Walker Buckland Park Developments Pty Ltd

Precinct 1 and 2 Interim and Ultimate Development

STORMWATER MANAGEMENT PLAN – 2024

WGA080163

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Revision History

REV	DATE	ISSUE	ORIGINATOR	CHECKER	APPROVER
A	20 Dec 2023	For review	GLS/CIT	DB	DB
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CONTENTS

Figures

Tables

Appendices

1 INTRODUCTION

The Riverlea development covers an approximate area of 1,308 hectares. The site is situated approximately 32km north of the Adelaide CBD, bounded by Gawler River to the north, existing Cheetham salt fields to the south and west, Port Wakefield Road to the east.

The Riverlea Precinct is part of a proposed staged subdivision located in Buckland Park in northern Adelaide.

This report outlines the interim Stormwater Management Plan for Precinct 1 and Precinct 2 prior to the construction of the proposed Saltwater Lakes through the construction of a temporary open channel network to connect to Thompson's Outfall Channel and includes the temporary condition when the first salt water lake is constructed.

The report also presents the Ultimate Development condition, representing all salt water lakes constructed, and the large proposed detention basin developed at the southwestern corner of the site.

This is in accordance with the 'Playford Council Development Plan,' October 2011, for the purpose of Council approval. This report is an update of the previous SMP and includes all stages within Precinct 2 and the Ultimate development.

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

- Internal network drainage design (interim for Precinct 1 & 2 and Ultimate)
- Design of regional flood conveyance channels
- The management of stormwater quality and its integrated approach within the overall project
- The management of stormwater within an overall risk management framework
- Staged implementation of the stormwater strategy

A previous stormwater study 'Stormwater Management, Water, Wastewater and Recycled Water – Technical Paper,' prepared by WGA dated December 2023 for the Buckland Park Environmental Impact Assessment has been considered as part of this SMP for the Precinct 2. This previous report developed the strategy for flood protection across the entire site and was at the time reviewed by the relevant State Government agencies including Emergency Services.

This Stormwater Management Plan (SMP) relates to Precinct 1 and Precinct 2 of the Riverlea development as Shown in Figure 1.

Figure 1: Extent of the Precinct 1 & 2 – Interim Arrangement

Figure 2 shows the interim arrangement when Salt Water Lake 1 is constructed. It includes a 750mm outlet pipe that connects directly to Thompson's Outfall Channel.

Figure 3 shows the Ultimate arrangement when all 3 salt water lakes are constructed including the large detention basin at the southern end of the site.

All of the catchments in red are covered in the Interim solution. The green lines represent the proposed channels to be constructed to service Precinct 2 prior to development of the lakes.

Figure 2: Extent of the Precinct 1 & 2 – Interim Arrangement with Salt Water Lake 1 Constructed

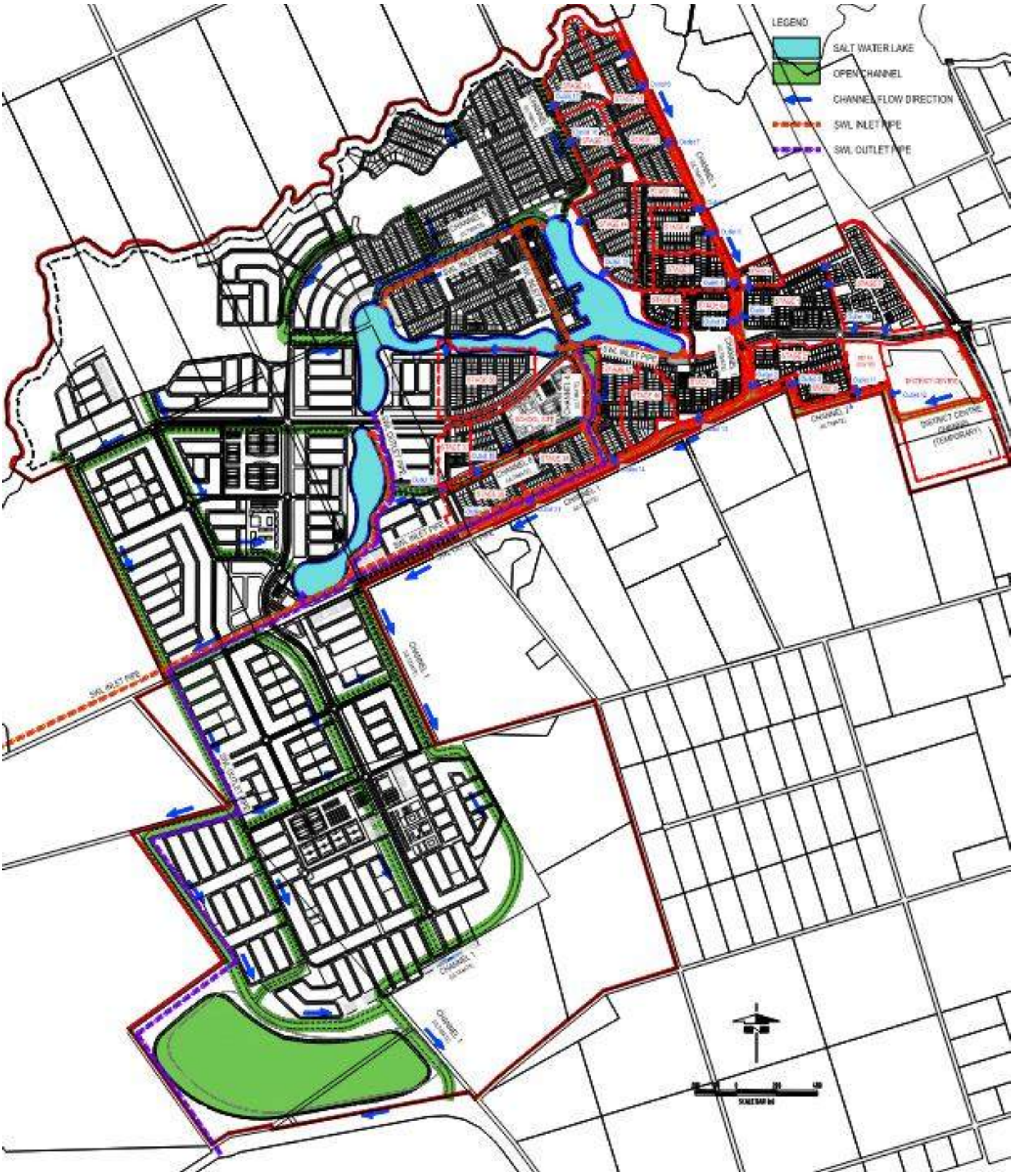

Figure 3: Ultimate Arrangement – Saltwater Lakes and Open Channel Network

1.1 Changes Since Previous Revision

As the previous revision of this report was prepared in January of 2024, this section has been incorporated to provide a summary of changes made to the Riverlea Precinct since the previous revision:

- Catchment plan has been updated with relevant pre-development and post-development areas, including Precincts 3 and 4.
- DRAINS Model has been extended to include the Precinct 2 catchments shown in Figure 1 and the proposed open channel network which includes some temporary channels until the future Saltwater Lakes are constructed.
- DRAINS Model also developed to include the temporary condition where Salt Water Lake 1 is constructed.
- DRAINS Model incorporates hydrograph from Smith Creek where development channel connects to Thompson's Outfall.
- HEC-RAS Model has been extended to capture the proposed channel arrangements for Precinct 1 and 2.
- HEC-RAS Model geometry has been updated to reflect changes channel low-flow extents and channel widths.
- TUFLOW Model has been used to model the Ultimate development condition with the Saltwater Lakes and open channel network including the proposed southern detention basin, to demonstrate the performance of the system when complete. Refer to WGA report, 2009 Technical Paper Update – Flood Assessment, November 2003 that outlines in detail the TUFLOW Modelling parameters.
- References to ARI updated to AEP as per latest 2019 AR&R Guidelines.
- Discussion added on sea-level rise, storm surge and tide levels.
- TUFLOW Model has been updated to include a tailwater condition to simulate Sea Level Rise (SLR) and tidal conditions at the outlet.
- TUFLOW modelling of the channel network has been updated and provided to demonstrate:
  - Compliance to provide flood protection within the floodplain (flooding from Gawler River).
  - Demonstrate flood capacity for a localised 1% AEP storm from within the development has suitable capacity to prevent flooding within the development and downstream to Thompson Creek.
- Risk assessment matrix and flood modelling have been updated following further flood plain modelling undertaken to demonstrate that flood risks have been addressed for flooding from Gawler River as well as 1% AEP runoff from within the development is detained within the new channel network.
- Section 6.4 has now been included to outline the strategy required to mitigate and manage erosion and sediment deposition within the channels prior to landscaping.
- Section 7 Climate Change Is no longer up to date with current knowledge and has therefore been deleted. A climate change risk assessment has been included and discussed in Section 3.2.
- Climate change and scenarios have been evaluated as part of the hydrology and hydraulic modelling. Climate change parameters scenarios are now included.

1.2 Stormwater Management Requirements

The City of Playford and the Environmental Protection Authority provide their own guideline and requirements as relevant to stormwater management. These have been outlined below.

Environment Protection Authority

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:

- Where practical and feasible 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 50 mm for flows up to a 3-month Average Recurrence Interval (ARI) peak flow.
  - No visible oils for flows up to a 3-month ARI peak flow.
- Environment Protection Policy (Water Quality) 2015, under the Environment Protection Act, 1993.

City of Playford

Further to the EPA requirements outlined above, there are a number of general Council requirements relating to stormwater design and assets as outlined below.

Council's guidelines require minimum gradients for both pipe and road grades. These are based on providing suitable provision to accommodate maintenance requirements and hydraulic performance. Council acknowledge that road gutter gradients have been reduced in some instances where necessary to accommodate the flatness of the terrain. In this regard, Council has advised the following compliance requirements:

- Councils standard minimum grade is 0.5%. This is considered the target minimum gradient that Council seeks to be achieved in the design.
- In some instances where constraints will result in the minimum gradient cannot be achieved, then Council may accept the following minimum gradients:
  a. 375 mm RCP – 0.5%
  b. 450 – 600 mm RCP at 0.4%
  c. Greater than or equal to 675 mm RCP 0.3%
- All road crossings to shall not be less than 0.5%.
- In the upper reaches of the system, at the start of the stormwater network, the minimum grade is 0.5% (in order to achieve a sufficient velocity prior to joining the larger network).
- At Council's discretion an assessment of self-cleansing velocity check may be required.

The design criteria used is further discussed in Section 5.2.

2 CATCHMENT AREA OVERVIEW

2.1 Soils and Groundwater Setting

The geological survey of South Australia indicates that the majority of the site should be underlain by the Pooraka formation, typically comprising of pale red-brown sandy clay containing calcareous lenses. Bedrock is not expected to occur in the upper 30 m depth at the site. Reference is made to a geotechnical investigation undertaken by Coffey (1998) across the majority of the proposed development.

As a part of the initial site investigations ground water mapping was undertaken by Resource and Environmental Management (now Jacobs). This mapping indicated that the depth to ground water within the site ranges from 0.2 metres to 7 metres below the natural surface level. It can be seen in Figure 4 that approximately 75% of the site has a depth to ground water of approximately 3 metres below the surface level. Groundwater was found to be saline ranging from 1000 ppm to 5000 ppm.

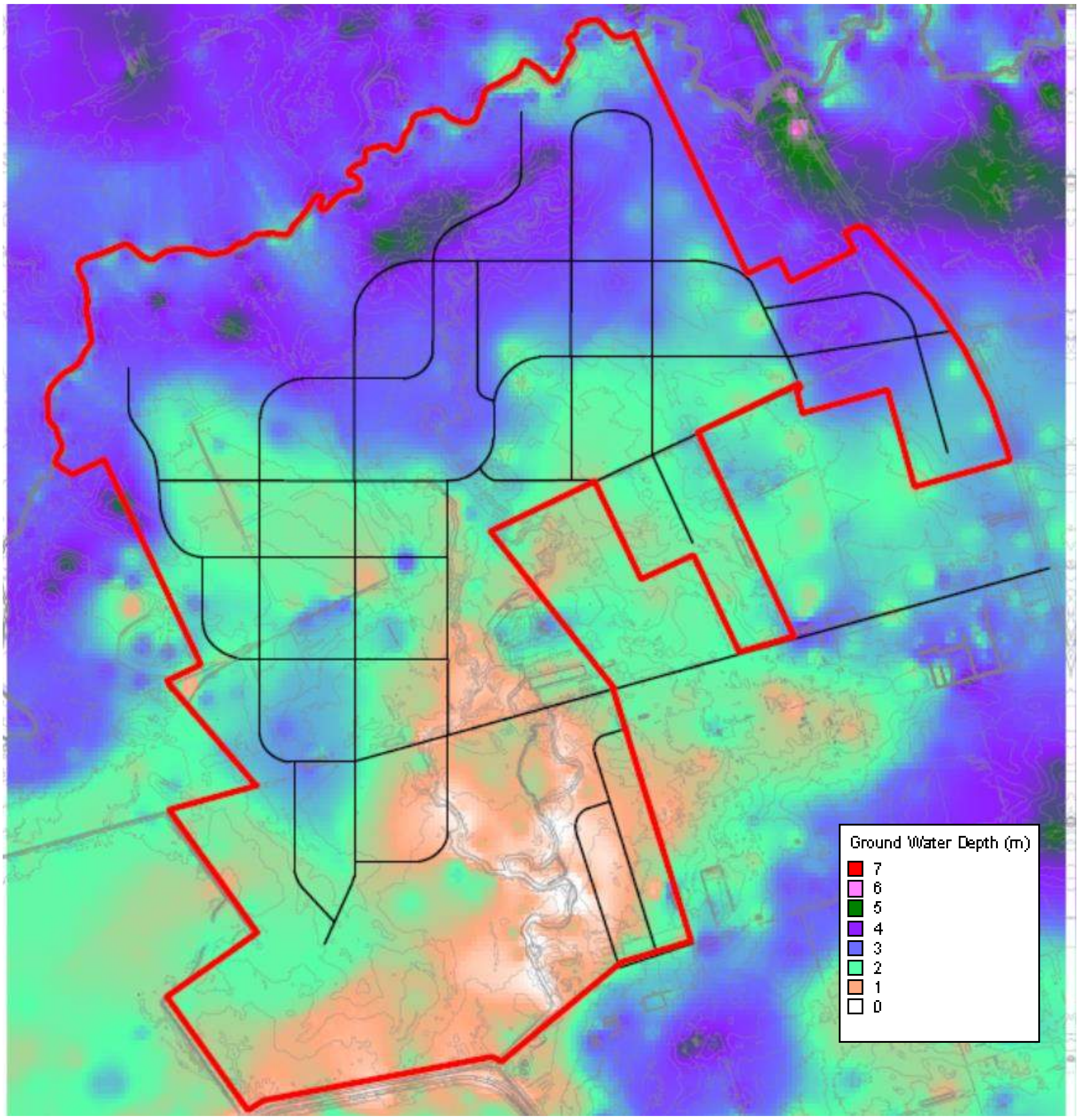

Figure 4: Depth to Groundwater

2.2 Existing Catchment

The Buckland Park site is situated approximately 2.7 kilometres inland of the Gulf St Vincent coastline and it is for this reason not considered to be a coastal site. The topography of the site is relatively flat with an approximate fall of 0.2% across the site from east to west. The site also lies within the Gawler River flood plain.

The Buckland Park site generally drains away from the Gawler River in a south westerly direction towards the Thompson Outfall Channel. The Development will naturally drain to Thompsons Creek and channel to the west of the site.

The Gawler River is situated within the Northern section of the Buckland Park site and is a perched river system. As the banks of the Gawler River are higher than the adjacent floodplain, stormwater runoff from the Buckland Park site will not drain to the Gawler River nor to the Buckland Park Lake System as they are both effectively located upstream of the Buckland Park development area.

Figure 5 shows the site levels in metres to Australian Height Datum (AHD) and shows that the site falls away from the Gawler River towards the Thompson Outfall Channel.

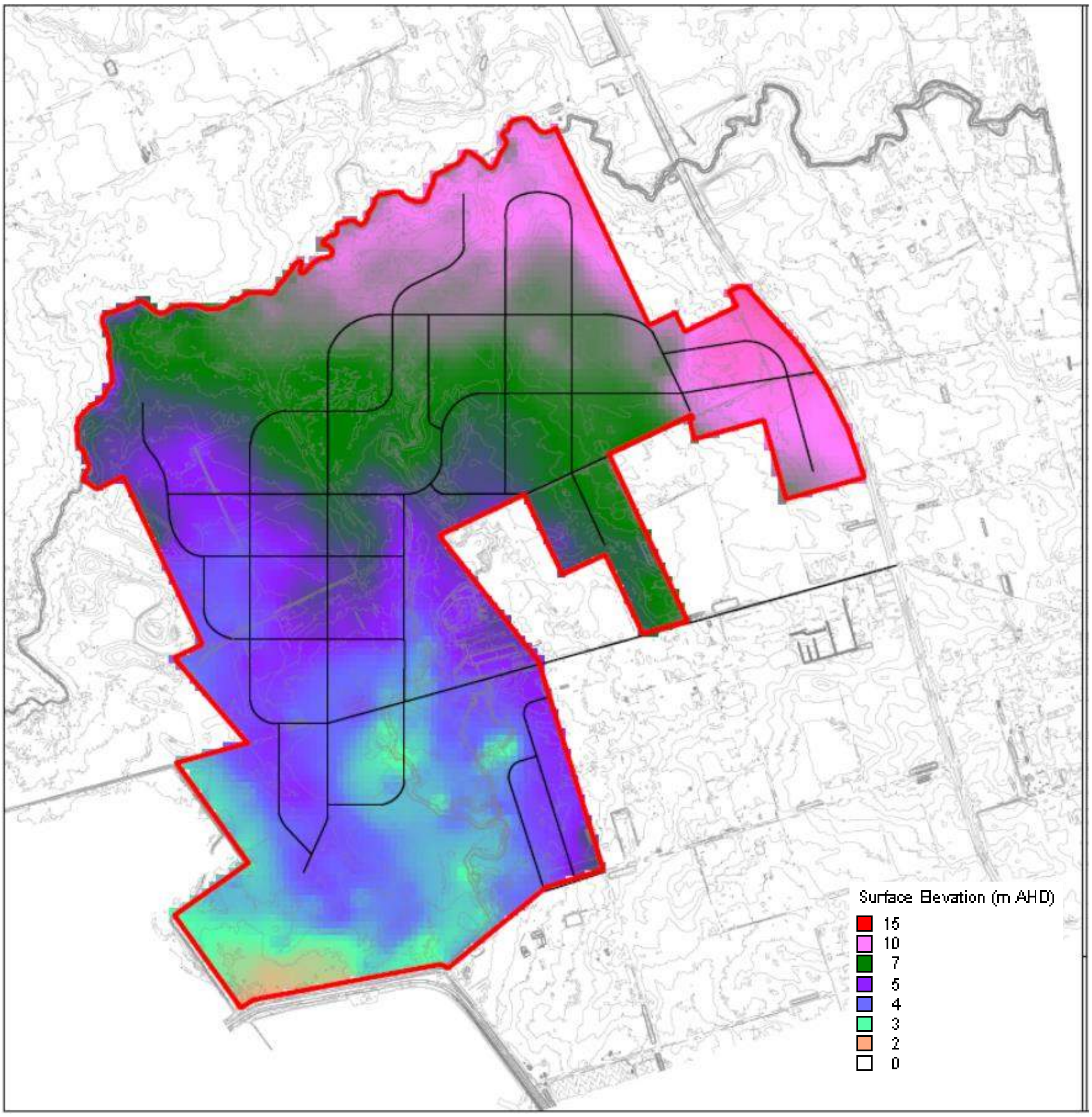

Figure 5: Existing Site Levels

2.3 Development

Precincts 1 and 2 including all stages are currently a combination of greenfield sites including current areas already developed or under construction with a total area of approximately 346 Ha. The development comprises of mixed size urban allotments. In order to facilitate appropriate gradients along proposed roadways and allotments, Precinct 1 and 2 allotments will be filled in some areas with material excavated from the new extensive open channel network and graded to ensure Council's minimum road and pipe network grades are achieved. This allows drainage (above and below ground) to drain to the proposed regional drainage channels and future lakes through the development. This is required as the overall natural site gradient is flatter than the permissible minimum gradients for kerb and water table and stormwater pipes.

As the site is characterised by relatively flat topography, stormwater drainage from Precinct 1 and Precinct 2 is proposed to discharge at a number of distinct locations to a proposed regional channel system which includes some temporary channels. Post-development of Precinct 2 with its interim channel arrangement, the project will begin to introduce the proposed Saltwater Lake system which will be used to provide stormwater detention and amenity for the northern catchments within the development.

2.4 Existing Known Assets

The current method of stormwater management within the Buckland Park site relies on a system of natural open channel lines and roadside open drains and culverts to move the stormwater runoff through the catchment and discharge it to the ocean via the Thompson Creek Outfall Channel. It is also understood that some groundwater is pumped to the Thompsons Creek from the Virginia area, however to date, no details have been able to be obtained. As this is a pumped arrangement, the volumes and peak flows are small compared to the predicted ultimate site runoff and this arrangement will not have any significant impact on the flood capacity of the proposed stormwater network.

WGA contacted Tony Fox of the Adelaide and Mount Lofty Ranges Natural Resource Management Board (AMRNRMB) in regard to obtaining further details about the system. Tony confirmed to date none are available. He did confirm that the outlet size from the pump discharge is only a 90 mm to 100 mm pipe, which confirms that the impact on flood capacity from this discharge is negligible.

3 IDENTIFICATION OF PROBLEMS 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 during the design, construction and operational phases of the development. This process is undertaken to assist in identifying appropriate management measures to manage the project impacts, and/or determine if intervention is required to manage these risks.

The main steps in the risk management process are:

- Identify risks – as determined by 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
- Treat risks – prioritise, address and mitigate identified risks

This Risk Management process covers a significant proportion of Precinct 1 and Precinct 2 of the development. The information sourced to inform this risk management process comes from various technical reports that have been undertaken for the Buckland Park development. These reports have been based on investigations associated with the site characteristics including groundwater, vegetation, soils and other physical aspects. These reports are listed below for reference to provide the background to this process:

- Buckland Park ASR, Groundwater Modelling, AGT (2011).
- Buckland Park Drain Model, AGT (2011).
- Buckland Park Flood Modelling Maps, AWE (2011).
- Buckland Park Biodiversity Strategy, EBS Ecology (2011).
- Bulk earthworks Modelling, W&G (2012).
- Buckland Park Country Township Master Planning Report, Connell Wagner (2007).
- Buckland Park Residential Development Stage 1, Geotechnical Investigation, Coffey Geotechnics (2011).
- Preliminary Acid Sulphate Soils Investigations, Buckland Park, Golder Associates (2008).
- Buckland Park Country Town Development, Thompson Creek Outfall Capacity Assessment, Connell Wagner (2007).
- Riverlea Development - Recycled Water Strategy, WGA (2012).
- Aquifer Storage and Recovery Potential for Buckland Park, REM (2008).
- Stage 1A and 6A Flood Management System Modelling, AWE (2012).
- Buckland Park Stage 1 Stormwater Quality Management, WGA (2011).
- Western Catchment Stormwater Master Plan, Tonkin (2008).
- Enviro Development Technical Standards National Version 1, UDIA (2011).
- Water Technology Floodplain modelling and mapping (updated 12 December 2021 and included in report).

Following a review of the referenced texts above the risk assessment has been prepared for the design, construction and operational phases of the project. This is presented in Table 4 and Table 6 inclusive. The likelihood and consequence matrix are provided in Table 3 for reference.

3.2 Consideration for Climate Risk

WGA have undertaken a climate risk assessment for the project to:

- To consider the potential nature, scale and likelihood of any impacts of future climate risk to the project.
- To assist in identifying appropriate treatment measures to manage the potential impacts of climate change on the project.

The following climate change projections were considered relevant for the site when considering the impact on stormwater management:

- Decrease in average rainfall
- Increase in potential evaporation
- Increase in solar radiation
- Increase in rainfall intensity

For drainage infrastructure with a long-term design-life both the Intergovernmental Panel for Climate Change (IPCC) scenarios RCP 4.5 and RCP 8.5 were considered for the assessment of drainage infrastructure.

3.2.1 Projections

The climate change projections consider the useful design life of the proposed asset to determine the appropriate climate change scenarios. Table 1 outlines the asset, useful design life and the climate change projections assessed.

For long-term scenarios (i.e. greater than 2050) both the RCP 8.5 and RCP 4.5 scenario has been assessed for a broader range of possible futures.

Table 1: Relevant Infrastructure Assets and their Corresponding Design Life and Climate Change Projections

ASSET	DESIGN LIFE	PROJECTIONS	CLIMATE SCENARIO
Accessible Drainage – stormwater assets including culverts	98 Years	Long-term asset 2050 & 2090	RCP 8.5 & RCP 4.5

Table 2 below summarises the climate change projections based on the above.

Table 2: Climate Change Projection Scenarios (Adelaide and Mount Lofty Ranges Climate Data)

VARIABLE	SCENARIO (RCP 8.5)			
	2030	2050	2070	2090
Increase in average temperatures (°C)	+1.1	+1.8	+2.6	+3.4
Decrease in average rainfall (%)	-5.4	-8.4	-13.6	-17.4
Increase in potential evaporation (%)	+3.1	+5.2	+7.4	+9.9
Increase in very high or extreme fire risk days	+0.5	+9.8	-	+20.3

VARIABLE	SCENARIO (RCP 8.5)			
	2030	2050	2070	2090
Increase in rainfall intensity (%)*	5.5%	-	13%	17%
Sea Level Rise	+0.13 (+0.08-+0.17)	0.25 (+0.16-+0.33)	-	+0.61 (+0.4-+0.84)
Storm Surge	State Government Policy is to allow for 0.3 m of sea level rise from 1990 to 2050 and 1.0m to 2100. The Coast Protection Board is able to advise on anticipated sea level rise at specific locations.			

*Interim factors. Refer to next section for further discussion

It is anticipated that the majority of climate change impacts can be managed with regular monitoring and maintenance of assets. However, the following adaptation actions should be considered during planning and design:

- Materials selection to consider the future climate conditions (e.g. consideration of saline conditions for culvert design as sea level rises), consider new technology where available.
- Consideration of climate change scenarios during the design phase.
- Flood modelling and stormwater design to consider climate change projections.
- Maintenance and monitoring plans to consider increased frequency following major climatic events (flood, fire, extreme heat).
- Maintenance planning to consider the impacts of extreme climatic conditions on staff and provide necessary management (training, PPE, flexibility).

3.2.2 Climate Change Multiplier

A climate change multiplier of 1.2 has been applied to the rainfall intensities in the hydrologic and hydraulic modelling. This was above the 17% increase by 2090 as stated in the interim factors.

In September 2024, AR&R was updated with new advice relating to climate change. The multipliers are now storm duration-dependent and have been revised upwards from the interim factors. To provide some context, the adopted factor of 1.2 equates to:

- 2100 projections for SSP2.6 (9-hour duration)
- 2060 projections for SSP4.5 (9 hour duration)
- 2050 projections for SSP7.0 (9 hour duration)
- 2040-2050 projections for SSP8.5 (9-hour duration)

The adopted factor of 1.2 is therefore considered appropriate for a short-term scenario (2050) for the most conservative Shared Socioeconomic Pathway (SSP) of SSP8.5.

The ARR Data Hub provides a climate change factor of 1.5 for a 9-hour storm duration for SSP8.5 for 2100.

It is also noted that initial losses and continuing loss factors are expected to reduce with climate change. Continuing loss factors could increase by up to 27%, however this relates more to the upstream rural catchments than for a development that is urbanised.

3.3 Strategies to Manage Risk

The response measures are outlined in the Risk Management Table 4 to Table 6 inclusive for Precinct 1 and Precinct 2. 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).

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 approach. In this regard the design of the regional channels would adopt the multi-objective approach to stormwater management such that the development incorporates corridors not solely for conveyance of flood waters. As part of this project a framework will provide the methodology for the design of the regional channels project.

Principles in this framework are proposed for:

- Reducing mains water usage
- Improving quality runoff
- Managing the rates of runoff
- Managing the volume of runoff
- Enhancement in amenity, environmental values, habitat and biodiversity

Table 3: 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 4: 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 increase impervious areas and flat gradients.	Low	High	Medium	Drainage systems (including culverts, drainage networks, kerb and channel and open drains) shall cater for 1 in 5 Average Recurrence Interval (ARI) storm events, with a one in 100-year ARI storm event checked for overland flooding through flow paths. The system shall have sufficient capacity to accommodate the design drainage flow in accordance with the drainage requirements and without causing damage or nuisance to surrounding landowners and properties. Council requirement to provide detention to reduce post development flows to predevelopment level, which for Precinct 1 will be accommodated within the Stage 1 open channel construction as the volumes that can be contained within this system, which provides protection largely from the Gawler River flooding is significant.	Drainage network designed in accordance with Council standards.
B	Flooding - Gawler River	Flooding (large magnitude) of low-lying land due to overland flooding from floodwater breaking out of Gawler River.	Medium	High	High	Incorporate a network of regional drainage channels in design - elements to be designed to maximise stormwater interception of overland flooding with no flows to surrounding low lying areas. Regional drainage channels to be located and tested with flood plain modelling by Water Technologies. Regional channels to be hydraulically sized and modelled as part of the design.	
C	Flooding - Increase downstream flooding / exceeding capacity of Outfall channel	Flooding of low-lying land and erosion of channel and adjacent area.	Medium	High	High	Incorporate a network of regional drainage channels in design - elements to be designed to maximise stormwater interception of overland flooding with no flows to surrounding low lying areas. Detention to control rate of discharge to pre-development levels.	

1. DESIGN PHASE							
D	Erosion at outlets	Scouring and erosion associated with increase velocities, peak, volume of water.	Medium	High	High	Drainage outlets to incorporate rock pitching, energy dissipation and vegetation	
E	Shallow ponding / stagnant water conducive to mosquito breeding	Nuisance issues, health risks to community.	Medium	High	High	Minimise ponding to controlled areas Incorporate naturalistic design principles to create habit for natural predators in channels and pools Incorporate porous rock riffles that enable pools to drain out slowly after rainfall events Swales and drainage channels designed with longitudinal gradients to avoid stagnant and isolated pools	Regional channels incorporate a pool and riffle sequence for stormwater treatment. The pools are designed to drain out through porous rock riffles. The channel has been designed using naturalistic design principles and incorporates vegetation to create habitat and biodiversity which provides natural control of mosquito population.
F	Waterway function - Thompson Outfall channel	Decrease in waterway function due to changes to hydrological regimes, sedimentation, erosion, water quality.	Medium	Medium	Medium	The design and layout for stormwater treatment ponds will follow the rationale and design features associated with naturalistic water design, and wetland design. The treatment flow adopted in the design will be based on a three month to one-year ARI peak discharge rate from the local catchment. This will allow for 98 percent of all annual rainfall and daily runoff events from the local catchment will receive treatment to the WSUD standards. Any flows of a higher rate above the one-year ARI would still pass through a stormwater treatment system and receive some treatment. The regional channels are designed to slow the flow of stormwater through the local catchment. The regional channels will accommodate a large retention storage during the interim phase of the development which will hold back stormwater.	The regional channel will accommodate a large detention volume in the interim phase to hold back urban flows from Precinct 1 and 2 with the channel being extended to connect to Thompson' Creek. Ultimately a detention basin is proposed at the downstream end of the development where it connects to Thompson Outfall channel. This is modelled together with the future lakes in the Ultimate Development scenario.

1. DESIGN PHASE							
G	Acid Sulphate Soils	Long term impacts on infrastructure associated with acid (from the disturbance of acid sulphate soils).	Low	Medium	Low	Undertake geotechnical investigations to determine if these soils are present.	Acid sulphate soils have not been encountered within the Precinct 1 development site.
H	Water Sensitive Urban Design	Runoff quality leads to long term water quality impacts to receiving environments. **while impacts are operational, unless addressed during design, little chance of addressing impacts during operations.	Medium	Medium	Medium	Project based treatment design using treatment train approach. The design and layout for stormwater treatment ponds 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 three month to one-year ARI peak discharge rate from the Local catchment. This will allow for 98% of all annual rainfall and daily runoff events from the Local catchment will receive treatment to the best practice standards. Any flows of a higher rate above the one-year ARI 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 WSUD Guidelines for the Greater Adelaide Region (2013 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 3-month ARI peak flow. - Oil and grease, no visible oils for flows up to the 3-month ARI peak flow.	**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)

1. DESIGN PHASE							
I	Groundwater	Increase in groundwater levels due to increased runoff from paved areas.	Medium	Medium	High	AGT had assessed the likelihood of increased groundwater levels due to the increase in impervious areas in their report titled. *Buckland Park Drain Model, AGT (2011)* and the report suggests there may be some local raising of water levels at the inverts of the open channel system, but that water levels will remain largely unchanged across the site. The open channel system will intercept shallow groundwater in some locations across the site, however, the flow rates of groundwater passing through the extensive open channel system are estimated to be of the order of 200l/s which is considered small given the scale of the network.	
J	Thompson's Creek in private ownership	Modification of the creek by private landowners increasing the risk of flooding.	Low	Medium	Medium	There is a section of Thompson's Creek that is outside the development boundary and is in private ownership. There is a risk that private landowners could fill or modify the creek, and impact on its capacity. Modifications to the creek would be a 'Water Affecting Activity' under the Natural Resource Management Act and would require a permit, so there are penalty measures in place should this occur notwithstanding there is still a risk. Ultimately the main channel will be constructed down to the Thompson's Outfall Channel, and the system will not rely on any part of the existing Thompson's Creek, and the risk will be removed. In the short term, the extent of storage provision within the main channel constructed down to Thompson's Creek will result in only very minor flow rates in Thompson's Creek.	

Table 5: 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	Low	Medium	SEDMP	
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	
C	Gross pollution (litter)	Impacts on receiving waters: - visual / aesthetics - decreased water quality.	Medium	Low	Medium	Construction Environmental Management Plan (CEMP) 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	

2. CONSTRUCTION							
E	Hydrocarbons	Impacts to water quality including: - increased toxicity - algae outbreaks and eutrophication - visual / surface scum.	Low	Medium	Medium	CEMP	
F	Acid Sulphate Soils	Impacts on receiving water quality including: - decreases in pH - increases in heavy metals - increased toxicity to aquatic flora / fauna - soil contamination along flow lines.	Low	High	Medium	Site does not lie in the extent of Coastal acid sulphate soils.	
G	Interception of groundwater (<3m unconfined saline aquifer)	Impacts on receiving water quality (associated with dewatering activities).	Low	Low	Medium	CEMP	
H	Accidental spills and/or release of contaminated soil into groundwater systems	Contamination of groundwater.	Low	High	Medium	CEMP	
I	Temporary changes in direction and flow of surface water and groundwater	Pooling in undesirable areas, including excavations.	Medium	Low	Low	CEMP	
J	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	Regional channel will retain stormwater without direct discharge to Thompson Outfall channel.

Table 6: Operations (Post Construction) Phase Risk Management Process

3. OPERATIONAL - POST CONSTRUCTION							
ID	**Issue**	**Potential Impact**	**Likelihood**	**Consequence**	**Level of Risk**	**Response/Management Measure**	**Notes**
A	Urban stormwater pollution	Impacts to water quality including: - increased toxicity - accumulation in aquatic sediments.	High	Medium	High	Project based treatment design e.g. drains, wetlands, detention basins (interchanges), 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.	High	Medium	High	No runoff from any part of the project shall be discharged out of the road corridor unless it is in an underground or surface drainage system that is intercepted by a treatment wetland prior to entering a watercourse.	
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 treatment design e.g. sediment ponds. Treatment train response. Existing regional drainage catchments and flow patterns should be maintained where practicable and drainage flows shall not cause scour, damage or nuisance to surrounding landowners and properties.	
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. Treatment train response (primary treatment).	

3. OPERATIONAL - POST CONSTRUCTION							
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		
F	Gross pollution (litter)	Impacts on receiving waters: - visual / aesthetics - decreased water quality.	Medium	Low	Low	Maintenance Provision of gross pollutant traps at stormwater outlets.	
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 swales, soakage systems and pool and riffle sequence in regional channel Revegetate regional channels with indigenous plant species to slow surface water flow, protect from erosion, and restore habitat and environmental values.	
H	Rising groundwater levels due to irrigation of playing field and residential properties	Impact on infrastructure, vegetation due to rising saline groundwater.	Low	High	Medium	Regional channel intercepts groundwater and therefore water levels remain unchanged.	Study report by Australian Groundwater Technology suggests that this is unlikely.
I	Climate Change	Sea-level rise resulting in elevated tailwater levels.	High	High	High	Sea-level rise scenarios have been incorporated into tailwater levels within modelling.	
J	Climate Change	Increased rainfall intensity	High	Medium	High	Climate change factor of 1.2 has been adopted for hydrological models.	

3.4 Construction Environment Management Plan (CEMP)

The CEMP is expected to be developed to mitigate the risks associated with construction and to address risks appropriate to avoid impacts to the downstream waterways. The CEMP is expected to have contents similar to 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

Conclusion

The Construction Environment Management Plan will be prepared by the Construction Contractors (for each stage of the development) and will be submitted to Council for approval 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. These stages will follow the principles as outlined in this report.

4 STORMWATER MANAGEMENT OBJECTIVES AND STRATEGIES

4.1 Objectives

The key aspects to achieve in the strategy for the management of stormwater runoff from the development relate to the following:

- Flooding
- Water Quality
- Water Use
- Environmental Protection and Enhancement

From these key aspects, broad objectives for management of stormwater runoff can be developed and are identified as follows:

Objective 1: Flood Management - Provide and maintain flood protection to Precinct 1 and parts of Precinct 2 and future development based on local catchment (Development) and flooding arising from the broader Gawler River system (Regional).

Objective 2: Water Quality Improvement – Treat stormwater to meet the requirements for protection of the receiving environment to EPA and WSUD standards. Use green infrastructure to manage water quality and to integrate with Objective 4.

Objective 3: Water Use – Capture and use of stormwater runoff for beneficial purposes.

Objective 4: Amenity, Recreation & Environmental Enhancement and Protection - Where possible, develop land used for stormwater management purposes to facilitate recreation use, amenity & environmental enhancement.

The development of the stormwater strategy for Precinct 1 and Precinct 2 requires these broad objectives to be further refined to identify specific management objectives. These specific objectives are outlined in the following Sections and will then enable targeted management strategies to be identified, assessed, and implemented.

4.2 Flooding

A number of strategies have been implemented to achieve the objectives for flood management set out in Section 5. These strategies are briefly set out below.

Strategy 1: Primary Drainage Infrastructure

The inclusion of a drainage network designed to manage the minor/major principles for Precinct 1 and Precinct 2. The standards are described in Section 5 have been applied to the detailed design of all current stages and will be applicable for the remainder of Precinct 1 and Precinct 2 and the entire development.

Strategy 2: Regional Flood Management

The inclusion of a network of channels designed to intercept overland flooding from Gawler River. Refer to Section 5 for further detail. This has been updated to include an extended length of open channel network to connect the drainage system to Thompson's Creek in the interim to allow for an outfall connection to Thompson's Outfall channel. The initial SMP used stormwater retention in the open channel network to control outflows from the site, however, this did not allow for a free draining channel, which has resulted in difficulty being able to undertake the proposed channel planting which is part of the stormwater quality treatment needs.

The flood modelling conditions were based off the modelling of the floodplain carried out by Water Technology (refer to Appendix C). Pre-development, current and future development conditions were considered to ensure flood management objectives were met.

4.3 Stormwater Quality

Strategy 1: Green Infrastructure (WSUD)

The provision of WSUD elements is to be incorporated at key locations in the development for management and treatment of stormwater. The construction of regional drainage channel system for the management of flood flows will provide the opportunity to incorporate linear ephemeral wetland pools for water quality improvement. Based on the significant length of channel and based on their widths, several potential sites are highlighted in Section 6.

Other WSUD opportunities are to be pursued within the development include the use of:

- Vegetative swales
- Ephemeral wetland pools along the regional channel network
- Ephemeral wetland ponds will also be included where pipe outfalls are in close proximity to the proposed saltwater lakes to achieve nutrient reductions prior to discharge to the lakes

The ephemeral wetlands will be based on a shallow, densely vegetated basins that will incorporate a temporary average pool depth of 300 mm (the pool depth will vary from 200 mm to 600 mm). The residence time will be controlled using a discharge control pit to release treated stormwater over a period of 60 - 72 hours. Treatment will occur using settling, absorption, and uptake of nutrients through wetland processes.

The ephemeral wetland ponds will accommodate a rainfall runoff volume from a 20 mm rain event to temporarily fill the ephemeral wetland. This pond will slowly drain down over a two- to three-day period to a dry condition. It is envisaged that the ephemeral wetland pond will exhibit strong environmental value through biodiversity, habitat, and sustainability.

For stages locally interfacing with the future Salt Water Lakes 1-3, the agreed stormwater treatment system is yet to be confirmed. The currently documented treatment is subject to change post planning approval for the Salt Water Lakes Environmental Impact Statement and agreement with City of Playford.

Walker has recently provided a Technical Memorandum developed by Simmonds & Bristow which provides a detailed assessment of two scenarios for treatment of Urban stormwater runoff and the resulting impact (if any) on the previously analysed Lake Water Treatment System:

Scenario 1: GPT and Wetland Treatment

Scenario 2: GPT and Membrane Treatment

Council is to consider the future operational and maintenance requirements for both scenarios and advise on their preferred treatment system. This will be reflected in a future version of the Stormwater Management Plan.

Strategy 2: Interception of Gross Pollutants

The development drains within Precincts 1 and 2 include a number of outfalls into the regional channels which will ultimately drain out to the Gulf St Vincent. The outfalls will each accommodate a GPT using Continuous Deflection Separation (CDS) technology to intercept gross pollutants, as will any other outlets to the open channel system that are required for the balance of Precinct 1 and Precinct 2.

The detailed engineering of relevant stages will seek to optimise the landform and stormwater pit/pipe network to consolidate the number of GPTs within the development.

4.4 Stormwater Reuse

Strategy 1: Implement Aquifer Storage and Recovery Scheme

Provision of a stormwater harvesting scheme within Precinct 1 and Precinct 2 is not considered viable at this early phase of development due to the lack of development and runoff to generate sufficient water.

Walker Corporation are negotiating with SA Water to have a Northern Adelaide Irrigation Scheme (NAIS) water brought into the development to supply irrigation water for streetscapes and reserves. The need therefore for consideration of an ASR scheme is no longer warranted.

5 STORMWATER DESIGN BASIS

5.1 Interim and Ultimate Development Scenarios

General

A system of regional channels has been proposed throughout the Buckland Park Development in order to manage and convey breakout flows from Gawler River for long duration flooding events, in addition to managing stormwater outflows from the development during short duration events. The regional channel network will protect the development from flooding both regional and localised flood events. The basis on which the channels were designed is the flood modelling undertaken by Water Technology (formerly Australian Water Environments).

In the Ultimate Development scenario, three saltwater lakes are proposed which will provide for stormwater detention above the permanent lake level. Outflows from the lakes will be conveyed to Thompson's Outfall channel via a gravity pipe network so that saltwater flows are prevented from entering the open channel network and therefore risk infiltration into the shallow groundwater systems.

Appendix C shows flood modelling results provided in Water Technology floodplain maps for the 1% AEP flood event in the context of Riverlea Precinct 1 and Precinct 2. This demonstrates that the extent of channel systems proposed to be constructed within Precincts 1 and 2 will provide protection to those stages. The channel network will need to be extended in the future as further development occurs, but the extent of channel network required will be dependent on the location of the next precinct.

5.1.1 Interim Development

For the purpose of Precinct 1 and Precinct 2, it is suggested that construction of the ultimate detention basin is not required at that stage, and an interim solution requiring a lesser proportion of channel construction is more appropriate including a smaller interim basin. Figure 6 shows the proposed channel layout for Precinct 1 and 2. The following is noted for the assessment of the 'Interim Development':

- Precincts 1 and 2 are fully-developed with Precincts 3 and 4 contributing as undeveloped areas.
- The saltwater lake system is not yet installed, and the following stages are assumed to contribute flows directly to the channel system during the 'interim' scenario.
  - Stage 9B
  - Stage 14A
  - Stage 14B
  - Stage 15
  - Stage 16
  - Stage 18
  - Stage 19
  - Stage 20

There is a higher peak flow in the Precinct 1 and 2 channels in the 'interim scenario' due to the fact that all stages are discharging to the channels and there is no buffer capacity from the lakes (as in the ultimate scenario). The channels will therefore be sized for the ultimate capacity but have an appropriate level of protection for the interim development (given that this is a temporary arrangement). This is discussed further in Section 5.2.1.

The catchment plan for the interim scenario is included as Appendix A. Note there are two separate plans showing the contributing catchment to the main channel and a larger catchment for the basin (noting Precincts 3 and 4 do not drain to Channel 1).

Figure 6: Proposed Extent of Channel Construction for Precincts 1 and 2.

The open channel network is outlined in green, and includes some temporary channels aligned along the future salt water lakes until such times as the proposed lakes are constructed.

5.1.2 Ultimate Development

The ultimate development scenario considers the ultimate channel network, the salt-water lakes constructed and assumes Precincts 1, 2, 3 and 4 are fully developed. Refer to Appendix A for relevant catchment plan.

5.2 Design Criteria

5.2.1 Minor and Major Storms

The internal stormwater system is designed for the following Annual Exceedance Probability (AEP)

- Minor storms (internal underground drainage) 20% AEP
- Major storms (overland flow) 1% AEP
- Permanent channels 1% AEP
- Temporary channels 5% AEP

A lesser design standard has been adopted for the temporary channels as the likelihood of a rare storm event occurring within a shorter, fixed period of time is lower. The probability of exceedance within a fixed time period of an event with a constant probability can be modelled with a binomial probability distribution. If the channels are designed to a 5% AEP, the probability of having at least one exceedance for different fixed periods of time is shown below:

- 1 year – 5% chance of exceedance
- 2 years – 9.8% chance of exceedance
- 5 years – 22.6% chance of exceedance
- 10 years – 40% chance of exceedance
- 20 years – 64% chance of exceedance

5.2.2 Minimum Grades

A minimum grade of 0.50% for the internal drainage system should be achieved where possible. Where a 0.50% grade could not be achieved due to constraints, the following minimum grades for the relevant pipe sizes have been decided upon as per discussions with Council:

- 375 mm 0.50%
- 450 mm – 600 mm 0.40%
- Greater than or equal to 675 mm 0.30%

The minimum grade at all road crossings shall remain at 0.50%. In addition, the minimum grade for the upper reaches of a system shall also remain at 0.50% so as to achieve sufficient velocity prior to joining the larger network.

5.2.3 Minimum Pipe Size

The following criteria are used for the minimum allowable pipe size:

- Reinforced concrete pipe 375 mm dia
- uPVC pipe (allotment connections) 150 mm dia
- Minimum freeboard (minor storm) 150 mm

5.2.4 Freeboard and FFL

The underground internal drainage system will be designed to accommodate flows from a 20% AEP storm event with no surcharging. A minimum freeboard at pits for minor storms of 150 mm will be adopted so that the hydraulic grade line (HGL) is at least 150 mm beneath all pit openings.

Overland flow paths were defined for the 1%AEP storm event.

The minimum floor level for dwellings is also required to be 150 mm higher than the top of kerb.

Internal stormwater runoff from catchments will be discharged at a number of locations into the regional stormwater channel system. Each outlet is proposed to be fitted with a gross pollutant trap (GPT) in order to satisfy primary stormwater treatment requirements, so that stormwater runoff is improved and pollutant transfer to receiving waters is minimised. The treatment flow for each GPT was calculated using the 4EY (3-month ARI) storm event and they have been sized on this basis.

5.3 Modelling Approach

The modelling approach used for stormwater management of the site has adopted a combination of different software packages. These include:

- DRAINS software for the internal development stages with pit and pipe networks and defining safe overland flow paths. The peak flows from DRAINS have been used as an input into the channel design in HEC-RAS 1D.
- HEC-RAS 1D for the internal channel network based on extracted sections from the Civil 3D model and hydrological inputs from DRAINS at tie-in points along the channel.
- TUFLOW for the 2D regional floodplain mapping including scenario mapping for upstream and downstream boundary conditions. TUFLOW has also been used for the sizing of the downstream detention basin.

5.4 Modelling Parameters

5.4.1 DRAINS Parameters

5.4.1.1 Catchment Parameters

A catchment plan outlining the modelled area for the interim and ultimate scenario can be found in Appendix A. In the ultimate scenario, Precincts were assumed to be fully ‘developed’, with the following catchment breakdown applied:

- 60% paved area
- 20% supplementary area
- 20% grassed area

5.4.1.2 Hydrological Model Parameters

An IL-CL model has been used for the regional hydrology to be consistent with the TUFLOW assumptions obtained from the ARR Data Hub. This has been used for the sizing of the detention basin but not the individual stages for the site.

An IL-CL model has been used for the regional hydrology to be consistent with the TUFLOW assumptions obtained from the ARR Data Hub. This has been used for the sizing of the detention basin but not the individual stages for the site as basin sizing requires the inclusion of undeveloped areas, which are best suited to the IL-CL model.

- Initial Loss of 30 mm
- Continuing Loss of 4 mm/hr
- Paved Area Depression Loss of 1 mm

ILSAX has been for the detailed design of individual stages and used to model catchment hydrology in DRAINS. The following runoff parameters have been selected for the purpose of stormwater modelling:

- Paved (impervious) area depression storage — 1 mm
- Supplementary area depression storage — 1 mm
- Grassed (pervious) area depression storage — 10 mm
- Soil type — 3
- Antecedent moisture condition — 3 (all storms)

The model utilised channel cross-sections and modelling was carried out using the Unsteady State mode to reflect channel storage.

5.4.1.3 Tailwater Condition Assumptions

A tailwater condition has been set at the end node of the model to reflect the conditions in the existing Thompson's Creek Channel.

The existing Thompson's Creek channel has been modelled at the outlet of the basin. A dummy hydrograph has been adopted to simulate a variable tailwater condition in the channel consisting of an upstream flow that starts at 9 hours, peaks at 1 m water depth at 15 hours and subsides after 21 hours. This is largely governed by the contributing hills catchment in Smith's Creek that feeds into Thompson's Outfall Channel that has a long time to peak. Further scenarios of the variable tailwater condition are explored within the TUFLOW model outputs. This tailwater condition is considered suitable for the sizing of the detention basin for the ultimate development.

5.4.2 HEC-RAS Parameters

HEC-RAS is a hydraulic software package developed by the US Army Corp of Engineers that enables one-dimensional steady flow calculations. To determine the hydraulic performance of the proposed channel, HEC-RAS (Version 6.5) was used to create a steady-state 1D model of the system.

Flows were generated from the DRAINS model of the ultimate development during the 1% AEP event. The DRAINS model provided the hydrological component in addition to rainfall runoff routing required for the simulation of flows (DRAINS modelling parameters can be found in Section 5.4.1). The flows generated from DRAINS were then used to inform the flows used for the channels and at flow change locations within the HEC-RAS model.

15 m^3/s of flow generated from the catchments upstream of the Port Wakefield culverts was also simulated within the HEC-RAS model to test the hydraulic capacity of the channel during peak events. As it is unlikely that this peak duration would coincide with the 1% AEP event duration of the ultimate development, this scenario was tested separately to the development flows. Regional flooding is discussed in more detail in Section 5.5.1.

The following design parameters have been adopted within the model:

- Culvert manning's n = 0.015
- Channel manning's n (with no low-flow section) = 0.050
- Channel manning's n (with low-flow section):
  - Low-flow section = 0.060
  - Main channel section = 0.035
- Average channel longitudinal gradient of 0.04%-0.1%
- Average channel dimensions 28 m wide, 1 in 5 batters, ~ 2 m deep
- A maximum channel spacing of 20 m was used (with the exception of overlapping cross-sections). More frequent channel spacings were used in specific areas to allow for more stable computation and convergence within model calculations.
- Minimum 600 mm freeboard
- No blockage factor has been applied to culverts
- Normal depth used as boundary conditions

Due to the invert of the channels relative to the groundwater level on the site, the base of the channel will intercept groundwater. A low flow channel has been designed into the base to convey 250 L/s of continual 'base-flow'. The low flow channel has been defined in order to mitigate the risk of siltation across the entire channel floor and also manage the risk of localised scour across the channel floor.

Refer to design drawings for channel sizes and relevant details.

5.4.3 TUFLOW Parameters

A 1D/2D TUFLOW model has been developed in accordance with AR&R 2019 guidelines. The latest design surface for the development site has been used. The modelling has been undertaken for 1% AEP event.

The model shown in Figure 8 and covers about 10.2 km^2.

A range of storm durations was selected and for each duration 10 temporal patterns were modelled. The median of all 10 temporal patterns for each duration was processed and the maximum of the medians were then extracted to form the critical results. This approach ensures only the critical results are presented for each modelling cell. The results have been checked for all the modelled durations to ensure the peak results have been captured.

Hydrological data including rainfall and losses has been entered directly into the model using the Rain on Grid (RoG) approach, which directly applies rainfall to the modelling area. By using this approach, both hydrologic and hydraulic modelling can be simulated together in TUFLOW rather than separately.

5.4.3.1 Digital Elevation Model (DEM)

The latest development site design DEM has been used. Minor modifications have been undertaken to correct identified DEM generated anomalies.

5.4.3.2 Durations and Temporal Patterns

A wide range of short and long rainfall durations were modelled to ensure peak flood elevations for the development site were captured. Durations modelled included 15 min, 30 min, 60 min, 120 min, 180 min, 360 min, 540 min, 720 min, 1,080 min, 1,440 min, 1,800 min, 2,160 min and 2,880 min. For each duration 10 temporal patterns were modelled.

5.4.3.3 Rainfall Data

Rainfall depths and temporal patterns have been sourced from the AR&R 2019 data hub and the Bureau of Meteorology (BOM). The design rainfall inputs adopted, used the coordinates below, which is the centroid of the modelling area:

- Latitude : -34.663200
- Longitude : 138.507350

5.4.3.4 Loss Estimation

The initial and continuing loss method has been used for the modelling. The losses have been sourced from the AR&R 2019 data hub. The initial and continuing loss adopted was 29 mm and 4 mm/hr respectively. The initial loss has been adjusted to model the pre-burst rainfall. The pre-burst rainfall depths have been deducted from the initial losses.

5.4.3.5 Surface Materials and Manning's n Value

The development site has several different surfaces and terrains to account for with the flood modelling. The surfaces have different loss and roughness coefficients (manning's n value). To model this, the modelling area was classified based on the different land use that will be present with completion of the development site. The surface material classification assigned for the site are shown in Figure 7.

The following surface material categories were used in the model:

- Saltwater lakes (standing water)
- Open channel, straight banks, and well-maintained channel
- Roads
- Park reserves, containing light shrub and tree planting and grass lands
- Lots, block of lands containing high density of impervious area such as roofs, concretes and it was assumed 70% of the area was impervious
- Water surface, which covers tall shrubs and average depth of flow

The Manning's n value used for the modelled land uses are presented in Table 7.

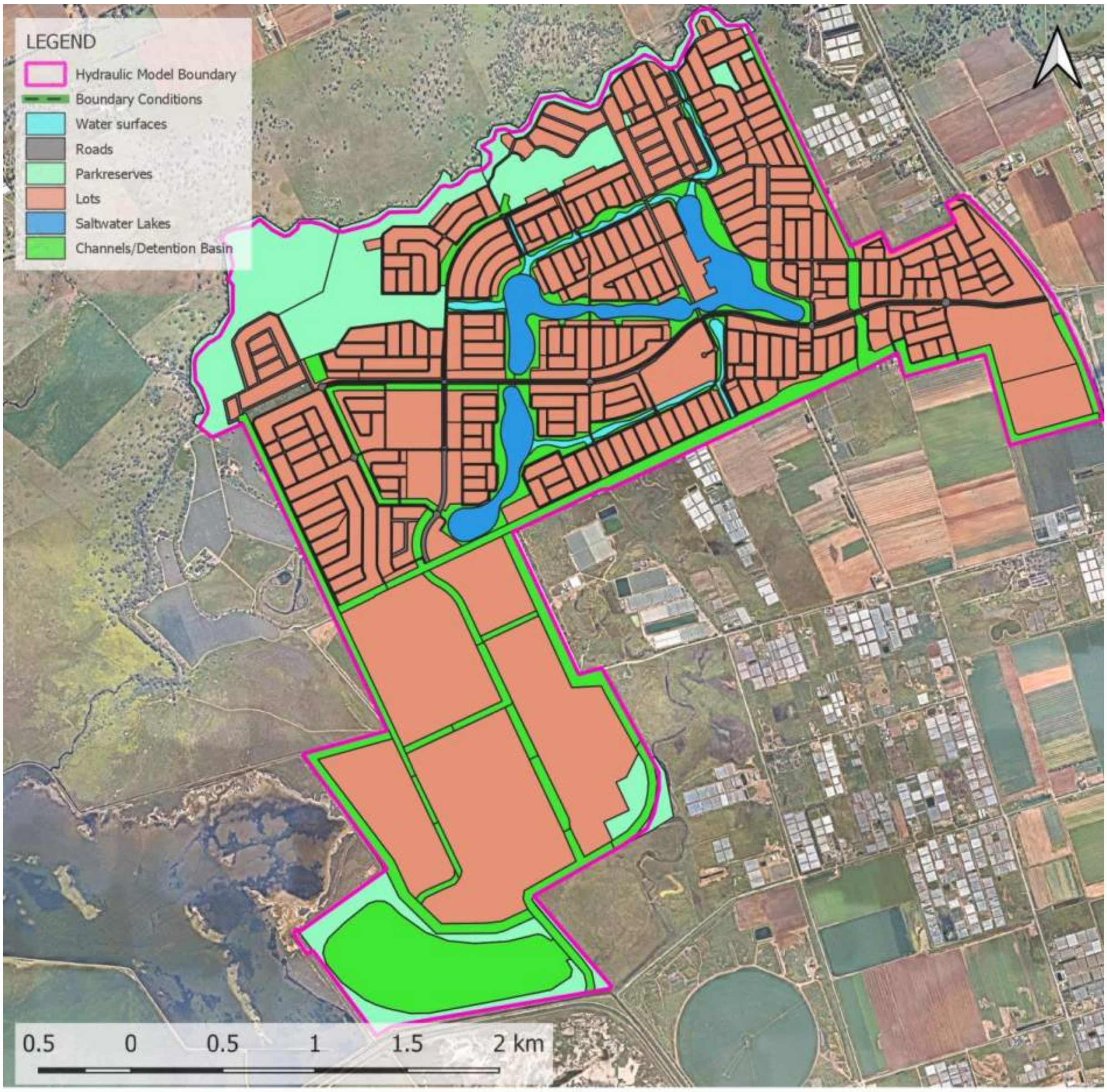

Figure 7: TUFLOW MODEL – Surface Condition Assumptions

Table 7: Manning's n Value

LAND USE	MANNING'S N VALUE
Saltwater lakes	0.03
Park reserve	0.04
Open space/channel	0.03
Water surface	0.05
Lots	0.30
Roads	0.02

5.4.3.6 Detention Basin

A detention basin has been included within the TUFLOW model with a total volume of 250,000m3. The detention basin has been modelled in the location in Figure 8 and was chosen for the following reasons.

- Lowest point on the site
- Low possibility of encountering acid sulphate soils
- Limited development potential of this area as the site elevations are low
- Site can be used to generate fill for the development

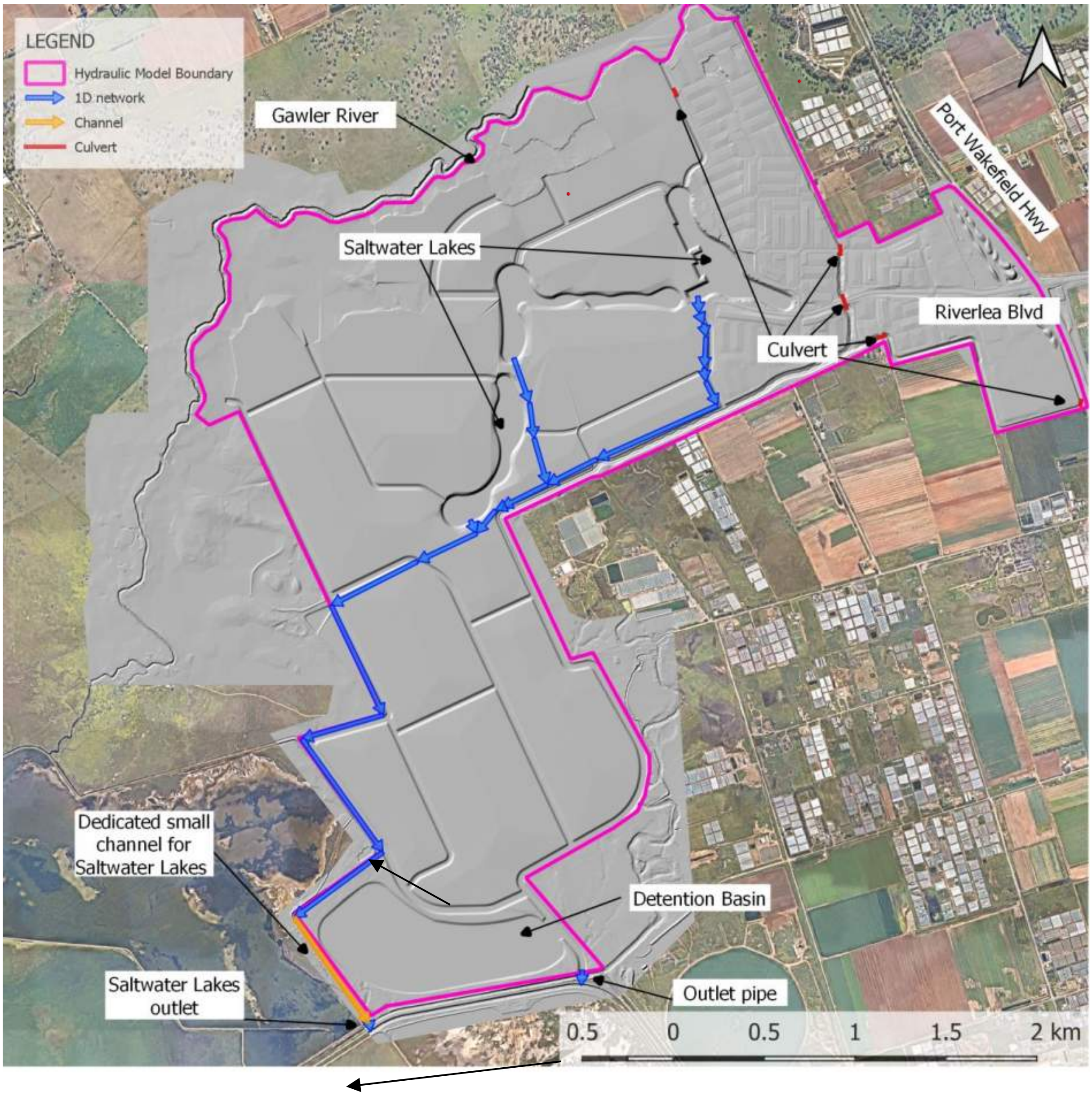

Figure 8: Proposed Ultimate Channel System including Saltwater Lakes

5.5 Design Envelope - Modelled Scenarios

The following scenarios have been adopted as a sensitivity check for the flood modelling and to understand the design envelope of possible scenarios with the intent of informing the client and relevant stakeholders of the potential flood risk as a result of climate change and conditions external to the site.

The scenarios have been modelled in TUFLOW as it is important to understand the 2D behaviour of floodwaters across the site. The following scenarios have not been modelled in DRAINS or HEC-RAS as a 2D flood model provides a more robust assessment of flood extents across the site.

Due to the complexities surrounding coincident probabilities for a range of different factors, a scenario-based approach has been adopted to explore the impact on flood risk.

The combinations of flooding and tide shown in Table 8 provide a balanced approach between accounting for potential rainfall, impacts of climate change, upstream catchment effects, and tidal interactions.

Table 8 Summary of Modelled Scenarios within TUFLOW.

SCENARIO	UPSTREAM BOUNDARY CONDITION	DEVELOPMENT FLOWS	DOWNSTREAM BOUNDARY CONDITION
Scenario 1	15 m^3/s from Port Wakefield Culvert	1% AEP with 1.2 climate change multiplier	1.3 mAHD
Scenario 2	N/A	10% AEP with 1.2 climate change multiplier	2100 Scenario SLR (1m) + Mean High Water Springs (MHWS) tide from 1m AHD to 2m AHD over 0-6 hours and 2m AHD to 1m AHD over 6-12 hours. Tailwater condition is looped for longer duration events.
Scenario 3	N/A	10% AEP with 1.2 climate change multiplier	2100 Scenario SLR (1 mAHD) + Mean High Water Springs (MHWS) tide from 2m AHD to 1 mAHD over 0-6 hours and 1m AHD to 2m AHD over 6-12 hours. Tailwater condition is looped for longer duration events.
Scenario 4	N/A	1 EY (63.21% AEP) with 1.2 climate change multiplier	Storm Surge 2.5 mAHD for duration of storm event.

5.5.1 Regional Flooding

The regional flooding within the development area is a result of breakout flow from the Gawler River. Extensive flood plain hydraulic modelling was undertaken to inform the extent and risks for pre and post development flooding scenarios. A network of regional flood conveyance channels was developed to manage and convey flood waters safely through the development. These channels not only provide protection to the development from regional flooding (Gawler River) but also form part of the development's flood conveyance for short duration storm events.

WGA has been in discussions with WaterTech to understand the impact of Gawler River breakout flows on the development. The breakout flows are conveyed to the site via the existing culverts under Port Wakefield Road. These are shown in Figure 9.

Figure 9: Port Wakefield Road Culverts

The design of the channel system has considered a peak-flow of 15 m^3/s from the culverts under Port Wakefield Road based on advice from Water Technology. The critical storm duration for the Gawler River is 72 hours compared with approximately 4.5 hours from the development. The probability of the coincident flooding is therefore less likely than the probability of flooding from the development alone for the same AEP. However, this scenario has been assessed as a sensitivity check for the site.

Flood mapping was undertaken by Water Technology to inform the extent of regional flooding for pre-development, current and post-development conditions (refer to Appendix C Further discussion and flood mapping is outlined in the following Sections. The map in Appendix C provide water surface elevations for flooding from the Gawler River in the 1% AEP event.

5.5.2 Sea Level Rise (SLR), Storm-Surge and Tidal Effects

The development discharges into Thompsons Outfall, which has an invert level of approximately 1.0 mAHD. The existing Thompson's Outfall channel has a grade of 0.02% and aerial imagery shows water present in the channel. Thompson's Outfall has been identified as being within a tidal inundation zone and it is important for the modelling to consider the impacts of variable tailwater conditions.

5.5.2.1 Literature Review

In order to understand the precedents within the Adelaide Metropolitan coastal regions, a literature review has been undertaken of similar areas that have considered the impact of SLR, storm surge and tidal effects. The following reports have been considered:

- Department for Environment and Water 2021, South Australian Flood Hazard Plan.
- Wavelength Consulting 2022, Assets Vulnerability and Risk Assessment: Coastal Hazards Study, prepared for City of Charles Sturt.

- Tonkin Consulting 2018, Western Adelaide Region Climate Change Adaption Plan, prepared for City of Charles Sturt, City of Port Adelaide Enfield and City of West Torrens.
- Department for Infrastructure and Transport 2015, Climate Change Adaptation Guideline, viewed 13th August, <https://dit.sa.gov.au/__data/assets/pdf_file/0010/165943/DIT_Climate_Change_Adaptation_Guideline.pdf>.
- City of Port Adelaide Enfield 2021, Engineering & Infrastructure Statement of Requirements (EISOR).
- City of Port Adelaide Enfield 2016, Stormwater Infrastructure Design Criteria.
- Jensen Planning and Design 2009, Gillman Structure Plan Final Report, prepared for Land Management Corporation.
- Tonkin Consulting 2014, Stormwater Management Plan Coastal Catchments Between Glenelg and Marino, viewed 12th August 2024, https://www.sma.sa.gov.au/wp-content/uploads/Glenelg-MarinoSMP2014_WEB.pdf
- South Australian Coast Protection Board 1992, Coastal erosion, flooding and sea level rise standards and protection policy, viewed 12th August 2024, https://cdn.environment.sa.gov.au/environment/docs/no26.pdf
- Southfront 2021, Barker Inlet Central Stormwater Management Plan, prepared for City of Port Adelaide Enfield and City of Prospect, viewed 12th August 2024, https://hdp-au-prod-app-pae-haveyoursay-files.s3.ap-southeast-2.amazonaws.com/5216/3280/4255/Barker_Inlet_Central_SMP_-_Draft_for_final_review.pdf
- Tonkin Consulting 2013, Port Adelaide/LeFevre Peninsula (Phase 2) Port Adelaide River Seawall Study, prepared for Port Adelaide Enfield Council.
- URPS, SEED consulting & AECO 2014, AdaptWest Research Paper – Assets, Infrastructure and Economy, prepared for Port Adelaide Enfield Council, https://www.adaptwest.com.au/sites/adaptwest/media/pdf/adaptwest-assets,-infrastructure-and-economy-research-paper.pdf

5.5.2.2 Sea Level Rise (SLR)

SLR has been assessed based on a 1 m rise in mean sea level by the year 2100. This equates to 1 mAHD, which is approximately equal to the invert of the Thompson's Outfall at the tie-in point. It is noted that this equates to SLR associated with the most conservative climate change emissions pathway of RCP8.5.

5.5.2.3 Storm Surge

The storm surge scenario has adopted a tailwater level of 2.5 mAHD consistent with the Port Adelaide/LeFevre Peninsula (Phase 2) Port Adelaide River Seawall Study. An event in May 2016 resulted in an observed sea level (tide plus storm surge) of 2.51 m, which is the highest observed historical sea level for the Outer Harbor/LeFevre Peninsula area.

Version 4.2 of ARR 2019 (updated August 2024) Book 6 Chapter 5 discusses the statistical dependence between rainfall intensity and storm surge. A study by Zheng et al (2013)[1] analysed daily rainfall and daily maximum storm surge date throughout the Australian coastline. The study showed that if the events were completely statistically independent, it would be expected that one event every 100 x 100 = 10,000 days would exceed the joint threshold by random chance. The actual number varied between 8 and 27, which is an order of magnitude higher than what it would be if the two events were completely independent.

The degree to which storm surge and rainfall are dependent was found to vary across the Australian coastline. The higher the dependence value, the weaker the dependence (i.e. more independence between storm surge and rainfall). The south Australian coast was found to have a relatively high dependence value (between 0.90 and 0.95 depending on the storm duration) compared to the rest of Australia.

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[1] Zheng, F., Westra, S. and Sisson, S.A. (2013), The dependence between extreme rainfall and storm surge in the coastal zone, Journal of Hydrology, 505: 172-187.

Due to the possibility of compound probability storm surge value of 2.5 mAHD has been adopted in combination with a 1EY storm event, which is in-line with what was adopted in the Western Adelaide Region Climate Change Adaptation Plan (Tonkin Consulting, 2018) that assumed a 100-year ARI tide with a 1-year ARI storm event.

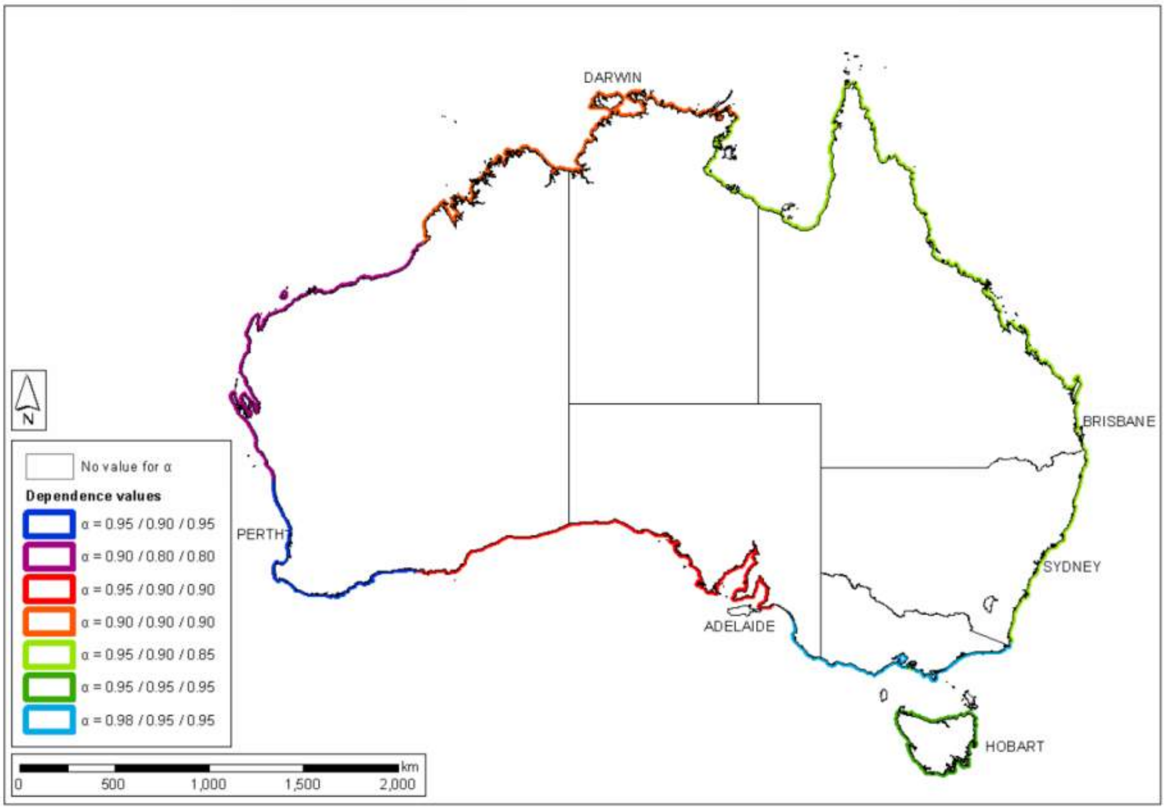


Figure 10: Dependence Parameter Map for the Australian Coastline (Source: ARR2019 Book 6 Chapter 5)

5.5.2.4 Tidal Effects

The Mean High Water Springs (MHWS) tide is the average throughout the year of two successive high waters during the periods of 24 hours when the range of the tide is at its greatest. This typically occurs once a fortnight or twice a month, during full and new moon. This means that on any given day there is a probability of approximately 1/15 (6.6%) that a MHWS tide is occurring.

Table 9: Adopted MHWS Tide Levels for Outer Harbor Station

PARAMETER	UNIT	MHWS
Peak Water Level	mAHD	1.02
Mean Water Level	mAHD	0
Amplitude	m	1.02
Period	hrs	12.4

5.6 Modelling Outcomes

Council's requirement for the Buckland Park Development is that post-development outflow does not exceed the pre-development level. The need for an ultimate major detention basin to service the entire development and the basis of its design are discussed in detail in 'Stormwater Management, Water, Wastewater and Recycled Water- Technical Paper,' prepared by Wallbridge & Gilbert, 2022. The following is a summary of key outcomes from the stated technical paper relating to stormwater detention requirements:

Pre-development peak 1% AEP flow rate was calculated to be approximately 10 m^3/s.

5.6.1 DRAINS Modelling

DRAINS models were established with channel cross-sections and run in the Unsteady State Mode to model the effect of channel storage. Two different modelling scenarios were considered; the Interim scenario incorporated developed Precincts 1 and 2, while the Ultimate scenario incorporate fully developed Precincts 1, 2, 3 and 4.

The modelling approach and parameters used within DRAINS can be found in Sections 5.3 and 5.4.1. Results of the DRAINS modelling can be found in Appendix B.

5.6.1.1 Restriction of Post-Development Outflows – Interim Scenario

A 125,000 m^3 Interim detention basin is required to be constructed when the channel system is extended to Thompson's Outfall Channel to restrict the peak flows of the 2% AEP event to 10 m^3/s. The critical duration for this storm was found to be the 9-hour event.

In order to restrict the 5% AEP event to 10 m^3/s, a 75,000 m^3 basin is required.

The 2% AEP event was used for detention basin sizing in the Interim scenario due to the lower level of risk presented in the Interim scenario. The arrangement has also been tested for the 1% AEP event, where a 285,000 m^3 basin would be required to detain flows. This was considered impracticable for the application of the interim scenario (given the temporary nature) and would be achieved as the development progresses into the Ultimate scenario. Under the ultimate scenario, the saltwater lakes would act as additional detention storage and would provide a buffer for catchments with direct connections. The peak flows into the basin are therefore lower under the ultimate scenario.

A summary of the actual flows within the channel system for the Interim senario during the 2% AEP event is provided in Appendix B.

5.6.1.2 Internal Stormwater Runoff

Internal stormwater runoff from Precinct 1 and 2 is discharged at a number of locations into the regional stormwater channel system as by the outlet locations marked on the catchment plan (Appendix A). Each outlet is proposed to be fitted with a gross pollutant trap (GPT) in order to satisfy primary stormwater treatment requirements, so that stormwater runoff is improved and pollutant transfer to receiving waters is minimised. The treatment flow for each GPT was calculated using the 4EY storm event and they have been sized on this basis.

5.6.2 HEC-RAS Modelling

The outputs from the Ultimate scenario DRAINS model were also inputted into HEC-RAS to demonstrate that the channel system has sufficient capacity to cope with the 1% AEP flows. Details of the modelling approach and HEC-RAS parameters can be found in Sections 5.3 and 5.4.2.

HEC-RAS outputs for the channel system are provided in Appendix E for the 1% AEP event.

5.6.2.1 Carmelo Road Culvert Sizing

HEC-RAS was also used to size culvert crossings along Carmelo Road. The following modelling parameters were used:

- Manning's n for culverts is assumed to be n = 0.015
- Base width of channel assumed to be 28 m
- Culvert wingwalls with 30-75° flare have been used
- Culvert lengths assumed to be 35 m
- Deck height set at 3.94 mAHD
- Flows from the 1% AEP Ultimate Scenario have been used

6 x 3.6 m (W) x 1.2 m (H) culverts have been specified at the crossing on Carmelo Road. A profile plot of the channel and crossing can be found in Appendix E.

5.6.3 TUFLOW Modelling

The TUFLOW model results outputs for the 4 scenarios discussed in Section 5.4.3.6 are included as Appendix B. The maps show both peak flood depth (m) and level (m AHD).

It is important to note that due to discrepancies of the Triangular Irregular Network (TIN) surface within the 3D model some areas are shown as ponding within the network. These are particularly defined in Precincts 3 and 4 where the designed 3D surface is much less refined than the areas within Precinct 1 and 2 where a more detailed 3D surface exists.

The TUFLOW model does not contain the 1D pit and pipe network, which explains why the sag points within the roadways are shown as inundated. The detailed design pit/pipe network along with overflow routes has been modelled in DRAINS and should be referred to for the internal stages of the development. The TUFLOW model is intended to demonstrate the regional flooding behaviour of the site.

5.6.3.1 Restriction of Post-Development Outflows – Ultimate Scenario

The basin size for the ultimate scenario was modelled in TUFLOW to better account for flow routing, attenuation via storage and to consider the sensitivity under the scenarios discussed in Section 5.5.

The detailed design of the ultimate basin will need to consider a spillway to convey the upstream peak flows of 15m3/s that are not required to be detained. Floodgates will also need to be considered as part of the detailed design of the ultimate arrangement.

This basin is proposed to be augmented in the future to a minimum of 250,000 m^3 to service the ultimate development for the 1% AEP event. This basin size was found to be sufficient to limit post-development outflows to less than 10m3/s.

A summary of the actual flows within the channel system for the Interim and Ultimate scenarios is provided in Appendix B.

6 WATER SENSITIVE URBAN DESIGN

6.1 Strategy

The implementation of a water sensitive urban design (WSUD) strategy is based on the following considerations:

- Selection of techniques that suit the site's physical, climatic and environmental setting.
- Selecting techniques that are robust and sustainable, and therefore will suit the water regimes.
- Locating techniques such that they are maintainable.
- Development of a strategy that is integrated within the site and contributes to deliver multi-objective outcomes for the development.

Further discussion about the WSUD is outlined below and in this Section.

The overall WSUD and water quality management strategy has been based on the inclusion of the following key elements into Precinct 1 of the development, noting that detailed design has been progressed for Stages 1 to 12 of Precinct 1:

- Gross pollutant traps at major stormwater outlets.
- Integration of vegetated swales for localised sub catchments.
- Linear ephemeral wetland pools which have been incorporated into pool and riffle sequences within the low flow channels of the larger regional drainage channels.
- Design the regional channels to incorporate naturalistic waterway design principles. (See further information below with regards to the multi objective approach).

The key WSUD design features for the development is the design of the regional drainage channels. Their design adopts a multi-objective approach within the development to incorporate functions that go beyond flood conveyance. These are summarised in the following points:

- The design adopts a landscape design approach that aims to enhance existing environmental values while adding to create new habitat opportunities through restoration and revegetation using local indigenous species.
- Development of wetland habitat pools into the low flow channels and riparian areas along the regional drainage channels to enhance their function as habitat, biodiversity and ecological service corridors.
- The integration of the above features into passive recreation uses for the community through the inclusion of share path networks and linkages.
- Avoiding the direct connection of stormwater drainage systems into existing waterways downstream of the development by limiting the number of outlets and locating these at treatment pools within the regional channel. These outlets have been designed with rock and plantings to reduce their visual impact and prevent erosion.
- The regional drainage channels have been designed to operate as living ephemeral streams through the incorporation of design features that mimic natural waterways. Such design features include:
  - Incorporation of pool and riffle sequences within the low flow channels which facilitate stormwater treatment from the development.
  - Creating batters of varying slopes.
  - Ensuring velocities are managed appropriately to prevent bed and bank erosion.
  - Revegetation to facilitate filtering, sediment deposition, nutrient uptake and while also providing opportunities for habitat and visual amenity.
  - Inclusion of porous rock riffles which aim to allow stormwater to be released from the online wetland pools at a slow rate in order to facilitate treatment while reducing risks associated with mosquito breeding.

The functionality of the online wetland pools is discussed in detail in Section 5.2. The treatment performance of the online wetland pools and other associated WSUD elements are presented in Section 5.4. A general layout plan showing the location of the treatment wetland pools together with the WSUD strategy is provided in Appendix D.

Ephemeral Wetland Treatment Pools

A series of online ephemeral wetland pools have been designed and integrated as part of the low flow channels which are within the regional drainage channels. These pools are densely vegetated shallow water bodies of 200 to 300 mm depth that provide treatment of urban stormwater from the development. Their treatment function provides enhanced sedimentation, fine filtration, adhesion and biological uptake, and chemical processes to remove pollutants from urban stormwater.

The online pools consist of a macrophyte zone which is a shallow densely vegetated (reed bed) which is wide and shallow. The pools are controlled by a porous rock riffle which allows water to be held within the pond for a sufficient duration to facilitate treatment. These riffles are porous, in that they have been designed to incorporate an open rock structure to allow seepage through the voids, which provides a detention time of approximately 4 to 10 hours for each pool. The pools lie in succession along the channel and therefore a total detention time of approximately 2 to 3 days is provided which follows the principles of wetland design. It is expected that the pools will dry out following the emptying time.

The porous rock riffle designs offer an effective and sustainable means of controlling water levels within the pools using an informal approach. The riffles are of a robust design comprising of an open graded rock matrix along the crest to facilitate seepage, while the base or apron will comprise of a densely well graded matrix of rock which is held into position by a row of toe rock (rock key which anchors the riffle) to prevent downstream migration of rock.

The wetland systems will dry out seasonally which mimics natural flood plains. Such systems are considered to be highly biologically productive that provide habitat and ecological value within an urban setting.

As the wetland pools are located online, treatment effectiveness is limited by the ability of the pools and vegetation to entrain pollutants and assimilate them to prevent transfer downstream. In this regard it is necessary to ensure that the 100-year storm flow velocity through the regional drainage channel resulting from a major flood within the Gawler River catchment is not in excess of 0.5 m/s. This follows the recommendations contained in the “Constructed Wetland Guidelines – Melbourne Water, April 2010”. The guidelines suggest that the flow velocity during the major storm flow should not exceed 0.5 m/s for online systems to avoid the removal of trapped pollutants to downstream environments. This design requirement has been checked using Mannings equation for normal flow and Hec ras hydraulic river model, and it has been confirmed that the requirement is met. Further to this point, given that the maximum velocity does not exceed 0.5 m/s, there is no risk associated with erosion along the channel and loss of plantings.

Sedimentation processes associated with coarse particles within the low flow channel/online pools is expected to occur upstream of the treatment systems. Coarse sediments that may enter the regional channel at the upstream of the development from the broader Gawler River catchment are expected to drop out of suspension quickly as a result of deep flow and low velocity. Coarse sediments require velocities not exceeding approximately 0.8 m/s to settle out of suspension. Once they are entrained into the bottom of the main channel, it is expected that they cannot be re-entrained into the flow due to the low velocities of less than 0.5 m/s. As is the case with similar regional channels and constructed urban wetland systems, it is envisaged that the channel and online pools will require dredging of sediments and removal of decayed vegetation at approximately 20-year frequencies. This process is not uncommon for vegetative stormwater treatment systems within an urban setting.

It is noted that there are two groups of pools that are located on the upstream and downstream side of the main road bridge crossing. These pools have been designed using similar principles as per other ephemeral wetland pools, however they differ in that they incorporate a pool storage volume that is semi-permanent. Council have raised a concern with regards to the potential for these pools to create favourable conditions for mosquito breeding.

It is expected that these pools will dry out, however as the water level drops, it is expected that groundwater intrusion will replace the stormwater and hence maintain aquatic fauna. Mosquito control is reliant upon maintaining a healthy population of aquatic fauna. Hence it is concluded that a permanent water body that is maintained by groundwater and stormwater can provide an environment whereby aquatic fauna can survive and provide a natural means of control.

Gross Pollutant Traps

There are a number of gross pollutant traps (GPT) proposed, located at each of each of the outlets for to the open channel system. This methodology will be applied for all future outlets into the open channel system. These GPTs will provide an effective means of pre-treatment to trap debris and coarse sediments prior to entering the downstream system.

6.2 Modelling and Results

In preparing this stormwater management plan, we have developed MUSIC models for both the Ultimate scenario where the full saltwater lake scheme has been implemented, and the Interim stage where temporary channel system is used to capture and treat flows from Precinct 1 and 2. The interim solution relies on the channel being constructed all the way to Thompson's Outfall channel, which will then provide for a free draining channel solution which will allow the low flow channel inverts to be suitably planted to achieve the required water quality outcomes.

Figure 11 outlines the MUSIC model catchments for the Ultimate Development scenario and Figure 12 outlines the catchments for the Interim Scenario.

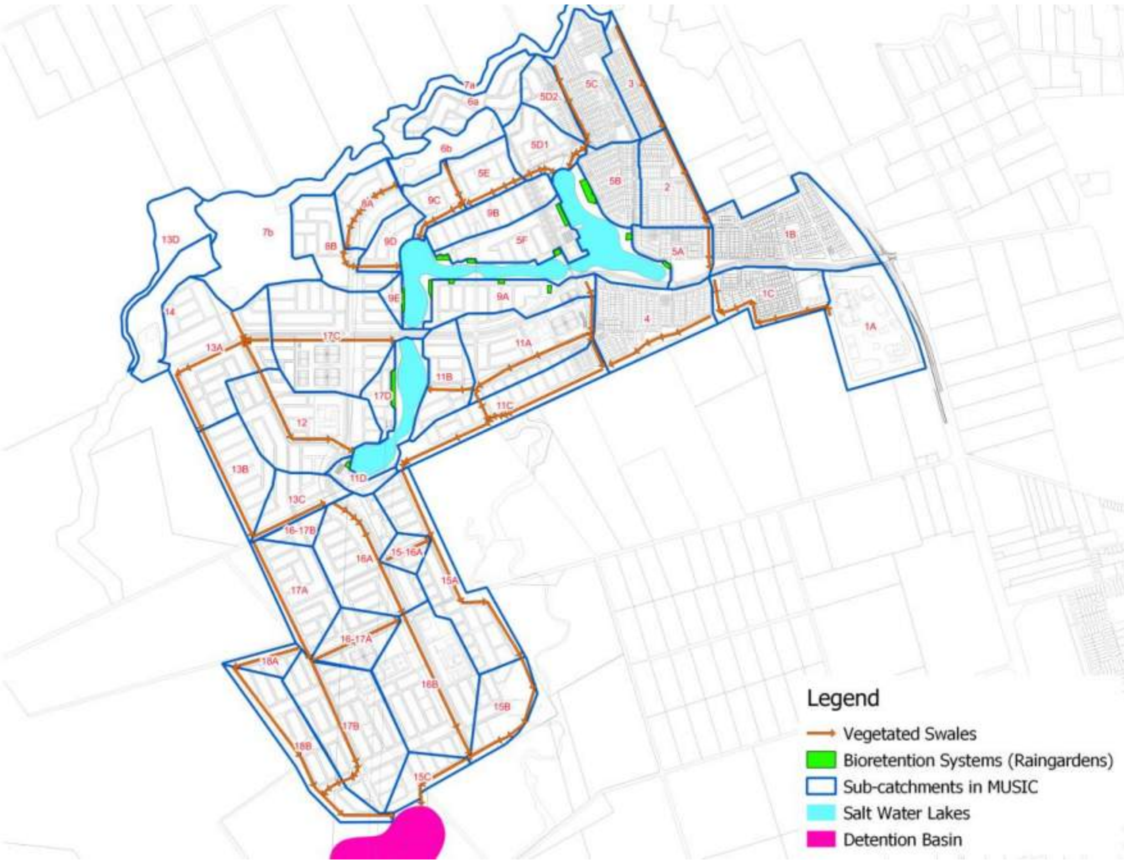


Figure 11: MUSIC Model Catchment Plan and WSUD Assets locations with Indicative Proposed Layouts for the Ultimate Development

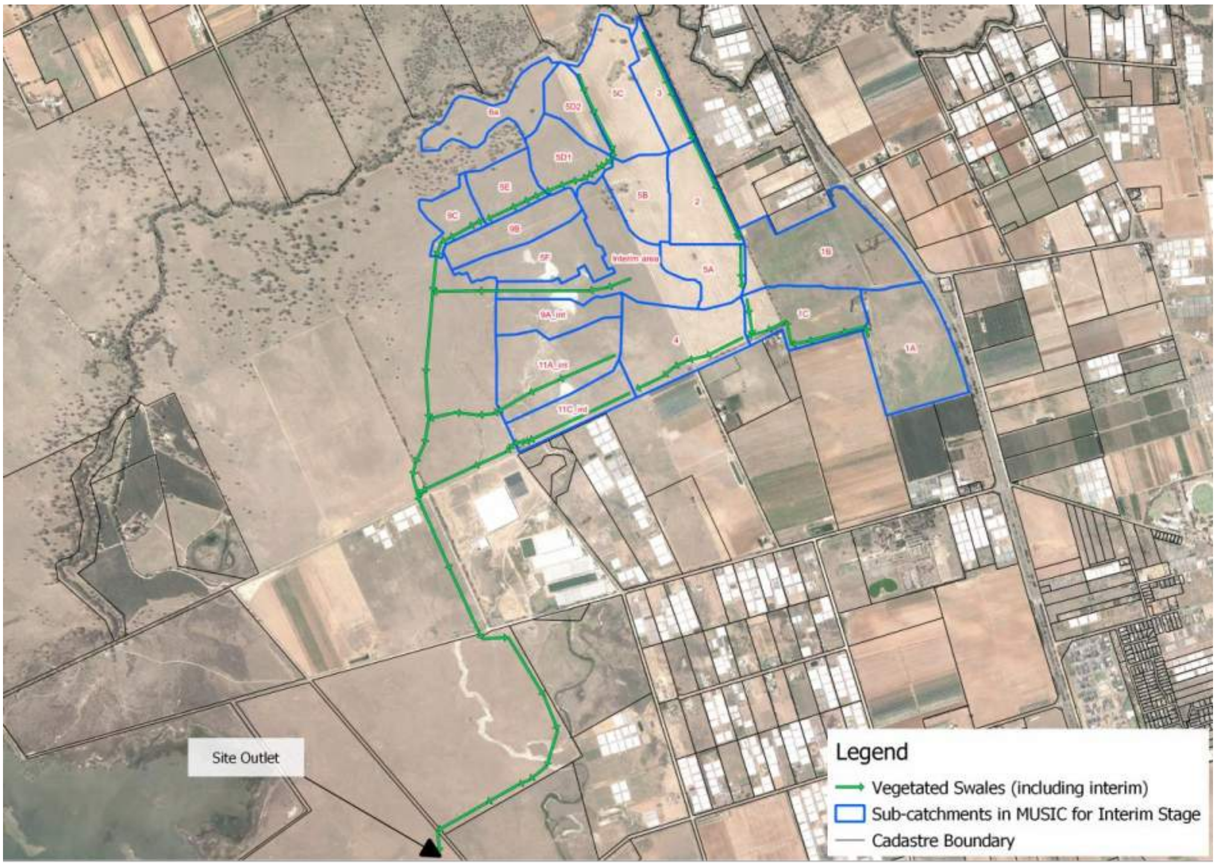


Figure 12: MUSIC Model Catchment Plan and WSUD Assets locations with indicative proposed Layouts for the Interim Scenario for Precinct 1 and 2

This section summarises the water quality simulation carried out using MUSIC software and compares the outcomes to the EPA Water Policy and WSUD treatment 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 wetland treatment pools to ensure that the treatment requirements can be met from for the development of Precinct 1. Refer to Appendix D showing the extent of the modelled catchment that is covered within the MUSIC model. The extent of modelling includes future stages beyond Stage 1A and 6A which ensures that this strategy considers the ultimate development of Precinct 1 and parts of Precinct 2.

MUSIC version 6 has been used to assess the performance of the design. The model layout has been included in Appendix D and shows that adjacent/future catchments have been included in the model to provide proof of concept that the treatment strategy will accommodate the immediate adjacent future stages of development.

MUSIC Software

MUSIC is the Model for Urban Stormwater Improvement Conceptualisation, developed by the CRC for Catchment Hydrology in Victoria. MUSIC provides the ability to simulate both quantity and quality of runoff from catchments ranging from a single house block and urban areas up to many square kilometres, and the effect of a wide range of treatment facilities on the quantity and quality of runoff downstream. MUSIC predicts the performance of the stormwater quality management systems.

This simulation is based on an assessment of the treatment systems required for the development of Stages 1 to 12. Preliminary sizes were developed using first design principles for wetland design, and this formed the basis for testing and modelling in MUSIC to ensure that the space requirement for treatment can be met for the development.

MUSIC Modelling

Stages 1 to 12 development characteristics and parameters have been entered into the MUSIC model based on the sub-catchments. Refer to Appendix D for screen output of the model showing catchment nodes and treatment systems graphically displayed. The treatment elements of the system, including gross pollutant traps and vegetated swales are all included in the model as per their adopted design configurations shown on the design drawings. MUSIC model uses climatic data comprising of daily rainfall interval and evaporation data from Edinburgh RAAF from 1979 to 2010. This data is used to simulate the rainfall runoff on site and the subsequent treatment performance for the development. The results and outcomes are in this Section.

The parameters entered into MUSIC model for the source and treatment nodes are summarised in Table 10. The table 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 and vegetated swales.

Table 10: MUSIC Modelling Parameters

NODE TYPES	PARAMETERS				
Urban	Soil storage capacity 40 mm	1 mm depression storage	Typical impervious fraction 65%	Stochastically generated pollutants	Initial storage capacity of 25%
Treatment	**Parameters**				
Low Flow Swale	Gradient 0.2%	Vegetation height 250 mm	Base width 15 m	Infiltration loss 0.70 mm/hr	Batter 1 in 3 Depth 2.0 m
GPT	Treatment flow to the 3-month ARI (4EY)	TSS removal rate 70%	TP removal rate ZERO	TN removal rate ZERO	Gross pollutant removal rate 90%

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 WSUD targets.

WSUD best management practice pollutant reduction targets as defined in the WSUD Guidelines for the Greater Adelaide Region.

The pollutant treatment criteria are presented in Table 11 which have been compared to the simulated results using MUSIC.

Stormwater Quality Simulation Results – Ultimate Development

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 standards were entered into the model to enable a direct comparison to be made. The results have been reported at the downstream node located at the development stage boundary.

Based on the EPP Water Quality limiting concentrations, the model results are presented in Table 11 and compared to the target values.

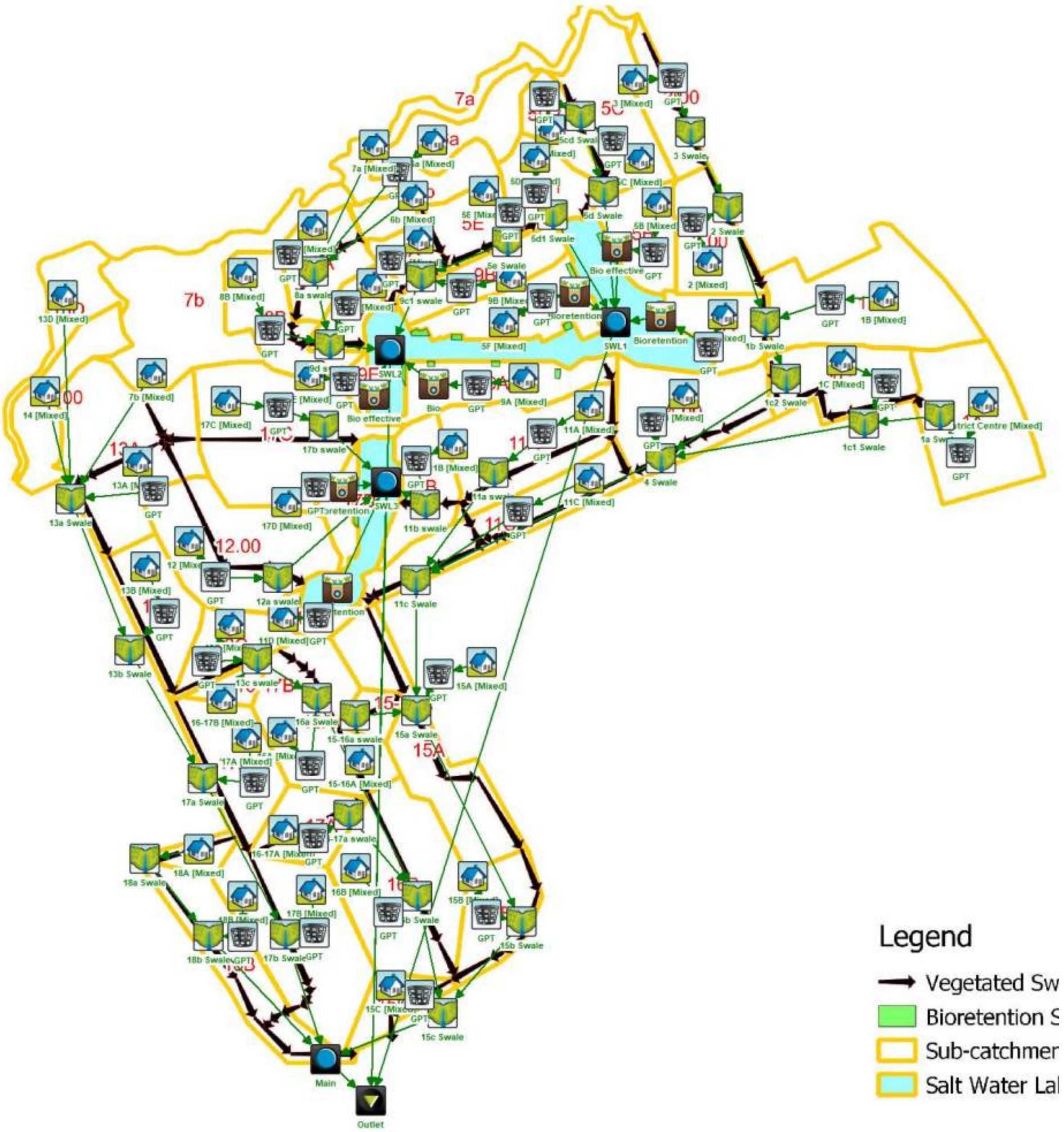


Figure 13: MUSIC Model Schematic - Ultimate Development

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 11 along with the results achieved.

Table 11: Water Quality Results Compared to Best Practice Standards – Ultimate Development

POLLUTANT TYPE	TSS	TP	TN	GROSS POLLUTANTS/LITTER
Target percentage reduction (%)	80	60	45	>50 mm and retention in 3-month ARI (4EY)
Reduction achieved at SWL1 (%)	94.8	70.2	49.6	100% trapped (averaged over the simulated period)
Reduction achieved at SWL2 (%)	96.5	79.8	61.0	100% trapped (averaged over the simulated period)
Reduction achieved at SWL3 (%)	95.2	70.1	45.4	100% trapped (averaged over the simulated period)
Reduction achieved at Site Overall (%)	96.6	82.0	63.1	100% trapped (averaged over the simulated period)

The results summarised in Table 11 demonstrate that the suspended solids, TP and TN reductions will meet the required performance criteria. 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 phosphorous (TP) and total suspended solids (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.

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 set in the referenced codes and guidelines Therefore the design of the site treatment system is satisfactory in terms of meeting the required performance limits of pollutant concentrations.

Stormwater Quality Simulation Results – Interim Solution Precinct 1 and 2

The results presented in this section demonstrate water quality compliance in accordance with the target values specified for the Interim development stage. These are assessed against the standards defined in the tables below. The results have been reported at the downstream node located at the development stage boundary.

Based on the EPP Water Quality limiting concentrations, the model results are presented in Table 12 and compared to the target values

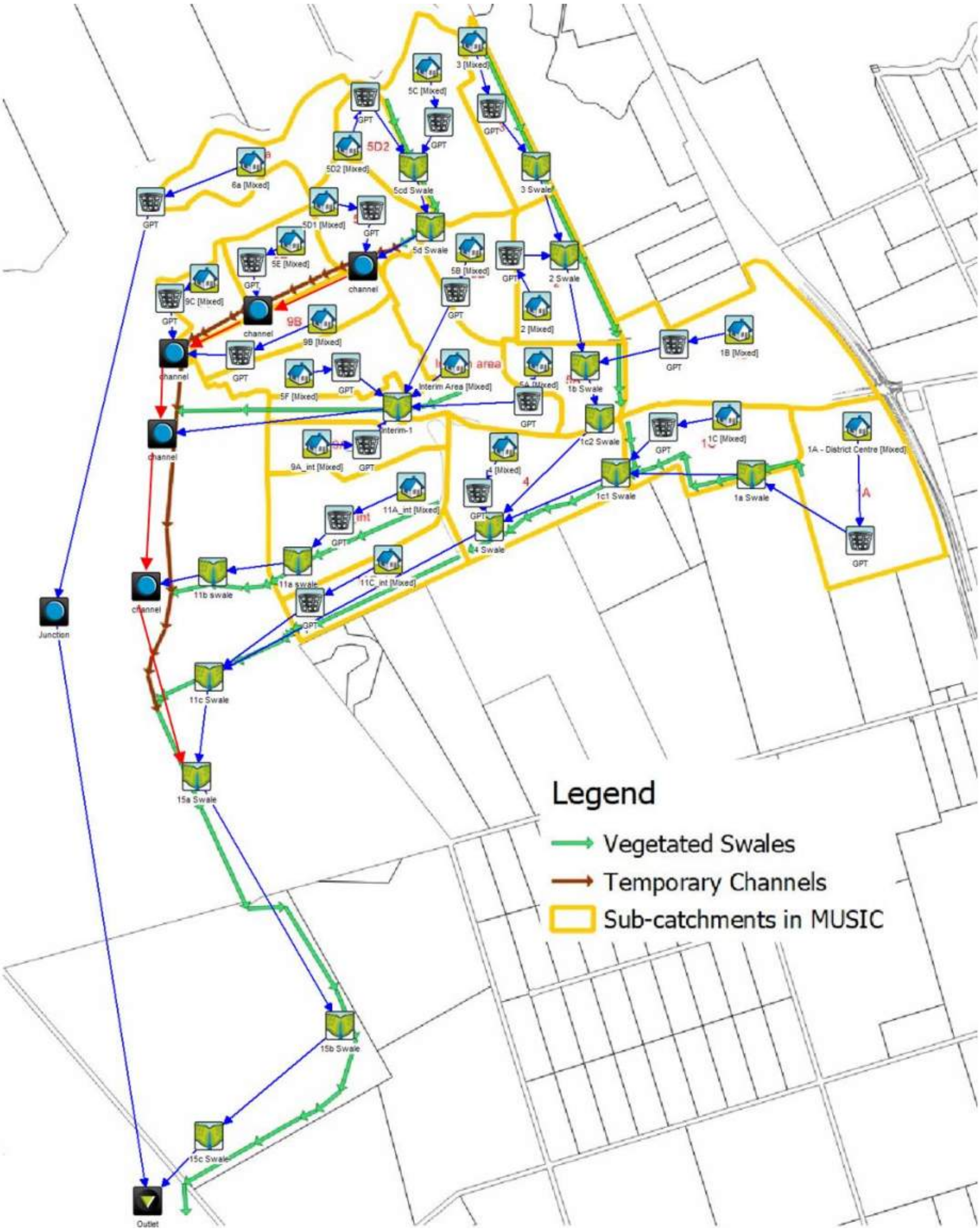


Figure 14: MUSIC Model Schematic – Interim – Precinct 1 and 2

Table 12: Water Quality Results Compared to Best Practice Standards – Interim Scenario

POLLUTANT TYPE	REDUCTION ACHIEVED AT INTERIM STAGE (%)	TARGET REDUCTION (%)
TSS	95.30	80
TP	79.80	60
TN	59.90	45
Gross Pollutants/ Litter	99.5% trapped (averaged over the simulated period)	> 50 mm and retention in 3-month ARI

The permanent channels are intended to be fully planted out, however, the temporary channels will be topsoiled and just grassed and are not intended to contribute to water quality improvements. The MUSIC model does not include any contribution to water quality improvements from the temporary channels.

The results summarised in Table 12 demonstrate that the suspended solids, TP and TN reductions will meet the required performance criteria for the Interim development scenario where there is a combination of temporary and permanent open channels. 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 phosphorous (TP) and total suspended solids (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.

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 set in the referenced codes and guidelines Therefore the design of the site treatment system is satisfactory in terms of meeting the required performance limits of pollutant concentrations.

6.3 Management of Sediment Loads

Land Division Construction Phase SEDMP

During the construction phase of the development a Stormwater, Erosion and Drainage Management Plan (SEDMP) shall be implemented in accordance with the Environment Protection Act 1993. The SEDMPs for all stages will be prepared to meet the requirements in accordance with the Code of Practice for the Construction and Building Industry (1999). The SEDMPs will be developed for each design stage during the detailed design process. These plans are submitted as part of the Engineering approval process attached to this report. SEDMPs for future stages will be undertaken as part of the engineering design and will be submitted via a separate engineering design report for those stages. It is noted that these will follow the principles as outlined in this report.

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 in order to prevent 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 has been 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 and other measures as deemed necessary. It is noted that the SEDMP will not be limited to the adoption of sediment basins within the regional channels, the SEDMP will require a sequence of management techniques to work collectively. The Contractor shall consider other techniques that form part of the strategy within the SEDMP. This includes:

- The minimisation of cleared land to minimised exposure to wind and rain
- Focussing efforts on minimising soil loss through erosion
- Techniques to minimise the generation of airborne dust

It should be noted that the proposed in-line pools within the channels will be constructed during the early phase of construction and can function as a sediment capture basin during the major earthworks and roadwork construction phases. In this regard these will ensure that all site generated runoff will pass through the pools prior to discharge downstream from the development. Upon completion of the development works, these pools will be reinstated in accordance with the design documentation to ensure that their ultimate design function of stormwater treatment is restored in accordance with the design intent.

The SEDMP will form a key component of the constructor's environmental management plan (CEMP) that will be developed prior to construction.

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.

The SEDMP 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:

- Gross pollutant traps are located on all major stormwater outlets into the regional channel. These will trap debris and coarse sediment.
- Sedimentation traps located at each of the stormwater outlets into the regional channels. These will trap medium to finer sediment.

The sediment traps should remain functional for a period of time not less than to the equivalent of 70% of the houses completed or as advised by Council. Upon this timeframe, the sediment traps should be removed, and the channel should be reinstated in accordance with the design documentation.

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 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 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.
- Hydro seeding areas left exposed for periods of time.

Post Land Division Construction Phase Sediment Loading

In consultation with approval authorities, concerns have been raised in relation to the absence of a sedimentation basin to trap sediments from the local catchment (Buckland Park development). Sediment loads have been estimated and used to assess the potential depth of sediment expected to accumulate within the ephemeral wetland pools over time.

Sediment loads from developing and established catchments can vary significantly depending upon a number of factors. According to the widely adopted text “Managing Urban Stormwater, Soils and Construction, Landcom NSW (2006), a developing catchment can be expected to discharge between 50 m^3/ha and 200 m^3/ha of sediment each year. In a developed catchment, the annual sediment export is generally one to two orders of magnitude lower with an expected mean annual rate of 1.60 m^3/ha. These rates are adopted as standard practice in NSW.

Therefore, it is acknowledged that these loading rates are based on the climatic conditions experienced along the east coast of Australia where higher rainfall intensity and annual totals vary considerably from local conditions in Buckland Park. It is envisaged that these rates would be lower for South Australian conditions.

For the purpose of this exercise, we have adopted a loading rate of 1.60 m^3/ha, while acknowledging that this rate is based on conditions experienced along the east coast of Australia and is therefore expected to provide a conservative estimate. The calculation of estimated potential sediment load and depth along the regional channels is outlined below.

Catchment area = 170 Ha

Sediment loading rate = 1.60 m^3/ha/a

Volume of sediment / annum = 270 m^3

Length of channel in Stages 1 to 12 = 5000 m

Annual depth of sediment accumulation (assuming uniform distribution) = 5 mm

Estimated depth accumulation in 5 years = 25 mm

These estimates are only intended to provide a guide only.

6.4 Channel Sediment and Erosion Management

Purpose and scope

A management plan to address the current and future issues associated with erosion and sediment deposition within the channel has been deemed necessary This sediment stems from sources associated with:

- Open channels primary earthworks undertaken with no stabilisation measures to control surface runoff and erosion on exposed subgrades, and
- Overland runoff from sites that have undergone the first phase of earthworks with limited SEDMP measures, and or have not been developed following the primary earthworks phase.

Both above issues provide a source of sediment into the channel, which has raised concerned the City of Playford (Council), particularly when landscaping works are imminent. Subsequently, Council has requested a long-term sediment and erosion management plan to reduce the risk of siltation within the primary channel network within Riverlea. The main section of concern lies between Riverlea Boulevard and the Gawler River. The Stages of Development along the channel has been characterised based on their current level of soil exposure on their current state of development at the time of writing this report. For this purpose, the most recent aerial photography has been adopted. Sheet 1 in Appendix F indicates the following:

- Stages that are developed, partially developed, and currently exposed earthworks
- Channel sections that are landscaped, exposed with or without topsoil

The aim of this management plan is to:

- Prepare a channel sediment and erosion management plan to suit longer timeframes
- Indicate measures required to manage the risk association with the mobilisation or exposed soils either by:
  - land surface runoff
  - bank erosion by direct rainfall and land runoff
  - Silt deposition within the channel
- Identify suitable management measures.
- Prepare a strategy plan.
- Provide a guide for routine maintenance.

6.5 Management Strategy

The management strategy focusses on a broad area wide measures based on:

- Surface runoff control measures that aim to prevent or reduce soil erosion caused by broad areas of undeveloped and exposed land surfaces.
- Channel embankment erosion control and stabilisation measures to reduce soil erosion processes caused by raindrop impact, sheet flow and rill erosion over the exposed earthworks batters.
- Sediment control measures that aim to trap and retain sediment that has already entered the channel and conveyed along the channel causing siltation.

This management strategy adopts measures along the perimeters of the underdeveloped/exposed land sites adjacent to the channel. This approach allows for flexibility and for construction of those land areas at any time. While it is important to note that this strategy relates to the current situation over the subject land area, some adjustments to this overarching strategy will be necessary to allow for progressive development of land areas. This also applies to channels, such that landscaping of various sections can occur, if erosion and sediment control measures are implemented and managed upstream of each length of channel that is landscaped.

Management techniques

The management techniques (measures) have been selected and planned into the site to provide longer term management of surface runoff and erosion along the channel embankments. These have been adopted to provide a robust approach to account for the longer-term operational requirements, and therefore are in addition to the SEDMP measures that are normally provided during the construction of each Development stage.

The following listed control measures have been selected to offer a longer-term management approach, and are outlined together their application:

Land surface management control measures

- Soil stockpile management – Ensure these are not located near to the channel, drainage line/overland flow path and a road. Long term stockpiles should be hydromulched.
- Diversion drains – temporary surface drainage lines to control and direct surface runoff flow to a sediment trap. These are shallow swales measuring 300mm deep with a broad flat cross section with 600mm wide base and 1 in 5 batters. Diversion drains should be hydroseeded with a grass mix.
- Sediment traps – a small basin that collects surface runoff or from a diversion drain that allows sediment to settle or trap. The sediment is periodically removed and can be respread/reused on site where appropriate. Sediment traps 10m Long, x 3m wide x 1m deep with 1 in 3 batters.
- Organic mulch buffer strip 1.5m wide.0.15m high. Located 1m off from the adjacent top of channel (overbank area), heavy organic mulching (not wood chipping) to form barriers or overland buffer strip. These strips of organic mulch are used to slow the progress of surface runoff to allow for infiltration, pooling and or slow seepage from runoff generated over a broad land area. The mulch should be fibrous to allow for good interlocking and to integrate with the land surface. Alternatively, use a silt fence in lieu of the mulch strip and noting that a silt fence will require ongoing and regular maintenance.
- Grassed buffer strip 10m wide, Hydroseed buffer strip (HBS) – a dryland grassed area to form a buffer that will assist to manage and absorb rainfall and runoff adjacent to the channel.

Channel management control measures

- Stabilisation of channel banks – Tyne and rip the subgrade, place topsoil and hydromulch (Bonded fibre matrix) including a grass seed mix.
- Channel check dams – in channel sediment trap barriers using temporary sandbags stacked to 400mm high and partially up the side batter 300mm to prevent outflanking.
- Prepare the site for the expected weather conditions – Refer to maintenance guidance in Section 3.
- Site inspection and monitoring - as part of the maintenance regime, the site will need to be monitored and measures repaired and maintained. Refer to maintenance guidance in Section 3 below.

The above control measures have been tried and tested recently on the first channel packages locally to channel 01, stages 05 - 12. Refer to Appendix F for details which will be progressively monitored and adapted as necessary to provide suitable and functional control measures. The details are typical and will continue to be deployed on all future drainage channel packages at the delivery of the civil works, to ensure the controls are fully established, functional and inspected prior to any landscape works commencing.

Below are actual images of the control measures implemented for the aforementioned stages:

Maintenance

All erosion and sediment control measures are to be progressively inspected, repaired, maintained, and updated as needed by Walker Corporation and their sub-contractor until the relevant channel package is handed over to Council. It is important to note that such measures are not considered a set and forget installation and therefore should be inspected and maintained. The following inspection regime provides guidance, which has been adapted to suit Riverlea:

- Winter and Spring – every 2 weeks to ensure measures are in good working order and additional inspections to comply with the parameters outlined below.
- Summer autumn – every 3 weeks to ensure measures are in good working order and additional inspections to comply with the parameters outlined below.
- Each time (within 2 days) preceding a forecast large rain event (say > 20mm).
- Immediately following a large rainfall event and in addition to following prolonged rainfall over several days where cumulative totals may exceed 20mm over a 3-day period.

Maintenance activities include:

- Checking measures to ensure these are in good condition and operating effectively.
- Making repairs and adjustments to measures to maintain good operating condition.
- Desilting sediment traps to ensure capacity is regularly available.
- Checking and topping up mulch barriers if required to ensure these are operating as required.
- Updating any existing measures to respond to changes in land use, and or for stages of development.
- Responding to damage and at times when storms and rain events as required to ensure the measures are operating effectively.

6.6 Revegetation Guide - Planting List

A study report prepared by EBS Ecology titled “Buckland Park Significant Environmental Benefit (SEB) 5 Revegetation Management Plan, September 2012” has been prepared to define the vegetation communities to be incorporated into the regional drainage network. The aim is to establish a functioning ecosystem while also meeting the requirements of the Native Vegetation Council to provide SEB offset areas associated with the residential development. The Development open space areas will be subsequently revegetated with a range of indigenous flora species that will contribute to improvement of biodiversity values in the regional landscape.

The revegetation of the regional channels and ephemeral pools are intended to provide a vegetation community of native vegetation that aims to restore pre-European ecosystems and biodiversity. The revegetation management plan sets out the vegetation communities for each zone associated with the regional channels. These zones generally correspond to the water regimes and aspect associated with the channels.

The following species lists in Table 13 to Table 16.

Table 16 have been provided by EBS Ecology for each vegetation zone. These are intended to provide general information only.

Table 13: Revegetation Species Aquatic Zone

STRATUM	SPECIES NAME	COMMON NAME
Understorey <1m	*Bulboschoenus caldwellii*	Salt Club Rush
	Cyperus gymnocaulos	Spike rush
	Cyperus vaginatus	Stiff Flat-sedge
	Juncus kraussii	Sea Rush
	Juncus subsecundus	Finger Rush
	Muehlenbeckia florulenta	Lignum
	Phragmites australis	Common Reed

Revegetation within the aquatic zone has been designed to re-establish reed bed/sedgeland vegetation within the aquatic and riparian zones. These zones will become self-regulating over time based on seasonal variation.

Table 14: Revegetation Species for the Riparian Zone

STRATUM	SPECIES NAME	COMMON NAME
Understorey <1m	*Atriplex paludosa* ssp. *cordata*	Marsh Saltbush
	Atriplex semibaccata	Berry Saltbush
	Chenopodium pumilio	Small Crumbweed
	Disphyma crassifolium ssp. *clavellatum*	Round-leaf Pig-face
	Einadia nutans	Climbing Saltbush
	Enchylaena tomentosa var. tomentosa	Ruby Saltbush
	Maireana aphylla	Leafless Cotton-bush
	Maireana brevifolia	Short-leaf Bluebush
	Rhagodia candolleana	Sea-berry Saltbush
	Suaeda australis	Austral Sea-blight
	Threlkeldia diffusa	Coast Bone-fruit
	Vittadinia cuneata	Fuzzy New Holland Daisy

Riparian - is intended to provide a buffer of 1-2 m around the aquatic zone which will allow some self-transitioning of the vegetation dependent on seasonal flows and storm events. These will not significantly reduce flow rates of the drainage network. These shrubs will provide increased habitat values for small birds and reptiles while also outcompeting alien species which are expected to invade from storm water transport and upstream run-off flows.

Table 15: Revegetation Species List for Upper Slope Zone

STRATUM	SPECIES NAME	COMMON NAME
Understorey <1m	*Austrostipa scabra*	Spear Grass
	Themeda triandra	Kangaroo Grass
	Aristida behriana	Brush Wire grass
	Chloris truncata	Windmill Grass
	Rhytidosperma setacea	Wallaby Grass
	Rhytidosperma caespitosa	Wallaby Grass

Upper Slopes - include the banks from the riparian zone to the top of the bank.

Table 16: Revegetation Species for Buffer Zone

STRATUM	SPECIES NAME	COMMON NAME
Overstorey	*E. camaldulensis* var. *camaldulensis*	River Red Gum
Small trees / large shrubs >1m	*Acacia pycnantha*	Golden Wattle
	Pittosporum angustifolium	Native Apricot
	Callitris gracilis	Southern Cypress Pine
	Dodonaea viscosa ssp. *spatulata*	Sticky Hop-bush
Understorey <1m	*Aristida behriana*	Brush Wire-grass
	Atriplex semibaccata	Berry Saltbush
	Rhytidosperma setacea	Small-flower Wallaby-grass
	Chloris truncata	Windmill Grass
	Convolvulus remotus	Grassy Bindweed
	Dianella brevifolia	Black-anther Flax-lily
	Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush
	Maireana brevifolia	Short-leaf Bluebush
	Rhagodia parabolica	Mealy Saltbush
	Themeda triandra	Kangaroo Grass

Buffers- will serve important ecological functions in the drainage network. Primarily, it will act as an amenity for the drains with this section providing a break in the flat landscape and greening the site significantly. It will also serve as a buffer for weed invasion with the natural mulched surface being readily maintainable for weed management.

7 IMPLEMENTING THE STRATEGY

7.1 Priorities and Timeframes

The staging of the works will depend on the timing of land releases into the future. It is anticipated that the overall development will have a completion timeframe in the order of 20 to 30 years.

The key priorities for Precinct 1 and Precinct 2, are based on achieving the key objectives outlined in Section 4 of this report. In this regard these are:

- Flood protection from local catchment and regional catchment (Gawler River). The release of stormwater to pre-development flow rates to the Thompson Creek outfall channel.
- Water Quality management from the current land release to meet the required standards defined in Section 6.
- Environmental Protection and Enhancement by using a multi-objective approach to stormwater management such that it contributes to the delivery of this objective.

The scope outlined in this report sets out to deliver these priorities. It is intended that all subsequent land releases will set to deliver the same objectives.

Assuming that the timing of future land releases is not a limiting factor, we would anticipate the following key stormwater infrastructure elements could be implemented within the sequence and timeframes as outlined below:

- Year 2024/2025:
  - Open Channel network and 125,000m3 basin to protect Precincts 1 and 2 are implemented.
- Years 2025 to 2035 – Extensions to the network of regional flood conveyance channels with integrated online treatment systems and development of the salt water lake network.
- Year 2035 – Detention basin and wetland downstream of Buckland Park at connection with Thomson Creek outfall channel. Further modelling work is required to determine the likely timing for this basin which will largely depend on the rate of development.

These works are discussed in more detail in Sections 7.2 and 7.3.

7.2 Interim Works

The interim works relate to permanent stormwater infrastructure elements that will be constructed as part of Precinct 2. These works include:

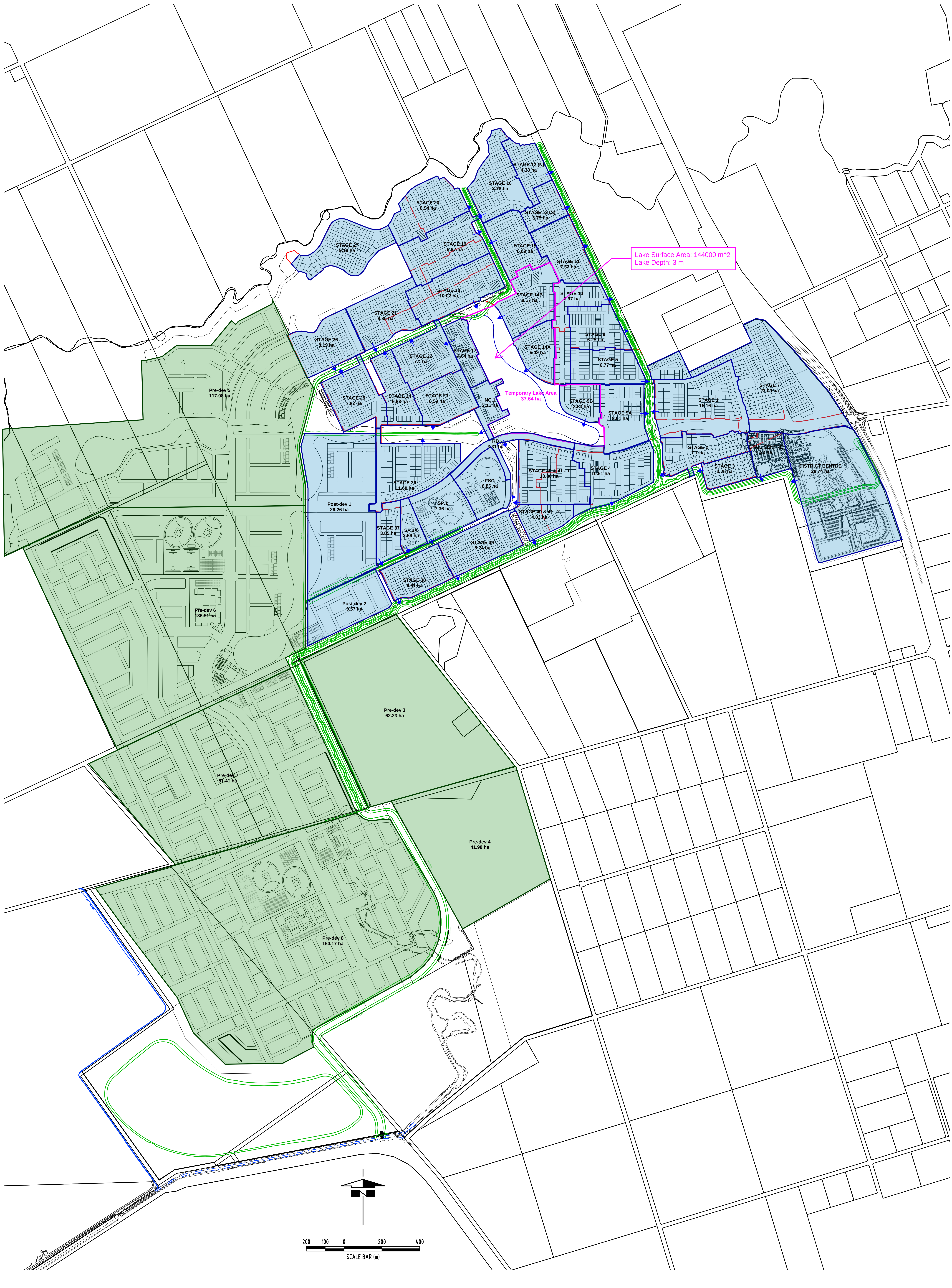
- Stormwater drainage infrastructure associated with the road network to collect and convey runoff to the regional channel at two outlet points.
- Regional drainage channels required to protect Precinct 1 and 2 which include some temporary channel sections. Refer to Appendix F.
- When Salt Water Lake 1 is constructed a new 750mm outlet pipe will need to be constructed as the outfall from the lake. The pipe will serve two purposes, one to provide circulation to the salt water lakes, and secondly to provide an outfall for stormwater discharging to the lake.
- Stormwater treatment systems integrated into channels as discussed in Section 6 of this report.

7.3 Future Works

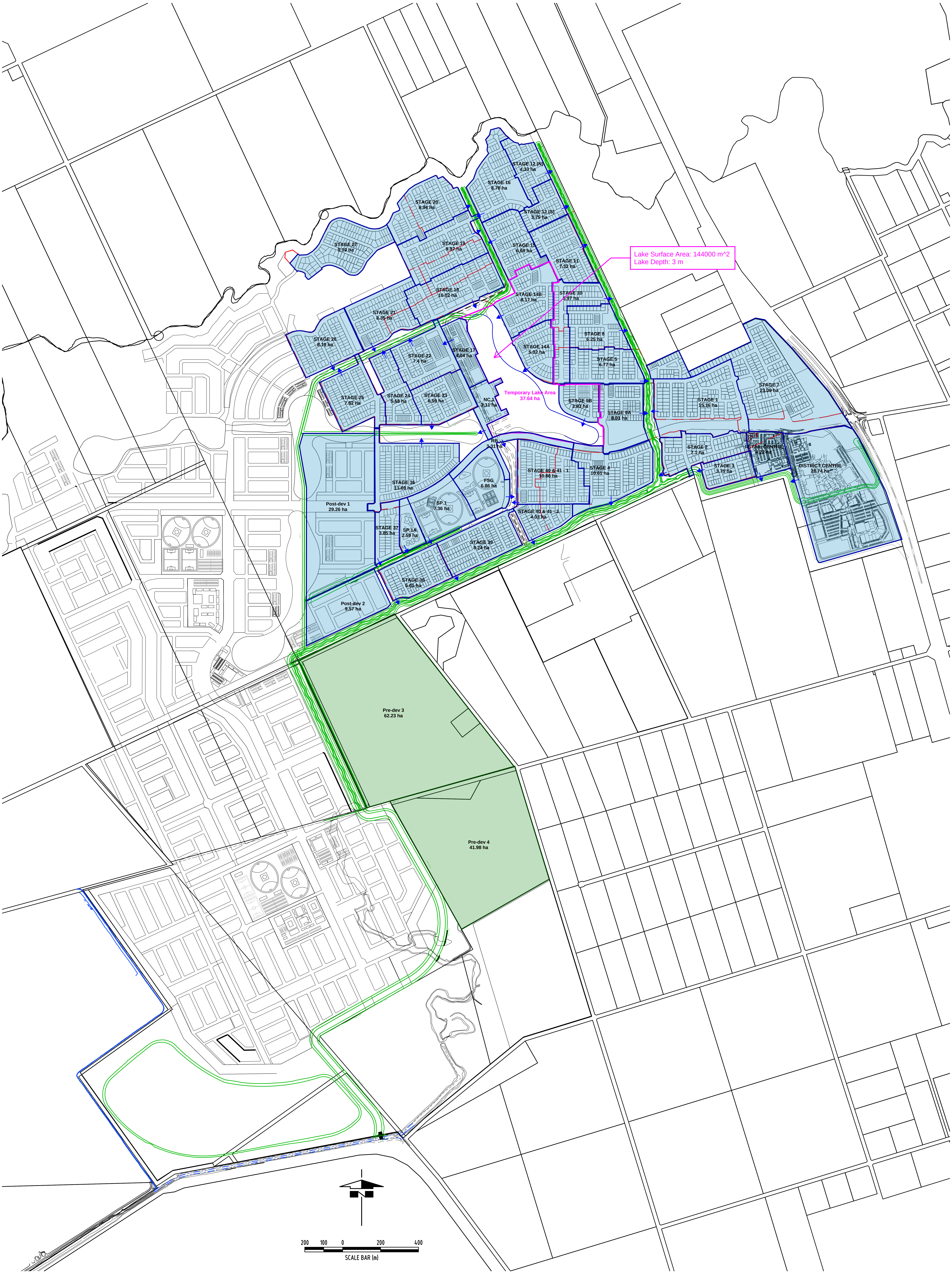
Ultimately the full extent of regional channels and the future salt water lakes proposed will provide flood protection to all subsequent developed stages of Buckland Park. Further studies will be required to determine the staging of future drainage requirements and their timing.

APPENDIX A
CATCHMENT PLAN

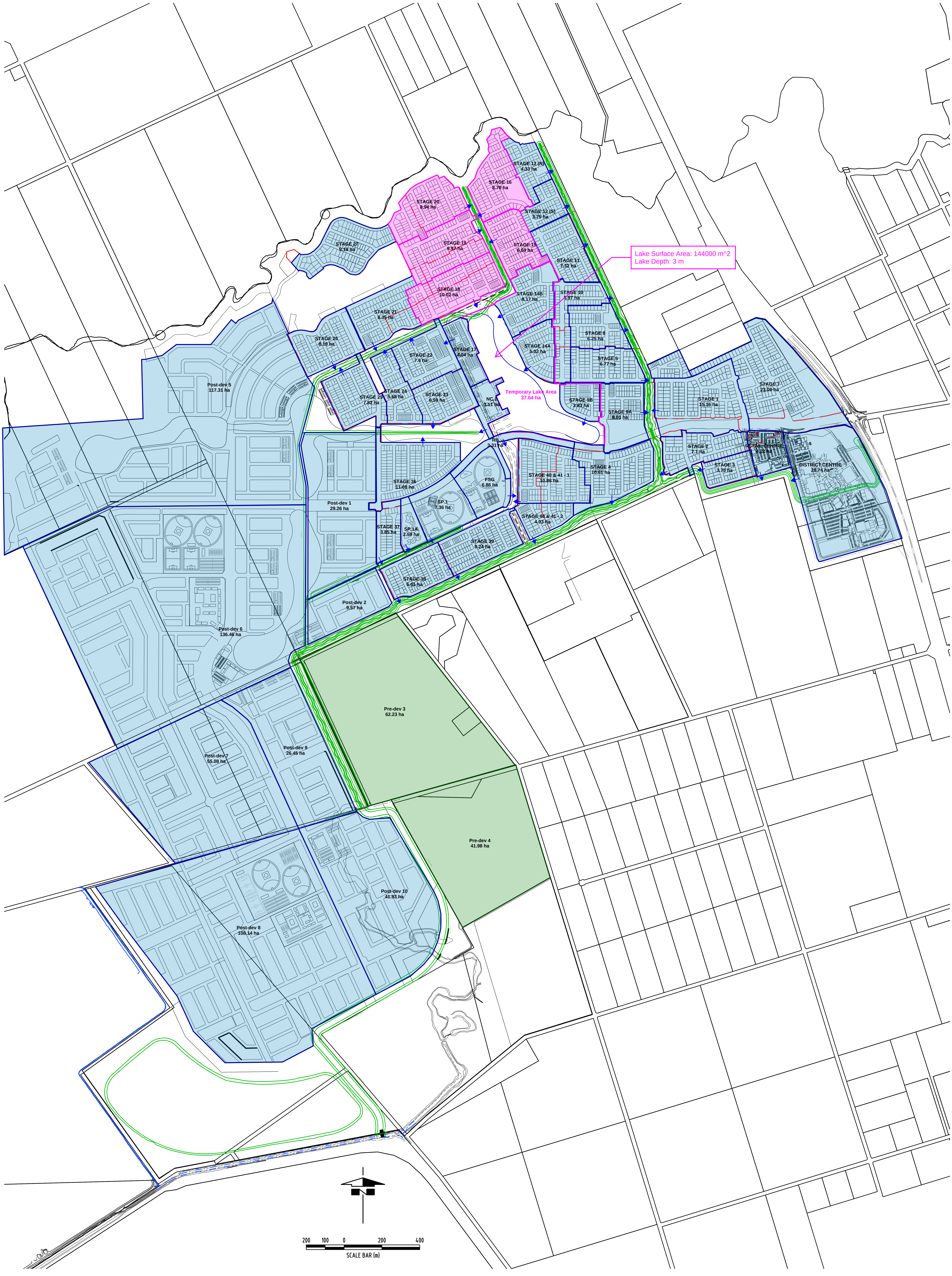
CATCHMENT PLAN - INTERIM SCENARIO



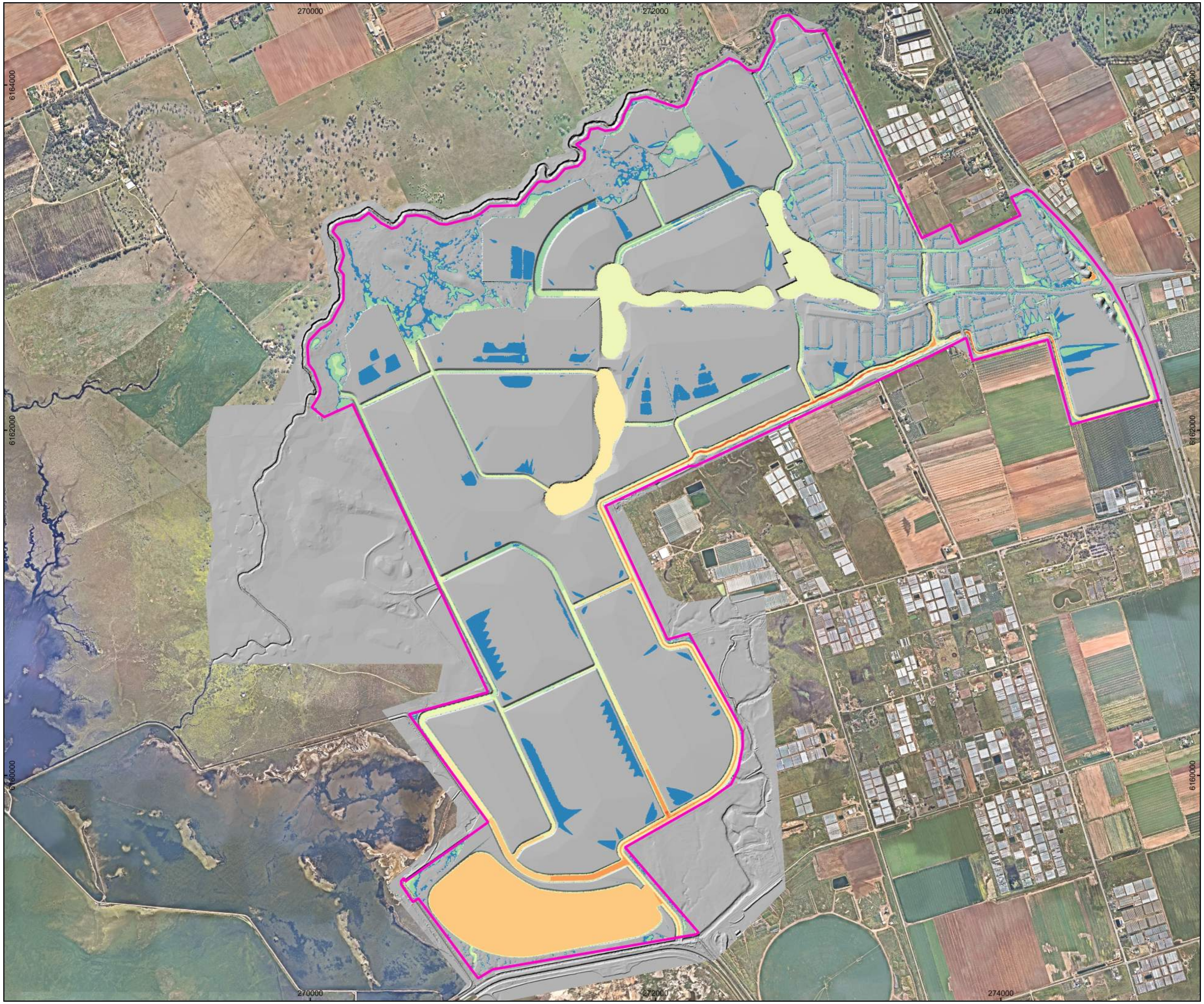
CHANNEL CATCHMENT PLAN - INTERIM SCENARIO



CATCHMENT PLAN - ULTIMATE SCENARIO



APPENDIX B
TUFLOW & DRAINS RESULTS



LEGEND

Hydraulic Model Boundary

Peak Flood Depth (m)

- <= 0.05
- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- > 2.00

200 0 200 400 600 800 m

Scale 1:21,000 on A3

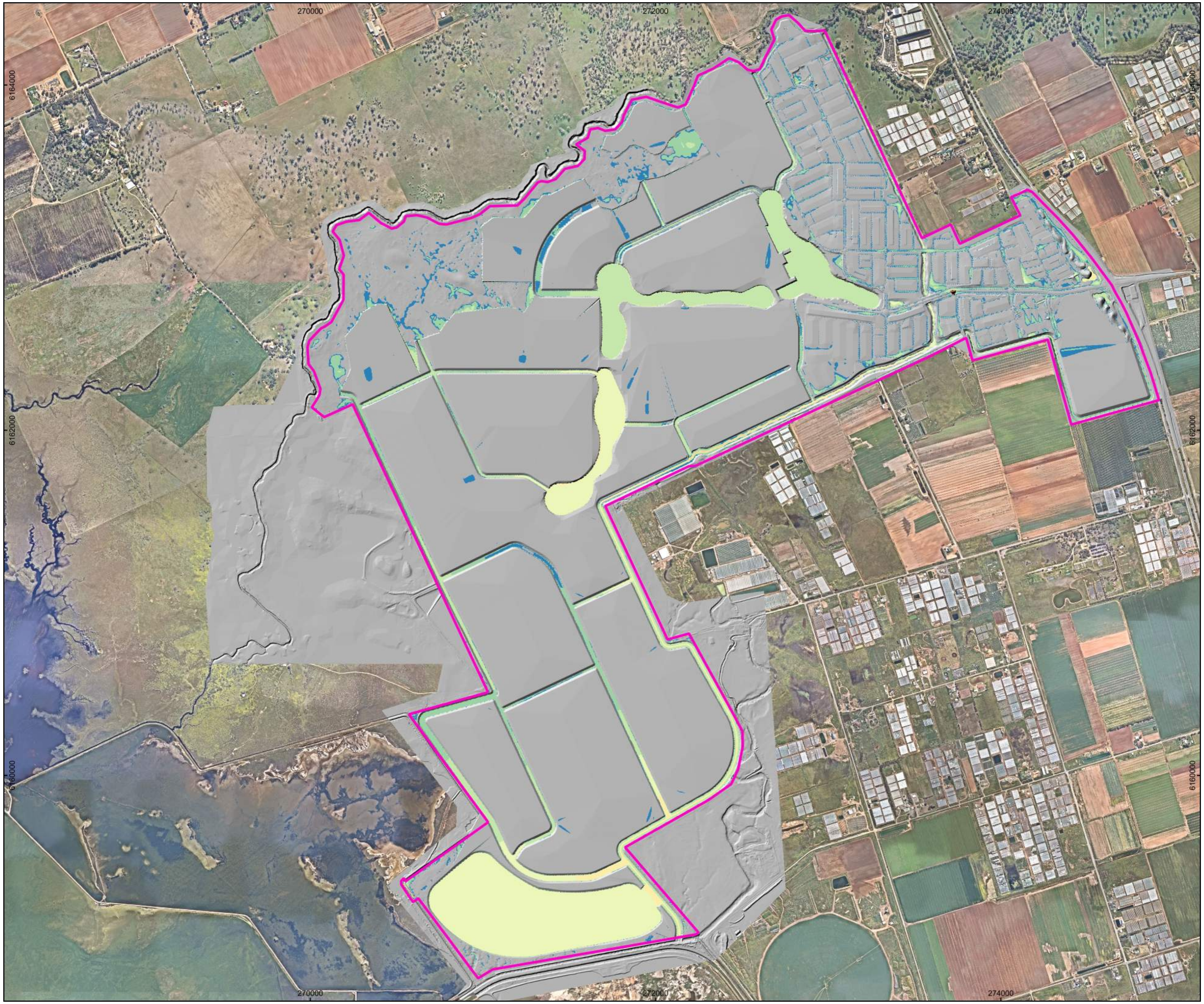
Coordinate System: GDA 1994 MGA Zone 54

WGA

Map B01

Riverlea Development

Peak Flood Depth
Scenario 1
1% AEP + Climate Change



LEGEND

Hydraulic Model Boundary

Peak Flood Depth (m)

- <= 0.05
- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- > 2.00

200 0 200 400 600 800 m

Scale 1:21,000 on A3

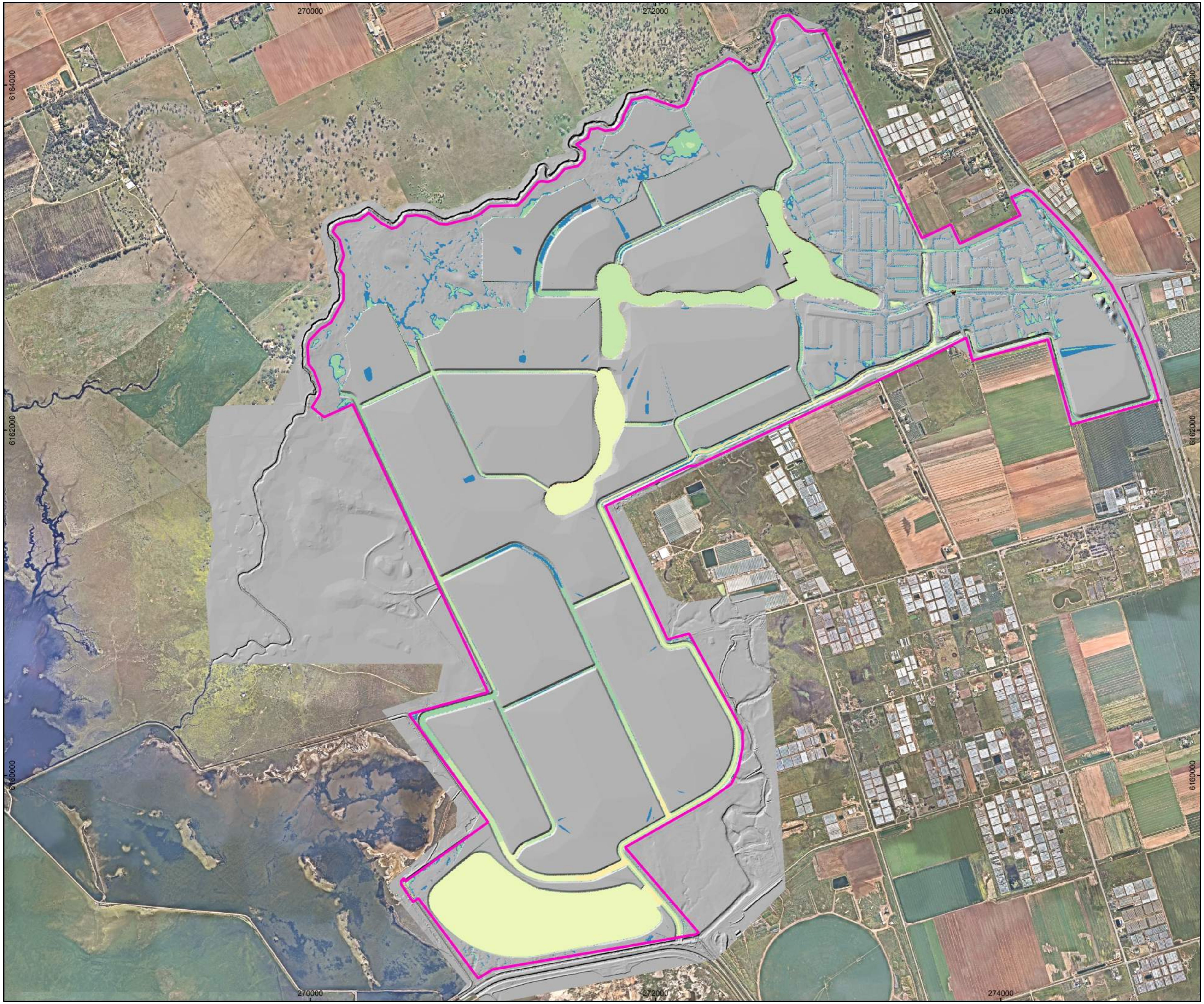
Coordinate System: GDA 1994 MGA Zone 54

WGA

Map B02

Riverlea Development

Peak Flood Depth
Scenario 2
10% AEP + Climate Change



LEGEND

Hydraulic Model Boundary

Peak Flood Depth (m)

- <= 0.05
- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- > 2.00

200 0 200 400 600 800 m

Scale 1:21,000 on A3

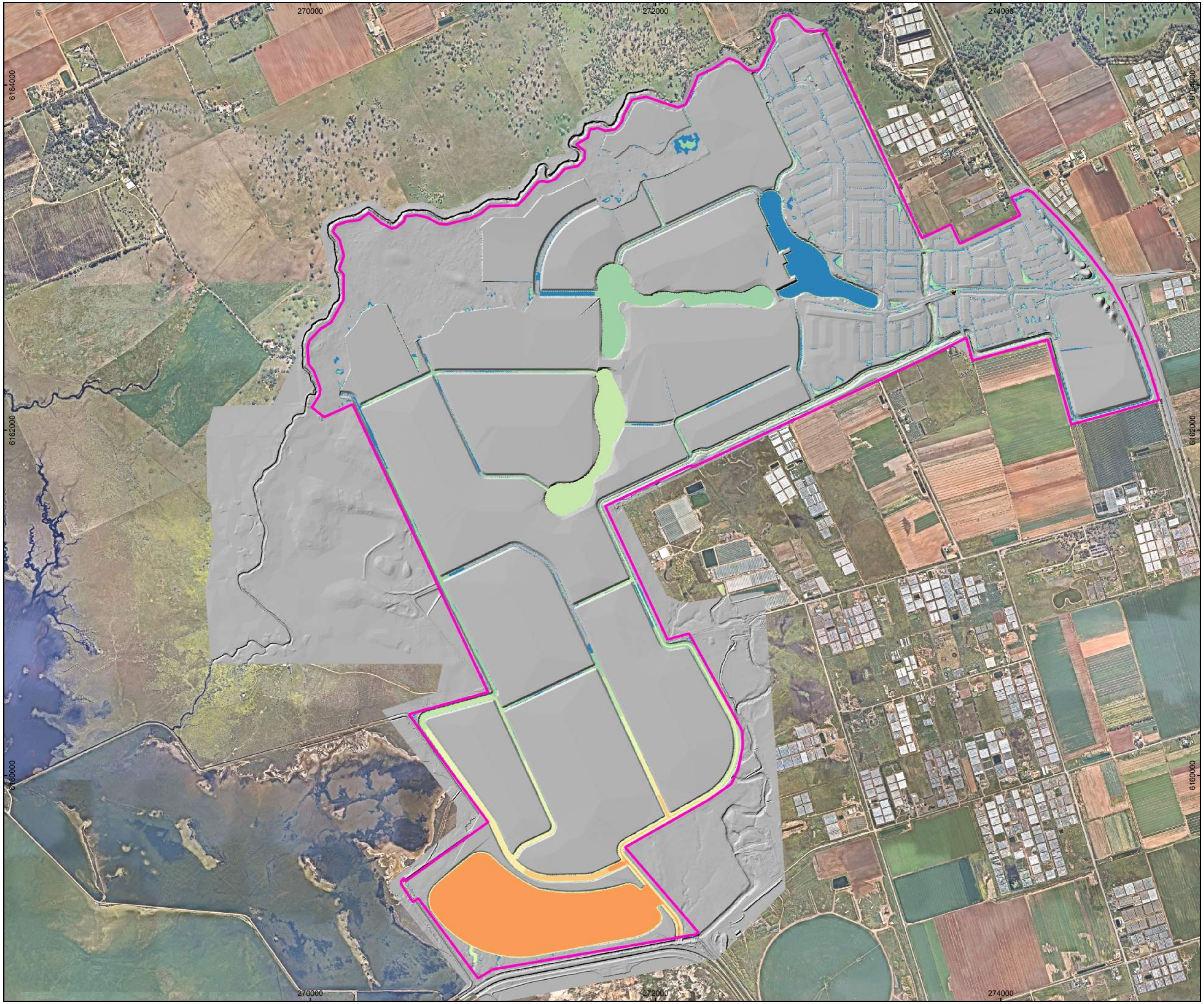
Coordinate System: GDA 1994 MGA Zone 54

WGA

Map B03

Riverlea Development

Peak Flood Depth
Scenario 3
10% AEP + Climate Change



LEGEND

Hydraulic Model Boundary

Peak Flood Depth (m)

- <= 0.05
- 0.05 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- > 2.00

200 0 200 400 600 800 m

Scale 1:21,000 on A3

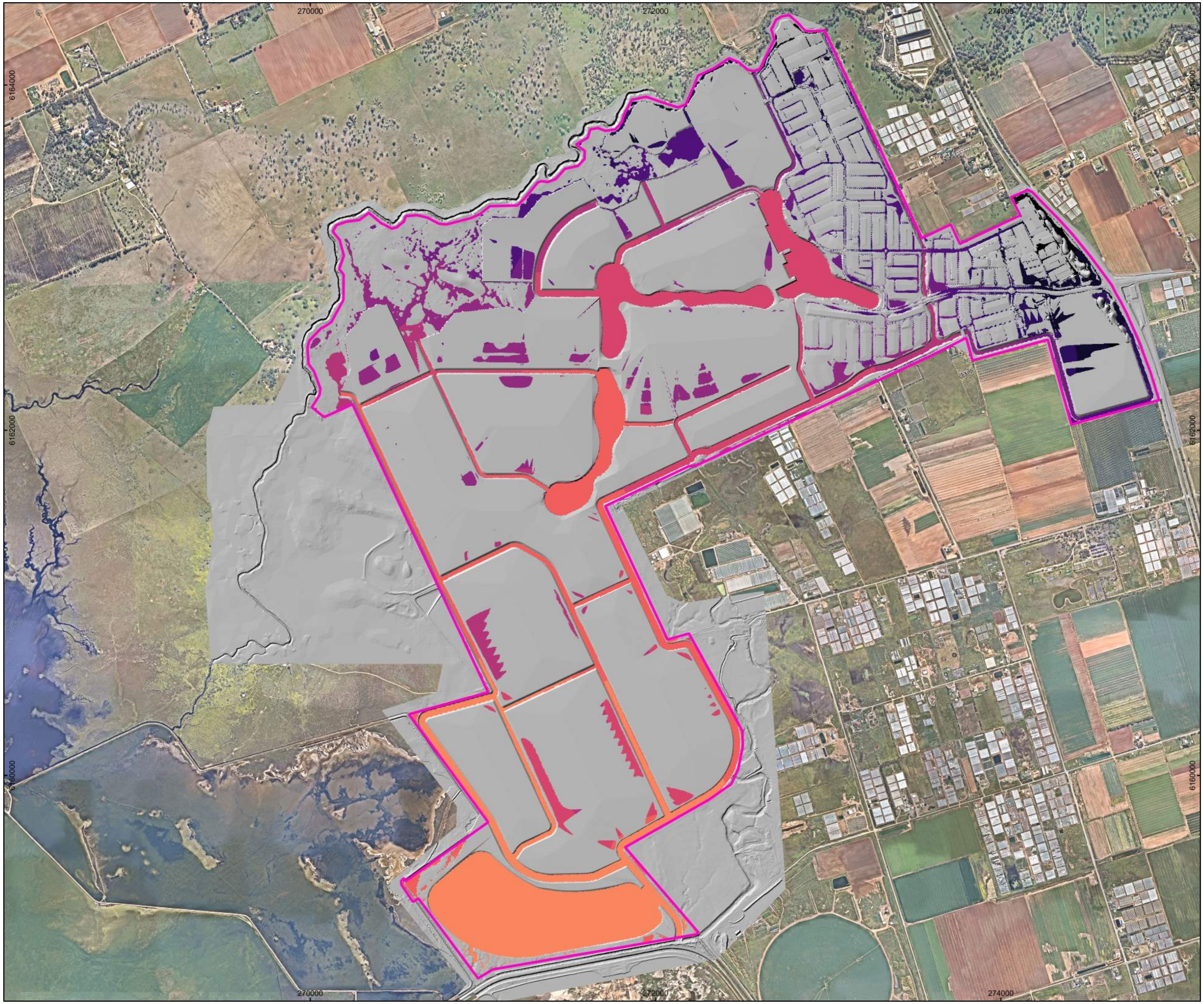
Coordinate System: GDA 1994 MGA Zone 54

WGA

Map B04

Riverlea Development

Peak Flood Depth
Scenario 4
63.2% AEP + Climate Change



LEGEND

- Hydraulic Model Boundary

Peak Flood Level (mAHD)

- <= 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- 8.0 - 9.0
- 9.0 - 10.0
- 10.0 - 11.0
- > 11.0

200 0 200 400 600 800 m

Scale 1:21,000 on A3

Coordinate System: GDA 1994 MGA Zone 54

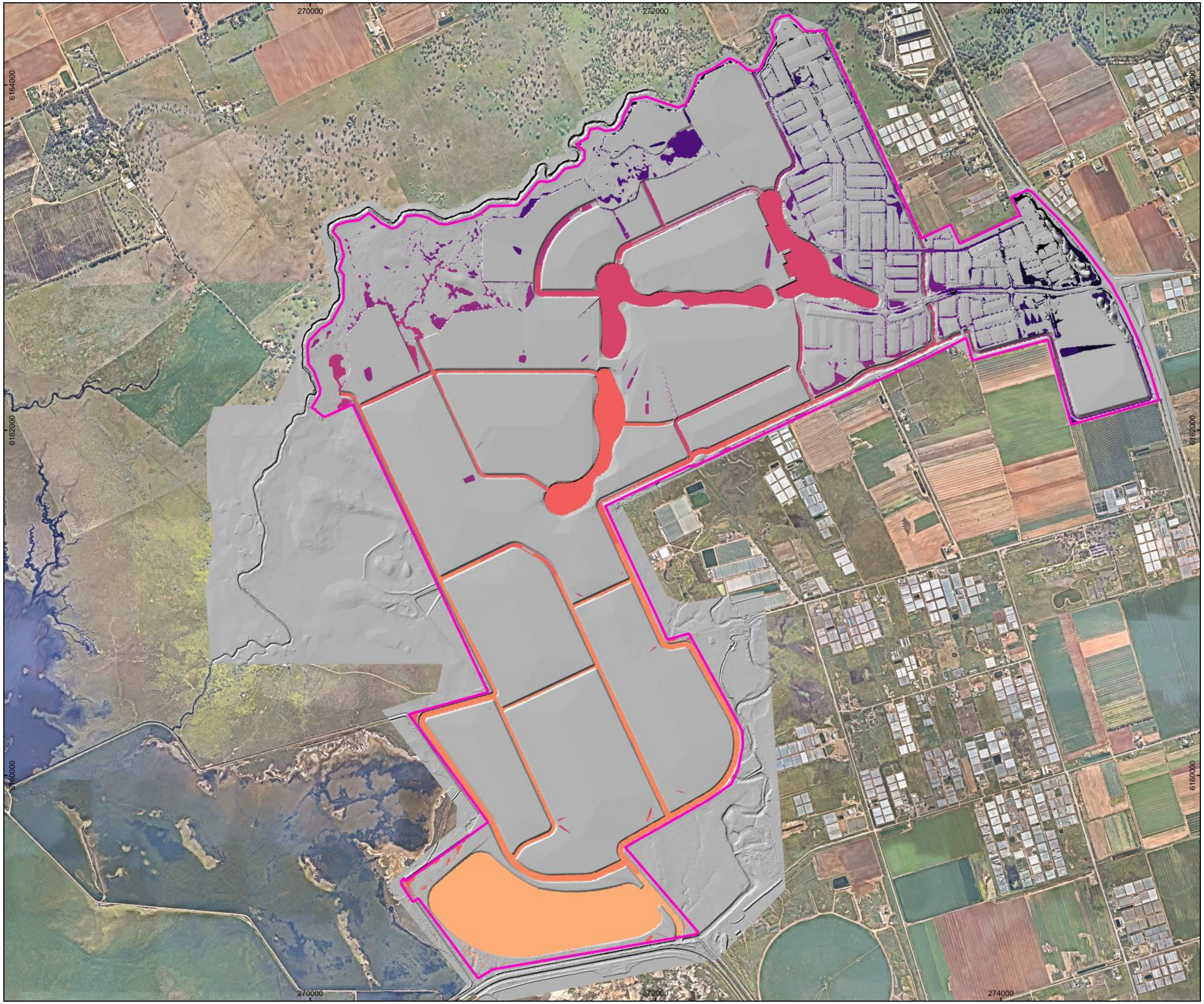
WGA

Map B05

Riverlea Development

Peak Flood Level
Scenario 1
1% AEP + Climate Change

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.



LEGEND

Hydraulic Model Boundary

Peak Flood Level (mAHD)

- <= 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- 8.0 - 9.0
- 9.0 - 10.0
- 10.0 - 11.0
- > 11.0

200 0 200 400 600 800 m

Scale 1:21,000 on A3

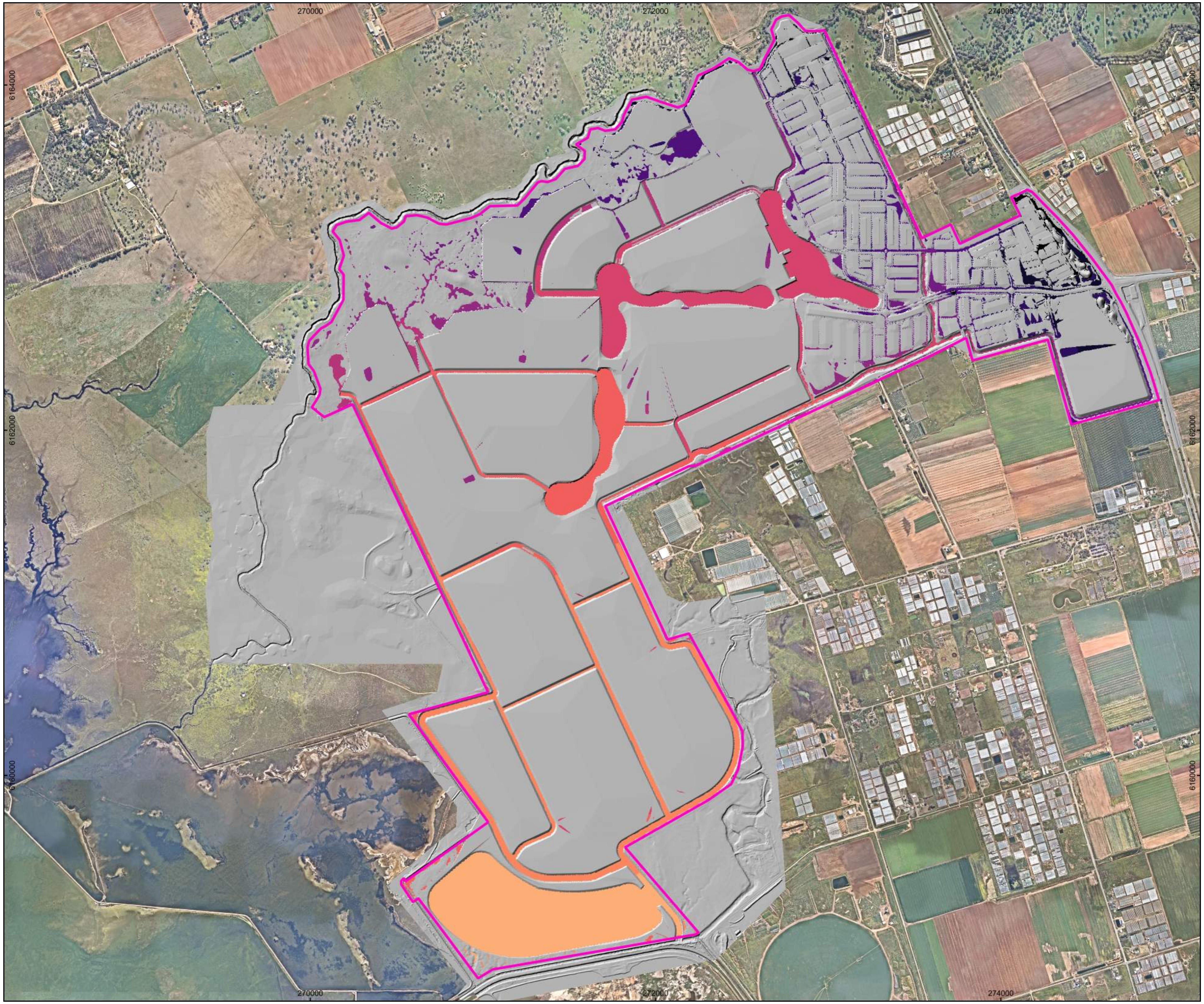
Coordinate System: GDA 1994 MGA Zone 54

WGA

Map B06

Riverlea Development

Peak Flood Level
Scenario 2
10% AEP + Climate Change



LEGEND

Hydraulic Model Boundary

Peak Flood Level (mAHD)

- <= 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- 8.0 - 9.0
- 9.0 - 10.0
- 10.0 - 11.0
- > 11.0

200 0 200 400 600 800 m

Scale 1:21,000 on A3

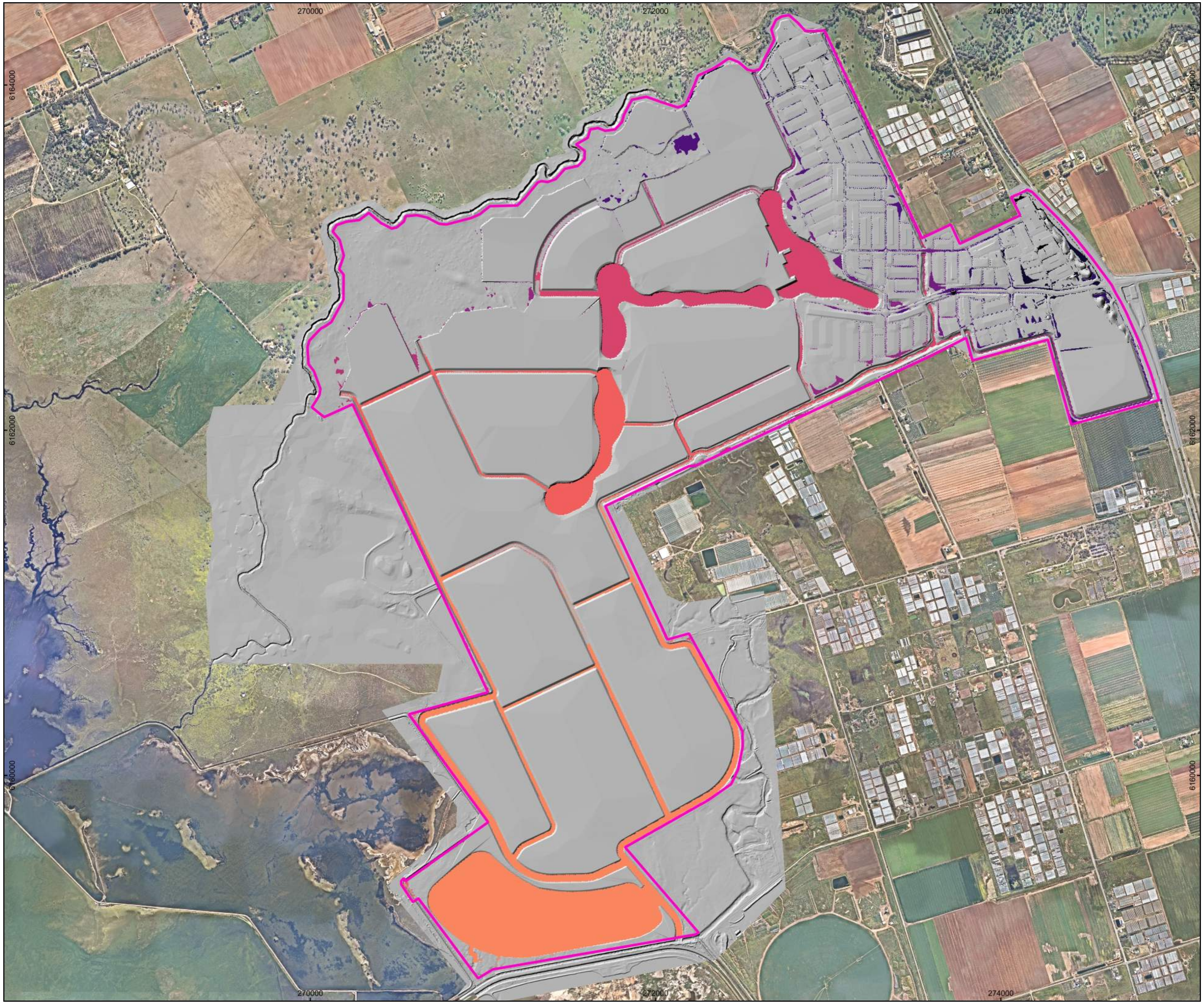
Coordinate System: GDA 1994 MGA Zone 54

WGA

Map B07

Riverlea Development

Peak Flood Level
Scenario 3
10% AEP + Climate Change



LEGEND

Hydraulic Model Boundary

Peak Flood Level (mAHD)

- <= 1.0
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- 8.0 - 9.0
- 9.0 - 10.0
- 10.0 - 11.0
- > 11.0

200 0 200 400 600 800 m

Scale 1:21,000 on A3

Coordinate System: GDA 1994 MGA Zone 54

WGA

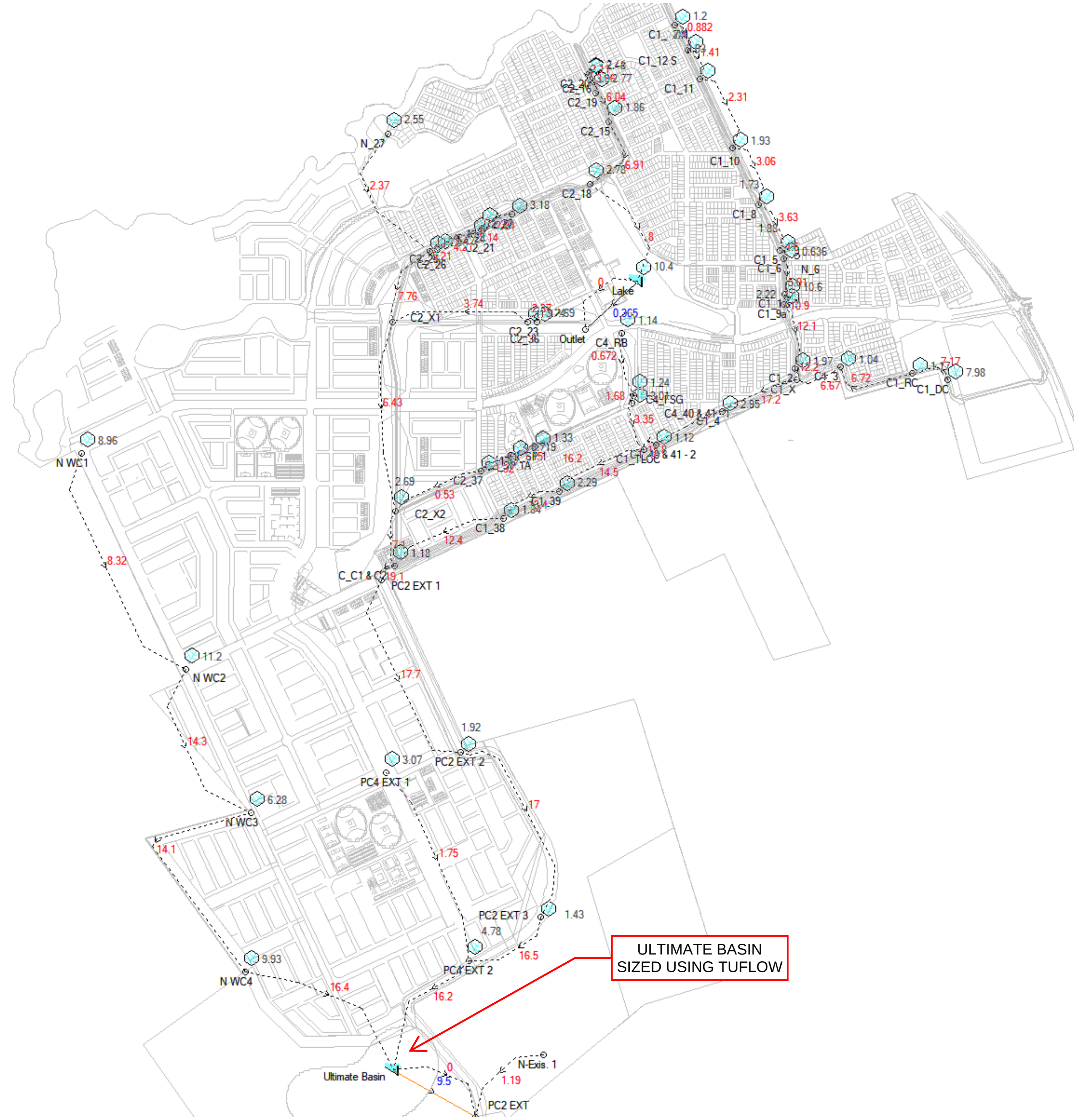
Map B08

Riverlea Development

Peak Flood Level
Scenario 4
63.2% AEP + Climate Change

ULTIMATE SCENARIO - DRAINS MODEL LAYOUT

ULTIMATE SCENARIO - 1% AEP EVENT DRAINS RESULTS



INTERIM SCENARIO - DRAINS MODEL LAYOUT

INTERIM SCENARIO - 2% AEP EVENT DRAINS RESULTS

APPENDIX C
REGIONAL FLOODING

MEMORANDUM

To Brent Eddy

From Alison Miller

Date 31 October 2022

Subject Modelling of Riverlea development in the broader Gawler River floodplain model

Riverlea is a proposed housing development at Buckland Park, currently under development by Walker Corporation. Water Technology have been engaged at various stages of the project to provide advice on riverine flood impacts at the development site and adjacent properties.

This memo documents the hydraulic modelling undertaken to assess the performance of the proposed division of floodwaters from the Gawler River along the western side of the development. Modelling was undertaken in the broader Gawler River floodplain model, versions of which are currently being used in the development of the Gawler Stormwater Management Plan and for the Enhanced Flood Hazard Mapping project.

MODEL DETAILS

The existing conditions model, currently being developed for the Enhanced Flood Hazard Mapping project, was adopted as the base case for assessment of the Riverlea development. The model is a coupled MikeFlood model, with the river and floodplain represented in 2D (Mike21), linked to 1D representation of culverts (Mike11).

Topography

The model adopts a flexible mesh representation, which allows higher resolution detail to be incorporated in the model where required (e.g. along the river) without dramatically increasing run times. The model adopts elevations from the two recently captured LiDAR datasets:

- Middle Beach 50cm LiDAR, captured 26 November 2021
- Adelaide Metro LiDAR, captured 21-31 January 2022.

The two datasets overlap along the alignment of the Gawler River. Where this has occurred, the 2022 data has been used in preference.

Note that the only difference between the model adopted for this assessment, and that in development for the Gawler SMP, is the underlying topography. The Gawler SMP model adopts the 2021 LiDAR, but the topography on the south-eastern side of the river alignment is based on a series of earlier topographic datasets.

The model incorporates 344 dike structures, which have been used to control the level at which water can move across various areas. Typically, these are representative of levees, however dikes have also been used to incorporate other key features such as road crests, where the element vertex sampling may have missed this detail. Crest elevations for each dike have been sampled from the 2021 or 2022 LiDAR.

Inflow/outflow boundaries

Inflow boundaries to the model were retained, and include:

- A hydrograph input for the South Para River at South East of Gawler
- A hydrograph input for the North Para River downstream of Turretfield.

Note that the hydrology inputs were derived from the XP-RAFTS hydrology model which incorporates the Bruce Eastick Dam and the upgraded South Para Dam. Hydrographs to the model were extracted at the spatial location of the hydraulic model. This is downstream of the South Para Dam (hence the flood mitigation is incorporated in the hydrology) and upstream of the Bruce Eastick Dam (flood mitigation here is incorporated in the hydraulic model).

A sea level of 1.5 mAHD (equivalent to the Highest Astronomical Tide) was applied as a downstream boundary along the western and (partial) southern model edges. This has been retained form the original study in 2008 which assessed tidal data for Port Adelaide and Outer Harbour.

A second 'free outflow' boundary has been incorporated on the southern edge of the model further upstream, on the western side of the Northern Expressway. This was to prevent breakouts from the Gawler River from artificially ponding at the model edge. In reality, this water is anticipated to flow initially south-west and then further west to meet other breakout flows from the Gawler River near Port Wakefield Road.

Infrastructure

All major bridges and culverts, of which there are 89, have been incorporated in the 1D domain. These were adopted from the previous Light River and Smith Creek models. Where these relate to drainage infrastructure for the Northern Expressway, these have been validated against details in the DRAINS model provided by City of Playford.

Where the mesh resolution was coarser than the width of the culvert/bridge outlet, the elevation of the linking cell has generally required altering to represent the invert.

Updates for the current assessment

The underlying mesh was refined across the area of the Riverlea site, to ensure sufficient resolution to capture the proposed development layout of swales. As a result of changes to the mesh, existing conditions have also been updated to ensure the same representation of detail.

The proposed development conditions have been represented by sampling a digital elevation model of the proposed conditions, created from the design drawing provided by Walker Corporation 'Riverlea_Existing+Sitewide EW_05092022.dwg'.

Further details of the model schematisation will be made available through the Enhanced Flood Hazard Mapping project report for the Gawler River.

Note that the model is currently undergoing validation, and further refinements will be made. This will include re-enforcement of the bank levels on the eastern side of the Gawler River near Windermere. The model version adopted here, is appropriate for comparing like-for-like but may not necessarily be representative of actual flood levels, depending on the outcome of the validation process.

SCENARIOS

Scenarios analysed for this assessment include:

- Current conditions (referred to as 'existing').
- Future development conditions.

The digital elevation model for the proposed developed conditions can be seen in Figure 1. The proposed design includes a concept for diverting breakouts from the Gawler River into a zone along the northern edge of the development, conveying floodwaters along the north and western borders to a discharge point at the south-western corner.

Figure 1 Proposed development surface elevations

RESULTS

The resulting flood depth for the 1% AEP flood event in the Gawler River for the current and future development scenarios is provided in Attachment 1 and 2. The scheme to divert breakouts to the south-western corner works as intended, however it demonstrates that the floodwaters are diverted from the location further west than intended.

The developed conditions (Attachment 2) show an extensive area of flooding surrounding the most southern basin, near the existing salt pans. While the majority of this area is inundated in existing conditions, refinement to the outflow path may need to be considered.

Differences in 1% AEP flood levels between the two scenarios is shown in Figure 2 (and Attachment 3). The results indicate reduced flooding along the western portion of the development (i.e. 'was wet now dry'), and reduced flood levels further west and south of the site.

Note that the existing conditions 1% AEP flood extent differs slightly to that provided previously. Output from the previously adopted TUFLOW site specific model indicated floodwaters breakout out near the intersection with Port Wakefield Road to south of the Gawler River, inundating the existing greenhouses and extending south-west across the Riverlea site. This breakout flow is not observed in the updated modelling adopted here as the bank heights have been more accurately represented through the adoption of recently captured 2022 LiDAR.

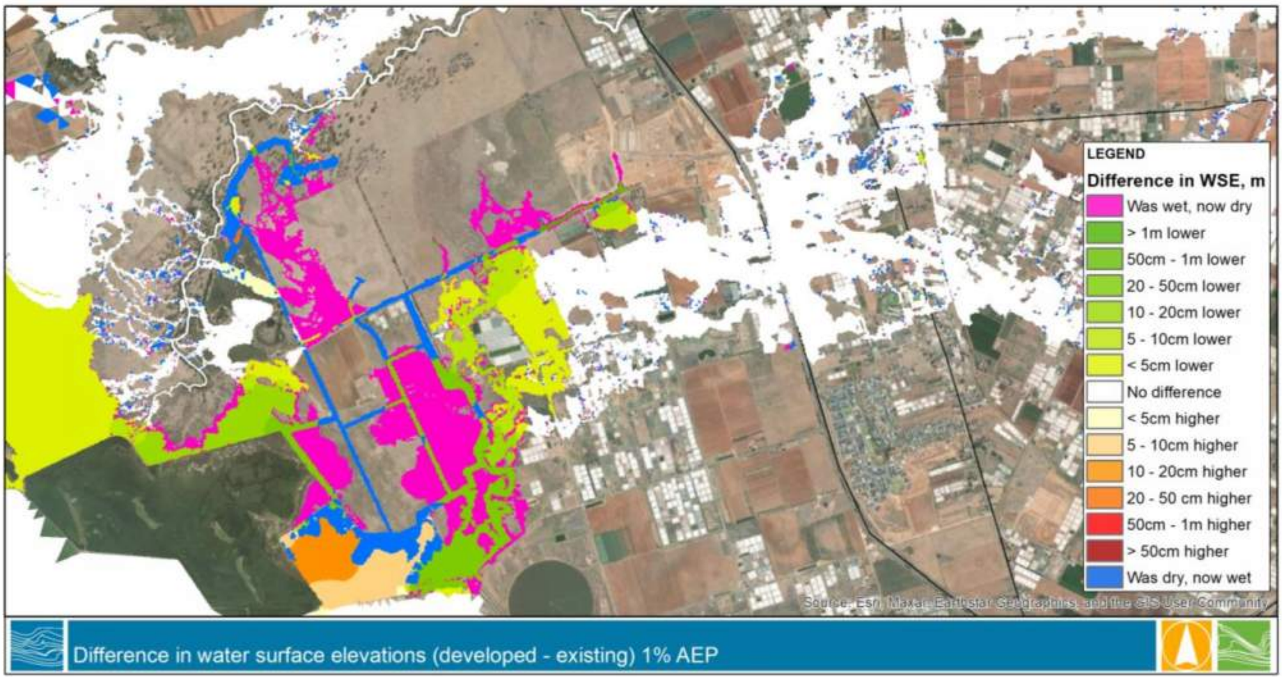


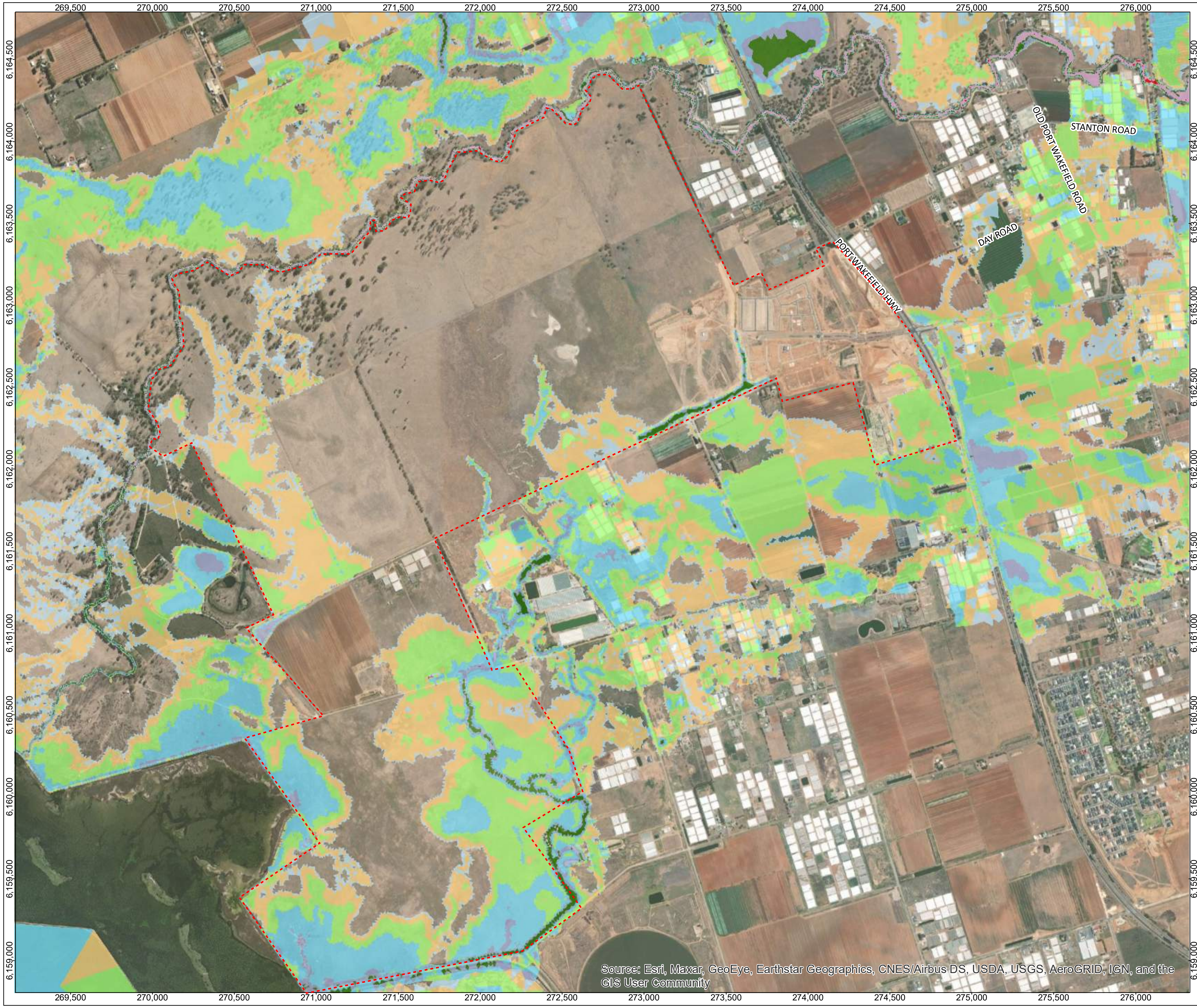
Figure 2 1% AEP flood depth for current development conditions across site

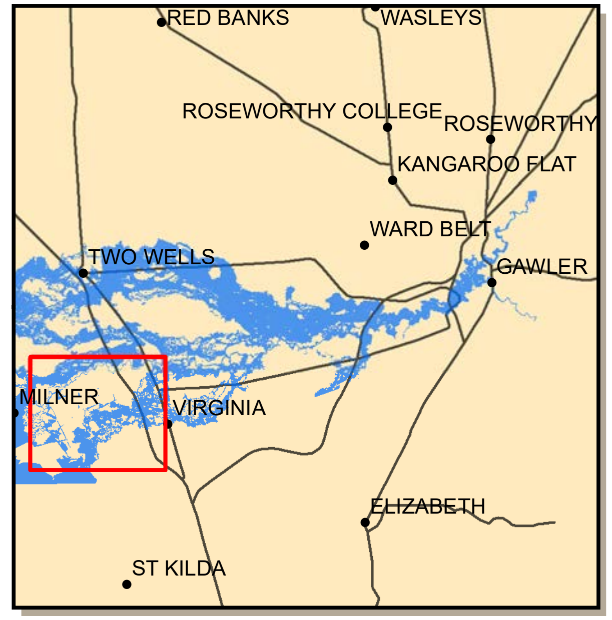
Enclosed:

Attachment 1 – 1% AEP flood depth, existing conditions

Attachment 2 – 1% AEP flood depth, proposed development conditions

Attachment 3 – 1% AEP difference in water surface elevation (developed minus existing)





Legend

Depth, m

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2.5
- 2.5 - 5
- Greater than 5

NOTE
Water Technology Pty. Ltd. has prepared this document in accordance with instruction of Walker Corp for their specific use.

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Contains PLB Images, https://maps.sa.gov.au/SAPPA/

0 250 500 1,000 Meters

Coordinate System: GDA 1994 MGA Zone 54

1:25,000 at A3

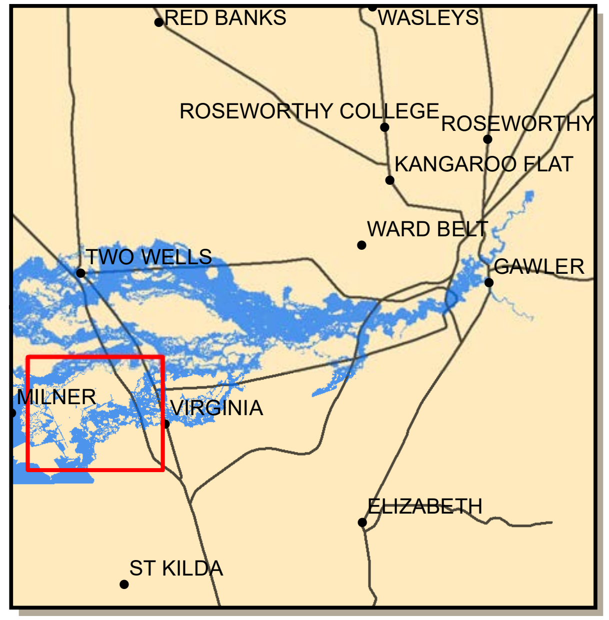
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Existing Conditions 1% AEP Depth

Riverlea Development Site

REFERENCE: A3L_wInset_Riverlea_Ex_1AEP_DEPTH

DATE: 28/10/2022 | SHEET: 1 of 1 | DRAWING NUMBER: 1



Legend

Depth, m

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2.5
- 2.5 - 5
- Greater than 5

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Contains PLB Images, https://maps.sa.gov.au/SAPPA/

0 250 500 1,000 Meters

Coordinate System: GDA 1994 MGA Zone 54

1:25,000 at A3

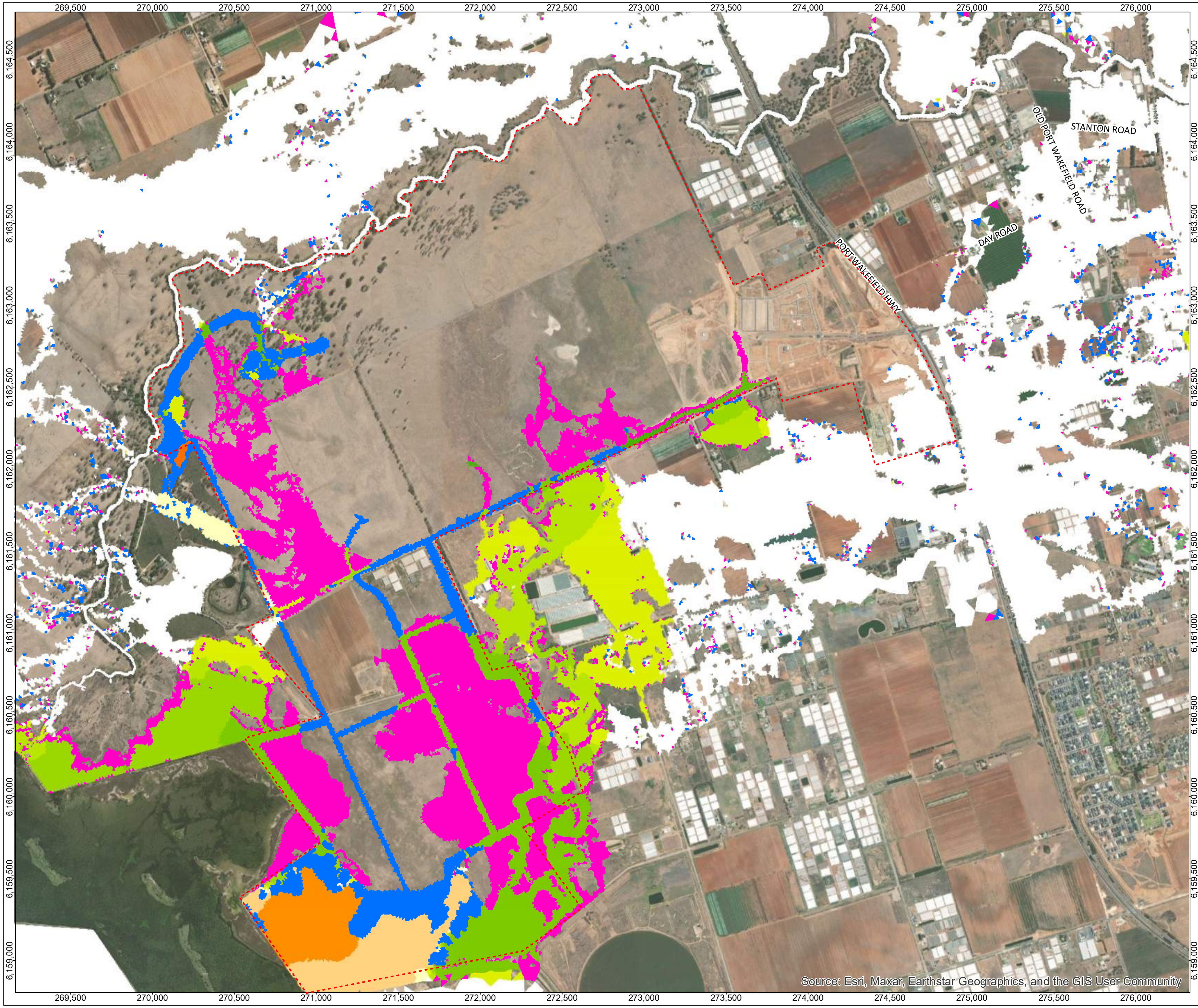
WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

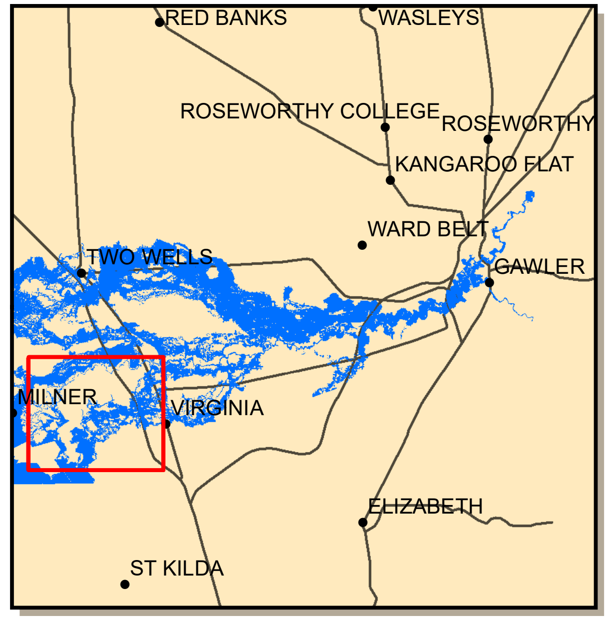
Developed Conditions 1% AEP Depth

Riverlea Development Site

REFERENCE: A3L_wInset_Riverlea_Dev_1AEP_DEPTH_v3

DATE: 28/10/2022 | SHEET: 1 of 1 | DRAWING NUMBER: 1





LEGEND

Difference in WSE, m

- Was wet, now dry
- > 1m lower
- 50cm - 1m lower
- 20 - 50cm lower
- 10 - 20cm lower
- 5 - 10cm lower
- < 5cm lower
- No difference
- < 5cm higher
- 5 - 10cm higher
- 10 - 20cm higher
- 20 - 50 cm higher
- 50cm - 1m higher
- > 50cm higher
- Was dry, now wet

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0 250 500 1,000 Meters

Coordinate System: GDA 1994 MGA Zone 54

1:25,000 at A3

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Difference in flood levels (Dev-Ex) 1% AEP Depth

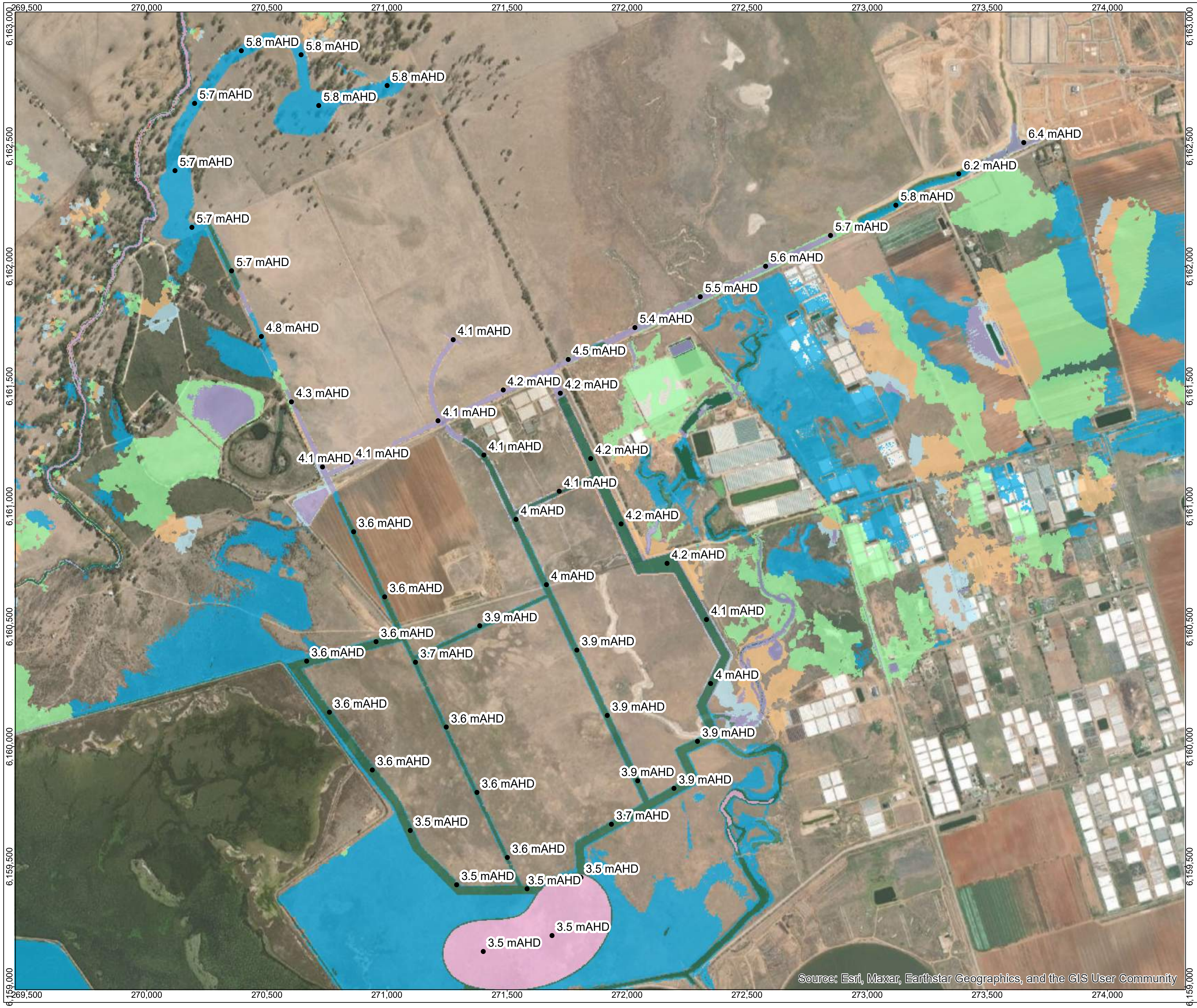
Riverlea Development Site

REFERENCE: A3L_wInset_Riverlea_Dev-Ex_1AEP_DIFF_v2

DATE: 31/10/2022

SHEET: 1 of 1

DRAWING NUMBER: 1



Legend

- • Water surface elevation at point

Depth, m

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2.5
- 2.5 - 5
- Greater than 5

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Contains PLB Images, https://maps.sa.gov.au/SAPPA/

N W E S

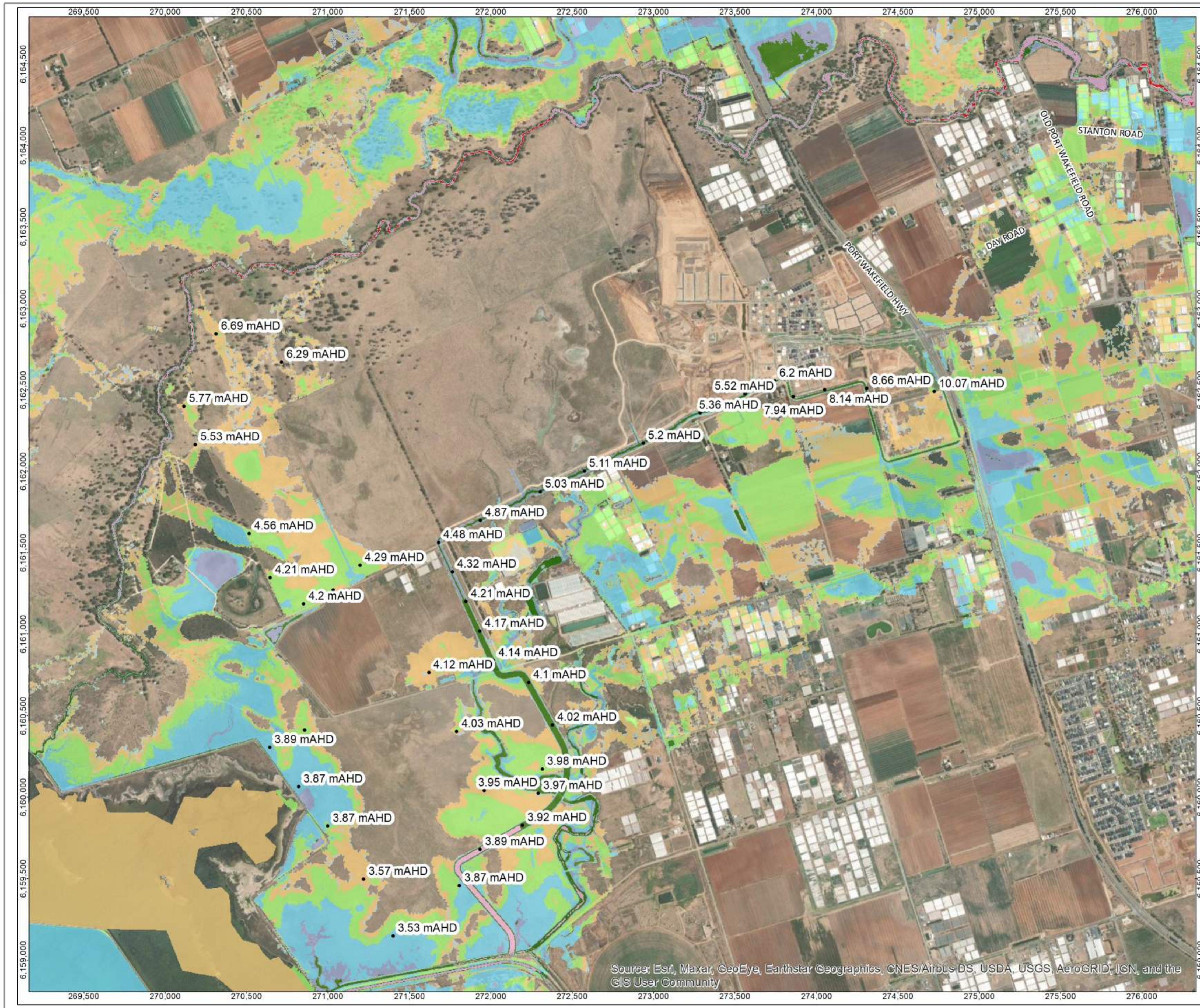
0 250 500 1,000 Meters

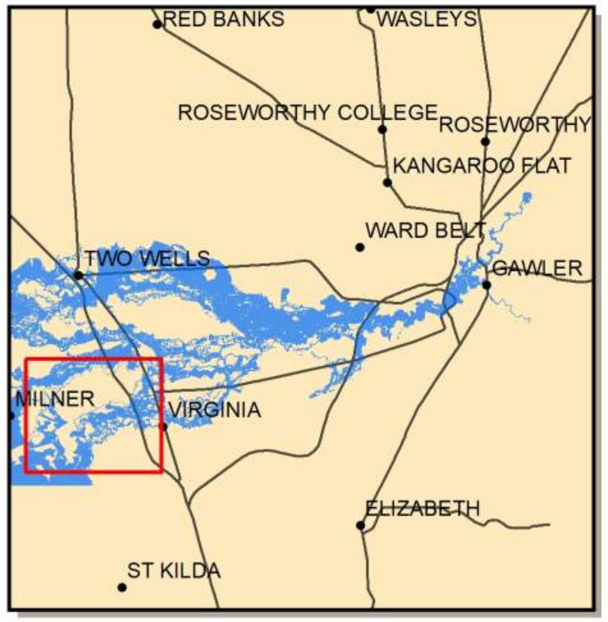
Coordinate System: GDA 1994 MGA Zone 54 1:17,000at A3

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Developed Conditions 1% AEP Depth
Riverlea Development Site

REFERENCE: A3L_wInset_Riverlea_Dev_1AEP_DEPTH_v3_w_WSEpts
DATE: 2/11/2022
SHEET: 1 of 1
DRAWING NUMBER: 1





Legend

• Water surface elevation at point

Depth, m

- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2.5
- 2.5 - 5
- Greater than 5

NOTE
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Contains PLB Images, https://maps.sa.gov.au/SAPPA/

0 250 500 1,000 Meters

Coordinate System: GDA 1994 MGA Zone 54

1:25,000 at A3

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Developed Conditions 1% AEP Depth

Riverlea Development Site

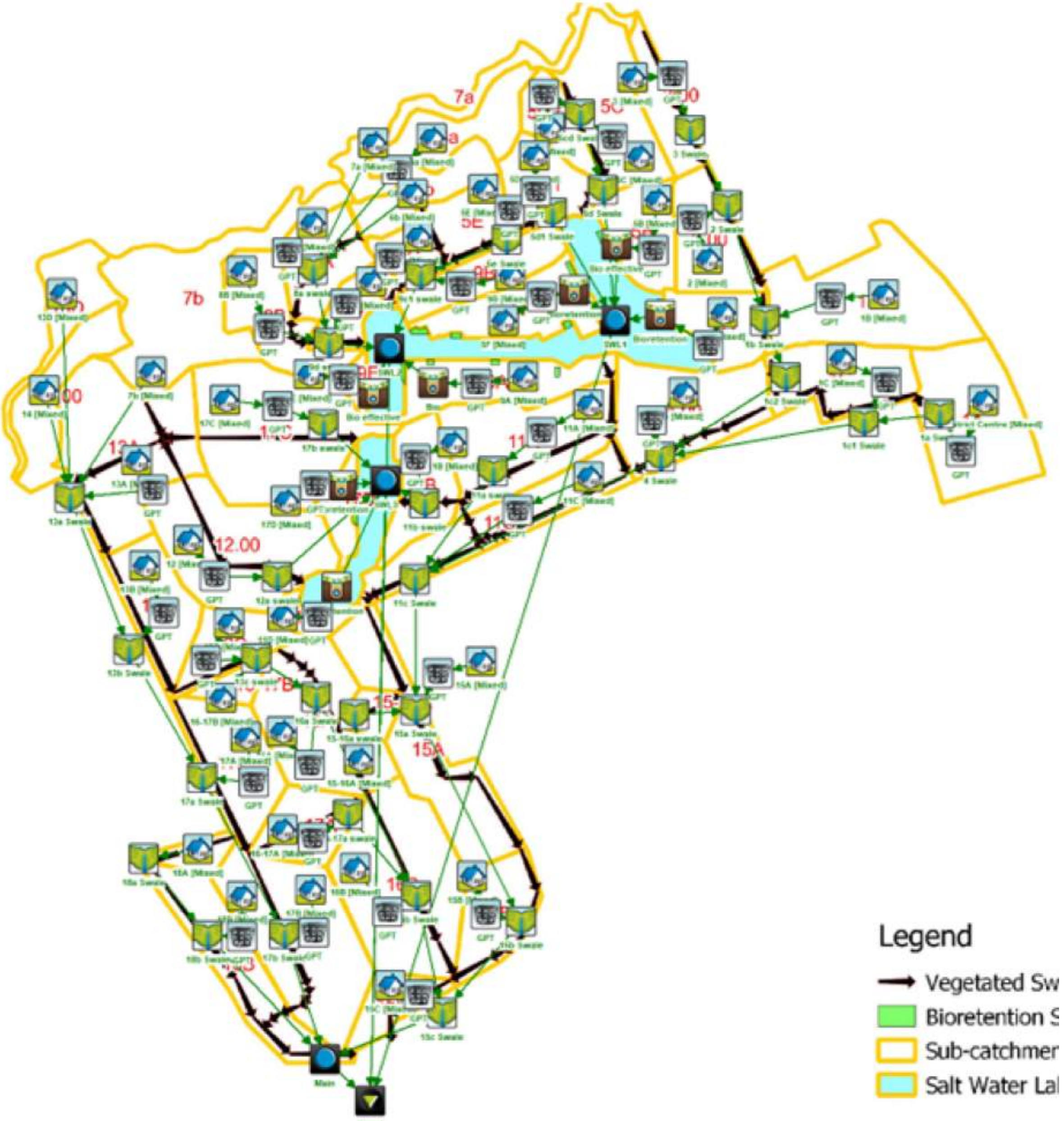
REFERENCE: A3L_w/inset_Riverlea_Ex_1AEP_DEPTH-2

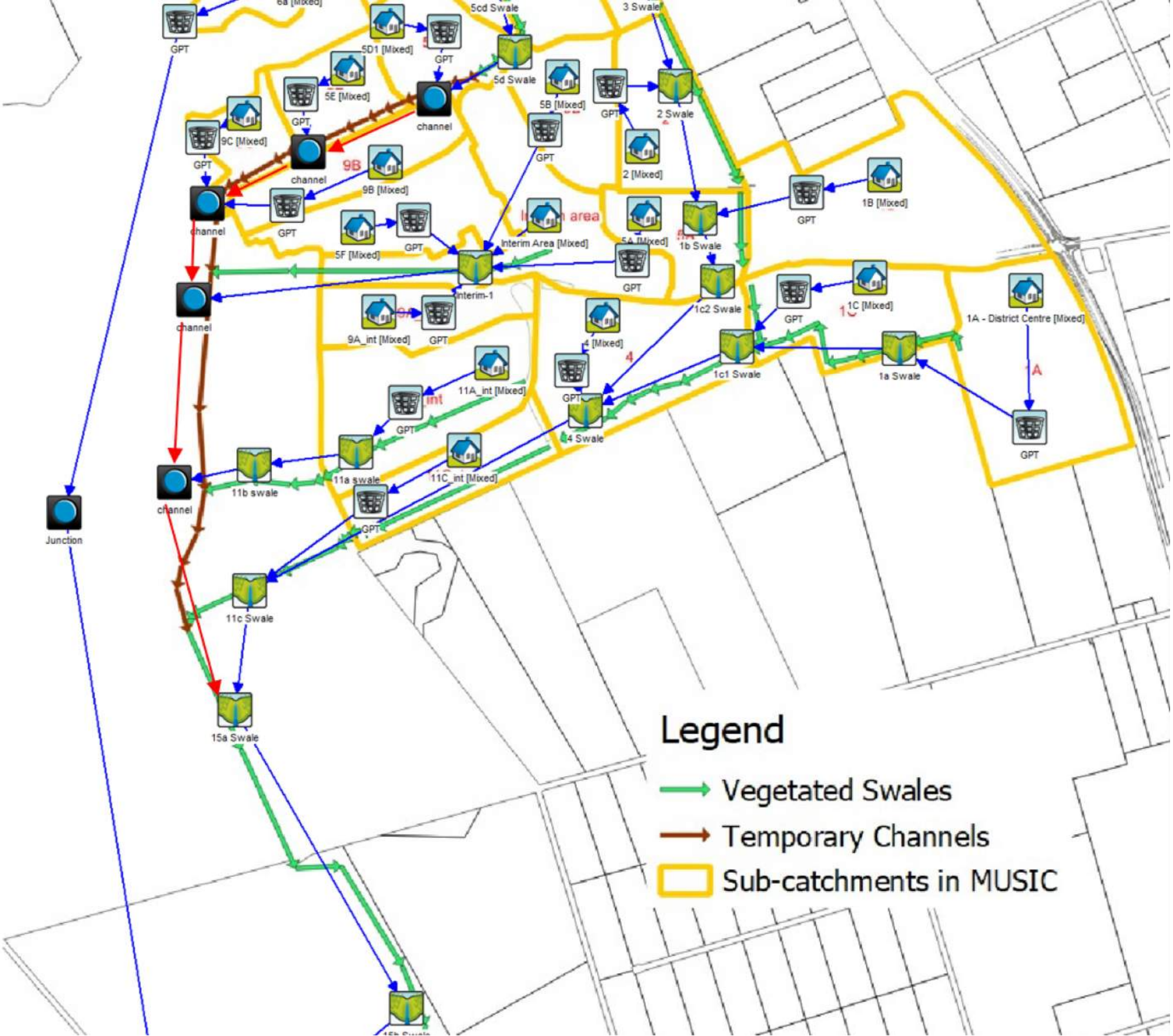
DATE:

SHEET: 1 of 1

DRAWING NUMBER: 1

APPENDIX D
MUSIC MODEL SCHEMATICS

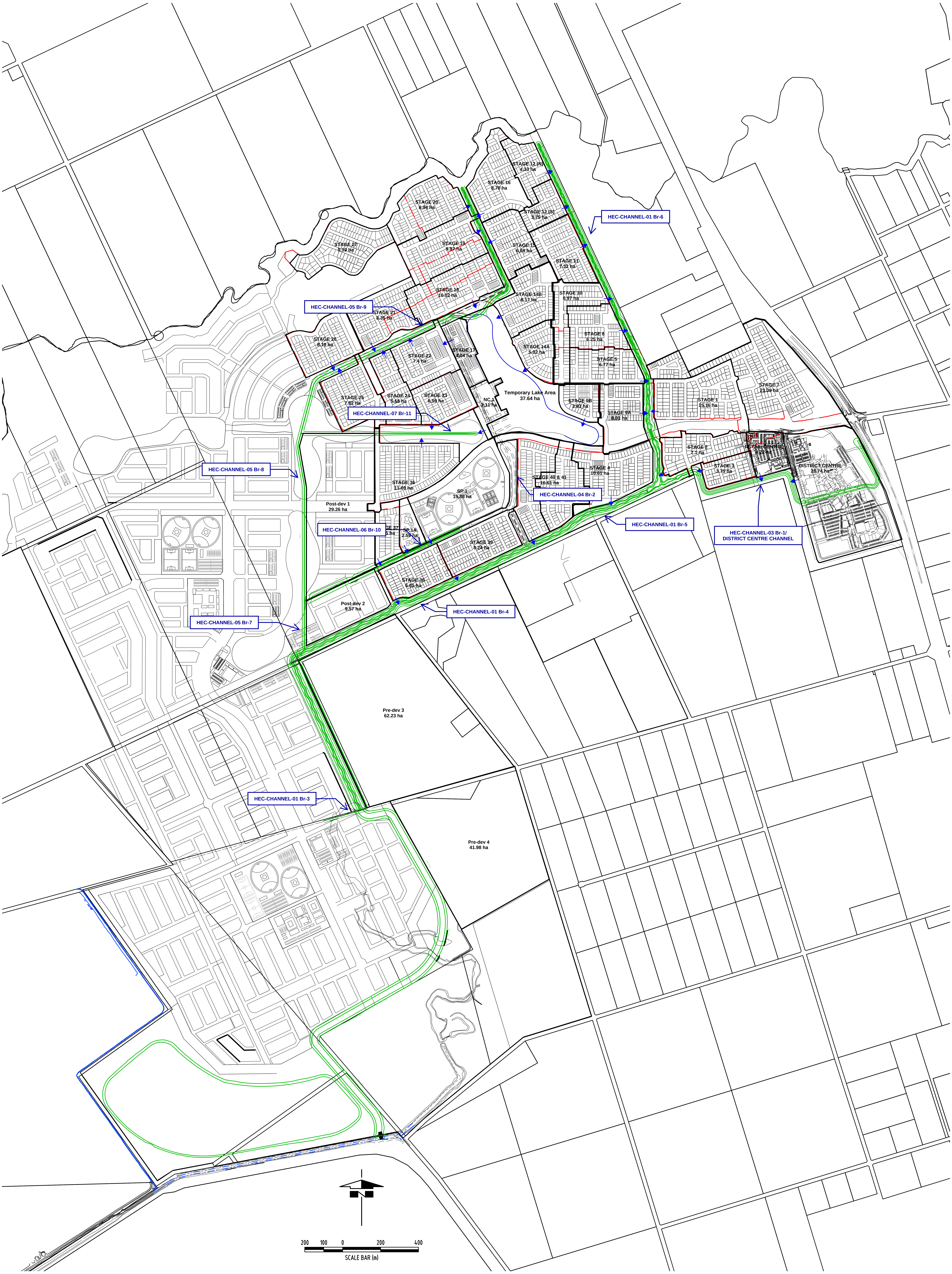

7a
7b
12.00
Legend
Vegetated Sw
Bioretention S
Sub-catchmer
Salt Water Lal



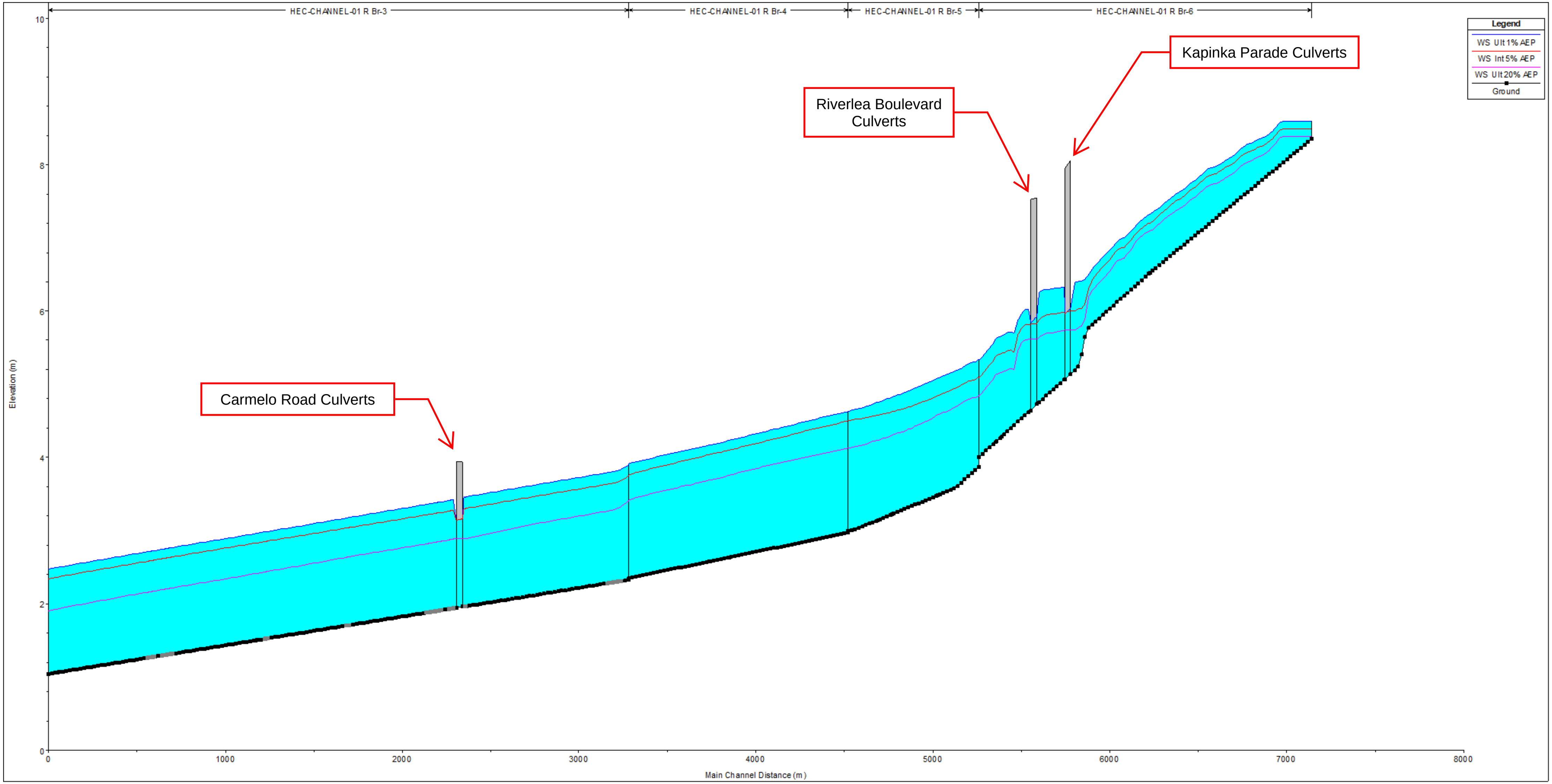
6a [Mixed]
5cd Swale
3 Swale
GPT
5D1 [Mixed]
5d Swale
5E [Mixed]
5B [Mixed]
2 Swale
channel
9C [Mixed]
9B
9B [Mixed]
2 [Mixed]
1B [Mixed]
Interim Area [Mixed]
5A [Mixed]
1b Swale
5F [Mixed]
Interim-1
1c2 Swale
1C [Mixed]
1A - District Centre [Mixed]
9A_int [Mixed]
4 [Mixed]
1c1 Swale
1a Swale
11A_int [Mixed]
4 Swale
11a swale
11b swale
11C_int [Mixed]
Junction
11c Swale
15a Swale
Legend
Vegetated Swales
Temporary Channels
Sub-catchments in MUSIC

APPENDIX E
HEC-RAS OUTPUTS

CHANNEL LOCATIONS

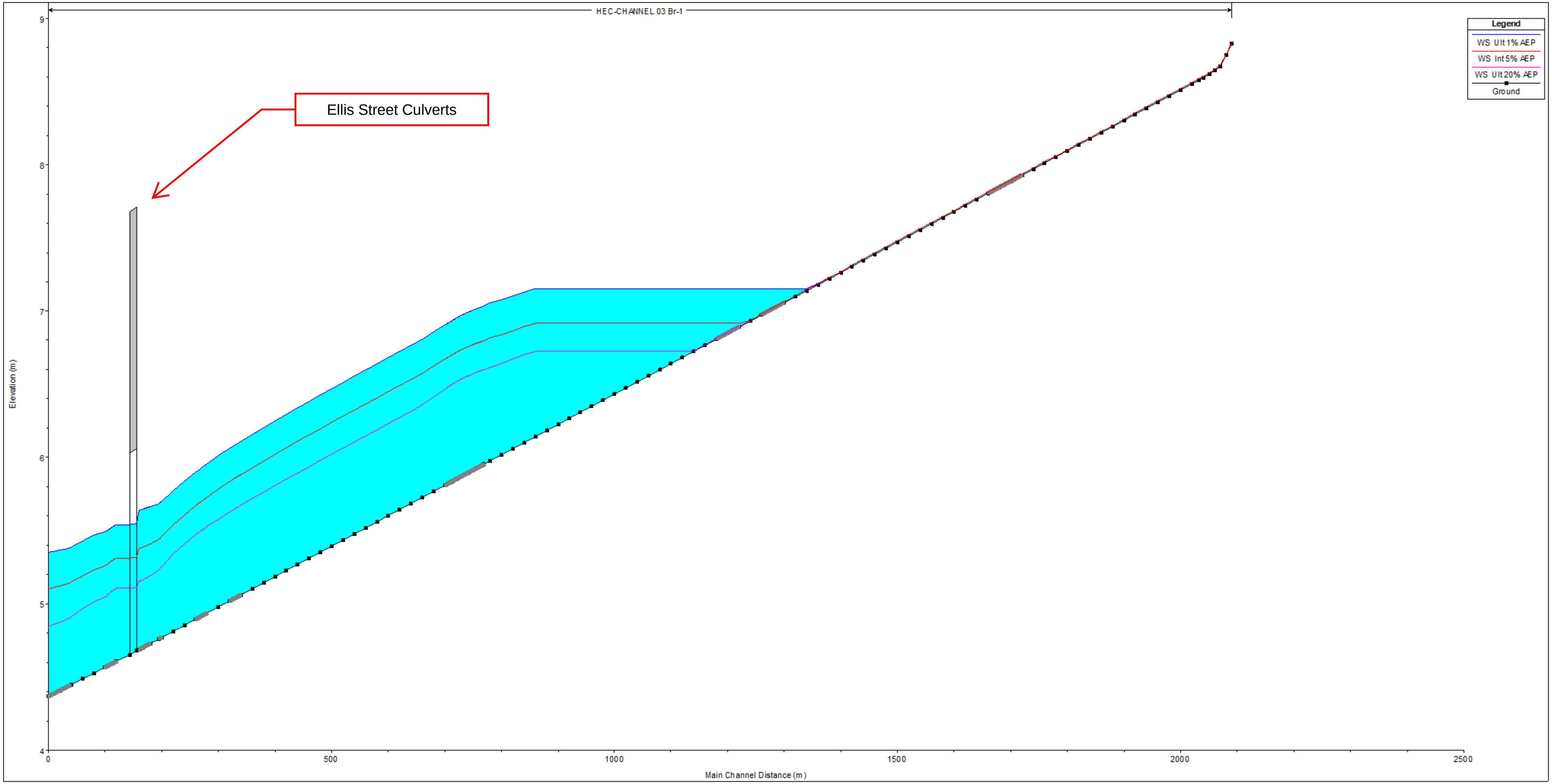


Channel 01 Water Surface Profile



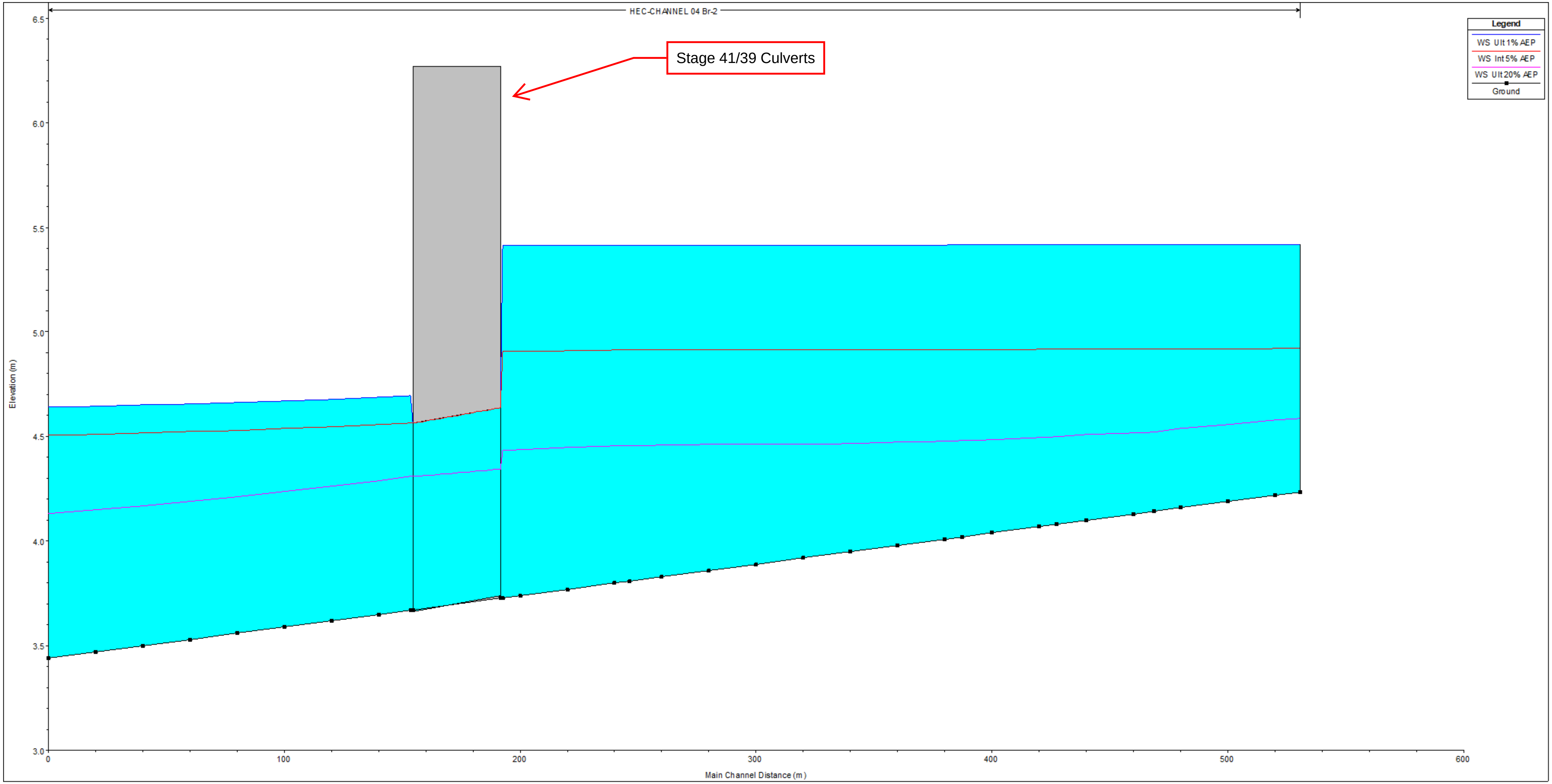
*Refer to drawings for top of bank RLs.

Channel 03/District Centre Channel Water Surface Profile



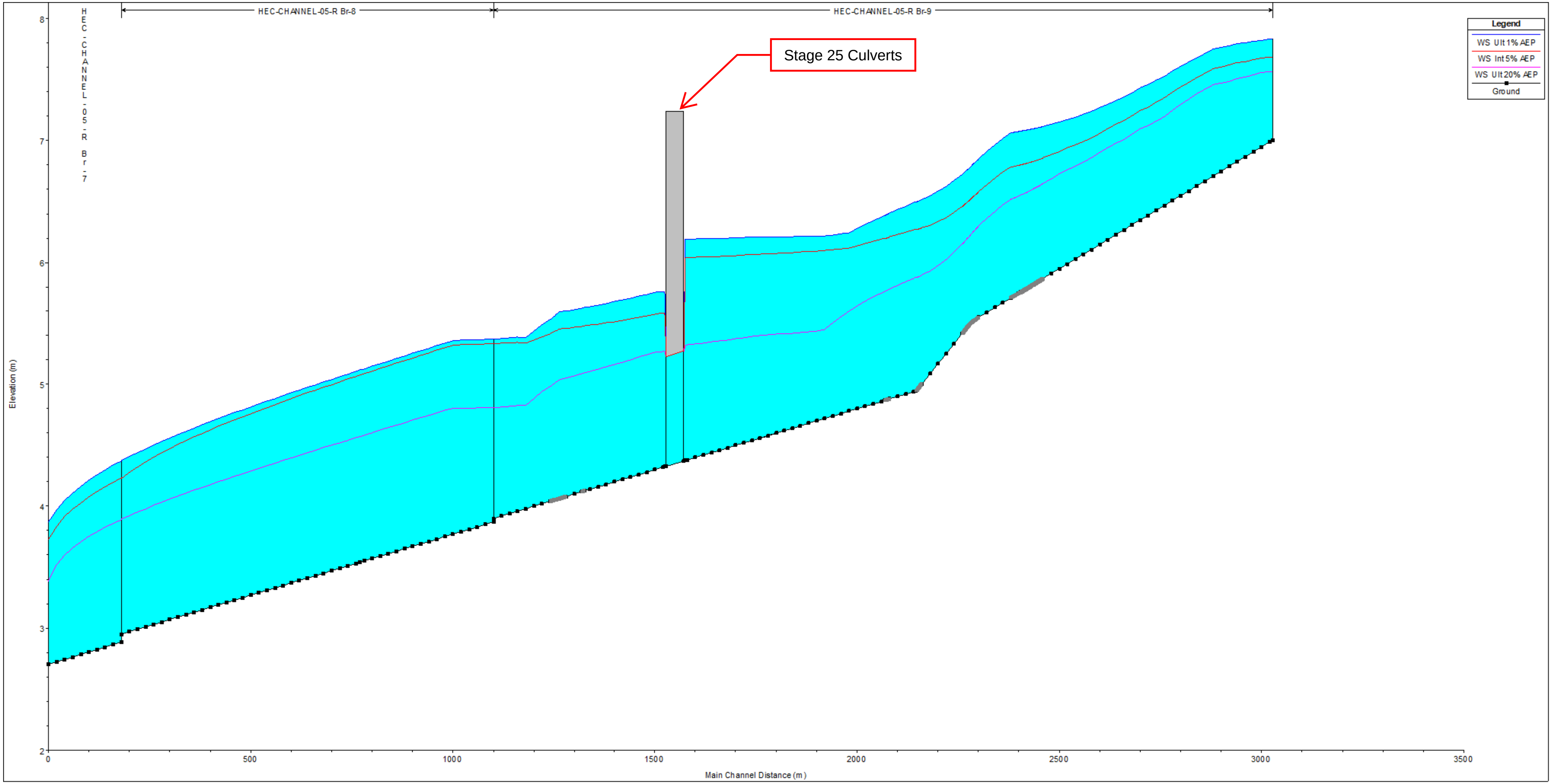
*Refer to drawings for top of bank RLs.

Channel 04 Water Surface Profile



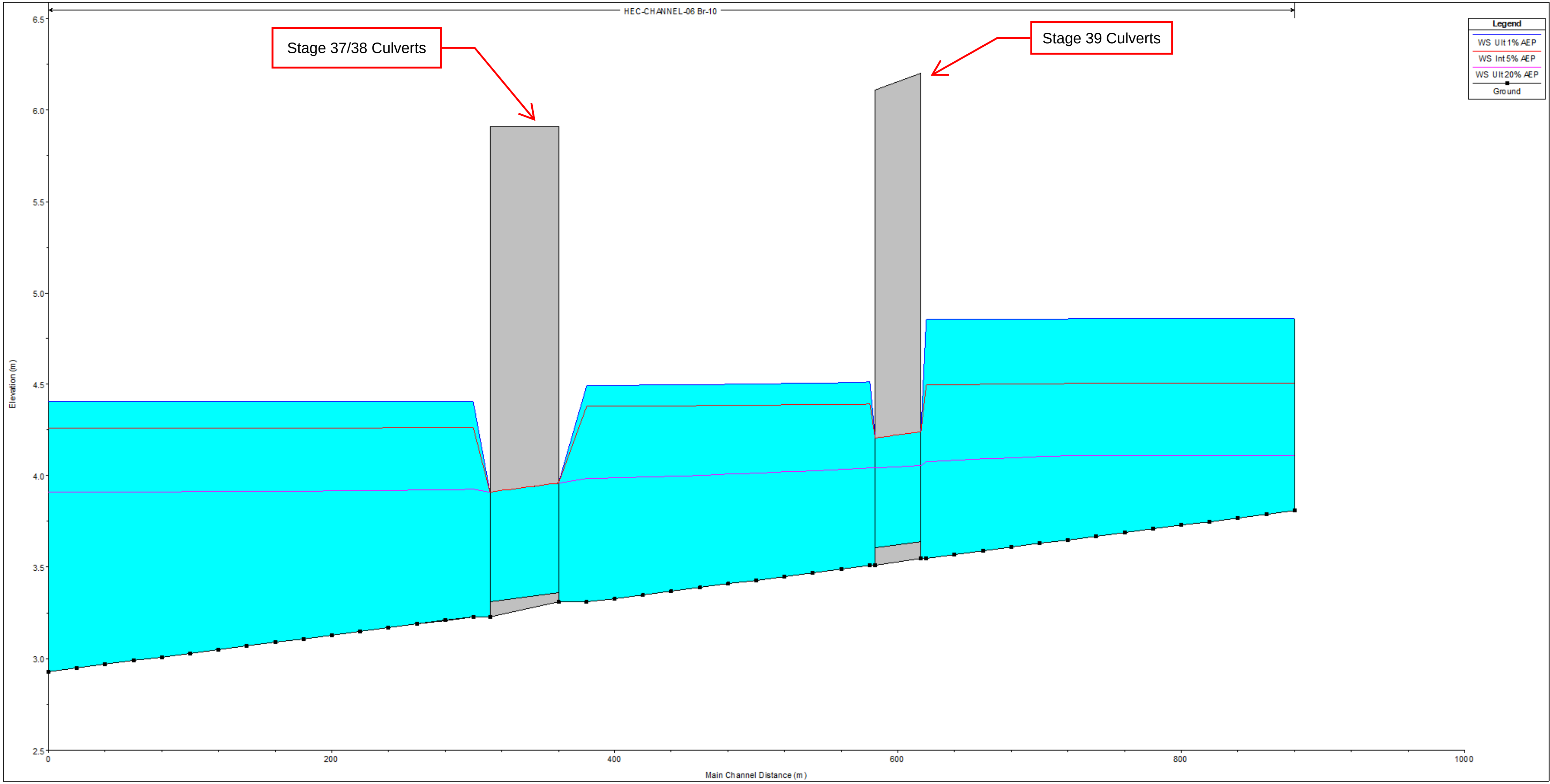
*Refer to drawings for top of bank RLs.

Channel 05 Water Surface Profile



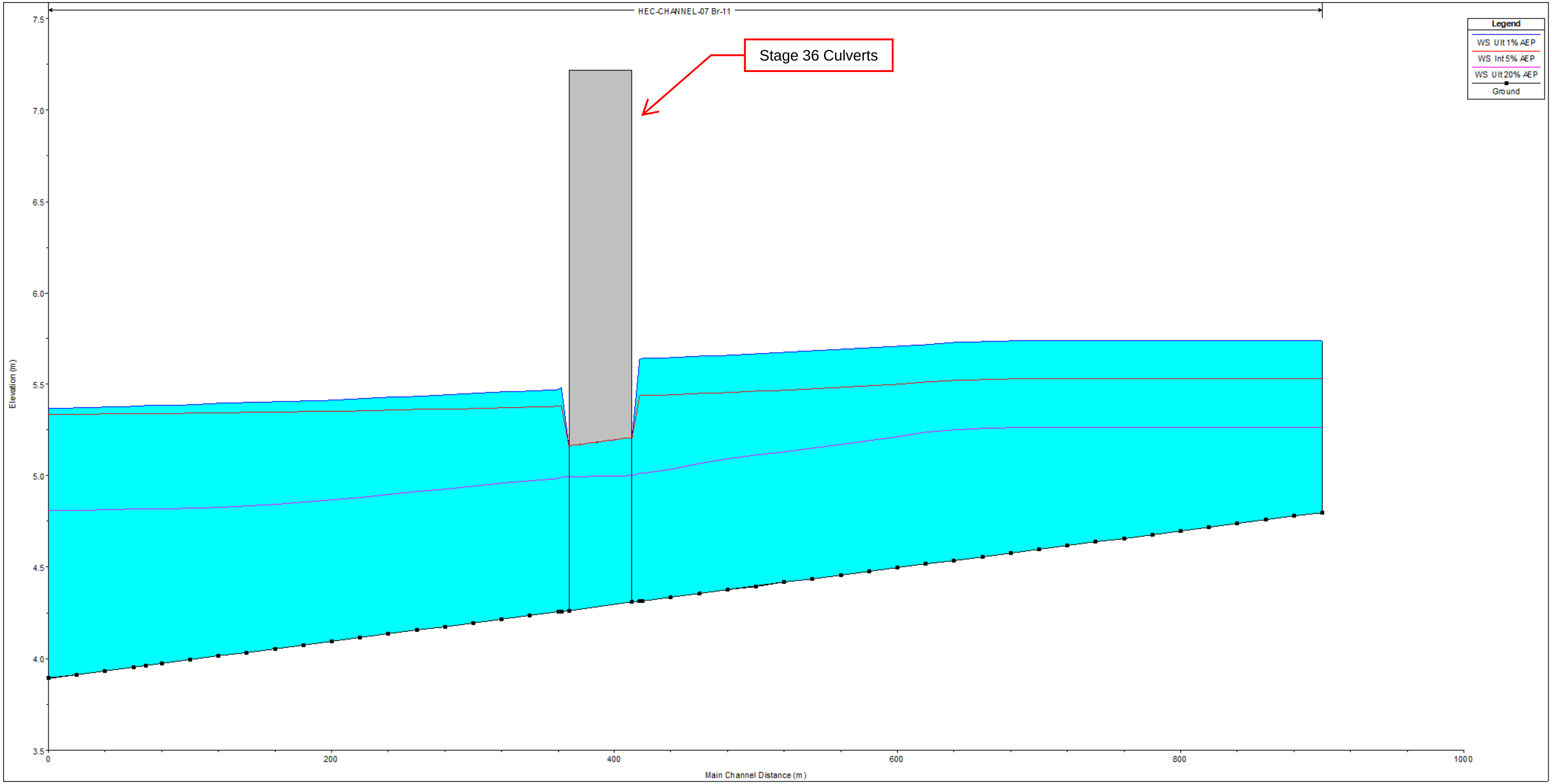
*Refer to drawings for top of bank RLs.

Channel 06 Water Surface Profile



*Refer to drawings for top of bank RLs.

Channel 07 Water Surface Profile



*Refer to drawings for top of bank RLs.

APPENDIX F

CHANNEL EROSION AND SEDIMENT MANAGEMENT PLANS

WGA

RIVERLEA DEVELOPMENT
PRECINCT 2
SEDMP GENERAL ARRANGEMENT

C080163 SK121 A

WGA

RIVERLEA DEVELOPMENT
PRECINCT 2
SEDMP PLAN 1/2

C080163 SK122 A

20 10 0 20 40
SCALE BAR (m)

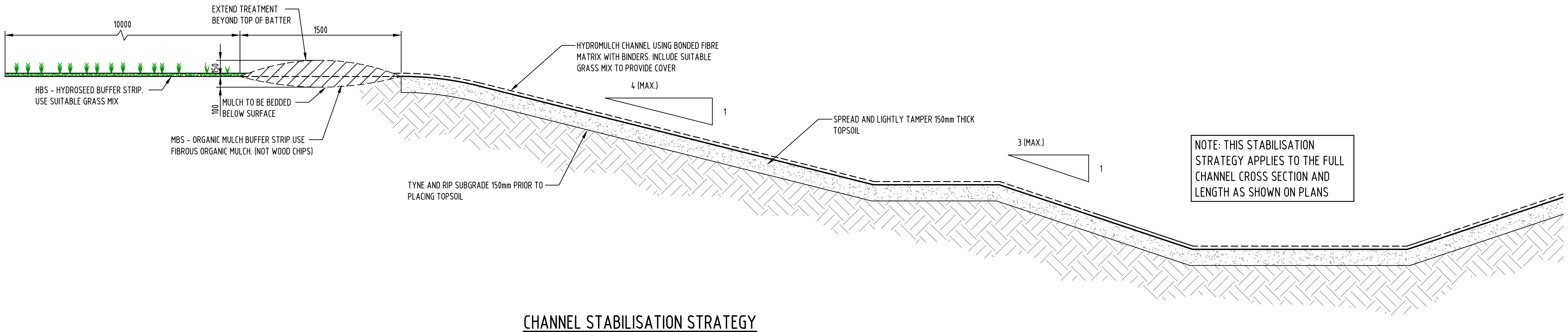
LEGEND:

- MULCH BUFFER STRIP 1.5m WIDE (MBS) OR SILT FENCE
- SEDIMENT TRAP 3.0m W x 10.0m L x 1.0m D (ST)
- SANDBAG CHECK DAM (SBC)
- 10m WIDE OF HYDROSEED GRASS MIX (HBS)
- CHANNEL TO BE STABILISED. RIP / TYNE SUBGRADE PLACE TOPSOIL HYDROMULCH WITH GRASS SEED MIX. REFER TO CROSS SECTION DETAIL ON SHEET SK124
- CHANNEL SECTION TO BE LANDSCAPED

NOTES:

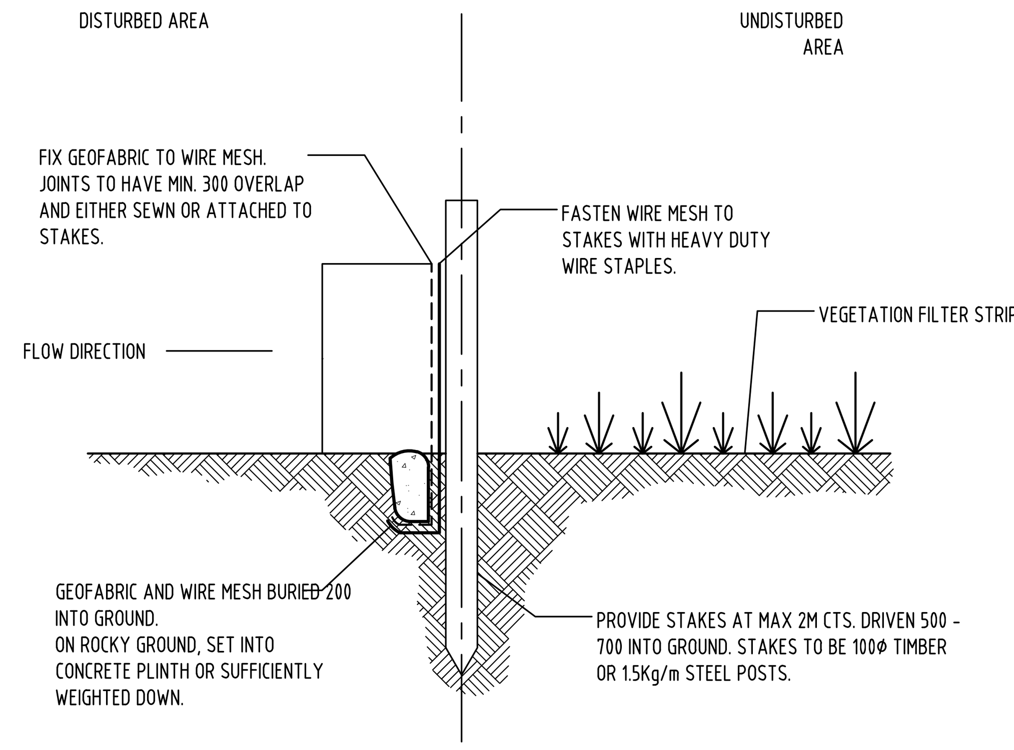
ALL MANAGEMENT MEASURES SHALL BE CONFIRMED ON SITE AS THESE WILL DEPEND ON STATUS OF EARTHWORKS AND ROAD CONSTRUCTION. SOME TECHNIQUES MAY THEREFORE NOT BE REQUIRED


WGA
RIVERLEA DEVELOPMENT
PRECINCT 2
SEDMP PLAN 2/2
C080163 SK123 A
20 10 0 20 40
SCALE BAR (m)
LEGEND:
MULCH BUFFER STRIP 1.5m WIDE (MBS) OR SILT FENCE
SEDIMENT TRAP 3.0m W x 10.0m L x 1.0m D (ST)
SANDBAG CHECK DAM (SBC)
10m WIDE OF HYDROSEED GRASS MIX (HBS)
CHANNEL TO BE STABILISED. RIP / TYNE SUBGRADE PLACE TOPSOIL HYDROMULCH WITH GRASS SEED MIX. REFER TO CROSS SECTION DETAIL ON SHEET SK124
CHANNEL SECTION TO BE LANDSCAPED
NOTES:
ALL MANAGEMENT MEASURES SHALL BE CONFIRMED ON SITE AS THESE WILL DEPEND ON STATUS OF EARTHWORKS AND ROAD CONSTRUCTION. SOME TECHNIQUES MAY THEREFORE NOT BE REQUIRED
S10
x90
S08
x91
S05
x85
S06b
x28
S09B
x60
S09a
x93
WINDMILL CIRCUIT
CARISSA AVENUE
KINGFISHER DRIVE
SEDGE STREET
CYPERUS STREET
WORCESTER PLACE
POWICK STREET
HAMILTON STREET
EASTBOURNE STREET
WILTSHIRE GROVE
LAURISTON GROVE
OSPREY DRIVE
KAPINKA PARADE
BONNEY LOOP
HAWDON LANE
ELIZA LANE
COORONG CIRCUIT
NEWLAND STREET
MACDONNELL STREET
MARCHANT TRAIL
RIVERLEA BOULEVARD
MBS
SBC
ST
GPT



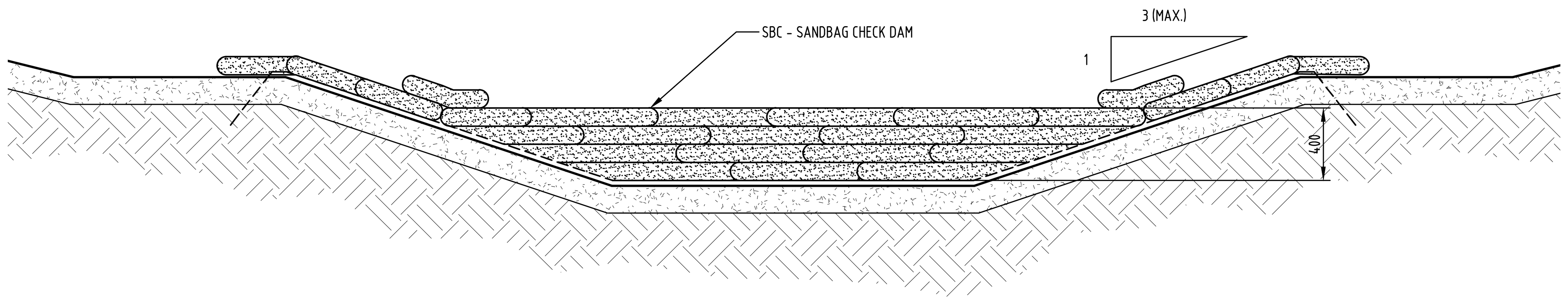
CHANNEL STABILISATION STRATEGY

SCALE 1:25



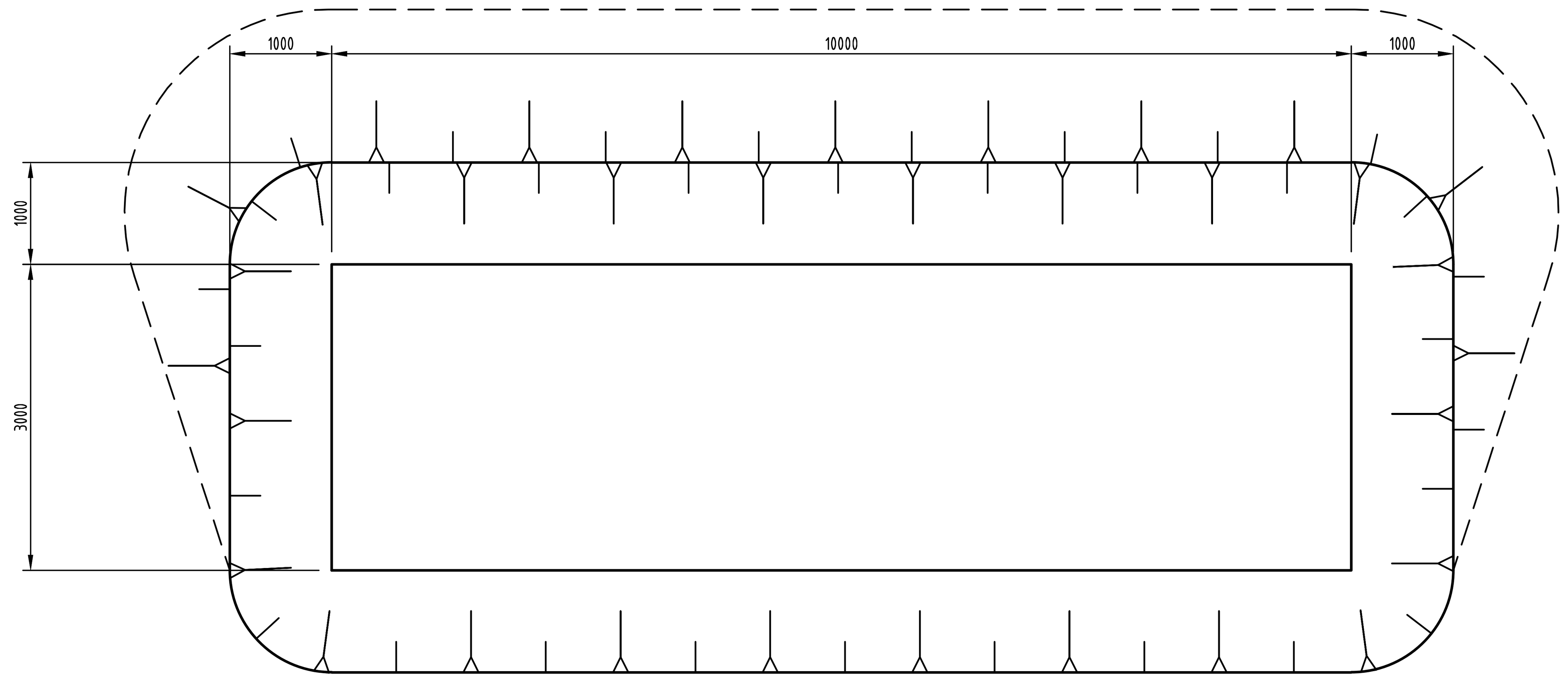
SILT FENCE DETAIL

SCALE 1:20



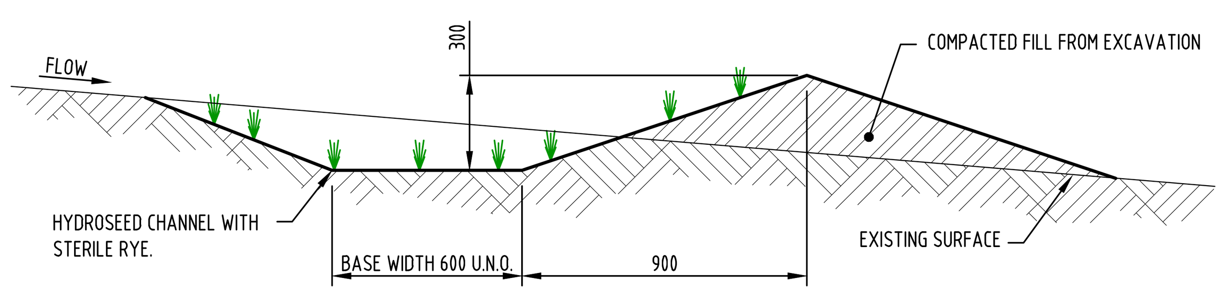
SANDBAG CHECK DAM DETAIL

SCALE 1:25



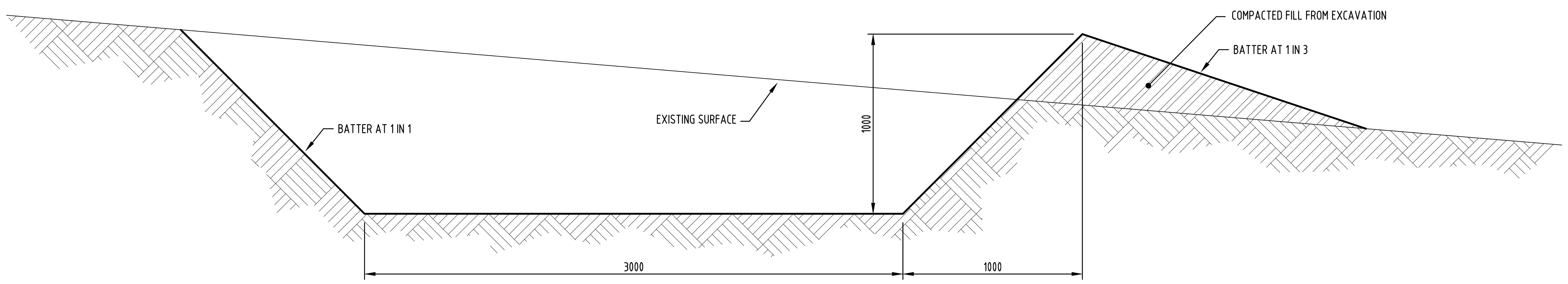
SEDIMENT TRAP PLAN

SCALE 1:50



DIVERSION DRAIN DETAIL

SCALE 1:20



SEDIMENT TRAP SECTION

SCALE 1:20

WGA

RIVERLEA DEVELOPMENT
PRECINCT 2
CHANNEL STABILISATION DETAIL

C080163 SK124 A

FOR FURTHER INFORMATION CONTACT:

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Director

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M 0417 841 948
E dbyrne@wga.com.au

WGA.COM.AU
WGANZ.CO.NZ