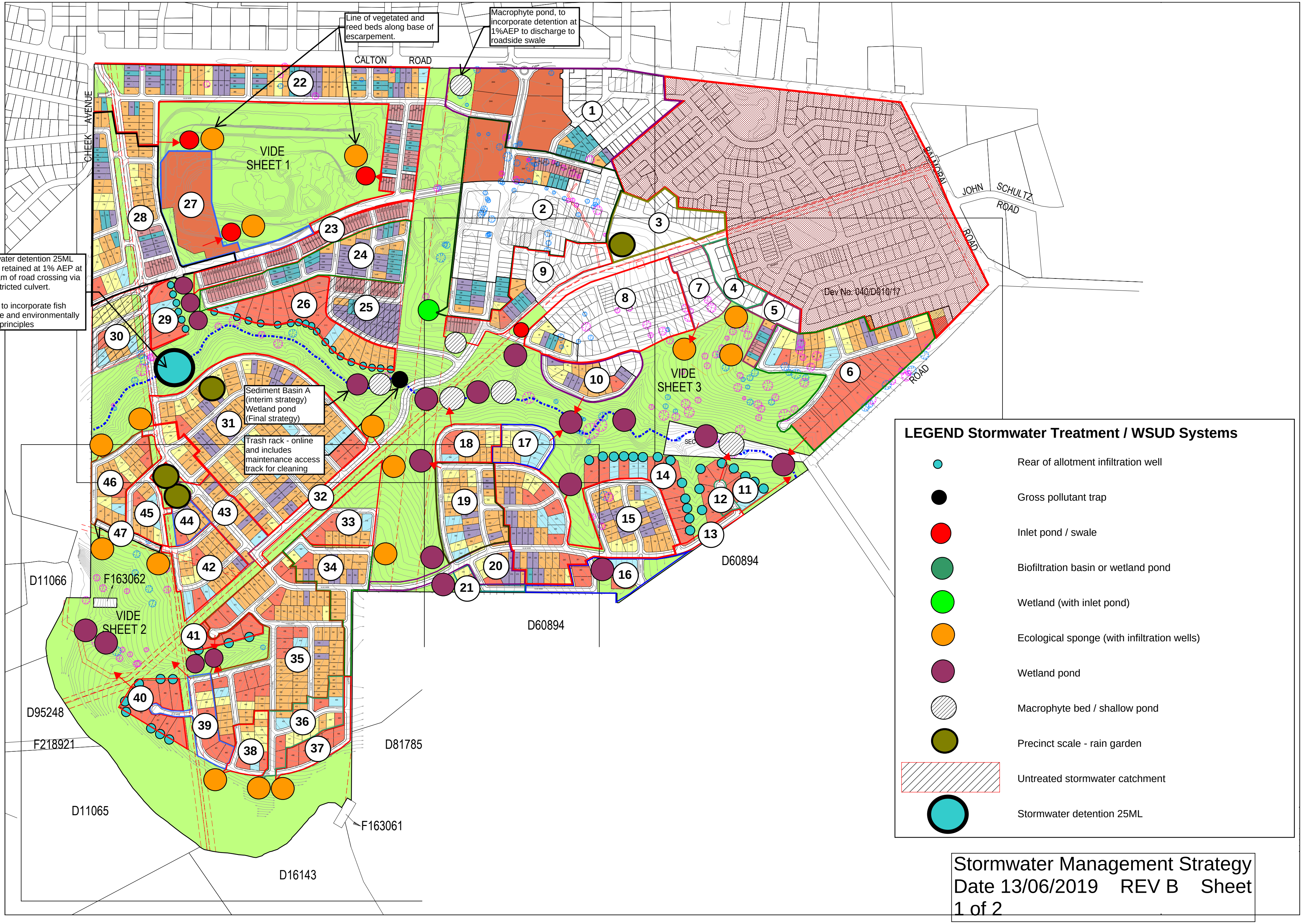


Figure 8.1: Staging and sequencing of development and treatment system

APPENDIX A

STORMWATER MANAGEMENT STRATEGY



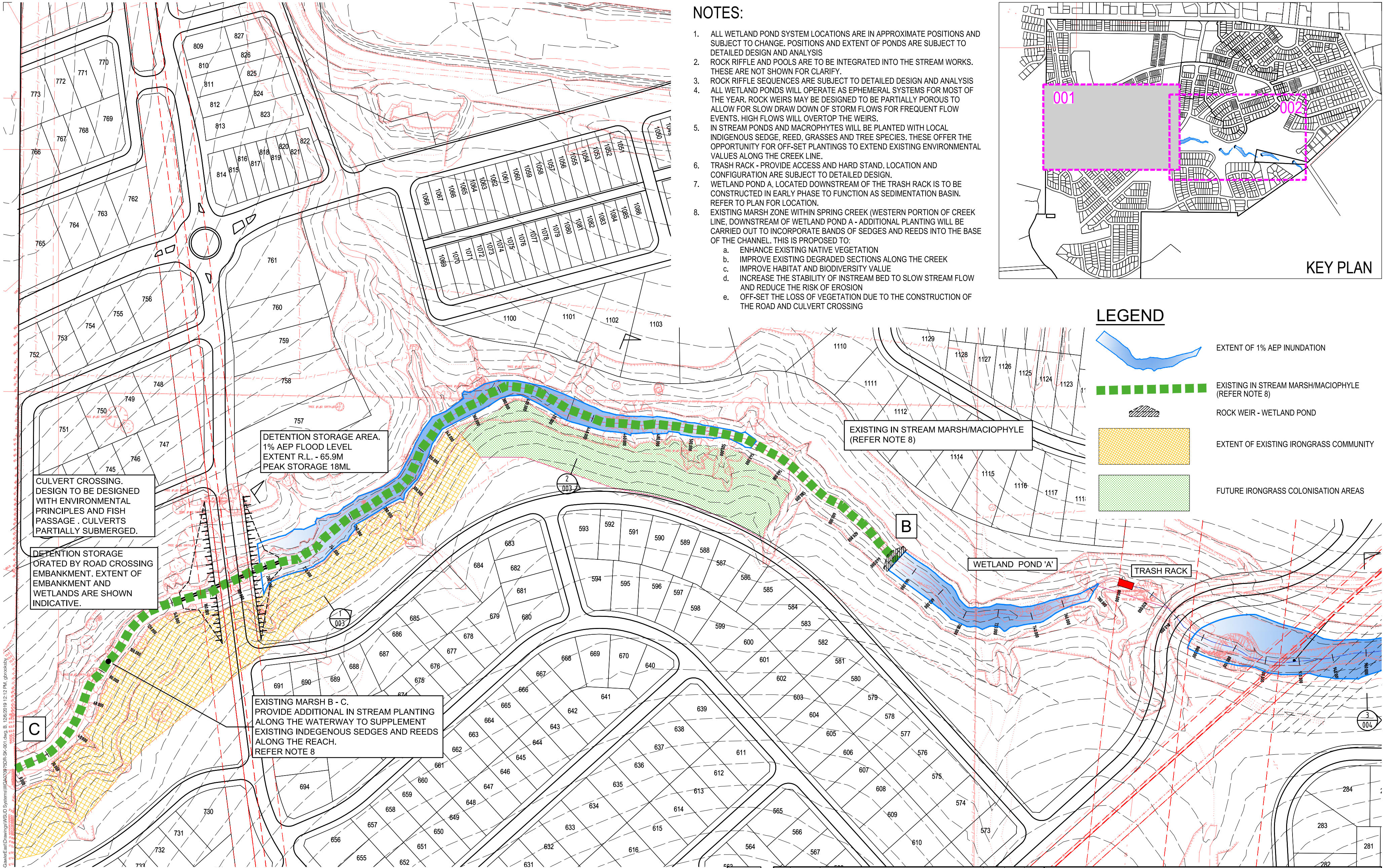
Stormwater Management Strategy
Date 13/06/2019 REV B Sheet 1 of 2

Table 1: Stormwater Quality Management Summary

Sub Area Reference Number	Catchment sub area (Ha)	Treatment Measures	Stormwater Treatment Area (m^2)	Comments
1	1.73	Macrophyte Bed/Shallow Pond	400	Accommodate detention storage to 1%AEP
2	2.32	Wetland	500	Small scale wetland system
3	0.35	Precinct scale - Rain Garden	100	
4	0.21	Ecological Sponge	100	
5	0.3	Ecological Sponge	100	
6	1.26	Wetland Pond in Creek	250	Discharges directly to creek treatment system
7	0.3	Ecological Sponge	100	
8	1.25	Wetland Pond	200	
9	0.62	Macrophyte Bed/Shallow Pond	100	
10	0.23	Wetland pond	100	Discharges directly to creek treatment system
11	0.23	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
12	0.06	Macrophyte Bed/Shallow Pond in Creek	100	Roadway (only) discharges directly to creek treatment system
13	0.08	Wetland Pond in Creek	100	Discharges directly to creek treatment system
14	0.4	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
15	1.57	Wetland Pond	300	
16	0.37	Wetland Pond	100	
17	0.24	Wetland Pond in Creek	100	Discharges directly to creek treatment system
18	0.27	Macrophyte Bed/Shallow Pond in Creek	100	Discharges directly to creek treatment system
19	0.65	Wetland Pond	100	
20	0.31	Wetland Pond	100	
21	0.08	Wetland Pond	50	
22	2.24	Swale and Ecological Sponge	2 x 200	Linear system of swale and shallow marsh zones along the base of the escarpment
23	0.47	Wetland Pond	100	Tiered sequence of ponds
24	0.78	Wetland Pond	150	Tiered sequence of ponds
25*	0.49	No Treatment	-	Localised untreated catchment
26	0.62	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
27	0.76	Swale and Ecological Sponge	200	Linear system of swale and shallow marsh zones along the base of the escarpment
28	1.43	Wetland Pond	250	Tiered sequence of ponds
29	0.23	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
30*	0.43	No Treatment	-	Localised untreated catchment
31	2.55	Precinct scale - Rain Garden	400	
32	0.19	Ecological Sponge	100	
33	0.41	Ecological Sponge	100	
34	0.53	Ecological Sponge	100	
35	1.68	Wetland Pond	250	
36	0.4	Ecological Sponge	100	
37	0.237	Ecological Sponge	100	
38	0.23	Ecological Sponge	100	
39	0.31	Wetland Pond	100	
40	0.3	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
41	0.13	Rear of Allotment Infiltration Well	-	Individual infiltration per allotment
42	0.48	Ecological Sponge	100	
43	0.33	Precinct scale - Rain Garden	50	Combine with 44 if feasible
44	0.13	Precinct scale - Rain Garden	50	Combined with 43 if feasible
45	0.5	Ecological Sponge	100	
46	0.42	Ecological Sponge	100	
47	0.06	Ecological Sponge	50	

APPENDIX B

INSTREAM MANAGEMENT STRATEGY



NOTES:

1. ALL WETLAND POND SYSTEM LOCATIONS ARE IN APPROXIMATE POSITIONS AND SUBJECT TO CHANGE. POSITIONS AND EXTENT OF PONDS ARE SUBJECT TO DETAILED DESIGN AND ANALYSIS
2. ROCK RIFFLE AND POOLS ARE TO BE INTEGRATED INTO THE STREAM WORKS. THESE ARE NOT SHOWN FOR CLARIFY.
3. ROCK RIFFLE SEQUENCES ARE SUBJECT TO DETAILED DESIGN AND ANALYSIS
4. ALL WETLAND PONDS WILL OPERATE AS EPHEMERAL SYSTEMS FOR MOST OF THE YEAR. ROCK WEIRS MAY BE DESIGNED TO BE PARTIALLY POROUS TO ALLOW FOR SLOW DRAW DOWN OF STORM FLOWS FOR FREQUENT FLOW EVENTS. HIGH FLOWS WILL OVERTOP THE WEIRS.
5. IN STREAM PONDS AND MACROPHYTES WILL BE PLANTED WITH LOCAL INDIGENOUS SEDGE, REED, GRASSES AND TREE SPECIES. THESE OFFER THE OPPORTUNITY FOR OFF-SET PLANTINGS TO EXTEND EXISTING ENVIRONMENTAL VALUES ALONG THE CREEK LINE.
6. TRASH RACK - PROVIDE ACCESS AND HARD STAND, LOCATION AND CONFIGURATION ARE SUBJECT TO DETAILED DESIGN.
7. WETLAND POND A, LOCATED DOWNSTREAM OF THE TRASH RACK IS TO BE CONSTRUCTED IN EARLY PHASE TO FUNCTION AS SEDIMENTATION BASIN. REFER TO PLAN FOR LOCATION.
8. EXISTING MARSH ZONE WITHIN SPRING CREEK (WESTERN PORTION OF CREEK LINE, DOWNSTREAM OF WETLAND POND A - ADDITIONAL PLANTING WILL BE CARRIED OUT TO INCORPORATE BANDS OF SEDGES AND REEDS INTO THE BASE OF THE CHANNEL. THIS IS PROPOSED TO:
   a. ENHANCE EXISTING NATIVE VEGETATION
   b. IMPROVE EXISTING DEGRADED SECTIONS ALONG THE CREEK
   c. IMPROVE HABITAT AND BIODIVERSITY VALUE
   d. INCREASE THE STABILITY OF INSTREAM BED TO SLOW STREAM FLOW AND REDUCE THE RISK OF EROSION
   e. OFF-SET THE LOSS OF VEGETATION DUE TO THE CONSTRUCTION OF THE ROAD AND CULVERT CROSSING

KEY PLAN

LEGEND

- EXTENT OF 1% AEP INUNDATION
- EXISTING IN STREAM MARSH/MACIOPHYLE (REFER NOTE 8)
- ROCK WEIR - WETLAND POND
- EXTENT OF EXISTING IRONGRASS COMMUNITY
- FUTURE IRONGRASS COLONISATION AREAS

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0 50 100mm

PRELIMINARY ISSUE
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REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
A	24.05.19	PRELIMINARY ISSUE			
B	12.06.19	PRELIMINARY ISSUE	GPB	MO	

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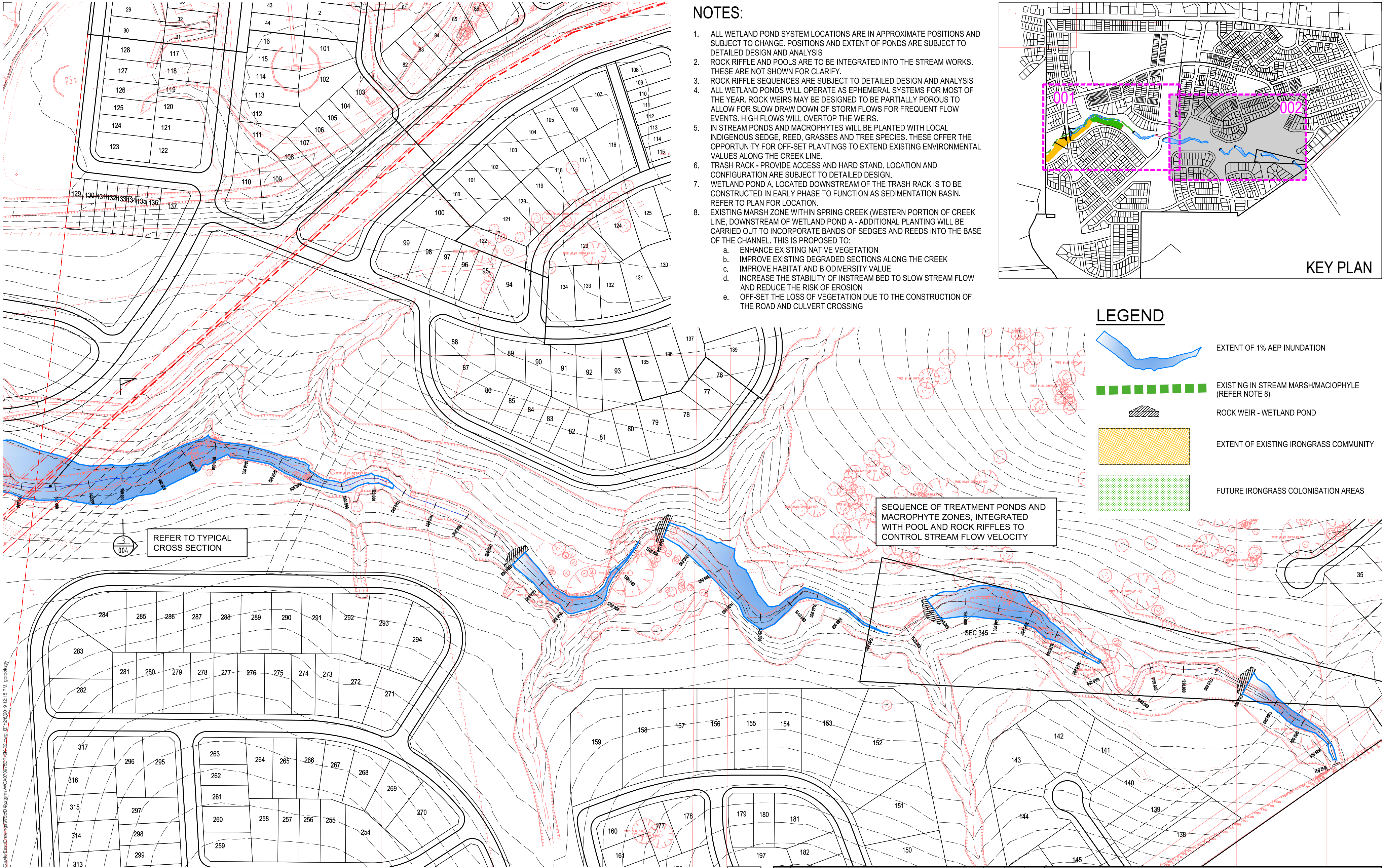
GAWLER EAST RESIDENTIAL
PRELIMINARY WATER COURSE TREATMENT
STORMWATER DETENTION LAYOUT SH. 1 OF 2

A1 DOCUMENT NUMBER
Project Number Sheet No. Rev.
Design Drawn
WGA070975DR-SK-001 B



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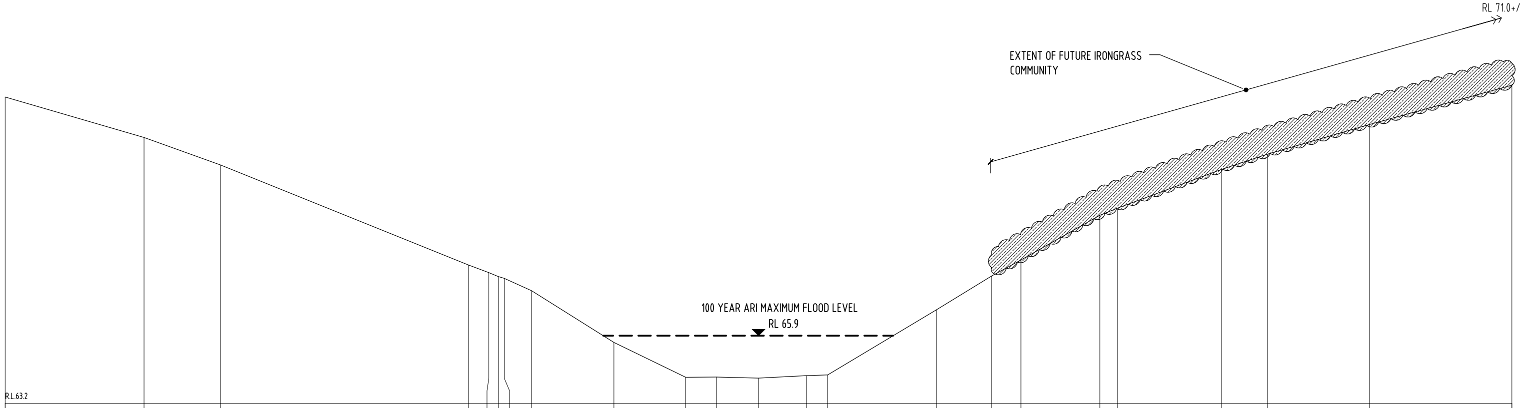
GAWLER EAST RESIDENTIAL
PRELIMINARY WATER COURSE TREATMENT

STORMWATER DETENTION LAYOUT SH. 2 OF 2

A1 — DOCUMENT NUMBER: WGA070975DR-SK-002 — Rev. B



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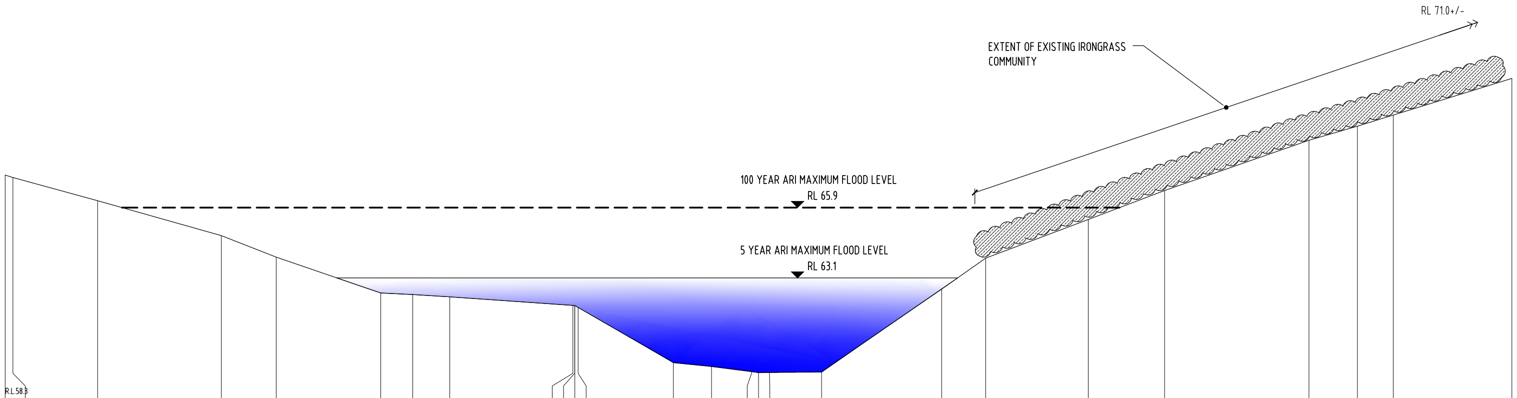
-21.427	72.71	
-11.558	68.72	
-10.740	68.41	
-10.363	68.26	
-10.124	68.19	
-9.037	67.69	
-5.758	65.63	
-2.900	64.24	
-1.682	64.25	
0.000	64.21	
1.911	64.31	
2.755	64.34	
7.095	66.94	
9.284	68.28	
10.450	68.92	
13.593	70.70	
14.287	70.98	
18.426	72.52	
20.261	73.13	
24.326	74.32	
30.000	75.89	

Ch 440.000

SECTION (2/001)
SCALE 1:1000



Offsets	EXISTING SURFACE	DESIGN SURFACE
-30.000	67.20	
-29.691	67.10	
-26.318	66.17	
-21.392	64.78	
-19.207	63.93	
-15.044	62.50	
-13.769	62.44	
-12.295	62.35	
-7.392	62.01	
-7.321	62.00	
-7.314	62.00	
-7.183	61.93	
-3.390	59.73	
-1.871	59.58	
-0.277	59.38	
0.000	59.33	
0.436	59.34	
2.511	59.36	
7.294	62.66	
9.046	63.89	
13.131	65.43	
16.170	66.58	
21.920	68.58	
23.849	69.14	
25.276	69.58	
30.000	71.04	

Ch 220.000

SECTION (1/001)
SCALE 1:1000

I:\2007\09Sep\2007\C070975-GawlerEast\Drawings\WSUD Systems\WGA070975DR-SK-03.dwg, B, 12/6/2019 12:07 PM, gbrooksby

When sheet printed full size, the scale bar is 100mm.
0 50 100mm

PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
A	24.05.19	PRELIMINARY ISSUE			
B	12.06.19	PRELIMINARY ISSUE	GPB	MO	

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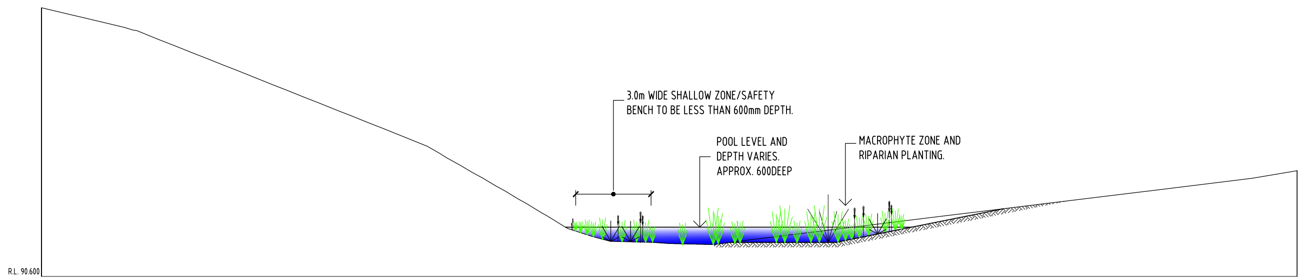
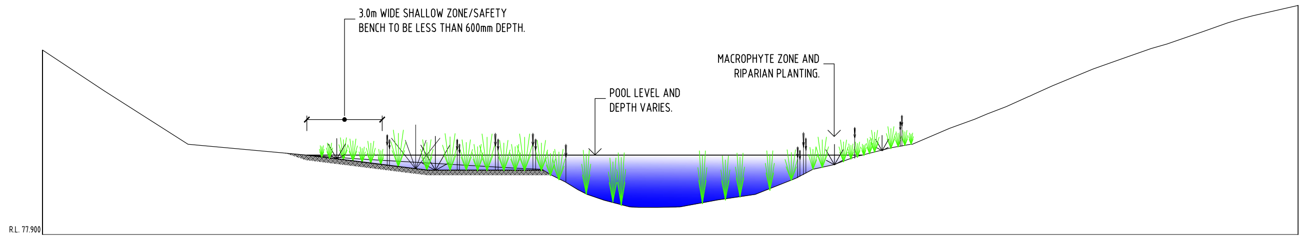
GAWLER EAST RESIDENTIAL
PRELIMINARY WATER COURSE TREATMENT

CROSS SECTION

A1
Design Drawn
DOCUMENT NUMBER
Project Number Sheet No. Rev.
WGA070975DR-SK-0003 B



TYPICAL CROSS SECTION



TYPICAL CROSS SECTION

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
A	24.05.19	PRELIMINARY ISSUE			
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PRELIMINARY WATER COURSE TREATMENT

TYPICAL CROSS SECTIONS

A1 DOCUMENT NUMBER
Project Number Sheet No. Rev.
Design Drawn
WGA070975DR-SK-0004 B

APPENDIX C

TYPICAL STORMWATER TREATMENT TECHNIQUES

Ecological Sponge

Biofiltration basin

Precinct scale rain garden

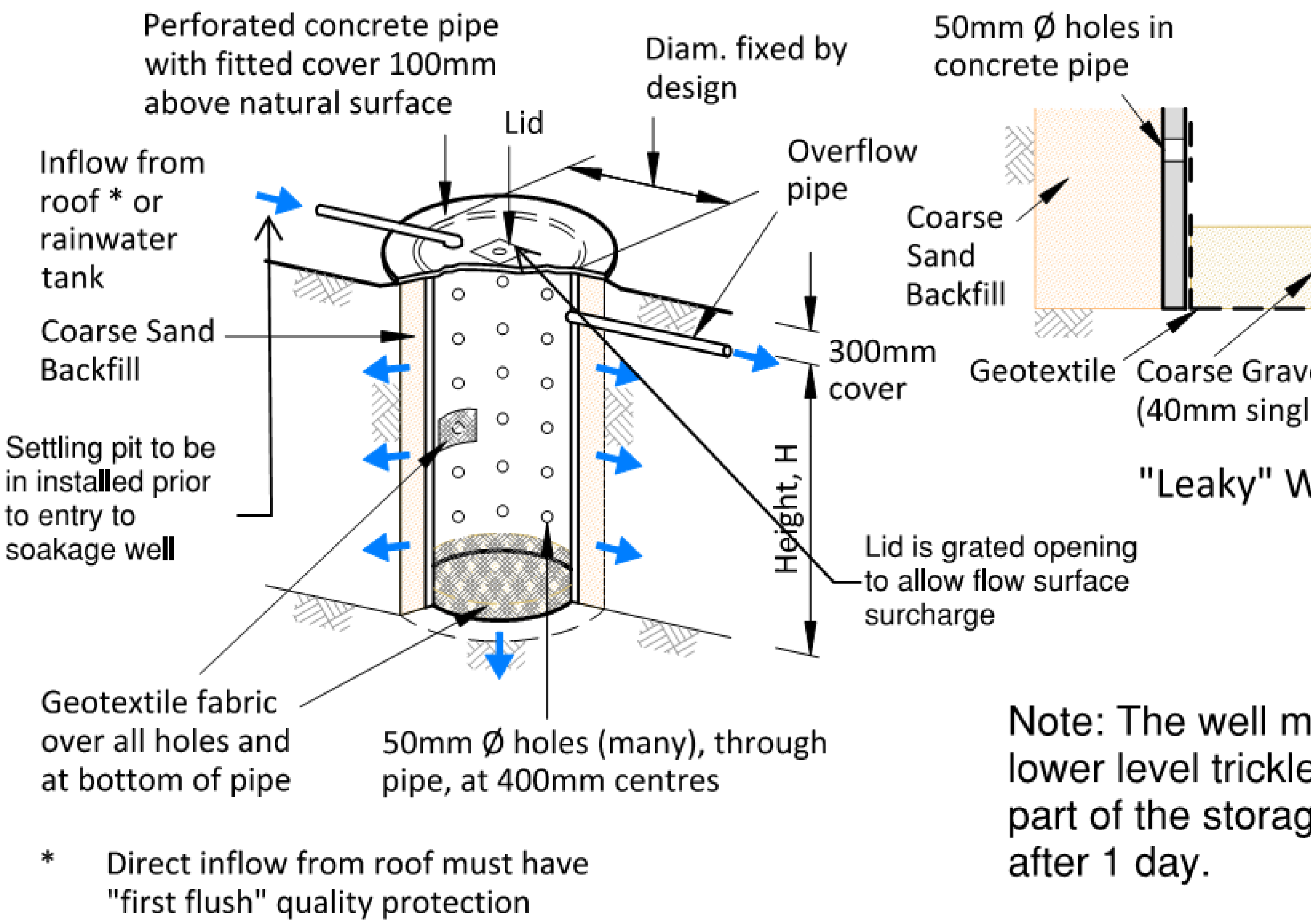
Wetland System

Wetland Pond

Rock riffle and pool sequence

Rock riffle and pool sequence / instream pond and macrophyte zone

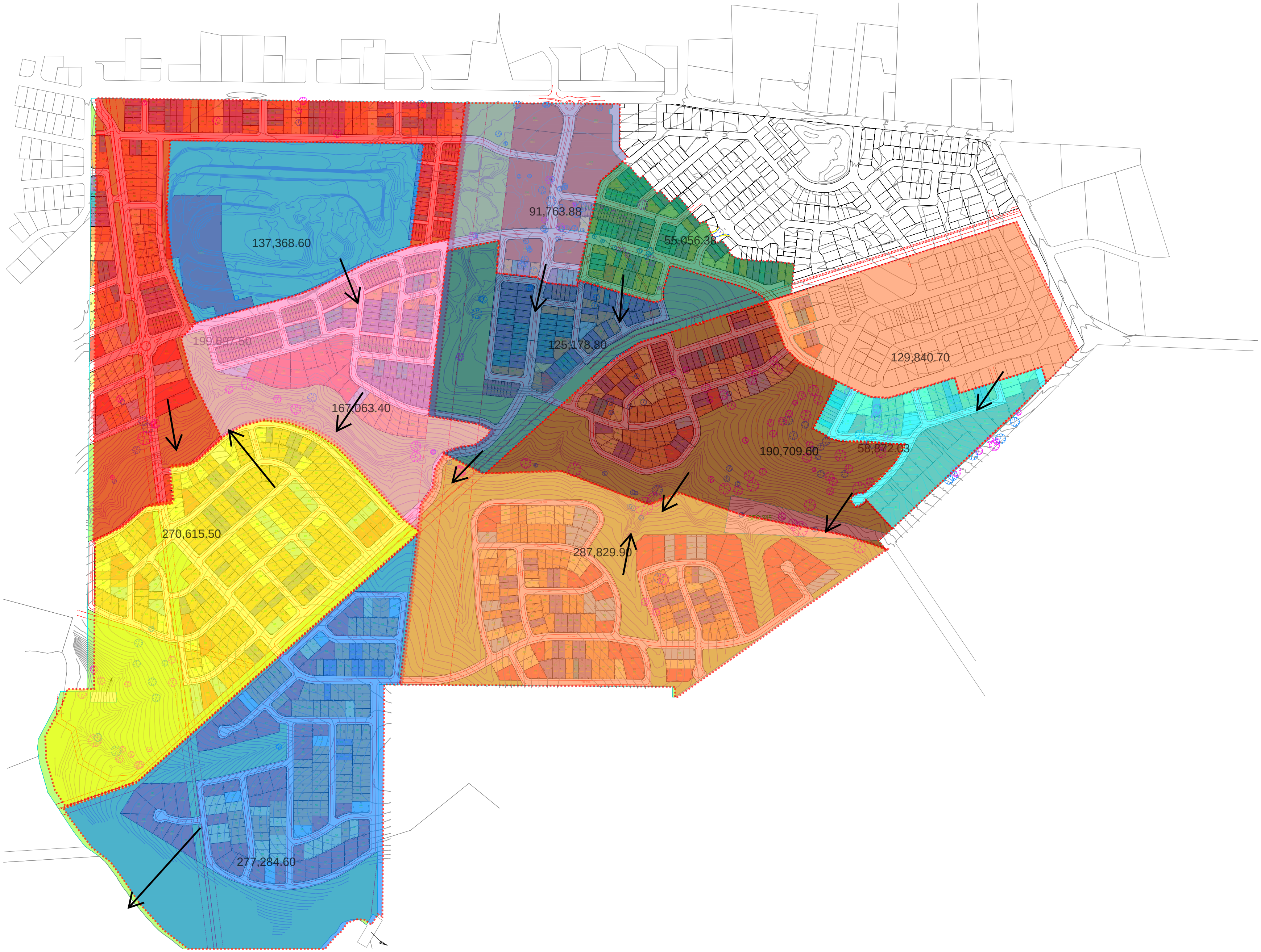
Rear of allotment infiltration well



Infiltration Well with Overflow

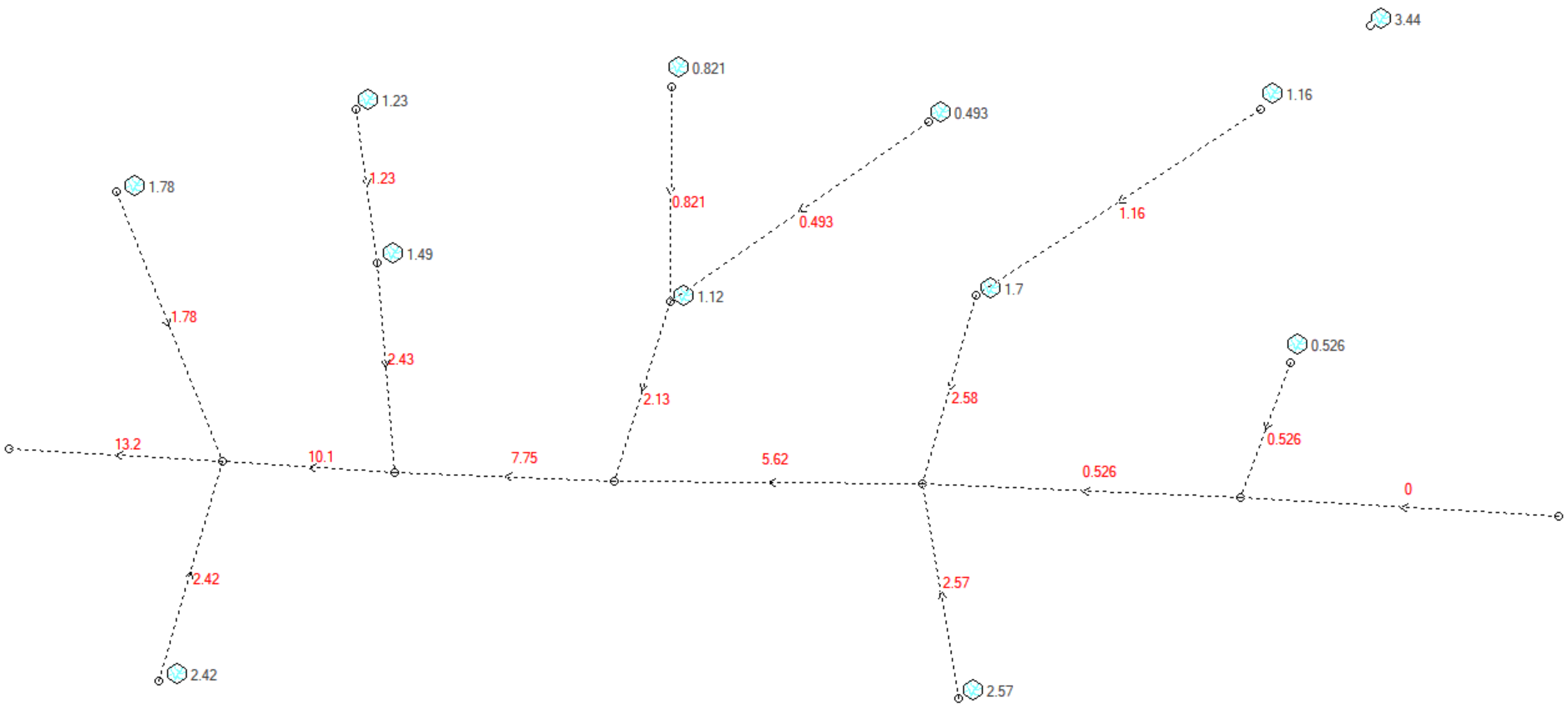
APPENDIX D

CATCHMENT PLAN, HYDROLOGY OUTPUTS AND CALCULATIONS

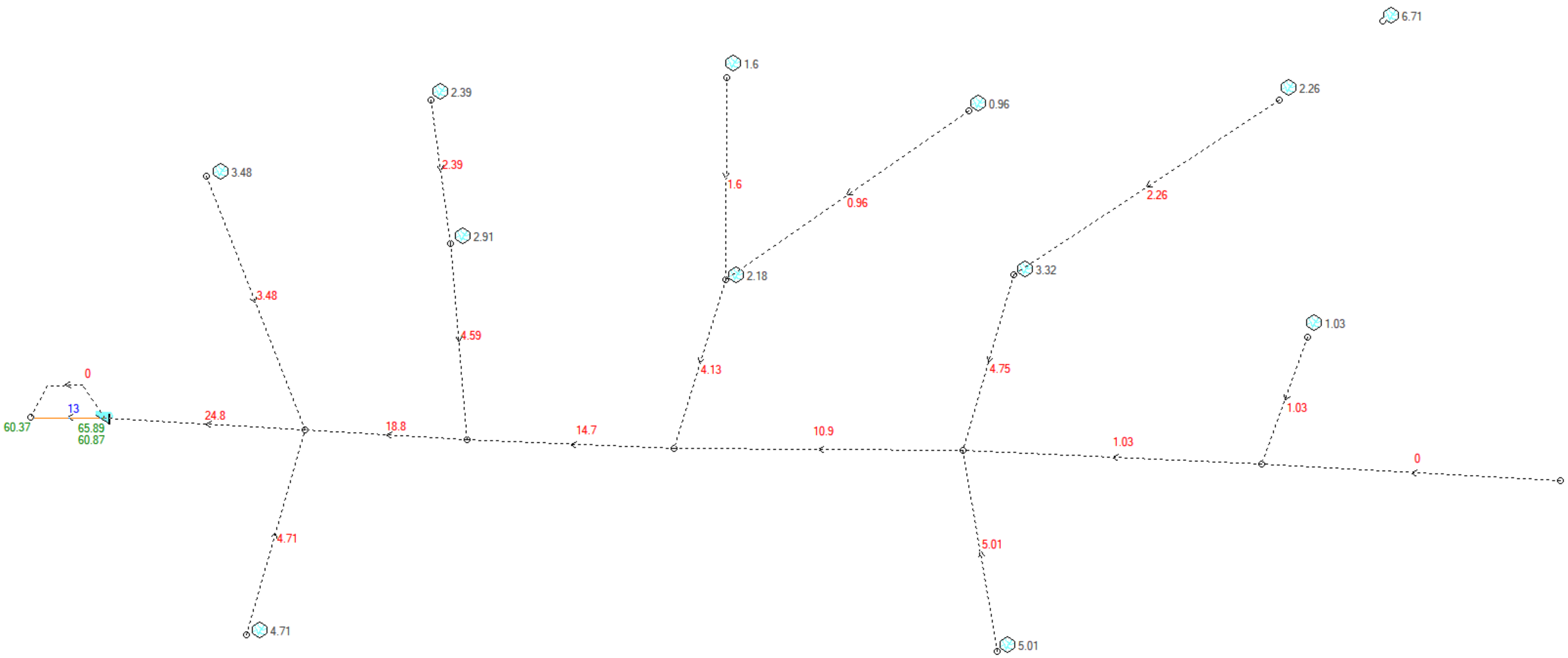


91,763.88
137,368.60
55,056.38
199,697.50
125,178.80
129,840.70
167,063.40
190,709.60
58,872.03
270,615.50
287,829.90
277,284.60

Pre-Development Flows
(1% AEP)



Post-Development Flows (1% AEP)



Treatment Surface Area Calculation

Sub Area Reference Number	Surface Area (Ha)	2% EIA (m2)	Treatment Area (m2)
1	1.73	281.4	350
2	2.32	368.4	400
3	0.35	52.5	100
4	0.21	31.5	50
5	0.3	45	100
6	1.26	189	N/A
7	0.3	45	100
8	1.25	187.5	200
9	0.62	93	100
10	0.23	34.5	N/A
11	0.23	34.5	N/A
12	0.06	9	N/A
13	0.08	16	N/A
14	0.4	60	N/A
15	1.57	235.5	300
16	0.37	55.5	100
17	0.24	36	N/A
18	0.27	40.5	N/A
19	0.65	97.5	100
20	0.31	46.5	100
21	0.08	12	50
22	2.24	336	2 x 200
23	0.47	70.5	100
24	0.78	117	150
25*	0.49	73.5	N/A
26	0.62	93	N/A
27	0.76	114	200
28	1.43	214.5	250
29	0.23	34.5	N/A
30*	0.43	64.5	N/A
31	2.55	382.5	400
32	0.19	38	100
33	0.41	61.5	100
34	0.53	79.5	100
35	1.68	252	250
36	0.4	60	100
37	0.237	35.55	100
38	0.23	34.5	100
39	0.31	46.5	N/A
40	0.3	45	N/A
41	0.13	19.5	N/A
42	0.48	72	100
43	0.33	49.5	50
44	0.13	19.5	50
45	0.5	75	100
46	0.42	63	100
47	0.06	12	50

APPENDIX E

CREEK PHOTOS

Spring Creek
East of major Water Main Crossing (Degraded and poor in-stream vegetation)

Spring Creek
West of major Water Main Crossing (Good quality in – stream marsh / macrophytes)

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