



NEILLY GROUP

engineering for the environment

DISTRICT COUNCIL OF LOXTON WAIKERIE

STORMWATER MANAGEMENT PLAN – LOXTON

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Author(s)	Aaroehi Singhel Adrian Crocetti Brent Hennekam Estelle O'Donohue Tyson Blaser
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End User Groups

End user group	Examples identified for this project	Purpose
Strategic decision makers	District Council of Loxton Waikerie, SMA	Forward planning, financial forecasting, service standard setting and compliance
Funding agencies	SMA, landscape boards, Department for Infrastructure and Transport	Funding eligibility
Agencies with statutory responsibilities and powers	Landscape boards, Environment Protection Authority, Department for Infrastructure and Transport, SA Water	Statutory and policy compliance
Community	Community groups, residents	Improve understanding, gaining community support, identify responsibilities, opportunities for involvement
Engineers involved in designing, constructing and maintaining mitigation works	Council engineering, asset management and maintenance staff, consultants, contractors	Technical background and support for further investigations
Emergency management planners	State Emergency Service, Police, council emergency management staff	Coordinate flood risk priorities and responses
Land-use planners (strategic planning and planning controls)	Council development staff, Attorney-General's Department (Planning and Land Use Services), SA Planning Commission	Implement planning reform and compliance requirements
Industry with vested interests in the catchment	Land developers	Identify suitability of and requirements for development of land

Executive Summary

The Loxton Stormwater Management Plan (SMP) has been prepared by Neilly Group for the District Council of Loxton Waikerie to provide a long-term strategy for managing stormwater, reducing flood risk, improving water quality, and strengthening resilience to climate change across the township of Loxton.

The project was delivered through a staged process comprising data collection, baseline assessment, hydrological and hydraulic modelling, water quality assessment, risk analysis, and the development and evaluation of management responses. Collectively, these stages established a robust technical foundation for identifying and prioritising future stormwater management investments.

Stage 1 – Information Compilation

Stage 1 focused on compiling and validating information on the existing stormwater network. A total of 425 drainage pits and 444 pipes were identified, with many assets requiring further inspection to confirm materials, levels, and condition. Existing detention basins were catalogued, although additional investigations were required to confirm storage volumes and capacities. Integration of the 2021 and 2024 LiDAR datasets provided the most representative ground surface for modelling.

Community consultation played an important role in identifying existing drainage issues. Residents highlighted recurring flooding and drainage problems at locations including Bookpurnong Terrace, Drabsch Street, Tobruk Terrace, and Third Street, where blocked drains, undersized infrastructure, and erosion have contributed to ongoing stormwater issues.

Stage 2 – Baseline Assessment of the Catchment

Stage 2 provided a comprehensive assessment of Loxton's 2,080-hectare catchment, including land use, topography, hydrology, and existing drainage infrastructure. The township is generally flat, with numerous local depressions that have limited natural drainage to the River Murray, increasing susceptibility to localised flooding. Approximately one-third of the catchment is urbanised, 40% is used for agriculture, and the remainder comprises reserves, recreation areas, and vacant land.

The assessment confirmed that much of the stormwater network was constructed before the 1970s and is approaching the end of its service life. Assets in locations such as East Terrace and Kokoda Terrace, dating back to the 1950s, are showing signs of deterioration and reduced hydraulic performance.

Climate change was identified as a significant future challenge. Although average annual rainfall is projected to decline, rainfall events are expected to become more intense, increasing the frequency and severity of flash flooding. Increased drought frequency, evapotranspiration, and bushfire risk will also place greater pressure on water resources and infrastructure.

To support future decision-making, an integrated modelling framework was developed using DRAINS for hydrological modelling and TUFLOW for hydraulic analysis. The modelling represents existing conditions together with future development scenarios identified in the Loxton Waikerie Growth Strategy and incorporates climate change projections to 2090, ensuring that proposed management responses remain effective under a range of future scenarios.

Stage 3 – Identification of Stormwater Management Risks and Issues

Flood Modelling

Flood modelling confirmed many of the issues identified during community consultation. Flash flooding occurs in depressions throughout the township, particularly along Bookpurnong Terrace, Tobruk Terrace, Drabsch Street, and Mill Road. Future urban growth is expected to alter natural flow paths and increase runoff volumes unless supported by detention basins, swales, and other Water Sensitive Urban Design (WSUD) measures. The modelling also identified an increased risk of coincident stormwater and riverine flooding, particularly in areas adjacent to the River Murray floodplain.

Water Quality Modelling

Water quality modelling was undertaken using MUSIC to assess pollutant loads and identify opportunities to improve stormwater quality. The assessment found that runoff from agricultural, residential, and commercial areas transports significant loads of sediments, nutrients, and other pollutants to the River Murray, affecting water quality and aquatic ecosystems.

The assessment also identified opportunities to expand Water Sensitive Urban Design (WSUD) throughout the township to improve stormwater treatment, reduce pollutant loads, and support stormwater harvesting and reuse. These opportunities complement planned upgrades to the Loxton Wastewater Treatment Plant, which are expected to provide approximately 200 ML/year of recycled water and reduce reliance on potable water supplies.

Risk Assessment

Flood risks were assessed under four scenarios representing existing and future development conditions during both minor and major storm events. Risks were categorised as safety, operational, strategic, regulatory, and reputational, and prioritised using a consequence-likelihood framework.

The assessment demonstrated that, without intervention, both the frequency and severity of flood risks will increase as the township grows. Mapping of key risks—including road closures, property damage, public safety hazards, and impacts on sensitive environmental assets—provides a sound basis for prioritising future investment and stormwater management actions.

Stage 4 – State of Catchment

Stage 4 synthesised the findings from the preceding investigations into a comprehensive State of Catchment assessment. The report consolidated information on:

- existing conditions;
- key flood risks;
- flood modelling outcomes;
- water quality outcomes; and
- future challenges.

Stage 4 established the evidence base for developing the stormwater management objectives, performance targets, and preferred management responses.

Stage 5 – Stormwater Management Objectives and Targets

A series of stormwater management objectives and performance targets were established to guide future decision-making. Targets were categorised as either absolute or aspirational and are intended to support sustainable stormwater management outcomes that protect the community, enhance environmental values, and align with regional and state planning frameworks.

Stage 6 – Stormwater Management Responses

A range of stormwater management responses were developed and assessed against the adopted objectives and performance targets. Responses were grouped into solution sets based on common catchment characteristics, drainage behaviour, flow paths, and discharge locations. These were reviewed with Council and the SMP Steering Committee to identify preferred management responses for further assessment.

Stage 7 – Preferred Management Responses

The preferred management responses identified during Stage 6 were further developed and evaluated to determine the most effective and practical solutions for implementation. Each preferred management response was assessed through:

- flood modelling to quantify flood risk reduction;
- water quality modelling to assess environmental benefits;
- assessment of broader social, environmental, and community outcomes;
- risk reduction assessment;
- cost–benefit analysis; and
- Multi-Criteria Analysis (MCA) to prioritise investment.

Implementation of the preferred management responses will deliver a more resilient, efficient, and sustainable stormwater system for Loxton. The recommended strategy will reduce flood risk, improve water quality, enhance community amenity, support future growth, and protect the environmental values of the River Murray and the surrounding catchment.

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Acronyms

Acronym	Meaning
ABS	Australian Bureau of Statistics
AEP	Annual Exceedance Probability
AIDR	Australian Institute for Disaster Resilience
AR5 (& AR6)	Fifth (and Sixth) Assessment Report [by the IPCC]
ARR	Australian Rainfall & Runoff (version 4.2)
ASR	Aquifer Storage and Recovery
BOM; The Bureau	Bureau of Meteorology
CCRM	Climate Change Rainfall Modifier
CCTV	Closed-Circuit Television
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCIA	Directly Connected Impervious Area
DCLW	District Council of Loxton Waikerie
DEM	Digital Elevation Model
DU	Deferred Urban
EOC	Emerging Organic Contaminants
EPBC	Environment Protection and Biodiversity Conservation
EY	Exceedances per Year
GL	Gigalitres
GPT	Gross Pollutant Trap
IFD	Intensity-Frequency-Duration
IL	Invert Level
IL-CL	Initial Loss – Continuing Loss
INFFEWS	Investment Framework for Economics of Water Sensitive Cities
IPCC	Intergovernmental Panel on Climate Change
JB	Junction Box
LiDAR	Light Detection And Ranging
MDBA	Murray-Darling Basin Authority
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
NWL	Nominal Water Level
RCP	Representative Concentration Pathways
RIA	Remaining Impervious Area
SAPPA	South Australian Property & Planning Atlas
SEP	Side Entry Pit
SGS	Sub Grid Sampling
SMP	Stormwater Management Plan
SSP	Shared Socio-economic Pathway
P&D	Planning and Design
PMST	Protected Matters Search Tool
PWC	Prescribed Water Courses
VC1 to VC6	Value Class (1-6)
WAP	Water Allocation Plan
WSUD	Water Sensitive Urban Design

1. Introduction

The District Council of Loxton Waikerie (DCLW) commissioned Neilly Group to undertake a Stormwater Management Plan (SMP) to establish a cohesive framework for stormwater control throughout the town of Loxton. The SMP provides a strategic approach to addressing existing drainage and flooding issues, improving stormwater quality, enhancing community resilience to climate change, and supporting sustainable urban growth. The SMP outlines a structured approach for the development Loxton's urban centre that protects the environmental values of the River Murray and its surrounding catchment.

Loxton's urban centre lies elevated above the River Murray on a crest. The township is surrounded by floodplain lining the river and undulating sands that stabilise with distance inland. The combination of varied topography, ageing drainage infrastructure, changing land use, and increasing development pressure presents a range of complex stormwater management issues. Intense rainfall events can result in localised flooding, while stormwater runoff has the potential to transport pollutants to downstream receiving environments. With climate change expected to increase the frequency and intensity of short-duration storm events, the existing stormwater system is likely to face additional demands, reinforcing the importance of resilient and adaptable infrastructure.

The SMP has been prepared to guide the long-term management of stormwater-related challenges through an evidence-based approach. It documents the key constraints and deficiencies affecting the existing stormwater network, considers both current and future flood risk, and examines opportunities to improve stormwater quality and reuse.

The plan also outlines a prioritised suite of structural nature-based and management responses intended to reduce risks to people and property, improve water quality outcomes, strengthen community amenity, and allow for future growth in a manner that remains environmentally and economically sustainable.

Development of the SMP followed a detailed and staged methodology. This included the:

- collection and verification of data
- assessment of the catchment
- hydrological and hydraulic modelling
- water quality modelling
- flood risk assessment
- engagement with stakeholders, and:
- review of potential management responses.

The software modelling tools used were:

- DRAINS was used for hydrological modelling
- TUFLOW for hydraulic modelling, and
- MUSIC for water quality assessment.

These tools allowed the existing stormwater system and proposed responses to be tested against existing conditions, future development scenarios, and projected climate change conditions through to 2100.

The preferred management responses were assessed through a combination of flood modelling, water quality modelling, risk reduction assessment, cost–benefit analysis, and Multi-Criteria Analysis (MCA). These assessments collectively provide a robust approach to investment prioritisation and the delivery of practical, cost-effective measures that will improve the resilience and long-term performance of Loxton’s stormwater system.

This Stormwater Management Plan gives Council a strategic basis for future planning, infrastructure investment, maintenance planning, and funding applications. It provides a clear direction for progressively improving stormwater management outcomes, reducing flood risk for the community, protecting the health of the River Murray, and supporting Loxton’s sustainable development.

2. Baseline Assessment of the Catchment

The baseline assessment provides a detailed overview of Loxton's physical environment, stormwater infrastructure, and community context. It establishes a baseline for future modelling, risk assessments, and strategy development to improve stormwater management and climate resilience.

2.1. Study boundary

The study area for the Loxton Stormwater Management Plan (SMP) is bounded by the River Murray and extends from the boundary of Karoonda Highway and Kingston Road in the west, to southern extent of the town and proposed future growth areas, and north to include Loxton North (Figure 1). This encompasses the main existing and planned developed areas of the town of Loxton, the largest township of the District of Loxton Waikerie (DCLW), with 1,928 dwellings housing 3,947 residents as at the 2021 census (ABS 2021).

The study area covers approximately 2,080 hectares and is made up of several catchments. Despite its proximity to the river, many catchments do not naturally drain to the river, instead the land is predominantly flat, with catchments defined by large depressions in the landscape that have no natural ability to drain.

2.2. Topography and land use

Topography of the study area can be broadly categorised as follows:

- Floodplain areas between river bends, sitting around 10 to 13 mAHD, with little infrastructure apart from the caravan park. The flood plain area is marked in Figure 2 by shades of blue.
- For most of the study area, the land then quickly rises to a crest that varies in height between 24 to 31 mAHD. This area is illustrated in Figure 2 as green. Most infrastructure sits landside of this crest, with very limited infrastructure on the river-side.
- Beyond this crest, land undulates between high points and depressions, ranging between ~45 to 60 m AHD in the western part of the township (red zone in Figure 2), ~33 to 48 m AHD in the central section of the study area (orange zone) and ~25 to 40 m AHD for the north-eastern section (green zone).
- These depressions are typically land-locked and contain the majority of the Council's storage dams.

Land use through the area was sourced from the South Australian Government Data Directory and the Department for Housing and Urban Development's Land Use shapefiles(2022), which are determined based on valuation information for each cadastral boundary and depicts actual land use, rather than zoning.

Land use categories that involve built environments account for approximately 35% of the study area, while agriculture, forestry and farming account for approximately 40%. The remaining 25% accounts for recreation and reserves plus vacant land. Full details can be seen in Figure 3.

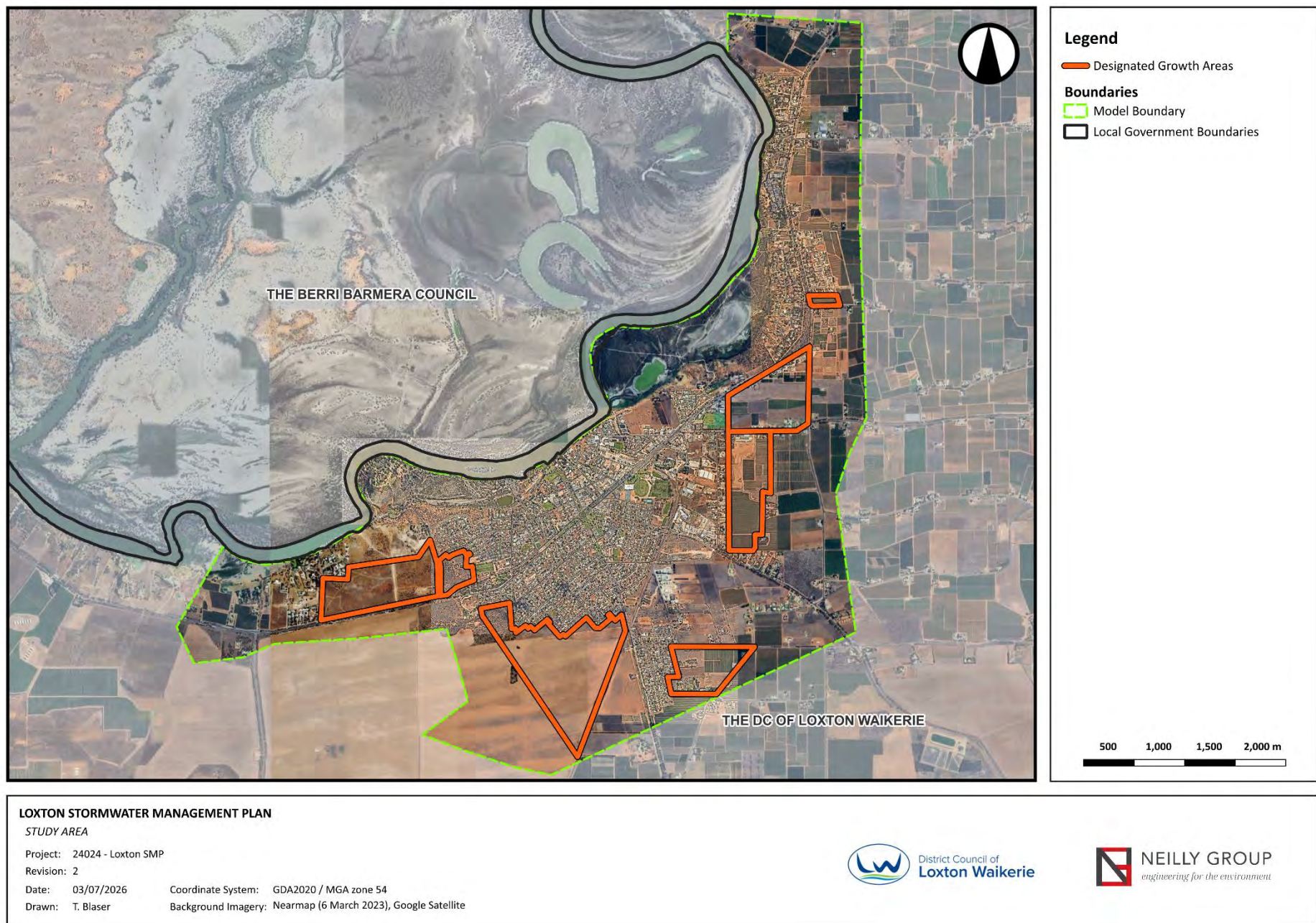


Figure 1. Study Area.

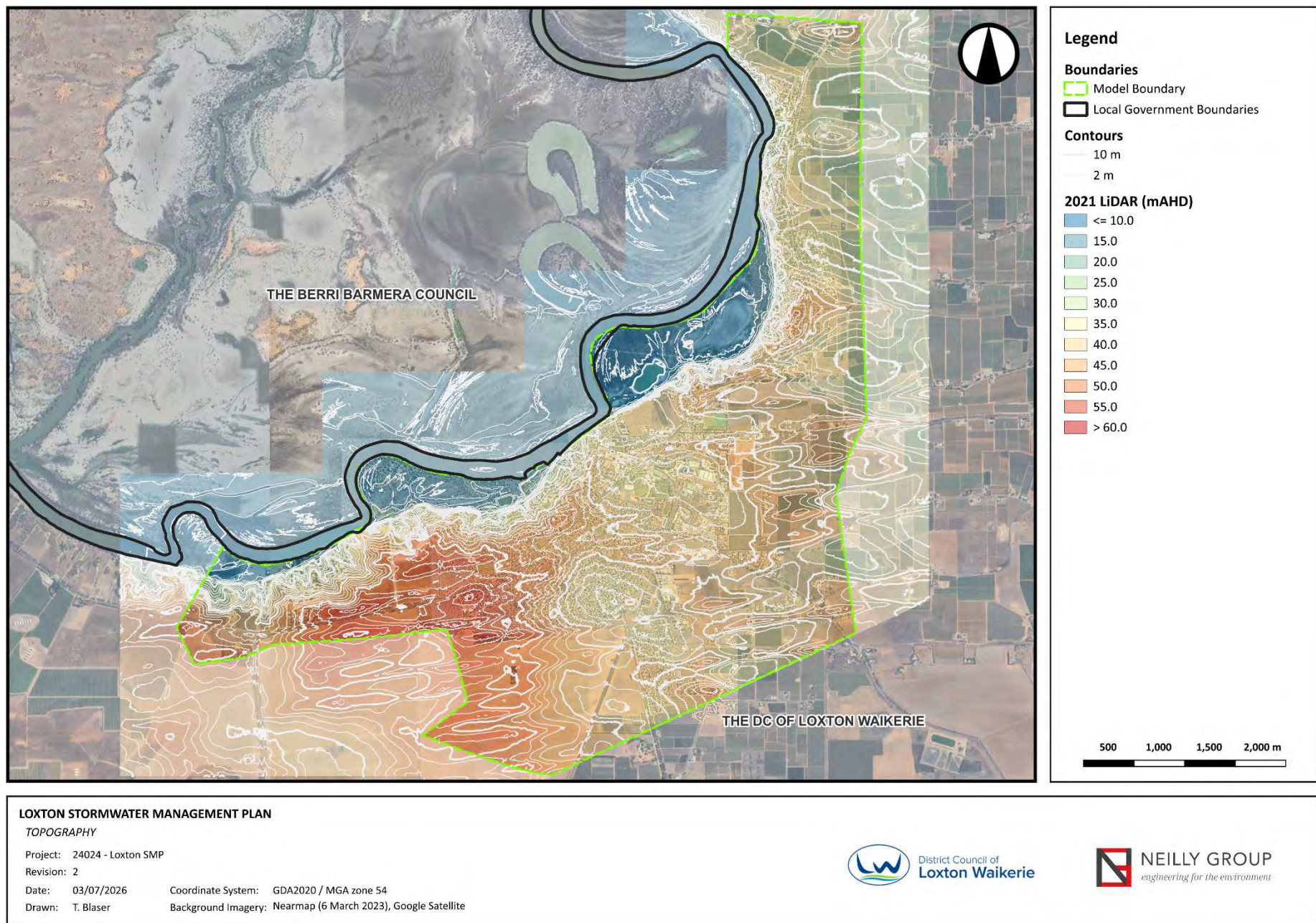


Figure 2. Elevation map.

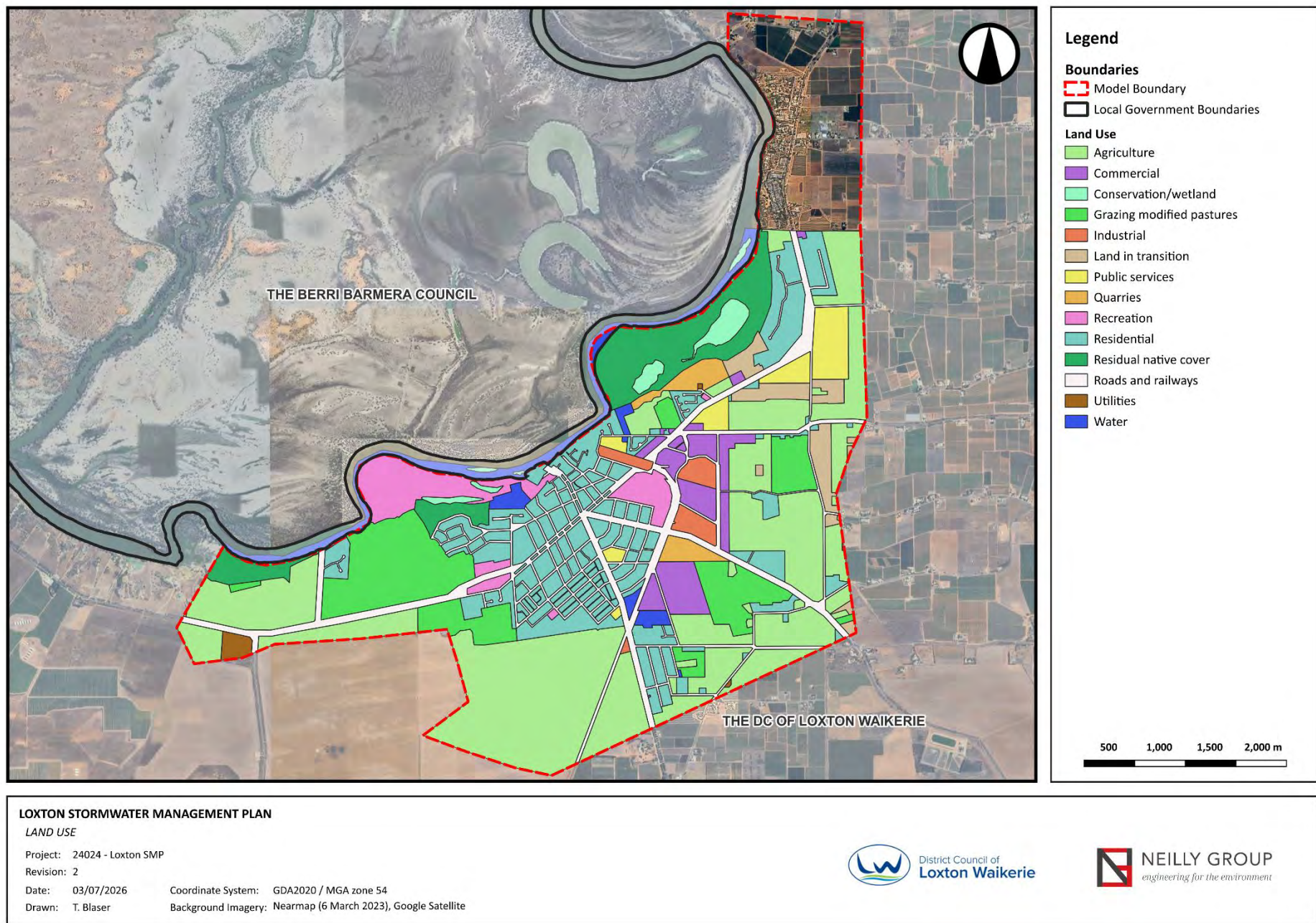


Figure 3. Land use distribution map.

2.3. Geology and soils

The Loxton area sits on the Loxton Sands, deep (calcareous) sands and sandy loams with a calcrete cap. These sands are generally overlain by a layer of Blanchetown clay, with dunes typical of the Woorinen Formation above that (One Basin CRC 2024; DEWNR n.d; Cupper & White 2003), see Figure 4.

The One Basin Cooperative Research Centre (CRC) have identified three aquifers in the Loxton / Berri area with potential for use in Aquifer Storage and Recovery (ASR) operations. They note that:

“The Loxton/Pliocene Sands and Murray Group Limestone aquifers offer the potential for sustainable extraction of brackish groundwater and discharge of desalination brine, based on their stable hydrogeological properties.

...the Murray Group Limestone aquifer and Loxton Sands aquifer can facilitate the extraction and reinjection of water, as they are separated by the Bookpurnong beds. This layer is sufficiently thick and impermeable to prevent connectivity between the aquifers, hence avoiding adverse environmental effects like salt mobilisation or a reduction in water quality...

the lower Murray Group Limestone aquifer is less saline than the upper Loxton/Pliocene sands aquifer. This difference provides the possibility of aquifer reinjection of brine. The Murray Group Limestone aquifer is to be used for extraction (and desalination), with reinjection into the more saline Loxton/Pliocene Sands aquifer. The desalination process concentrates salt in the liquid brine stream. To avoid environmental degradation, brine injection must occur into an aquifer that has a salinity equal to or greater than that of the brine.”

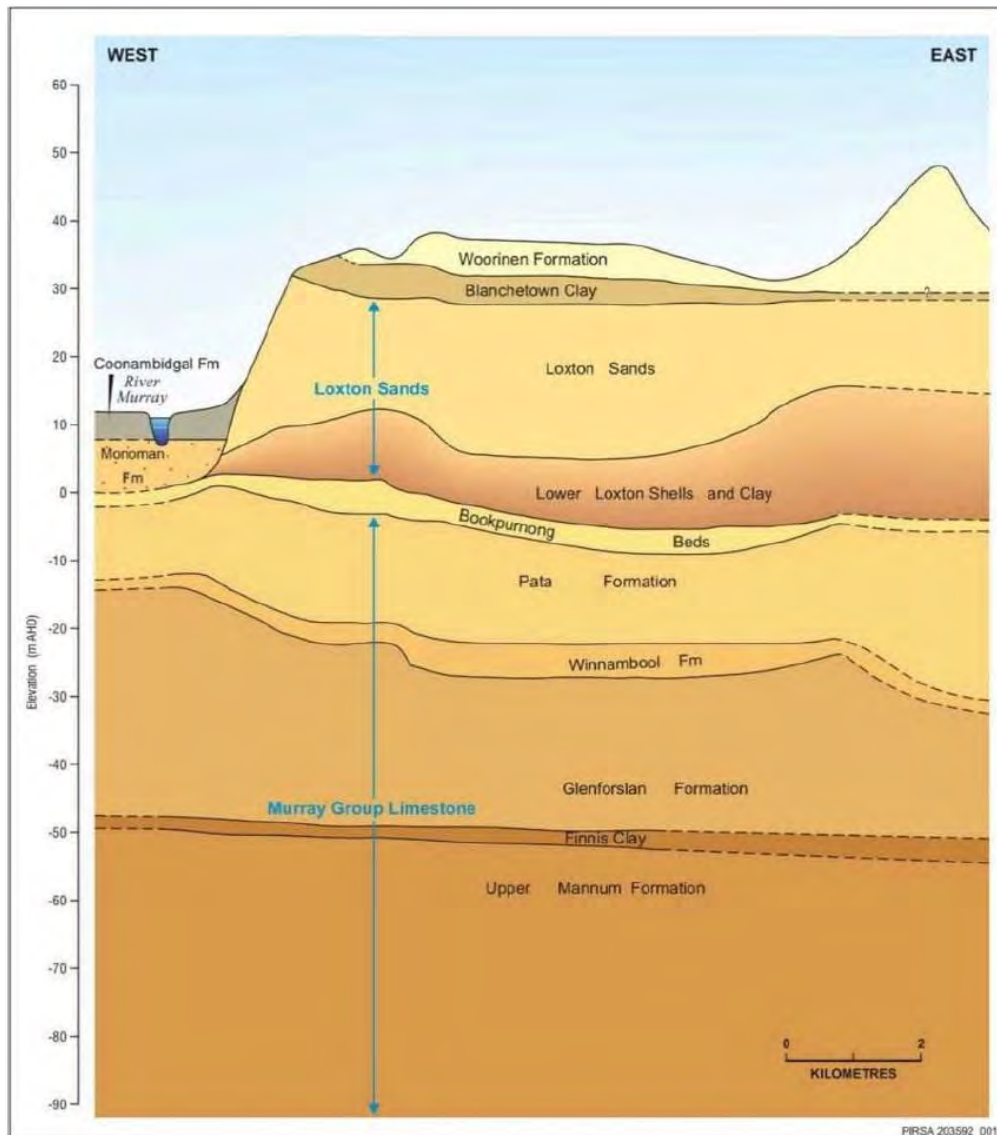


Figure 4. Soil horizons at Loxton (OneBasin CRC).

2.4. Climate and hydrology

Loxton is located within the arid zone of South Australia, with an average annual rainfall of just 260 mm/yr. The Bureau of Meteorology (BOM) has two weather stations that collect daily rainfall values in the vicinity of Loxton: Loxton (Pyap) [Station ID: 024013] which has been operating since 1896, and Loxton Research Centre [Station ID: 024024] which has been operating since 1984. Both have high levels of completeness and quality rating across their full range.

The Loxton (Pyap) station has almost 125 years of data, and shows that 24-hr IFD's (Intensity-Frequency-Duration) have not been reached as frequently as expected (see Table 1), which suggests they should perhaps be revised down, and therefore flood modelling using these design values may overestimate flood impacts.

Table 1. Number of occurrences that IFD values have been exceeded within the 125-year record.

Event	Threshold (mm)	No. occurrences (no. expected)	Years reached
1EY (63.2% AEP)	28.1	115 (125)	(not calculated)
0.5EY	35.9	48 (62)	(not calculated)
20% AEP	46.7	21 (25)	1906, 1908 , 1910, 1913 (x2) , 1917, 1941 , 1946, 1950 (x2) , 1957, 1961, 1973, 1996, 2010 (x2) , 2011 (x2) , 2014, 2017 (x2) .
10% AEP	57.5	6 (12)	1910, 1913 , 1917, 1946 , 2010, 2014
5% AEP	68.9	2 (6)	1917 , 2010
2% AEP	85.7	1 (2)	2010
1% AEP	100	0 (1)	-
1-in-500 yr	138	0 (0)	-

Annual rainfall, and the 10-yr moving average, for the station is shown in Figure 5.

On average, Loxton receives less than 50 rain days (>1mm) per year, and evaporation greatly exceeds rainfall every month, Figure 6. Flooding issues in Loxton are typically due to shorter duration, high intensity storms. Climate change is expected to decrease overall rainfall, however, increase both the frequency, and intensity, of short bursts of high intensity downpours (BOM & CSIRO 2015).

Loxton is likely to face more frequent and severe extreme weather events. Thomas & Hayman (2019) highlights that the future climate of Loxton is expected to be warmer and drier. Rising temperatures and increasing heat will certainly result in more frequent heatwaves and rainfall changes. As a result of high temperatures, increased evapotranspiration could raise irrigation needs. In addition to high temperatures, uncertainty in rainfall projections may affect crop production.

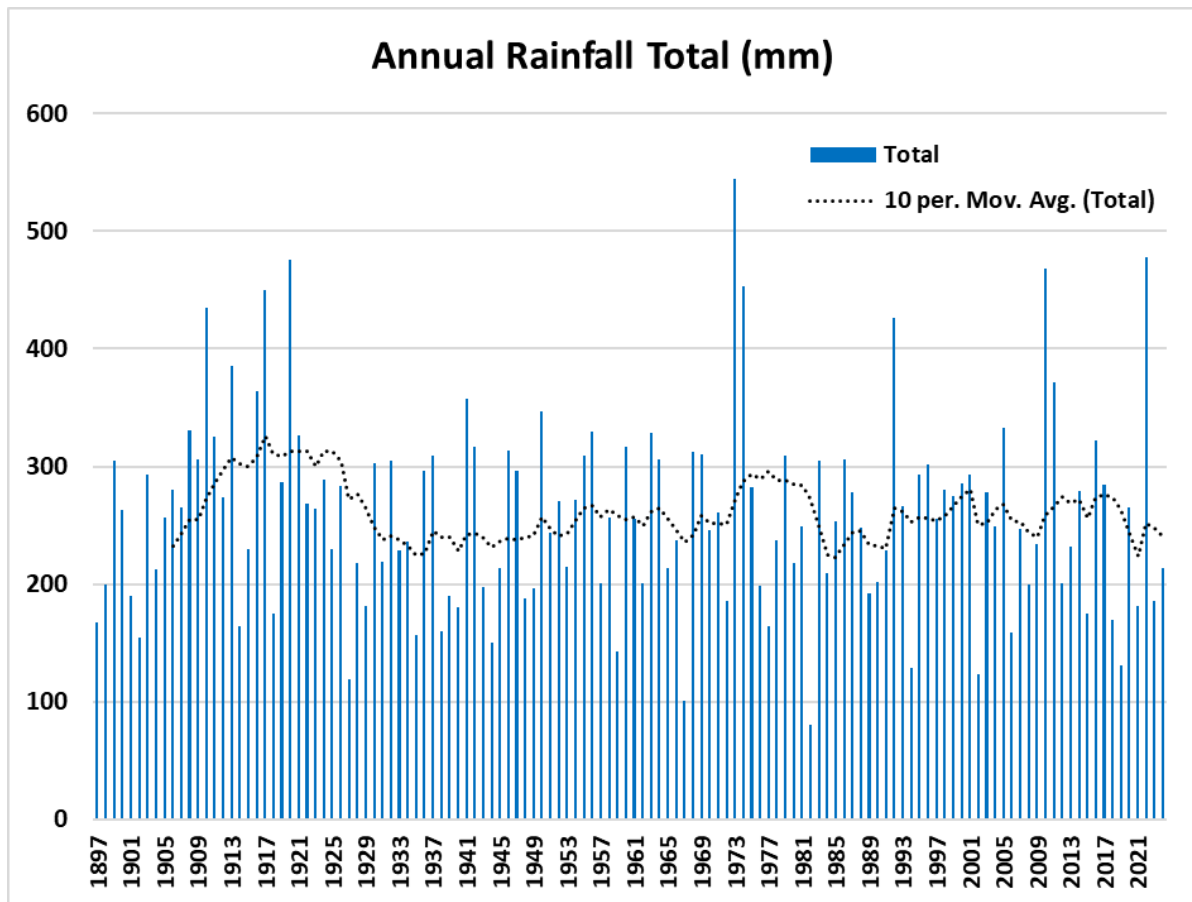


Figure 5. Graphical representation of annual rainfall and moving average.

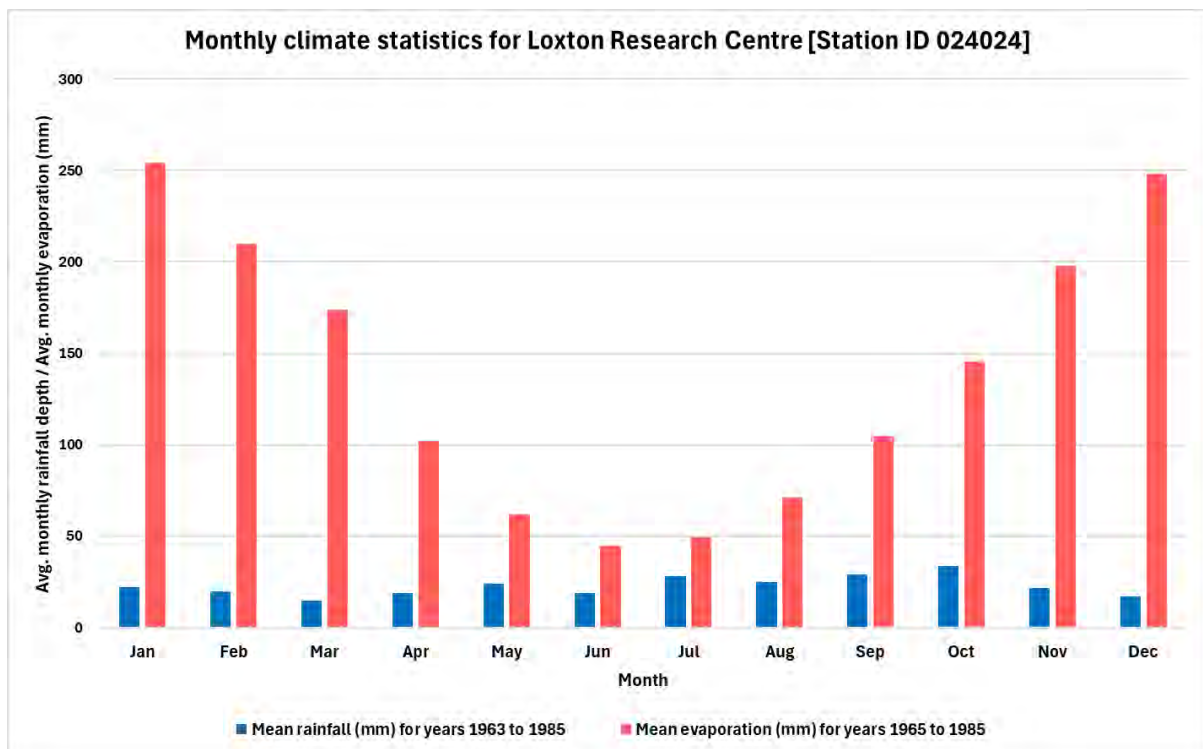


Figure 6. Comparison of Loxton's monthly rainfall average and monthly evaporation average.

2.5. Climate change

The global climate is changing as a direct result of anthropogenic greenhouse gas emissions. Climate change across Australia is expected to alter temperatures, rainfall, and other weather events that will impact the River Murray and Riverland region. Figure 1.6.2 of the ARR (Book 1, Chapter 6, Section 6.4.1) shows changes to date, plus possible future changes according to four Shared Socioeconomic Pathways (SSPs)*.

Note that the Intergovernmental Panel on Climate Change (IPCC) changed its preferred modelling scenarios from Representative Concentration Pathways (RCPs) in the Fifth Assessment Report (AR5) to Shared Socioeconomic Pathways (SSPs) in AR6. These scenarios share the same assumed levels of radiative forcing in the year 2100 (e.g., RCP4.5 $\approx$ SSP2-4.5); however, the new SSP framework incorporates more socioeconomic complexity, leading to a broader range of potential outcomes. For more details, see: <https://environment.govt.nz/what-you-can-do/climate-scenarios-toolkit/climate-scenarios-list/ipccs-ssp-rcp-scenarios/>

Given the age of the existing the town's existing stormwater infrastructure (discussed further in Section 2.6.1) it is likely that much of the existing network is undersized for expected future conditions.

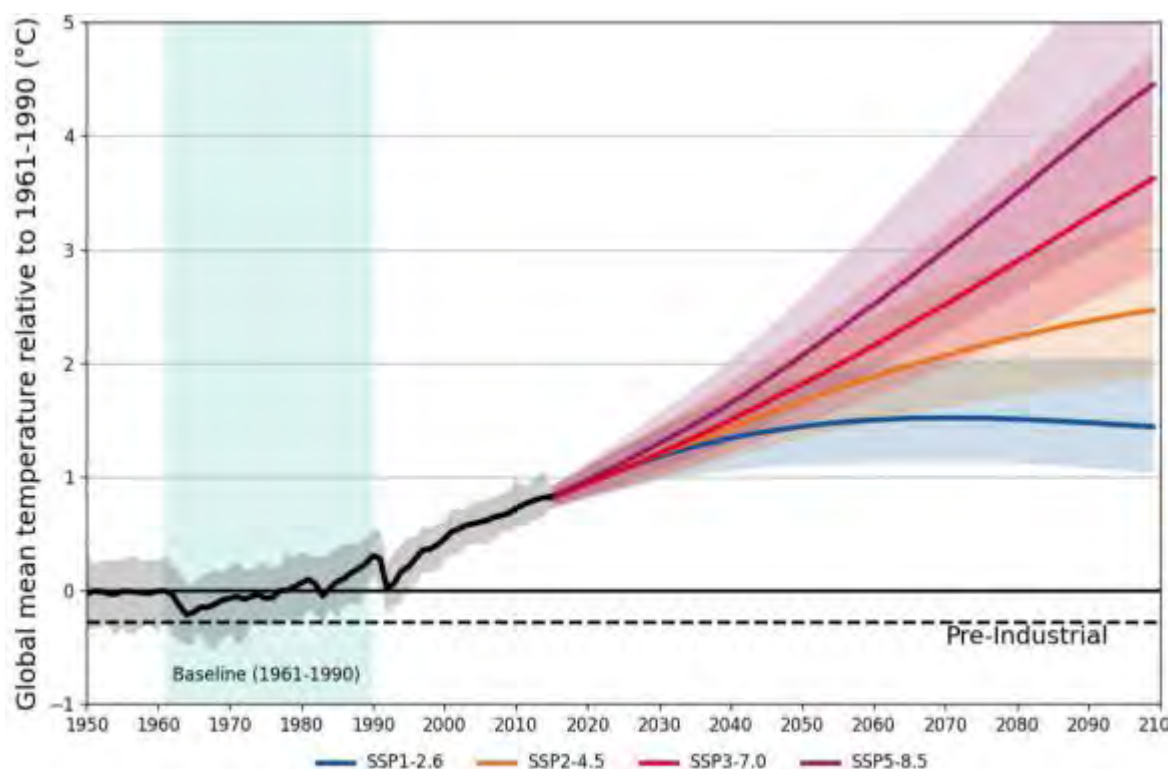


Figure 1.6.2. Projected temperature increases associated with AR6 socioeconomic pathways relative to 1961-1990 and their associated uncertainty²

Figure 7. Change (and climate change predictions) to mean temperature since 1950.

Loxton is zoned under the 'Murray Basin' region by CSIRO and the Bureau of Meteorology who predict that temperatures and intense weather systems will both increase as average rainfall decreases. Furthermore, drought conditions and fire danger are both expected to worsen according to the 2015 *Climate Change in Australia* technical report.

The climate change predictions for the Murray Basin region made by The Bureau of Meteorology and CSIRO are summarised in Table 2. Three representative concentration pathways* (RCPs) are included in this table: RCP2.6, RCP4.5, and RCP8.5 (noting these assimilate to SSP1-2.6, SSP2-4.5 and SSP5-8.5, respectively under the updated framework). These scenarios model climate change under increasing intensity of greenhouse gas emissions, with RCP2.6 representing the lowest emission scenario, and RCP8.5 representing the highest.

Table 2. Climate change predictions for Murray Bridge Region.

Condition change	2030 RCP4.5	2090 RCP2.6	2090 RCP4.5	2090 RCP8.5
Avg. temperature (°C)	+0.8	+0.9	+1.7	+3.5
Annual rainfall (%)	-4	-3	-7	-8
Winter rainfall (%)	-4	-3	-9	-17
Summer rainfall (%)	-1	-5	-2	+1
Time in drought (%)	+11	+16	+18	+21
Soil moisture (%)	-1.5	Not recorded	-3	-5.5
Runoff (%)	-10	Not recorded	-14	-26
Severe fire danger days	3.6	Not recorded	3.8	5.3

Under RCP4.5, climate change is expected to have the following effects on Loxton's long-term weather by 2090 (CSIRO, BOM 2015):

- The average annual maximum temperature will increase from 24.1°C to 25.8°C, with the average maximum summer temperature to reach 33.0°C (BOM 2025).
- Annual rainfall will decline from 260mm/year to only 241.8mm/year, with the most loss occurring in winter months.
- Rainfall intensity is expected to increase as synoptic weather systems originating in tropical regions travel further south.
- Time in drought will increase by nearly 20% as the number of rain events decline and become more intense. This is a direct causation of an additional 3-4 severe fire danger days each year in Loxton.
- Both soil moisture and runoff will decrease as warmer temperatures and less rainfall contribute to enhanced evapotranspiration.

Stormwater infrastructure in Loxton must therefore be planned to withstand the demanding conditions induced by global climate change.

2.6. Stormwater infrastructure

2.6.1. Existing infrastructure

GIS layers of the stormwater infrastructure in Loxton have been provided by Council. These were updated during a Condition Assessment, which took the opportunity to confirm pit types, depths and pipe sizes. Loxton relies on underground drainage systems to remove stormwater from its populous regions. Stormwater traverses the underground system and drains to six collection dams around Loxton or into the River Murray. Some open swales exist to redirect stormwater into grates that link to the underground system, plus a large, grassed swale has recently been installed to replace the final underground section leading to the Mill Corner basin.

Loxton has one GPT among its stormwater assets. Stormwater is filtered with a GPT along Third Street before it drains into the basin at the bottom of Third St. Based on visual inspection, the GPT is well maintained and effectively limits gross pollutants in the Third St basin.

A summary of Loxton's existing stormwater infrastructure and drainage system within the study boundary is displayed in Figure 8, and Table 3 lists the different asset quantities, including Water Sensitive Urban Design (WSUD) assets.

A significant portion of Loxton's stormwater network was built before the 1990's. Of note:

- Pits and pipes along East Terrace and Kokoda Terrace dates to the 1950's and is approaching the end of its standard life.
- Most of the rest of the infrastructure north of Bookpurnong Terrace, plus between the old railway yard and Mill Corner basin dates to the 1960's and 70's.

Exceptions to this include:

- The system along Pioneer Walk / Scenic Drive was installed in 1998
- The section connecting the retirement village off View St to the McMillan St basin was installed in the early 2000's and includes much more recent trunk upgrades.

The drainage system along Third Street was upgraded in 2011, and drains to a detention basin at the bottom of the street. The basin on Fifth street is designed to spill into the Third Street system when it reaches a certain threshold. This network drains to a basin at the bottom of Third Steet, which itself balances levels with another on Tobruk Terrace.

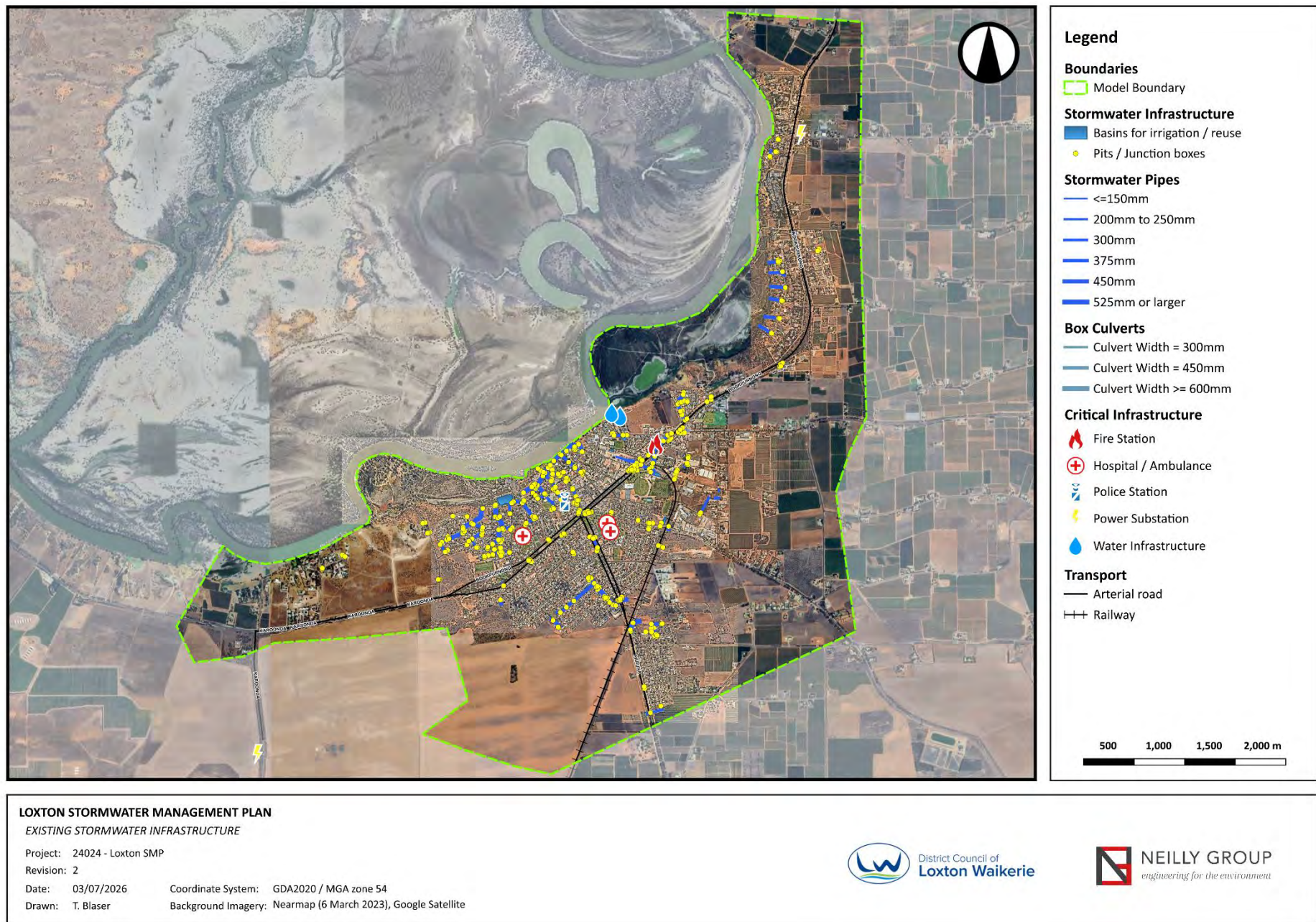


Figure 8. Existing stormwater infrastructure in Loxton.

Table 3. Existing stormwater assets in Loxton.

Asset Type	Description	Quantity	
Pipes	<= 150 mm dia	4 -	34 m
	200 mm or 225 mm dia	41 -	817 m
	300 mm dia	101 -	3,009 m
	375 mm dia	132 -	4,228 m
	400 mm or 450 mm dia	48 -	1,303 m
	525 mm dia	14 -	485 m
	600 mm dia	11 -	338 m
	750 mm dia	12 -	545 m
	825 mm dia	3 -	151 m
	900 mm dia	10 -	282 m
	1050 mm dia	3 -	96 m
	1200 mm dia	6 -	221 m
	1500 mm dia	6 -	233 m
Box culverts	< 900 mm wide	36 -	628 m
	=> 900 mm wide	3 -	62 m
Pits	Side entry pit (SEP)		232
	Grated inlet		23
	Field gully		15
	Junction Box (JB)*		98
WSUD assets	GPT		1
	Detention Basins		12
	Wetlands		0

** Note that junction boxes have been inserted at every change of direction and pipe junction in the provided shapefile that couldn't be confirmed during the Condition Assessment.*

2.6.2. Known flood issues

Loxton experiences flood issues in depressions across its relatively flat topography.

A community feedback meeting on SMP for Loxton and Waikerie townships was conducted in November 2024 by DCLW. The aim was to address flooding issues, especially in areas prone to heavy rainfall or low-lying spots. Key goals include identifying stormwater risks, defining stakeholder responsibilities, enhancing environmental and social values, and prioritising investments for flood mitigation. The residents were encouraged to provide input on additional drainage problems for a comprehensive SMP.

Members of the public reported issues with overflow on Bookpurnong Terrace between First and Third Street, and limited runoff and water accumulation at Bookpurnong Terrace between Goodyear Autocare and Riverland Floor Centre. Most highlighted poor drainage, especially during heavy

rainfall. A blocked drain at Tobruk Terrace was identified as a cause of flooding across the road, leading to property damage. Concerns were also raised about trenches along the footpath of Milne Street and Acacia Avenue, as well as erosion on the Kokoda Terrace footpath. Comments on Facebook also highlighted issues in front of the Rusty Spoon café.

During fieldwork in December 2024, community members voiced concern for flood potential across the western end of Loxton's urban area nearby Drabsch Street. Additionally, Council representatives advised that recent changes to land use on Starceovich Road have built up a previous depression that used to store runoff during high events, resulting in flooding now occurring and affecting properties at the end of Mill Road.

The locations of all reports of flood issues are visible Figure 9.



Figure 9. Known flood issues.

2.7. Water Allocation Plan

The Water Allocation Plan (WAP) for the River Murray Prescribed Watercourse (PWC) was regulated to protect the environmental, social and cultural aspects of the River Murray and boost the economic conditions. The aim of WAP is to supply clean water to the public and outlines how the River Murray water resources should be managed, focusing on principles for the take and use of water.

Its objectives include providing allocations for water-dependent ecosystems, ensuring equitable and sustainable water distribution, and promoting efficient use. The WAP prevents the loss of refuge habitats and aquatic life, protects water quality, and addresses issues such as soil salinity and acid sulphate soils. Figure 10 shows the portion of the study area that falls within the PWC. The remaining area falls under the Murraylands and Riverland Landscape Board's Water Affecting Activities (WAA) Control Policy (2011).

Per Murray-Darling Basin Authority (MDBA) 2021, country towns, including Loxton, are entitled to total of 50 GL/yr (combined) for all consumptive purposes, and an additional 50 GL/yr is allocated for urban water supply by SA Water. The township receives water from the River Murray for various purposes, including stock and domestic use, urban water supply, irrigation, industrial activities, dairy farming, and environmental land management.

Engineering solutions likely to be recommended in the SMP will all be regulated according to the WAA Policy, rather than the WAP.

2.7.1. Water Affecting Activities

2.7.1.1. Stormwater capture and reuse

Adoption of stormwater capture and reuse strategies can reduce the town's reliance on external water sources. Implementing rainwater harvesting (e.g. rainwater tanks) and reuse systems (e.g. irrigation, toilets and laundry connections), will decrease dependence on potable water and help conserve freshwater from the River Murray.

Capturing stormwater can reduce runoff carrying pollutants into River Murray and mitigate the risk of localised flooding in urban areas. It will also ease the pressure on the stormwater drainage system and support sustainable urban water management. Furthermore, reusing captured runoff promotes a healthier environment, provides water for irrigation and landscaping, and benefits urban ecosystems.

2.7.1.2. Applicable regulations

Infrastructure relating to stormwater capture, detention, reuse and discharge is considered a WAA in the WAA Policy 2021, and are regulated according to Section 3 of the policy.

Proposed solutions will include assessment against the regulations in the SMP to aid in project planning.

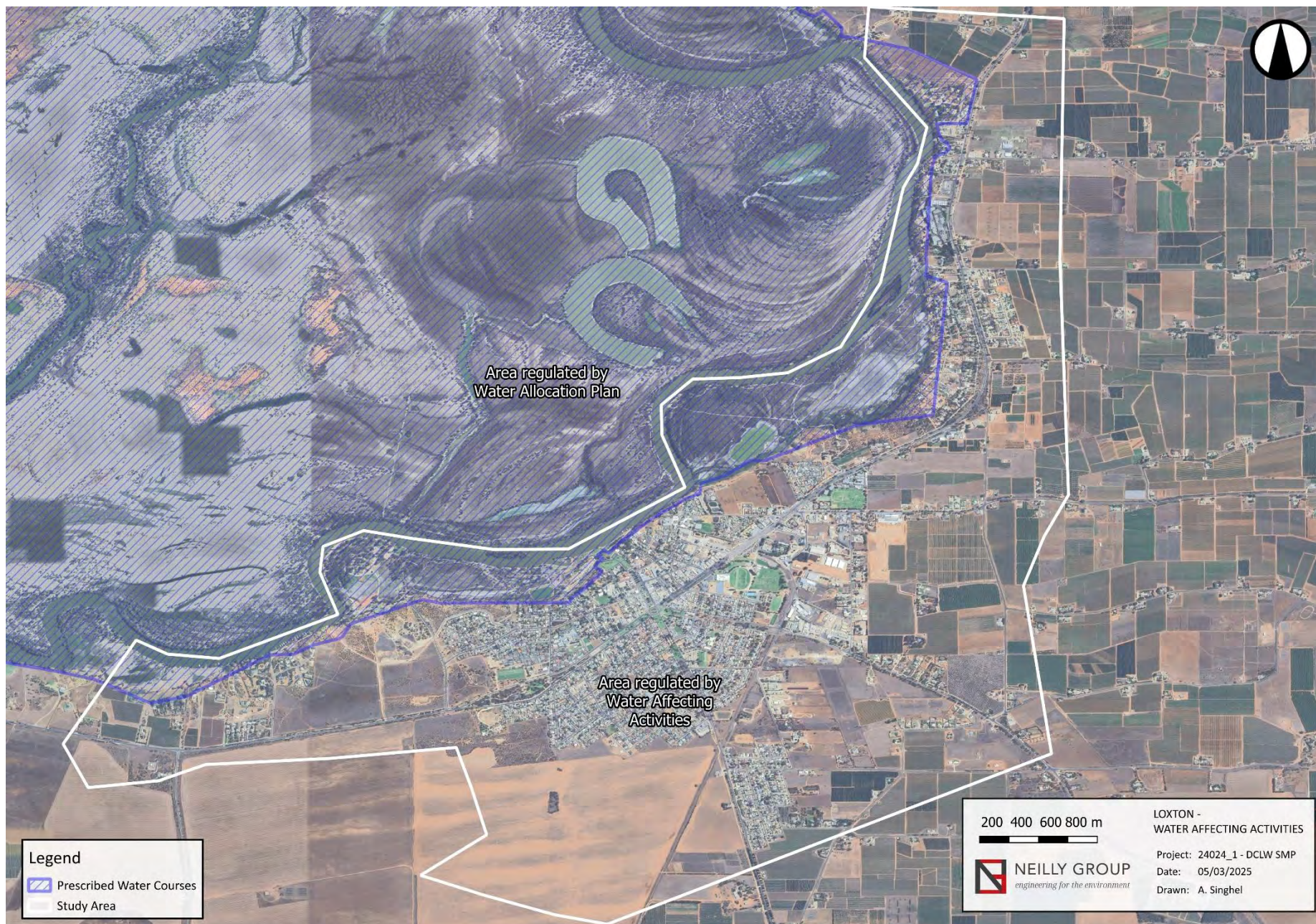


Figure 10. Areas affected by different policies (MDBA 2021).

2.8. Environmental values

2.8.1. Water quality

Water quality is a key environmental value within the Riverland, where urban stormwater runoff can directly influence the health of local waterways, wetlands and the River Murray. Urban development increases the extent of impervious surfaces such as roads, car parks and rooftops, resulting in greater runoff volumes, higher peak flows and reduced infiltration.

Stormwater runoff can transport a range of pollutants, including sediments, nutrients, hydrocarbons, heavy metals, litter and pathogens, into receiving environments. These pollutants can degrade water quality, impact aquatic ecosystems, reduce recreational values and contribute to the deterioration of River Murray water resources.

Stormwater management must balance water quality protection with opportunities for stormwater harvesting and reuse. Harvesting stormwater can provide a valuable alternative water source for irrigation of public open spaces, streetscapes, sporting facilities and other municipal uses, reducing reliance on River Murray allocations and other water supplies. However, stormwater intended for reuse must be appropriately treated to achieve the required water quality objectives and managed in accordance with relevant South Australian and Australian guidelines.

The SMP seeks to improve the quality of stormwater entering the drainage network and receiving waters through the application of water-sensitive urban design (WSUD) principles. The plan promotes the capture, treatment and beneficial reuse of stormwater while maintaining appropriate conveyance for flood management. Stormwater treatment measures will aim to reduce pollutant loads before discharge or reuse, thereby protecting downstream environmental values, including the River Murray and associated wetlands.

Potential management measures include the installation of raingardens, bioretention systems, vegetated swales, gross pollutant traps and permeable pavements. These measures can effectively reduce concentrations of sediments, nutrients and other urban pollutants, while also moderating runoff volumes and flow velocities. Retention and detention systems should be designed to achieve water quality objectives while maintaining adequate flow pathways and avoiding adverse impacts on downstream hydrology.

Where stormwater is discharged to waterways, energy dissipation structures, appropriately designed outlets and the establishment of native riparian vegetation can assist in minimising erosion and sediment transport. Riparian vegetation provides additional benefits by filtering runoff, stabilising soils, enhancing habitat connectivity and improving the ecological condition of waterways. Through the implementation of these measures, the SMP aims to protect and enhance water quality outcomes across the catchment while supporting sustainable stormwater reuse and the long-term health of the River Murray system.

2.8.1.1. Water quality assessment

Water quality assessment will be modelled using eWater's Model for Urban Stormwater Improvement Conceptualisation Version X (MUSIC). MUSIC is the industry standard for modelling water quality and WSUD treatment train effectiveness. MUSIC modelling will be undertaken to model existing water quality parameters, and then to model proposed effectiveness of the different solutions put forward in the SMP.

2.8.1.2. Types of pollutants and their sources

Suspended sediment

Suspended sediments are fine particles, like silt, clay and organic matter that degrade the quality of water by reducing light penetration. Suspended solids cause turbidity and leads to disruption of the aquatic environment. The sources of suspended solids include

- Eroded and washed soil from construction sites
- Sediment-laden agricultural runoff, particularly from areas lacking vegetation and with ploughed soil
- Sediments released from natural erosion during heavy rainfall
- Sediments from exposed land, due to logging and deforestation
- Sediments from mismanaged waste disposal areas and landfills

Nutrients

Nutrients, especially nitrogen and phosphorous, when present in excess creates imbalance in nutrient cycles and ecosystem functions. The sources include

- Farmlands rich in fertilisers and animal manure
- Urban landscapes with fertilisers application on lawns and golf courses
- Poorly maintained septic systems with leakages
- Industrial discharge
- Atmospheric deposition of nutrients, especially nitrogen, from vehicle exhaust, industrial emissions, etc.

Gross pollutants

Gross pollutants are large waste material and cause significant harm to water quality and surrounding environment. The sources of gross pollutants are as follows:

- Litter and trash from public spaces, recreational areas and urban areas
- Waste from commercial and industrial sites
- Roads and highways with plastic bags and vehicle debris
- Construction debris
- Improper disposal of waste and poor management
- Wastewater overflow from improperly managed wastewater systems

Other contaminants

Metals

Metals often bind to sediments, leading to deposition and degradation of environment. Presence of harmful metals in stormwater runoff pose risks to natural resources and surrounding ecosystems. Metals can originate from various sources including vehicle emission, industrial activities, construction sites and atmospheric deposition. Lead and nickel often generate from vehicle emissions. Activities in the automotive industry release many metals. For instance, copper from manufacturing and repairing brake pads and zinc from manufacturing tires. Lead often comes from paints at construction sites or older infrastructure, chromium from metal plating and leather tanning and cadmium is released as a by-product from battery production.

Hydrocarbons

Contamination of stormwater by hydrocarbon indicates presence of petroleum-based products. These contaminants are sourced from urban and industrial areas where traffic and fuel consumption is common. Hydrocarbons can enter stormwater system from various pathways, such as fuel spills, industrial discharge, urban runoff and deposits from vehicle emissions.

Emerging Organic Contaminants (EOCs)

The term Emerging Organic Contaminants (EOCs) described new or previously less understood organic compounds that are now gaining attention due to their impacts on environment and public health. These contaminants can be sourced from pharmaceuticals, personal care products, industrial materials, pesticides and herbicides and other synthetic compounds.

2.8.1.3. Impact of pollutants

Receiving waters

Suspended sediment insertion to the River Murray increases water turbidity and hence restricts light penetration to support the photosynthesis of benthic vegetation (Rutherford et al. 2019). This prevents the growth of macrophytes that feed native fish and limits the development of submerged shrubs that control erosion. Suspended sediments in stormwater may settle on the riverbed and bury established flora, preventing the gas exchange that allows submerged flora to access oxygen.

Excess nitrogen and phosphorus contribute to a population boom of phytoplankton that raise levels of organic matter and consequently reduce oxygen in the River Murray (Verhoeven, Khan, & Evans 2024). Eutrophication in stagnant water like the River Murray in low rainfall years spawns blue-green algae (cyanobacteria) that multiplies exponentially. Cyanobacteria near the water surface impedes light penetration to macrophytes and can inhibit food sources for fish, waterbirds, and amphibians. Moreover, cyanobacteria are organic matter that draw oxygen from the water, reducing its quality and the health of its benthic ecosystems.

Gross pollutants may accumulate on the banks of the River Murray and continue to pollute land systems and waterways. Gross pollutants smother vegetation and prevent exposure to sunlight and carbon dioxide for photosynthesis. Declining growth of riverine vegetation hinders the growth and diversity of River Murray fauna. The consumption of gross pollutants by riverine fauna like fish and waterbirds may choke these animals or cause a plethora of digestive issues.

Excessive accumulation of metal cause toxicity, resulting in disruption of natural processes and ecological functions. The presence of hydrocarbons and EOCs can disrupt the aquatic habitat. EOCs can cause endocrine imbalance and disruption, affecting reproduction, growth and survival rates of aquatic fauna.

Stormwater reuse and impacts on settlement

Adequate treatment and proper reuse of stormwater can reduce reliance on potable water systems and freshwater resources. If not treated properly, collected runoff can nurture pathogens and harbour pollutants, posing risk to public health. Reusing untreated stormwater for irrigation and landscape watering can inadvertently harm local ecosystems by introducing pollutants and possibly invasive species into the environment.

Stormwater drains are primarily designed to redirect runoff and prevent accumulation. Gross pollutants may settle in stormwater pipes and catch suspended sediment to form sediment deposits. The sediment builds up in these drains creates obstruction limiting flow of stormwater through urban channels and causing flooding. Prolonged stagnation of stormwater can weaken the foundations of pipes and other urban infrastructure, escalating the risk of damage and expensive repairs. Sediment deposits can accumulate within stormwater drains and pipes, leading to blockages, reduced flow efficiency, and the increased need for regular maintenance. The deposition of sediment can cause corrosion which strains infrastructure and increase cost of maintenance. Blockages and damage within the drains and pipes can lead to sewer overflows, resulting in environmental pollution. This poses a risk to public health, surrounding structures and nearby ecosystems.

Water-dependent ecosystems

The pollutants and sediments in stormwater are capable to infiltrate groundwater supplies, potentially compromising groundwater quality and affecting local water sources. Sediment accumulation clogs soil pores and reduces rate of water infiltration. Consequently, there is a decline in rate of groundwater recharge and supply. Some sediments may carry harmful contaminants, like pesticide and heavy metals, which can have long-term effects on water quality. Excessive seepage of sediments raises turbidity of water making it unsuitable for consumption and irrigation. Excessive nutrients runoff reduces oxygen levels and increases the risk of nutrient pollution. Nutrient pollution causes eutrophication and acidification of groundwater and disrupts the aquatic ecosystems.

The sediment deposition can lead to destabilisation of soil and degradation of soil structure. The loss in structure reduces the soil's ability to retain moisture. The aggregation of sediments limits the process of soil aeration and causes soil compaction, leading to restricted microbial activity and root growth and increased surface runoff. The deposition of harmful contaminations along with sediment can pollute the soil and harm the ecosystem.

The build-up of nutrients can disrupt the natural life cycles and create soil imbalances. Consequently, this can lead to poor soil quality and reduced productivity and fertility. Nutrient pollution in soil can be determined by increased pH and increased salinity. Nitrogen and phosphorus present in stormwater may drain into groundwater deposits and reduce water quality. In stagnant water bodies, eutrophication is significantly more prominent and may induce cyanobacterial growth that salinises and acidifies groundwater (Mosley et al. 2023). In Loxton, a major decline of groundwater quality could impinge both agricultural and horticultural growth.

Contamination of wetlands and floodplains from stormwater runoff can reduce the water holding capacity, leading to more frequent flooding. In addition, wetlands are healthy water-dependent ecosystems that store carbon. However, when exposed to pollutants and contaminants, wetlands can diminish the ability to capture and store carbon.

Hydrocarbons and EOCs can degrade water quality, making is unusable for consumption, recreational activities, irrigation and agriculture. Metals, hydrocarbons and EOCs can accumulate in soil and groundwater and impinge plant growth. Possibly, these contaminants can enter the food chain and poses health risks to human.

2.8.2. Threatened Ecological communities

The Protected Matters Search Tool (PMST), under Environment Protection and Biodiversity Conservation (EPBC) Act 1999, was launched to identify threatened/sensitive ecological communities in and around the region of Loxton. The community identification and status is shown in Table 4.

Table 4. Listed threatened ecological communities.

Community name	Threatened category	Presence text
Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions	Endangered	Community may occur within area
Plains mallee box woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions	Critically Endangered	Community may occur within area

(Source: Protected Matters Search Tool, 03 March 2025)

2.8.3. Watercourse assessment

The state of the River Murray is generally considered to be poor, heavily impacted by human activities – especially the introduction of the locks in the mid-1930's which led to decades of constant water levels. These constant water levels have severely deteriorated bank conditions and the health of riparian vegetation through two mechanisms:

- i. Constant water levels remove the natural flow variability that supports healthy soils and vegetation. Soils above the pool level gradually dry out, vegetation - a key part of binding soils together – begins to die and banks become more unstable leading to increased erosion.
- ii. Boat wake becomes concentrated on specific sections of the weakened bank further increases erosion.

The recent 2022/23 River Murray flood caused significant damage to riverbank locations such as increased bank erosion, loss of vegetation and other infrastructure, e.g. houseboat mooring locations, caravan parks, private pumps and pump sheds. The flood caused significant damage to the riverbank from the stairs at the end of William Street through to Lions Park, the Caravan Park and the houseboat moorings at the end of Pioneer Landing Drive.

Community amenity exists along this entire riverbank and remediation works are already underway by Council at various locations to repair damage and provide flood resilient improvements to the highly used riverfront.

2.9. Social, Socioeconomic and Cultural Values

The natural environment and climate surrounding Loxton have a major impact on its social and economic values (DCLW 2019). Loxton's riverfront geography and community culture attract both retirees and tourists to the town. Loxton's retirement community compose a significantly greater portion of Loxton's demographic in comparison to young adults and professionals, as visible in Figure 11.

Loxton's retirees value the serenity of the River Murray, as well as the community culture that is enhanced by the abundance of locally owned businesses in the town. Loxton attracts tourists of all ages who utilise the River Murray for water sports, fishing, and leisure.

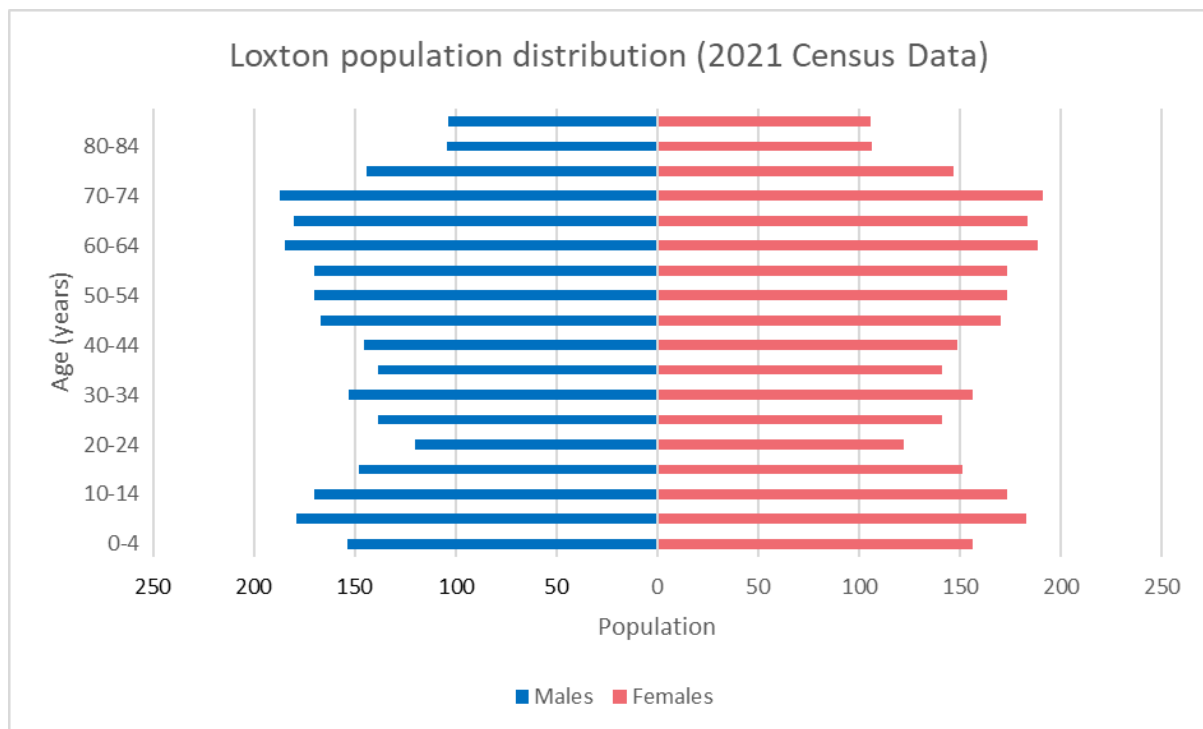


Figure 11. Population distribution graph of Loxton.

Loxton's primary employment industries are agriculture, healthcare, and retail. Agriculture is the main driver of economic growth in Loxton, employing 16.2% of Loxton's residents and contributing to 41% of the region's economy (DCLW 2019). Healthcare employs 15.7% of Loxton's workforce to support the town's ageing population through both aged care facilities and general health improvement opportunities.

The town of Loxton presents culture through the Historical Village, riverfront walking trails and lookouts, Community Conservation and Heritage Park, and local produce showcases. Loxton's main point of cultural and spiritual significance is the River Murray.

Loxton is located on Erawirung country with ties to the custodians of the Ngawait, Ngarkat, and Ngarrindjeri lands of the River Murray and Mallee region. The Erawirung people have a strong relationship with the Murrundi (River Murray) which has provided freshwater, food, and resources crucial to human life and spiritual well-being for millennia. Along the banks of the River Murray are numerous sites of cultural significance for the Erawirung mob, attributable to their rich history of inhabitancy that is showcased through middens, canoe trees, and clay stoves (DEW 2024).

2.10. Development policy

A map outlining the Planning and Design code (P&D) zones for the township of Loxton has been created and is presented in Figure 12. The P&D zones shapefile is sourced from the Department of Housing and Urban Development.

The P&D zones map highlights the predominance of rural horticulture, rural living, and rural settlements. A significant portion of land in the northeast of the Loxton boundary is dedicated to

caravan and tourist parks. Smaller areas are designated for neighbourhood, rural neighbourhood, and infrastructure zones. Additionally, there are minor portions allocated to open spaces, conservation zones, and other uses.

2.10.1. Council's Growth Management Plan

Loxton is renowned for its beautiful gardens and expansive boulevards and is referred to as the 'Garden Town of the Riverland'. Its close location to the River Murray, scenic views, and excellent services contribute to making it a desirable place for both residents and visitors. Loxton has a population of 5,019 (DCLW 2024) serves as a service centre for the surrounding district, offering healthcare, aged care, education, open spaces, recreation facilities, and access to the River Murray.

The strategies for the growth and development of Loxton focus on attracting new residents by promoting the town's benefits and improving the waterfront public realm with added shade and amenities. The town will ensure a sufficient supply of well-connected, mixed-use and serviced land for new investment and population growth. A diversity of living options and services will be planned to cater to families and people of all age groups. Residential subdivision and infill will be encouraged to preserve primary production land.

Loxton aims to promote farm-based food and unique tourism experiences that highlight its produce, environment, and culture. Additionally, opportunities for renewable energy and freight hubs will be explored to support economic growth. Key priority action for Loxton includes preparing a prospectus to attract major sporting events. A main street shop front activation program will be established, along with a pedestrian plan to create green, shaded links to the waterfront. Rezoning underdeveloped land near the High School will enable residential development and accommodating ageing population with housing options and services.

The Growth Management Plan (DCLW 2024) outlines regions of Residential Growth and Future Employment. A set of five services are termed as supporting infrastructure requirements of five residential and one employment growth areas.

2.10.2. Value mapping

Figure 13 illustrates locations of cultural heritage significance at Loxton. The heritage places shapefile is sourced from the Department of Housing and Urban Development. According to this dataset, Loxton Institute, Loxton Villa and St Peter's Evangelical Lutheran Church and Hall are recorded as sites of heritage importance and are categorised under hall, house and religious building, respectively.

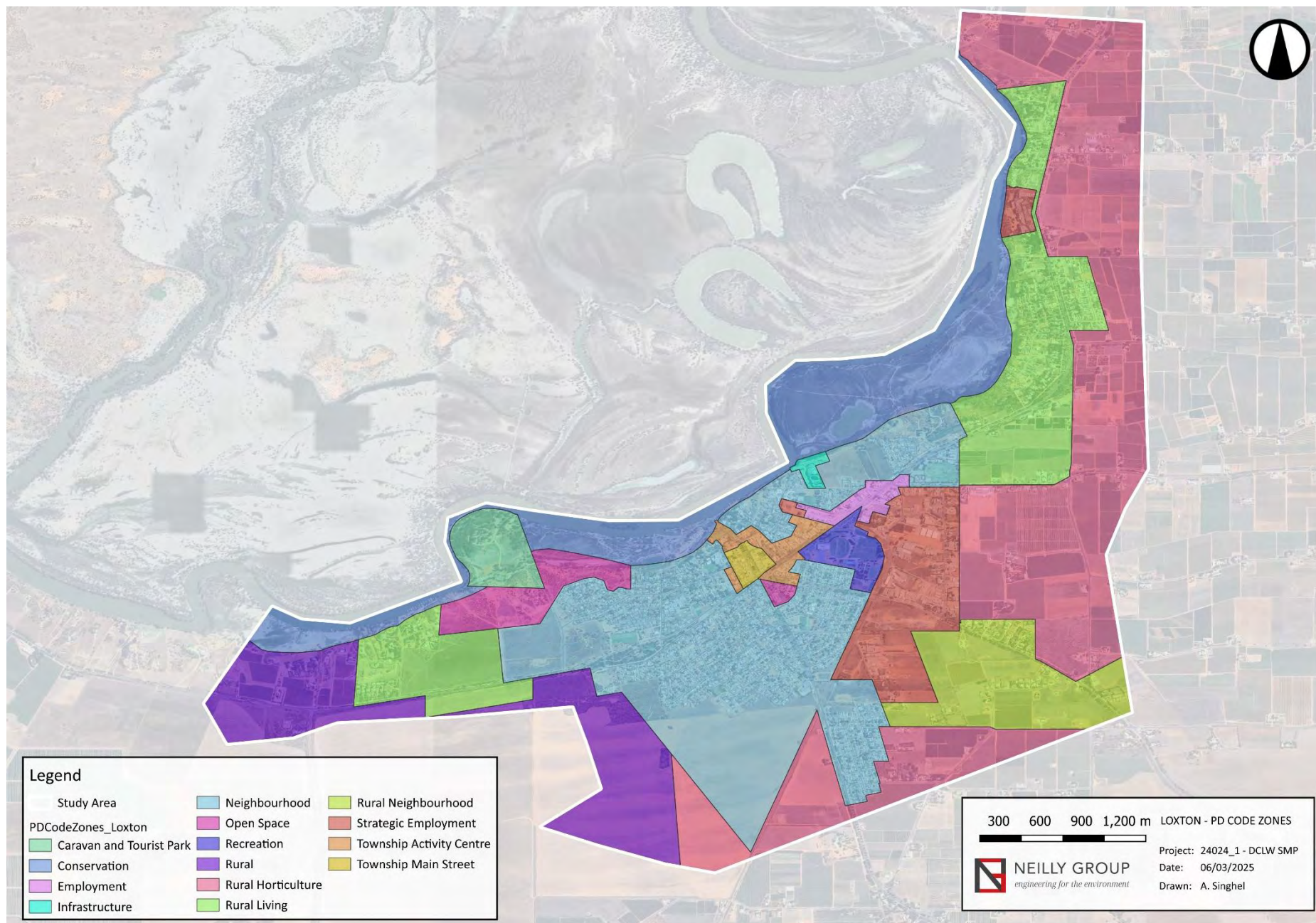


Figure 12. Planning & Design Code Zones .



Figure 13. Cultural heritage sites

3. Flood Modelling and Validation

Hydrologic and hydraulic modelling was undertaken to provide a detailed analysis of stormwater drainage performance under existing and future growth scenarios. The modelling integrates DRAINS for hydrology and TUFLOW (1D/2D) for hydraulics, leveraging updated LiDAR datasets (2021 and 2024), verified pipe and pit data from field inspections, and rainfall inputs based on Australian Rainfall and Runoff (ARR v4.2) guidelines. The outputs provide a comprehensive understanding of drainage system performance, overland flow paths, and vulnerabilities, validated through field observations and community feedback.

3.1. Events and scenarios

Flood modelling was undertaken for the following events and scenarios.

Events:

- 1) 18% AEP
- 2) 10% AEP
- 3) 5% AEP
- 4) 2% AEP
- 5) 1% AEP
- 6) 0.2% AEP (modelled as the 1-in-500 yr event)

The flood impact assessment undertaken throughout this report recognises the minor event as 18% AEP and the major event as 1% AEP.

Scenarios:

- a. **Existing conditions** – existing conditions, using hydrologic inputs modified (*using SSP1-2.6 and the year 2030 – see Section 3.2.2*) to reflect changes that have already occurred as a result of climate change, per latest ARR recommendations.
- b. **Ultimate development** – existing infrastructure, assuming future development and future climate change conditions to the year 2100.
- c. **Post mitigation** – proposed remediation designs, modelled with future development and future climate change conditions to the year 2100.

Note- Throughout this report, events will be referred to by Event-Scenario combinations, e.g. 1a refers to the 18% event under existing conditions.

Durations:

All available storm durations from the 10-minute to the 72-hour storm were modelled, plus the 96-hr storm was modelled for a few selected events as necessary upon viewing results. Critical duration was then determined uniquely across the entire model area.

3.2. Hydrology (DRAINS)

DRAINS is leading stormwater drainage software package used across Australia for modelling stormwater runoff in urban catchments. It enables engineers to simulate rainfall, surface runoff, and flow routing through drainage networks, supporting both design and assessment of infrastructure performance under various storm scenarios.

For the purposes of this SMP, DRAINS was solely used to develop hydrographs for input into a TUFLOW hydrodynamic model. An Initial Loss-Continuing Loss (IL-CL) model was developed for this; the modelling parameters used are described below.

3.2.1. IL-CL model

Table 5 presents the final loss parameters adopted for the model. A detailed description of the IL-CL model development is included in Attachment B.

Table 5. Loss parameters for hydrologic modelling.

	Initial Loss (mm)	Continuing Loss (mm/hr)
EXISTING CONDITIONS		
(Recommended multiplier)	1.04	1.08
Impervious Area	2	0
Pervious Area	36	2.5
FUTURE CONDITIONS		
(Recommended multiplier)	1.07	1.17
Impervious Area	2	0
Pervious Area	37	2.7

3.2.2. Rainfall Data

Rainfall data was downloaded from the ARR Data Hub and the Bureau of Meteorology (the Bureau) website. Rainfall depths were then modified using Watercom's CCRM to reflect conditions (see Table 6). Design rainfall depths for all scenarios are provided in Attachment B.

Table 6. Chosen SSP scenarios for the study.

Scenario	Shared Socio-economic Pathway (SSP) Scenario	Target Horizon (/Design) Year
Current conditions	SSP1-2.6 Low emissions/warming, "Sustainability"	2030 <i>Midpoint of 'current/near-term horizon</i>
Future conditions	SSP2-4.5 Moderate emissions/warming, "Sustainability"	2090 <i>Midpoint of 'long-term horizon</i>

3.2.3. Catchments

3.2.3.1. Catchment boundaries

Catchments were determined for each stormwater inlet location, where water can enter the underground network. Additional catchments were also defined for large areas where there is no stormwater network in locations where it was considered a pit may be warranted. An example of this is the area between Bookpurnong Terrace and Third St (see Figure 14 – *the existing network is shown in blue, additional catchment outlets are shown in white*).



Figure 14. Additional sub-catchments added to allow for more informed decision-making.

3.2.3.2. Pervious and impervious percentages of catchments

Catchments were set up using the 'Abbreviated data' method. Catchment imperviousness was determined by visually assessing aerial imagery and categorising blocks according to density. Percentages for sample sub-areas were determined, then averaged to produce approximate percentages for each classification – shown in Table 7.

These were converted to raster layers for Directly Connected Impervious Area (DCIA) and Remaining Impervious Area (RIA), representing 'Paved %' and 'Supplementary %', respectively, then zonal statistics was then used for the sub-catchment to determine unique impervious percentages for each sub-catchment.

Table 7. Impervious percentages for each land use classification.

Classification	Paved (%)	Supplementary (%)	Pervious (%)
Road / other isolated DCIA	100	0	0
RIA (isolated buildings)	0	100	0
Very high density	95	0	5
High density	75	5	20
Med-high density	50	10	40
Medium density	35	10	55
Low density	20	10	70
Very low density	5	10	85

DCIA values across the study area for existing conditions are shown in Figure 15.

3.2.3.3. Updated pervious and impervious percentages for future scenarios

The ultimate development scenario projected changes to the current conditions by considering the following sources:

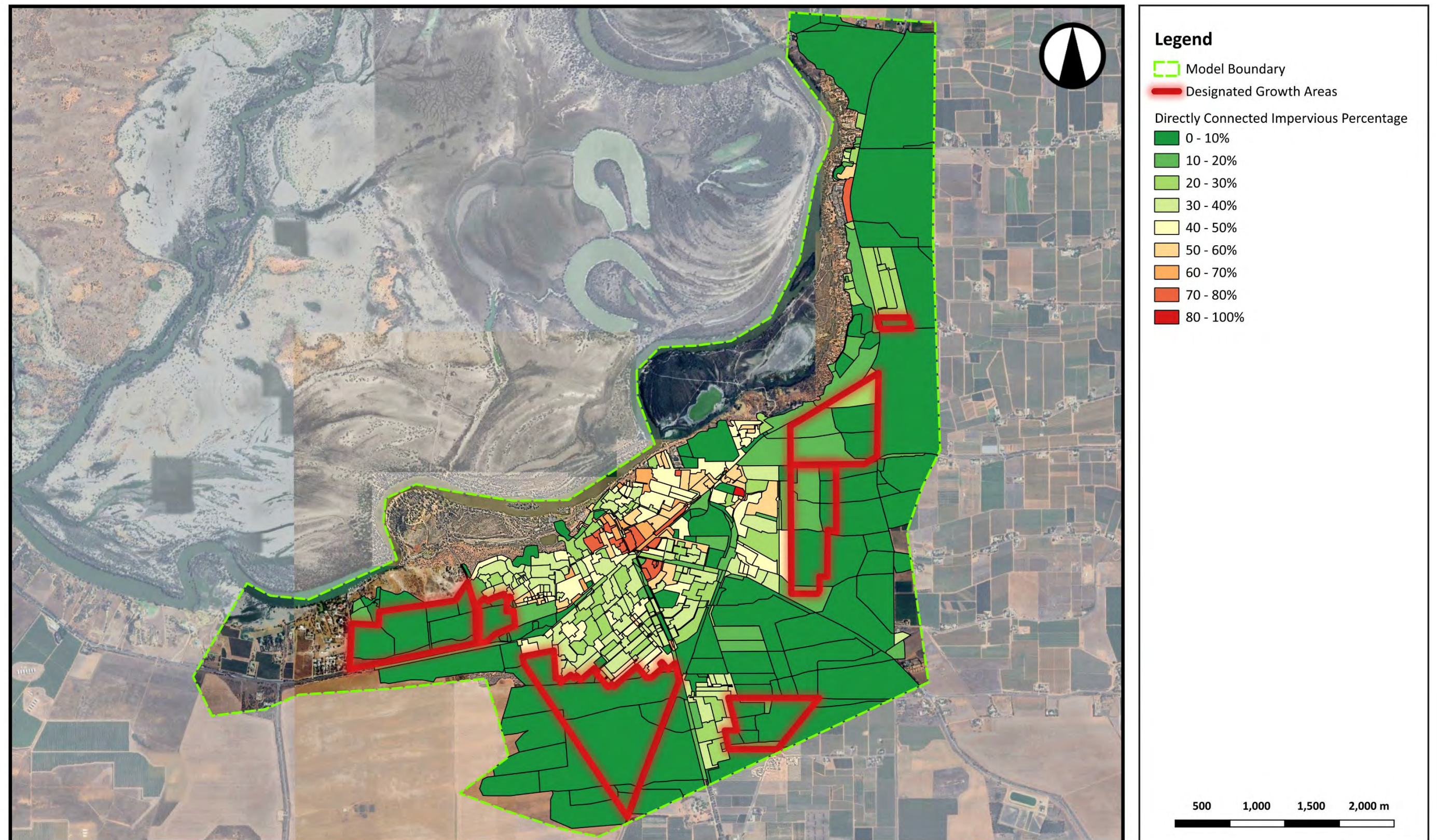
1. Council's Growth Plan (DCLW & URPS, 2024)
2. The online South Australian Property & Planning Atlas (SAPPA)
3. Population Projections for South Australia and Regions – 2021 to 2051 (PlanSA 2023)

These sources were used to estimate population change and update imperviousness fractions; full details and calculations can be found in Attachment B.

The resulting DCIA values for ultimate development are listed in Table 8 and shown in Figure 16; the change in percentage points (e.g. 30% → 50% expressed as 20% change) is shown in Figure 17.

Table 8. Changes to impervious percentages for the ultimate development scenario.

Classification	Paved (%)	Supplementary (%)	Pervious (%)
Med-high density	55 (+5%)	15 (+5%)	30
Medium density	50 (+15%)	10	40
Low density	30 (+10%)	10	60
Very low density	15 (+10%)	10	75



LOXTON STORMWATER MANAGEMENT PLAN

DIRECTLY CONNECTED IMPERVIOUS AREA - SCENARIO A (EXISTING CONDITIONS)

Project: 24024 - Loxton SMP

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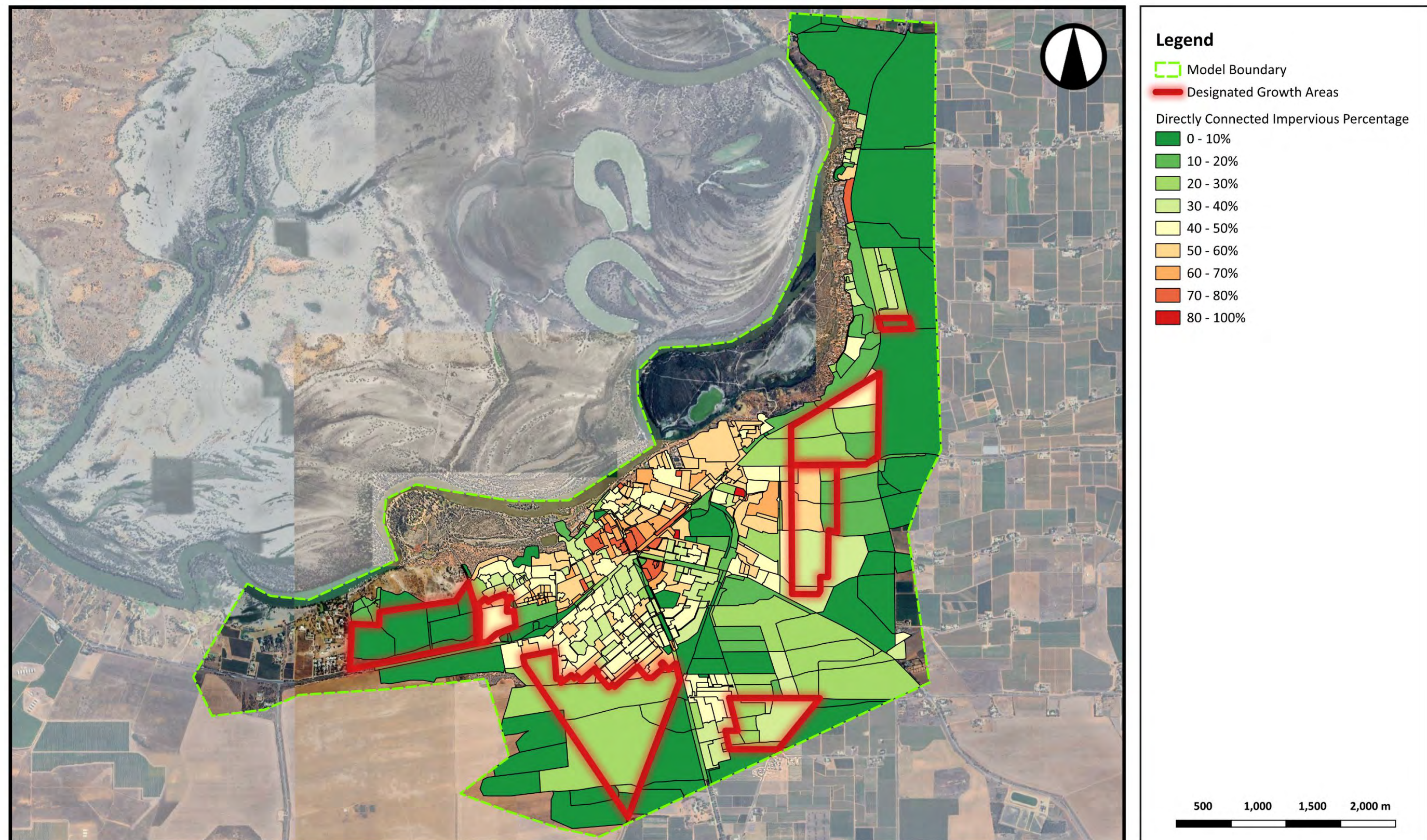
Drawn: T. Blaser

Coordinate System: GDA2020 / MGA zone 54

Background Imagery: Nearmap (6 March 2023), Google Satellite



Figure 15. Directly connected impervious areas for Scenario A.



LOXTON STORMWATER MANAGEMENT PLAN

DIRECTLY CONNECTED IMPERVIOUS AREA - SCENARIO B + C (ULTIMATE DEVELOPMENT)

Project: 24024 - Loxton SMP

Revision: 2

Date: 03/07/2026

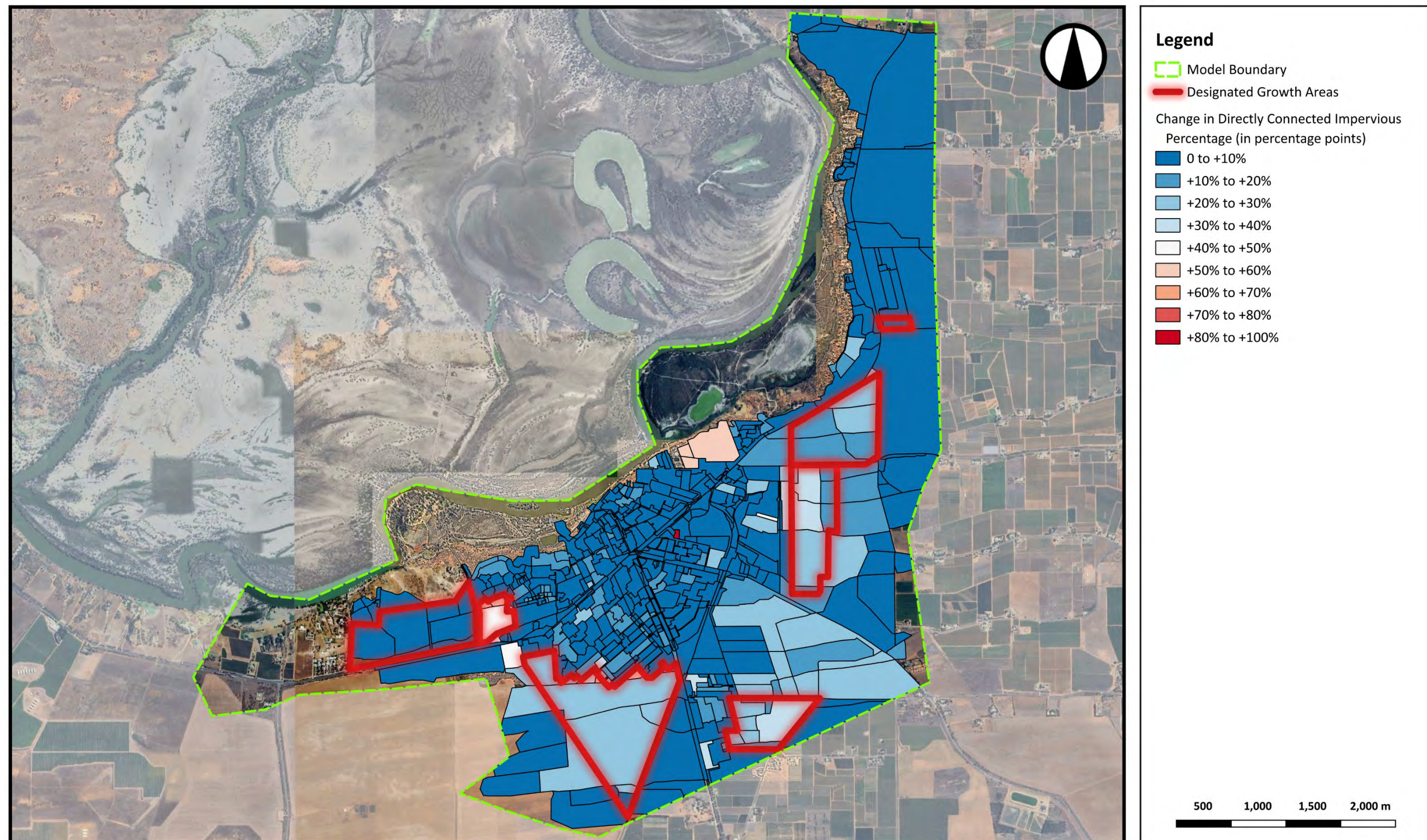
Drawn: T. Blaser

Coordinate System: GDA2020 / MGA zone 54

Background Imagery: Nearmap (6 March 2023), Google Satellite



Figure 16. Directly connected impervious areas for Scenarios B + C.



LOXTON STORMWATER MANAGEMENT PLAN
CHANGE IN DIRECTLY CONNECTED IMPERVIOUS AREA

Project: 24024 - Loxton SMP

Revision: 2

Date: 03/07/2026

Drawn: T. Blaser

Coordinate System: GDA2020 / MGA zone 54

Background Imagery: Nearmap (6 March 2023), Google Satellite



Figure 17. Change in directly connected impervious areas (expressed in percentage points).

3.3. Hydraulics (TUFLOW)

TUFLOW is a 1D/2D hydrodynamic modelling software that enables integrated simulation of both underground pipe networks and surface flows. This dual capability allows for detailed representation of urban drainage systems, capturing interactions between subsurface and overland flow paths. An initial model was developed and calibrated in consultation with Council, based on local anecdotal knowledge of previous flood events.

All ten (10) temporal patterns, across 20 durations of all six (6) events were modelled and assessed to determine critical durations across the study area, allowing for spatial variations in observed maximums.

3.4. Drainage network

Council provided shapefiles of the drainage network in Loxton, which was updated during a Condition Assessment prior to the commencement of modelling. The updated network was used as the basis for modelling, with additional information obtained from Council, where possible, or infilled using assumptions based on professional judgement in line with current best practice principles, for example missing invert levels were assumed using the formula:

$$\text{Surface} = 600\text{mm cover} - \text{pipe diameter}$$

Where measured values were available, these were preferenced for the surface level in the above calculations: if not, the Digital Elevation Model (DEM) from the LiDAR was used. Levels were then assessed and adjusted via linear interpolation, where necessary, to ensure continuation of gravity flow.

All outlets to rivers or basins were assumed free draining.

3.5. Adopted parameters

3.5.1. Model domain and resolution

The model domain was set to encompass the whole town, planned growth areas and their respective contributing catchment areas. The 2D model took advantage of TUFLOW's Quadtree feature, to vary cell sizes according to the level of detail required in different areas. Cell sizes used are shown below:

- 16m - Base cell size
- 8m – Peri-urban areas
- 4m – Urban areas
- 2m – roadways

Additionally, Sub Grid Sampling (SGS) was used with a 0.5 m sampling distance. SGS samples cell walls to better control flows and volumes of cells, which allows for greater accuracy in modelling with larger cell sizes and enhances water movements at stormwater inlets.

3.5.2. Digital Elevation Model

The DEM for the model was developed using a combination of the 2024 and 2021 DEW 50cm resolution LiDAR datasets available through the ELVIS platform. The 2024 LiDAR was preferenced where it was available, with the 2021 LiDAR only used in areas not covered by the 2024 data. No

adjustments were made at the join, which was typically less than +/- 100 mm. While this affects approximately 14% of the model area, it mostly covers undeveloped land, with the exception of the two suburban blocks south of Betty Rd, between Paruna Rd and Sturt St. The join also cuts through Growth Areas 1 & 3, but does not appear to impact results in any noticeable way.

3.5.3. Topographic modifications

To better represent true ground conditions, the following topographic adjustments were made:

- The 2021 LiDAR surface was stamped over the 2024 surface for the deeper eastern section of Fifth St basin and the Railway Yard basin, when water levels were lower, and thus more storage was available for the model.
- The Luther Rd, Mill Corner and Kokoda basins were all reduced according to measured depths (from top of basin) provided by Council.

3.5.4. Surface roughness

TUFLOW models bed resistance using GIS “Materials” layers that specify the Manning’s n value to be used at any given location. Table 9 outlines the categories used for this project, and the corresponding Manning’s n value.

Table 9. Roughness coefficients used throughout the modelling.

Classification	Example area(s)	Manning’s roughness coefficient used
Water	River Murray, Basins	0.015
Road	Roads, asphalted carparks	0.016
Bare earth	Areas with little or no vegetation (e.g. gravel roads)	0.03
Urban areas	Urban residential areas	0.035
‘Low’ vegetation	Grassed and mostly grassed areas (e.g. parks, sports fields)	0.04
‘Medium’ vegetation	Areas of trees and shrubs	0.05
‘Dense’ vegetation	Heavily vegetated, non-agricultural areas	0.075
Horticulture	Vineyards and plantations	0.15
Buildings	Building footprints	0.3

3.5.5. Basins

There are 12 basins noted within the Loxton township, plus a number of smaller basins that appear to be privately owned. Six (6) of these appear to be permanent storages, while the other nine (9) appear to spend the majority of the year dry, outside of rain events and their respective drying times.

The basins with permanent water volumes include:

- McMillan St – near Scenic Drive

- ii. Fifth St (eastern portion) – near Klingberg St
- iii. Kokoda Terrace – corner of Aleppo St & Starceovich Rd
- iv. Mill Corner – Raymont Ave at end of new swale from Bookpurnong Terrace, near Mill Rd
- v. Luther Rd – adjacent to school; opposite WWTP

The basins that are typically dry include:

- vi. Third St – corner of Nalara Ave & Tobruk Terrace
- vii. Tobruk Terrace – near Aleppo St
- viii. Eyre St – two connected basins at the northern end of Eyre St
- ix. Robertson Ave – near Badcoe Rd
- x. Trenerry Ave – near Kenna Rd
- xi. Keith Payne Crt – end of cul-de-sac
- xii. Starceovich Rd – at Nut Producers Australia production facility

Aerial imagery and assessment of LiDAR also suggests a number of private basins, plus one basin in development. The larger, more noteworthy of the above include:

- xiii. Jan Cass Crescent – near Hayward Terrace / Queen Place (in construction)
- xiv. Loxton Historic Village – off Scenic Drive
- xv. Wells St / Traeger St
- xvi. Paruna Rd – southern extent, where it becomes Browns Well Highway
- xvii. Old Railway Yard – on Railway Terrace
- xviii. Gratwick Rd – near Costi & Sons

Private basin:

- xix. Bookpurnong Rd – just north of The Wine Group

3.5.6. Inflows

Inflows to the model were as hydrographs from the DRAINS model, entered into the 2D domain directly at the pit. TUFLOW's default processes (which use the Engelund loss approach) were then used to determine inflows into the underground network (the 1D domain), with water not entering the network at that pit continuing overland (in the 2D domain).

There are large sections of Loxton that either flow to a single pit, or are not currently served by existing infrastructure. To ensure that modelling highlights excessive roadside and kerb flows, plus to aid in upstream decision-making where required, catchments were created or pit catchments were further divided into sub-catchments and hydrographs were inserted directly onto the 2D model domain at these locations.

3.6. Assumptions and limitations

The modelling approach is appropriate for a study of this scale but includes assumptions that limit its use for detailed, site-specific assessments.

Urban sub-catchments were assumed to drain to the fronting street. Pipe sizes and directions were verified during field inspections, with unconfirmed assets either removed or retained based on available data. Recommendations include CCTV inspections of critical pipelines to confirm capacity and condition.

Pipe invert levels (ILs) were determined using measured values where possible, supplemented by calculations or DEM estimates - as described in Section 3.4 - and adjusted to ensure gravity flow through linear interpolation. The model followed industry-standard IL-CL methods, while soil and groundwater interactions, such as seepage from unlined basins, were not modelled.

3.7. Validation

No photographic evidence, recorded basin heights or stream flows were available for the purpose of validating the model, aside from 24-hr Bureau totals. Validation relied on observations from Neilly Group staff, and anecdotal evidence from Council.

On Dec 4, 2024, Neilly Group staff were on site when a storm delivered approximately 3-5 mm in 45 minutes. This matches the design rainfall for a 6 EY event. This event was modelled and results viewed by staff who were on site that day. Consensus was that for the area visited, the results appeared consistent with observations on the day.

Neilly Group also reviewed recent Bureau records for nearby stations and simulated two of the largest recent events for review with Council. Results were considered representative for most of the town, with only minor modifications requested at specific locations. To facilitate this, Council provided additional information on basin depths and pipe sizes, results were again presented to council via email and the model was accepted for use.

Additionally, during the development of the SMP, an event of the 2% AEP magnitude occurred in Loxton. Council staff noted the consistency with model results, and provided photographic imagery of specific areas which were used in later stages to assist in calibration of the model.

4. Flood Modelling Results

Flood maps for all modelled events are provided in Attachment C (Scenario A: Existing Conditions) and Attachment D (Scenario B: Ultimate Development).

Loxton experiences significant kerb and channel flows even in relatively minor events, with modelling predicting impacts to properties along specific flow paths that increase in magnitude as events get larger. It is worth noting, however, that fence lines have not been modelled, and may provide some measure of protection.

Flows typically follow the west to east nature of the underlying topography, and in many cases terminate in basins. It is essential therefore to ensure sufficient capacity in both the network leading to these basins, and in the basins themselves, which will likely include ensuring basins can be drained prior to large events wherever possible.

The follow sections assess results in greater detail, with a detailed flood impact assessment provided for the 18% AEP (Minor) and 1% AEP (Major) design events.

4.1. Drainage performance

To aid in the analysis and discussion of results, the town has been separated into 21 “Damage Areas”, as shown in Figure 18. Drainage performance has been assessed by reviewing pit surcharging and has been categorised according to the least frequent event that causes surcharging. Results are shown in Figure 19.

Key locations in the stormwater network have been determined with corresponding peak flow details. Critical duration information and peak flow rates for each location are provided in Attachment B.

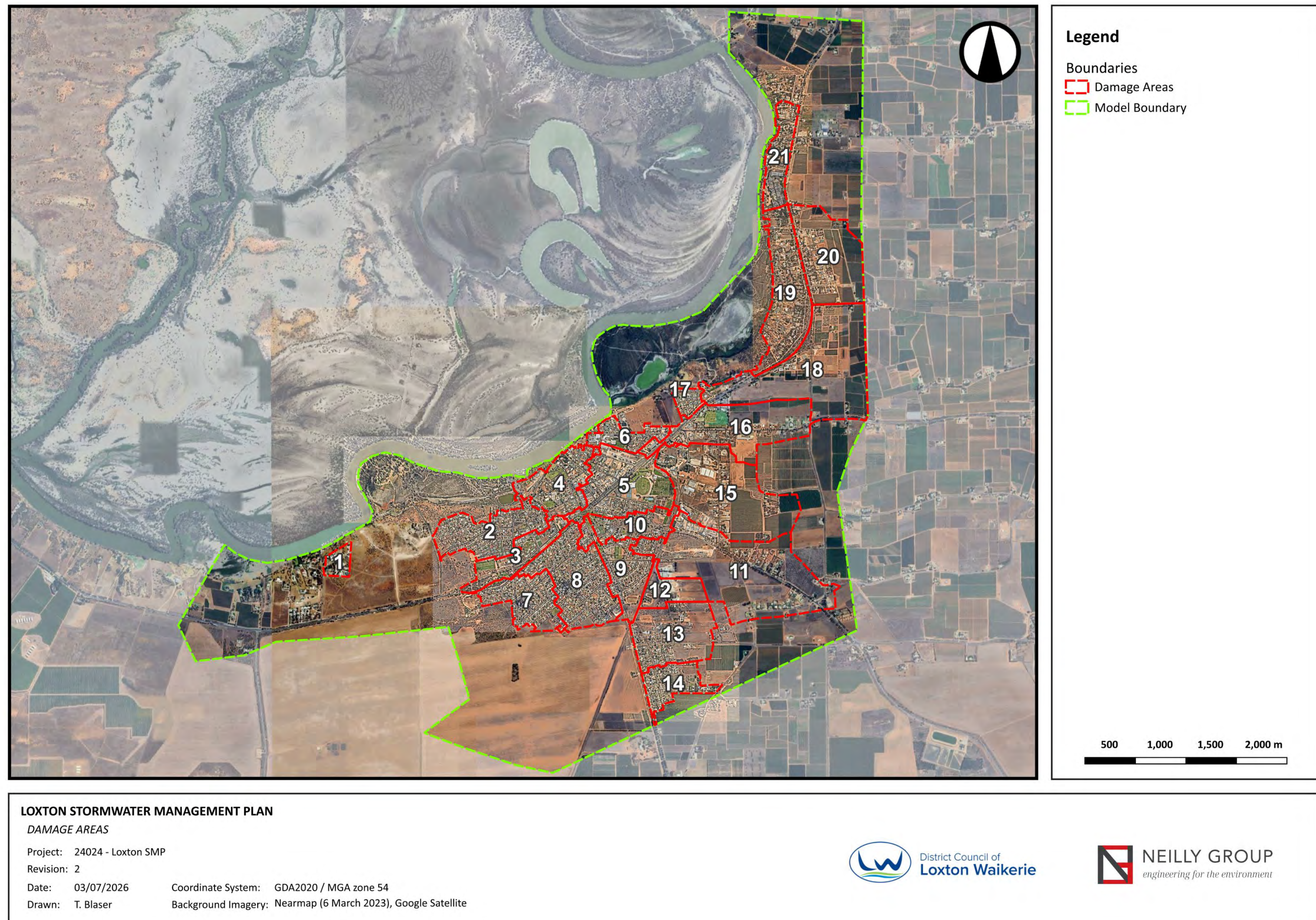
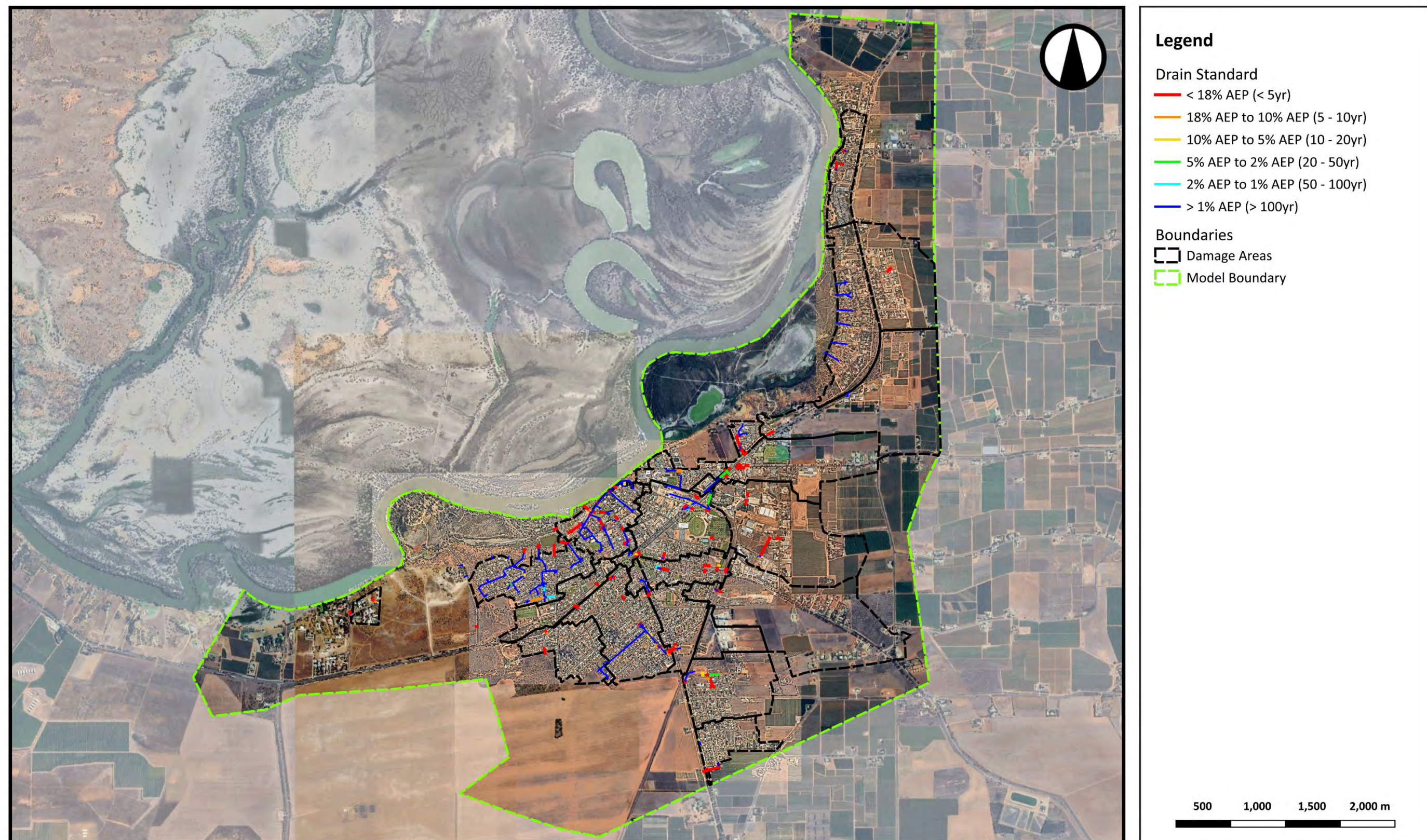


Figure 18. Damage Areas.



LOXTON STORMWATER MANAGEMENT PLAN

DRAINAGE PERFORMANCE (SURCHARGE) - SCENARIO A (EXISTING CONDITIONS)

Project: 24024 - Loxton SMP

Revision: 2

Date: 03/07/2026

Coordinate System: GDA2020 / MGA zone 54

Drawn: T. Blaser

Background Imagery: Nearmap (6 March 2023), Google Satellite



Figure 19. Drain Standard - Scenario A (Existing Conditions)

4.2. Flood impacts

Resulting flooding was assessed for the following criteria:

- Flooding of allotments (300 mm depth minimum threshold)
- Excessive gutter flows
 - Depths: 300 mm minimum threshold
 - Widths: considered as a car needing to leave the lane to avoid.
- Road closures (full road width flooded, min. 300 mm depth)
- Flood islands (isolated areas with safe no escape route – includes areas where residents cannot safely exit the property)
- Basin performance / overflows
- Any inundation of critical infrastructure sites
- Any inundation of socially, culturally or environmentally sensitive sites

Over floor flooding has not been included in this section and is discussed in Section 4.3.

Flood maps and a register of impacts are provided for the minor (18% AEP) and major (1% AEP) events, under both Existing Conditions and Ultimate Development. Details are provided in Table 10, below.

Table 10. Details of flood maps and risk register.

Scenario		Figure	Table
1a	18% AEP - Existing Conditions	Figure 21	Table 11
5a	1% AEP - Existing Conditions	Figure 22	Table 12
1b	18% AEP - Ultimate Development	Figure 23	Table 13
5b	1% AEP - Ultimate Development	Figure 24	Table 14

A complete set of flood mapping results, for all modelled scenarios, is provided in Attachment C (Existing Conditions) and Attachment D (Ultimate Development). A list of additional locations that have been identified outside the damage areas are provided in Attachment G. These locations are typically in areas that are distant from existing stormwater infrastructure and/or do not present significant risk to the general public (i.e. in the middle of fields).

4.2.1. Flood hazard

Flood hazard analysis has been undertaken following *Guideline 7.3 Flood Hazard*, from the Australian Disaster Resilience handbook collection (Australian Institute for Disaster Resilience (AIDR) 2017).

Flood hazard is defined in this guideline based on a combination of the flooding depth and the velocity of floodwaters. Six categories break this down into levels - H1, generally safe; to H6, unsafe for vehicles and people, all building types vulnerable to failure – as shown in Figure 20.

The maximum hazard classification for each impact location is included in the Impact Registers.

This report considers categories H3 and H4 as “**High hazard**”, and H5 and H6 as “**Extreme hazard**”. Additional areas of high or extreme hazard risk in the minor or major event, that are not identified in the impact registers, include:

- Roadside (kerb) flows along McMillan St and Fifth St
- Locations listed in Attachment G.

Complete hazard mapping results are provided in Attachment F.

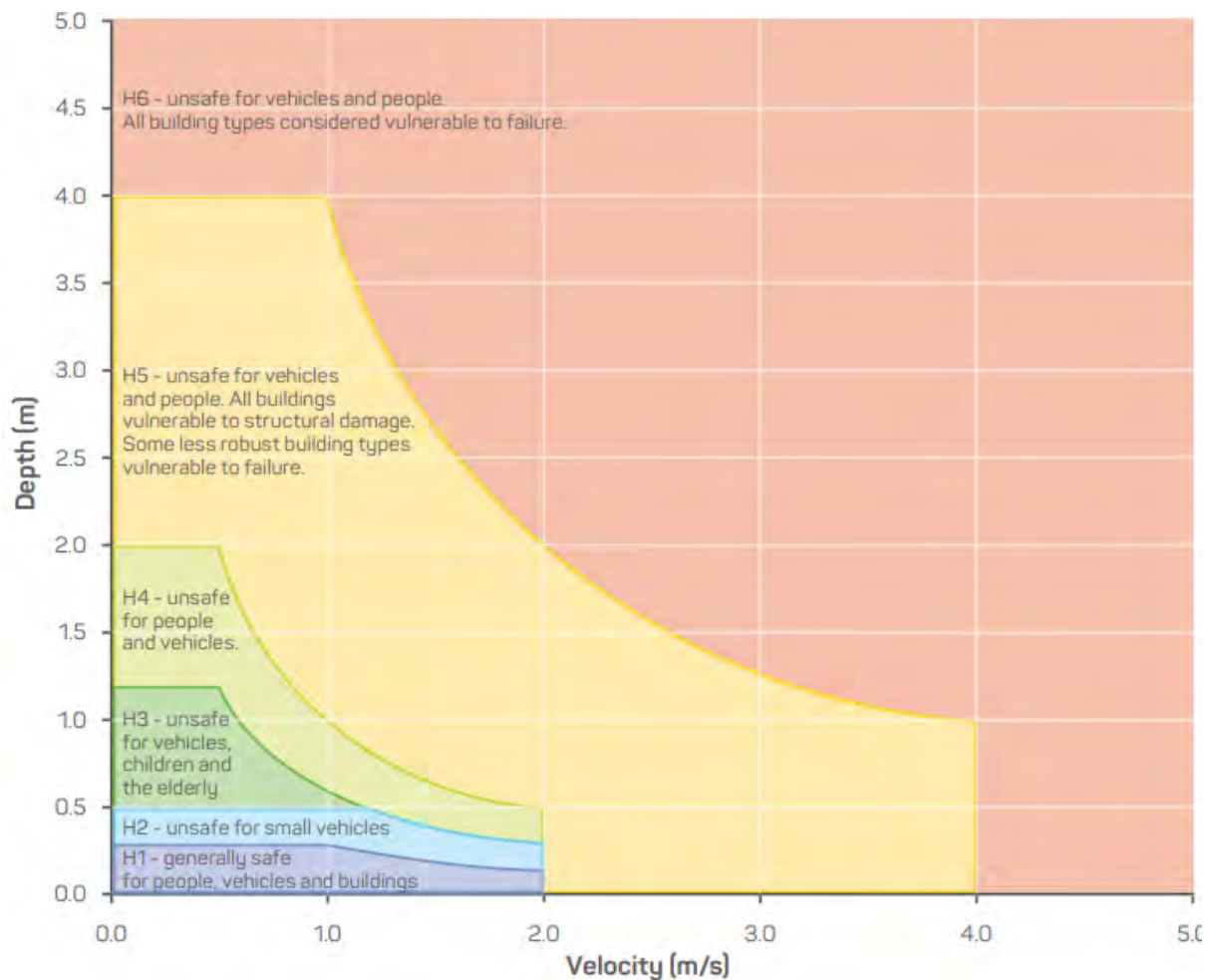


Figure 20. General flood hazard vulnerability curves (AIDR 2017, p. 10).

4.2.2. Basins

There are many formal, informal and private basins in and around Loxton, as described in Section 3.5.5. These include shaped, lined basins, such as the Mill Corner and Tobruk Terrace basins, shaped, unlined basins, such as the Eyre St basins, and many natural (or less well-defined) unlined depressions such as the Third St and Robertson Rd basins.

Basins that are unlined have not been modelled to allow infiltration, which may have the benefit of reducing the levels suggested in the modelling.

The Fifth St, Third St and Tobruk Terrace basins are all connected via overflow pipes, which have been included in the modelling, with overflows from Fifth St going to Third St, and overflows from Third St going to Tobruk Terrace.

Results from the modelling show the following:

Minor event – Scenario A

- The Starcevich Rd, Mill corner, Third St, Paruna Rd and Trenerry Ave basins overflow to some degree in all modelled events. For the 18% AEP event, under Existing Conditions, the Starcevich Rd & Trenerry Ave basins cause significant problems.

Minor event – Scenario B

- Under Ultimate Development conditions the Third St basin also floods adjacent roads and properties, and flooding extends between the Starcevich and Trenerry Ave basins, flooding all properties in between. The Keith Payne Court basin also overtops, causing additional flooding on the road and adjacent properties in this event.

Major event – Scenario A & B

- The basins listed above all overflow significantly under both ultimate development scenarios, causing widespread flooding that affects roads and properties. These basins are responsible for the majority of flood damage costs – see Section 4.3.
- In addition, the following basins also overflow onto adjacent roads and properties in these events:
 - Kokoda Terrace
 - Eyre St
 - Paruna Rd
 - Traeger / Wells Streets
 - Luther Rd
 - Gratwick Rd

4.2.3. Swales

There are several swales located around Loxton that help control stormwater runoff. The major swales, and their performance in the minor and major events, are discussed below.

The large grassed swale that connects the stormwater network in the vicinity of the Railway Terrace & Bookpurnong Rd intersection overflows in all modelled events.

There are both formal and informal swales along Gratwick Rd and the intersection with Bookpurnong Rd. These perform reasonably well in the minor event under existing conditions, but begin to impact buildings under Ultimate Development. There are significant overflows under the major events that completely flood Gratwick Rd and the service road heading south adjacent to Bookpurnong Rd.

The swale leaving the Loxton Historic Village retains all flows in channel under all modelled events.

The swale that passes flows from Thiele Ave to the McMillan St basin shows some slight overflows in the major event; however, these simply spill onto the floodplain and do not appear to be cause for concern.

4.2.4. Flood Impacts Registers

Table 11. Impacts Register - Scenario 1a - 18 % AEP Existing Conditions

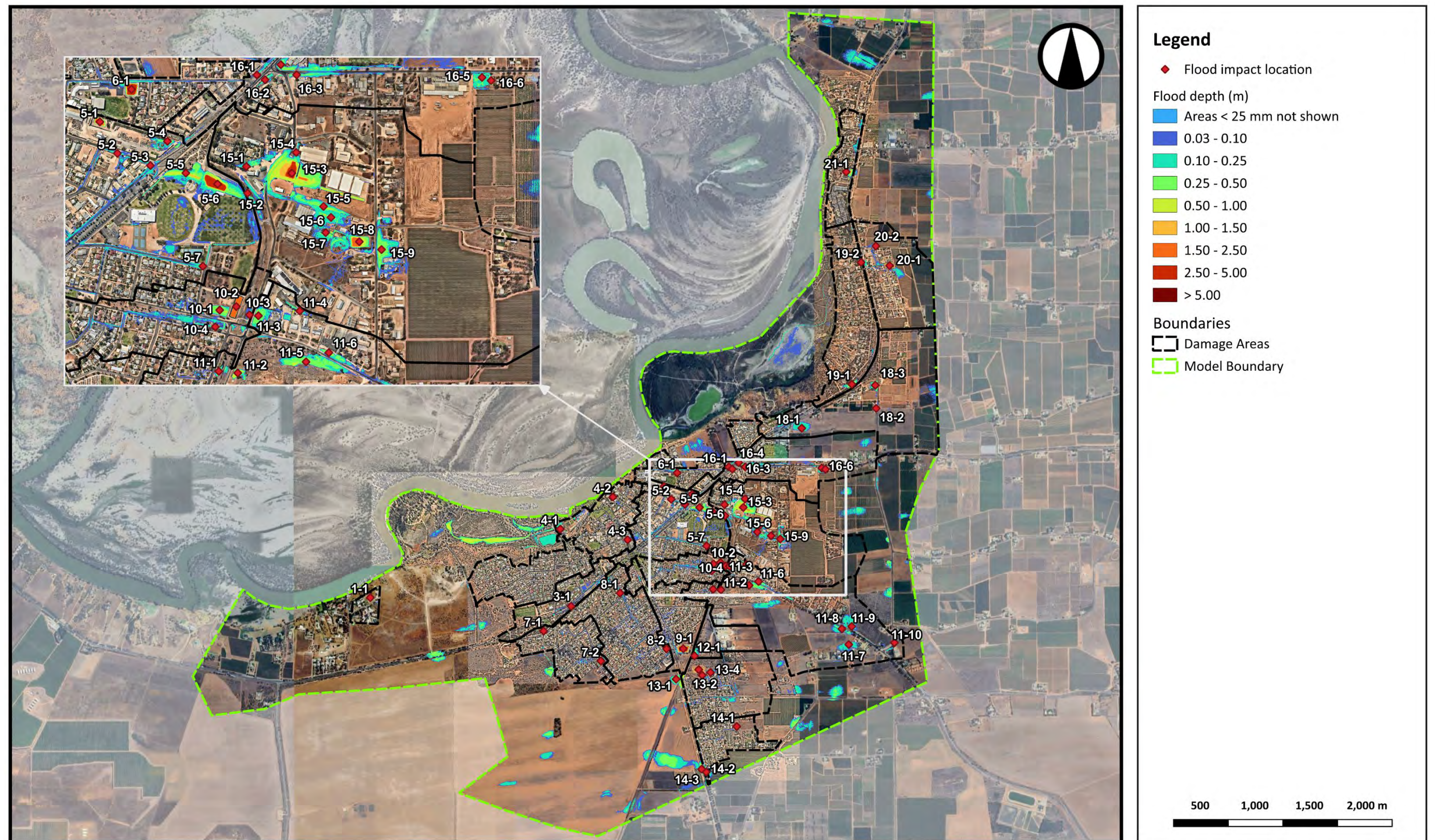
ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
1-1	25 Katarapko Dr	Ponding in depression north-west of cul-de-sac	Flooding of allotment		32	552	H1
3-1	Bookpurnong Tce (Near Fifth St)	Ponding along swale in median strip, near walking track	Inundation of environmentally sensitive site Inundation of culturally sensitive site		102	569	H2
4-1	Intersection of McMillan St and Grant Schubert Dr	Ponding in swale	Inundation of environmentally sensitive site Inundation of culturally sensitive site		348	608	H2
4-2	21 William St	Ponding in garden area of property	Flooding of allotment		116	722	H3
4-3	20 East Tce	Significant gutter flows	Excessive gutter flows Inundation of culturally sensitive site		20	704	H2
5-1	Hentschke Transport Grain Storage, Railway Terrace	Basin filled to capacity	Ponding greater than 300 mm		983	2550	H5
5-2	3 Railway Tce	Significant gutter flows	Excessive gutter flows	23	27	342	H1
5-3	Riverland Floor Centre	Ponding on side of road	Excessive gutter flows	9	10	360	H1
5-4	1968 Bookpurnong Rd	Ponding next to main road and into Henschke Transport yard	Flooding of allotment		412	815	H2
5-5	Mill Corner railway memorial	Ponding in grassed swale between Raymont Ave and Bookpurnong Rd	Basin / swale overflow Inundation of culturally sensitive site		3101	1361	H3
5-6	Mill Corner Basin (Raymont Ave)	Ponding in basin, overflowing into depression on south-east boundary	Basin / swale overflow		5032	3569	H5

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
5-7	Intersection of A W Traeger Dr and Pine Ave	Ponding on and along road	Excessive gutter flows Road closures	77	113	388	H2
6-1	Luther Rd (Across Water treatment plant)	Basin filled to capacity and minor ponding on Luther Rd	Excessive gutter flows		1866	2660	H5
7-1	127 Bookpurnong Tce	Ponding in depression in median strip, near Community Conservation and Heritage Park	Ponding greater than 300 mm		352	930	H3
7-2	Basin at Fifth St/Klingberg St	Basin overflows	Basin / swale overflow		2096	1532	H4
8-1	10-18 Third St	Significant gutter flows	Excessive gutter flows	66	88	402	H2
8-2	Basin at the end of Third St	Ponding in basin	Basin / swale overflow		2621	6630	H6
9-1	Basin at Tobruk Tce/Paruna Rd	Basin filled to capacity	Ponding greater than 300 mm		5079	4399	H6
10-1	Kokoda Tce (Woodleigh)	Ponding in vacant land. Since been developed which may change hazards.	Flooding of allotment		1634	634	H3
10-2	Kokoda Tce detention basin	Basin filled to capacity	Excessive gutter flows		1666	2247	H5
10-3	Intersection between Starceвич Rd and Kokoda Tce	Ponding in depressions on side of Starceвич Rd	Ponding greater than 300 mm		31	400	H1
10-4	Across 50 Kokoda Tce	Ponding in median strip between Coral St and Aleppo St	Excessive gutter flows		149	401	H2
11-1	Between Aleppo St and Robertson Ave	Ponding in depression between the two roads, along railway line	Flooding of allotment		263	613	H3
11-2	Basin on Robertson Ave	Overflowing basin	Flooding of allotment		926	1162	H3
11-3	83 Starceвич Rd (Loxton Ice Works)	Ponding in depression on side of road and into yard	Flooding of allotment		1167	470	H2
11-4	26 Starceвич Rd (Riverland Cold Stores)	Ponding in block behind building	Flooding of allotment		231	1426	H3
11-5	23 Badcoe Rd (Southern side)	Ponding in vacant land by quarry	Flooding of allotment		3921	626	H3

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
11-6	Badcoe Rd (Northern side)	Ponding in depression on side of road between driveways	Flooding of allotment		639	748	H2
11-7	130 Badcoe Rd	Ponding in block behind house, encroaching on shed in backyard	Flooding of allotment		389	460	H2
11-8	Across 111 Badcoe Rd	Ponding on southern side of road in vacant land	Flooding of allotment		641	452	H2
11-9	111 Badcoe Rd	Ponding around house and in vacant land around house	Flooding of allotment		67	376	H1
11-10	Intersection between Dorsch Ave and Kingsbury Rd	Ponding in depression next to intersection	Flooding of allotment		192	481	H2
12-1	Near Tobruk Tce basin	Ponding in vacant land along railway line	Flooding of allotment		492	1131	H2
13-1	Intersection between Paruna Rd and railway line	Ponding in depressions on the sides of the elevated intersection	Flooding of allotment		5143	880	H3
13-2	Eyre St (Small basin)	Basin filled to capacity	Ponding greater than 300 mm		868	1475	H4
13-3	Eyre St (bigger basin)	Basin filled to capacity	Ponding greater than 300 mm		3377	2542	H5
13-4	Between Eyre St and Torrens St	Ponding along dirt track connecting the northern ends of each road	Flooding of allotment		67	408	H2
14-1	Basin at Wells St	Basin filled to capacity	Ponding greater than 300 mm		904	1418	H4
14-2	163 Paruna Rd	Ponding in depression on side of road, below basin inlet	Flooding of allotment		199	1027	H3
14-3	Basin at Paruna Rd	Basin filled to capacity and ponding in surrounding depressions	Flooding of allotment Basin / swale overflow		1439	2321	H5
15-1	3 Mill Rd	Ponding in garden in front of house	Flooding of allotment	55	193	464	H2
15-2	Between Raymont Ave and Starceovich Rd	Ponding along the railway line between the roads	Ponding greater than 300 mm		133	450	H2

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
15-3	Basin on Starceвич Rd	Ponding in basin, overflowing onto road and into Riverland Almonds	Excessive gutter flows Flooding of allotment Road closures Basin / swale overflow		12858	3570	H5
15-4	29 Starceвич Rd (Riverland Almonds)	Ponding in swale in front of building	Flooding of allotment		149	774	H3
15-5	51 Starceвич Rd (Handbuilt warehouse)	Ponding around the sheds behind the office	Flooding of allotment		2869	1233	H3
15-6	51 Starceвич Rd (Handbuilt warehouse)	Ponding in block behind warehouse	Flooding of allotment		436	1466	H3
15-7	63 Starceвич Rd (Viva Olives)	Ponding in block behind office	Flooding of allotment		393	1275	H3
15-8	Basin across 65-71 Trenerry Ave	Basin filled to capacity	Flooding of allotment		2499	2409	H5
15-9	65-71 Trenerry Ave	Ponding in depression on side of road	Flooding of allotment		2411	787	H3
16-1	Between Luther Rd and Bookpurnong Rd	Ponding in swale between main road and Luther Rd, in front of Mammoth Fitness	Excessive gutter flows	28	66	456	H2
16-2	1937 Bookpurnong Rd (In front of Loxton Irrigation Centre)	Ponding in swale between main road and service road	Ponding greater than 300 mm	7	127	508	H2
16-3	18 Gratwick Rd	Ponding along the south side of the road	Excessive gutter flows Flooding of allotment	190	271	421	H2
16-4	Ronco Powersports (Ronco motors)	Ponding in depression on side of road, and along the north side of Gratwick Rd	Flooding of allotment	309	1081	617	H3
16-5	78 Gratwick Rd	Ponding around property	Flooding of allotment		263	408	H2
16-6	88 Gratwick Rd	Basin filled to capacity	Ponding greater than 300 mm		394	2643	H5
18-1	1839 Bookpurnong Rd	Ponding in paddock	Flooding of allotment		113	328	H2
18-2	39 Dorsch Ave	Ponding around property	Flooding of allotment		556	507	H2

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
18-3	18 Dorsch Ave	Ponding around property and encroaching on shed	Flooding of allotment		2868	818	H3
19-1	1800 Simpson Rd	Ponding along both sides of the road	Excessive gutter flows Flooding of allotment	105	2108	817	H3
19-2	1672 Simpson Rd	Ponding along both sides of the road	Ponding greater than 300 mm	67	439	702	H3
20-1	Basin at Keith Payne Ct	Basin filled to capacity	Ponding greater than 300 mm		3408	2916	H5
20-2	18 French Rd	Ponding on side of road	Flooding of allotment		31	383	H2
21-1	1594 Bookpurnong Rd (Winery weighbridge)	Ponding in east-most depression, overflowing onto asphalt area	Flooding of allotment Basin / swale overflow		1458	1390	H4



LOXTON STORMWATER MANAGEMENT PLAN

FLOOD IMPACT LOCATIONS - MINOR EVENT (18% AEP) - EXISTING CONDITIONS

Project: 24024 - Loxton SMP

Revision: 2

Date: 02/07/2026

Drawn: T. Blaser

Coordinate System: GDA2020 / MGA zone 54

Background Imagery: Nearmap (6 March 2023), Google Satellite



Figure 21. Flood impact locations - minor event - Scenario A (Existing Conditions).

Table 12. Impacts Register - Scenario 5a – 1% AEP Existing Conditions

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
1-1	25 Katarapko Dr	Ponding in depression north-west and south-east of cul-de-sac	Flooding of allotment		347	1133	H5
2-1	9 Thiele Ave	Ponding on north-eastern side of road	Excessive gutter flows		35	461	H2
2-2	9 Westbrook Ave	Significant flows along gutter and through property	Excessive gutter flows		22	488	H2
2-3	8 Hilltop Dr	Ponding near SEP at the base of View St	Excessive gutter flows		42	405	H2
2-4	McMillan St (Near detention basin)	Ponding along road and in bushland near basin	Excessive gutter flows	58	91	559	H1
3-1	Bookpurnong Tce (Near Fifth St)	Ponding along swale in median strip, near walking track	Inundation of environmentally sensitive site Inundation of culturally sensitive site		130	601	H2
3-2	72 Bookpurnong Tce	Significant gutter flows and ponding over McMillan/Bookpurnong intersection	Excessive gutter flows	28	73	407	H2
3-3	Bookpurnong Rd median strip (Between Sadlier St and McMillan St)	Ponding over grassed area and walking track	Flooding of allotment Inundation of culturally sensitive site	79	465	410	H2
3-4	Intersection of View St and Bookpurnong Tce	Flows through spoon drain parallel to Bookpurnong Rd	Excessive gutter flows	44	46	344	H2
3-5	Bookpurnong Tce (Community Conservation and Heritage Park)	Ponding in basin under bridge, not overflowing	Ponding greater than 300 mm		99	540	H2
3-6	Bookpurnong Tce median strip (Opposite 141 Bookpurnong Tce)	Ponding along walking trail	Ponding greater than 300 mm		91	511	H2

ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
4-1	Intersection of McMillan St and Grant Schubert Dr	Ponding in swale + wetland area and over walking trails	Inundation of environmentally sensitive site Inundation of culturally sensitive site		1384	761	H3
4-2	21 William St	Ponding in garden area of property	Flooding of allotment		253	1192	H3
4-3	20 East Tce	Significant gutter flows	Excessive gutter flows Inundation of culturally sensitive site	7	31	739	H2
4-4	Loxton Historical Village	Ponding in depressions across village and above floor levels	Flooding of allotment Flood islands Inundation of culturally sensitive site		4260	2066	H5
4-5	Swale parallel to Scenic Dr	Flows through swale system and some ponding	Flooding of allotment		610	579	H3
4-6	Swale adjacent Scenic Drive	Ponding in swale	Ponding greater than 300 mm		42	993	H2
4-7	Corner of Pioneer Walk and William St	Ponding on corner next to road	Excessive gutter flows		22	421	H2
5-1	Hentschke Transport Grain Storage, Railway Terrace	Basin filled to capacity	Ponding greater than 300 mm		1803	4170	H6
5-2	3 Railway Tce	Significant gutter flows	Excessive gutter flows	39	79	380	H2
5-3	Riverland Floor Centre	Ponding in median strip between Bookpurnong Rd lanes	Excessive gutter flows		402	470	H2
5-4	1968 Bookpurnong Rd	Ponding in depression on side of road, in mulched area	Flooding of allotment		743	890	H3
5-5	Mill Corner railway memorial	Ponding in grassed swale between Rayment Ave and Bookpurnong Rd, Mill Corner basin overflowing into swale and into showgrounds	Road closures Basin / swale overflow Inundation of culturally sensitive site		12189	3706	H5

ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
5-7	Intersection of A W Traeger Dr and Pine Ave	Ponding on and along road, flows over Pine Ave	Excessive gutter flows Road closures Inundation of culturally sensitive site	97	485	478	H2
5-8	Pine Ave (Football oval car park)	Ponding in dirt car park by swimming pool	Ponding greater than 300 mm		59	456	H2
5-9	Intersection of Geraldton St and Pine Ave	Ponding over intersection parallel to Pine Ave	Excessive gutter flows	78	47	358	H2
6-1	Luther Rd and basin (Across Water treatment plant)	Significant gutter flows along, basin overtopping capacity onto road and into school grounds	Excessive gutter flows Flooding of allotment Road closures Basin / swale overflow Inundation of culturally sensitive site	180	3433	2902	H5
7-1	127 Bookpurnong Tce	Ponding in depression in median strip, near Community Conservation and Heritage Park	Ponding greater than 300 mm	58	574	1165	H3
7-2	Basin at Fifth St and Klingberg St	Ponding in basin overflowing onto Fifth St	Excessive gutter flows Basin / swale overflow		4123	3303	H5
7-3	10 Trantalis Ct	Ponding along gutter and SEP	Excessive gutter flows		39	363	H2
8-1	10-18 Third St	Significant gutter flows	Excessive gutter flows	148	495	523	H2
8-3	61 Bookpurnong Tce	Significant gutter flows and ponding in front yard of property	Excessive gutter flows Flooding of allotment	55	193	437	H2
9-1	Third St and Tobruk Tce/Paruna Rd basins	Third St and Paruna Rd basins overflowing into properties, inundation of houses, yards, and roads. Basins connected by overflows	Excessive gutter flows Flooding of allotment Road closures Flood islands Basin / swale overflow		75808	7998	H6

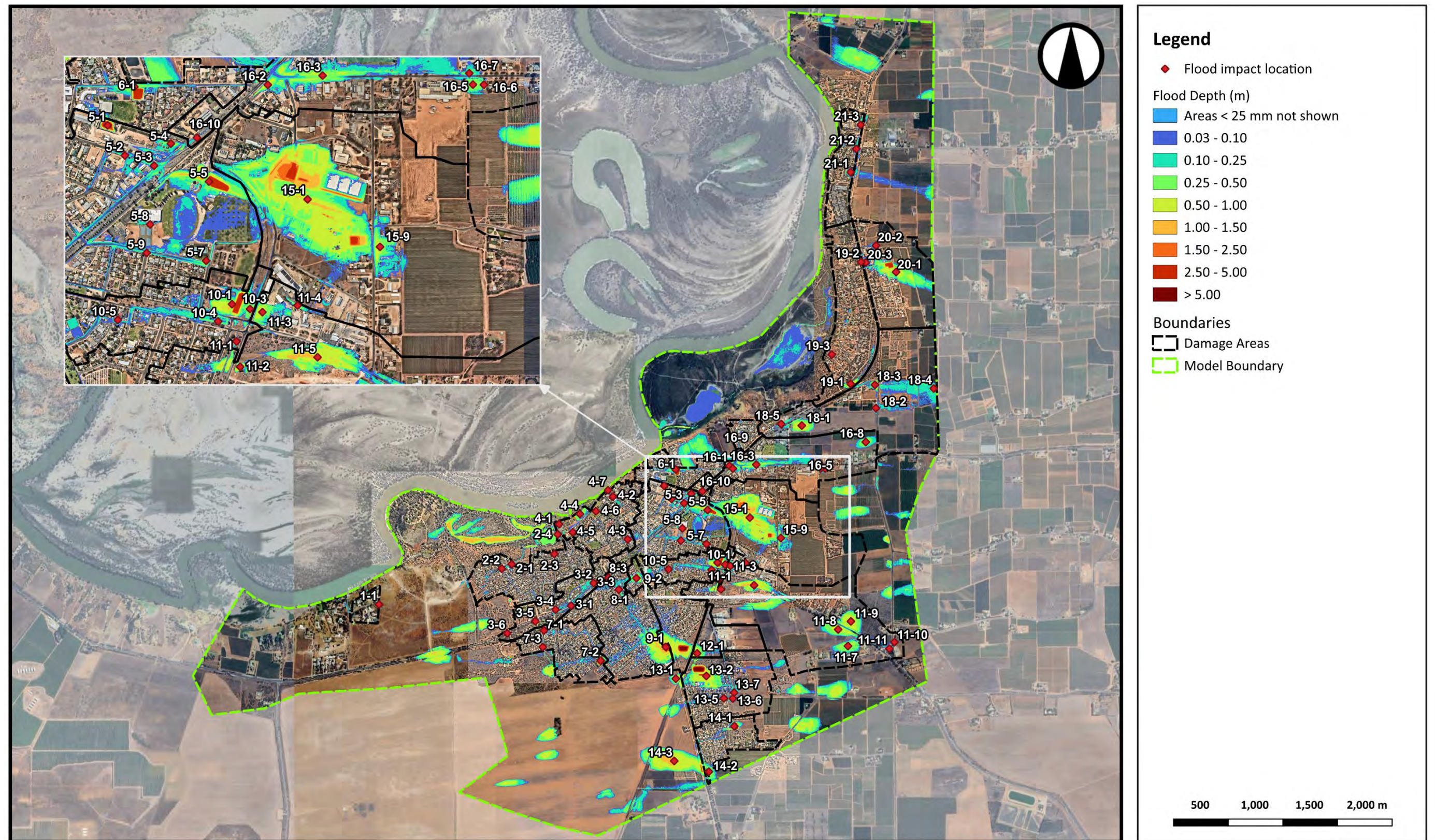
ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
9-2	14-18 Tobruk Tce	Inundation of houses and yards, ponding over surrounding roads into Tobruk Tce median strip	Excessive gutter flows Flooding of allotment Road closures Flood islands		5014	740	H3
10-1	Kokoda Tce (Woodleigh) detention basin	Ponding in median strip between Coral St and Aleppo At and in basin, overflowing onto Woodleigh site and along railway line	Excessive gutter flows Flooding of allotment Basin / swale overflow Inundation of culturally sensitive site		8790	4077	H6
10-3	Intersection of Kokoda Tce and Starceвич Rd	Ponding in depression west of Starceвич Rd, overflowing onto road	Excessive gutter flows Flooding of allotment		1108	739	H3
10-4	Across 50 Kokoda Tce	Ponding in median strip between Coral St and Aleppo At	Ponding greater than 300 mm		587	521	H2
10-5	Laneway between Geraldton St and Anzac Cres	Significant gutter flows	Excessive gutter flows	45	12	341	H1
11-1	Between Aleppo St and Robertson Ave	Ponding over road and into depression along railway line	Excessive gutter flows Flooding of allotment Road closures		2534	1165	H3
11-2	Basin on Robertson Ave	Overflowing basin	Flooding of allotment		983	1199	H3
11-3	83 Starceвич Rd (Loxton Ice Works)	Ponding in depression on side of road and into yard, up to floor level of sheds	Flooding of allotment		3295	697	H3
11-4	26 Starceвич Rd (Riverland Cold Stores)	Ponding in block behind building	Flooding of allotment		399	1496	H3
11-5	23 Badcoe Rd	Ponding in vacant land by quarry, over Badcoe Rd and into roadside properties	Excessive gutter flows Flooding of allotment Road closures		37340	1263	H4
11-7	130 Badcoe Rd	Ponding in block behind house and into yards of houses on Drummond Ave	Flooding of allotment		11920	749	H3

ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
11-8	Across 111 Badcoe Rd	Ponding on southern side of road in vacant land	Excessive gutter flows Flooding of allotment		18337	931	H3
11-9	111 Badcoe Rd	Ponding around block and over floor level of entire house	Excessive gutter flows Flooding of allotment Flood islands		23232	844	H3
11-10	Intersection between Dorsch Ave and Kingsbury Rd	Ponding in depression next to intersection	Flooding of allotment		254	525	H2
11-11	8 Kingsbury Rd	Ponding in depression next to road	Ponding greater than 300 mm	26	56	340	H1
12-1	Near Tobruk Tce basin	Ponding in vacant land along railway line	Flooding of allotment		10038	1696	H3
13-1	Intersection between Paruna Rd and railway line	Ponding in depressions on the sides of the elevated intersection	Flooding of allotment		7062	1257	H4
13-2	Eyre St	Ponding in basin system, overflowing into houses on Eyre St	Excessive gutter flows Flooding of allotment Road closures Flood islands Basin / swale overflow Inundation of culturally sensitive site		41481	6640	H6
13-5	12 Barker St	Ponding over house level and around yard	Flooding of allotment Flood islands		473	473	H2
13-6	Vacant block west of 14 Barker St	Ponding in block	Ponding greater than 300 mm		38	345	H1
13-7	33 Barker St	Significant gutter flows along Robertson St	Excessive gutter flows	89	97	356	H2
14-1	Basin at Wells St	Ponding in basin, overflowing onto roads, houses and into paddock behind	Excessive gutter flows Flooding of allotment Road closures Basin / swale overflow		3995	3029	H5

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
			Inundation of culturally sensitive site				
14-2	163 Paruna Rd	Ponding in depression on side of road, overflowing into surrounding properties. Also ponding on corner of Paruna Rd and Betty St	Excessive gutter flows Flooding of allotment Flood islands Basin / swale overflow Inundation of culturally sensitive site		6548	1374	H3
14-3	Basin at Paruna Rd	Ponding in basin, overflowing onto roads and into paddock behind	Excessive gutter flows Flooding of allotment Basin / swale overflow		81342	2772	H5
15-1	3 Mill Rd	Inundation of buildings and yards, overflowing of basins on both Trenerry and Starcevic, encroaching on Mill Rd, and ponding in Mill Corner basin, with overflowing into swale	Excessive gutter flows Flooding of allotment Road closures Flood islands Basin / swale overflow Inundation of culturally sensitive site		116083	4318	H6
15-9	65-71 Trenerry Ave	Ponding in depression on side of road and encroaching on buildings	Excessive gutter flows Flooding of allotment Flood islands		4251	909	H3
16-1	Between Luther Rd and Bookpurnong Rd	Ponding in spoon drain between main road and Luther Rd, in front of Mammoth Fitness	Excessive gutter flows	61	164	553	H2
16-2	1937 Bookpurnong Rd (In front of Loxton Irrigation Centre)	Ponding in swale and overflowing onto service road	Excessive gutter flows Road closures Basin / swale overflow		1957	1127	H3
16-3	18 Gratwick Rd	Ponding over road and into yards of buildings on both sides of road	Excessive gutter flows Flooding of allotment Road closures		9800	788	H3

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
			Flood islands Inundation of culturally sensitive site				
16-5	78 Gratwick Rd	Ponding around property and in basin	Flooding of allotment Flood islands		1307	494	H2
16-6	88 Gratwick Rd	Ponding in basin, overflowing in natural swale towards road	Ponding greater than 300 mm		456	2729	H5
16-7	73 Gratwick Rd	Ponding in front of house along Gratwick Rd	Flooding of allotment		253	350	H2
16-8	119 Gratwick Rd	Ponding in paddock behind house (away from structures)	Flooding of allotment		5154	538	H2
16-9	1920 Bookpurnong Rd	Flows in swale near Tanko Cres	Ponding greater than 300 mm	43	59	400	H1
16-10	1966 Bookpurnong Rd	Ponding in swale between main road and service road, near field gully	Ponding greater than 300 mm	19	17	424	H1
18-1	1839 Bookpurnong Rd	Ponding along service road, around house, and in paddock	Flooding of allotment Flood islands		15964	721	H3
18-2	39 Dorsch Ave	Ponding around property	Excessive gutter flows Flooding of allotment Flood islands		1259	642	H3
18-3	18 Dorsch Ave	Ponding over entrance to property / shed	Excessive gutter flows Flooding of allotment Flood islands		4130	949	H3
18-4	13 Dorsch Ave	Ponding in block behind buildings (away from structures)	Flooding of allotment		555	450	H2
18-5	1868 Bookpurnong Rd (Loxton High School ag. block)	Ponding on side of road	Ponding greater than 300 mm		139	557	H2
19-1	1800 Simpson Rd	Ponding along both sides of the road and onto Bookpurnong Rd	Excessive gutter flows Flooding of allotment	169	4800	1116	H3

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
			Road closures Flood islands				
19-2	1672 Simpson Rd	Ponding along both sides of the road	Excessive gutter flows	118	700	755	H3
19-3	82 Wheatley Rd	Ponding in depression in front of house	Flooding of allotment		22	820	H2
20-1	Basin at end of Keith Payne Ct	Ponding in basin, overflowing into surrounding houses and paddocks behind	Excessive gutter flows Flooding of allotment Road closures Flood islands Basin / swale overflow		39634	3917	H5
20-2	18 French Rd	Ponding in paddock	Flooding of allotment		144	448	H2
20-3	1679 Bookpurnong Rd	Ponding in depression in front of house and up to house level	Flooding of allotment		796	481	H2
21-1	1594 Bookpurnong Rd (Winery weighbridge)	Ponding in east-most depression, overflowing onto asphalt area	Flooding of allotment Basin / swale overflow		1919	1443	H4
21-2	Intersection of Alamein Ave and Bookpurnong Rd	Ponding on side of road and scattered through vacant block	Flooding of allotment		83	402	H2
21-3	1546 Bookpurnong Rd	Ponding on side of road	Ponding greater than 300 mm	64	127	661	H1



LOXTON STORMWATER MANAGEMENT PLAN

FLOOD IMPACT LOCATIONS - MAJOR EVENT (1% AEP) - EXISTING CONDITIONS

Project: 24024 - Loxton SMP

Revision: 2

Date: 02/07/2026

Coordinate System: GDA2020 / MGA zone 54

Drawn: T. Blaser

Background Imagery: Nearmap (6 March 2023), Google Satellite



Figure 22. Flood impact locations - major event - Scenario A (Existing Conditions).

Table 13. Impacts Register - Scenario 1b – 18 % AEP Ultimate Development

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
1-1	25 Katarapko Dr	Ponding in earthen space	Flooding of allotment		36	561	H1
2-1	9 Thiele Ave	Ponding on north-eastern side of road	Excessive gutter flows		6	341	H1
2-2	9 Westbrook Ave	Significant flows along gutter and through property	Excessive gutter flows		5	403	H1
2-3	8 Hilltop Dr	Ponding near SEP at the base of View St	Excessive gutter flows		4	325	H1
2-4	McMillan St (Near detention basin)	Ponding along road and in bushland near basin	Inundation of environmentally sensitive site	58	7	496	H1
3-1	Bookpurnong Tce (Near Fifth St)	Ponding along swale in median strip, near walking track	Flooding of allotment Inundation of environmentally sensitive site Inundation of culturally sensitive site		103	570	H2
3-2	72 Bookpurnong Tce	Significant gutter flows and ponding over McMillan/Bookpurnong intersection	Excessive gutter flows	28	8	317	H1
3-3	Bookpurnong Tce (Community Conservation and Heritage Park)	Ponding in basin under bridge, not overflowing	Ponding greater than 300 mm		9	394	H1
3-4	Bookpurnong Tce median strip (Opposite 141 Bookpurnong Tce)	Ponding along walking trail	Ponding greater than 300 mm		19	368	H2
4-1	Intersection of McMillan St and Grant Schubert Dr	Ponding in swale + wetland area and over walking trails	Inundation of environmentally sensitive site Inundation of culturally sensitive site		371	622	H2
4-2	21 William St	Ponding in garden area of property	Flooding of allotment		199	1018	H3
4-3	20 East Tce	Significant gutter flows	Excessive gutter flows	14	23	708	H2

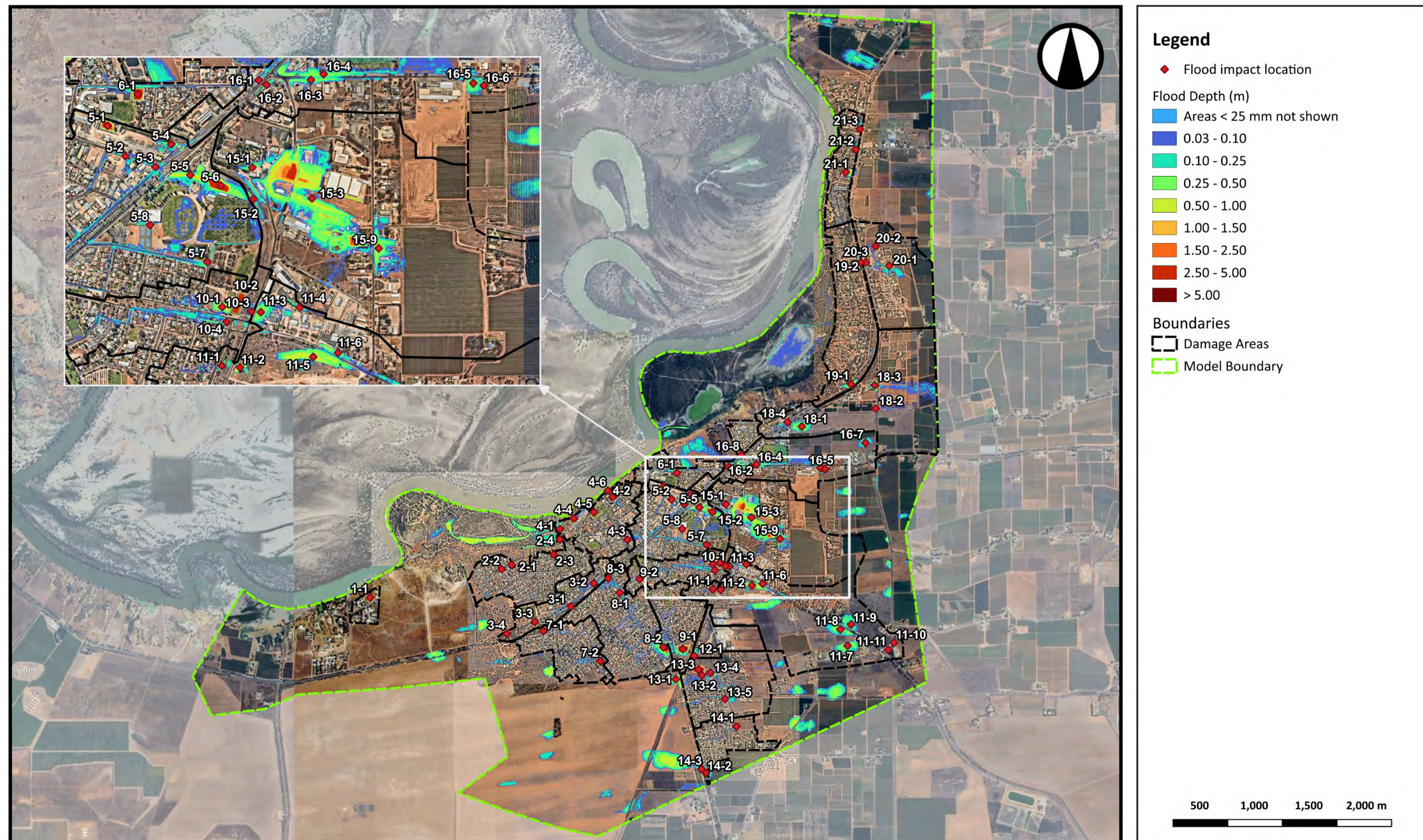
ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
4-4	Loxton Historical Village	Ponding in depressions across village and above floor levels	Flooding of allotment Inundation of culturally sensitive site		270	546	H3
4-5	Swale adjacent Scenic Drive	Ponding in swale	Ponding greater than 300 mm		8	558	H1
4-6	Corner of Pioneer Walk and William St	Ponding on corner next to road	Excessive gutter flows		4	338	H1
5-1	Hentschke Transport Grain Storage, Railway Terrace	Basin filled to capacity	Ponding greater than 300 mm		1664	3962	H5
5-2	3 Railway Tce	Significant gutter flows	Excessive gutter flows	33	40	355	H1
5-3	Riverland Floor Centre	Ponding on side of road	Excessive gutter flows		29	381	H2
5-4	1968 Bookpurnong Rd	Ponding in depression on side of road, in mulched area	Flooding of allotment		479	827	H2
5-5	Mill Corner railway memorial	Ponding in grassed swale between Raymont Ave and Bookpurnong Rd, overflowing towards Railway Memorial	Flooding of allotment Basin / swale overflow		3328	1383	H3
5-6	Mill Corner Basin (Raymont Ave)	Ponding in basin, overflowing into depression on south-east boundary	Flooding of allotment Basin / swale overflow		5227	3592	H5
5-7	Intersection of A W Traeger Dr and Pine Ave	Ponding on and along road, flows over Pine Ave	Excessive gutter flows Road closures	97	207	415	H2
5-8	Pine Ave (Football oval car park)	Ponding in dirt car park by swimming pool	Ponding greater than 300 mm		51	437	H2
6-1	Luther Rd (Across Water treatment plant)	Significant gutter flows and basin filled to capacity	Excessive gutter flows	163	2033	2738	H5
7-1	127 Bookpurnong Tce	Ponding in depression in median strip, near Community Conservation and Heritage Park	Excessive gutter flows Flooding of allotment	56	397	1005	H3

ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
7-2	Basin at Fifth St and Klingberg St	Basin filled to capacity	Ponding greater than 300 mm		2818	2075	H5
8-1	10-18 Third St	Significant gutter flows	Excessive gutter flows	148	163	431	H2
8-2	Basin at the end of Third St	Ponding in basin, overflowing onto Third St and into surrounding properties	Excessive gutter flows Flooding of allotment Road closures Flood islands Basin / swale overflow		9262	7248	H6
8-3	61 Bookpurnong Tce	Significant gutter flows and ponding in front yard of property	Excessive gutter flows	43	14	341	H1
9-1	Basin at Tobruk Tce/Paruna Rd	Overflowing basin	Flooding of allotment Basin / swale overflow		6498	5025	H6
9-2	14-18 Tobruk Tce	Ponding on road	Excessive gutter flows		8	315	H1
10-1	Kokoda Tce (Woodleigh)	Site under construction; few ponded areas	Flooding of allotment Inundation of culturally sensitive site		2017	722	H3
10-2	Kokoda Tce detention basin	Basin filled to capacity	Ponding greater than 300 mm		1968	2982	H5
10-3	Intersection between Starceovich Rd and Kokoda Tce	Ponding in depressions on side of Starceovich Rd	Ponding greater than 300 mm		38	411	H1
10-4	Across 50 Kokoda Tce	Ponding in median strip between Coral St and Aleppo At	Ponding greater than 300 mm		243	422	H2
11-1	Between Robertson Ave and Aleppo St	Ponding in depression; overflows on road	Flooding of allotment		362	693	H3
11-2	Basin on Robertson Ave	Overflowing basin	Flooding of allotment		943	1173	H3
11-3	83 Starceovich Rd (Loxton Ice Works)	Ponding in depression on side of road and into yard, up to floor level of sheds	Excessive gutter flows Flooding of allotment		1771	532	H3

ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
11-4	26 Starcevich Rd (Riverland Cold Stores)	Ponding in block behind building	Flooding of allotment		266	1438	H3
11-5	23 Badcoe Rd (Southern side)	Ponding in vacant land by quarry	Flooding of allotment		13648	822	H3
11-6	Badcoe Rd (Northern side)	Ponding in depression on side of road between driveways and over walking track	Inundation of culturally sensitive site		1047	801	H3
11-7	130 Badcoe Rd	Ponding in block behind house and into yards of houses on Drummond Ave	Flooding of allotment		5378	622	H2
11-8	Across 111 Badcoe Rd	Ponding on southern side of road in vacant land	Flooding of allotment		5414	637	H3
11-9	111 Badcoe Rd	Ponding around block and over floor level of house	Flooding of allotment		1305	436	H2
11-10	Intersection between Dorsch Ave and Kingsbury Rd	Ponding in depression next to intersection	Ponding greater than 300 mm		194	482	H2
11-11	8 Kingsbury Rd	Ponding in depression next to road	Ponding greater than 300 mm	27	4	309	H1
12-1	Near Tobruk Tce basin	Ponding in vacant land along railway line	Flooding of allotment		673	1153	H2
13-1	Intersection between Paruna Rd and railway line	Basin filled to capacity	Flooding of allotment		5955	954	H3
13-2	Eyre St	Basin filled to capacity	Ponding greater than 300 mm		990	1693	H4
13-3	Eyre St (bigger basin)	Basin filled to capacity	Ponding greater than 300 mm		5305	4840	H6
13-4	Between Eyre St and Torrens St	Ponding along dirt track connecting the northern ends of each road	Ponding greater than 300 mm		78	429	H2
13-5	12 Barker St	Ponding over house level and around yard	Flooding of allotment		40	357	H2
14-1	Basin at Wells St	Basin filled to capacity	Flooding of allotment		1278	2386	H5
14-2	163 Paruna Rd	Ponding in depression on side of road, below basin inlet	Flooding of allotment		541	1069	H3

ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
14-3	Basin at Paruna Rd	Ponding in basin, overflowing towards road	Flooding of allotment Basin / swale overflow		1614	2341	H5
15-1	3 Mill Rd	Ponding in garden in front of house	Flooding of allotment		265	482	H2
15-2	Between Raymont Ave and Starceвич Rd	Ponding along the railway line between the roads	Ponding greater than 300 mm		192	472	H2
15-3	Basin on Starceвич Rd	Inundation of buildings and yards, overflowing of basins on both Trenerry and Starceвич, ponding in Riverland Almonds and neighbouring properties	Excessive gutter flows Flooding of allotment Road closures Flood islands Basin / swale overflow		45831	3884	H5
15-9	65-71 Trenerry Ave	Ponding in depression on side of road and encroaching on buildings	Flooding of allotment		2920	830	H3
16-1	Between Luther Rd and Bookpurnong Rd	Ponding in spoon drain between main road and Luther Rd, in front of Mammoth Fitness	Excessive gutter flows	54	77	472	H2
16-2	1937 Bookpurnong Rd (In front of Loxton Irrigation Centre)	Ponding in swale and overflowing onto service road	Ponding greater than 300 mm		193	618	H2
16-3	18 Gratwick Rd	Ponding over road and into yards of buildings on southern side of Gratwick Rd	Flooding of allotment		1339	557	H2
16-4	Ronco Powersports (Ronco motors)	Ponding in depression on side of road, and along northern side of Gratwick Rd	Flooding of allotment Flood islands		3303	661	H3
16-5	78 Gratwick Rd	Ponding around property and in basin	Flooding of allotment Flood islands		612	442	H2
16-6	88 Gratwick Rd	Basin filled to capacity and overflowing in natural swale towards road	Flooding of allotment Basin / swale overflow		415	2677	H5
16-7	119 Gratwick Rd	Ponding in paddock behind house (away from structures)	Flooding of allotment		158	373	H2

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
16-8	1920 Bookpurnong Rd	Flows in swale near Tanko Cres	Ponding greater than 300 mm	33	10	323	H1
18-1	1839 Bookpurnong Rd	Ponding along service road, around house, and in paddock	Flooding of allotment		4594	430	H2
18-2	39 Dorsch Ave	Ponding around property	Flooding of allotment		732	545	H2
18-3	18 Dorsch Ave	Ponding over entrance to property / shed	Flooding of allotment Flood islands		3454	889	H3
18-4	1868 Bookpurnong Rd (Loxton High School ag. block)	Ponding on side of road	Ponding greater than 300 mm		6	503	H1
19-1	1800 Simpson Rd	Ponding along both sides of the road and onto Bookpurnong Rd	Excessive gutter flows Flooding of allotment Road closures	168	2903	913	H3
19-2	1672 Simpson Rd	Ponding along both sides of the road	Excessive gutter flows	118	496	709	H3
20-1	Basin at end of Keith Payne Ct	Ponding in basin, overflowing into cul-de-sac	Excessive gutter flows Road closures Basin / swale overflow		4109	3399	H5
20-2	18 French Rd	Ponding in paddock	Flooding of allotment		34	385	H2
20-3	1679 Bookpurnong Rd	Ponding in depression in front of house and up to house level	Flooding of allotment		69	350	H2
21-1	1594 Bookpurnong Rd (Winery weighbridge)	Ponding in east-most depression, overflowing onto asphalt area	Flooding of allotment Basin / swale overflow		1539	1397	H4
21-2	Intersection of Alamein Ave and Bookpurnong Rd	Ponding on side of road and scattered through vacant block	Excessive gutter flows		23	359	H2
21-3	1546 Bookpurnong Rd	Ponding on side of road	Excessive gutter flows	66	10	563	H1



LOXTON STORMWATER MANAGEMENT PLAN

FLOOD IMPACT LOCATIONS - MINOR EVENT (18% AEP) - ULTIMATE DEVELOPMENT

Project: 24024 - Loxton SMP

Revision: 2

Date: 02/07/2026

Coordinate System: GDA2020 / MGA zone 54

Drawn: T. Blaser

Background Imagery: Nearmap (6 March 2023), Google Satellite



Figure 23. Flood impact locations - minor event - Scenario B (Ultimate Development).

Table 14. Impacts Register - Scenario 5b – 1% AEP Ultimate Development

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
1-1	25 Katarapko Dr	Ponding in earthen space	Flooding of allotment		334	1048	H5
2-1	9 Thiele Ave	Ponding on north-eastern side of road	Excessive gutter flows		58	525	H2
2-2	9 Westbrook Ave	Significant flows along gutter and through property	Excessive gutter flows		46	549	H2
2-3	8 Hilltop Dr	Ponding near SEP at the base of View St	Excessive gutter flows Flood islands		55	427	H2
2-4	McMillan St (Near detention basin)	Ponding along road and in bushland near basin	Excessive gutter flows	62	147	590	H2
3-1	Bookpurnong Tce (Near Fifth St)	Ponding along swale in median strip, near walking track	Flooding of allotment Inundation of environmentally sensitive site Inundation of culturally sensitive site		132	604	H2
3-2	72 Bookpurnong Tce	Significant gutter flows and ponding over McMillan/Bookpurnong intersection	Excessive gutter flows Road closures	28	89	421	H2
3-3	Bookpurnong Rd median strip (Between Sadlier St and McMillan St)	Ponding over grassed area and walking track	Flooding of allotment Inundation of culturally sensitive site	79	635	429	H2
3-4	Intersection of View St and Bookpurnong Tce	Flows through spoon drain parallel to Bookpurnong Rd	Excessive gutter flows	38	80	356	H2
3-5	Bookpurnong Tce (Community Conservation and Heritage Park)	Ponding in basin under bridge, not overflowing	Ponding greater than 300 mm		112	553	H2
3-6	Bookpurnong Tce median strip (Opposite 141 Bookpurnong Tce)	Ponding along walking trail	Ponding greater than 300 mm		92	516	H2

ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
4-1	Intersection of McMillan St and Grant Schubert Dr	Ponding in swale + wetland area and over walking trails	Inundation of environmentally sensitive site Inundation of culturally sensitive site		1663	797	H3
4-2	21 William St	Ponding in garden area of property	Flooding of allotment		266	1230	H3
4-3	20 East Tce	Significant gutter flows	Excessive gutter flows Inundation of culturally sensitive site	7	15	692	H2
4-4	Loxton Historical Village	Ponding in depressions across village and above floor levels	Flooding of allotment Inundation of culturally sensitive site		5293	2171	H5
4-5	Swale parallel to Scenic Dr	Flows through swale system and some ponding	Flooding of allotment		1345	737	H3
4-6	Swale adjacent Scenic Drive	Ponding in swale	Ponding greater than 300 mm		68	1167	H4
4-7	Corner of Pioneer Walk and William St	Ponding on corner next to road	Excessive gutter flows		39	469	H2
5-1	Hentschke Transport Grain Storage, Railway Terrace	Basin filled to capacity	Ponding greater than 300 mm		1804	4171	H6
5-2	3 Railway Tce	Significant gutter flows	Excessive gutter flows	42	94	396	H2
5-3	Riverland Floor Centre	Ponding in median strip between Bookpurnong Rd lanes and along Railway Tce	Excessive gutter flows Flood islands		941	514	H2
5-4	1968 Bookpurnong Rd	Ponding in depression on side of road, in mulched area	Flooding of allotment		800	897	H3
5-7	Intersection of A W Traeger Dr and Pine Ave	Ponding on and along road, flows over Pine Ave	Excessive gutter flows Road closures Inundation of culturally sensitive site	97	589	498	H2

ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
5-8	Pine Ave (Football oval car park)	Ponding in dirt car park by swimming pool	Flooding of allotment Inundation of culturally sensitive site		272	514	H2
5-9	Intersection of Geraldton St and Pine Ave, and Oak St and Pine Ave	Ponding over entire width of intersections parallel to Pine Ave	Excessive gutter flows Road closures		217	385	H2
6-1	Luther Rd (Across Water treatment plant)	Luther Rd basin overflowing, significant gutter flows, ponding in Lutheran School property	Excessive gutter flows Flooding of allotment Road closures Basin / swale overflow Inundation of culturally sensitive site	163	4184	2948	H5
7-1	127 Bookpurnong Tce	Ponding in depression in median strip, near Community Conservation and Heritage Park	Ponding greater than 300 mm	56	621	1196	H3
7-2	Basin at Fifth St and Klingberg St	Ponding in basin overflowing onto Fifth St	Excessive gutter flows Basin / swale overflow		4382	3364	H5
7-3	10 Trantalis Ct	Ponding along gutter and SEP	Excessive gutter flows Flood islands	22	111	397	H2
8-1	10-18 Third St	Significant gutter flows	Excessive gutter flows Flood islands	148	611	542	H2
8-3	61 Bookpurnong Tce	Significant gutter flows and ponding in front yard of property	Excessive gutter flows Flooding of allotment	43	290	453	H2
8-4	Intersection of Eringa Ave and Fourth St	Significant gutter flows	Excessive gutter flows	14	42	389	H2
9-1	Basin at Tobruk Tce/Paruna Rd	Inundation of houses and yards, overflowing basin, Tobruk Tce and Third Ave flooded. Flows and ponding connect Third Ave basin with Paruna Rd basin	Excessive gutter flows Flooding of allotment Road closures		95203	8156	H6

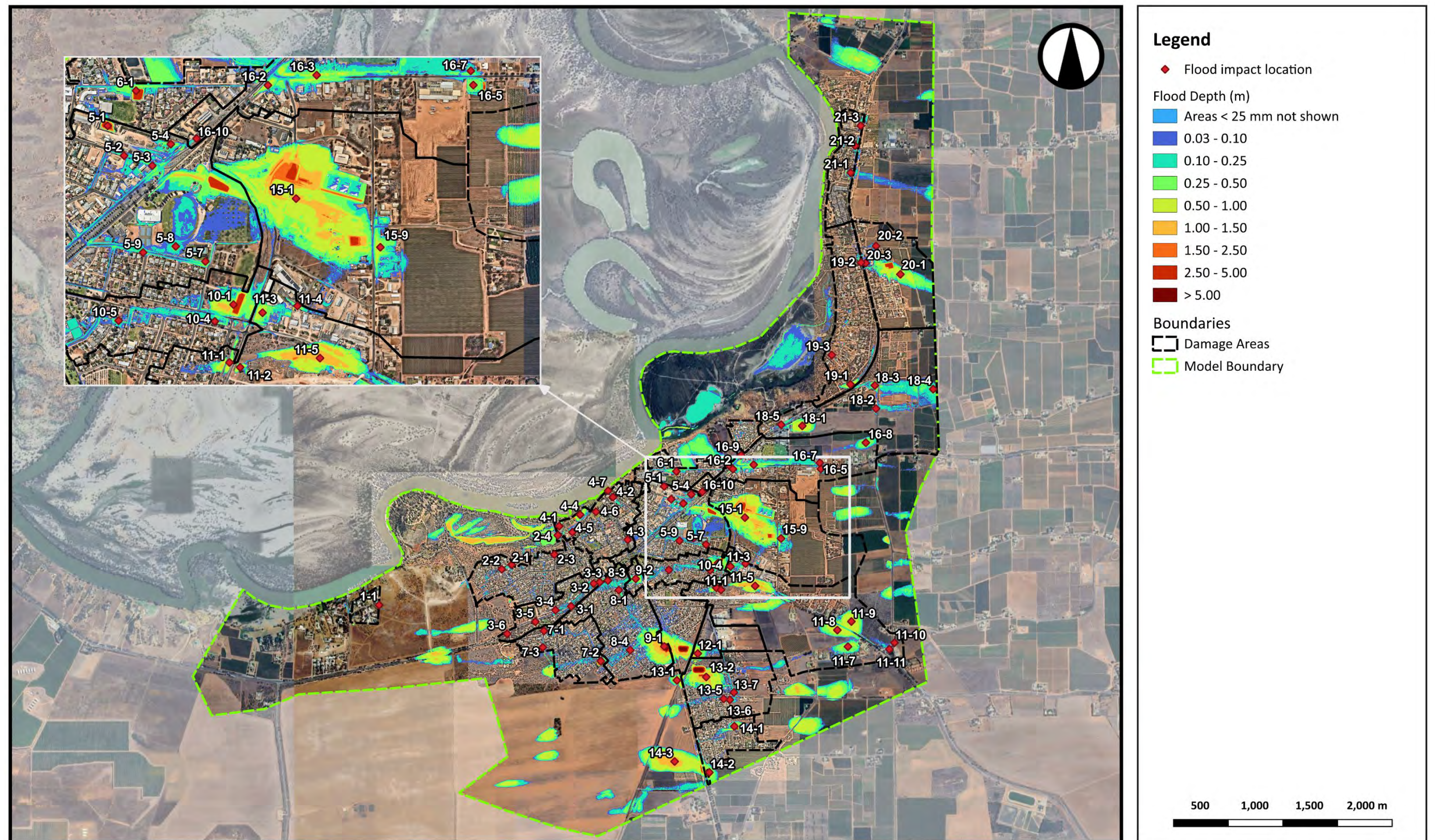
ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
			Flood islands Basin / swale overflow				
9-2	14-18 Tobruk Tce	Inundation of houses and yards, ponding over surrounding roads	Excessive gutter flows Flooding of allotment Road closures Flood islands		6426	793	H3
10-1	Kokoda Tce (Woodleigh) detention basin	Basin filled to capacity, ponding in grass-lined drain; overflows into Woodleigh property and over train line towards Starceвич Rd	Excessive gutter flows Flooding of allotment Basin / swale overflow Inundation of culturally sensitive site		12552	4183	H6
10-4	Across 50 Kokoda Tce	Ponding in median strip between Coral St and Aleppo St	Flooding of allotment		821	557	H2
10-5	Laneway between Geraldton St and Anzac Cres	Significant gutter flows	Excessive gutter flows	45	88	433	H2
11-1	Between Robertson Ave and Aleppo St	Ponding in depression; overflows over road	Excessive gutter flows Flooding of allotment Inundation of critical infrastructure		2986	1200	H3
11-2	Basin on Robertson Ave	Overflowing basin	Flooding of allotment		986	1201	H3
11-3	83 Starceвич Rd (Loxton Ice Works)	Ponding in depression on side of road and into yard, up to floor level of sheds	Flooding of allotment Flood islands		3518	717	H3
11-4	26 Starceвич Rd (Riverland Cold Stores)	Ponding in block behind building	Flooding of allotment		463	1516	H3
11-5	23 Badcoe Rd	Ponding in vacant land by quarry, extending over Badcoe Rd and into yards on northern side of the road	Excessive gutter flows Flooding of allotment Road closures Flood islands		49056	1598	H4

ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
11-7	130 Badcoe Rd	Ponding in block behind house and into yards of houses on Drummond Ave, encroaching on houses	Flooding of allotment		13118	777	H3
11-8	Across 111 Badcoe Rd	Ponding on southern side of road in vacant land	Excessive gutter flows Flooding of allotment		23155	1056	H3
11-9	111 Badcoe Rd	Ponding around block and over floor level of entire house, ponding over walking track	Excessive gutter flows Flooding of allotment Flood islands Inundation of culturally sensitive site		29042	994	H3
11-10	Intersection between Dorsch Ave and Kingsbury Rd	Ponding in depression next to intersection	Ponding greater than 300 mm		261	530	H2
11-11	8 Kingsbury Rd	Ponding in depression next to road	Ponding greater than 300 mm	27	68	348	H1
12-1	Near Tobruk Tce basin	Ponding in vacant land along railway line	Flooding of allotment		11552	1784	H3
13-1	Intersection between Paruna Rd and railway line	Ponding in depressions on the sides of the elevated intersection	Excessive gutter flows Flooding of allotment		7625	1022	H3
13-2	Eyre St basin	Ponding in basin system, overflowing into houses on Eyre St	Excessive gutter flows Flooding of allotment Road closures Flood islands Basin / swale overflow		56541	6899	H6
13-5	12 Barker St	Ponding over house level and around yard	Flooding of allotment Flood islands		516	479	H2
13-6	Vacant block west of 14 Barker St	Ponding in block	Flooding of allotment		115	357	H2
13-7	33 Barker St	Significant gutter flows along Robertson St	Excessive gutter flows	90	174	382	H2
14-1	Basin at Wells St	Ponding in basin, overflowing onto roads, houses and into paddock behind	Excessive gutter flows Flooding of allotment		6501	3184	H5

ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
			Road closures Flood islands Basin / swale overflow				
14-2	163 Paruna Rd	Ponding on corner of Paruna Rd and Betty St, ponding at basin inlet and overflowing into surrounding houses and blocks	Excessive gutter flows Flooding of allotment Road closures Flood islands Basin / swale overflow		11013	1527	H3
14-3	Basin at Paruna Rd	Ponding in basin, overflowing onto roads and into paddock behind	Flooding of allotment Basin / swale overflow		95008	2924	H5
15-1	3 Mill Rd	Inundation of buildings and yards, overflowing of basins on both Trenerry and Starceвич, encroaching on Mill Rd, and ponding in Mill Corner basin, with overflows into swale and over showgrounds	Excessive gutter flows Flooding of allotment Road closures Flood islands Basin / swale overflow Inundation of culturally sensitive site		161623	4490	H6
15-9	65-71 Trenerry Ave	Ponding in depression on side of road and encroaching on buildings	Excessive gutter flows Flooding of allotment Flood islands		4746	933	H3
16-1	Between Luther Rd and Bookpurnong Rd	Ponding in spoon drain between main road and Luther Rd, in front of Mammoth Fitness	Excessive gutter flows	60	207	576	H2
16-2	1937 Bookpurnong Rd (In front of Loxton Irrigation Centre)	Ponding in swale and overflowing over service road	Excessive gutter flows Road closures		2258	1155	H3
16-3	18 Gratwick Rd	Ponding over road and into yards of buildings on both sides of road	Excessive gutter flows Flooding of allotment Road closures Flood islands		11137	813	H3

ID	Location	Description	Impact type	Length (m)	Area (m²)	Max. Depth (mm)	Max Hazard rating
			Inundation of culturally sensitive site				
16-5	78 Gratwick Rd	Ponding around property and in basin. Basin overflowing through natural swale and ponding over floor level of house	Flooding of allotment Flood islands Basin / swale overflow		2089	2744	H5
16-7	73 Gratwick Rd	Ponding in front of house along Gratwick Rd	Flooding of allotment		654	401	H2
16-8	119 Gratwick Rd	Ponding in paddock behind house (away from structures)	Flooding of allotment		7707	591	H3
16-9	1920 Bookpurnong Rd	Flows in swale near Tanko Cres	Ponding greater than 300 mm	43	77	425	H1
16-10	1966 Bookpurnong Rd	Ponding in swale between main road and service road, near field gully	Ponding greater than 300 mm	19	29	466	H1
18-1	1839 Bookpurnong Rd	Ponding along service road, around house, and in paddock	Flooding of allotment Flood islands		18946	848	H3
18-2	39 Dorsch Ave	Ponding around property	Excessive gutter flows Flooding of allotment Flood islands		1363	662	H3
18-3	18 Dorsch Ave	Ponding over entrance to property / shed	Excessive gutter flows Flooding of allotment Flood islands		4602	975	H3
18-4	13 Dorsch Ave	Ponding in block behind buildings (away from structures)	Flooding of allotment		1552	479	H2
18-5	1868 Bookpurnong Rd (Loxton High School ag. block)	Ponding on side of road	Ponding greater than 300 mm		178	564	H2
19-1	1800 Simpson Rd	Ponding along both sides of the road and onto Bookpurnong Rd	Excessive gutter flows Flooding of allotment Road closures Flood islands	168	5183	1149	H3

ID	Location	Description	Impact type	Length (m)	Area (m ²)	Max. Depth (mm)	Max Hazard rating
19-2	1672 Simpson Rd	Ponding along both sides of the road	Excessive gutter flows	117	721	759	H3
19-3	82 Wheatley Rd	Ponding in depression in front of house	Flooding of allotment		23	827	H2
20-1	Basin at end of Keith Payne Ct	Ponding in basin, overflowing into surrounding houses and paddocks behind	Excessive gutter flows Flooding of allotment Road closures Flood islands Basin / swale overflow		50674	4000	H5
20-2	18 French Rd	Ponding in paddock	Flooding of allotment		159	456	H2
20-3	1679 Bookpurnong Rd	Ponding in depression in front of house and up to house level	Flooding of allotment Flood islands		835	491	H2
21-1	1594 Bookpurnong Rd (Winery weighbridge)	Ponding in east-most depression, overflowing onto asphalt area	Flooding of allotment Basin / swale overflow		1984	1450	H4
21-2	Intersection of Alamein Ave and Bookpurnong Rd	Ponding on side of road and scattered through vacant block	Flooding of allotment		138	414	H2
21-3	1546 Bookpurnong Rd	Ponding on side of road	Ponding greater than 300 mm	66	184	667	H1



LOXTON STORMWATER MANAGEMENT PLAN

FLOOD IMPACT LOCATIONS - MAJOR EVENT (1% AEP) - ULTIMATE DEVELOPMENT

Project: 24024 - Loxton SMP

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Drawn: T. Blaser

Coordinate System: GDA2020 / MGA zone 54

Background Imagery: Nearmap (6 March 2023), Google Satellite



Figure 24. Flood impact locations - major event - Scenario B (Ultimate Development).

4.3. Flood damages

Estimating the damages associated with different flood events is a key component in the preparation of a Stormwater Management Plan. This process supports more informed decision-making and enables cost-benefit analysis to be undertaken when evaluating remediation options and potential actions during flood events.

For this SMP, flood damages were informed by the CRC for Water Sensitive Cities' "Investment Framework for Economics of Water Sensitive Cities" (INFFEWS) Value Tool. This package includes a series of Stage-Damage curves developed for the Brisbane River Strategic Floodplain Management Plan (State of Queensland, 2018). The values have been adjusted to reflect 2025 prices and to account for Loxton's regional location in the SA Riverland.

4.3.1. Damage categories

Damages from flooding typically include both tangible and intangible damages, and direct and indirect damages. Combined these form four categories:

1. Direct tangible damages – typically material damage caused by the flood
2. Indirect tangible damages – typically disruptions due to the flood
3. Direct intangible damages – direct damages that cannot be objectively quantified or valued
4. Indirect intangible damages – indirect damages that cannot be objectively quantified or valued

The methodology described above has been used to estimate direct damages, with direct damages taken straight from the values calculated, and indirect estimates produced using the proportions of direct damages recommended within the Value Tool.

Indirect damages have not been estimated, due to the difficulty of doing so, and the lack of guidance available. It has been noted in other studies that these values often match, or exceed, those of tangible damages.

4.3.2. Affected buildings

The value tool considers residential, commercial and industrial buildings separately. Flood damages to rural properties (fields, crops. etc) and transport infrastructure have not been considered in the report.

4.3.2.1. Residential buildings

Residential buildings in the tool are categorised as Small (<140 m²), Medium (140-210 m²) or Large (>210 m²). Average residential building sizes were assessed for all sub-catchments, which found that all the average building size for each fell between 140-210 m², see Table 15.

While several individual catchments have larger average building sizes, affected buildings were still typically within the medium category, and with few exceptions, larger affected buildings typically had average flood depths less than 50 mm, so the Medium category was used for the whole study area.

Table 15. Average residential building sizes.

Sub-catchment	Average building size (m ²)	Sub-catchment	Average building size (m ²)
1	235	12	140

Sub-catchment	Average building size (m ²)	Sub-catchment	Average building size (m ²)
2	195	13	170
3	245	14	160
4	260	15	280
5	200	16	200
6	215	17	235
7	190	18	160
8	180	19	235
9	165	20	250
10	155	21	195
11	210		
All combined	200		

Stage-Damage curves are supplied for six (6) house types:

1. Fully detached single storey (slab-on-ground)
2. Fully detached single storey (on stumps)
3. Fully detached single storey (highset)
4. Fully detached double storey
5. Multi-unit single storey
6. Multi-unit double storey

Due to the lack of information available for this distinction, all houses were assumed 'Fully detached single storey (slab-on-ground)', which is consistent with our knowledge of the town and what was observed on site. Floor level survey has not been undertaken, so slab heights were assumed to be 150 mm above the ground surface to be consistent with Australian Standards.

The tool provides separate curves for internal damage, external damage and structural damage. These values were added together to provide a single value for each stage. The final, adjusted, stage-damage curve used for direct tangible damages for residential buildings is shown in Table 16.

Table 16. Stage-Damage curve for Residential buildings.

Flood Depth (m)	Direct Tangible Damage Estimate
Up to 0.1	\$85,524
0.1 to 0.15	\$113,327
0.15 to 0.25	\$165,574
0.25 to 0.5	\$229,361
0.5 to 1.0	\$268,840
1.0 to 1.5	\$293,584

Flood Depth (m)	Direct Tangible Damage Estimate
1.5 to 2.5	\$333,737
2.5 to 5.0	\$376,747

4.3.2.2. Commercial and industrial buildings

The tool provides stage-damage curves for commercial buildings under three sizes – ‘Small’ (<186 m²), ‘Medium’ (186 to 650 m²) and ‘Large’ (>650 m²) – and five value classes:

1. VC1 (Very low) – e.g. Florists, garden centres, vehicle sales areas, schools, churches
2. VC2 (Low) – e.g. Cafes/takeaway, service stations, pubs, second hand goods, clubs
3. VC3 (Medium) – e.g. Chemists, musical instruments, printing, electronic goods, clothing
4. VC4 (High) – e.g. Bottle shops, cameras
5. VC5 (Very High) – e.g. Pharmaceuticals, electronics.

For the purposes of estimating flood damages, it has been assumed that all commercial buildings are VC2 (Low), given that VC1 and VC2 would account for the vast majority of commercial buildings in Loxton.

The tool does not provide values for industrial buildings. However, the State of Queensland (2018) report – from which the value tool was produced – states that while internal and structural damages for commercial and industrial properties can vary significantly depending on the property type, the structural damages are generally comparable. For this reason, damages to industrial properties have been determined in the same manner as commercial properties. The Value Class for industrial buildings was also assumed as VC2 (Low).

The tool estimates damages for large commercial values by square metre. Therefore, commercial and industrial buildings greater than 650 m² have been grouped and are calculated using this method. The average size of all remaining commercial and industrial buildings is 445 m², so these buildings have been calculated using the adjusted stage-damage curve for Medium buildings.

The final, adjusted, stage-damage curves used for direct tangible damages commercial and industrial buildings are shown in Table 17.

Table 17. Stage-Damage curve for Commercial and Industrial buildings.

Flood Depth (m)	Direct Tangible Damage Estimate	
	Medium buildings (\$)	Large buildings (\$/m ²)
Up to 0.1	\$56,959	\$14
0.1 to 0.15	\$77,617	\$21
0.15 to 0.25	\$125,034	\$98
0.25 to 0.5	\$178,574	\$290
0.5 to 1.0	\$286,439	\$698
1.0 to 1.5	\$366,704	\$1,186
1.5 to 2.5	\$431,446	\$1,804

Flood Depth (m)	Direct Tangible Damage Estimate	
	Medium buildings (\$)	Large buildings (\$/m2)
2.5 to 5.0	\$593,300	\$3,350

4.3.3. Scenario A damages

4.3.3.1. Affected properties

Building footprints were download from Google Earth Engine, then verified to a level suitable for flood damage estimation. Zonal statistics were used to determine if any part of the building was impacted by flood waters. The flood depth was determined as the average flood height impacting the building, with damages reduced by half for buildings with 50% or less of the floor area affected.

The total number of buildings impacted under existing conditions are shown in Table 18, summarised into depth categories. Table 19 shows the breakdown per building type.

Table 18. Inundated buildings by depth under Existing Conditions.

Flood depth range* (m)	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
0 - 0.1	84	113	172	249	306	402
0.1 - 0.15	3	4	19	20	18	19
0.15 - 0.25	1	3	11	16	28	35
0.25 - 0.5	1	2	6	34	47	60
0.5 - 1.0	0	0	1	7	24	77
1.0 - 1.5	0	0	0	0	1	25
1.5 - 2.5	0	0	0	0	0	1
2.5 - 5.0	0	0	0	0	0	0
Total	89	122	209	326	424	619

* For residential buildings, flood depth is taken as the depth above floor level.

The results above show that a substantial number of properties are at risk of minor flooding even in the 18% AEP event, with impacts increasing significantly from the 5% AEP event.

Table 19. Inundated buildings by land use under Existing Conditions.

Land use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	24	43	101	193	281	459
Commercial / Industrial – Medium	52	63	87	110	118	132
Commercial / Industrial – Large	13	16	21	23	25	28
Total	89	122	209	326	424	619

For the more frequent events, the majority of affected buildings are commercial or industrial buildings, due to the assumption that these sit at ground level, while residential buildings are afforded some protection by the underlying slabs. If commercial buildings also sit slightly elevated, these numbers could reduce significantly.

From the 5% AEP to the less frequent events, the number of residential properties that are affected increase substantially.

4.3.3.2. Direct tangible damage estimates for Scenario A

Using the determined stage-damage curves, the damages under Scenario A are shown by land use (Table 20) and sub-catchment (Table 21) for each modelled event.

Table 20. Inundated buildings by land use under Existing Conditions.

Land use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	\$2.0m	\$3.5m	\$9.5m	\$21.4m	\$32.8m	\$61.0m
Commercial / Industrial – Medium	\$2.1m	\$2.6m	\$3.7m	\$5.4m	\$7.5m	\$12.0m
Commercial / Industrial – Large	\$0.2m	\$0.3m	\$0.4m	\$3.1m	\$3.6m	\$12.2m
Total	\$4.2m	\$6.3m	\$13.7m	\$29.8m	\$43.9m	\$85.2m

Table 21. Direct tangible damages per damage area under Existing Conditions.

Damage Area	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
1	\$0.0m	\$0.0m	\$0.0m	\$0.0m	\$0.0m	\$0.0m
2	\$0.0m	\$0.0m	\$0.1m	\$0.9m	\$1.8m	\$3.1m
3	\$0.0m	\$0.0m	\$0.0m	\$0.1m	\$0.1m	\$0.3m
4	\$0.7m	\$0.8m	\$1.2m	\$1.4m	\$2.4m	\$3.0m
5	\$0.5m	\$0.7m	\$0.9m	\$1.1m	\$1.3m	\$2.0m
6	\$0.0m	\$0.0m	\$0.3m	\$0.3m	\$0.3m	\$0.4m
7	\$0.5m	\$0.7m	\$0.9m	\$1.4m	\$1.8m	\$2.6m
8	\$0.3m	\$0.7m	\$3.9m	\$10.1m	\$14.5m	\$25.8m
9	\$0.1m	\$0.3m	\$1.3m	\$3.3m	\$4.8m	\$8.2m
10	\$0.1m	\$0.1m	\$0.2m	\$0.2m	\$0.4m	\$1.4m
11	\$0.3m	\$0.4m	\$0.6m	\$0.9m	\$1.1m	\$1.8m
12	\$0.0m	\$0.0m	\$0.0m	\$0.0m	\$0.0m	\$0.0m
13	\$0.2m	\$0.3m	\$0.6m	\$1.7m	\$5.4m	\$12.3m
14	\$0.1m	\$0.2m	\$0.2m	\$0.3m	\$0.4m	\$1.9m
15	\$0.2m	\$0.4m	\$0.9m	\$4.4m	\$5.6m	\$16.4m
16	\$0.4m	\$0.7m	\$0.8m	\$0.8m	\$0.9m	\$1.3m
17	\$0.0m	\$0.0m	\$0.1m	\$0.1m	\$0.1m	\$0.2m
18	\$0.4m	\$0.4m	\$0.5m	\$0.6m	\$0.6m	\$0.8m
19	\$0.0m	\$0.0m	\$0.0m	\$0.3m	\$0.3m	\$0.4m
20	\$0.1m	\$0.1m	\$0.2m	\$0.6m	\$0.8m	\$2.1m
21	\$0.0m	\$0.0m	\$0.1m	\$0.1m	\$0.2m	\$0.2m
Outside of these areas	\$0.4m	\$0.6m	\$1.0m	\$1.0m	\$1.1m	\$1.2m
Total	\$4.2m	\$6.3m	\$13.7m	\$29.8m	\$43.9m	\$85.2m

The results above show that most of the damages are contained within a few damage areas, with damage areas 8, 9, 13 and 15 contributing around half to two-thirds of all damages from the 5% event and up. These catchments contain the Third St, Tobruk Terrace, Eyre St, and Starcevich/Trenerry basins, respectively, all of which are unlined basins that have not been modelled to include infiltration. Further investigation is recommended to understand the infiltration rates at these basins to refine damage estimates in their vicinity.

At the other end of the scale, damage areas 1, 3, 6, 12, 17, 19 and 21 contribute only \$1.5m between them in the 0.2% AEP event.

4.3.3.3. Total tangible damage estimates for Scenario A

Indirect tangible damage estimates were calculated using the recommendations in the INFFEWS tool, which are:

- 15% of direct tangible damages for Residential buildings
- 55% of direct tangible damages for Commercial and Industrial buildings.

Combining both the direct and indirect tangible damage estimates, total tangible damage estimates are provided in Table 22, below.

Table 22. Total tangible damages under Existing Conditions.

Land use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	\$2.3m	\$4.0m	\$11.0m	\$24.6m	\$37.8m	\$70.1m
Commercial / Industrial – Medium	\$3.2m	\$4.0m	\$5.7m	\$8.4m	\$11.6m	\$18.5m
Commercial / Industrial – Large	\$0.3m	\$0.4m	\$0.7m	\$4.8m	\$5.5m	\$19.0m
Total	\$5.8m	\$8.4m	\$17.4m	\$37.7m	\$54.9m	\$107.6m

4.3.4. Scenario B damages

4.3.4.1. Affected properties

The total number of buildings impacted under Ultimate Development conditions are shown in Table 23, summarised into depth categories. Table 24 shows the breakdown per building type.

Table 23. Inundated buildings by depth under Ultimate Development.

Flood depth range * (m)	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
0-0.1	151	188	254	305	366	451
0.1-0.15	5	14	18	18	20	33
0.15-0.25	4	12	19	31	32	32
0.25-0.5	4	6	30	41	57	63
0.5-1.0	0	0	3	49	49	93
1.0-1.5	0	0	0	11	3	53
1.5-2.5	0	0	0	0	0	4
2.5-5.0	0	0	0	0	0	0

Flood depth range* (m)	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Total	164	220	324	455	527	729
<i>Change from Scenario A</i>	75	98	115	129	103	110
	+84.3%	+80.3%	+55.0%	+39.6%	+24.3%	+17.8%

Results show a significant increase in affected properties across all modelled events, with the number of properties affected in more frequent events representing a substantial increase compared to Existing Conditions. The 18% AEP event shows an 84% rise in the number of inundated buildings compared to Scenario A.

Significant flooding is also observed in many of the future growth areas, which would need to be carefully planned to ensure that local actions taken for these areas do not increase flood risks in existing areas.

Table 24. Inundated buildings by land use under Ultimate Development.

Land use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	76	110	197	310	378	552
Commercial / Industrial – Medium	70	89	103	119	122	145
Commercial / Industrial – Large	18	21	24	26	27	32
Total	164	220	324	455	527	729
<i>Change from Scenario A</i>	75	98	115	129	103	110
	+84.3%	+80.3%	+55.0%	+39.6%	+24.3%	+17.8%

4.3.4.2. Direct tangible damage estimates for Scenario B

Using the determined stage-damage curves, the damages under Scenario B are shown by land use (Table 25) and sub-catchment (Table 26) for each modelled event.

Table 25. Direct tangible damages under Ultimate Development.

Land use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	\$6.2m	\$9.7m	\$20.0m	\$40.8m	\$45.8m	\$77.6m
Commercial / Industrial – Medium	\$3.0m	\$3.9m	\$5.7m	\$8.3m	\$9.3m	\$14.8m
Commercial / Industrial – Large	\$0.4m	\$1.1m	\$3.0m	\$8.0m	\$8.4m	\$14.2m
Total	\$9.5m	\$14.8m	\$28.7m	\$57.1m	\$63.5m	\$106.7m
<i>Change from Scenario A</i>	\$5.3m	\$8.5m	\$15.0m	\$27.3m	\$19.6m	\$21.5m
	+125%	+135%	+110%	+91.4%	+44.6%	+25.3%

As noted previously, the biggest changes to flood impacts occur in the more frequent events, with estimated damages more than doubling in the 18% AEP, 10% AEP, and 5% AEP events compared to Existing Conditions.

Table 26. Direct tangible damages per damage area under Ultimate Development.

Damage Area	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
1	\$0.0m	\$0.0m	\$0.0m	\$0.0m	\$0.0m	\$0.1m
2	\$0.2m	\$0.6m	\$1.5m	\$1.9m	\$2.8m	\$3.8m
3	\$0.0m	\$0.0m	\$0.1m	\$0.1m	\$0.3m	\$0.3m
4	\$1.1m	\$1.2m	\$2.1m	\$2.2m	\$2.5m	\$3.6m
5	\$0.8m	\$0.9m	\$1.0m	\$1.2m	\$1.5m	\$2.9m
6	\$0.0m	\$0.3m	\$0.3m	\$0.3m	\$0.4m	\$0.5m
7	\$0.7m	\$0.9m	\$1.6m	\$1.9m	\$2.0m	\$3.3m
8	\$2.1m	\$3.8m	\$8.6m	\$20.6m	\$19.3m	\$31.2m
9	\$0.7m	\$1.2m	\$2.9m	\$6.7m	\$6.1m	\$9.8m
10	\$0.2m	\$0.2m	\$0.2m	\$0.4m	\$0.9m	\$1.9m
11	\$0.5m	\$0.6m	\$0.8m	\$1.1m	\$1.5m	\$2.4m
12	\$0.0m	\$0.0m	\$0.0m	\$0.0m	\$0.0m	\$0.0m
13	\$0.4m	\$0.5m	\$1.7m	\$5.8m	\$8.9m	\$17.1m
14	\$0.1m	\$0.2m	\$0.3m	\$0.5m	\$1.0m	\$3.2m
15	\$0.7m	\$1.9m	\$4.5m	\$10.4m	\$11.4m	\$19.2m
16	\$0.7m	\$0.8m	\$0.8m	\$1.0m	\$1.3m	\$1.4m
17	\$0.0m	\$0.1m	\$0.1m	\$0.1m	\$0.2m	\$0.2m
18	\$0.4m	\$0.5m	\$0.5m	\$0.6m	\$0.7m	\$1.2m
19	\$0.0m	\$0.0m	\$0.3m	\$0.3m	\$0.4m	\$0.6m
20	\$0.1m	\$0.2m	\$0.4m	\$0.8m	\$1.2m	\$2.5m
21	\$0.0m	\$0.0m	\$0.1m	\$0.2m	\$0.2m	\$0.3m
Outside of these areas	\$0.8m	\$0.8m	\$1.0m	\$1.1m	\$1.1m	\$1.3m
Total	\$9.5m	\$14.8m	\$28.7m	\$57.1m	\$63.5m	\$106.7m
<i>Change from Scenario A</i>	<i>\$5.3m</i> <i>+125%</i>	<i>\$8.5m</i> <i>+135%</i>	<i>\$15.0m</i> <i>+110%</i>	<i>\$27.3m</i> <i>+91.4%</i>	<i>\$19.6m</i> <i>+44.6%</i>	<i>\$21.5m</i> <i>+25.3%</i>

Of the increased costs between the existing conditions and ultimate development scenario, the four damage areas mentioned previous (8, 9, 13 & 15) account for a notable increase in all modelled scenarios. Damage areas 1, 3, 6, 12, 17, 19 and 21 only account for \$2m in the 0.2% AEP event, an increase of 33% from Existing Conditions.

4.3.4.3. Total tangible damage estimates for Scenario B

Using the same methodology described previously, total tangible damage estimates for Ultimate Development are provided in Table 27, below.

Table 27. Total tangible damages under Ultimate Development.

Land use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	\$7.1m	\$11.2m	\$23.0m	\$46.9m	\$52.7m	\$89.3m
Commercial	\$4.6m	\$6.1m	\$8.8m	\$12.9m	\$14.4m	\$23.0m
Industrial	\$0.6m	\$1.7m	\$4.6m	\$12.5m	\$13.0m	\$22.0m
Total	\$12.3m	\$19.0m	\$36.4m	\$72.2m	\$80.1m	\$134.3m
<i>Change from Scenario A</i>	<i>\$6.5m</i> <i>+112%</i>	<i>\$10.6m</i> <i>+127%</i>	<i>\$19.1m</i> <i>+110%</i>	<i>\$34.5m</i> <i>+91.5%</i>	<i>\$25.2m</i> <i>+45.8%</i>	<i>\$26.7m</i> <i>+24.8%</i>

Total tangible damage estimates also show a rise of more than 100% for the 18%, 10%, and 5% AEP events compared to Scenario A.

5. Water Quality Modelling

A water quality modelling was developed for the town of Loxton to assess how stormwater runoff from the town affects the River Murray and identify opportunities to improve water management. The modelling process follows current best practice guidelines according to the South Australian MUSIC Guidelines.

5.1. Water Quality Modelling Approach

Stormwater runoff from the catchment of Loxton discharges through a network of drainage systems, ultimately discharging directly into the River Murray. This runoff carries with it a variety of pollutants. As a result, the influx of untreated or partially treated stormwater can negatively impact the ecological health of the riparian ecosystem of the River Murray. The changes in water quality can disrupt habitat conditions and degrade the natural functions of these sensitive environments.

The water quality in urbanised areas of Loxton is significantly influenced by residential zones and commercial developments. Pollutants generated from urban catchment include:

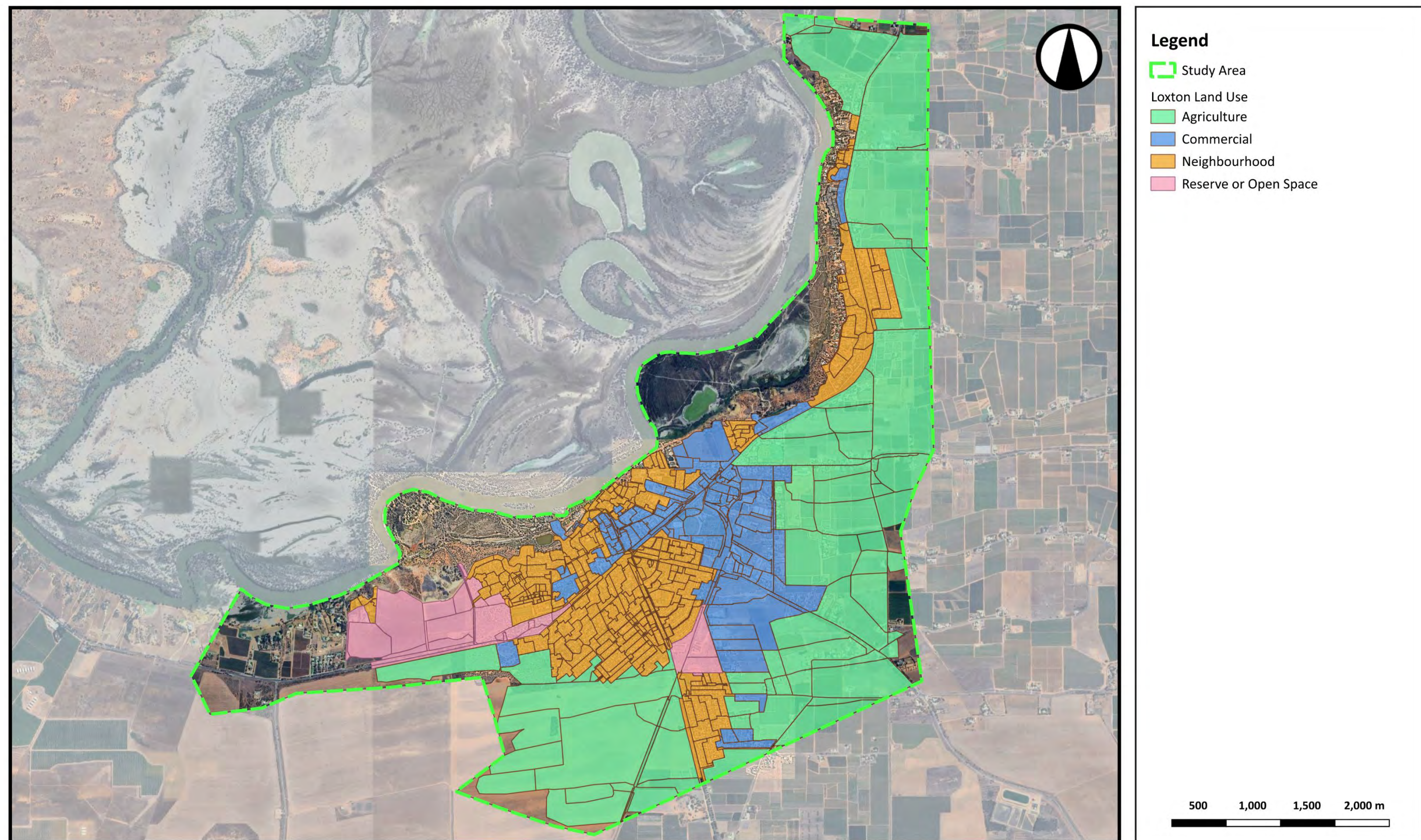
- Gross pollutants
- Sediments
- Nutrients (nitrogen and phosphorous)
- Other dissolved pollutants (hydrocarbons, organic matter and chemicals)
- Metals

Pollutant loads in Loxton's stormwater were estimated using MUSIC software, which simulates stormwater quantity, quality, and treatment performance. By combining catchment data with weather inputs, MUSIC predicts pollutants such as sediment, nutrients, and contaminants, and evaluates the effectiveness of different management strategies to reduce impacts on waterways.

Rainfall and evapotranspiration data from the Loxton Research Centre (1976–2010), recorded at six-minute intervals, were used in the model.

The Loxton catchment was divided into four sub-catchments based on land use: agricultural, commercial, residential, and reserve and open space. This classification was carried out through a desktop spatial analysis, referencing Google Satellite imagery and the 2022 Land Use shapefile from DataSA. The digitised catchment is shown in Figure 25.

A 1 mm rainfall threshold was applied to impervious surfaces, with 139 mm soil storage and 69 mm field capacity used for pervious areas, based on Loxton Sands. These settings follow MUSIC guidelines and have little effect on runoff volumes except where impervious coverage is low.



LOXTON STORMWATER MANAGEMENT PLAN

EXISTING LOXTON SUB-CATCHMENTS BASED ON LAND USE

Project: 24024 - Loxton SMP

Revision: 1

Date: 05/09/2025

Drawn: A. Singhel

Coordinate System: GDA2020 / MGA zone 54

Background Imagery: Nearmap (13 March 2023), Google Satellite



District Council of
Loxton Waikerie



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engineering for the environment

Figure 25. Existing Loxton sub-catchments based on land use

MUSIC's default pollutant concentrations for TSS, TN, and TP were used, consistent with South Australian MUSIC Modelling Guidelines. Default values for gross pollutant removal efficiency were also applied, ensuring consistency and regulatory compliance where site-specific data is unavailable.

An existing catchment scenario (Scenario 1) was developed to assess potential improvements in water quality and evaluate the overall performance of stormwater management strategies for the township of Loxton. This model will serve as a baseline for comparison and support the development of future strategies aimed at enhancing water quality outcomes.

It is important to note that desktop assessment was done to identify existing Water Sensitive Urban Design (WSUD) systems in Loxton. The assessment identified the following structures, without any associated treatment systems:

- Swale running from Loxton Historical Village functions as a drain leads to the floodplains.
- Grass-lined swale at Raymont Avenue navigates runoff to the basin located north of Loxton Hockey Club

Currently, Loxton does not have a stormwater treatment system designed or operated in accordance with WSUD principles. Scenario 1 represents an important first step towards establishing a WSUD framework for the township.

MUSIC outputs include:

- Source loads: Runoff and pollutants without treatment.
- Residual loads: Runoff and pollutants after treatment.
- Percent reduction: Pollutant reduction from treatment.

The following sections summarise the water quality performance of the existing modelled scenario.

5.2. MUSIC Modelling for Scenario 1

5.2.1. Study Area

Baseline Water Quality Performance

A MUSIC model was developed for the catchments of Loxton using the input parameters outlined above to represent the current conditions. This model calculated both the 'baseline' pollutant loads and the Scenario 1 pollutant loads, which represents the existing case. The 'baseline' pollutant load, also known as the 'source' load, represents the total pollutant load produced by the catchment before any treatment. In contrast, the Scenario 1 pollutant load reflects the pollutant load that exits the catchment after treatment by the existing measures.

5.2.2. Catchments

MUSIC estimated the pollutant loads generated in each sub-catchment based on the specific land use types present (shown in Table 28). These individual estimates were then aggregated to calculate the total pollutant load for each catchment, ultimately providing an overall value for the entire study area.

5.2.3. Results

The results for the baseline scenario are summarised in Table 28 below.

Table 28. MUSIC modelling for pollutant loads

Parameter	Pollutant Loads			
	Agricultural	Commercial	Residential	Reserve or Open Space
Flow (ML/yr)	48.89	102.45	176.63	5.90
Total Suspended Solids (kg/yr)	13,120.25	14,657.64	31,890.32	959.11
Total Phosphorus (kg/yr)	14.31	41.57	48.30	1.47
Total Nitrogen (kg/yr)	88.67	239.89	366.52	11.18

Scenario 1 Water Quality Performance

Scenario 1 MUSIC model analysis the impact of existing catchment conditions on water quality. Included in Table 29 below. The "Reduction Target" column outlines the South Australian water quality performance targets for WSUD (South Australian MUSIC Guidelines, 2021), as defined by the Department of Environment, Water, and Natural Resources.

Table 29. MUSIC modelling results and Target Reduction % for baseline scenario

Parameter	Source	Reduction Target
Flow (ML/yr)	333.87	-
Total Suspended Solids (kg/yr)	60627.32	80%
Total Phosphorus (kg/yr)	105.64	60%
Total Nitrogen (kg/yr)	706.26	45%
Gross Pollutants (kg/yr)	15403.07	90%

5.2.4. Pollutant Concentrations

The Riverland reach of the Murray River, located in South Australia's south-central, low-rainfall region, has the following water quality characteristics: TN is measured at 1.0 mg/L (1000 µg N/L), TP at 0.10 mg/L (100 µg P/L), and TSS are not directly measured using Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) default values. Pollutant concentrations at each catchment and the cumulative are shown in Table 30. It's important to note that these concentrations were modelled using the full range of rainfall data, encompassing both dry and wet periods.

Table 30. Scenario 1 pollutant concentrations

Catchment	Pollutant Load		
	Total Nitrogen P ₅₀ /P ₉₀ (mg/L)	Total Phosphorous P ₅₀ /P ₉₀ (mg/L)	Total Suspended Solids P ₅₀ /P ₉₀ (mg/L)
Agricultural	0/0.699	0/0.699	0/10
Commercial	0/2.089	0/0.251	0/6.025

Catchment	Pollutant Load		
	Total Nitrogen P ₅₀ /P ₉₀ (mg/L)	Total Phosphorous P ₅₀ /P ₉₀ (mg/L)	Total Suspended Solids P ₅₀ /P ₉₀ (mg/L)
Residential	0/3.311	0/0.288	0/3.388
Reserve or Open Space	0/3.311	0/0.288	0/3.388

5.3. Pollutant information

Table 31 shows the sources and impacts of the pollutants determined in MUSIC and other residual pollutants.

Table 31. Pollutants, sources and impacts

Types of Pollutants	Sources	Impacts
Suspended Sediments and Solids	– Eroded and washed soil from construction sites – Sediment-laden agricultural runoff – Sediments from natural erosion during heavy rainfall – Logging, deforestation, and exposed land – Mismanaged waste disposal and landfills	– Reduces light penetration, disrupting aquatic plants and ecosystems – Increases turbidity in rivers (e.g., River Murray) - Sediment deposits clog stormwater drains and pipes, leading to blockages, corrosion, and maintenance issues - Weakens infrastructure, escalating damage and costs - Accelerates soil degradation and loss of fertility
Nutrients (Nitrogen and Phosphorus)	– Farmlands rich in fertilisers and animal manure – Urban landscapes with fertilisers on lawns – Poorly maintained septic system – Industrial discharge – Atmospheric deposition (vehicle exhaust, industrial emissions)	– Eutrophication and algal blooms (e.g., cyanobacteria/blue-green algae) – Oxygen depletion in water bodies, suffocating fish and aquatic life – Acidification of groundwater – Disturbance of soil microbial activity and increased surface runoff – Imbalances in natural life cycles and food chains

Types of Pollutants	Sources	Impacts
Gross Pollutants	– Litter and trash from public spaces and roads – Waste from commercial and industrial sites – Roads and highways (plastic bags, debris) – Construction debris – Poor waste and wastewater management	– Visual pollution and harm to aquatic ecosystems – Blocks drains, causing flooding and reduced efficiency – Health risks from untreated waste – Degrades riverbanks and aquatic habitats – Reduces recreational and aesthetic values of waterways
Other incidental pollutants		
Metals	– Industrial activities, construction sites, automotive industry – Atmospheric deposition – Stormwater runoff	– Bind to sediments, degrading ecosystems – Accumulate in soil and groundwater – Toxicity affecting aquatic life and human health – Can enter the food chain and pose health risks
Hydrocarbons	– Petroleum-based products (fuel spills, industrial discharge, urban runoff, vehicle emissions)	– Indicate petroleum contamination – Pollute rivers, impair water quality – Harm aquatic ecosystems – Toxic accumulation in soil and groundwater – Health hazards if they enter food chains
Emerging Organic Contaminants (EOCs)	– Pharmaceuticals, personal care products, industrial materials, pesticides, herbicides, synthetic compounds	– Disrupt natural processes and ecological functions – Cause toxicity and resistance in aquatic organisms – Affect reproduction, growth, and survival rates of aquatic fauna – Accumulate in soil and groundwater – Enter the food chain, creating long-term health risks

5.4. Water demand and supply

Loxton sources its potable water supply from the River Murray, which is classified as a ‘prescribed watercourse’ under the Water Allocation Plan (WAP). In accordance with the WAP, the town is allocated water from the River Murray for residential, irrigation, and community purposes. This water is treated locally at the Loxton Water Treatment Plant, operated under SA Water’s Riverland network.

In addition to the potable supply, large-volume irrigation water for horticulture is delivered by the Central Irrigation Trust (CIT). Wastewater generated in the town is treated at the Loxton Wastewater Treatment Plant, which operates in accordance with SA Health guidelines to meet the standards required for reuse in irrigation. As part of the WISER initiative, the plant is currently being upgraded to deliver approximately 200 ML per year of recycled water. This upgrade aims to reduce potable water demand and mitigate flood risk at key community facilities.

Table 32 shows the water supply sources at Loxton and their details.

Table 32. Water supply sources

Sources / Scheme	Facility	Design Capacity and Volume
Water Allocation Plan	Loxton Water Treatment Plant	-
Recycled water	Loxton Wastewater Treatment Plant	Approximately 200 ML/year planned reuse
Water for irrigation	Central Irrigation Trust	Approximately 150 GL/year across region wide districts

Currently, no publicly available data details Loxton's specific water demand. However, water use across Riverland towns typically peaks during the summer months due to the region's climate and increased outdoor use.

Table 33 shows the estimated stormwater harvesting capacity for each sub-catchment, as determined using the MUSIC model.

Table 33. Harvesting capacity at each sub-catchment

Sub-catchment	Flow (ML/yr)
Agricultural	48.89
Commercial	102.45
Residential	176.63
Reserve or Open Space	5.90

6. Risk Assessment

Flood risk assessment is a critical process for identifying, evaluating, and managing the potential impacts of flooding on communities, infrastructure, and the environment.

Four scenarios were analysed during this risk assessment to evaluate the current and future risks for the town of Loxton:

- Scenario 1a showing existing conditions at 18% AEP
- Scenario 1b showing future development conditions at 18% AEP
- Scenario 5a showing existing conditions at 1% AEP
- Scenario 5b showing future development conditions at 1% AEP

The risks were classified under safety, strategic, operational, regulatory, and reputational categories and prioritised using a consequence-likelihood matrix. Risk categories with descriptions are outlined as in Table 34. The risk assessment matrix and description of each classification is shown in Figure 26.

Results show that without improvements, the number of high and severe flood risk areas is likely to increase as the town grows.

Table 34. Risk categories

Risk category	Description
Safety (Including public health and well-being)	Includes contaminated water exposure, drowning possibility and injuries, electrocution, traffic and evacuation and emergency locations accessibility
Strategic risks	Includes changes in land uses, Water-Sensitive Urban Design (WSUD) strategy and future development potential
Operational risks	Includes blockages or debris, overflows, asset recovery and capacity outfall
Regulatory risks	Includes land-use controls, waste and hazardous material management, water quality, safety obligations, emergency protocol, cultural heritage and biodiversity approvals and public health standards
Reputational and political risks	Includes prioritisation disputes, transparency gaps, cost increases, environmental harm and malformation

				Consequence				
				Negligible impact on cost, safety, schedule, or environment. Easily managed.	Small financial or schedule impact; minor inconvenience or minor maintenance response.	Measurable cost or delay; localised flooding; moderate maintenance or public impact.	Significant cost increase or construction delay; failure of asset function; safety risk; possible media attention.	Catastrophic failure; serious injury or fatality; major flood or legal action; reputational damage.
				Insignificant	Minor	Moderate	Major	Severe
				1	2	3	4	5
Likelihood	May occur only in exceptional circumstances	Rare	1	Low	Low	Low	Low	Moderate
	Could occur at some time, but not expected under normal conditions	Unlikely	2	Low	Low	Moderate	Moderate	High
	Might occur; reasonable chance within planning period	Possible	3	Low	Moderate	Moderate	High	High
	Will probably occur in most years	Likely	4	Low	Moderate	High	High	Severe
	Expected to occur in most circumstances or multiple times per year	Almost Certain	5	Moderate	Moderate	High	Severe	Severe

Figure 26. Risk assessment matrix and description of each classification

6.1. Risk Assessment

The risk assessments for scenarios 1a, 1b, 5a and 5b are shown in Table 35, Table 36, Table 37 and Table 38, respectively.

Table 35. Risk assessment for Scenario 1a – 18% AEP Existing Conditions

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
1-1	25 Katarapko Dr	Ponding in depression north-west of cul-de-sac	Regulatory/ Reputational	5	2	Moderate
3-1	Bookpurnong Tce (Near Fifth St)	Ponding along swale in median strip, near walking track	Operational	2	1	Low
4-1	Intersection of McMillan St and Grant Schubert Dr Ponding in wetland area and over walking trails	JB connecting flows from around the library & main street	Regulatory	5	3	High
4-2	21 William St	Ponding in garden area of property	Strategic	1	2	Low
4-3	20 East Tce	Significant gutter flows	Reputational/ Safety	3	3	Moderate
5-1	Hentschke Transport Grain Storage, Railway Terrace	Basin filled to capacity	Strategic	1	2	Low
5-2	3 Railway Tce	Significant gutter flows	Operational	2	4	Moderate
5-3	Riverland Floor Centre	Ponding on side of road	Operational	1	2	Low
5-4	1968 Bookpurnong Rd	Ponding next to main road and into Henschke Transport yard	Operational/ Regulatory	2	3	Moderate
5-5	Mill Corner railway memorial	Ponding in grassed swale between Raymont Ave and Bookpurnong Rd	Regulatory/ Reputational	4	2	Moderate
5-6	Mill Corner Basin (Raymont Ave)	Ponding in basin, overflowing into depression on south- east boundary	Operational/ Regulatory	2	3	Moderate
5-7	Intersection of A W Traeger Dr and Pine Ave	Ponding on and along road	Operational	3	3	Moderate
6-1	Luther Rd (Water treatment plant)	Significant gutter flows	Operational/ Regulatory	4	5	Severe
7-1	127 Bookpurnong Tce	Ponding in depression in median strip, near Community Conservation and Heritage Park	Regulatory	2	2	Low
7-2	Basin at Fifth St/Klingberg St	Basin overflows	Strategic/ Operational	3	2	Moderate
8-1	10-18 Third St	Significant gutter flows	Operational/ Safety	3	3	Moderate
8-2	Basin at the end of Third St	Ponding in basin	Operational/ Safety	2	3	Moderate

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
9-1	Basin at Tobruk Tce/Paruna Rd	Basin filled to capacity	Strategic	1	2	Low
10-1	Kokoda Tce (Woodleigh)	Ponding in vacant land. It has since been developed which may change hazards.	Strategic/ Regulatory	2	2	Low
10-2	Kokoda Tce detention basin	Basin filled to capacity	Strategic	1	2	Low
10-3	Intersection between Starceвич Rd and Kokoda Tce	Ponding in depressions on side of Starceвич Rd	Operational/ Strategic	1	3	Low
11-1	Between Aleppo St and Robertson Ave	Ponding in depression between the two roads, along railway line	Operational/ Strategic	3	4	High
11-2	Basin on Robertson Ave	Ponding in basin, not overflowing	Strategic	2	3	Moderate
11-3	83 Starceвич Rd (Loxton Ice Works)	Ponding in depression on side of road and into yard	Strategic/ Safety	4	3	High
11-4	26 Starceвич Rd (Riverland Cold Stores)	Ponding in block behind building	Strategic/ Safety	2	2	Low
11-5	23 Badcoe Rd (Southern side)	Ponding in vacant land by quarry	Strategic	3	2	Moderate
11-6	Badcoe Rd (Northern side)	Ponding in depression on side of road between driveways	Strategic	2	2	Low
11-7	130 Badcoe Rd	Ponding in block behind house	Safety	1	1	Low
11-8	Across 111 Badcoe Rd	Ponding on southern side of road in vacant land	Strategic	1	3	Low
11-9	111 Badcoe Rd	Ponding around house and in vacant land around house	Strategic	3	1	Low
11-10	Intersection between Dorsch Ave and Kingsbury Rd	Ponding in depression next to intersection	Strategic	3	3	Moderate
12-1	Near Tobruk Tce basin	Ponding in vacant land along railway line	Strategic	2	1	Low
13-1	Intersection between Paruna Rd and railway line	Ponding in depressions on the sides of the elevated intersection	Strategic/ Safety	2	5	Moderate
13-2	Eyre St (Small basin)	Basin filled to capacity	Strategic	1	2	Low
13-3	Eyre St (bigger basin)	Basin filled to capacity	Strategic	1	2	Low
13-4	Between Eyre St and Torrens St	Ponding along dirt track connecting the northern ends of each road	Strategic	2	3	Moderate
14-1	Basin at Wells St	Basin filled to capacity	Strategic	1	2	Low
14-2	163 Paruna Rd	Ponding in depression on side of road, below	Strategic	2	1	Low

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
		basin inlet				
14-3	Basin at Paruna Rd	Basin filled to capacity and ponding in surrounding depressions	Strategic/ Operational	2	2	Low
15-1	3 Mill Rd	Ponding in garden in front of house	Strategic	2	1	Low
15-2	Between Raymont Ave and Starceвич Rd	Ponding along the railway line between the roads	Operational/ Safety	4	2	Moderate
15-3	Basin on Starceвич Rd	Ponding in basin, overflowing onto road and into Riverland Almonds	Operational/ Safety	5	4	Severe
15-4	29 Starceвич Rd (Riverland Almonds)	Ponding in swale in front of building	Strategic/ Safety	4	2	Moderate
15-5	51 Starceвич Rd (Handbuilt warehouse)	Ponding around the sheds behind the office	Strategic/ Safety	4	3	High
15-6	51 Starceвич Rd (Handbuilt warehouse)	Ponding in block behind warehouse	Safety	4	4	High
15-7	63 Starceвич Rd (Viva Olives)	Ponding in block behind office	Strategic	5	3	High
15-8	Basin across 65-71 Trenerry Ave	Basin filled to capacity	Strategic	1	2	Low
15-9	65-71 Trenerry Ave	Ponding in depression on side of road	Safety	5	4	Severe
16-1	Between Luther Rd and Bookpurnong Rd	Ponding in swale between main road and Luther Rd, in front of Mammoth Fitness	Operational	2	2	Low
16-2	1937 Bookpurnong Rd (In front of Loxton Irrigation Centre)	Ponding in swale between main road and service road	Operational	3	2	Moderate
16-3	18 Gratwick Rd	Ponding along both sides of the road	Operational	3	2	Moderate
16-4	Ronco Powersports (Ronco motors)	Ponding in depression on side of road, around Ronco Motors	Operational	4	4	High
16-5	78 Gratwick Rd	Ponding around property	Safety	5	3	High
16-6	88 Gratwick Rd	Ponding in basin, not overflowing	Operational	3	3	Moderate
18-1	1839 Bookpurnong Rd	Ponding in paddock	Strategic	1	2	Low
18-2	39 Dorsch Ave	Ponding around property	Safety	3	3	Moderate
18-3	18 Dorsch Ave	Ponding around property	Safety	4	3	High
19-1	1800 Simpson Rd	Ponding along both sides of the road	Strategic/ Operational	3	4	High
19-2	1672 Simpson Rd	Ponding along both sides of the road	Strategic/	3	4	High

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
			Operational			
20-1	Basin at Keith Payne Ct	Basin filled to capacity	Strategic	1	2	Low
20-2	18 French Rd	Ponding on side of road	Strategic	1	1	Low
21-1	1594 Bookpurnong Rd (Winery weighbridge)	Ponding in east-most depression	Strategic/ Operational	4	4	High

Table 36. Risk assessment for Scenario 1b – 18% AEP Ultimate Development

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
1-1	25 Katarapko Dr	Ponding in depression north-west of cul-de-sac	Regulatory/ Reputational	5	2	Moderate
2-1	9 Thiele Ave	Ponding on north-eastern side of road	Operational	3	2	Moderate
2-2	9 Westbrook Ave	Significant flows along gutter and through property	Operational/ Safety	2	3	Moderate
2-3	8 Hilltop Dr	Ponding near SEP at the base of View St	Operational	2	2	Low
2-4	McMillan St (Near detention basin)	Ponding along road and in bushland near basin	Strategic/ Regulatory	1	2	Low
3-1	Bookpurnong Tce (Near Fifth St)	Ponding along swale in median strip, near walking track	Operational	2	1	Low
3-2	72 Bookpurnong Tce	Significant gutter flows and ponding	Operational	3	3	Moderate
3-3	Bookpurnong Tce (Community Conservation and Heritage Park)	Ponding in basin under bridge, not overflowing	Regulatory	3	3	Moderate
3-4	Bookpurnong Tce median strip (Opposite 141 Bookpurnong Tce)	Ponding along walking trail	Operational	2	4	Moderate
4-1	Intersection of McMillan St and Grant Schubert Dr	Ponding in swale + wetland area and over walking trails	Operational/ Strategic	2	2	Low
4-2	21 William St	Ponding in vegetated area	Strategic	1	3	Low
4-3	20 East Tce	Significant gutter flows	Operational	2	3	Moderate
4-4	Loxton Historical Village	Ponding in depressions across village and above floor levels	Strategic	4	3	High
4-5	Swale adjacent Scenic Drive	Ponding in swale	Operational/ Strategic	1	3	Low
4-6	Corner of Pioneer Walk and William St	Ponding on corner next to road	Operational	1	2	Low
5-1	Hentschke Transport Grain Storage, Railway Terrace	Basin overflows	Regulatory/ Strategic	3	1	Low
5-2	3 Railway Tce	Significant gutter flows	Operational	2	4	Moderate
5-3	Riverland Floor Centre	Ponding on side of road	Operational	1	4	Low
5-4	1968 Bookpurnong Rd	Ponding next to main road and into Henschke Transport yard	Operational/ Regulatory	3	2	Moderate

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
5-5	Mill Corner railway memorial	Ponding in grassed swale between Raymont Ave and Bookpurnong Rd	Regulatory/ Reputational	4	3	High
5-6	Mill Corner Basin (Raymont Ave)	Ponding in basin, overflowing into depression on south-east boundary	Operational/ Regulatory	4	3	High
5-7	Intersection of A W Traeger Dr and Pine Ave	Ponding on and along road	Operational	3	4	High
5-8	Pine Ave (Football oval car park)	Ponding in dirt car park by swimming pool	Operational	2	2	Low
6-1	Across Luther Rd from Trility WTP	Ponding on side of road	Operational/ Regulatory	4	5	Severe
7-1	127 Bookpurnong Tce	Ponding in depression in median strip, near Community Conservation and Heritage Park	Regulatory	2	2	Low
7-2	Basin at Fifth St and Klingberg St	Basin at capacity	Strategic	4	2	Moderate
8-1	10-18 Third St	Significant gutter flows	Operational/ Safety	3	3	Moderate
8-2	Basin at the end of Third St	Ponding in basin, overflow into Third St and surrounding properties	Operational/ Safety	4	3	High
8-3	61 Bookpurnong Tce	Ponding on side of road	Operational/ Safety	3	4	High
9-1	Basin at Tobruk Tce/Paruna Rd	Overflowing basin	Operational/ Strategic	3	2	Moderate
9-2	14-18 Tobruk Tce	Inundation of houses and yards, ponding over surrounding roads	Operational/ Safety	4	3	High
10-1	Kokoda Tce (Woodleigh) detention basin	Ponding in grass-lined drain; overflows	Strategic	3	2	Moderate
10-2	Kokoda Tce (Woodleigh) detention basin	Site under construction; few ponded areas	Operational	2	2	Low
10-3	Intersection of Kokoda Tce and Starcevic Rd	Ponding in depression	Operational/ Strategic	3	3	Moderate
10-4	Across 50 Kokoda Tce	Ponding in median strip between Coral St and Aleppo St	Operational/ Strategic	2	2	Low
11-1	Between Robertson Ave and Aleppo St	Ponding in depression	Operational/ Strategic	4	2	Moderate
11-2	Basin on Robertson Ave	Ponding in basin, not overflowing	Strategic	2	3	Moderate

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
11-3	23 Badcoe Rd (Southern side)	Ponding in vacant land by quarry	Strategic	2	3	Moderate
11-4	Badcoe Rd (Northern side)	Ponding in depression on side of road between driveways	Strategic	2	3	Moderate
11-5	26 Starceвич Rd (Riverland Cold Stores)	Ponding in block behind building	Strategic/ Safety	5	3	High
11-6	Badcoe Rd (Northern side)	Ponding in depression on side of road between driveways	Strategic/ Safety	2	2	Low
11-7	130 Badcoe Rd	Ponding in block behind house and into yards of houses on Drummond Ave	Strategic	2	2	Low
11-8	Across 111 Badcoe Rd	Ponding on southern side of road in vacant land	Strategic	4	3	High
11-9	111 Badcoe Rd	Ponding around block and over floor level of entire house	Strategic	2	3	Moderate
11-10	Intersection of Dorsch Ave and Kingsbury Rd	Ponding in earthen/vegetated space	Strategic	3	3	Moderate
11-11	8 Kingsbury Rd	Ponding in depression next to road	Operational	1	1	Low
12-1	Near Tobruk Tce basin	Ponding in vacant land along railway line	Strategic	2	1	Low
13-1	Intersection between Paruna Rd and railway line	Basin filled to capacity	Strategic	2	2	Low
13-2	Eyre St	Basin filled to capacity	Strategic	2	2	Low
13-3	Eyre St (bigger basin)	Basin filled to capacity	Strategic	2	2	Low
14-1	Basin at Wells St	Basin filled to capacity	Strategic	2	2	Low
14-2	163 Paruna Rd / Sturt St	Ponding in depression on side of road, below basin inlet	Operational	2	3	Moderate
14-3	Basin at Paruna Rd	Ponding in basin, overflowing towards road	Operational/ Strategic	2	2	Low
15-1	3 Mill Rd	Ponding in garden in front of house	Strategic	2	1	Low
15-2	Between Raymont Ave and Starceвич Rd	Ponding along the railway line between the roads	Operational/ Safety	3	3	Moderate
15-3	Basin on Starceвич Rd	Inundation of buildings and yards, overflowing of basins on both Trenerry and Starceвич, ponding in Riverland Almonds and	Safety	5	5	Severe

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
		neighboring properties				
15-9	65-71 Trenerry Ave	Ponding in depression on side of road and encroaching on buildings	Safety	4	3	High
16-1	Between Luther Rd and Bookpurnong Rd	Ponding in spoon drain between main road and Luther Rd, in front of Mammoth Fitness	Operational	3	3	Moderate
16-2	1937 Bookpurnong Rd (In front of Loxton Irrigation Centre)	Ponding in swale and overflowing onto service road	Operational	2	2	Low
16-3	18 Gratwick Rd	Ponding over road and into yards of buildings on both sides of road	Operational	3	2	Moderate
16-4	Ronco Powersports (Ronco motors)	Ponding in depression on side of road, and along Gratwick Rd	Operational	4	5	Severe
16-5	78 Gratwick Rd	Ponding around property and in basin	Safety	5	4	Severe
16-6	88 Gratwick Rd	Basin filled to capacity	Operational	4	4	High
16-7	119 Gratwick Rd	Ponding in paddock behind house (away from structures)	Strategic	2	2	Low
16-8	1920 Bookpurnong Rd	Flows in swale near Tanko Cres	Strategic	3	3	Moderate
18-1	1839 Bookpurnong Rd	Ponding along service road, around house, and in paddock	Strategic	3	2	Moderate
18-2	39 Dorsch Ave	Ponding around property	Safety	4	3	High
18-3	18 Dorsch Ave	Ponding over entrance to property / shed	Safety	4	3	High
19-1	1800 Simpson Rd	Ponding along both sides of the road and onto Bookpurnong Rd	Strategic/ Operational	3	4	High
19-2	1672 Simpson Rd	Ponding along both sides of the road	Strategic/ Operational	3	4	High
20-1	Basin at end of Keith Payne Ct	Ponding in basin, overflowing into surrounding houses and paddocks behind	Operational/ Safety	2	3	Moderate
20-2	18 French Rd	Ponding in paddock	Strategic	1	1	Low
20-3	1679 Bookpurnong Rd	Ponding at property entrance	Safety	2	2	Low
21-1	1594 Bookpurnong Rd	Ponding in earthen space (at the entrance)	Strategic/ Operational	4	4	High
21-2	Intersection of Alamein Ave and Bookpurnong Rd	Ponding on side of road and scattered through vacant block	Strategic	3	3	Moderate

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
21-3	1546 Bookpurnong Rd	Ponding on side of road	Operational	1	4	Low

Table 37. Risk assessment for Scenario 5a – 1% AEP Existing Conditions

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
1-1	25 Katarapko Dr	Ponding in depression north-west of cul-de-sac	Regulatory/ Safety	5	3	High
2-1	9 Thiele Ave	Ponding on north-eastern side of road	Operational	3	3	Moderate
2-2	9 Westbrook Ave	Significant flows along gutter and through property	Operational/ Safety	2	3	Moderate
2-3	8 Hilltop Dr	Ponding near SEP at the base of View St	Operational/ Safety	3	3	Moderate
2-4	McMillan St (Near detention basin)	Ponding along road and in bushland near basin	Regulatory/ Operational	4	3	High
3-1	Bookpurnong Tce (Near Fifth St)	Ponding along swale in median strip, near walking track	Operational	2	2	Low
3-2	72 Bookpurnong Tce	Significant gutter flows and ponding over McMillan/Bookpurnong intersection	Operational	4	3	High
3-3	Bookpurnong Rd median strip (Between Sadlier St and McMillan St)	Ponding over turfed area and walking track	Operational	3	3	Moderate
3-4	Intersection of View St and Bookpurnong Tce	Flows through spoon drain parallel to Bookpurnong Rd	Operational	3	3	Moderate
3-5	Bookpurnong Tce (Community Conservation and Heritage Park)	Ponding in basin under bridge, not overflowing	Regulatory	3	3	Moderate
3-6	Bookpurnong Tce median strip (Opposite 141 Bookpurnong Tce)	Ponding along walking trail	Operational	2	3	Moderate
4-1	Intersection of McMillan St and Grant Schubert Dr	Ponding in swale + wetland area and over walking trails	Regulatory	2	2	Low
4-2	21 William St	Ponding in garden area of property	Strategic	2	3	Moderate
4-3	20 East Tce	Significant gutter flows	Regulatory/ Safety	1	3	Low
4-4	Loxton Historical Village	Ponding in depressions across village and above floor levels	Regulatory	5	2	Moderate
4-5	Swale parallel to Scenic Dr	Flows through swale system and some ponding	Operational	1	3	Low
4-6	Swale adjacent Scenic Drive	Ponding in swale	Strategic	2	2	Low

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
4-7	Corner of Pioneer Walk and William St	Ponding on corner next to road	Operational	2	3	Moderate
5-1	Hentschke Transport Grain Storage, Railway Terrace	Basin filled to capacity	Strategic	2	2	Low
5-2	3 Railway Tce	Significant gutter flows	Operational	3	3	Moderate
5-3	Riverland Floor Centre	Ponding in median strip between Bookpurnong Rd lanes	Operational	1	3	Low
5-4	1968 Bookpurnong Rd	Ponding in depression on side of road, in mulched area	Operational/ Regulatory	3	3	Moderate
5-5	Mill Corner railway memorial	Ponding in grassed swale between Rayment Ave and Bookpurnong Rd	Reputational/ Regulatory	4	3	High
5-7	Intersection of A W Traeger Dr and Pine Ave	Ponding on and along road, flows over Pine Ave	Operational	4	4	High
5-8	Pine Ave (Football oval car park)	Ponding in dirt car park by swimming pool	Operational	2	2	Low
5-9	Intersection of Geraldton St and Pine Ave	Ponding over intersection parallel to Pine Ave	Operational	2	3	Moderate
6-1	Luther Rd and basin (Across Water treatment plant)	Significant gutter flows along, basin overtopping capacity onto the road	Operational/ Regulatory	5	5	Severe
7-1	127 Bookpurnong Tce	Ponding in depression in median strip, near Community Conservation and Heritage Park	Regulatory	3	2	Moderate
7-2	Basin at Fifth St and Klingberg St	Ponding in basin overflowing onto Fifth St	Operational	4	3	High
7-3	10 Trantalis Ct	Ponding along gutter and SEP	Operational	2	4	Moderate
8-1	10-18 Third St	Significant gutter flows	Operational/ Safety	2	3	Moderate
8-3	61 Bookpurnong Tce	Significant gutter flows and ponding in front yard of property	Operational	2	3	Moderate
9-1	Basin at Tobruk Tce/Paruna Rd	Inundation of houses and yards, and overflowing basin	Safety	3	4	High
9-2	14-18 Tobruk Tce	Inundation of houses and yards, ponding over surrounding roads	Operational/ Safety	4	3	High
10-1	Kokoda Tce (Woodleigh) detention basin	Ponding in median strip between Coral St and Aleppo At and in basin, overflowing onto Woodleigh site and along railway line	Strategic	3	3	Moderate

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
10-3	Intersection of Kokoda Tce and Starceвич Rd	Ponding in depression	Operational/ Strategic	3	3	Moderate
10-4	Across 50 Kokoda Tce	Ponding in median strip between Coral St and Aleppo St	Operational/ Strategic	2	2	Low
10-5	Laneway between Geraldton St and Anzac Cres	Significant gutter flows	Operational	2	2	Low
11-1	Between Aleppo St and Robertson Ave	Ponding over road and into depression along railway line	Operational/ Strategic	4	4	High
11-2	Basin on Robertson Ave	Overflowing basin	Strategic	2	2	Low
11-3	83 Starceвич Rd (Loxton Ice Works)	Ponding in depression on side of road and into yard, up to floor level of sheds	Strategic/ Safety	5	4	Severe
11-4	26 Starceвич Rd (Riverland Cold Stores)	Ponding in block behind building	Strategic/ Safety	3	1	Low
11-5	23 Badcoe Rd	Ponding in vacant land by quarry, over Badcoe Rd and into roadside properties	Strategic/ Safety	5	5	Severe
11-7	130 Badcoe Rd	Ponding in block behind house and into yards of houses on Drummond Ave	Strategic/ Safety	4	4	High
11-8	Across 111 Badcoe Rd	Ponding on southern side of road in vacant land	Strategic	4	2	Moderate
11-9	111 Badcoe Rd	Ponding around block and over floor level of entire house	Strategic/ Safety	4	3	High
11-10	Intersection between Dorsch Ave and Kingsbury Rd	Ponding in depression next to intersection	Strategic/ Safety	5	3	Low
11-11	8 Kingsbury Rd	Ponding in depression next to road	Strategic	2	2	Low
12-1	Near Tobruk Tce basin	Ponding in vacant land along railway line	Strategic	5	1	Moderate
13-1	Intersection between Paruna Rd and railway line	Ponding in depressions on the sides of the elevated intersection	Strategic/ Safety	3	5	High
13-2	Eyre St	Ponding in basin system, overflowing into houses on Eyre St	Strategic/ Safety	5	3	High
13-5	12 Barker St	Ponding over house level and around yard	Safety	3	2	Moderate
13-6	Vacant block west of 14 Barker St	Ponding in block	Strategic	1	2	Low
13-7	33 Barker St	Significant gutter flows along Robertson St	Operational	2	4	Moderate

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
14-1	Basin at Wells St	Ponding in basin, overflowing onto roads, houses and into paddock behind	Safety	5	4	Severe
14-2	163 Paruna Rd	Ponding on corner of Paruna Rd and Betty St	Strategic/ Safety	2	4	Moderate
14-3	Basin at Paruna Rd	Ponding in basin, overflowing onto roads and into paddock behind	Operational/ Strategic	3	3	Moderate
15-1	3 Mill Rd	Inundation of buildings and yards, overflowing of basins on both Trenerry and Starceвич, encroaching on Mill Rd, and ponding in Mill Corner basin, with overflowing into swale	Safety	5	3	High
15-9	65-71 Trenerry Ave	Ponding in depression on side of road and encroaching on buildings	Operational/ Safety	5	3	High
16-1	Between Luther Rd and Bookpurnong Rd	Ponding in spoon drain between main road and Luther Rd, in front of Mammoth Fitness	Operational	3	2	Moderate
16-2	1937 Bookpurnong Rd (In front of Loxton Irrigation Centre)	Ponding in swale and overflowing onto service road	Operational/ Safety	5	3	High
16-3	18 Gratwick Rd	Ponding over road and into yards of buildings on both sides of road	Operational/ Safety	3	3	Moderate
16-5	78 Gratwick Rd	Ponding around property and in basin	Safety	4	3	High
16-6	88 Gratwick Rd	Ponding in basin, overflowing in natural swale towards road	Operational	4	3	High
16-7	73 Gratwick Rd	Ponding in front of house along Gratwick Rd		4	2	Moderate
16-8	119 Gratwick Rd	Ponding in paddock behind house (away from structures)	Strategic	3	1	Low
16-9	1920 Bookpurnong Rd	Flows in swale near Tanko Cres	Operational	2	3	Moderate
16-10	1966 Bookpurnong Rd	Ponding in swale between main road and service road, near field gully	Strategic	2	2	Low
18-1	1839 Bookpurnong Rd	Ponding along service road, around house, and in paddock	Strategic	5	2	Moderate
18-2	39 Dorsch Ave	Ponding around property	Safety	5	3	High
18-3	18 Dorsch Ave	Ponding over entrance to property / shed	Safety	5	3	High

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
18-4	13 Dorsch Ave	Ponding in block behind buildings (away from structures)	Strategic	3	1	Low
18-5	1868 Bookpurnong Rd (Loxton High School ag. block)	Ponding on side of road	Operational	1	2	Low
19-1	1800 Simpson Rd	Ponding along both sides of the road and onto Bookpurnong Rd	Strategic/ Operational/ Safety	4	4	High
19-2	1672 Simpson Rd	Ponding along both sides of the road	Strategic/ Operational	2	3	Moderate
19-3	82 Wheatley Rd	Ponding in depression in front of house	Strategic/ Safety	2	2	Low
20-1	Basin at end of Keith Payne Ct	Ponding in basin, overflowing into surrounding houses and paddocks behind	Operational/ Safety	5	4	Severe
20-2	18 French Rd	Ponding in paddock	Strategic	1	2	Low
20-3	1679 Bookpurnong Rd	Ponding in depression in front of house and up to house level	Safety	4	3	High
21-1	1594 Bookpurnong Rd (Winery weighbridge)	Ponding in east-most depression, overflowing onto asphalt area	Strategic/ Operational	4	3	High
21-2	Intersection of Alamein Ave and Bookpurnong Rd	Ponding on side of road and scattered through vacant block	Strategic	2	3	Moderate
21-3	1546 Bookpurnong Rd	Ponding on side of road	Operational	1	3	Low

Table 38. Risk assessment for scenario 5b – 1% AEP Ultimate Development

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
1-1	25 Katarapko Dr	Ponding in swale and culvert under road	Regulatory/ Safety	5	3	High
2-1	9 Thiele Ave	Ponding on north-eastern side of road	Operational	2	3	Moderate
2-2	9 Westbrook Ave	Significant flows along gutter and through property	Operational/ Safety	4	4	High
2-3	8 Hilltop Dr	Ponding near SEP at the base of View St	Operational/ Safety	3	3	Moderate
2-4	McMillan St (Near detention basin)	Ponding along road and in bushland near basin	Regulatory/ Operational	4	3	High
3-1	Bookpurnong Tce (Near Fifth St)	Ponding along swale in median strip, near walking track	Operational	2	2	Low
3-2	72 Bookpurnong Tce	Significant gutter flows and ponding over McMillan/Bookpurnong intersection	Operational	4	3	High
3-3	Bookpurnong Rd median strip (Between Sadlier St and McMillan St)	Ponding over turfed area and walking track	Operational	2	3	Moderate
3-4	Intersection of View St and Bookpurnong Tce	Flows through spoon drain parallel to Bookpurnong Rd	Operational	4	3	High
3-5	Bookpurnong Tce (Community Conservation and Heritage Park)	Ponding in basin under bridge, not overflowing	Regulatory	3	3	Moderate
3-6	Bookpurnong Tce median strip (Opposite 141 Bookpurnong Tce)	Ponding along walking trail	Operational	2	3	Moderate
4-1	Intersection of McMillan St and Grant Schubert Dr	Ponding in swale + wetland area and over walking trails	Strategic	2	2	Low
4-2	21 William St	Ponding in garden area of property	Operational	2	3	Moderate
4-3	20 East Tce	Significant gutter flows	Regulatory/ Safety	2	3	Moderate
4-4	Loxton Historical Village	Ponding in depressions across village and above floor levels	Operational	4	3	High
4-5	Swale parallel to Scenic Dr	Flows through swale system and some ponding	Operational	2	3	Moderate
4-6	Swale adjacent Scenic Drive	Ponding in swale	Regulatory	4	3	High

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
4-7	Corner of Pioneer Walk and William St	Ponding on corner next to road	Strategic	3	3	Moderate
5-1	Hentschke Transport Grain Storage, Railway Terrace	Basin filled to capacity	Strategic	2	2	Low
5-2	3 Railway Tce	Significant gutter flows	Operational	3	3	Moderate
5-3	Riverland Floor Centre	Ponding in median strip between Bookpurnong Rd lanes	Operational	3	3	Moderate
5-4	1968 Bookpurnong Rd	Ponding in depression on side of road, in mulched area	Operational/ Regulatory	3	3	Moderate
5-7	Intersection of A W Traeger Dr and Pine Ave	Ponding on and along road, flows over Pine Ave	Operational	4	4	High
5-8	Pine Ave (Football oval car park)	Ponding in dirt car park by swimming pool	Operational	2	2	Low
5-9	Intersection of Geraldton St and Pine Ave	Ponding over intersection parallel to Pine Ave	Operational	3	3	Moderate
6-1	Luther Rd (Water treatment plant)	Ponding in basin, overflowing into gutter	Operational/ Regulatory	5	5	Severe
7-1	127 Bookpurnong Tce	Ponding in depression in median strip, near Community Conservation and Heritage Park	Regulatory	4	2	Moderate
7-2	Basin at Fifth St and Klingberg St	Ponding in basin overflowing onto Fifth St	Operational	5	3	High
7-3	10 Trantalis Ct	Ponding along gutter and SEP	Operational	3	3	Moderate
8-1	10-18 Third St	Significant gutter flows	Operational/ Safety	2	3	Moderate
8-3	61 Bookpurnong Tce	Significant gutter flows and ponding in front yard of property	Operational	2	3	Moderate
8-4	Intersection of Eringa Ave and Fourth St	Significant gutter flows	Operational	4	4	High
9-1	Basin at Tobruk Tce/Paruna Rd	Inundation of houses and yards, and overflowing basin	Safety	5	3	High
9-2	14-18 Tobruk Tce	Inundation of houses and yards, ponding over surrounding roads	Operational/ Safety	5	3	High
10-1	Kokoda Tce (Woodleigh) detention basin	Ponding in grass-lined drain; overflows	Strategic	4	3	High
10-4	Across 50 Kokoda Tce	Ponding in median strip between Coral St and	Operational/	2	2	Low

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
		Aleppo St	Strategic			
10-5	Laneway between Geraldton St and Anzac Cres	Significant gutter flows	Operational	2	2	Low
11-1	Between Robertson Ave and Aleppo St	Ponding over road and into depression along railway line	Operational/ Strategic	4	4	High
11-2	Basin on Robertson Ave	Ponding in basin, not overflowing	Strategic	2	2	Low
11-3	83 Starceвич Rd (Loxton Ice Works)	Ponding in depression on side of road and into yard, up to floor level of sheds	Strategic/ Safety	5	4	Severe
11-4	26 Starceвич Rd (Riverland Cold Stores)	Ponding in block behind building	Strategic/ Safety	3	2	Moderate
11-5	23 Badcoe Rd	Ponding over road and in vacant land by quarry	Strategic/ Safety	5	5	Severe
11-7	130 Badcoe Rd	Ponding in block behind house and into yards of houses on Drummond Ave	Strategic/ Safety	4	4	High
11-8	Across 111 Badcoe Rd	Ponding on southern side of road in vacant land	Strategic	4	3	High
11-9	111 Badcoe Rd	Ponding around block and over floor level of entire house	Strategic/ Safety	5	4	Severe
11-10	Intersection between Dorsch Ave and Kingsbury Rd	Ponding in depression next to intersection	Strategic	2	2	Low
11-11	8 Kingsbury Rd	Ponding in depression next to road	Strategic	2	2	Low
12-1	Near Tobruk Tce basin	Ponding in vacant land along railway line	Strategic	5	3	High
13-1	Intersection between Paruna Rd and railway line	Ponding in depressions on the sides of the elevated intersection	Strategic/ Safety	3	5	High
13-2	Eyre St	Ponding in basin system, overflowing into houses on Eyre St	Strategic/ Safety	5	3	High
13-5	12 Barker St	Ponding over house level and around yard	Safety	5	2	Moderate
13-6	Vacant block west of 14 Barker St	Ponding in block	Strategic	2	3	Moderate
13-7	33 Barker St	Significant gutter flows along Robertson St	Operational	2	4	Moderate
14-1	Basin at Wells St	Ponding in basin, overflowing onto roads, houses and into paddock behind	Operational/ Strategic	5	4	Severe

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
14-2	163 Paruna Rd	Ponding on corner of Paruna Rd and Betty St	Operational	2	4	Moderate
14-3	Basin at Paruna Rd	Ponding in basin, overflowing onto roads and into paddock behind	Strategic/ Safety	3	3	Moderate
15-1	3 Mill Rd	Inundation of buildings and yards, overflowing of basins on both Trenerry and Starceвич, encroaching on Mill Rd, and ponding in Mill Corner basin, with overflowing into swale	Operational/ Safety	5	4	Severe
15-9	65-71 Trenerry Ave	Ponding in depression on side of road and encroaching on buildings	Operational/ Safety	5	3	High
16-1	Between Luther Rd and Bookpurnong Rd	Ponding in spoon drain between main road and Luther Rd, in front of Mammoth Fitness	Operational	3	2	Moderate
16-2	1937 Bookpurnong Rd (In front of Loxton Irrigation Centre)	Ponding in swale and overflowing onto service road	Operational/ Safety	5	3	High
16-3	18 Gratwick Rd	Ponding over road and into yards of buildings on both sides of road	Operational/ Safety	3	3	Moderate
16-5	78 Gratwick Rd	Ponding around property and in basin	Operational/ Strategic	4	3	High
16-7	73 Gratwick Rd	Ponding in front of house along Gratwick Rd	Safety	2	3	Moderate
16-8	119 Gratwick Rd	Ponding in paddock behind house (away from structures)	Strategic	1	3	Low
16-9	1920 Bookpurnong Rd	Flows in swale near Tanko Cres	Strategic	1	2	Low
16-10	1966 Bookpurnong Rd	Ponding in swale between main road and service road, near field gully	Strategic	1	3	Low
18-1	1839 Bookpurnong Rd	Ponding along service road, around house, and in paddock	Strategic	4	3	High
18-2	39 Dorsch Ave	Ponding around property	Safety	5	3	High
18-3	18 Dorsch Ave	Ponding over entrance to property / shed	Safety	5	3	High
18-4	13 Dorsch Ave	Ponding in block behind buildings (away from structures)	Strategic	1	3	Low
18-5	1868 Bookpurnong Rd (Loxton High School ag. block)	Ponding on side of road	Operational	1	2	Low

ID	Location	Description	Risk Category	Consequence	Likelihood	Risk Rating
19-1	1800 Simpson Rd	Ponding along both sides of the road and onto Bookpurnong Rd	Strategic/ Operational/ Safety	4	4	High
19-2	1672 Simpson Rd	Ponding along both sides of the road	Strategic/ Operational	2	3	Moderate
19-3	82 Wheatley Rd	Ponding in depression in front of house	Strategic/ Safety	2	2	Low
20-1	Basin at end of Keith Payne Ct	Ponding in basin, overflowing into surrounding houses and paddocks behind	Operational/ Safety	5	4	Severe
20-2	18 French Rd	Ponding in paddock	Strategic	1	3	Low
20-3	1679 Bookpurnong Rd	Ponding in depression in front of house and up to house level	Safety	4	3	High
21-1	1594 Bookpurnong Rd (Winery weighbridge)	Ponding in east-most depression, overflowing onto asphalt area	Strategic/ Operational	3	4	High
21-2	Intersection of Alamein Ave and Bookpurnong Rd	Ponding in earthen space	Strategic	2	3	Moderate
21-3	1546 Bookpurnong Rd	Ponding in earthen space	Operational	1	3	Low

6.2. Distribution of Risk Ratings

Table 39 summarises identified risk ratings for all scenarios.

Table 39. Risk ratings distribution

	Low	Moderate	High	Severe
Scenario 1a – 18% AEP Existing Conditions	26	21	12	3
Scenario 1b - 18% AEP Ultimate Development	28	28	16	4
Scenario 5a – 1% AEP Existing Conditions	22	32	23	5
Scenario 5b – 1% AEP Ultimate Development	17	28	28	7

7. Stormwater Management Objectives and Targets

The purpose of this stage is to define clear objectives and measurable targets for the management of stormwater within the Loxton township and the catchment area. These objectives support the overarching goal of achieving sustainable stormwater management that protects the community, enhances the environment, and ensures compliance with regional and State planning frameworks.

7.1. Guidelines and Policies

The Stormwater Management Planning Guidelines (Stormwater Management Authority, 2007) instructs that:

“As a minimum, objectives are to set goals for:

- An acceptable level of protection of the community and both private and public assets from flooding;*
- Management of the quality of runoff and effect on the receiving waters, both terrestrial and marine where relevant;*
- Extent of beneficial use of stormwater runoff;*
- Desirable end-state values for watercourses and riparian ecosystems;*
- Desirable planning outcomes associated with new development, open space, recreation and amenity;*
- Sustainable management of stormwater infrastructure, including maintenance.”*

Further guidance is provided in Water Sensitive Urban Design – Creating More Liveable and Water Sensitive Cities in South Australia (Department of Environment, Water and Natural Resources, 2013), which defines the following indicative stormwater quality improvement targets:

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

These targets are consistent with the performance targets recommended in the Water Sensitive SA – South Australian MUSIC Modelling Guidelines (Water Sensitive SA, 2021), and represent current best practice for achieving sustainable, catchment-based stormwater outcomes in South Australia.

These benchmarks have been adopted as ‘Aspirational’ targets for the water quality improvement objectives within this Stormwater Management Plan (SMP) to support a more sustainable and liveable environment for the community, however in reality all water quality improvements will be beneficial to the receiving waterways.

7.2. Overall Goal

The overall goal of this SMP is to establish a comprehensive and sustainable stormwater management system for the town of Loxton that:

- Minimises flood risks to people, property, and infrastructure;
- Improves the quality of stormwater discharging to the River Murray;
- Minimises adverse impacts on receiving environments;

- Supports urban growth consistent with sustainable land use and water-sensitive design principles;
- Enhances the amenity and resilience of the Loxton community; and
- Delivers cost-effective, climate-resilient outcomes for the Loxton community.

7.3. Objectives and Targets

Objectives and targets set for achieving the overall goals are shown in Table 40.

Table 40 Stormwater Management Objectives and Targets

No.	Objectives	Targets	Absolute (Abs) or Aspirational (Asp)
1	Provide an acceptable level of flood protection for public and private assets.	a. Ensure all developments have habitable floor levels protected from a 5% AEP (1 in 20 years) or more frequent flood event, including the required freeboard allowance.	Abs
		b. Ensure all new developments have habitable floor levels protected from a 1% AEP (1 in 100 year) or less frequent flood event.	Asp
		c. Ensure no private property is subject to high or extreme hazard (H3 hazard and above) in a 1% AEP flood event or less.	Abs
		d. Ensure no residential roadways or properties are exposed to H3 or higher hazard during a 18% AEP flood event.	Abs
		e. Ensure no commercial or industrial roadways or properties experience H3 or higher hazard during a 18% AEP flood event, or higher.	Abs
		f. Maintain safe vehicle access (H1 hazard) along state and local arterial roads during a 1% AEP event.	Abs
		g. Council provide flood risk information to the community and provide assistance to community for creating flood plans.	Asp
2	Planning for new developments	a. A stormwater management plan must be developed for new developments and submitted to Council for approval.	Abs

No.	Objectives	Targets	Absolute (Abs) or Aspirational (Asp)
		b. Maximise opportunities for on-site stormwater reuse and storage in all new developments.	Asp
		c. For developments connecting to existing underground networks, restrict post-development peak flow to pre-development levels for 5% AEP and 1% AEP events through on-site detention.	Abs
		d. Ensure all new developments do not increase downstream flood risk and include a major overland flow path for the 1% AEP critical storm.	Abs
		e. All new developments will consider their impact on the downstream network, including swales and basins, and will provide adequate mitigation where the downstream network is subsequently over capacity considering both peak flow and runoff volume.	Asp
		f. Incorporate WSUD measures to achieve water-quality improvement targets consistent with WSUD Guidelines, including: • 80% reduction in TSS • 60% reduction in TP • 45% reduction in TN	Abs
3	Provide an acceptable level of performance in underground stormwater system and pits	a. Design minor drainage systems for a 18%AEP capacity with no overflows where practical. Lower standards may be acceptable where physical or economic constraints exist, and a safe overflow route is available. higher standards should apply where no overflow route exists.	Abs
		b. Protect existing development from inundation in a 1% AEP event, where practical and economically viable.	Abs
4	Improve water quality discharging to the River	a. Achieve an 80% reduction in TSS compared to the 'untreated' case	Abs

No.	Objectives	Targets	Absolute (Abs) or Aspirational (Asp)
	Murray and protect aquatic ecosystem health	b. Achieve a 60% reduction in TP compared to the 'untreated' case	Abs
		c. Achieve a 45% reduction in TN compared to the 'untreated' case	Abs
		d. Achieve a 90% reduction in litter/gross pollutants compared to the 'untreated' case	Abs
5	Increase the beneficial use of stormwater	a. Opportunities for stormwater harvesting for non-potable uses including irrigation of parks, sporting fields, and streetscapes are to be assessed.	Abs
		b. Promote reuse within commercial and industrial developments through planning incentives.	Abs
		c. Council are to require developments to utilise stormwater reuse where authority allows.	Asp
6	Protect and enhance ecological and biodiversity values associated with stormwater infrastructure.	a. Maintain or enhance riparian and floodplain vegetation along drainage lines	Abs
		b. All new and upgraded stormwater outlets, discharging to the river are to be designed to control silt deposits, discharging velocities and mitigate any adverse effects to the physical conditions of the receiving environment.	Abs
		c. Prevent untreated stormwater discharge into sensitive environmental areas.	Abs
		d. Design and manage detention basins and wetlands as multi-functional ecological assets.	Asp
		e. Integrate biodiversity corridors within stormwater reserves through targeted revegetation and landscaping.	Asp
7	Incorporate open space, recreation, and amenity outcomes in planning.	a. Develop and implement planning and design policies that minimise the impact of flooding on new and existing developments.	Abs

No.	Objectives	Targets	Absolute (Abs) or Aspirational (Asp)
		b. Adopt integrated design principles to achieve multiple outcomes (water management, amenity, biodiversity) in new development, retrofits, stormwater, road and streetscape upgrades.	Asp
		c. Promote design approaches that protect and enhance natural systems, increase biodiversity, and enable passive stormwater treatment and reuse.	Asp
8	Asset Management and Governance	a. Council to maintain up to date information on the location, size, age and condition of stormwater infrastructure.	Abs
		b. Ensure all WSUD assets have an operation and maintenance plan in place.	Abs
9	Climate Resilience and Adaptation	a. Design new stormwater infrastructure with consideration of 2090 climate-change rainfall projections.	Asp
10	Communication and engagement with stakeholders, businesses, and the community	a. Effectively engage with the community on stormwater management issues and proposed strategies including WSUD and stormwater reuse opportunities where possible.	Asp
		b. Increase community and business awareness to enable effective response to extreme-weather and flood warnings.	Asp
		c. Identify opportunities for partnerships with the community and agencies in the development and implementation of strategies.	Asp

8. Stormwater Management Responses

A range of stormwater management solutions was developed to address the key flooding, water quality, and drainage challenges identified throughout the study. These solutions were assessed against the project's objectives and reviewed with Council and the SMP Steering Committee to identify the most effective and achievable management responses.

The preferred management responses were evaluated for their ability to reduce flood risk, improve water quality, support future growth, and deliver environmental and community benefits. The resulting strategy provides a balanced and practical framework for enhancing the resilience, performance, and long-term sustainability of the stormwater system across the town of Loxton.

8.1. Summary of strategies

Loxton is situated on predominantly flat terrain, with numerous local depressions that have limited natural drainage to the River Murray, making the township susceptible to localised flooding during rainfall events. Much of the existing stormwater network was constructed prior to the 1970s and is now approaching the end of its service life, reducing its capacity to accommodate current and future stormwater flows.

Flood modelling and flood risk assessment identified a number of problem areas, grouped as Damage Areas (DAs) based on catchment characteristics, drainage behaviour, and the performance of the existing stormwater network. To address these issues, the proposed stormwater management responses have been organised into solution sets, each targeting one or more Damage Areas.

The proposed management responses combine conventional stormwater infrastructure upgrades with Water Sensitive Urban Design (WSUD) measures to achieve the flood management and water quality objectives established in Section 7. Conventional measures include stormwater pipe upgrades, network extensions, detention basins, and drainage improvements, while WSUD measures provide complementary benefits by reducing runoff volumes, improving water quality, and enhancing urban amenity.

A fundamental principle of this Stormwater Management Plan is to manage stormwater as close to its source as practicable. Treating, retaining, and slowing runoff before it enters the drainage network reduces peak flows, improves water quality, promotes infiltration, and reduces pressure on downstream infrastructure and receiving environments. This source-control approach complements conventional drainage upgrades by reducing demand on the existing network, improving system resilience, and supporting more sustainable stormwater management outcomes.

Where conventional engineering solutions are constrained or impractical, additional WSUD measures have been incorporated to improve overall system performance. These include:

- Infiltration system, such as leaky wells, tree inlets;
- Series of biofilters and vegetated swales;
- Permeable paving/porous asphalt;
- Constructed wetlands;
- Underground detention systems; and,
- Stormwater harvesting and reuse opportunities.

Several of the proposed management responses also incorporate whole-of-catchment or end-of-pipe treatment systems. These should be designed using a treatment train approach that combines natural treatment systems with proprietary devices, such as gross pollutant traps (GPTs) and trash racks, to maximise the removal of litter, sediments, nutrients, and other pollutants before discharge to receiving waters.

In addition to improving water quality, centralised treatment systems can reduce long-term maintenance requirements while delivering broader environmental and community benefits, including enhanced visual amenity, wetlands, walking trails, and recreational spaces. Early planning and integration of these systems into future projects will help maximise these environmental, social, and operational outcomes.

8.1.1. Increasing inlet capacity [S1]

A significant number of single side entry pits are present across the study areas. It is recommended that, where feasible, these be upgraded to double side entry pits as part of repair and renewal works on the existing stormwater network. This approach would improve inlet capacity and overall system performance during storm events. Upgrade works may include retrofitting existing pits or full replacement, depending on asset condition and site constraints.

8.1.2. Increasing onsite storage [S2]

This is not limited to larger-scale basins such as detention, retention, or bioretention basins, nor to the specific solutions identified in this SMP.

It is recommended to incorporate Water Sensitive Urban Design (WSUD) measures and increase minor on-site storage (retention) as part of road infrastructure upgrades, including streetscape improvements, traffic channelisation works, and kerb extension redesign. Integrating these measures can help reduce runoff volumes, improve water quality, and enhance the overall performance of the stormwater network.

8.1.3. Installation of Water Quality Treatment Devices at Stormwater Outlets [S3]

Where practical, stormwater outlets and major discharge points should incorporate water quality treatment measures as part of a treatment train approach. This approach integrates natural treatment systems, such as wetlands, biofiltration systems, and vegetated swales, with proprietary treatment devices, including gross pollutant traps (GPTs) and trash racks, to maximise the removal of litter, sediments, nutrients, and other pollutants before discharge to receiving waters.

A treatment train approach should be considered for both whole-of-catchment and end-of-pipe management responses to improve overall water quality performance while enhancing the resilience of the stormwater network. Selection of treatment measures should consider catchment characteristics, pollutant loads, maintenance requirements, available land, lifecycle costs, and opportunities to provide broader environmental and community benefits.

8.1.4. Review of existing stormwater and WSUD assets and programming [S4]

A staged condition assessment of the stormwater drainage network is recommended to identify blockages and pipes that are in poor or very poor condition and require repair or replacement. Undertaking the assessment in stages will enable defects to be prioritised and addressed efficiently, reducing the risk of damage to trench reinstatement works and adjacent assets while minimising further deterioration of the drainage network.

An associated asset renewal program should be reviewed, amended where necessary, and progressively updated based on the findings of the condition assessments, together with the outcomes of completed maintenance and renewal works. This will support a targeted, risk-based approach to asset management and help ensure the ongoing performance, reliability, and service life of the stormwater network.

All existing Water Sensitive Urban Design (WSUD) assets should be incorporated into Council's asset management system, together with any new WSUD assets constructed following adoption of this SMP. This will enable the development of a coordinated maintenance and renewal program based on the expected service life, condition, and performance of each asset. Integrating WSUD assets into the broader asset management framework will support proactive maintenance, optimise lifecycle costs, and ensure the long-term effectiveness of these stormwater management measures.

8.1.5. Coordination with other infrastructure programs

Following endorsement of this SMP, implementation of the proposed solutions should be coordinated with relevant road and infrastructure programs to maximise efficiency and minimise rework. This includes:

- Ensuring planned stormwater upgrades are aligned with road reseal and reconstruction programs to avoid conflicts and duplication of works.
- Prioritising stormwater infrastructure installation ahead of new road construction to prevent retrofitting and associated costs.
- Coordinating stormwater upgrade works with kerb and water-table construction or renewal to achieve integrated delivery and improved drainage outcomes.

This coordinated approach will support cost-effective implementation, reduce disruption, and optimise the performance of both stormwater and transport infrastructure.

8.2. Structural strategies

The proposed stormwater management solutions are shown in Figure 27, with their descriptions and expected outcomes summarised in Table 41.

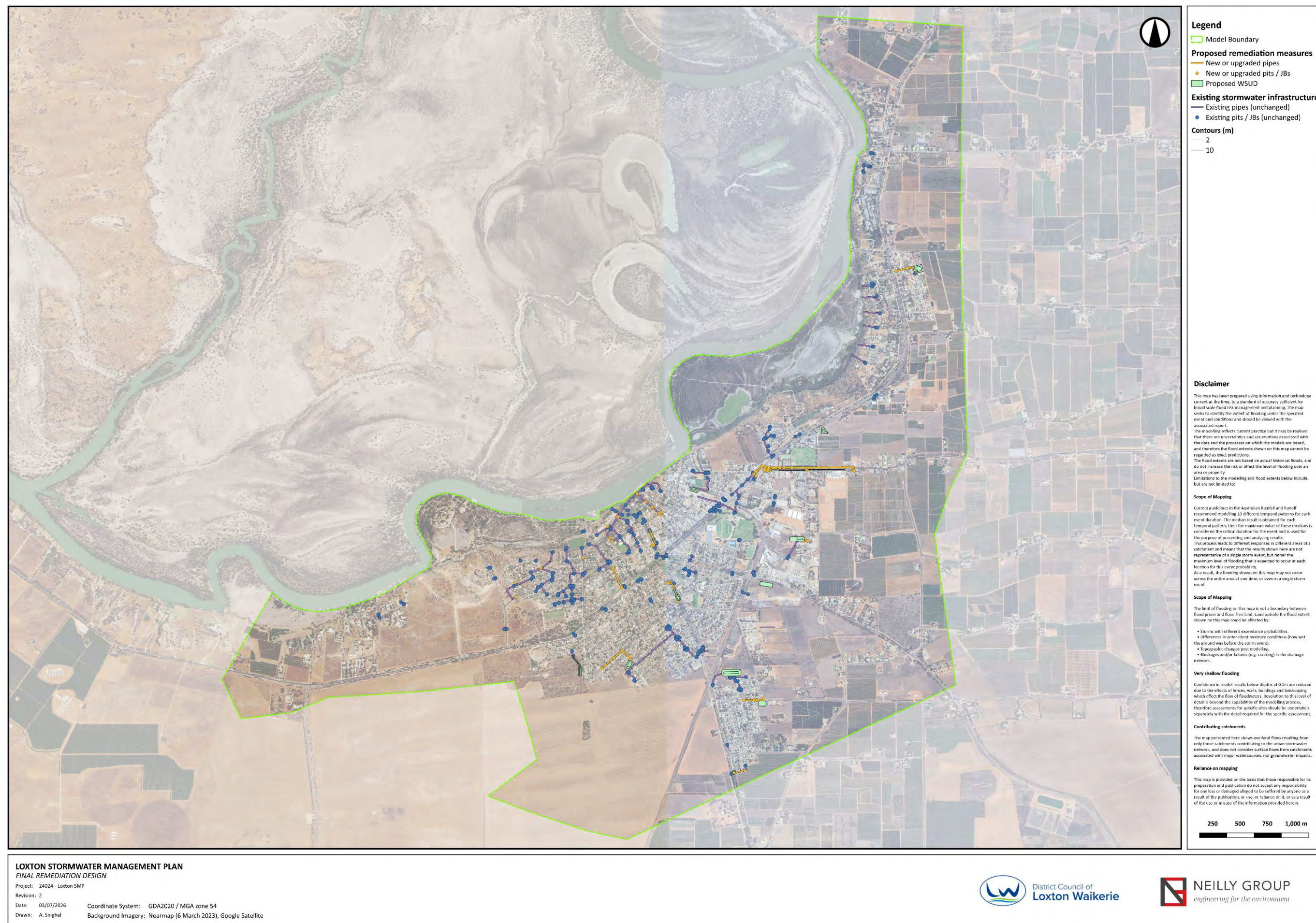


Figure 27. Proposed remediation measures.

Table 41. Stormwater Management Responses

Solution Set	ID	Brief Description	Benefit Provided				Cost		Reduction in Flood Damages
			Flood protection	Water quality	Stormwater Reuse	Improved amenities	Capital Cost (\$)	Operating Cost (\$/year)	
B	B1	Minor stormwater upgrades along Kaesler St/Westbrook Ave branch drain	✓			✓	\$35,200	\$240	18% AEP: \$425k 1% AEP: -\$435k*
	B2	Increase drainage capacity in front of property #8 Hilltop Dr	✓			✓	\$23,800	\$90	
	B3	Minor stormwater upgrades coupled with tree pits/leaky wells at various locations	✓			✓	\$254,100	\$1,542	
C	C2	Solution for Bookpurnong median & Third St	✓			✓	\$808,800	\$670	18% AEP: \$2.36m 1% AEP: \$3.75m
	C5	Enlarging Fifth St basin	✓	✓	✓	✓	\$432,200	\$4,725	
	C6	Installation of underground stormwater network upstream of Fifth St basin	✓			✓	\$571,900	\$1,432	
	C7	Swale and detention basin at Sixth Avenue	✓	✓	✓	✓	\$375,000	\$6,030	
	C8	Leaky wells and new retention basin on Tobruk Tce	✓	✓	✓	✓	\$747,100	\$4,850	
D	D1	Enlarge existing Eyre St basin	✓	✓	✓	✓	\$1,096,900	\$15,750	18% AEP: \$85.5k 1% AEP: \$3.02m
	D3	Geotechnical investigation to inform retention basin near Paruna Rd					\$36,118	\$200	
	D6	New detention/retention basin at the intersection of Traeger St and Barker St	✓	✓	✓	✓	\$689,800	\$5,480	
	D7	Bund to protect Paruna Rd basin	✓			✓	\$47,000	\$200	
E	E2	Swale along Kokoda Tce	✓	✓		✓	\$234,000	\$2,129	18% AEP: \$312k 1% AEP: \$400k
	E3	Installation of pipe underneath the new roundabout	✓				\$746,000	\$710	
	E5	WISER basin (wetland and pond at Robertson Ave)	✓	✓	✓	✓	\$932,900	\$5,940	
	E6	Increasing volumes of existing basins	✓	✓	✓	✓	\$884,500	\$8,198	
	E14	Increasing capacity of existing Railway Yard basin	✓	✓	✓	✓	\$384,500	\$3,780	
F	F4	Installation of stormwater pipes in Gratwick Rd and Luther Rd	✓	✓	✓	✓	\$1,196,800	\$9,169	18% AEP: \$668k 1% AEP: \$323k
G	G1	Retention basin adjacent to property # 1861 Bookpurnong Rd	✓	✓	✓	✓	\$377,800	\$3,345	18% AEP: No change 1% AEP: \$354k
	G3	Increasing the volume of the Keith Payne basin and stormwater infrastructure upgrades	✓	✓	✓	✓	\$831,500	\$7,990	

* Flooding increases in the Historic Village due to optimisations upstream. Detailed design should consider increasing capacity at the outlet of this trunk drain to reduce localised overflows and ensure sufficient capacity in the network to mitigate this, as discussed in Section 8.2.1.4.

8.2.1. Solution Set B

Flooding throughout these areas mostly occurs at localised depressions, suggesting inlet or pipe capacity issues at those areas, or at formalised swales and channels. In the major event, this also includes depressions occurring on multiple properties.

8.2.1.1. Proposed options

The suite of solutions comprising Set B include:

- B1. Minor stormwater upgrades along Kaesler St/Westbrook Ave branch drain.
- B2. Increase drainage capacity in front of property #8 Hilltop Dr.
- B3. Minor stormwater upgrades

8.2.1.2. Minor stormwater upgrades along Kaesler St/Westbrook Ave branch drain [B1]

The proposed design includes the following measures:

- Three existing single SEPs upgraded to double SEPs

The flood extent under the ultimate development scenario is shown in Figure 28. The proposed design, together with the flood extent after mitigation, are shown in Figure 29.

8.2.1.3. Increase drainage capacity in front of property #8 Hilltop Dr [B2]

The proposed design includes the following measures:

- Upgrading the existing single SEP to a double SEP
- Upgrading the existing 225 mm connecting pipe to 300 mm

The flood extent under the ultimate development scenario is shown in Figure 30. The proposed design, together with the flood extent after mitigation, are shown in Figure 31.

8.2.1.4. Minor stormwater upgrades coupled with tree pits/leaky wells at various locations [B3]

The proposed design includes the following measures:

- Upgrading nine (9) existing single SEPs to double SEPs.
- One GIP upgraded from 450 mm square to 900 x 450 mm.
- Upgrading three pipes along East Terrace to 450 mm.

The flood extent under the ultimate development scenario is shown in Figure 32. The proposed design, together with the flood extent after mitigation, are shown in Figure 33.

Note that the changes made to optimise the upstream section of this branch of the network result in additional surcharging downstream, increasing flooding within the Historic Village. Detailed design should confirm the pipe arrangement at the overflow outlet from the intersection of Scenic Dve and Pioneer Walk, and look to upgrade the main trunk outlet into the swale at the west of the Historic Village, if required.



Figure 28. Modelled flood extent at location of Option B1 under Scenario 5b.



Figure 29. Modelled flood extent for remediation Option B1 (Scenario 5c).

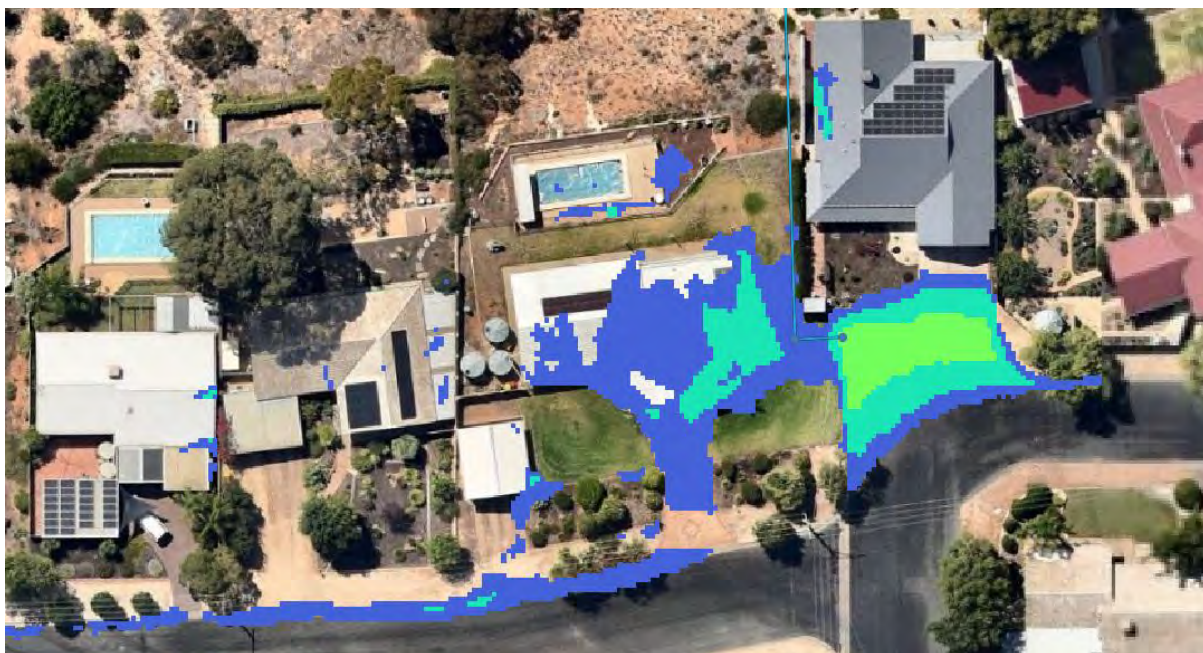


Figure 30. Modelled flood extent at location of Option B2 under Scenario 5b.



Figure 31. Modelled flood extent for remediation Option B2 (Scenario 5c).

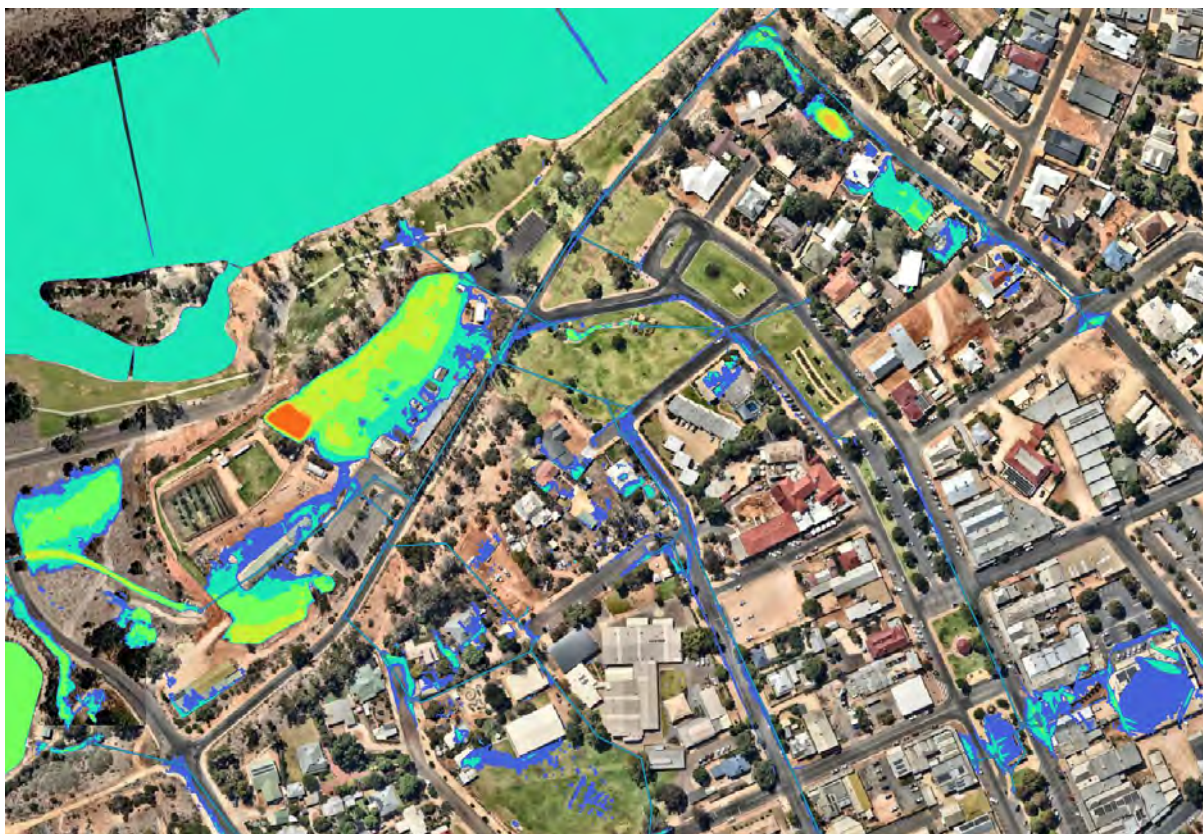


Figure 32. Modelled flood extent at location of Option B3 under Scenario 5b.

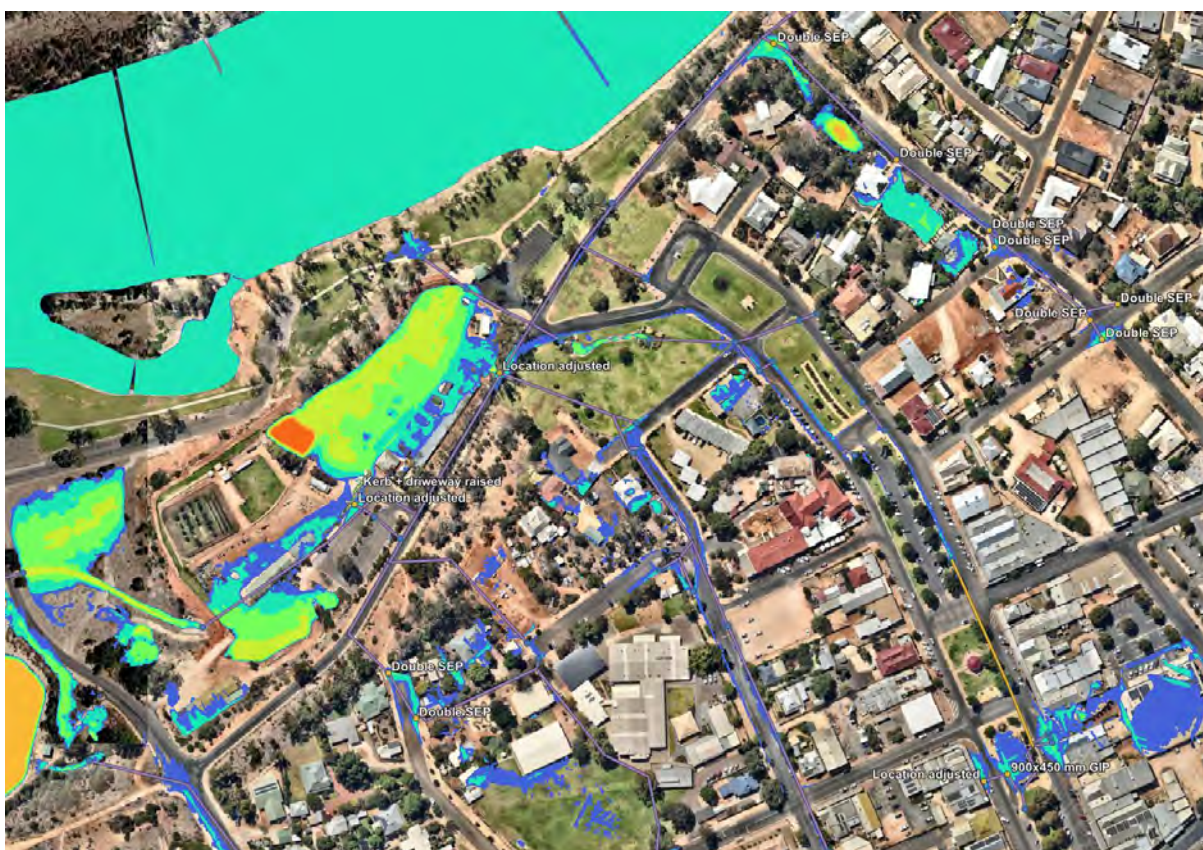


Figure 33. Modelled flood extent for remediation Option B3 (Scenario 5c).

8.2.2. Solution Set C

Solution Set C targets Damage Areas 3, 7, 8 and 9 which, combined, ultimately drain towards the Third St and Tobruk Terrace basins. The larger Council-owned basins in these areas are connected, such that the Fifth St basin overflows towards the Third St basin, which overflows towards the Tobruk Tce basin. Additionally, Council have the ability to pump water from the Tobruk Tce to the Eyre St basin when required.

The Third St basin is the most effective infiltration basin in Loxton, anecdotally emptying from full in just 2-3 days.

8.2.2.1. Proposed options

The suite of solutions comprising Set C include:

- C2. Solution for Bookpurnong median & Third St.
- C5. Enlarging Fifth St basin.
- C6. Installation of underground stormwater network upstream of Fifth St basin.
- C7. Swale and detention basin at Sixth Avenue.
- C8. Leaky wells and new retention basin on Tobruk Tce.

8.2.2.2. Solution for Bookpurnong median & Third St [C2]

While initial solutions sought to increase storage – either through a detention basin or underground storage – these would result in extremely long pipe lengths due to levels, and would simply push the problem down to the Third St basin.

Instead, underground pipe lengths could be shorter, and the water pushed to an area better able to cope with the additional volumes by intercepting flows along the northern side of Bookpurnong Tce and piping them along McMillan St towards the McMillan St basin. This requires piping at up to 3m depth (maximum), but would still be cheaper and easier than a detention basin or underground storage.

The proposed design includes the following measures:

- Installation of a new full road width GIP at the end of McMillan St (running parallel with Bookpurnong Rd).
- Installation of a 900 x 600 mm box culvert.
- Installation of a new surcharge pit (double SEP) to bring flows back into the kerb, to flow towards existing pits at the intersection of McMillan & Drabsch streets.

Detailed design should look to optimise pit and pipe arrangement to balance flows to McMillan St, versus those allowed to continue towards the median as currently occurs.

The flood extent under the ultimate development scenario is shown in Figure 34. The proposed design, together with the flood extent after mitigation, are shown in Figure 35.



Figure 34. Modelled flood extent at location of Option C2 under Scenario 5b.



Figure 35. Modelled flood extent for remediation Option C2 (Scenario 5c).

8.2.2.3. Enlarging Fifth St basin [C5]

The proposed design includes the following measures:

- Increasing the capacity of the Fifth St basin.

The results for this option are shown together with the results of Option C6 in Figure 36 and Figure 37

8.2.2.4. Installation of underground stormwater network upstream of Fifth St basin [C6]

The proposed design includes the following measures:

- Installation of six new double SEPs.
- Installation of new 375 mm pipes.
- Installation of new headwall.

The flood extent under the ultimate development scenario is shown in Figure 36. The proposed design, together with the flood extent after mitigation, are shown in Figure 37.

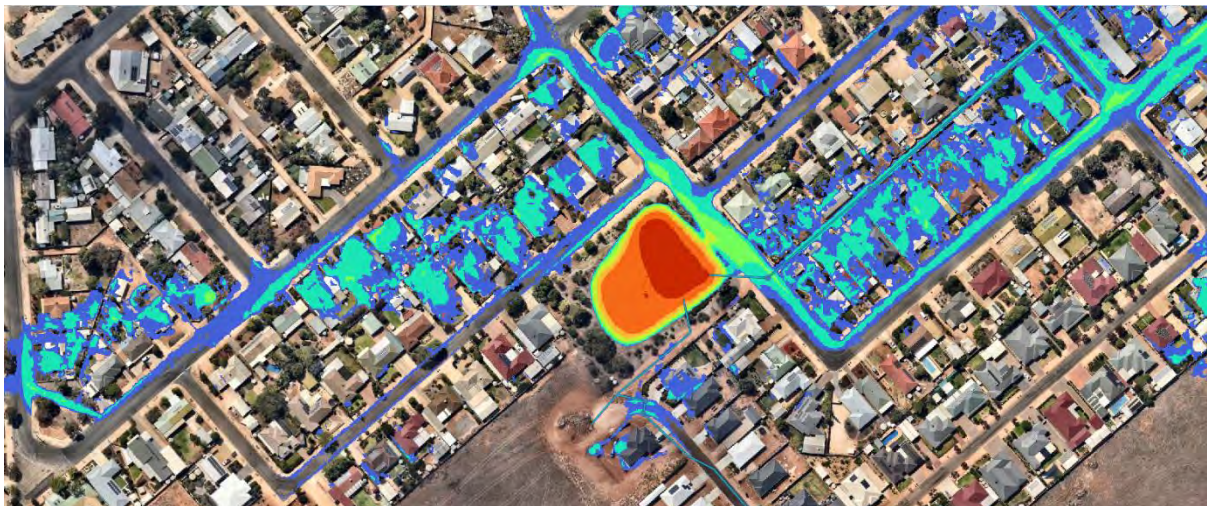


Figure 36. Modelled flood extent at location of Option C5 & C6 under Scenario 5b.

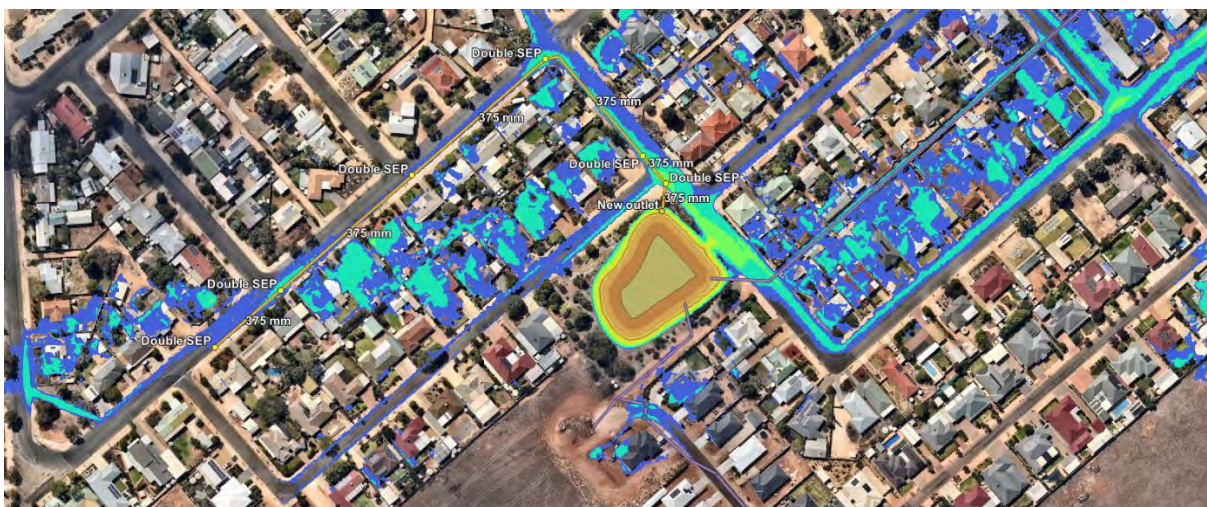


Figure 37. Modelled flood extent for remediation Option C5 & C6 (Scenario 5c).

8.2.2.5. Swale and detention basin at Sixth Avenue [C7]

The proposed design includes the following measures:

- New detention basin behind (west of) Sixth St.
- New swale leading from Trantalis Court outlet to basin.

The flood extent under the ultimate development scenario is shown in Figure 38. The proposed design, together with the flood extent after mitigation, are shown in Figure 39.

8.2.2.6. Leaky wells and new retention basin on Tobruk Tce [C8]

Tobruk Terrace generally runs from high to low as it runs from north to south, apart from a depression around the First St intersection. The current setup involves two single SEPs on the western side, and one on the eastern side, piping water to the median where it is piped beneath the carpark to the south, and then surcharges back to the road just north of the southwest corner of that section of the median. This is inadequate in all but the smallest events, and council noted that tree roots regularly intercept the pipe beneath the carpark.

The proposed design includes a pipe running beneath this carpark, however it is recommended that detailed design consider a leaky well for this section instead – essentially a rock-lined trench that would allow tree roots freedom to move while still conveying water away from the depression. Converting the carpark to permeable paving could also provide the opportunity to add additional storage underneath.

The effectiveness of this whole design is limited due to levels, and opportunities to optimise the design should be considered during detailed design.

The proposed design includes the following measures:

- Converting two existing single SEPs to double SEPs.
- Removal of existing surcharge pit and two sections of pipe.
- Replacing pipe underneath Tobruk Tce (west side) with 900 mm x 300 mm box culvert.
- Replacing pipes from eastern SEP on west side of Tobruk Tce to new swale with 900 mm x 450 mm box culverts.
- Constructing a swale down to a new retention basin at the southern end of the median.
- A restricted outlet (225 mm) to slow flows along Tobruk Tce and the end-of-system basins at the southern end.
- Two new headwalls (one at swale inlet; one at basin outlet).
- Installation of new surcharge pit (double SEP).

The flood extent under the ultimate development scenario is shown in Figure 40. The proposed design, together with the flood extent after mitigation, are shown in Figure 41.

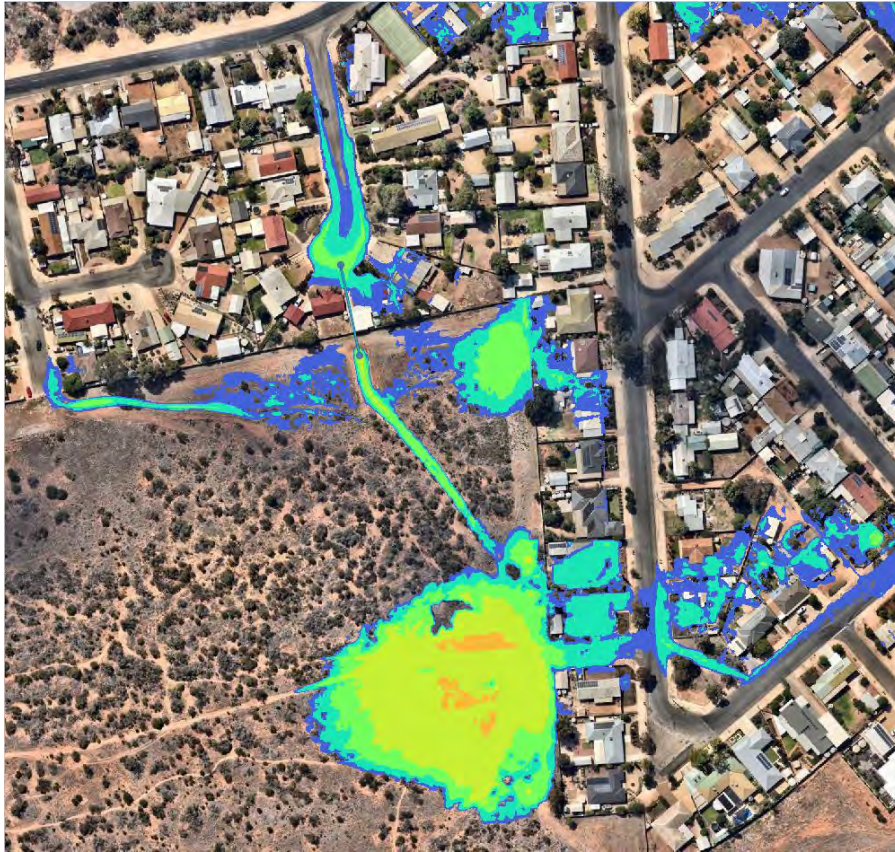


Figure 38. Modelled flood extent at location of Option C7 under Scenario 5b.

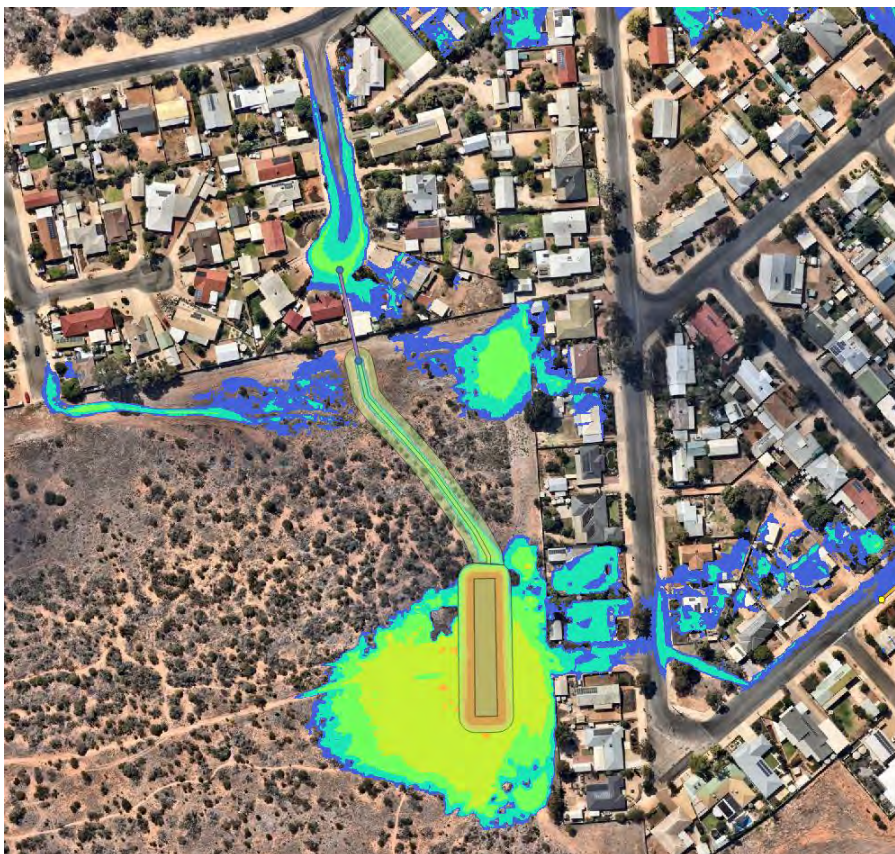


Figure 39. Modelled flood extent for remediation Option C7 (Scenario 5c).

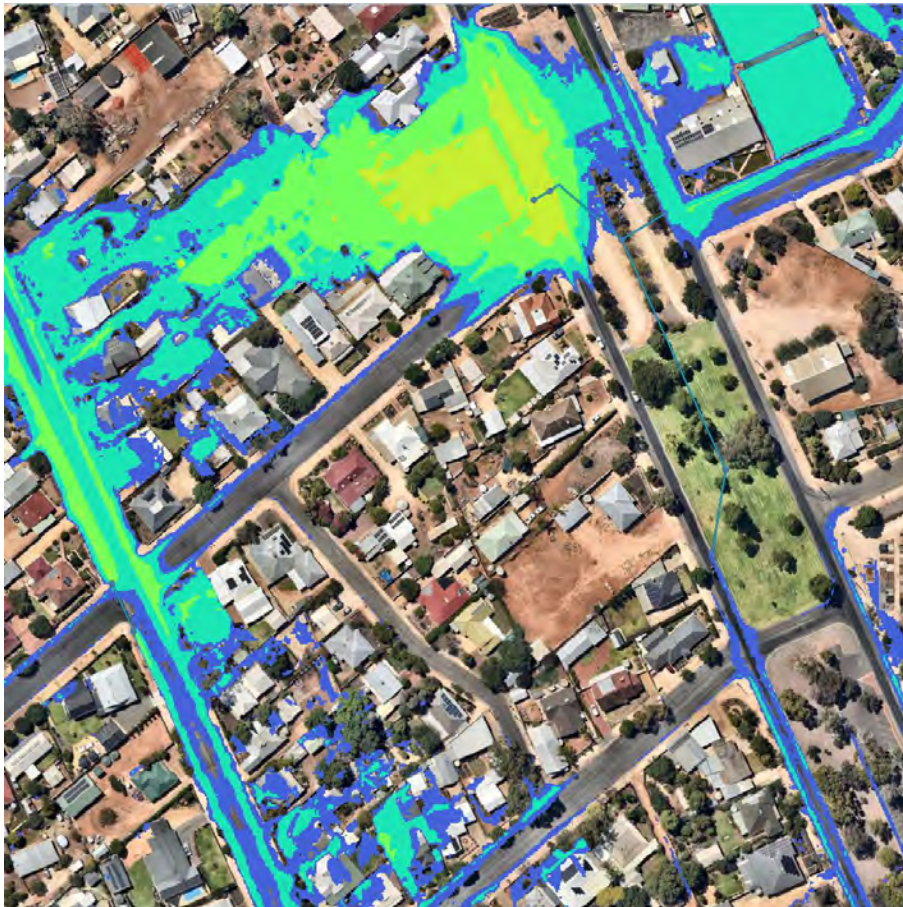


Figure 40. Modelled flood extent at location of Option C8 under Scenario 5b.

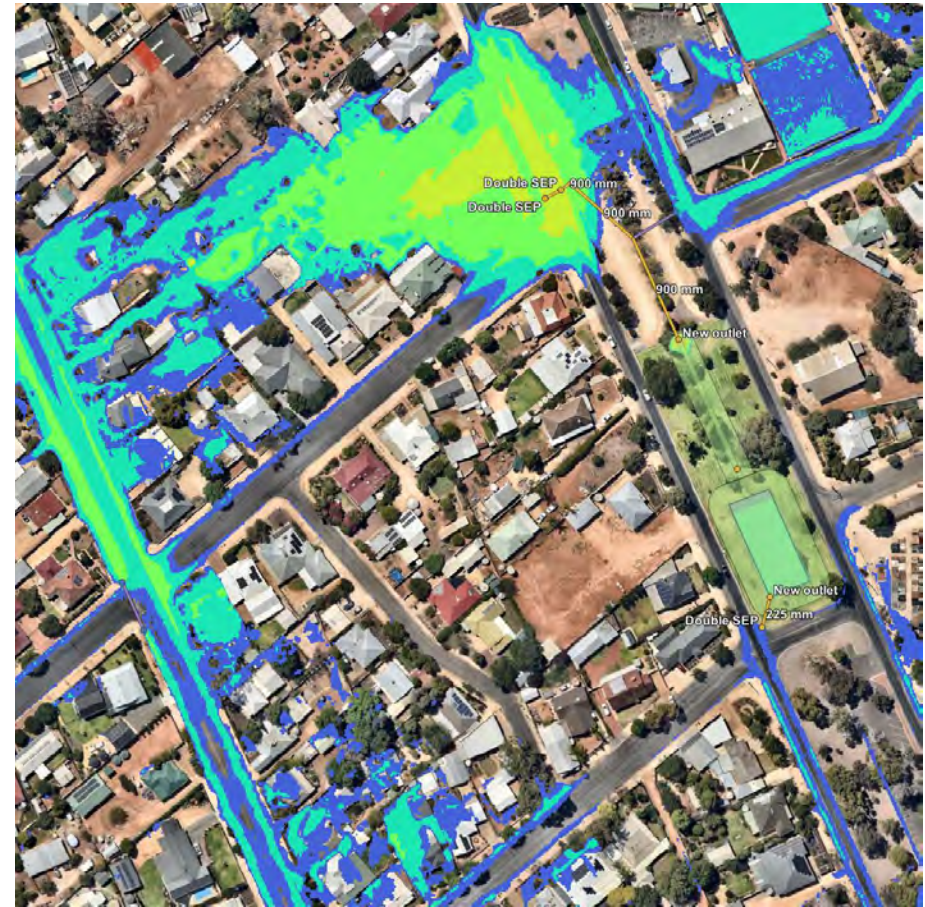


Figure 41. Modelled flood extent for remediation Option C8 (Scenario 5c).

8.2.3. Solution Set D

Solution Set D includes Damage Areas 12 to 14 (DA-12, DA-13 and DA-14). Of these, only DA-13 has a formalised network, which leads flows towards connected basins at the end of Eyre St.

8.2.3.1. Proposed options

The suite of solutions comprising Set D include:

- D1. Enlarge existing Eyre St basin.
- D3. Geotechnical investigation to inform retention basin near Paruna Rd.
- D6. New detention/retention basin at the intersection of Traeger St and Barker St.
- D7. Bund to protect Paruna Rd basin.

8.2.3.2. Enlarge existing Eyre St basin [D1]

The proposed design includes the following measures:

- Extending the northern (larger) Eyre St basin to the east.

The flood extent under the ultimate development scenario is shown in Figure 42. The proposed design, together with the flood extent after mitigation, are shown in Figure 43.

8.2.3.3. Geotechnical investigation to inform retention basin near Paruna Rd [D3]

There is significant flooding in all basins in the vicinity of the rail crossing on Paruna Rd (Third St basin, Tobruk Tce basin and the Eyre St basins). Water is currently pumped between them as needed during large events, and can also be pumped from the Kokoda basin, however it cannot be pumped back to the Kokoda basin due to restrictions on that basin in relation to the WWTP on Taplan Rd.

Borehole logs on Water Connect suggest that sand layers exist very close to the surface in this region, sometimes with thin layers of clay or calcrete before further sand layers continue much deeper. It is recommended that geotechnical drilling is undertaken to understand the subsurface characteristics at this location, particularly noting that the Third St basin is known to empty so quickly after filling.

Results from this study could better inform solutions – especially locations for new basins - that could aid in removing stormwater from Damage Areas 8, 9, 12 & 13, especially given the general difficulties in draining stormwater in these areas due to the topography and geology of the region.

8.2.3.4. New detention/retention basin at the intersection of Traeger St and Barker St [D6]

The proposed design includes the following measures:

- Four new double SEPs along Barker Rd.
- New 300 mm pipes connecting SEP's to a new junction box, then into the new basin.
- New detention basin on corner of Barker and Traeger streets.

The flood extent under the ultimate development scenario is shown in Figure 44. The proposed design, together with the flood extent after mitigation, are shown in Figure 45.

8.2.3.5. Bund to protect Paruna Rd basin [D7]

The Paruna Rd basin looks to overtop in larger events, however the majority of the runoff comes from the large open fields to the west. A bund should be raised to keep these flows on the landholder's land, and isolate them from the council basin. Modelling during detailed design should

determine the final length of the bund required, and whether the basin itself needs to be enlarged to contain flows from the residential area to the east.

The proposed design includes the following measures:

- A bund running along the property boundary.

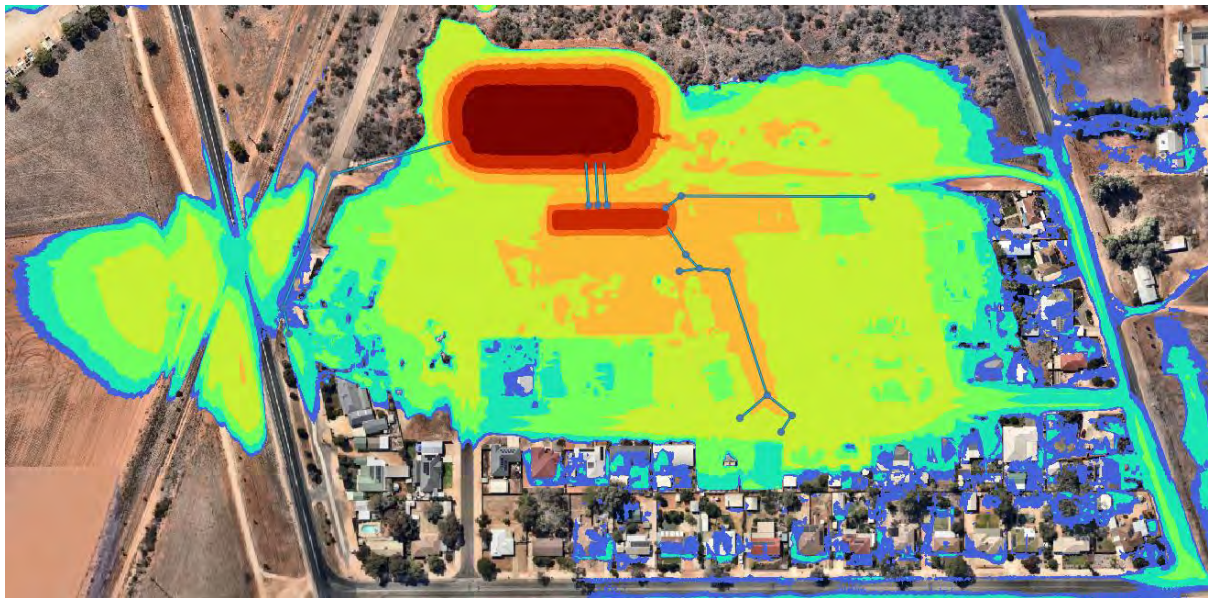


Figure 42. Modelled flood extent at location of Option D1 under Scenario 5b.

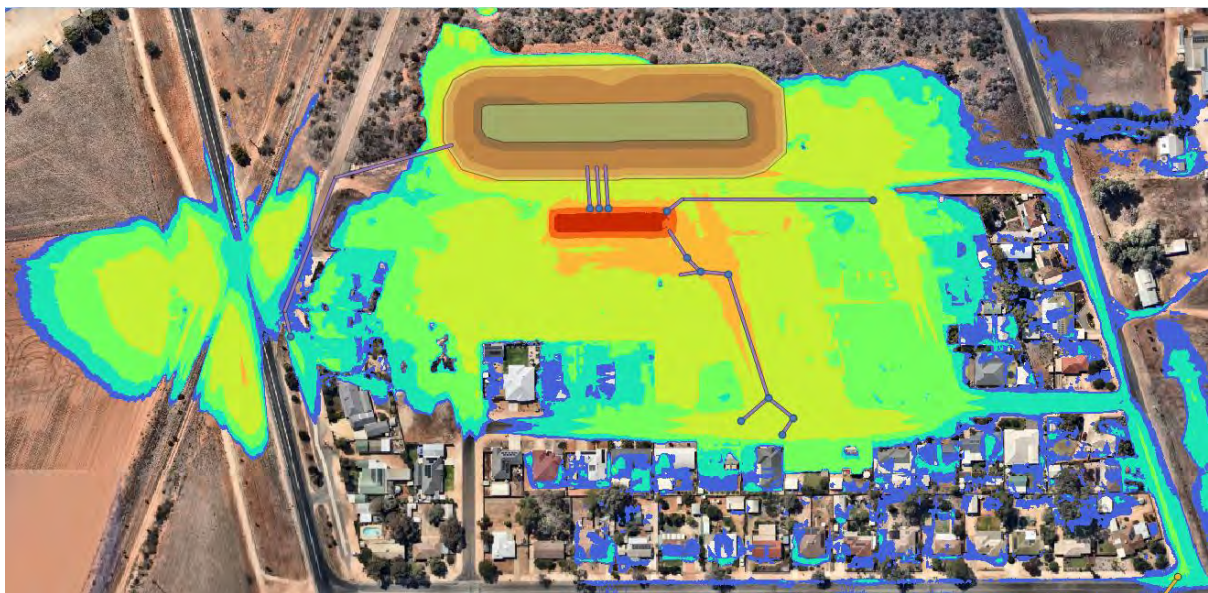


Figure 43. Modelled flood extent for remediation Option D1 (Scenario 5c).

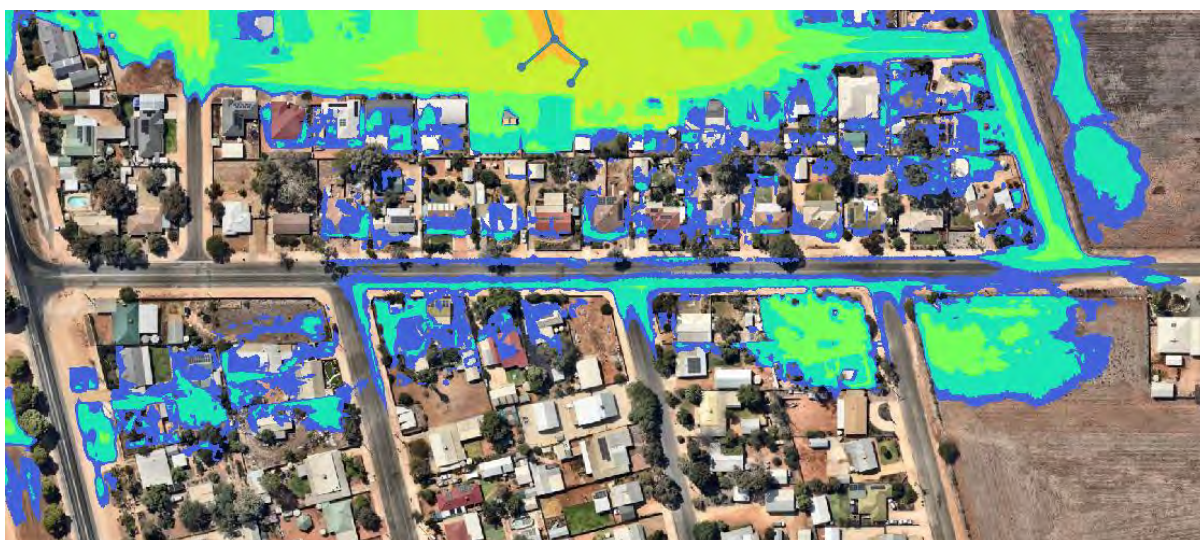


Figure 44. Modelled flood extent at location of Option D6 under Scenario 5b.

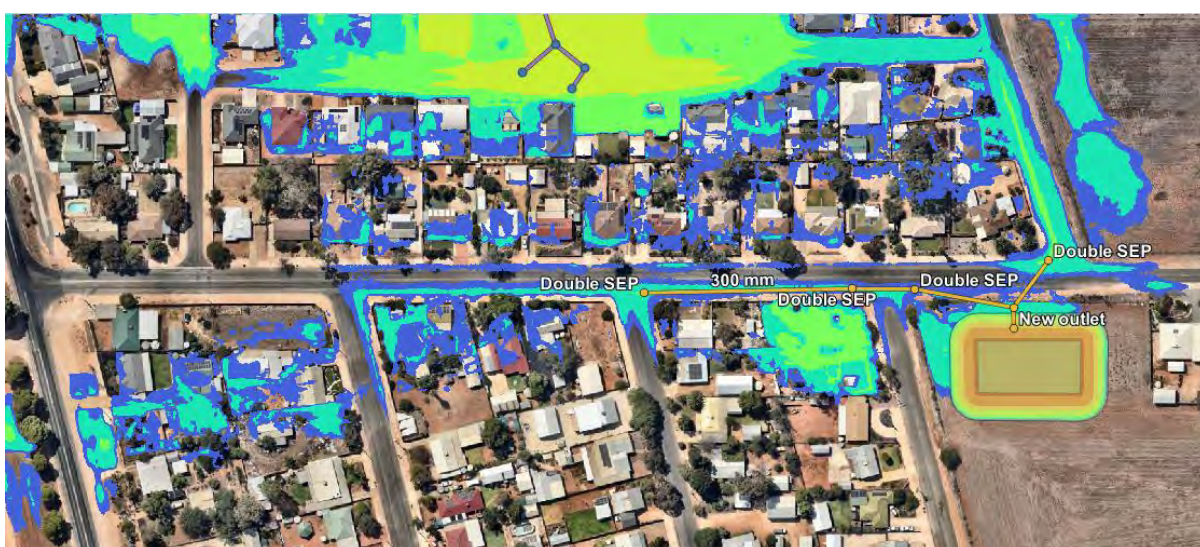


Figure 45. Modelled flood extent for remediation Option D6 (Scenario 5c).

8.2.4. Solution Set E

Solution Set E addresses Damage Areas 5, 10, 11 and 15. These have been grouped based on connectedness of basins, including the Kokoda Tce and Mill Corner basins, and a proposed basin at Robertson Ave / Badcoe Rd, which Neilly Group understand Council have already begun investigating.

It should be noted that between the completion of Existing and Future model runs, construction has begun on the new Woodleigh childcare centre on Kokoda Terrace, adjacent the Kokoda basin. The new landform, and changes to stormwater infrastructure have also been included in the Remediation modelling for this area. This affects the resulting model results for options E2 and E3.

8.2.4.1. Proposed options

The suite of solutions comprising Set E include:

- E2. Swale along Kokoda Tce.
- E3. Installation of pipe underneath the new roundabout.

E5. WISER basin (wetland and pond at Robertson Ave).

E6. Increasing volumes of existing basins.

E14. Increasing capacity of existing Railway Yard basin.

8.2.4.2. Swale along Kokoda Tce [E2]

The proposed design includes the following measures:

- New swale along final median section at eastern end of Kokoda Terrace.
- New headwall and 900 mm pipe to proposed WISER basin.
(Two parallel 900 mm x 600 mm box culverts could also be considered to optimise invert levels.)

Note that the proposed design fits within the existing roadways of the area, however if the northern section of Aleppo St that connects the two sides of the median is removed, then detailed design of the swale should look to increase its length, and potentially terminate in a small detention basin for additional storage, if levels permit.

Flood extents for this option are combined with Options E3 and E5 in Figure 46 and Figure 47.

8.2.4.3. Installation of pipe underneath the new roundabout [E3]

Neilly Group are aware that a new roundabout is being proposed for the intersection of Robertson Ave and Kokoda Tce / Badcoe Rd. It is strongly recommended that designs for pipe / box culverts connecting existing and proposed infrastructure are completed before the commencement of construction of this roundabout, to optimise costs and benefits for the council, and to remove the need for rework on this new road.

Preliminary guidance has been provided recommending allowing for 900 mm pipe heights, to allow connection between the existing Kokoda Tce basin, the proposed swale (Option E2), the new WISER basin (Option E5, that is currently progressing under the WISER grant program, and any potential upgrade required to assist in removing ponding from in front of the Loxton Ice Works.

Flood extents for this option are combined with Options E2 and E5 in Figure 46 and Figure 47.

8.2.4.4. WISER basin (wetland and pond at Robertson Ave) [E5]

Council has secured funding through the WISER Program to construct a new 20ML storage basin on the southern side of Badcoe Road, together with associated upgrades to the Wastewater Treatment Plant (WWTP) on Taplan Road. The primary purpose of the basin is to provide storage for treated wastewater from the WWTP while also contributing to stormwater flood mitigation.

Under the current operating arrangement, stormwater is pumped from existing basins to the WWTP ahead of larger storm events to maximise available storage capacity. While this provides additional flood storage, it also increases operational costs and energy consumption and places additional hydraulic loading on the treatment plant through increased inflows and dilution of the wastewater stream.

Following treatment, the recycled water is pumped back to the Kokoda Terrace and Mill Corner basins for storage and subsequent use in Council's restricted municipal irrigation scheme. Following completion of the WISER upgrades, the treated water is intended to meet the requirements for unrestricted reuse. Consequently, the mixing of treated wastewater with untreated stormwater

would compromise water quality and may affect the ability to achieve the required reuse classification. This operational requirement will need to be carefully considered during the detailed design of the proposed storage basin.

For the purposes of this SMP, the proposed basin has been modelled as a stormwater detention basin. However, the detailed design should consider the operational, water quality, and regulatory implications of combining stormwater with treated wastewater. In particular, consultation with SA Health and other relevant stakeholders will be required to determine whether a compartmentalised basin or an alternative configuration is necessary to meet operational and approval requirements.

The proposed management response includes:

- Construction of a new 20 ML storage basin adjacent to Badcoe Road.
- Additional implications related to the current open tender, such as pipe upgrades to/from the WWTP and any treatment measures or additional requirements to meet approvals have not been considered in this SMP.

The flood extent under the ultimate development scenario is shown in Figure 46. The proposed design, together with the flood extent after mitigation, are shown in Figure 47.

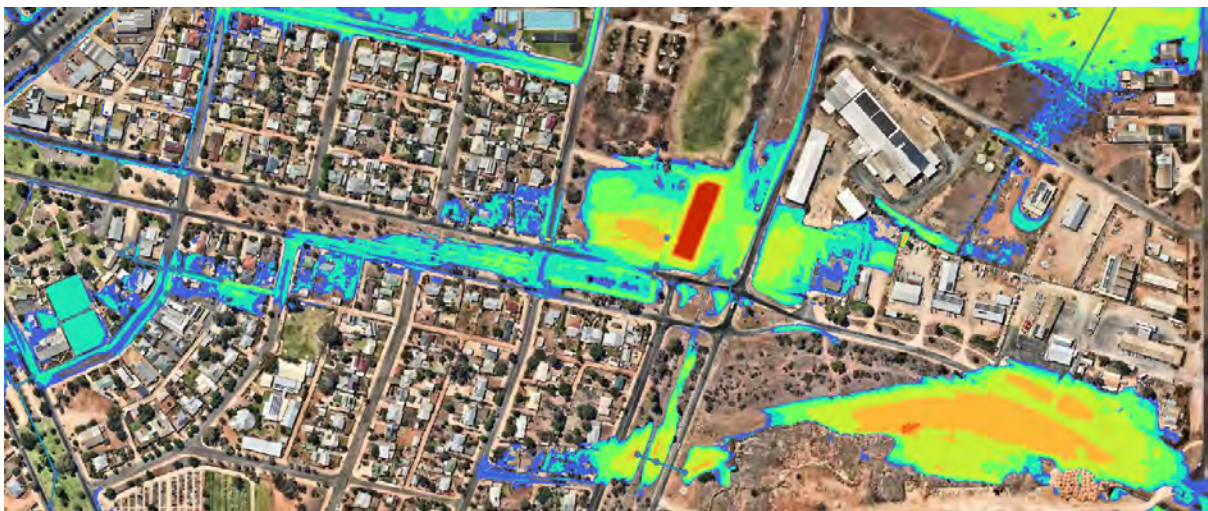


Figure 46. Modelled flood extent at location of Option E2, E3 & E5 under Scenario 5b.

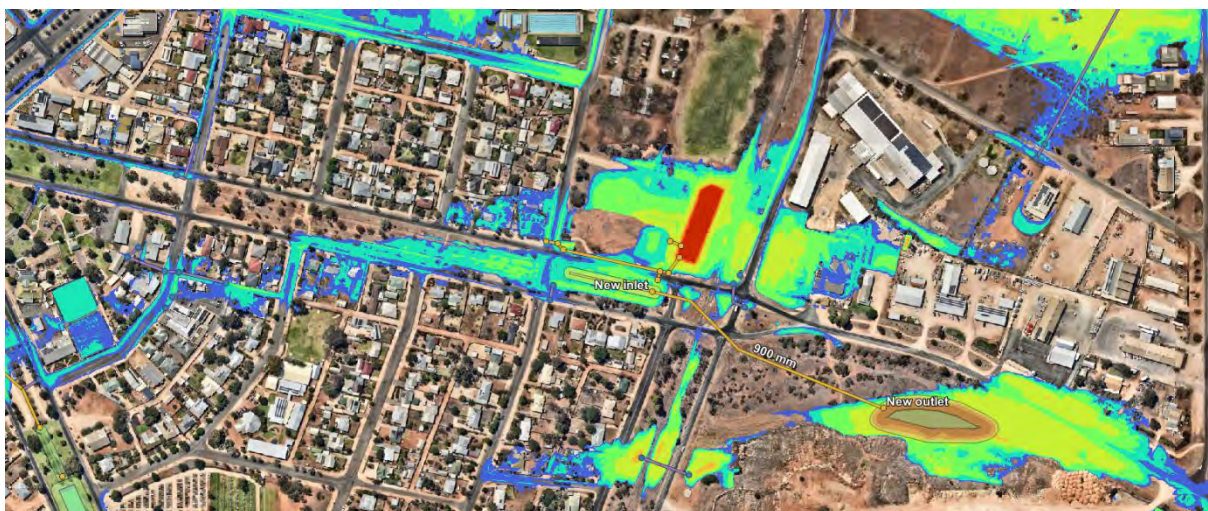


Figure 47. Modelled flood extent for remediation Option E2, E3 & E5 (Scenario 5c).

8.2.4.5. Increasing volumes of existing basins [E6]

Major flooding occurs due to overtopping and limited storage capacity within the following existing stormwater basins:

- Mill Corner
- Kokoda Tce
- Starceovich Rd
- Trenerry Ave

As discussed above, the Mill Corner and Kokoda Terrace basins are both subject to SA Health approval requirements associated with the Taplan Road WWTP. In addition, both are lined basins that supply treated water for Council's municipal irrigation network. Consequently, this SMP does not recommend enlarging these basins or modifying their primary function. Instead, opportunities to construct additional detention basins within adjacent railway land should be investigated, subject to landowner agreement. Any future designs should consider the operational requirements of the existing basins, and direct hydraulic interconnection between new and existing storages should be avoided where practicable. (Alternative concepts were considered during earlier stages of the SMP but were not progressed by the Steering Committee.)

The Starceovich Road basin has recently been upgraded, and further expansion is constrained by established mature vegetation. In contrast, the Trenerry Avenue basin has significant potential for expansion, including into the adjoining Council-owned land. Historic borehole records available through WaterConnect indicate that sandy soils may occur at depths of approximately 3.5 m, suggesting there may be opportunities to incorporate infiltration into the basin design.

It is recommended that geotechnical investigations be undertaken during the detailed design phase to assess the suitability and infiltration rates of the underlying soils at these locations.

The proposed management response includes:

- expansion and deepening of the existing Trenerry Avenue basin;
- upgrading the eastern Trenerry Avenue culverts to 900 mm × 600 mm box culverts to improve inflows to the basin; and
- incorporating infiltration into the basin design, subject to favourable geotechnical investigation results.

The flood extent under the ultimate development scenario is shown in Figure 48. The proposed design, together with the flood extent after mitigation, are shown in Figure 49.

8.2.4.6. Increasing capacity of existing Railway Yard basin [E14]

The proposed design includes the following measures:

- Increasing the capacity of the Railway Yard basin.

The flood extent under the ultimate development scenario is shown in Figure 50. The proposed design, together with the flood extent after mitigation, are shown in Figure 51.

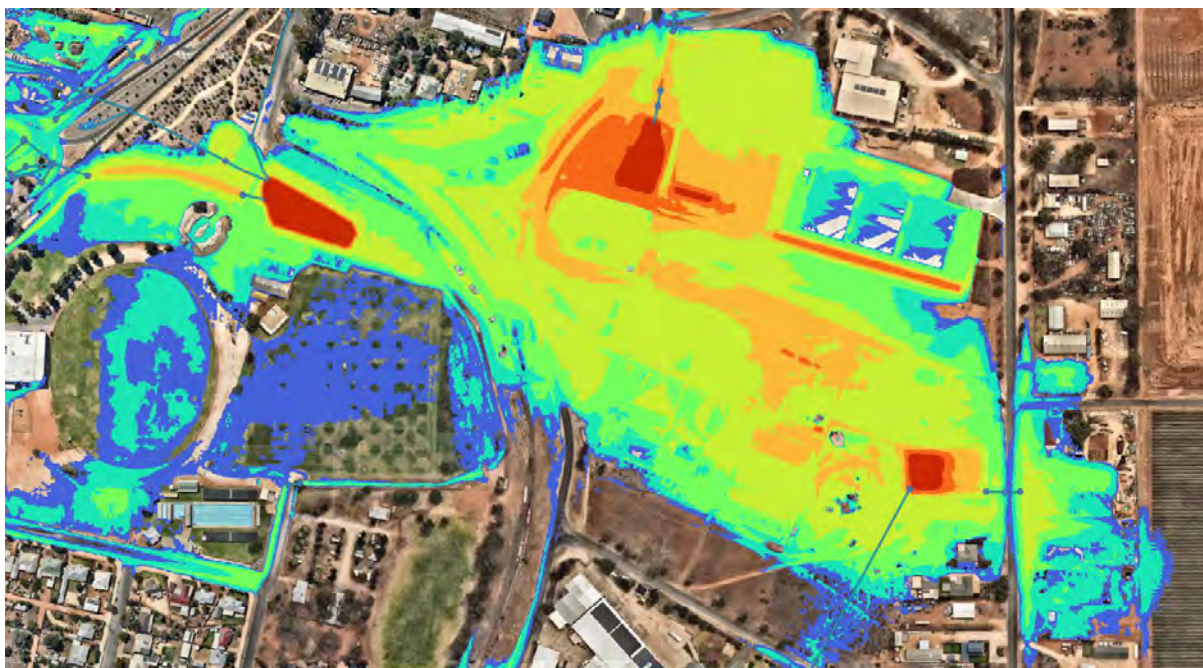


Figure 48. Modelled flood extent at location of Option E6 under Scenario 5b.

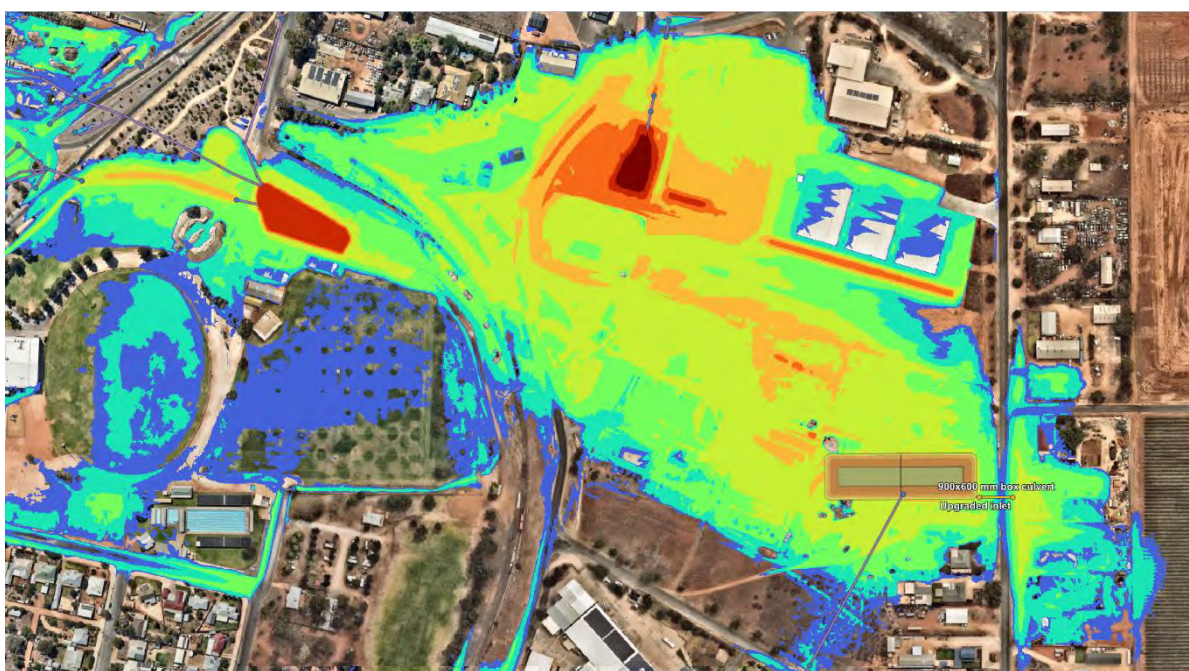


Figure 49. Modelled flood extent for remediation Option E6 (Scenario 5c).

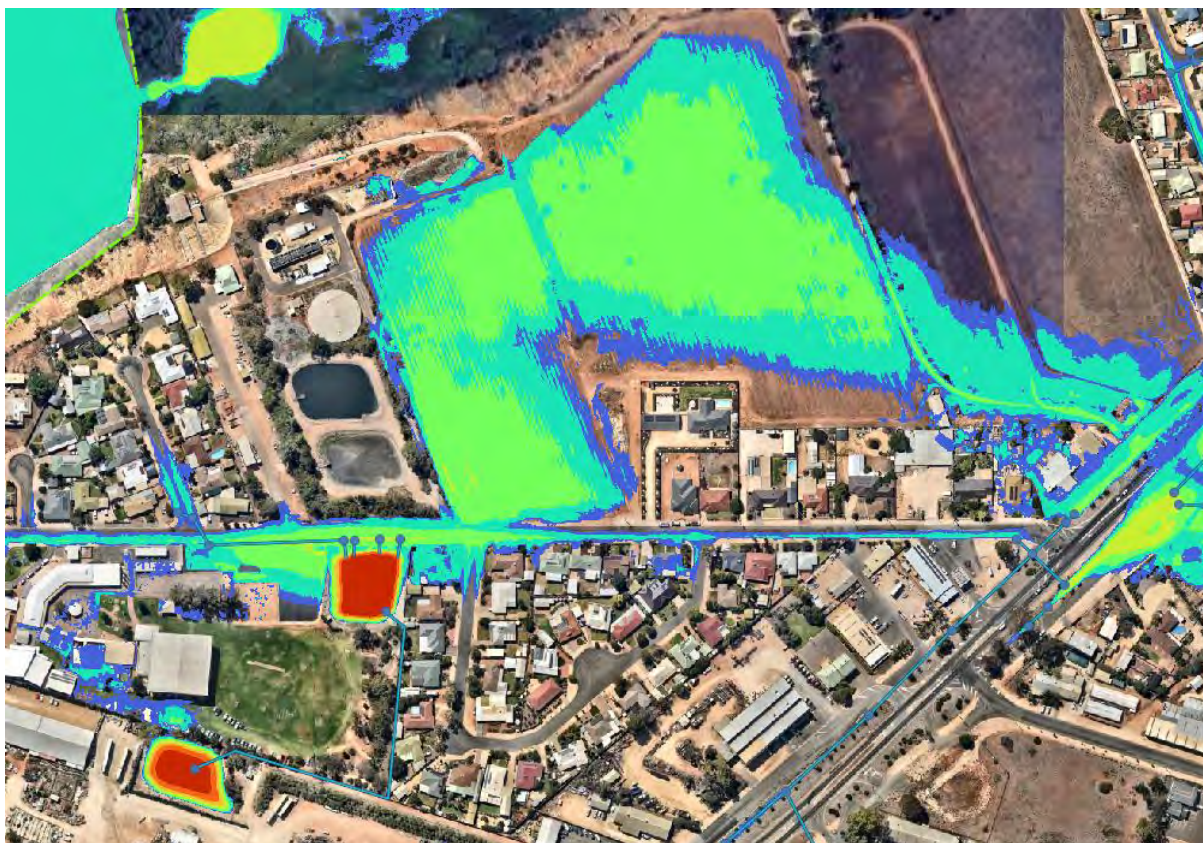


Figure 50. Modelled flood extent at location of Option E14 under Scenario 5b.

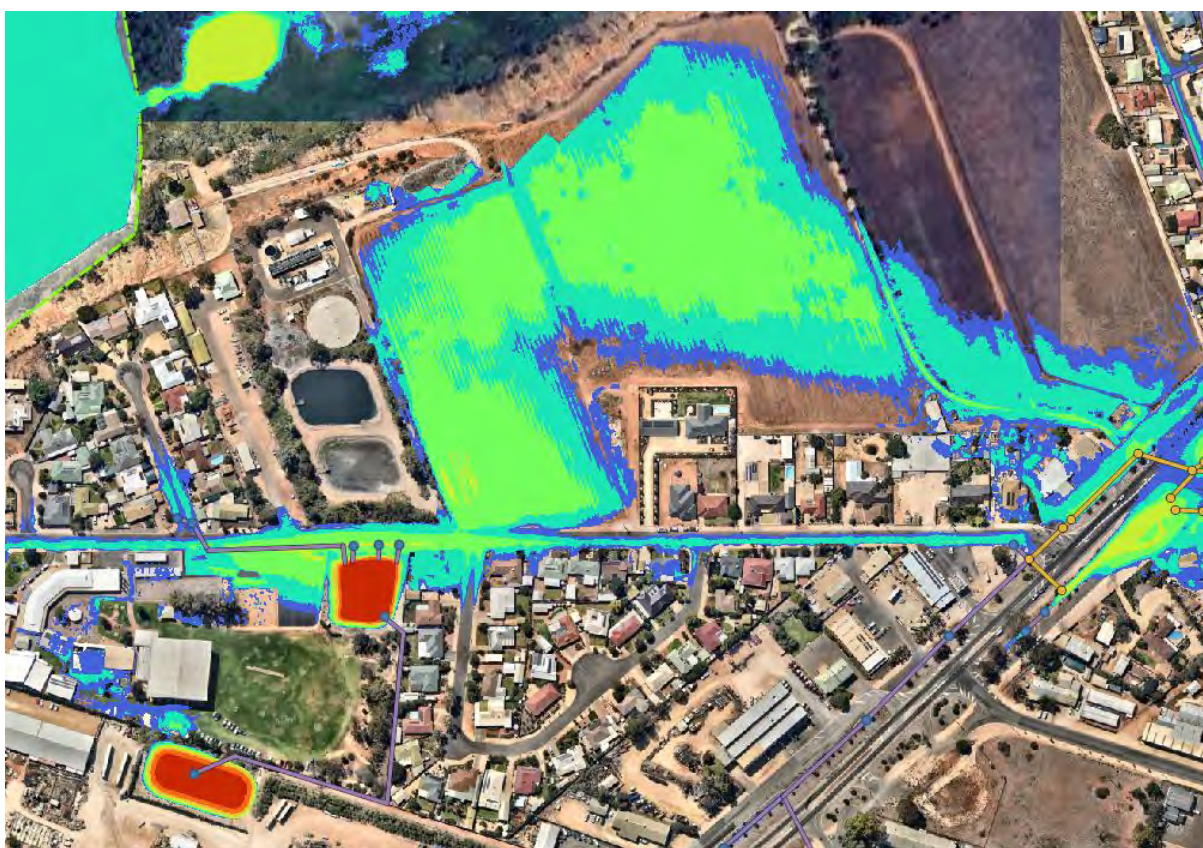


Figure 51. Modelled flood extent for remediation Option E14 (Scenario 5c).

8.2.5. Solution Set F

Solution Set F covers Damage Areas 6, 16 & 17 (DA-6, DA-16 & DA-17), which consider Luther Rd, Gratwick Rd and the Tanko Cres / Stasinowsky Crt estate, respectively. Despite the proximity of two of these (DA-6 & DA-17) to the River Murray and floodplains, there are no existing outlets that drain in that direction, and DEW have advised that new outlets to discharge to the river are not possible

That leaves this area as another very large, landlocked area that is already struggling with drainage issues and has large numbers of proposed developments at various stages of planning.

8.2.5.1. Proposed options

The suite of solutions comprising Set F include:

F4. Installation of stormwater pipes in Gratwick Rd and Luther Rd.

8.2.5.2. Installation of stormwater pipes in Gratwick Rd and Luther Rd [F4]

Implications on other damage areas

Compounding the above challenges, there are several proposed developments along these roads wishing to progress, however any solutions that look to reduce flooding along Gratwick Rd have implications on flooding downstream at the Mill Corner basin, or by surcharging at the grate on Luther Rd and exacerbating flooding at the Luther Rd basin and surrounding properties.

Proposed design

The proposed design includes different aspects, that could be completed as a package, or implemented in stages that could be determined during detailed design. There are existing, informal swales along Gratwick Rd, connected via culverts, and then discharging to formal swales along Bookpurnong Rd. From here, flows drop into pipes that have significant depth below the surface.

The design includes formalising these swales along the southern side of Gratwick Rd, and increasing the size of the existing culverts. These swales are constrained by levels, however these changes assist in keeping flows off Gratwick Rd during smaller events.

On the north side of Gratwick Rd, it's proposed to install a piped system, which allows a greater gradient by connecting through to the existing, deep pipes on Bookpurnong Rd. Inlets are designed slightly elevated from the existing swales, so that low flows continue along the swales, but higher flows can spill into the proposed piped network.

The proposed design includes the following measures:

- New swales along the southern side of Gratwick Rd, including one new culvert to connect them underneath Trenerry Ave.
- Upgrades (culvert + headwall) to increase opening of six existing culverts.
- A bund to protect the property at 78 Gratwick Rd from basin overflows.
- New inlet in basin, plus one new 300 mm pipe to connect the basin to the new stormwater network.
- Ten new pipes, grading from 300 mm to 900 mm.
- One new 900 mm x 600 mm box culvert segment, plus upgrade two existing pipes to 900 mm x 600 mm box culverts.
- Seven new double SEPs, plus one new 600 mm square GIP.

- Two existing SEP's and one junction box lowered to support pipeline extension.
- Two (minimum) new JB's to support new pipeline extension.

Additionally, detailed designs should look for opportunities to add storage between Gratwick Rd and downstream problem areas, to not simply shift the location of flooding issues.

The flood extent under the ultimate development scenario is shown in Figure 52. The proposed design, together with the flood extent after mitigation, are shown in Figure 53.

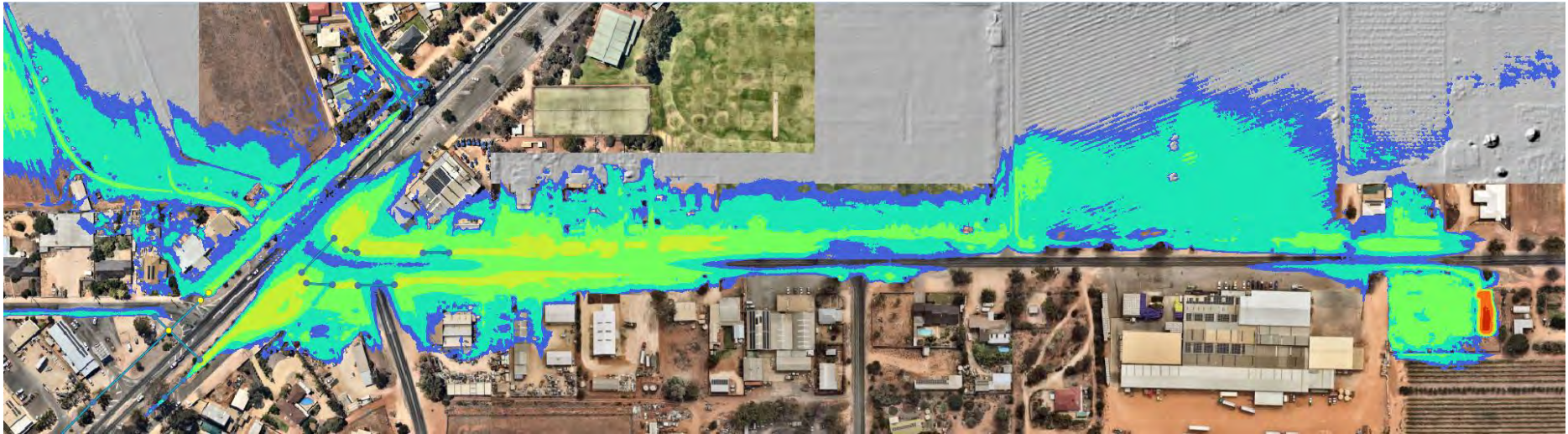


Figure 52. Modelled flood extent at location of Option F4 under Scenario 5b.

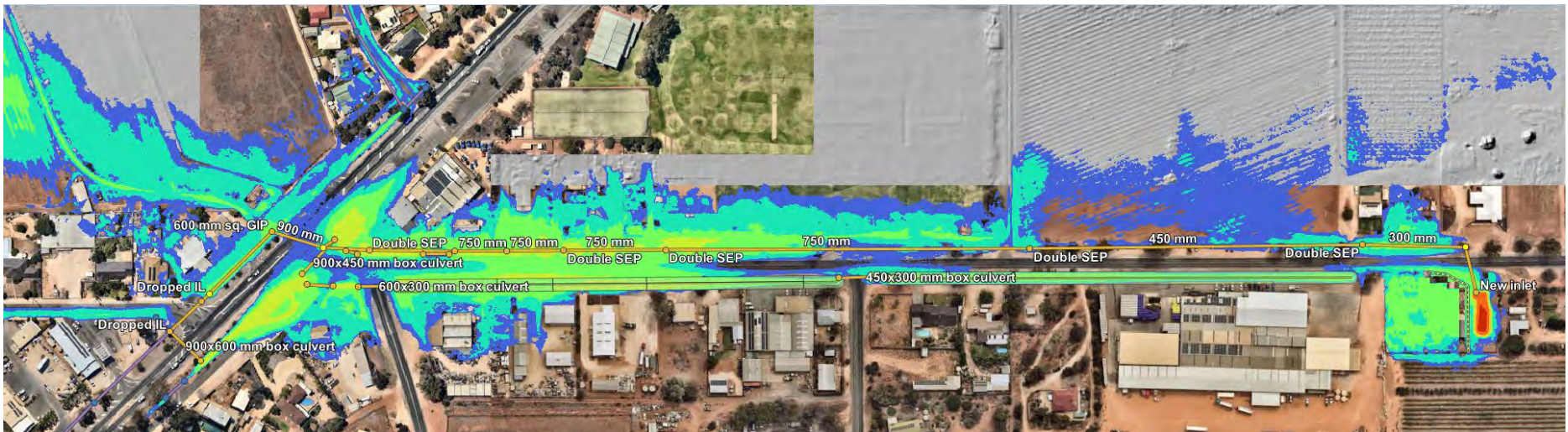


Figure 53. Modelled flood extent for remediation Option F4 (Scenario 5c).

8.2.6. Solution Set G

Set G includes Damage Areas 18 & 20 (DA-18 & DA-20), two landlocked areas on the east of Bookpurnong, heading north away from the town centre

8.2.6.1. Proposed options

The suite of solutions comprising Set G include:

G1. Retention basin adjacent to property # 1861 Bookpurnong Rd.

G3. Increasing the volume of the Keith Payne basin and stormwater infrastructure upgrades.

8.2.6.2. Retention basin adjacent to property # 1861 Bookpurnong Rd [G1]

Council have stated that they own this property and would like to build a basin here. Detailed design should look to optimise the basin by connecting to nearby flooding locations. The concept design uses 1V:4H side slopes. These could potentially be steeper to gain additional volume, however historical boreholes suggest this basin is unlikely to support infiltration, hence a deeper basin would take longer to drain via evaporation alone. It would be best if this water could be utilised within a reuse system in the local area.

The proposed design includes the following measures:

- New retention basin.

The flood extent under the ultimate development scenario is shown in Figure 54. The proposed design, together with the flood extent after mitigation, are shown in Figure 55.

8.2.6.3. Increasing the volume of the Keith Payne basin and stormwater infrastructure upgrades [G3]

The Keith Payne Crt basin was recently enlarged, however modelling still suggests it is undersized for even the Minor event. The proposal includes further increasing capacity of the basin, as well as installing an underdrain below the existing swale coming into the basin from the Bookpurnong Rd service lane.

The proposed design includes the following measures:

- Upsizing the existing basin.
- Installing two 900 mm square GIPS in the existing swale, 600 mm pipes beneath the swale and a new headwall outlet, to provide additional carrying capacity of runoff to the basin to reduce flooding among properties

The flood extent under the ultimate development scenario is shown in Figure 56. The proposed design, together with the flood extent after mitigation, are shown in Figure 57.

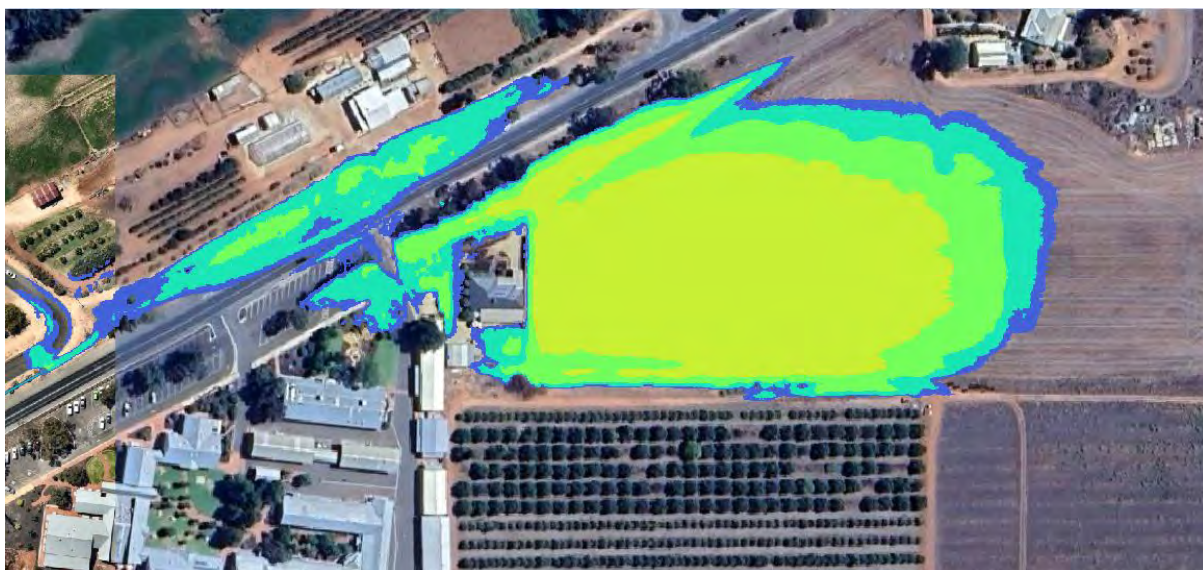


Figure 54. Modelled flood extent at location of Option G1 under Scenario 5b.

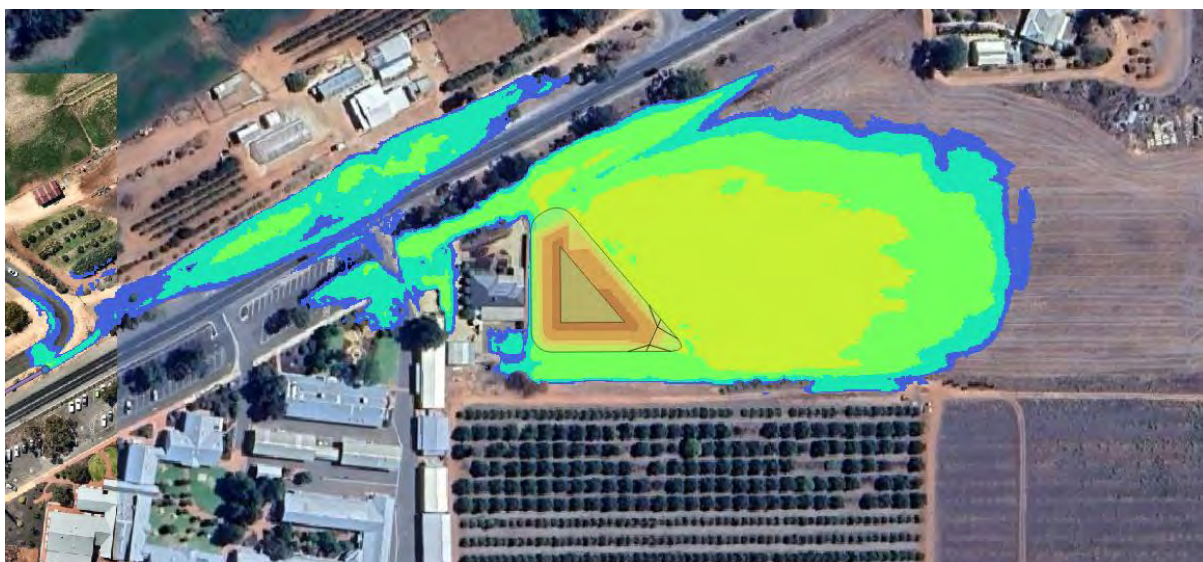


Figure 55. Modelled flood extent for remediation Option G1 (Scenario 5c).

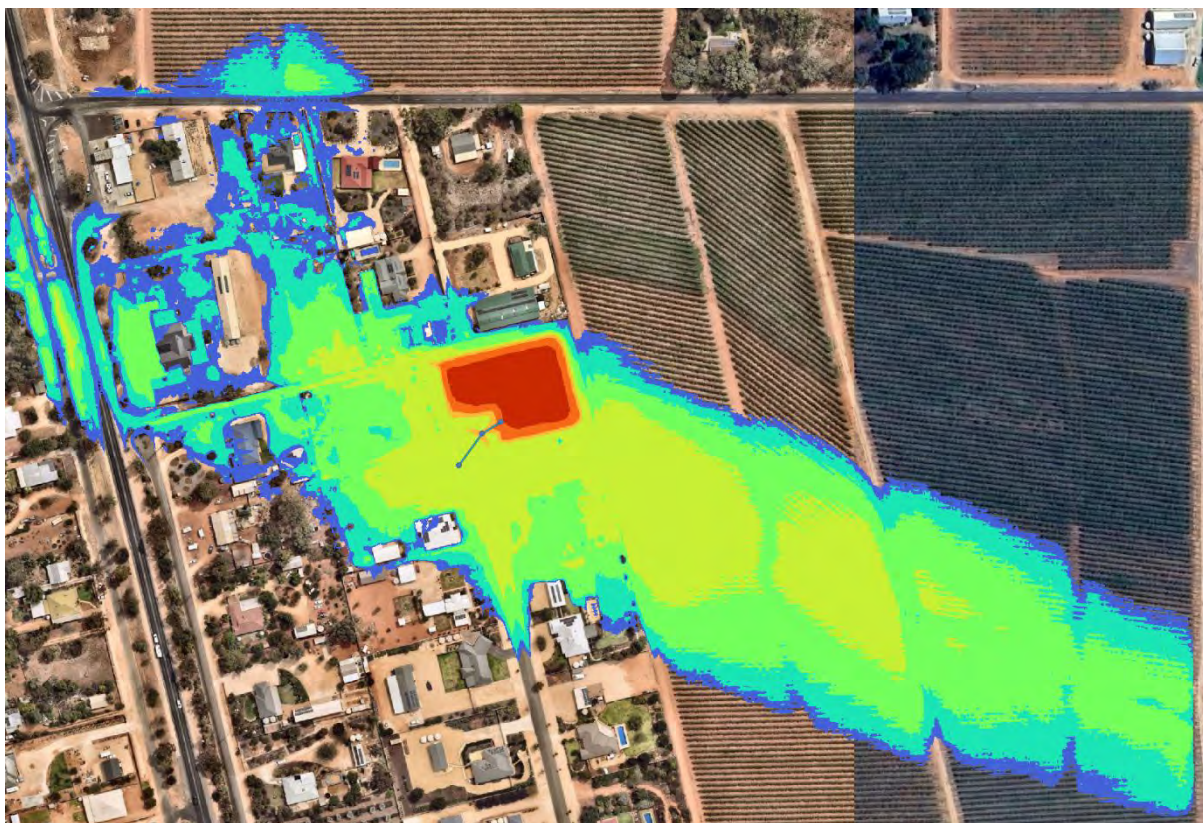


Figure 56. Modelled flood extent at location of Option G3 under Scenario 5b.

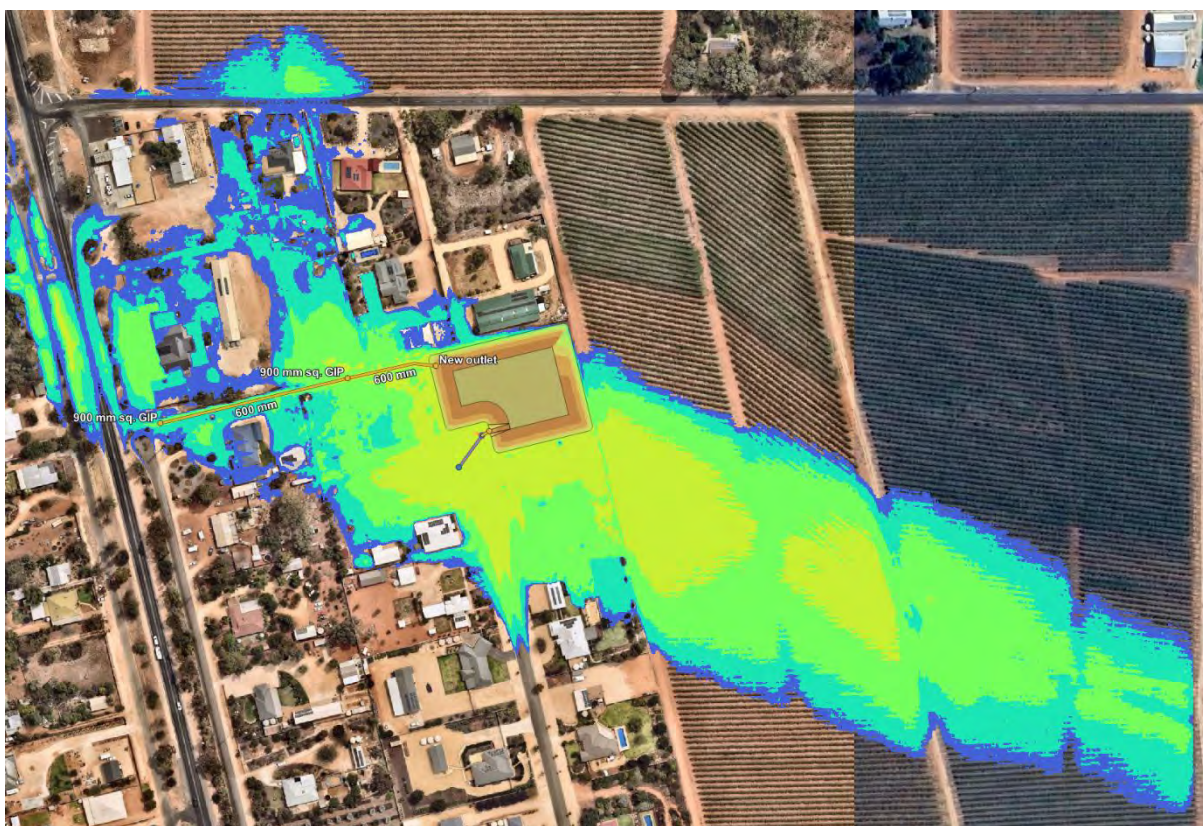


Figure 57. Modelled flood extent for remediation Option G3 (Scenario 5c).

9. Implementation Plan

A cost estimate was prepared for each proposed management response. These responses were then evaluated using a Multi-Criteria Analysis (MCA), which considered factors including flood risk reduction, environmental and ecological benefits, stormwater harvesting and reuse potential, social and community outcomes, and economic performance.

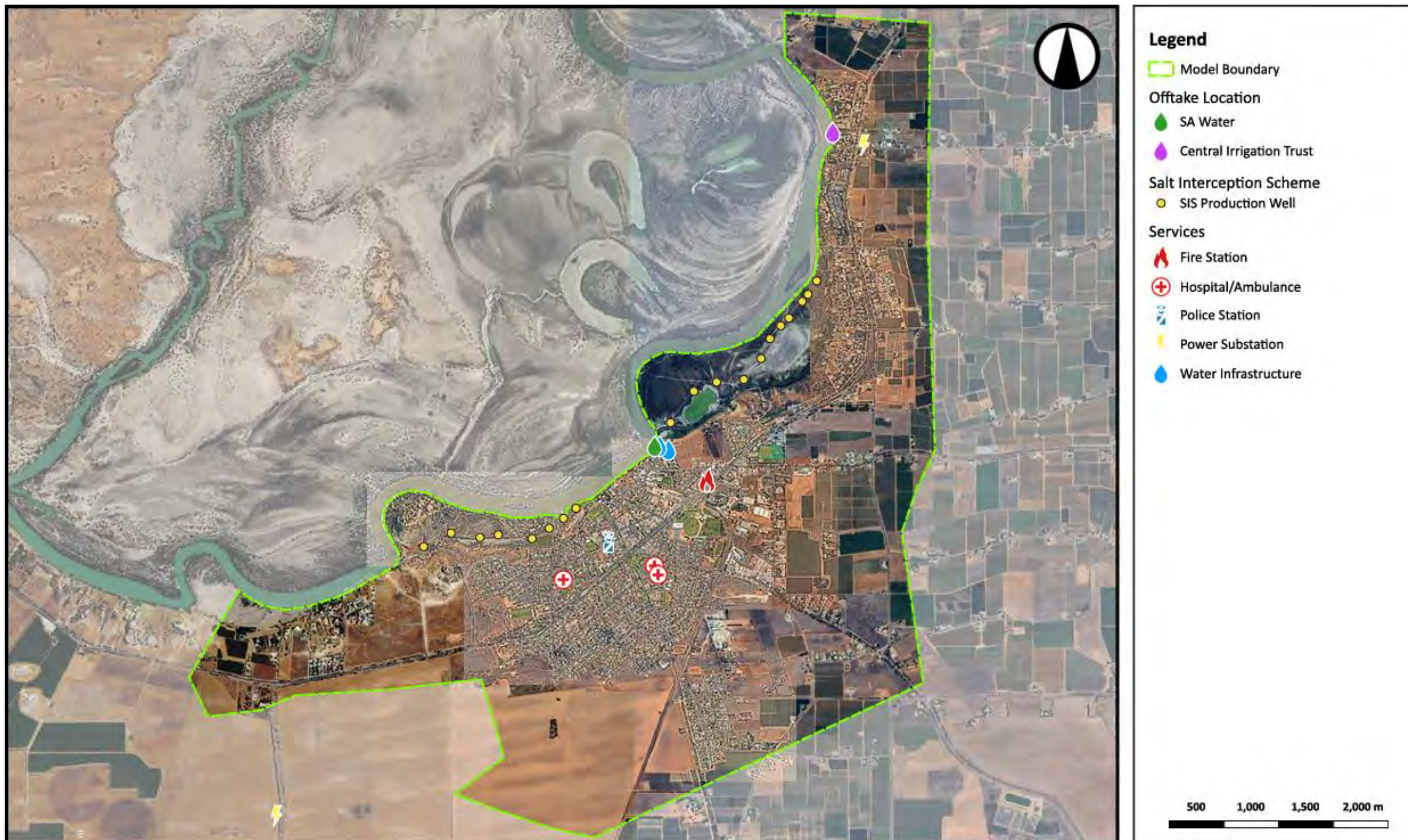
The results of the MCA, together with the cost estimates, were used to prioritise the proposed management responses and inform the development of the implementation plan.

When implementing the proposed management responses, consideration should be given to the legislative and policy requirements outlined in Table 42, as these may influence the design, approval, construction, and ongoing operation of the proposed works.

Table 42. Legislations and requirements

Legislation or Body	Description	Project Relevance
Landscape South Australia Act 2019, Murraylands and Riverland Water Affecting Activities Control Policy	The <i>Landscape South Australia Act 2019</i> provides for the development of Water Affecting Activities (WAA) Control Policies. The Murraylands and Riverland Water Affecting Activities Control Policy identifies activities that may require a WAA permit, the principles for assessment, and the relevant authority responsible for approvals.	Some proposed mitigation measures, such as detention basins and other works affecting watercourses or overland flow paths, may require assessment and approval under the WAA Control Policy.
Basin Plan 2012, SA River Murray Water Resource Plan (SA RM WRP)	Under the <i>Water Act 2007</i> (Commonwealth) and the <i>Basin Plan 2012</i> , a Water Resource Plan is required for the River Murray. The South Australia River Murray Water Resource Plan establishes objectives for surface water management and water quality, including water quality targets within the River Murray. The Plan is administered by the Department for Environment and Water (DEW).	The proposed mitigation measures should improve the quality of stormwater discharged to the River Murray and support the objectives of the SA River Murray Water Resource Plan.
Planning Development and Infrastructure (General) Regulations 2017, Planning and	Under the <i>Planning, Development and Infrastructure (General) Regulations 2017</i> , many routine stormwater works undertaken by Council are excluded from the definition of development. However, some works may require Development Approval and referral in	Certain mitigation measures, such as detention basins or works within regulated overlays, may require Development Approval and referral to the relevant authorities for assessment.

Legislation or Body	Description	Project Relevance
Design Code, River Murray Act	accordance with the Planning and Design Code and the <i>River Murray Act 2003</i> .	
Environment Protection Act 1993 Section 25 (General Environmental Duty)	Section 25 of the <i>Environment Protection Act 1993</i> establishes a general environmental duty requiring all reasonable and practicable measures to be taken to prevent or minimise environmental harm. Compliance is regulated by the Environment Protection Authority (EPA).	Construction and maintenance of the proposed mitigation measures should be undertaken in accordance with the General Environmental Duty to minimise environmental impacts.
Environment Protection (Water Quality) Policy 2015	The <i>Environment Protection (Water Quality) Policy 2015</i> is subordinate legislation under the <i>Environment Protection Act 1993</i> . It establishes the framework for protecting surface water and groundwater quality and outlines environmental values and water quality objectives. Although the Policy excludes diffuse stormwater discharges from public stormwater systems, its objectives remain relevant to stormwater management.	The proposed mitigation measures should improve stormwater quality before discharge to the River Murray, supporting the intent and objectives of the Policy.
SA Water	SA Water is responsible for the management and delivery of potable water throughout the state, drawing supply via offtakes along the River Murray.	Offtakes are located within the town along the River Murray (see Figure 58). Council may wish to notify the relevant bodies of any proposed management actions being implemented which may impact runoff quality during construction or operation and provide them an opportunity to comment on plans and designs as appropriate.
Central Irrigation Trust (CIT)	CIT manages and delivers irrigation water for agriculture throughout the Riverland, drawing supply via offtakes along the River Murray.	



LOXTON STORMWATER MANAGEMENT PLAN

RIVER MURRAY OFFTAKE LOCATIONS

Project: 24024 - Loxton SMP

Revision: 1

Date: 07/08/2026

Drawn: T. Blaser

Coordinate System: GDA2020 / MGA zone 54

Background Imagery: Nearmap (6 March 2023), Google Satellite



Figure 58. River Murray offtake locations

9.1. Prioritisation list

The Multi-Criteria Analysis (MCA) framework used to evaluate the proposed management responses is presented in Table 43. The MCA considered a range of factors, including flood risk reduction, environmental and ecological benefits, stormwater harvesting and reuse potential, social and community outcomes, and economic performance.

Weightings were assigned to each criterion based on its relative importance, with the greatest emphasis placed on outcomes that reduce risk and potential damages, such as improving public safety and protecting property and critical infrastructure. Criteria associated with broader community enhancements, such as amenity improvements, were assigned lower weightings.

Table 43. Multi-Criteria Analysis (MCA) Framework

Criterion	Weighting	Factors	
Flood Protection	30	Flood impacts, flood risk reduction, reduction in flood damages	30
Environmental and Ecological Benefits	25	Water quality improvement, including reductions in GP, TSS, TP, TN	6.25
		Watercourse protection, including erosion & sedimentation, create greater protection of watercourses improves environmental outcomes; less protection risks degradation of aquatic ecosystems.	8.75
		Biodiversity enhancement	5
		Habitat creation and ecological connectivity- create greater contribution to ecosystem protection enhances sustainability; less conservation effort risks ecological decline.	5
Stormwater Harvesting and Reuses	10	Increased infiltration capacity, including greater infiltration area, increased infiltration rates	2
		Stormwater harvesting and retention, increased retention volume and creating potential for stormwater reuse	4
		Stormwater reuse and community benefit	4
Social Amenities	10	Visual amenity enhancement	2
		Additional open space and recreational opportunities	2
		Improved public safety	2
		Increased Injury risk (post-mitigation), including increased chances of slips, falls, structural collapse	2
		Disruption during construction	2

Criterion	Weighting	Factors	
Economics	25	Capital costs	12.5
		Maintenance Costs (recurring costs)	5
		Economic viability, available funds	5
		Number of directly involved, impacted stakeholders	2.5
Total	100		100

9.1.1.1. Flood protection

Flood protection was assigned the highest weighting in the Multi-Criteria Analysis (MCA) to reflect the primary objective of reducing flood risk to the community. Management responses were assessed based on their ability to reduce flood extents, depths, velocities, and associated damages to residential, commercial, and public assets. Particular emphasis was placed on improving public safety, reducing property damage, maintaining access to critical infrastructure and emergency services, and increasing the capacity and resilience of the stormwater drainage network during storm events.

Higher scores were assigned to management responses that deliver the greatest reduction in flood risk and associated damages, particularly those that improve flooding conditions across larger catchment areas or provide benefits to a greater number of properties, critical assets, and community infrastructure.

9.1.1.2. Environmental and Ecological Benefits

Environmental and ecological benefits were assessed based on the ability of each management response to improve stormwater quality and protect the receiving environment. Consideration was given to reductions in gross pollutants (GP), total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN), together with improvements to waterway health through reduced erosion and sedimentation. Additional benefits, including biodiversity enhancement and habitat creation, were also considered to encourage sustainable stormwater management and improve the ecological values of the River Murray and surrounding environments.

9.1.1.3. Stormwater Harvesting and Reuse

Management responses were assessed for their potential to increase stormwater infiltration, detention, harvesting, and reuse. Preference was given to solutions that maximise infiltration opportunities, increase retention volumes, and provide opportunities for beneficial reuse of stormwater where practical. These measures improve water security, reduce potable water demand, and contribute to more sustainable management of urban water resources.

9.1.1.4. Social and Community Outcomes

Social and community outcomes considered the broader benefits of each management response beyond flood mitigation. Assessment criteria included improvements to visual amenity, creation or enhancement of public open space, and improvements to public safety following implementation. Potential adverse impacts, including disruption during construction and any residual public safety

risks associated with the completed works, were also considered to ensure that proposed solutions provide a positive overall outcome for the community.

9.1.1.5. Economic Performance

Economic performance assessed the financial viability and long-term affordability of each management response. Consideration was given to capital costs, ongoing maintenance and operational costs, funding availability, and the number of stakeholders directly affected by implementation. Preference was given to solutions that deliver the greatest overall benefit while representing a cost-effective and sustainable investment for Council and the community.

9.2. Implementation Plan

The resulting prioritisation of management responses is presented in Table 44 and forms the basis of the implementation plan.

Council have identified several priority locations for stormwater improvements based on known flooding issues, community feedback, and strategic importance. This has been reflected in the implementation plan through higher scores assigned under the social and community outcomes and economic performance criteria, recognising their greater strategic value and increased potential to attract funding. The assessment of flood risk reduction, environmental and ecological benefits, and stormwater harvesting and reuse potential remained based solely on the technical performance of each management response and was not influenced by Council's identified priorities.

Table 44. Implementation Plan

Solution ID	Brief Description	Score	Priority	Nominated Timeframe	Further Investigations Required?	Land Acquisition Required?	Planning or Policy Changes Required?
Structural Strategies							
E3	Installation of pipe underneath the new roundabout <i>Note: Although this option was assigned a 'Medium' priority through the Multi-Criteria Analysis (MCA), its implementation priority has been elevated due to Council's planned roundabout upgrade. Coordinating these stormwater works with the road upgrade and the implementation of Management Response E5 (Very High Priority) is expected to deliver a more cost-effective and efficient outcome, while minimising construction impacts and disruption to the community.</i>	3.83	High	0-2yrs	√		
E5	WISER basin (wetland and pond at Robertson Ave)	7.80	Very High	0-2yrs	√	√	
D3	Geotechnical investigation to inform retention basin near Paruna Rd <i>Note: The results of the geotechnical investigations may result in changes to the implementation priority of the proposed management responses.</i>	-	High	0-2yrs	√		
E6	Increasing volumes of existing basins, including: • Mill Corner • Kokoda Tce • Starceovich Rd • Trenerry Ave	6.60	High	0-5yrs		√	
C8	Leaky wells and new retention basin on Tobruk Tce	6.54	High	2-5yrs	√		
D1	Enlarge existing Eyre St basin	6.40	High	2-5yrs	√		
D6	New detention/retention basin at the intersection of Traeger St and Barker St	6.33	High	2-5yrs	√		
C5	Enlarging Fifth St basin	5.56	Medium	5-10yrs	√		
G1	Retention basin adjacent to property # 1861 Bookpurnong Rd	4.99	Medium	5-10yrs	√	√	
F4	Installation of stormwater pipes in Gratwick Rd and Luther Rd <i>Note: Basins proposed for large development areas along these roads are included in the relevant development applications. The costs associated with these basins have not been included in this solution.</i>	4.92	Medium	5-10yrs	√		
E2	Swale along Kokoda Tce	4.82	Medium	5-10yrs	√		
G3	Increasing the volume of the Keith Payne basin and stormwater infrastructure upgrades	4.81	Medium	5-10yrs	√		
B2	Increase drainage capacity in front of property #8 Hilltop Dr	4.60	Medium	5-10yrs		√	
C6	Installation of underground stormwater network upstream of Fifth St basin	4.46	Medium	5-10yrs	√		
E14	Increasing capacity of existing Railway Yard basin	4.30	Medium	5-10yrs	√	√	
B3	Minor stormwater upgrades coupled with infiltration devices at various locations	4.01	Medium	5-10yrs	√		
C7	Swale and detention basin at Sixth Avenue	3.99	Low	10-15yrs	√		
D7	Bund to protect Paruna Rd basin	3.79	Low	10-15yrs			

Solution ID	Brief Description	Score	Priority	Nominated Timeframe	Further Investigations Required?	Land Acquisition Required?	Planning or Policy Changes Required?
B1	Minor stormwater upgrades along Kaesler St/Westbrook Ave branch drain	3.71	Low	10-15yrs	√		
C2	Solution for Bookpurnong median & Third St	3.32	Low	10-15yrs	√		
Long-Term Strategies							
S1	Increasing inlet capacity		Medium	0-15yrs			
S2	Increasing on-site storage		Medium	0-15yrs	√		
S3	Installation of Water Quality Treatment Devices at Stormwater Outlets		High	0-3yrs			√
S4	Review of existing stormwater and WSUD assets and programming		High	0-3yrs			
	Education and Promotion of WSUD Measures		Medium	0-5yrs			√
	Ongoing Maintenance and Monitoring of Council Assets		Low	10-30yrs			√

10. Risk Reduction Assessment and Discussion

10.1. Residual flood risks

Using the methodology outlined in Section 7, a residual risk assessment was undertaken to evaluate the effectiveness of the proposed management responses and identify any remaining flood risks following implementation.

The assessment focused on future development post mitigation scenarios, including:

- Scenario 1c - future development conditions post mitigation during 18% AEP events, and;
- Scenario 5c - future development conditions post mitigation during 1% AEP events.

The residual risk assessment results Scenarios 1c and 5c are presented in Table 45 and Table 46, respectively.

Table 45. Post mitigation risk assessment for Scenario 1c – 18% AEP Ultimate Development

ID	Location	Risk Category	Existing Stormwater Infrastructure (Scenario 1b)			Post Mitigation (Scenario 1c)		
			Consequence	Likelihood	Risk Rating	Consequence	Likelihood	Risk Rating
1-1	25 Katarapko Dr	Regulatory/ Reputational	5	2	Moderate	3	2	Moderate
2-1	9 Thiele Ave	Operational	3	2	Moderate	REMEDIED		
2-2	9 Westbrook Ave	Operational/ Safety	2	3	Moderate	REMEDIED		
2-3	8 Hilltop Dr	Operational	2	2	Low	REMEDIED		
2-4	McMillan St (Near detention basin)	Strategic/ Regulatory	1	2	Low	REMEDIED		
3-1	Bookpurnong Tce (Near Fifth St)	Operational	2	1	Low	2	1	Low
3-2	72 Bookpurnong Tce	Operational	3	3	Moderate	REMEDIED		
3-3	Bookpurnong Tce (Community Conservation and Heritage Park)	Regulatory	3	3	Moderate	REMEDIED		
3-4	Bookpurnong Tce median strip (Opposite 141 Bookpurnong Tce)	Operational	2	4	Moderate	2	2	Low
4-1	Intersection of McMillan St and Grant Schubert Dr	Operational/ Strategic	2	2	Low	2	2	Low
4-2	21 William St	Strategic	1	3	Low	1	2	Low
4-3	20 East Tce	Operational	2	3	Moderate	REMEDIED		
4-4	Loxton Historical Village	Strategic	4	3	High	2	2	Low
4-5	Swale adjacent Scenic Drive	Operational/ Strategic	1	3	Low	REMEDIED		
4-6	Corner of Pioneer Walk and William St	Operational	1	2	Low	REMEDIED		

ID	Location	Risk Category	Existing Stormwater Infrastructure (Scenario 1b)			Post Mitigation (Scenario 1c)		
			Consequence	Likelihood	Risk Rating	Consequence	Likelihood	Risk Rating
5-1	Hentschke Transport Grain Storage, Railway Terrace	Regulatory/ Strategic	3	1	Low	2	2	Low
5-2	3 Railway Tce	Operational	2	4	Moderate	2	3	Moderate
5-3	Riverland Floor Centre	Operational	1	4	Low	1	4	Low
5-4	1968 Bookpurnong Rd	Operational/ Regulatory	3	2	Moderate	3	2	Moderate
5-5	Mill Corner railway memorial	Regulatory/ Reputational	4	3	High	3	3	Moderate
5-6	Mill Corner Basin (Raymont Ave)	Operational/ Regulatory	4	3	High	3	3	Moderate
5-7	Intersection of A W Traeger Dr and Pine Ave	Operational	3	4	High	2	4	Moderate
5-8	Pine Ave (Football oval car park)	Operational	2	2	Low	2	2	Low
6-1	Across Luther Rd from Trility WTP	Operational/ Regulatory	4	5	Severe	3	4	High
7-1	127 Bookpurnong Tce	Regulatory	2	2	Low	1	2	Low
7-2	Basin at Fifth St and Klingberg St	Strategic	4	2	Moderate	2	2	Low
8-1	10-18 Third St	Operational/ Safety	3	3	Moderate	1	3	Low
8-2	Basin at the end of Third St	Operational/ Safety	4	3	High	3	3	Moderate
8-3	61 Bookpurnong Tce	Operational/ Safety	3	4	High	REMEDIED		
9-1	Basin at Tobruk Tce/Paruna Rd	Operational/ Strategic	3	2	Moderate	2	2	Low
9-2	14-18 Tobruk Tce	Operational/ Safety	4	3	High	REMEDIED		

ID	Location	Risk Category	Existing Stormwater Infrastructure (Scenario 1b)			Post Mitigation (Scenario 1c)		
			Consequence	Likelihood	Risk Rating	Consequence	Likelihood	Risk Rating
10-1	Kokoda Tce (Woodleigh) detention basin	Strategic	3	2	Moderate	REMEDIED		
10-2	Kokoda Tce (Woodleigh) detention basin	Operational	2	2	Low	2	2	Low
10-3	Intersection of Kokoda Tce and Starceвич Rd	Operational/ Strategic	3	3	Moderate	2	2	Low
10-4	Across 50 Kokoda Tce	Operational/ Strategic	2	2	Low	1	3	Low
11-1	Between Robertson Ave and Aleppo St	Operational/ Strategic	4	2	Moderate	4	2	Moderate
11-2	Basin on Robertson Ave	Strategic	2	3	Moderate	2	3	Moderate
11-3	23 Badcoe Rd (Southern side)	Strategic	2	3	Moderate	2	3	Moderate
11-4	Badcoe Rd (Northern side)	Strategic	2	3	Moderate	2	3	Moderate
11-5	26 Starceвич Rd (Riverland Cold Stores)	Strategic/ Safety	5	3	High	4	3	High
11-6	Badcoe Rd (Northern side)	Strategic/ Safety	2	2	Low	2	2	Low
11-7	130 Badcoe Rd	Strategic	2	2	Low	2	2	Low
11-8	Across 111 Badcoe Rd	Strategic	4	3	High	4	3	High
11-9	111 Badcoe Rd	Strategic	2	3	Moderate	2	3	Moderate
11-10	Intersection of Dorsch Ave and Kingsbury Rd	Strategic	3	3	Moderate	3	3	Moderate
11-11	8 Kingsbury Rd	Operational	1	1	Low	REMEDIED		
12-1	Near Tobruk Tce basin	Strategic	2	1	Low	2	1	Low
13-1	Intersection between Paruna Rd and railway line	Strategic	2	2	Low	2	2	Low

ID	Location	Risk Category	Existing Stormwater Infrastructure (Scenario 1b)			Post Mitigation (Scenario 1c)		
			Consequence	Likelihood	Risk Rating	Consequence	Likelihood	Risk Rating
13-2	Eyre St	Strategic	2	2	Low	2	2	Low
13-3	Eyre St (bigger basin)	Strategic	2	2	Low	2	2	Low
14-1	Basin at Wells St	Strategic	2	2	Low	2	2	Low
14-2	163 Paruna Rd / Sturt St	Operational	2	3	Moderate	4	3	High
14-3	Basin at Paruna Rd	Operational/ Strategic	2	2	Low	4	2	Moderate
15-1	3 Mill Rd	Strategic	2	1	Low	2	1	Low
15-2	Between Rayment Ave and Starceвич Rd	Operational/ Safety	3	3	Moderate	3	3	Moderate
15-3	Basin on Starceвич Rd	Safety	5	5	Severe	5	5	Severe
15-9	65-71 Trenerry Ave	Safety	4	3	High	4	3	High
16-1	Between Luther Rd and Bookpurnong Rd	Operational	3	3	Moderate	3	3	Moderate
16-2	1937 Bookpurnong Rd (In front of Loxton Irrigation Centre)	Operational	2	2	Low	2	2	Low
16-3	18 Gratwick Rd	Operational	3	2	Moderate	2	2	Low
16-4	Ronco Powersports (Ronco motors)	Operational	4	5	Severe	2	3	Moderate
16-5	78 Gratwick Rd	Safety	3	4	High	REMEDIED		
16-6	88 Gratwick Rd	Operational	4	4	High	2	4	Moderate
16-7	119 Gratwick Rd	Strategic	2	2	Low	2	2	Low
16-8	1920 Bookpurnong Rd	Strategic	3	3	Moderate	REMEDIED		

ID	Location	Risk Category	Existing Stormwater Infrastructure (Scenario 1b)			Post Mitigation (Scenario 1c)		
			Consequence	Likelihood	Risk Rating	Consequence	Likelihood	Risk Rating
18-1	1839 Bookpurnong Rd	Strategic	3	2	Moderate	2	2	Low
18-2	39 Dorsch Ave	Safety	4	3	High	4	3	High
18-3	18 Dorsch Ave	Safety	4	3	High	4	3	High
19-1	1800 Simpson Rd	Strategic/ Operational	3	4	High	3	4	High
19-2	1672 Simpson Rd	Strategic/ Operational	3	4	High	3	4	High
20-1	Basin at end of Keith Payne Ct	Operational/ Safety	2	3	Moderate	2	2	Low
20-2	18 French Rd	Strategic	1	1	Low	1	1	Low
20-3	1679 Bookpurnong Rd	Safety	2	2	Low	2	2	Low
21-1	1594 Bookpurnong Rd	Strategic/ Operational	4	4	High	4	4	High
21-2	Intersection of Alamein Ave and Bookpurnong Rd	Strategic	3	3	Moderate	3	3	Moderate
21-3	1546 Bookpurnong Rd	Operational	1	4	Low	1	4	Low

Table 46. Post mitigation risk assessment for Scenario 5c – 1% AEP Ultimate Development

ID	Location	Risk Category	Existing Stormwater Infrastructure (Scenario 1b)			Post Mitigation (Scenario 1c)		
			Consequence	Likelihood	Risk Rating	Consequence	Likelihood	Risk Rating
1-1	25 Katarapko Dr	Regulatory/ Safety	2	4	Moderate	5	3	High
2-1	9 Thiele Ave	Operational	5	4	Severe	2	3	Moderate
2-2	9 Westbrook Ave	Operational/ Safety	2	4	Moderate	3	4	High
2-3	8 Hilltop Dr	Operational/ Safety	3	3	Moderate	3	3	Moderate
2-4	McMillan St (Near detention basin)	Regulatory/ Operational	5	4	Severe	4	3	High
3-1	Bookpurnong Tce (Near Fifth St)	Operational	5	3	High	2	2	Low
3-2	72 Bookpurnong Tce	Operational	3	2	Moderate	2	3	Moderate
3-3	Bookpurnong Rd median strip (Between Sadlier St and McMillan St)	Operational	5	3	High	2	2	Low
3-4	Intersection of View St and Bookpurnong Tce	Operational	3	3	Moderate	4	3	High
3-5	Bookpurnong Tce (Community Conservation and Heritage Park)	Regulatory	4	3	High	2	3	Moderate
3-6	Bookpurnong Tce median strip (Opposite 141 Bookpurnong Tce)	Operational	2	3	Moderate	2	3	Moderate
4-1	Intersection of McMillan St and Grant Schubert Dr	Strategic	1	3	Low	3	2	Moderate
4-2	21 William St	Operational	1	2	Low	2	3	Moderate
4-3	20 East Tce	Regulatory/ Safety	1	3	Low	2	3	Moderate

ID	Location	Risk Category	Existing Stormwater Infrastructure (Scenario 1b)			Post Mitigation (Scenario 1c)		
			Consequence	Likelihood	Risk Rating	Consequence	Likelihood	Risk Rating
4-4	Loxton Historical Village	Operational	4	3	High	3	3	Moderate
4-5	Swale parallel to Scenic Dr	Operational	5	3	High	2	3	Moderate
4-6	Swale adjacent Scenic Drive	Regulatory	5	3	High	4	3	High
4-7	Corner of Pioneer Walk and William St	Strategic	1	3	Low	3	3	Moderate
5-1	Hentschke Transport Grain Storage, Railway Terrace	Strategic	1	2	Low	2	2	Low
5-2	3 Railway Tce	Operational	4	4	High	3	3	Moderate
5-3	Riverland Floor Centre	Operational	2	3	Moderate	3	3	Moderate
5-4	1968 Bookpurnong Rd	Operational/ Regulatory	2	2	Low	3	3	Moderate
5-7	Intersection of A W Traeger Dr and Pine Ave	Operational	5	4	Severe	4	4	High
5-8	Pine Ave (Football oval car park)	Operational	1	3	Low	2	2	Low
5-9	Intersection of Geraldton St and Pine Ave	Operational	4	3	High	3	3	Moderate
6-1	Luther Rd (Water treatment plant)	Operational/ Regulatory	3	4	High	5	5	Severe
7-1	127 Bookpurnong Tce	Regulatory	2	3	Moderate	4	2	Moderate
7-2	Basin at Fifth St and Klingberg St	Operational	1	3	Low	5	3	High
7-3	10 Trantalis Ct	Operational	2	4	Moderate	3	3	Moderate
8-1	10-18 Third St	Operational/ Safety	5	4	Severe	2	3	Moderate
8-3	61 Bookpurnong Tce	Operational	2	4	Moderate	1	3	Low

ID	Location	Risk Category	Existing Stormwater Infrastructure (Scenario 1b)			Post Mitigation (Scenario 1c)		
			Consequence	Likelihood	Risk Rating	Consequence	Likelihood	Risk Rating
8-4	Intersection of Eringa Ave and Fourth St	Operational	3	3	Moderate	2	3	Moderate
9-1	Basin at Tobruk Tce/Paruna Rd	Safety	5	4	Severe	4	3	High
9-2	14-18 Tobruk Tce	Operational/ Safety	5	3	High	4	3	High
10-1	Kokoda Tce (Woodleigh) detention basin	Strategic	3	2	Moderate	3	3	Moderate
10-4	Across 50 Kokoda Tce	Operational/ Strategic	5	3	High	1	3	Low
10-5	Laneway between Geraldton St and Anzac Cres	Operational	3	3	Moderate	1	2	Low
11-1	Between Robertson Ave and Aleppo St	Operational/ Strategic	4	3	High	4	4	High
11-2	Basin on Robertson Ave	Strategic	2	3	Moderate	2	2	Low
11-3	83 Starceвич Rd (Loxton Ice Works)	Strategic/ Safety	1	3	Low	5	4	Severe
11-4	26 Starceвич Rd (Riverland Cold Stores)	Strategic/ Safety	1	2	Low	3	2	Moderate
11-5	23 Badcoe Rd	Strategic/ Safety	1	3	Low	3	5	High
11-7	130 Badcoe Rd	Strategic/ Safety	4	3	High	4	4	High
11-8	Across 111 Badcoe Rd	Strategic	5	3	High	4	3	High
11-9	111 Badcoe Rd	Strategic/ Safety	5	3	High	5	4	Severe
11-10	Intersection between Dorsch Ave and Kingsbury Rd	Strategic	1	3	Low	2	2	Low
11-11	8 Kingsbury Rd	Strategic	1	2	Low	1	2	Low

ID	Location	Risk Category	Existing Stormwater Infrastructure (Scenario 1b)			Post Mitigation (Scenario 1c)		
			Consequence	Likelihood	Risk Rating	Consequence	Likelihood	Risk Rating
12-1	Near Tobruk Tce basin	Strategic	4	4	High	4	3	High
13-1	Intersection between Paruna Rd and railway line	Strategic/ Safety	2	3	Moderate	3	5	High
13-2	Eyre St	Strategic/ Safety	2	2	Low	4	2	Moderate
13-5	12 Barker St	Safety	5	4	Severe	3	2	Moderate
13-6	Vacant block west of 14 Barker St	Strategic	1	3	Low	1	2	Low
13-7	33 Barker St	Operational	4	3	High	2	2	Low
14-1	Basin at Wells St	Operational/ Strategic	3	4	High	5	4	Severe
14-2	163 Paruna Rd	Operational	2	3	Moderate	3	4	High
14-3	Basin at Paruna Rd	Strategic/ Safety	1	3	Low	2	3	Moderate
15-1	3 Mill Rd	Operational/ Safety	2	4	Moderate	5	4	Severe
15-9	65-71 Trenerry Ave	Operational/ Safety	5	4	Severe	5	3	High
16-1	Between Luther Rd and Bookpurnong Rd	Operational	2	4	Moderate	3	2	Moderate
16-2	1937 Bookpurnong Rd (In front of Loxton Irrigation Centre)	Operational/ Safety	3	3	Moderate	4	3	High
16-3	18 Gratwick Rd	Operational/ Safety	5	4	Severe	2	3	Moderate
16-5	78 Gratwick Rd	Operational/ Strategic	5	3	High	4	3	High
16-7	73 Gratwick Rd	Safety	3	2	Moderate	1	3	Low
16-8	119 Gratwick Rd	Strategic	5	3	High	1	3	Low

ID	Location	Risk Category	Existing Stormwater Infrastructure (Scenario 1b)			Post Mitigation (Scenario 1c)		
			Consequence	Likelihood	Risk Rating	Consequence	Likelihood	Risk Rating
16-9	1920 Bookpurnong Rd	Strategic	3	3	Moderate	1	2	Low
16-10	1966 Bookpurnong Rd	Strategic	4	3	High	1	3	Low
18-1	1839 Bookpurnong Rd	Strategic	2	3	Moderate	3	3	Moderate
18-2	39 Dorsch Ave	Safety	1	3	Low	5	3	High
18-3	18 Dorsch Ave	Safety	1	2	Low	5	3	High
18-4	13 Dorsch Ave	Strategic	1	3	Low	1	3	Low
18-5	1868 Bookpurnong Rd (Loxton High School ag. block)	Operational	4	3	High	1	2	Low
19-1	1800 Simpson Rd	Strategic/ Operational/ Safety	5	3	High	4	4	High
19-2	1672 Simpson Rd	Strategic/ Operational	5	3	High	2	3	Moderate
19-3	82 Wheatley Rd	Strategic/ Safety	1	3	Low	2	2	Low
20-1	Basin at end of Keith Payne Ct	Operational/ Safety	1	2	Low	5	4	Severe
20-2	18 French Rd	Strategic	4	4	High	1	3	Low
20-3	1679 Bookpurnong Rd	Safety	2	3	Moderate	4	3	High
21-1	1594 Bookpurnong Rd (Winery weighbridge)	Strategic/ Operational	2	2	Low	3	4	High
21-2	Intersection of Alamein Ave and Bookpurnong Rd	Strategic	5	4	Severe	2	3	Moderate
21-3	1546 Bookpurnong Rd	Operational	1	3	Low	1	3	Low

10.1.1. Distribution of Risk Ratings - Post Mitigation

Table 47 summarises identified risk ratings for all scenarios.

Table 47. Risk ratings distribution – post mitigation

		18% AEP Future	1% AEP Future
Low	Existing Stormwater Infrastructure	28	17
	Post mitigation	35	21
	Change	+7	+4
Moderate	Existing Stormwater Infrastructure	28	28
	Post mitigation	19	29
	Change	-9	+1
High	Existing Stormwater Infrastructure	17	28
	Post mitigation	10	24
	Change	-7	-4
Severe	Existing Stormwater Infrastructure	3	7
	Post mitigation	1	6
	Change	-2	-1

Implementation of the recommended stormwater management measures is anticipated to substantially lower flood risk throughout Loxton during both minor (18% AEP) and major (1% AEP) storm events. The assessment indicates that the measures not only reduce the total number of identified flood risks but also result in the redistribution of residual risks from higher consequence ratings to lower-risk categories, as presented in Table 47.

For the 18% AEP (minor) event, the number of identified flood risks decreases from 76 to 65, equating to a 14% reduction. High-risk locations are reduced from 17 to 10, while moderate-risk locations decrease from 28 to 19. Two out of three severe risk identified in this event was remediated by the proposed mitigation strategies.

For the 1% AEP (major) event, the total number of identified flood risks remains unchanged, representing an overall redistribution of risk rather than a reduction in the total number of risks. Although the total number of risks remains the same, the severity of the residual risks is considerably reduced. High-risk locations decrease from 28 to 24, while severe-risk locations decrease from 7 to 6.

The increase in low and moderate risk locations demonstrates that the proposed measures effectively reduce the likelihood and consequences of flooding, with many residual risks shifting from the Severe and High categories to the Moderate and Low categories. Overall, the recommended management responses improve community safety, reduce the potential for flood-related damage to property and infrastructure, and strengthen the long-term resilience and functionality of the Loxton stormwater network.

10.2. Water quality improvements and residual pollutants

The estimated reductions in pollutant loads resulting from the implementation of the proposed WSUD measures are summarised in Table 48.

Table 48. Water quality results

Parameter	Source	Residual Load	Reduction	Reduction %	Target	Achieved?
Flow (ML/yr)	333.87	303.84	30.02	8.99		
Total Suspended Solids (kg/yr)	60627.32	54,338.94	6,288.39	10.37	80%	N
Total Phosphorus (kg/yr)	105.64	94.82	10.83	10.25	60%	N
Total Nitrogen (kg/yr)	706.26	638.69	67.57	9.57	45%	N
Gross Pollutants (kg/yr)	15403.07	13,826.11	1,576.95	10.24	90%	N

Only management responses specifically intended to improve water quality were modelled in MUSIC. Management responses involving basin enlargement or the installation of new basins primarily for flood mitigation and improved flood immunity were not included in the water quality modelling.

At present, there are no dedicated stormwater treatment devices incorporated into Loxton's existing drainage system for water quality management. Addressing this gap would provide a clearer pathway towards improved stormwater quality outcomes and stronger alignment with best-practice stormwater management objectives.

Some strategy-level management responses were also not modelled as part of the MUSIC assessment but are expected to provide significant additional water quality benefits. For example, Strategy S3 – Installation of Water Quality Treatment Devices at Stormwater Outlets is expected to substantially reduce gross pollutant loads and assist in achieving the adopted gross pollutant reduction target once fully implemented.

Further improvements could also be achieved through the incorporation of additional WSUD measures and on-site detention or storage systems, where feasible, as recommended under Strategy S2 – Increasing On-site Storage. These measures would help reduce runoff volumes and pollutant loads at their source, improve runoff management, and enhance the overall performance of the stormwater drainage system. Incorporating these measures into future development, redevelopment, and infrastructure upgrade projects would further strengthen water quality outcomes and support a more integrated and resilient approach to stormwater management.

11. Conclusion and Discussion

This Stormwater Management Plan provides the District Council of Loxton Waikerie with a comprehensive, evidence-based framework for managing stormwater across the township of Loxton over the long term. Through detailed catchment investigations, hydrological and hydraulic modelling, water quality assessment, flood risk analysis, and evaluation of management responses, the SMP has identified the key challenges affecting the existing stormwater network and established a prioritised program of works to improve its performance, resilience, and sustainability.

The investigations confirmed that much of Loxton's stormwater network is ageing and approaching the end of its service life. The township's relatively flat topography, numerous local depressions, and limited natural drainage pathways contribute to recurring localised flooding, while ongoing urban growth and changing land use are expected to further increase runoff volumes and pressure on the existing drainage network. Climate change is projected to intensify these challenges through more frequent and intense storm events, reinforcing the need for a proactive and integrated approach to stormwater management.

The recommended management responses combine conventional drainage upgrades with Water Sensitive Urban Design (WSUD), source-control measures, stormwater quality treatment, detention, stormwater harvesting opportunities, and enhanced asset management practices. Rather than relying solely on increasing pipe capacity, the strategy promotes a balanced approach that manages stormwater throughout the catchment by reducing runoff at its source, improving water quality, and reducing demand on the existing drainage network.

The investigations also highlight the importance of protecting the River Murray through improved stormwater quality management. The recommended expansion of WSUD measures throughout the township will reduce sediment, nutrient, and gross pollutant loads before discharge to receiving waters, while also providing opportunities for stormwater harvesting and reuse. Together with the planned upgrades to the Loxton Wastewater Treatment Plant, these initiatives will improve water security, reduce reliance on potable water supplies, and deliver broader environmental and community benefits.

The prioritised implementation plan provides Council with a practical framework for directing future capital investment, infrastructure renewal, maintenance programs, and external funding applications. By coordinating stormwater upgrades with future development, asset renewal, and other infrastructure projects, Council can maximise the value of future investment while progressively improving flood resilience and stormwater management outcomes. Ongoing monitoring, periodic review of the hydraulic model, and incorporation of future development information will ensure the SMP remains relevant and responsive to changing conditions.

Ultimately, the successful implementation of this Stormwater Management Plan will depend on continued collaboration between Council, developers, government agencies, and the local community. By integrating stormwater management with broader land use planning, asset management, and water resource management, the recommended strategy provides a clear pathway towards a more resilient, efficient, and sustainable stormwater system that supports future growth while protecting the environmental values of the River Murray and enhancing the liveability of Loxton.

12. References

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12.2. Websites used as data sources

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IFD data: <http://www.bom.gov.au/water/designRainfalls/revised-ifd/>

ELVIS – <https://elevation.fsd.org.au/>

Google Earth Engine – https://developers.google.com/earth-engine/datasets/catalog/GOOGLE_Research_open-buildings_v3_polygons

SAPPA – <https://sappa.plan.sa.gov.au/>

12.3. Tools for modelling and data manipulation

Climate Change Rainfall Modifier (CCRM) –

<https://watercom.com.au/resources/climate-change-rainfall-modifier/>

DRAINS – Version: 2025.01.9147.24925 (64 bit)
Supplier: Watercom

INFFEWS Value Tool – Version: 2022-12
Supplier: CRC for Water Sensitive Cities

TUFLOW – Build: 2023-03-AD-iSP-w64
Solution Scheme: HPC
Supplier: BMT Commercial Australia Pty Ltd