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Northern Areas Council

Georgetown Stormwater Management Plan

Draft Report



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Georgetown Stormwater Management Plan

Draft Report

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Executive Summary

This Stormwater Management Plan for Georgetown has been prepared for Northern Areas Council. The preparation of the plan has been jointly funded by Northern Areas Council and the Stormwater Management Authority.

This document contains:

- A summary of collated information covering a range of factors relevant to the management of stormwater in the town;
- The identification of flood impacts highlighting performance deficiencies ranging from nuisance ponding to major flooding hotspots;
- A review of the quality of stormwater runoff leaving the town;
- Findings from the community consultation and objectives and targets for managing stormwater within the town;
- Potential management strategies that may be used to meet the objectives and targets;
- Estimated costs and benefits associated with each of the strategies; and
- A clear definition of the priorities, responsibilities and timeframe for implementation of the Stormwater Management Plan.

The study area for this Stormwater Management Plan is approximately 350 hectares in size, and contains both urban land within Georgetown and the major watercourse of Yackamoorundie Creek, as well as several smaller watercourses. The study area is not defined by a single contributing catchment, but instead by large watercourses surrounding the town and numerous catchments within the town. The study area is wholly located within the jurisdiction of Northern Areas Council.

The topography of the study area varies, with higher elevations to the west and north of the township. Yackamoorundie Creek passes alongside the town to the east, before flowing to the south. The town generally grades from west to east, with several upstream catchments draining towards the western side of town.

Key issues identified by this Stormwater Management Plan include:

- A range of drainage system performance deficiencies including trapped ponding, insufficient drainage infrastructure and property inundation;
- Limited stormwater quality improvement measures have been implemented across the town to date;
- Future development, largely consisting of greenfield development, will exacerbate flood risk and decrease the quality of water entering the receiving waters; and
- The potential for climate change, in the form of higher intensity rainfall, to increase flood risk within the town.

A set of objectives specific to this Stormwater Management Plan was developed, addressing:

- Providing an acceptable level of flood protection for public and private assets;
- Improving the quality of runoff to the receiving waters;
- Finding opportunities for the beneficial use of stormwater;
- Planning for new developments to provide open space and maximise the onsite retention of stormwater runoff;
- The sustainable asset management of stormwater infrastructure;
- Improving the condition of receiving watercourses; and
- Effective communication and consultation with stakeholders, businesses and the community.

The Stormwater Management Plan recommends a range of structural and non-structural stormwater management responses, which have been summarised in the table below. These measures have been developed with a view to maximising the level of flood protection that can be achieved within practical constraints. In accordance with the objectives and targets, an absolute target of achieving no above floor inundation of properties in the 5% AEP storm was adopted, with an aspirational target to provide a 1% AEP standard.

The proposed flood mitigation strategies include new and upgraded underground drainage systems and various earthworks, all aimed at reducing surface ponding and property inundation in major storm events. Detention basins have also been proposed, which will mitigate runoff from the upstream catchments and improve the performance of downstream drainage systems. Flood damage estimates and structural cost estimates have been developed to evaluate the economic feasibility of the proposed flood mitigation measures. The total cost of implementing the various flood mitigation measures is estimated to be $4.6m.

Water quality improvement measures have also been recommended in this Stormwater Management Plan, including a wetland, streetscape raingardens and gross pollutant traps. The total cost of implementing the proposed Water Sensitive Urban Design (WSUD) strategy is estimated to be $2.9m, with an annual maintenance cost of $29,000.

Water quality modelling has shown that the proposed WSUD strategy outlined in this plan would achieve the adopted water quality improvement targets. The opportunity for further measures also exists at the street level, such as raingardens being incorporated into road reconstructions, and on private property.

A Multi-Criteria Analysis (MCA) was developed to enable relative priorities to be assigned to all proposed stormwater management responses, taking into account financial, environmental and social factors. A consolidated list of the prioritised measures is presented in the table below, which also provides capital cost estimates and highlights the actions that are potentially eligible for Stormwater Management Authority funding.

Priority	Project Description	Benefits	Capital Cost	Potentially Eligible for SMA Funding
Very High	Northern Channel Flood Protection	Flood mitigation, drainage service	$2,110,000	✓
Very High	SES Community FloodSafe Program	Flood mitigation, information and knowledge	-	✓
High	Pitts Street Drainage	Flood mitigation, drainage service	$660,000	✓
High	Streetscape Raingardens	Water quality improvement	$200,000	
High	Council's Emergency Management Plan	Flood mitigation, information and knowledge, administration efficiency	-	
Moderate	James Street Drainage	Flood mitigation, drainage service	$1,420,000	✓
Moderate	Golf Course Channel Works	Flood mitigation	$360,000	
Moderate	Georgetown Wetland	Water quality improvement	$1,180,000	
Moderate	Stormwater Harvesting and Reuse Scheme	Water quality improvement	$930,000	
Moderate	Rezoning Flood-prone Land	Flood mitigation, information and knowledge	-	
Moderate	New Building Floor Levels	Flood mitigation	-	
Low	Brogan Road Culvert	Drainage service	$40,000	
Low	Gross Pollutant Traps	Water quality improvement	$730,000	
Low	Rainwater Tanks and Allotment Level Reuse	Stormwater reuse, water quality improvement, information and knowledge	-	
Low	Ongoing Maintenance and Monitoring of Council Assets	Flood mitigation, drainage service, information and knowledge, administration efficiency	-	
Low	Education and Promotion of WSUD Measures	Stormwater reuse, water quality improvement, ecological improvement, information and knowledge	-	✓
Low	Development Controls – Beneficial Use of Stormwater	Stormwater reuse, information and knowledge	-	✓

1 Introduction

This Stormwater Management Plan (SMP) for the township of Georgetown has been prepared for the Northern Areas Council in accordance with the requirements of the brief. The preparation of the plan has been jointly funded by the Northern Areas Council (Council) and the Stormwater Management Authority (SMA).

The Plan will provide an overview of the existing catchments and issues relating to current stormwater management in the township of Georgetown. It also provides an overview of the opportunities to improve stormwater management to both address flood protection and the sustainable management of this resource and the environment.

This Plan has been developed primarily in consultation with Council staff, with external stakeholders from relevant State Government Authorities providing technical guidance regarding the objectives, targets and preferred management responses.

This progress report provides background on the township in the form of a baseline assessment, describing the current state and condition of the catchment and establishing a baseline against which the effectiveness of stormwater management options can be assessed. This report also summarises the proposed approach to identifying and managing stormwater risk and issues.

2 Baseline Assessment

2.1 Introduction

A baseline assessment of the township of Georgetown has been undertaken. This assessment describes the current state of the township and its catchments, establishing a baseline against which the effectiveness of future stormwater management options can be assessed. The following sections describe the elements included in the baseline assessment.

2.2 Administrative Boundaries

A Stormwater Management Plan boundary, forming the study area, has been prepared, and can be seen in Figure 2.1 below.

The study area is wholly contained within the Northern Areas Council local government area. The relevant Landscape SA board for the study area is the Northern and Yorke region, and the study area falls under the Southern and South-Western Flatlands (East) National Resource Management sub cluster.

2.3 Topography, Land Use, Geology and Soils

2.3.1 Major Catchments

The study area contains a major watercourse flowing towards Georgetown from the northeast and leaving to the south, being Yackamoorundie Creek. There is also a much smaller catchment draining to a large detention basin west of Georgetown. Major catchment boundaries for these systems were delineated using regional topographic data obtained from the ELVIS online spatial data service developed and maintained by Geoscience Australia.

In general, the upstream catchments are rural in nature with extensive agricultural land usage and minimal development. The Yackamoorundie Creek catchment is narrow and long in shape, extending to the north and containing the town of Caltowie.

The Yackamoorundie Creek catchment is characterised by hilly, steep terrain upstream in the catchment, with distinct ridges and peaks visible. At the extremities of the catchment, the elevations ramp up significantly and stream gradients reach over 2%. The main channel is comparatively flatter, with grades of approximately 0.3% to 0.5%. The full catchment is contained within the Northern Areas Council local government area.

The catchment for the western tributary, which is located to the west of Georgetown, is far steeper with a channel gradient of over 4%.

A summary of catchment sizes is presented in Table 2.1 and the catchment extents are shown in Figure 2.2.



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Data Sources:
Northern Areas Council (Aerial Photography)
Data SA (State Maintained Roads, Watercourses)

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FIGURE 2.1 - STUDY AREA

Table 2.1 Catchment Size Information

Catchment	Area (km^2)
Yackamoorundie Creek	334
Western Tributary	0.5

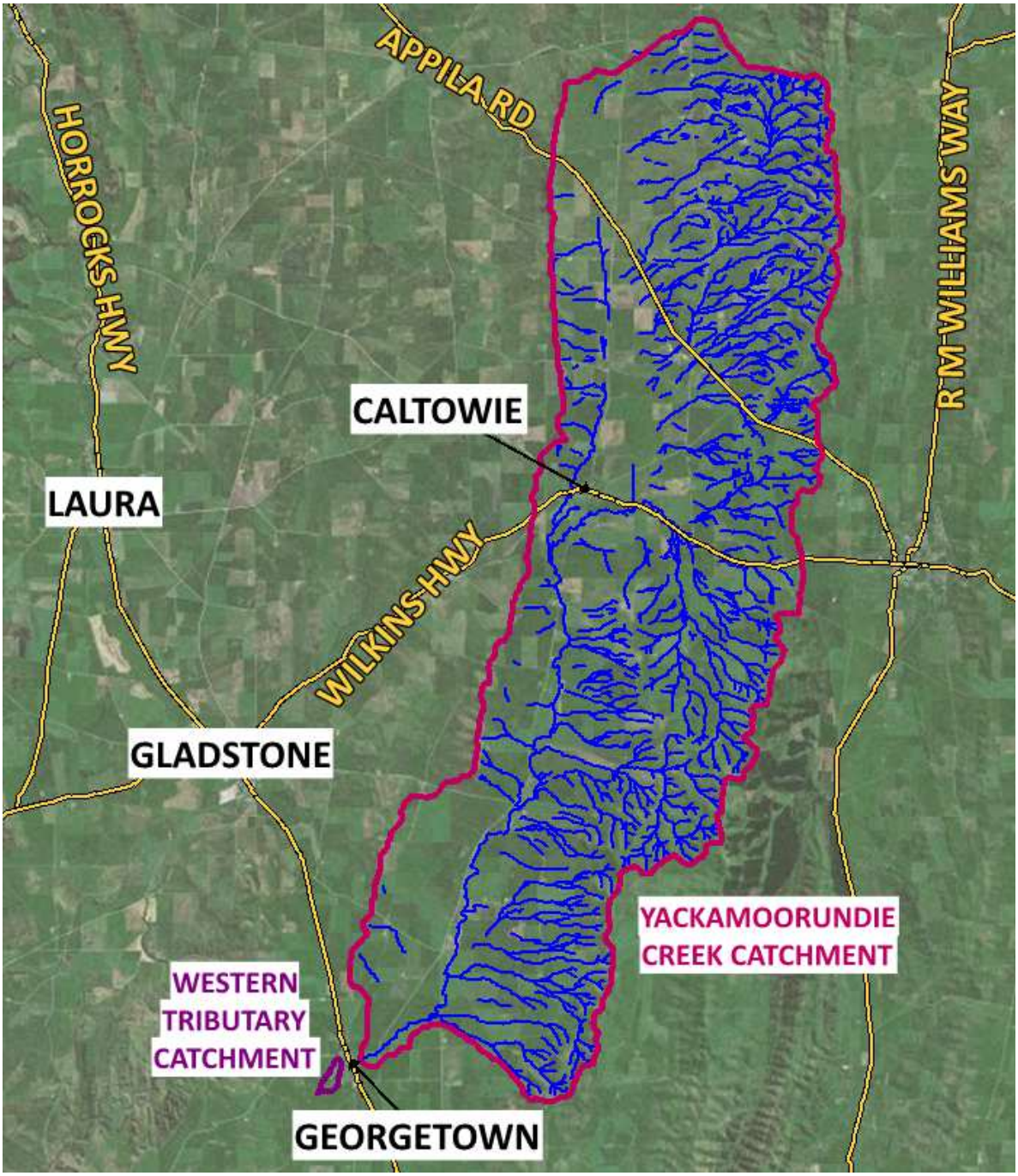


Figure 2.2 Major Catchment Boundaries

2.3.2 Topography

A Digital Terrain Model (DTM) of the Georgetown township has been provided by Council for this SMP. The DTM was generated from a Light Detection and Ranging (LiDAR) point data capture of nine regional South Australian townships undertaken between October 2021 and November 2021. The LiDAR has a spacing of approximately 14.2 to 15.6 points per square metre, and a reported vertical accuracy of +/- 0.06 m (95% confidence interval). The DTM is shown in Figure 2.3 below.

Regions of higher elevation can be seen to the southwest of town, with a small watercourse draining to a large detention basin just west of town. Elevations throughout the township can be seen grading in a general west to east direction, with the low-lying Yackamoorundie Creek to the east being the primary receiving waters for the township.

2.3.3 Land Use

Land use throughout the study area has been sourced from the Valuer General's Generalized Land Use Dataset (2021). This GIS layer is based on actual land use rather than zoning, and within the study area can be broken down as follows:

- 19 ha of Residential, 12 ha of Rural Residential and 22 ha of Vacant Residential;
- 200 ha of Agriculture and 1 ha of Livestock;
- 7 ha of Utility/Industry and 7 ha of Mine Quarry;
- 0.2 ha of Commercial and 0.6 ha of Retail Commercial;
- 1 ha of Public Institution;
- 5 ha of Recreation, 1 ha of Reserve and 26 ha of Golf; and
- 4 ha of Vacant.

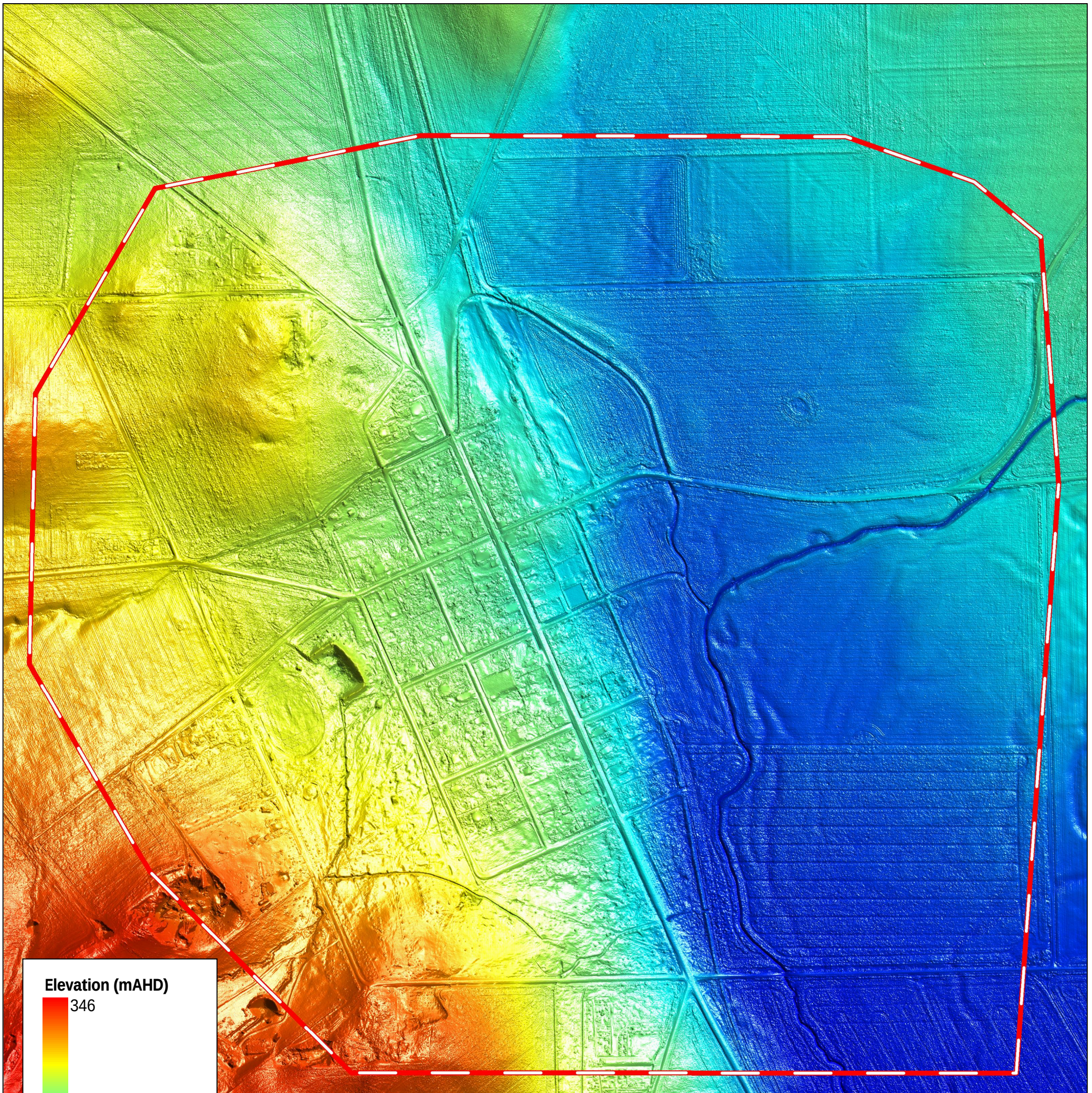
Land use within the study area can be seen in Figure 2.4.

2.3.4 Geology and Soils

Geological information throughout the study area and upstream catchments has been sourced from the South Australian Resources Information Gateway (SARIG) website developed by the Department for Energy and Mining. This dataset provides stratigraphic information throughout the state and was used to gain an understanding of the geology of the region.

The dataset indicates that the township of Georgetown is located on a mixture of Quaternary alluvial/fluvial sediments and Holocene alluvial/fluvial plain sediments. The Yackamoorundie Creek catchment is primarily comprised of quaternary alluvial/fluvial sediments, with far less extensive Tapley Hill Formation, Appila Tillite and Saddleworth Formation. The unnamed watercourse catchment largely consists of quaternary alluvial/fluvial sediments with minor amounts of Holocene alluvial/fluvial sediments and Miocene-Pliocene rocks.

We are not aware of any investigation into the feasibility of aquifer storage and recharge in Georgetown. The *Georgetown into the Future Urban Design Framework* (WAX, 2009) suggested that the topography of the town was favourable for aquifer storage and recharge, however no geotechnical investigation was undertaken.



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Data Sources:
Southfront (Study Area)
Northern Areas Council (DTM)

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FIGURE 2.3 - TOPOGRAPHY

Land Use

- Agriculture
- Commercial
- Golf
- Livestock
- Mine Quarry
- Public Institution
- Recreation
- Reserve
- Residential
- Retail Commercial
- Rural Residential
- Utility/Industry
- Vacant
- Vacant Residential
- Study Area

0 400

metres

N

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Data Sources:
Southfront (SMP Study Area)
Data SA (Generalised Land Use)

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FIGURE 2.4 - LAND USE

2.4 Climate and Hydrology

2.4.1 Rainfall and Temperature Analysis

Daily rainfall data from the Bureau of Meteorology rainfall gauge in Georgetown (Station 21020) was obtained from the Bureau of Meteorology weather station directory online service, for the years 1874-2022. The mean annual rainfall in Georgetown was found to be 475 mm.

Statistical analysis of the annual rainfall variation is also provided by the Bureau of Meteorology, which reports variations from the annual mean as summarised in Table 2.2 and Figure 2.5, which show monthly deviations from the annual mean and illustrate monthly trends.

Table 2.2 Rainfall Data for Georgetown (Station 21020)

Statistic [Year of Occurrence]	Annual Rainfall (mm)	% Difference to Mean
Mean	474.7	-
Lowest [1940]	229.3	-52%
5th percentile	310.4	-35%
10th percentile	344.7	-27%
Median	464.0	-2.3%
90th percentile	634.4	+34%
95th percentile	704.1	+48%
Highest [1992]	796.0	+67%

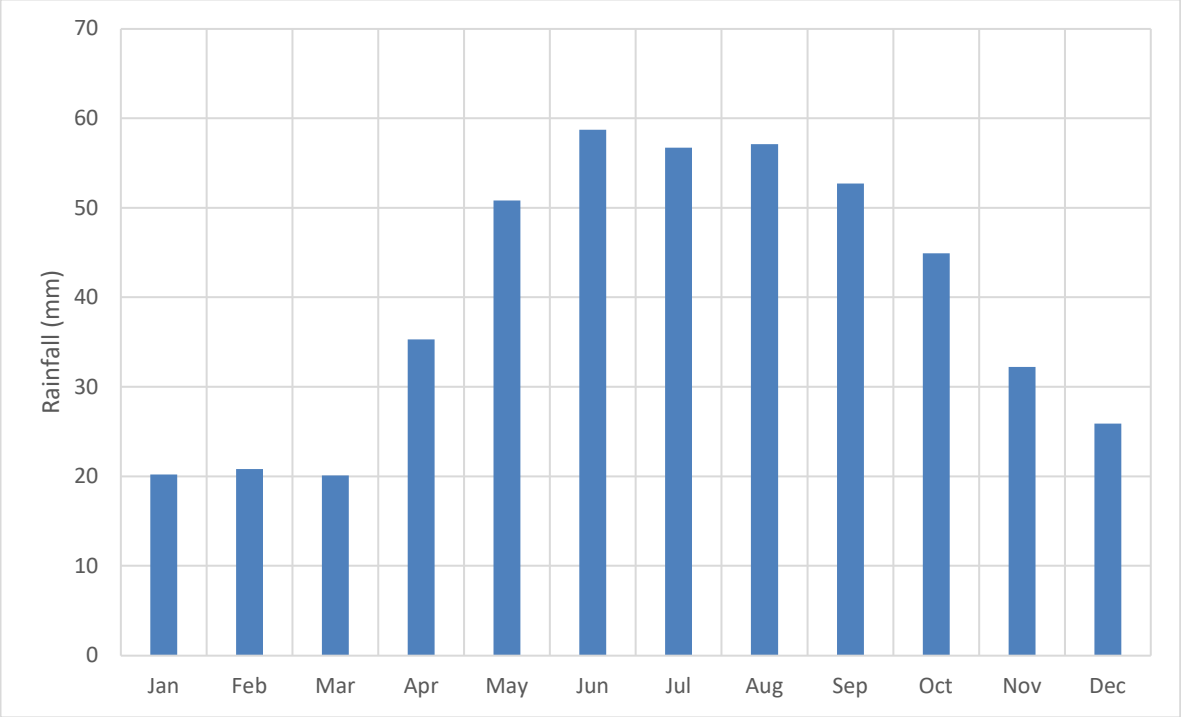


Figure 2.5 Georgetown Mean Monthly Rainfall

Historic daily maximum temperature information from 1900 to 2022 at Georgetown was acquired from the SILO website managed by the Queensland Government. This data was analysed and the average maximum temperature for each month was determined. Daily

evaporation data for the same time period was also obtained from the SILO website, and analysed to find average monthly evaporation. The two are shown in Figure 2.6 below.

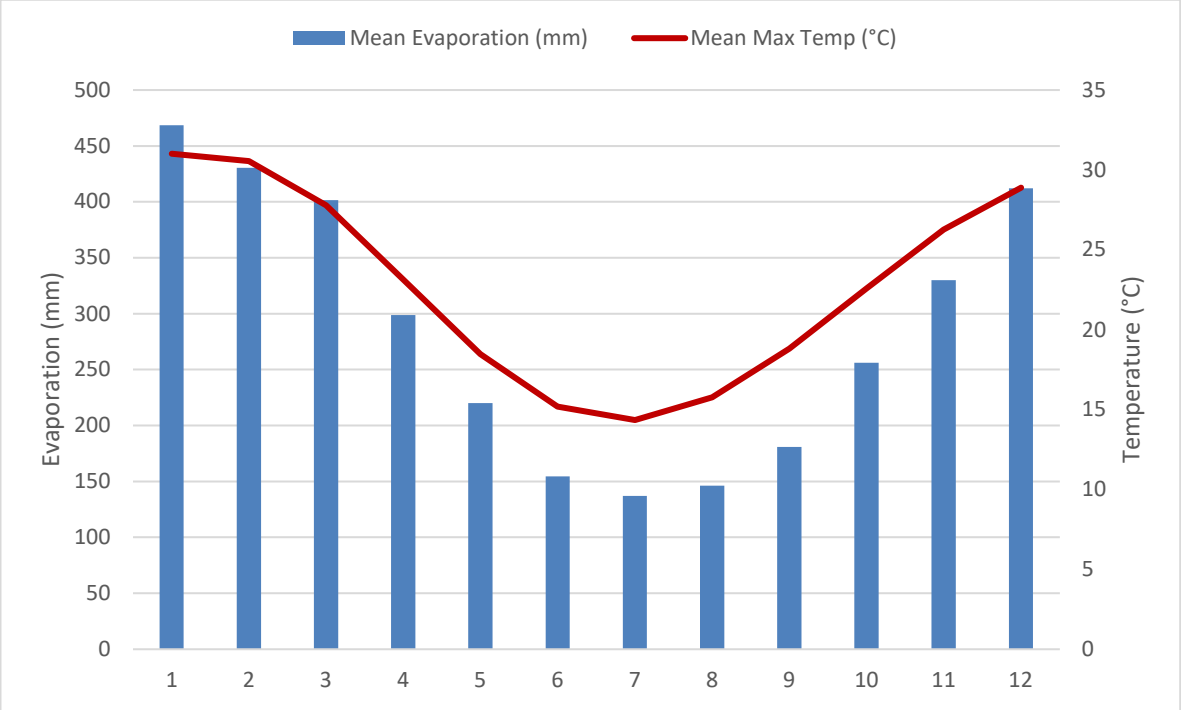


Figure 2.6 Georgetown Monthly Evaporation and Temperature

Figure 2.6 above shows that evaporation and maximum temperature are strongly correlated as would be expected.

2.4.2 Design Rainfalls

Design rainfall Intensity-Frequency-Duration (IFD) data has been prepared for Georgetown utilising the Australian Rainfall and Runoff 2019 (ARR 2019) online procedure provided by the Bureau of Meteorology. This data is presented in Table 2.3 for the relevant Annual Exceedance Probabilities.

Table 2.3 IFD Design Rainfall Intensities (mm/hr)

Duration	Annual Exceedance Probability (AEP)					
	18.2%	10%	5%	2%	1%	0.2%
1 min	119	143	171	213	248	323
2 min	103	124	150	188	220	290
3 min	92.5	112	135	168	196	258
4 min	84.6	102	123	153	178	234
5 min	78.1	94.3	113	141	164	214
10 min	57.9	69.8	83.6	104	121	157
15 min	46.9	56.6	67.8	84.1	97.9	127

Duration	Annual Exceedance Probability (AEP)					
	18.2%	10%	5%	2%	1%	0.2%
30 min	31.3	37.8	45.3	56.4	65.6	85.6
1 hour	20.1	24.2	29.1	36.2	42.2	55.2
2 hour	12.7	15.2	18.2	22.6	26.3	34.4
3 hour	9.67	11.6	13.8	17.1	19.8	25.8
6 hour	6.08	7.23	8.57	10.5	12.1	15.7
12 hour	3.82	4.51	5.32	6.47	7.43	9.62
24 hour	2.36	2.78	3.28	3.98	4.56	5.94
48 hour	1.42	1.68	1.97	2.4	2.76	3.68
72 hour	1.04	1.22	1.44	1.76	2.02	2.72

2.4.3 Impact of Climate Change

Climate change leads to changes in the frequency, intensity, spatial extent, duration and timing of extreme weather and climate events. Within a stormwater management context, potential future changes in rainfall patterns are of particular interest, as these result in changes to levels of flood protection, stormwater drainage performance and the availability of stormwater for harvesting and reuse.

ARR 2019 provides an approach for addressing the risks posed by climate change in projects and decisions that involve estimation of design flood characteristics. It draws on the most recent climate science, particularly the release of the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC, 2014) as well as *Guide to Climate Projections for Risk Assessment and Planning in South Australia* (Department for Environment and Water, 2022).

The procedure relies on the Climate Futures web tool developed by the CSIRO where projected changes from Global Climate Models (GCMs) can be explored for fourteen 20-year periods based on four Representative Concentration Pathways (RCPs) for greenhouse gas and aerosol concentrations that were used to drive the GCMs. The pathways are provided by regional Natural Resource Management (NRM) clusters (divided into 11 regions nationally), with the Georgetown study area falling within the Southern and South-Western Flatlands (East) region.

ARR 2019 recommends the use of RCPs 4.5 and 8.5 (low and high concentration pathways, respectively) for rainfall intensity impact assessment. Further details can be found at the Australian Climate Futures website (https://www.climatechangeinaustralia.gov.au).

For this study, the designated climate planning horizon is the year 2050. Using the web tool, Table 2.4 indicates the IPCC GCM consensus for rising temperatures as a result of rising greenhouse gas emissions for high and low scenarios for the region.

Table 2.4 GCM Predicted Changes to Annual Mean Surface Temperature (2050)

RCP Scenario	GCM Consensus	Projected Annual Mean Surface Temperature Change (°C)
4.5	Warmer (45 of 46)	+ 0.5 to + 1.5
8.5	Warmer (27 of 48), Hotter (21 of 48)	+ 0.5 to + 1.5 + 1.5 to + 3.0

ARR 2019 recommends using the temperature midpoint of the projected annual mean surface temperature change to calculate adjustments to the projected rainfall intensity using the following equation:

$$I_p = I_{ARR} \times 1.05^{T_m}$$

Where I_p is the projected rainfall intensity, I_{ARR} is the design rainfall intensity for current climate conditions, 1.05 is the assumed temperature scaling based on the approximately exponential relationship between temperature and humidity, and T_m is the temperature at the midpoint of the selected class interval.

As the models could not come to a consensus for both RCP scenarios, the temperature midpoint of the wider interval +0.5 to +3.0 °C (1.75 °C) was used. Therefore, $I_p = I_{ARR}$ x 1.09 (i.e. a 9% intensity increase for 2050). The Intensity-Frequency-Duration data is shown in Table 2.5 with this climate change factor applied. The modelling of proposed drainage infrastructure will utilise these rainfall intensities.

Table 2.5 IFD Design Rainfall Intensities (mm/hr) with Climate Change Factor (2050)

Duration	Annual Exceedance Probability (AEP)					
	18.2%	10%	5%	2%	1%	0.2%
1 min	130	156	186	232	270	352
2 min	112	135	164	205	240	316
3 min	101	122	147	183	214	281
4 min	92.2	111	134	167	194	255
5 min	85.1	103	123	154	179	233
10 min	63.1	76.1	91.1	113	132	171
15 min	51.1	61.7	73.9	91.7	107	138
30 min	34.1	41.2	49.4	61.5	71.5	93.3
1 hour	21.9	26.4	31.7	39.5	46.0	60.2
2 hour	13.8	16.6	19.8	24.6	28.7	37.5
3 hour	10.5	12.6	15.0	18.6	21.6	28.1
6 hour	6.63	7.88	9.34	11.4	13.2	17.1
12 hour	4.16	4.92	5.80	7.05	8.10	10.5

Duration	Annual Exceedance Probability (AEP)					
	18.2%	10%	5%	2%	1%	0.2%
24 hour	2.57	3.03	3.58	4.34	4.97	6.47
48 hour	1.55	1.83	2.15	2.62	3.01	4.01
72 hour	1.13	1.33	1.57	1.92	2.20	2.96

The Climate Futures web tool also showed that annual rainfall is predicted to decrease within the Southern and South Western Flatlands (East) National Resources Management Sub Cluster. GCM consensus results for RCP scenarios 4.5 and 8.5 are shown in Table 2.6.

Table 2.6 GCM Predicted Changes to Annual Rainfall (2050)

RCP Scenario	GCM Consensus Rainfall	Projected Annual Rainfall Change (%)
4.5	Drier (29 of 68) Little Change (28 of 68)	-15 to -5 -5 to +5
8.5	Drier (25 of 70) Little Change (27 of 70)	-15 to -5 -5 to +5

As can be seen, GCM consensus for both RCP scenarios indicates annual rainfall becoming 'drier' or having 'little change' by the year 2050. Taking the midpoint of the wider range (-15% to +5%), an average annual rainfall reduction of 5% by 2050 is predicted.

The impact of climate change on soil moisture, particularly within the study area, is unclear. However, it is expected that soil moisture will decrease as temperature increases, which is forecasted over the planning horizon for this Stormwater Management Plan.

2.4.4 Hydrology of the Study Area

As discussed in Section 2.3.1, the township of Georgetown is situated near a major watercourse, Yackamoorundie Creek, with a catchment size of 334 km^2. Yackamoorundie Creek flows towards Georgetown from the northeast, crossing under Lehmann Road where it is joined by the unnamed watercourse to the east of James Street. The creek then flows south across Lang Road and continues to the south.

There are also two smaller watercourses flowing towards Georgetown from the southwest. The larger of the two flows towards Georgetown-Narridy Road, crossing it through a culvert, then along an open channel crossing beneath Hurtle Street and then Horrocks Highway, finally crossing under Caltowie-Georgetown Road to connect into Yackamoorundie Creek.

The smaller of the two watercourses crosses Brogan Road, flows through the golf course and directs water into a large detention basin situated on the corner of School Road and West Terrace, just next to a sports oval.

2.4.5 History of Flooding and Drought in Georgetown

Georgetown has an extensive history of flooding, with *Floods in South Australia (1836-2005)* (Bureau of Meteorology, 2006) documenting flooding of varying severity in the town in 1871,

1874, 1877 and 1931. Additionally, *Georgetown into the Future Urban Design Framework* (WAX, 2009) reports that houses flooded in 1974 when the northern drain running alongside North Terrace and crossing Horrocks Highway was blocked. The frequency with which flooding has historically occurred within Georgetown speaks to the stormwater management challenges facing the township, being located between two watercourses and having only limited stormwater infrastructure.

While Georgetown has experienced many periods of intense rainfall, it has also experienced a number of droughts, including the following:

- The Federation drought (1895 to 1902);
- The 1914 to 1915 drought;
- The World War II drought (1937 to 1945);
- The 1965 to 1968 drought;
- The 1982 to 1983 drought;
- The Millenium drought (1997 to 2009); and
- The 2017 to 2019 drought.

2.4.6 Available Hydrometric Data

The Water Data SA website, operated by the Department for Environment and Water, was accessed to determine the availability of hydrometric data within the study area. No flow gauges were found within any of the upstream catchments, with the nearest gauge being on the Rocky River west of Georgetown, southeast of Crystal Brook. Similarly, there was no hydrometric data available for the drainage networks within the study area.

2.4.7 Surface Water and Groundwater Interaction

We are not aware of any studies or information investigating the interaction between surface water and groundwater in Georgetown. However publicly available drillhole log information from the WaterConnect website suggests the groundwater table is in excess of 4 m deep, and is therefore considered unlikely to meaningfully impact surface water from a stormwater management perspective.

2.5 Stormwater and Flood Infrastructure

2.5.1 Existing Infrastructure

Northern Areas Council maintains records of existing stormwater infrastructure, which have been provided for this Stormwater Management Plan. This information is in the form of a GIS point layer containing asset data, and a separate excel spreadsheet of stormwater asset data.

Using the supplied GIS data, together with aerial photography, the DTM and information gained on a site visit, stormwater pit and pipe layers were created. Figure 2.7 below provides an overview of the location and extent of existing stormwater infrastructure within the study area. A summary profile of existing infrastructure is provided in Table 2.7.

Table 2.7 Existing Stormwater Infrastructure

Asset Class	Description	Quantity
Pipe	150mm dia 225mm dia	4 m 79 m

Asset Class	Description	Quantity
	300mm dia 375mm dia 450mm dia 525mm dia 600mm dia 900mm dia 1200mm dia 1500mm dia	69 m 132 m 28 m 6 m 67 m 27 m 21 m 8 m
Box Culvert	Size varying	94 m
Node	Side Entry Pit Headwall Junction Box	2 52 1
Detention Basin	Max Depth = 2.7 m Surface Area = 6420 m^2 Volume = 7145 m^3	1

The detention basin at the corner of School Road and West Terrace does not appear to have a formalised outlet, instead spilling along an overland flow pathway towards West Terrace in line with James Street. It is understood this basin is used to irrigate the nearby sports oval. No emergency management plan has been identified for this asset, which on a site visit did not appear to be well-maintained.

2.5.2 Stormwater Asset Age and Condition

Council's GIS and spreadsheet stormwater asset databases contain condition information, however as discussed these are not linked to spatially accurate pit and pipe objects, and therefore it is difficult to map asset condition. The two databases do not list asset age, however the spreadsheet lists a date of expiry.

2.5.3 Stormwater Asset Management Planning

Council are in the process of developing a Stormwater Asset Management Plan (personal communication David McKinley, October 2022), which will be used to guide the planning and maintenance of Council's stormwater assets. Other relevant processes and plans include:

- *Stormwater Management Planning Guidelines* (Stormwater Management Authority, 2007);
- *Asset Management Policy* (Northern Areas Council, 2022); and
- *Long Term Financial Plan 2021-22 to 2030-31* (Northern Areas Council, 2021).

2.5.4 Actual and Desired Level of Service

From discussions with Council staff, it is assumed that there are no formalised level of service requirements for stormwater management within the study area. Rather, priorities involve protecting the town from major flooding and managing more frequent nuisance ponding. Key level of service targets for this study will be selected through discussions with Council staff.

It appears that the full study area flows untreated towards Yackamoorundie Creek. As with flood protection, we are unaware of defined water quality targets set by Council.

2.6 Environmental Values

2.6.1 Water Quality

The quality of water within the study area is of great importance. The primary downstream receiving waters is Yackamoorundie Creek, and therefore it is important that appropriate consideration is given to pollutants in runoff leaving the study area. Additionally, the quality of stormwater will impact the feasibility of potential stormwater harvesting and reuse schemes. *Water sensitive urban design – Creating more liveable and water sensitive cities in South Australia* (Department of Environment, Water and Natural Resources, 2013) provides WSUD performance targets for South Australia, which will be benchmarked against in this report.

Typical stormwater pollutants include:

- Total suspended solids (TSS), commonly clay, gravel, sand and silt, but also including algae and decomposing organic material;
- Total phosphorus (TP), with common sources including sewage, intensive livestock industries, soil, fertilisers and detergents;
- Total nitrogen (TN), with common sources including food processing industries, sewage, intensive livestock industries, soil and fertilisers; and
- Gross pollutants, typically including rubbish, plant debris and coarse sediment.

We are not aware of any pollutant base load or concentration information specific to the study area, however it is expected these would be comparable to those for catchments primarily comprised of agricultural and grazing land use.

The presence of total suspended solids in watercourses can result in cloudier water, affecting the oxygen levels within the water and potentially harming animals and plants living within it, as well as humans if the water is consumed. High levels of total phosphorus and total nitrogen often cause blue-green algal blooms, which can produce harmful toxins to humans through contact or consumption. Gross pollutants such as litter can be harmful to receiving waters if not screened, with animals potentially consuming plastics or other rubbish.

Australian Guidelines for Water Recycling: Stormwater Harvesting and Reuse (Natural Resource Management Ministerial Council, 2009) recommends including stormwater treatment to minimise operational risks. Operational risks include gross pollutants blocking pipes or damaging pumps and organic matter resulting in reduced oxygen levels, potentially creating odours and releasing pollutants from sediments.



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Data Sources:
Northern Areas Council (Aerial Photography, Stormwater Assets)
Data SA (State Maintained Roads, Watercourses)

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FIGURE 2.7 - STORMWATER INFRASTRUCTURE

2.6.2 Threatened/Sensitive Ecological Communities

As discussed, the major watercourse within the Study Area is Yackamoorundie Creek. *A River Management Plan for the Broughton Catchment* (Department of Water, Land and Biodiversity Conservation, 2004) undertook a condition assessment of all fourth order and larger watercourses, considering watercourse vegetation, channel condition, any structures and surrounding land use.

The Yackamoorundie Creek vegetation in the vicinity of the study area was found to consist of mainly annual exotic grasses or crops with less than 10% overstorey. Apart from the identified reedbeds, there was very little habitat for aquatic or other animals. A wide range of macro-invertebrates were found within the downstream receiving waters, including worms, amphipods, midge larva and springtails. Fish species identified within the downstream receiving waters include blue spot goby, mountain galaxia, eastern gambusia and goldfish.

2.6.3 Watercourse Assessment

The Yackamoorundie Creek immediately upstream of the study area was found in the *A River Management Plan for the Broughton Catchment* (Department of Water, Land and Biodiversity Conservation, 2004)to have poor native watercourse vegetation, being comprised mainly of exotic grasses or crops, with reedbeds in the channel. No exotic tree species were identified during a field survey undertaken for the catchment plan. The native understorey vegetation has been modified due to the impact of grazing and clearance. In general bank stability was found to be moderate to good, and structural items such as bridges and culverts were classified as high to medium stability.

In a site visit undertaken on 12 October 2022, Yackamoorundie Creek was inspected at the Lang Road crossing, and found to be relatively shallow with thick vegetation along the channel, banks and surrounding floodplain as seen in Figure 2.8 below.



Figure 2.8 Lang Road Floodway

2.6.4 Areas of Environmental Importance

The Yackamoorundie Creek channel and surrounding floodplain downstream of Georgetown was identified as an important riverine ecosystem in *A River Management Plan for the Broughton River Catchment* (Department of Water, Land and Biodiversity Conservation, 2004). Yackamoorundie Creek downstream of Georgetown has variable vegetation, with parts being in relatively good condition with structural and floristic diversity and in intact understorey. Within the lower reaches Broughton Willow and river red gum dominate the landscape.

No significant watercourse management issues were identified, a range of native vegetation was identified and the presence of permanent pools and reedbeds were found to provide suitable habitats for native fish and macro-invertebrates. These riparian and aquatic habitats are considered a high priority for conservation. The report identifies that the creek in the vicinity of Georgetown alternates between a dry grassy channel and reedbeds supported by groundwater, indicating an interaction between surface water and groundwater in the area.

2.6.5 Environmental Flows

A River Management Plan for the Broughton River Catchment (Department of Water, Land and Biodiversity Conservation, 2004) also assessed the environmental flow regimes and requirements for the different watercourses within the greater Broughton River catchment, including Yackamoorundie Creek. The ecological communities outlined previously all have varying environmental flow requirements, for example macro-invertebrates require various flow

regimes ranging from no flow to mid-bank flows. Table 2.8 below describes the environmental flow requirements for Yackamoorundie Creek in the vicinity of the study area.

Table 2.8 Yackamoorundie Creek Environmental Flow Requirements (Department of Water, Land and Biodiversity Conservation, 2004)

Flow Band	Key Functions	Frequency (every X years)
Groundwater table – Shallow water within stream bed with at least damp sediments	Maintain macrophyte beds Maintain in-stream habitat such as reeds	1
Mid flow – Near bankfull	Transport organic matter Migration of macro-invertebrates Sediment transport	1 to 2
Bankfull to overbank flow	Floodplain inundation Connect floodplain to in-stream zone Sediment transport Channel maintenance	2 to 10

Any activity which will modify the frequency, timing, seasonality or water quality of the natural flow regime can have a large impact on the downstream, often sensitive ecological communities. Additionally, on-line farm dams, which were found to be very common upstream in the Yackamoorundie Creek catchment, can significantly affect the natural flow regime, detaining low flows and restricting the volume of water entering the downstream channel.

The increased level of imperviousness associated with development has had a significant impact on the natural flow regime. Hard surfaces result in larger, more frequent runoff compared to previous surfaces such as that of the natural catchment, and also reduce the response time for a catchment.

2.7 Social, Socio-Economic and Cultural Values

A map has been prepared summarising locations within the study area of social, socio-economic and cultural importance, and is shown in Figure 2.9. This includes major industries and institutions, critical infrastructure, tourist, trade and social facilities and routes.

The Northern Areas Council is located within Ngadjuri and Nukunu land.

2.8 Development Policy

A map showing the planning and design code zones within the study area has been prepared, and is shown in Figure 2.10. As can be seen, within the 'Township' zone there remains a reasonable amount of vacant land. Vacant lots within this region can be considered potential sites of future development, and are scattered throughout the town.



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Data Sources:
Northern Areas Council (Aerial Photography)
Southfront (Locations of Interest)
Data SA (Roads, Watercourses)

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FIGURE 2.9 - SOCIAL, SOCIO-ECONOMIC AND CULTURAL VALUES

Planning and Design Code Zones

- Community Facilities
- Rural
- Township

- Study Area

N

0 400

metres

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Data Sources:
Northern Areas Council (Aerial Photography)
Southfront (SMP Study Area)
Data SA (Planning and Design Code Zones)

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FIGURE 2.10 - PLANNING AND DESIGN CODE ZONES

3 Identification of Stormwater Risks and Issues

3.1 General

Stormwater modelling of the study area has been undertaken, including hydrologic, hydraulic and water quality modelling. Details regarding the development of these models and their key results are provided in the *Georgetown Stormwater Management Plan Modelling Report* (Southfront, 2025). The results from these models have been used to identify risks and issues relating to stormwater within the township.

3.2 Model Scenarios

The hydrological and hydraulic modelling undertaken consider three scenarios, which are described below:

- Scenario A: Current stormwater infrastructure, current development and current climate;
- Scenario B: Current stormwater infrastructure, future development and future climate to the year 2050; and
- Scenario C: Proposed stormwater infrastructure, future development and future climate to the year 2050.

The range of storm frequencies modelled includes the 18% Annual Exceedance Probability (AEP), 10% AEP, 5% AEP, 2% AEP, 1% AEP and 0.2% AEP events.

The water quality modelling considered four scenarios as follows:

- Scenario 1: Existing development with no WSUD infrastructure;
- Scenario 2: Future development with no WSUD infrastructure;
- Scenario 3: Future development with existing WSUD infrastructure; and
- Scenario 4: Future development with existing and proposed WSUD infrastructure.

The climate data used was the Northern and Yorke climate template, as recommended in *South Australian MUSIC Guidelines* (Water Sensitive South Australia, 2021). This data was captured in Roseworthy between 2001 and 2010, during which time the mean annual rainfall was 404 mm. No climate change assumption has been applied in any scenario in line with the specifications of the brief.

3.3 Stormwater Infrastructure Hydraulic Performance

3.3.1 Background

The hydraulic performance of the stormwater network has been modelled across the required range of events and scenarios listed above. The development of the hydrological and hydraulic models has been documented in *Georgetown Stormwater Management Plan Modelling Report* (Southfront, 2025). The list of deficiencies considered includes over floor flooding (discussed in Section 3.5), high or extreme flood hazard, low freeboard or upwelling in the minor network, stormwater inlet capacity and excessive gutter flow depths or flow widths.

3.3.2 High/Extreme Flood Hazard

Flood hazard is defined by the Australian Institute for Disaster Resilience's Flood Hazard Guideline 7-3 (AIDR, 2017) as a relationship between water depth and velocity. This definition breaks hazard into 6 categories, ranging from lower hazard at H1 through to maximum hazard at H6, as shown in Figure 3.1 below.

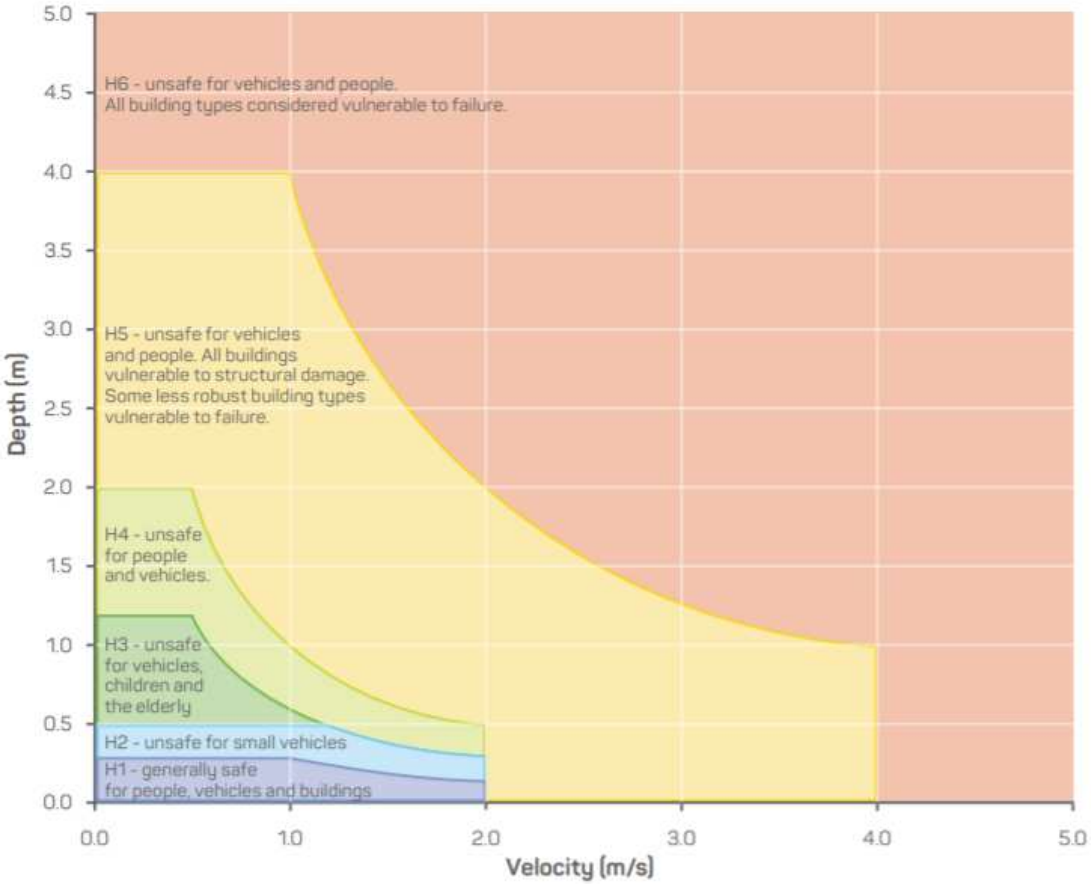


Figure 3.1 Flood Hazard Classification

For this assessment, high flood hazard is defined as category H3 or H4, while extreme flood hazard is defined as category H5 or H6. High and extreme flood hazard within the major watercourses has been ignored for this assessment, and instead flood hazard on roads and through developed land has been considered.

3.3.3 Low Freeboard and Upwelling

The results of the hydraulic modelling have been inspected to determine the maximum HGL level experienced at each stormwater inlet for each AEP. These levels were compared with the node surface level and the level 150 mm below the surface, and when these were exceeded the pit was considered to have upwelled or had insufficient freeboard respectively.

3.3.4 Stormwater Inlet Capacity

An assessment of inlet capacity was undertaken for the stormwater pits in the study area. The capture capacity of each pit was calculated with reference to *SA Road Stormwater Drainage Inlets: Hydraulic Study* (Urban Water Resources Centre). This study examined the performance of the most common stormwater drainage inlets used throughout South Australia, and produced curves relating approach flow with capture flow. Curves for standard side entry pits

have been taken from the City of Charles Sturt pits, while curves for double side entry pits were taken from the City of West Torrens pits.

The peak flow rate approaching each stormwater pit in the 18% AEP storm event was compared with the calculated pit capture capacity, highlighting locations where stormwater pits are undersized relative to their contributing catchment.

3.3.5 Gutter Flow Depth and Flow Width

An assessment was undertaken to determine excessive gutter flow depths and widths in the 18% AEP flood based on flood mapping results. Excessive gutter flow depths have been defined as flooding greater than 100 mm deep in the 18% AEP flood, while excessive gutter flow widths have been defined as flooding greater than 2.5 m wide in the 18% AEP flood.

3.3.6 Hydraulic Performance Assessment

Table 3.1 below presents the various identified stormwater issues in an impact register, providing an ID and a location, describing the type of deficiency, listing the AEP at which the deficiency occurs and providing any additional comments.

Table 3.1 Scenario A Flood Impact Register

ID	Location	Type of Deficiency	AEP Occurring	Comment
1	Lang Road	High/Extreme Flood Hazard	18% AEP/ 2% AEP	Yackamoorundie Creek spills across road
2	Georgetown Bowling Club	High Flood Hazard	10% AEP	
3	Lehmann Road	High/Extreme Flood Hazard	5% AEP/ 2% AEP	Yackamoorundie Creek spills across road
4	Caltowie-Georgetown Road	High Flood Hazard	2% AEP	Channel spills across Road
5	Georgetown-Narridy Road	High/Extreme Flood Hazard	2% AEP/ 1% AEP	
6	Properties between Fisher Street and Hurtle Street north of Pitts Street	High Flood Hazard	1% AEP	
7	Stormwater Inlet on southwestern corner of intersection of James Street and Fisher Street	Low Freeboard	18% AEP	
		Inlet Capacity	18% AEP	
8	Stormwater Inlet on northwestern corner of intersection of James Street and Fisher Street	Inlet Capacity	18% AEP	
9	Pitts Street between West Terrace and Fisher	Gutter Flow Depth/Width	18% AEP	

ID	Location	Type of Deficiency	AEP Occurring	Comment
	Street			
10	Hurtle Street north of Pitts Street	Gutter Flow Depth/Width	18% AEP	
11	Fisher Street between North Terrace and James Street	Gutter Flow Depth/Width	18% AEP	
12	West Terrace between Pitts Street and James Street	Gutter Flow Depth/Width	18% AEP	
13	Corner of Hurtle Street and James Street	Gutter Flow Depth/Width	18% AEP	
14	James Street between Hurtle Street and Fisher Street	Gutter Flow Depth/Width	18% AEP	
15	Pitts Street between Fisher Street and Charles Street	Gutter Flow Depth/Width	18% AEP	

The various identified stormwater deficiencies are also presented in Figure 3.2. Locations of high or extreme hazard were typically found where the Yackamoorundie Creek or other watercourse channels spilled across roads. There was only limited high or extreme flood hazard through private property, starting in the 1% AEP flood event. Low freeboard was an issue at one of the two stormwater inlets, while both suffered from insufficient inlet capacity. Excessive gutter flows were experienced throughout the town, resulting from the flow pathway from the catchments west of Georgetown.

The Scenario A flood impact register was then updated to reflect the flooding observed in Scenario B, and is presented in Table 3.2 below and shown in Figure 3.2.

Table 3.2 Scenario B Flood Impact Register

ID	Location	Type of Deficiency	AEP Occurring	Comment
1	Lang Road	High/Extreme Flood Hazard	18% AEP/ 5% AEP	Yackamoorundie Creek spills across road
2	Georgetown Bowling Club	High Flood Hazard	10% AEP	
3	Lehmann Road	High/Extreme Flood Hazard	10% AEP/ 5% AEP	Yackamoorundie Creek spills across road
4	Caltowie-Georgetown Road	High/Extreme Flood Hazard	5% AEP/ 0.2% AEP	Channel spills across Road
5	Georgetown-Narridy Road	High/Extreme Flood Hazard	5% AEP/ 2% AEP	

ID	Location	Type of Deficiency	AEP Occurring	Comment
6	Properties between Fisher Street and Hurtle Street north of Pitts Street	High Flood Hazard	2% AEP	
7	Stormwater Inlet on southwestern corner of intersection of James Street and Fisher Street	Low Freeboard	18% AEP	
		Inlet Capacity	18% AEP	
8	Stormwater Inlet on northwestern corner of intersection of James Street and Fisher Street	Inlet Capacity	18% AEP	
9	Pitts Street between West Terrace and Fisher Street	Gutter Flow Depth/Width	18% AEP	
10	Hurtle Street north of Pitts Street	Gutter Flow Depth/Width	18% AEP	
11	Fisher Street between North Terrace and James Street	Gutter Flow Depth/Width	18% AEP	
12	West Terrace between Pitts Street and James Street	Gutter Flow Depth/Width	18% AEP	
13	Corner of Hurtle Street and James Street	Gutter Flow Depth/Width	18% AEP	
14	James Street between Hurtle Street and Fisher Street	Gutter Flow Depth/Width	18% AEP	
15	Pitts Street between Fisher Street and Charles Street	Gutter Flow Depth/Width	18% AEP	

The table demonstrates the impact of climate change and development on flooding throughout Georgetown. Several locations with identified high or extreme flood hazard in Scenario A occur in a more frequent storm in Scenario B, demonstrating the impact of the increased flows as a result of future conditions.

3.3.7 Watercourse Peak Flows

Peak flow rates at key locations along Yackamoorundie Creek and the unnamed watercourses to the west of Georgetown have been determined for the 18% AEP and 1% AEP flood events, for both Scenario A and Scenario B, and are presented in Table 3.3 below. These locations have also been marked on the 18% AEP and 1% AEP flood maps alongside critical duration information.

Table 3.3 Peak Watercourse Flow Rates (m^3/s)

Watercourse	Location	Scenario A		Scenario B	
		18% AEP	1% AEP	18% AEP	1% AEP
Yackamoorundie Creek	Lehmann Road	21.6	160.9	28.0	196.5
Yackamoorundie Creek	Lang Road	23.3	191.1	29.7	238.4
Unnamed	Brogan Road	1.9	6.8	2.1	7.5
Unnamed	Georgetown-Narridy Road	3.0	9.3	3.3	10.1



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Data Sources:
Southfront (Flood Impacts)
Northern Areas Council (Aerial Photography)
Data SA (State Maintained Roads, Watercourses)

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FIGURE 3.2 - FLOOD IMPACTS LOCATION MAP

3.4 Flood Impacts and Characteristics

Flood and hazard maps for the required scenarios and AEPs have been prepared and are attached in Appendix B and Appendix C for Scenario A and in Appendix D and Appendix E for Scenario B. The flood and hazard maps have been reviewed to determine a range of flood impacts and characteristics within the study area. These maps highlight areas where life and property may be in a danger in a given flood, and show key vulnerabilities throughout the study area. General commentary on key flow pathways, high risk locations and other relevant points has been provided for Scenario A for the range of AEP events. It should be noted that surveyed floor levels were unavailable, and therefore it was uncertain if individual dwellings were inundated.

18% AEP Flood Event

Flooding in the 18% AEP event has a significant impact on Georgetown and the surrounding roads. There is widespread property inundation ranging in depth from shallow to over 250 mm deep along Pitts Street and Fisher Street as the channels flowing from west of Georgetown exceed their capacities and spill towards Yackamoorundie Creek. There is shallow flooding through the CFS site to depths of over 100 mm.

Within Georgetown, shallow water less than 100 mm deep flowed across Fisher Street between Pitt Street and James Street, affecting a length of road of over 70 m. There is flooding over 250 mm deep across Caltowie-Georgetown Road to the east of town as the wide floodplain flows south, and flooding over 100 mm deep across Lehmann Road where Yackamoorundie Creek crosses the road. There is shallow ponding of under 100 mm deep over Horrocks Highway at the intersection with Lang Road. Flood depths along Lang Road exceed 500 mm as Yackamoorundie Creek spills across the road. Flood behaviour north of Lang Road appears to be affected by crop rows planted in the field, restricting the movement of water overland.

10% AEP Flood Event

Flood behaviour in the 10% AEP event is largely similar to the 18% event, with increased extent and depths. The flow pathway through the town has increased, with more properties flooded over 250 mm deep. The magnitude of flooding at the CFS site has increased slightly.

Within Georgetown, shallow water less than 100 mm deep flowed across Fisher Street between North Terrace and James Street, affecting a length of road of over 80 m. There is flooding over 250 mm deep across Caltowie-Georgetown Road to the east of town as the wide floodplain flows south, and flooding over 250 mm deep across Lehmann Road where Yackamoorundie Creek crosses the road. There is shallow ponding of under 100 mm deep over Horrocks Highway at the intersection with Lang Road. Flood depths along Lang Road exceed 500 mm as Yackamoorundie Creek spills across the road.

5% AEP Flood Event

Flood behaviour in the 5% AEP event is again similar to smaller events, with increased flood extent and depths throughout the study area. The flow pathway through Georgetown has worsened, affecting many properties to depths of over 100 mm and some to over 250 mm. The CFS site is flooded over 100 mm deep throughout most of the land.

Within Georgetown, shallow water less than 100 mm deep flowed across Fisher Street between North Terrace and James Street, affecting a length of road of over 180 m. There is flooding over 250 mm deep across Caltowie-Georgetown Road to the east of town as the wide floodplain flows south, and flooding over 250 mm deep across Lehmann Road where Yackamoorundie Creek crosses the road. There is shallow ponding of under 100 mm deep over Horrocks Highway

at the intersection with Lang Road. Flood depths along Lang Road exceed 1 m as Yackamoorundie Creek spills across the road.

2% AEP Flood Event
Flood behaviour in the 2% AEP event is similar to smaller events, with increased flood extent and depths throughout the study area. The flow pathway through Georgetown has worsened, spreading further north through properties near North Terrace. Practically the whole CFS site is flooded over 100 mm deep.

Within Georgetown, water over 100 mm deep flowed across Fisher Street between North Terrace and James Street, affecting a length of road of over 300 m. There is flooding over 500 mm deep across Caltowie-Georgetown Road to the east of town as the wide floodplain flows south, and flooding over 500 mm deep across Lehmann Road where Yackamoorundie Creek crosses the road. There is shallow ponding of under 100 mm deep over Horrocks Highway at the intersection with Lang Road and again just north of this intersection. Flood depths along Lang Road exceed 1 m as Yackamoorundie Creek spills across the road.

1% AEP Flood Event
Flood behaviour in the 1% AEP event is similar to smaller events, with increased flood extent and depths throughout the study area. The flow pathway through Georgetown has worsened, now flooding more properties to over 100 mm deep and reaching over 500 mm deep at the deepest locations. The dam near the oval on School Road spills, contributing to a flow pathway through to Hurtle Street. Practically the whole CFS site is flooded over 100 mm deep.

Within Georgetown, water over 100 mm deep flowed across Fisher Street between North Terrace and James Street, affecting a length of road of over 310 m. There is flooding over 500 mm deep across Caltowie-Georgetown Road to the east of town as the wide floodplain flows south, and flooding over 500 mm deep across Lehmann Road where Yackamoorundie Creek crosses the road. There is shallow ponding of under 100 mm deep over Horrocks Highway at the intersection with Lang Road and again just north of this intersection. Flood depths along Lang Road exceed 1 m as Yackamoorundie Creek spills across the road.

0.2% AEP Flood Event
Flood behaviour in the 0.2% AEP event is similar to smaller events, with significantly increased flood extent and depths throughout the study area. The flow pathway through Georgetown has substantially worsened, causing widespread property inundation over 250 mm deep and reaching over 500 mm deep in several areas. The spill from the dam has substantially increased, contributing to a flow pathway reaching depths of over 250 mm through to Hurtle Street. Depths through the CFS site exceed 100 mm and reach over 250 mm at the deepest spots.

Within Georgetown, water over 100 mm deep for extended lengths flowed across Fisher Street between North Terrace and James Street, affecting a length of road of over 380 m. There is flooding over 500 mm deep across Caltowie-Georgetown Road to the east of town as the wide floodplain flows south, and flooding over 500 mm deep across Lehmann Road where Yackamoorundie Creek crosses the road. There is shallow ponding of under 100 mm deep over Horrocks Highway at the intersection with Lang Road and again just north of this intersection. Flood depths along Lang Road exceed 1 m as Yackamoorundie Creek spills across the road.

Impact of Climate Change and Future Development
In general, climate change and future development have increased the flood risk facing Georgetown. Increased rainfall associated with climate change has resulted in significantly

larger flows in Yackamoorundie Creek and the various smaller watercourses, exacerbating the extent of flooding observed across all AEPs. Future development has had a comparatively smaller impact on flooding, with the impacts centralised on the township.

3.5 Flood Damages

3.5.1 Background

Estimates of flood damages provide important information that can be used to prioritise flood mitigation works. Flood damages are typically split into the following categories:

- Direct tangible damages, which includes material damage caused by the flood;
- Indirect tangible damages, which mostly consists of damages caused by disruptions due to the flood;
- Direct intangible damages, which considers direct damages that cannot be objectively quantified; and
- Indirect intangible damages, which considers indirect damages that cannot be objectively quantified.

Estimating intangible damages is difficult, and minimal guidance is available for these categories, and therefore they have not been included. However, similar studies have noted that these damages may match or even exceed the tangible damage cost. Flood damages have been calculated for all modelled scenarios across all modelled AEPs.

The adopted methodology also does not consider the following items:

- Damage to public infrastructure
- Damage to crops and stock losses
- Damage to vehicles

3.5.2 Evaluation Approach

Direct tangible flood damages have been estimated with reference to the Investment Framework For the Economics of Water Sensitive Cities (INFFEWS) Value Tool, developed by the Cooperative Research Centre for Water Sensitive Cities (CRCWSC). The INFFEWS is a package of tools and documents for economic analysis of urban water and green infrastructure projects. The INFFEWS Value Tool is designed to assist users to estimate non-market values for the benefits arising from these projects.

INFFEWS provides stage-damage curves for a range of residential and commercial buildings which have been used to estimate flood damages. These curves were developed for the *Brisbane River Strategic Floodplain Management Plan* (State of Queensland, 2018) in 2018, and are based on a survey undertaken to determine stage-damage curves for properties affected by the Brisbane River flooding in late 2010 to early 2011. The stage-damage curves have been adjusted to account for inflation since the development of the curves.

As the stage-damage curves used were developed for the *Brisbane River Strategic Floodplain Management Plan*, this means they are based on properties in and around Brisbane. To account for this, the curves have been adjusted to suit Georgetown based on information from *Rawlinsons Australian Construction Handbook* (Rawlinsons, 2022). This document provides costs for various building types in the major cities, and regional index maps which provide an expected increase in cost associated with distance from the major city. The stage-damage

curves from INFFEWS were scaled by the difference in costs between Brisbane and Adelaide, and then increased by 10% according to the regional index.

Indirect tangible damages have been estimated as 15% of the direct tangible damages for residential buildings, and 55% of the direct tangible damages for commercial and industrial buildings, in line with recommendations of *INFFEWS Value Tool: Guidelines (Version 4)* (Iftekhar, Gunawardena, Fogarty, Pannell, & Rogers, 2022).

Residential Properties

Residential stage-damage curves are provided for three building sizes, small (<140 m²), medium (140-210 m²) and large (>210 m²). To determine an appropriate building size to use, an analysis of residential building sizes was undertaken. The sample-sub areas developed to determine subcatchment runoff coefficients for the DRAINS model were used, as these were considered representative of urban development in the study area. Building sizes within the sub-areas were determined, as summarised in Table 3.4.

Table 3.4 Residential Building Size Analysis

Sample Sub-Area	Average Building Size (m²)
Fisher Street / Pitts Street	215.7

As can be seen, the sub-area had an average residential building size of over 210 m². Therefore, direct tangible flood damages for residential properties were calculated using the stage-damage curves for 'large' residential properties, as this was considered a suitable representation of the residential properties throughout the study area.

For each building size, stage-damage curves are provided for six different house types:

- Fully detached single storey (slab on the ground);
- Fully detached single storey (on stumps);
- Fully detached single storey (highset);
- Fully detached double storey;
- Multi-unit single storey; and
- Multi-unit double storey.

Given the lack of available house type information, all residential properties were assumed to be fully detached single storey houses with a slab on the ground. This is broadly consistent with site visit observations during the project.

For residential properties, INFFEWS provides three separate stage-damage curves, representing internal damage, structural damage and external damage. Internal damage refers to the damage to the contents of the main building of a property, and includes furniture, appliances and other internal contents. Structural damage refers to the damage sustained by the fabric of a building, and includes foundations, floors, walls, doors and permanently fixed objects such as cupboard and benches. External damage refers to damage to objects outside of the main building such as cars, fences, gardens and sheds.

The total residential damage to each property was determined by summing the values of the three curves at the corresponding flood depth range as determined in the TUFLOW model. The

flood depth used for each property has been taken at the location of the dwelling. For allotments with no building, no flood damage has been calculated as the curves primarily consider structural damage associated with a building. Where a curve did not have a damage value for a required flood depth, it has been linearly interpolated from the surrounding values. Table 3.5 below shows the adopted residential stage-damage curve.

Table 3.5 Residential Stage-Damage Curve

Flood Depth Range (m)	Flood Damage Cost
0-0.15	0
0.15-0.25	$94,895
0.25-0.5	$212,876
0.5-1.0	$285,720
1.0-1.5	$314,260
1.5-2.5	$374,673
2.5-5.0	$388,780

The flood damage curves provided by INFFEWS start at floor level, and therefore when an assumed 150 mm slab height is factored in, the curves show no damage for the first 150 mm. The curves show that flooding of just 100 mm above the floor can have a substantial cost, with damage increasing to almost $400,000 for flooding over 2.5 m deep.

Commercial Buildings

Stage-damage curves for commercial buildings are provided for three building sizes, small (<186 m²), medium (186-650 m²) and large (>650 m²). Given the lack of building footprint information, it has been assumed that all commercial buildings are 'medium' in size due to the wide range of building sizes that would fit into this category.

For each building size, stage-damage curves have been provided for five 'value classes', which classify the relative value of the type of business being flooded. These are summarised in Table 3.6 below.

Table 3.6 Commercial Building Value Classes

Value Class	Example Businesses
VC1 (Very Low)	Florists, Garden Centres, Vehicle Sales Areas, Schools, Churches
VC2 (Low)	Offices, Cafes, Restaurants, Service Stations, Pubs, Clubs
VC3 (Medium)	Chemists, Musical Instruments, Printing, Clothing
VC4 (High)	Bottle Shops, Cameras
VC5 (Very High)	Pharmaceuticals, Electronics

For the purposes of flood damage estimation, it has been assumed that all commercial buildings are Value Class 2 (Low). This was considered a reasonable assumption as the majority of commercial businesses could be considered either Value Class 1 or Value Class 2. The adopted commercial stage-damage curve is shown in Table 3.7 below.

Table 3.7 Commercial Stage-Damage Curve

Flood Depth Range (m)	Flood Damage Cost
0-0.1	$54,682
0.1-0.15	$74,547
0.15-0.25	$116,988
0.25-0.5	$168,860
0.5-1.0	$270,857
1.0-1.5	$346,836
1.5-2.5	$407,868
2.5-5.0	$438,097

Unlike residential properties, the stage-damage curve for commercial properties shows significant costs even for flooding below 150 mm, as it is assumed the floor level for these properties is at ground level. Compared to the residential stage-damage curves, the damage for commercial flooding is much greater at smaller depths, lower at moderate depths and greater at higher depths.

Industrial Buildings
No industrial buildings were identified within the Georgetown SMP study area.

Limitations of Approach
The adopted approach comes with several limitations which affect the accuracy of the results, however it has been successfully adopted in previous flood studies. Key limitations of the method are discussed below.

A single damage curve has been adopted for each of residential, commercial and industrial building types. Not all properties are the same, and these curves attempt to represent the average property of each type. It is likely that a more in-depth, nuanced investigation to develop multiple curves based on property size and value would provide more accurate results.

All commercial buildings have been assumed to be of the same value class. As discussed, the value class describes the relative value of a commercial building, and there is quite a substantial difference between the lower and higher classes. Value Class 2 was adopted for all commercial buildings as this value class was thought to best represent the typical commercial buildings in the study area, however a more thorough investigation would likely result in more accurate damages.

The damage estimates prepared with this approach consider only structural damage to buildings and their surroundings, and not damages to public assets such as roads and open space features. This has the effect of producing lower benefit-cost ratios than would be determined if these assets were monetised. However research on determining flood damages for public assets is comparatively underdeveloped, with INFFEWS providing no guidance in this area, and therefore this approach was considered suitable.

The adopted damage curves for this study are based on curves developed for Brisbane that have been scaled according to property prices in Adelaide, factored to account for the distance from

Adelaide and finally factored once more to bring the curves to the current year. In reality, the damage curves for a property in Georgetown would be significantly different to those for a property in Brisbane, and this has not been accounted for with the adopted approach. However there is minimal guidance available for calculating flood damages, and the adopted methodology was considered the best available information at the time of the study.

3.5.3 Scenario A Flood Damages

Number of Properties Affected

Flood levels within each allotment were determined from the flood grids produced by the TUFLOW model, and these have been used to determine the number of affected properties in Scenario A. Table 3.8 below summarises the total number of properties affected by each stage-damage curve range for all modelled AEPs.

Table 3.8 Scenario A Inundated Properties by Flood Depth

Flood Depth Range (m)	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
0-0.1	22	24	31	34	31	27
0.1-0.15	4	8	9	11	8	10
0.15-0.25	1	3	7	10	18	17
0.25-0.5	0	0	0	2	2	11
0.5-1.0	0	0	0	0	0	0
1.0-1.5	0	0	0	0	0	0
1.5-2.5	0	0	0	0	0	0
2.5-5.0	0	0	0	0	0	0
Total	27	35	47	57	59	65

The table shows a steady increase in the number of affected properties as the flood severity increases, with the largest change occurring between the 10% AEP and 5% AEP floods. Overall the depth of property flooding is relatively shallow, remaining below 250 mm up until the 2% AEP flood and below 500 mm in all modelled AEPs.

Table 3.9 below categorises the affected properties by land use, being residential, commercial and industrial.

Table 3.9 Scenario A Inundated Properties by Land Use

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	21	24	34	44	46	51
Commercial	6	11	13	13	13	14
Industrial	0	0	0	0	0	0
Total	27	35	47	57	59	65

Residential land use makes up the vast majority of affected property, followed by commercial. There was no land classified as industrial within the study area.

Direct Tangible Flood Damages
Direct tangible flood damages for Scenario A have been estimated. The flood level determined for each property was compared with the appropriate stage-damage curve to determine a damage cost for each property, and these have been summed across the study area. Table 3.10 below shows the resulting flood damage by land use as well as the total flood damage for the range of modelled AEPs.

Table 3.10 Scenario A Direct Tangible Flood Damages

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.1m	$0.2m	$0.4m	$1.1m	$1.6m	$2.8m
Commercial	$0.4m	$0.7m	$0.9m	$1.0m	$1.1m	$1.5m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m
Total	$0.5m	$0.9m	$1.3m	$2.0m	$2.7m	$4.3m

Although many residential properties were considered flood-affected in the 18% AEP, 10% AEP and 5% AEP events, because for most of these the water depth was below 150 mm this has resulted in a relatively low direct tangible flood damage. Damages can be seen to increase gradually with increasing AEP as would be expected.

Indirect Tangible Flood Damages
As discussed, INFFEWS recommends indirect tangible flood damages of 15% for residential buildings and 55% for commercial and industrial buildings. This results in the total tangible flood damages summarised in Table 3.11.

Table 3.11 Scenario A Total Tangible Flood Damages

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.1m	$0.2m	$0.4m	$1.3m	$1.8m	$3.3m
Commercial	$0.6m	$1.1m	$1.5m	$1.5m	$1.7m	$2.3m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m
Total	$0.7m	$1.3m	$1.9m	$2.7m	$3.5m	$5.6m

Average Annual Damages
An average annual damage value, representing the damage that would occur in any given year if flood damages from all AEPs were spread out equally over time, was calculated for the study area, giving a value of $327,883.

3.5.4 Scenario B Flood Damages

Number of Properties Affected
Flood levels within each property were determined from the flood grids produced by the TUFLOW model, and these have been used to determine the number of affected properties in

Scenario B. Table 3.12 below summarises the total number of properties affected by each stage-damage curve range for all modelled AEPs.

Table 3.12 Scenario B Inundated Properties by Flood Depth

Flood Depth Range (m)	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
0-0.1	25	25	31	32	28	28
0.1-0.15	4	10	7	10	10	10
0.15-0.25	3	3	10	15	19	18
0.25-0.5	0	0	1	2	3	13
0.5-1.0	0	0	0	0	0	0
1.0-1.5	0	0	0	0	0	0
1.5-2.5	0	0	0	0	0	0
2.5-5.0	0	0	0	0	0	0
Total	32	38	49	59	60	69
Change from Scenario A	+19%	+9%	+4%	+4%	+2%	+6%

Like in Scenario A, the number of inundated properties was found to steadily increase with AEP in Scenario B. Climate change causes a relatively small number of additional properties to be affected, with the largest impacts occurring in the 18% AEP and 10% AEP floods. Although the overall number of affected properties has not substantially changed, future conditions resulted in additional properties being flooded to a deeper depth.

Table 3.13 below categorises the affected properties by land use.

Table 3.13 Scenario B Inundated Properties by Land Use

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	24	27	36	46	46	55
Commercial	8	11	13	13	14	14
Industrial	0	0	0	0	0	0
Total	32	38	49	59	60	69

The distribution of land use in the affected properties was found to be very similar to that of Scenario A.

Direct Tangible Flood Damages

Direct tangible flood damages for Scenario B have been estimated. The flood level determined for each property was compared with the appropriate stage-damage curve to determine a damage cost for each property, and these have been summed across the study area. Table 3.14 below shows the resulting flood damage by land use as well as the total flood damage for the range of modelled AEPs.

Table 3.14 Scenario B Direct Tangible Flood Damages

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.2m	$0.2m	$0.9m	$1.3m	$1.9m	$3.1m
Commercial	$0.5m	$0.7m	$1.0m	$1.1m	$1.2m	$1.7m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m
Total	$0.7m	$0.9m	$1.8m	$2.4m	$3.1m	$4.7m

Compared to Scenario A, flood damage has increased in all modelled AEPs except the 10% AEP, with the most significant increases coming from the 5% AEP and 2% AEP floods. While more properties were flooded in the Scenario B 10% AEP flood than in Scenario A, these properties were residential and flooded under 150 mm deep and therefore were assigned a damage value of zero.

Indirect Tangible Flood Damages

As discussed, INFFEWS recommends indirect tangible flood damages of 15% for residential buildings and 55% for commercial and industrial buildings. This results in the total tangible flood damages summarised in Table 3.15.

Table 3.15 Scenario B Total Tangible Flood Damages

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.2m	$0.2m	$1.0m	$1.5m	$2.2m	$3.5m
Commercial	$0.8m	$1.1m	$1.5m	$1.7m	$1.9m	$2.6m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m
Total	$1.0m	$1.3m	$2.5m	$3.2m	$4.0m	$6.1m

Average Annual Damages

The resulting average annual damages value was found to be $386,195, which is an 18% increase from the Scenario A value.

3.6 Water Quality Performance

3.6.1 Background

Details of the water quality modelling work undertaken for this assessment, including software selection, determination of key input parameters and model configuration, are provided in the modelling report. Key results from the water quality modelling are presented below for the required locations across the range of required water quality scenarios.

3.6.2 Scenario 1 Water Quality Modelling

Scenario 1 consists of existing development with no WSUD infrastructure. A summary of the average annual pollutant loads and stormwater runoff generated by the urban catchment in Scenario 1 is provided in Table 3.16 below.

Table 3.16 Scenario 1 Urban Catchment Pollutant Loads

Parameter	Pollutant Load

Flow (ML/yr)	34.1
Total Suspended Solids (kg/yr)	4,970
Total Phosphorous (kg/yr)	11.7
Total Nitrogen (kg/yr)	90.8
Gross Pollutants (kg/yr)	409

3.6.3 Scenario 2 Water Quality Modelling

Scenario 2 consists of future development with no WSUD infrastructure. Table 3.17 provides the annual pollutant loads generated by the urban catchment for Scenario 2, which considers future development of the study area.

Table 3.17 Scenario 2 Urban Catchment Pollutant Loads

Parameter	Pollutant Load
Flow (ML/yr)	35.7
Total Suspended Solids (kg/yr)	5,430
Total Phosphorous (kg/yr)	12.3
Total Nitrogen (kg/yr)	95.9
Gross Pollutants (kg/yr)	521

3.6.4 Scenario 3 Water Quality Modelling

Scenario 3 consists of future development with existing WSUD infrastructure. As no existing WSUD infrastructure within the study area was identified, the results from Scenario 3 are equal to those of Scenario 2.

3.7 Risk Assessment

The flood impacts registers presented in Section 3.3 have been expanded to form risk registers. Risk registers have been prepared for Scenario A and Scenario B, identifying the flooding hotspots which are most affected by future development and climate change.

In the preparation of the risk registers, a risk classification framework has been developed with reference to Council's Risk Management Plan, which considers the following categories:

- General
- Flooding
- Health & Safety
- Cost
- Environmental
- Social/Stakeholder

Traditionally risk is defined as a combination of likelihood and consequence. However, given that likelihood and consequence are inherently related for flooding, with less frequent events having a larger impact than more frequent events, it was necessary to define risk in relation to consequence. Table 3.18 below shows the adopted relationship between consequence and risk, with the full risk consequence matrix including definitions provided in Appendix A.

Table 3.18 Adopted Consequence Risk Relationship

Consequence Level	Risk Definition
1 Insignificant	Low
2 Minor	Moderate
3 Moderate	High
4 Major	Extreme
5 Catastrophic	Extreme

The flood impact registers developed in Section 3.3 have been expanded upon to consider the type of risks and the level of consequence associated with each flood hotspot, and are attached below as Table 3.19 for Scenario A and Table 3.20 for Scenario B. The consequence level adopted represents the greatest impact experienced across the various risk categories.

Table 3.19 - Scenario A Flood Risk Register

ID	Location	Type of Deficiency	1% AEP Impact Details	Risk Category	Consequence	Risk
1	Lang Road	High/Extreme Flood Hazard	Flooding over 1000mm deep across the road	Flooding, Health & Safety	3	High
2	Georgetown Bowling Club	High Flood Hazard	Flooding over 500 mm deep through bowling club field, 250 mm deep through surrounding properties	Flooding, Health & Safety, Social/Stakeholder	3	High
3	Lehmann Road	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
4	Caltowie-Georgetown Road	High Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
5	Georgetown-Narridy Road	High/Extreme Flood Hazard	Shallow flooding across the road	Flooding, Health & Safety	1	Low
6	Properties between Fisher Street and Hurtle Street north of Pitts	High Flood Hazard	Widespread property flooding over 250 mm deep, reaching over 500 mm	Flooding, Health & Safety, Social/Stakeholder	3	High
7	Stormwater Inlet on southwestern corner of	Low Freeboard, Inlet Capacity	Ponding over 250 mm deep along road	Flooding	1	Low
8	Stormwater Inlet on northwestern corner of	Inlet Capacity	Ponding over 500 mm deep along road	Flooding	2	Moderate
9	Pitts Street between West Terrace and Fisher Street	Gutter Flow Depth/Width	Flow pathway over 250 mm deep along road	Flooding	1	Low
10	Hurtle Street north of Pitts Street	Gutter Flow Depth/Width	Flow pathway over 250 mm deep along road	Flooding	1	Low
11	Fisher Street between North Terrace and James Street	Gutter Flow Depth/Width	Ponding over 250 mm deep along road	Flooding	1	Low
12	West Terrace between Pitts Street and James Street	Gutter Flow Depth/Width	Flow pathway over 250 mm deep along road	Flooding	1	Low
13	Corner of Hurtle Street and James Street	Gutter Flow Depth/Width	Ponding over 250 mm deep along road	Flooding	1	Low
14	James Street between Hurtle Street and Fisher Street	Gutter Flow Depth/Width	Flow pathway over 100 mm deep along road	Flooding	1	Low
15	Pitts Street between Fisher Street and Charles Street	Gutter Flow Depth/Width	Flow pathway over 100 mm deep along road	Flooding	1	Low

Table 3.20 - Scenario B Flood Risk Register

ID	Location	Type of Deficiency	1% AEP Impact Details	Risk Category	Consequence	Risk
1	Lang Road	High/Extreme Flood Hazard	Flooding over 1000mm deep across the road	Flooding, Health & Safety	3	High
2	Georgetown Bowling Club	High Flood Hazard	Flooding over 500 mm deep through bowling club field, 250 mm deep through surrounding properties	Flooding, Health & Safety, Social/Stakeholder	3	High
3	Lehmann Road	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
4	Caltowie-Georgetown Road	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
5	Georgetown-Narridy Road	High/Extreme Flood Hazard	Shallow flooding across the road	Flooding, Health & Safety	1	Low
6	Properties between Fisher Street and Hurtle Street north of Pitts	High Flood Hazard	Widespread property flooding over 250 mm deep, reaching over 500 mm	Flooding, Health & Safety, Social/Stakeholder	3	High
7	Stormwater Inlet on southwestern corner of	Low Freeboard, Inlet Capacity	Ponding over 250 mm deep along road	Flooding	1	Low
8	Stormwater Inlet on northwestern corner of	Inlet Capacity	Ponding over 500 mm deep along road	Flooding	2	Moderate
9	Pitts Street between West Terrace and Fisher Street	Gutter Flow Depth/Width	Flow pathway over 250 mm deep along road	Flooding	1	Low
10	Hurtle Street north of Pitts Street	Gutter Flow Depth/Width	Flow pathway over 250 mm deep along road	Flooding	1	Low
11	Fisher Street between North Terrace and James Street	Gutter Flow Depth/Width	Ponding over 250 mm deep along road	Flooding	1	Low
12	West Terrace between Pitts Street and James Street	Gutter Flow Depth/Width	Flow pathway over 250 mm deep along road	Flooding	1	Low
13	Corner of Hurtle Street and James Street	Gutter Flow Depth/Width	Ponding over 250 mm deep along road	Flooding	1	Low
14	James Street between Hurtle Street and Fisher Street	Gutter Flow Depth/Width	Flow pathway over 100 mm deep along road	Flooding	1	Low
15	Pitts Street between Fisher Street and Charles Street	Gutter Flow Depth/Width	Flow pathway over 100 mm deep along road	Flooding	1	Low

4 Stormwater Management Objectives and Targets

4.1 Introduction

The stormwater management objectives and targets adopted for this Stormwater Management Plan have been developed with reference to the recommendations of several government departments including the Stormwater Management Authority, the Department for Environment and Water and the Northern and Yorke Landscape Board. While documents from these entities formed the basis of the objectives and targets, they have been adjusted based on the community values determined during community consultation, ensuring they are relevant to the local context.

4.2 Stormwater Management Authority Guidelines

When developing a catchment-based Stormwater Management Plan, it is required to identify specific and measurable objectives and targets that are relevant to the local context. The *Stormwater Management Planning Guidelines* (Stormwater Management Authority, 2007) stipulates that:

As a minimum, the 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; and*
- *Sustainable management of stormwater infrastructure, including maintenance.*

The objectives and targets developed for this SMP will address the above criteria, and be classified as either absolute or aspirational, with the performance required tailored to suit the local context and community expectations.

4.3 Northern and Yorke Landscape Plan

The *Northern and Yorke Landscape Plan 2021-26* (Northern and Yorke Landscape Board, 2021) was developed in partnership with the community and key stakeholders following extensive consultation undertaken over a ten year time frame. The plan seeks to inspire, educate and work with the community to sustainably manage natural resources in the region.

The plan has identified 5 priorities to address over the 5 year period ending in 2026, being communities, biodiversity, water management, sustainable agriculture and pest plant and animal control. The priorities most relevant to the management of stormwater are biodiversity and water management, with the key focus areas summarised in Table 4.1.

Table 4.1 Northern and Yorke Landscape Plan Priorities

Priority	Focus Areas
Biodiversity	Coordinate programs to improve climate change resilience and adaptive capacity. Improve ecosystems through conservation and restoration.
Water management	Sustainably manage the region's prescribed water resources. Protect and rehabilitate watercourses and wetlands. Promote the sustainable use of water for environmental, cultural, social and industry outcomes.

The above priorities have been considered in the development of the Stormwater Management Plan Objectives and Targets, ensuring the outcomes of the plan align with the goals of the Northern and Yorke Landscape Board.

The plan also references *Conservation Action Planning Summary: Mid North Agricultural Districts* (Berkinshaw & McGregor, 2016), which lists objectives for the conservation of assets in the Mid North Agricultural Districts. Those relating to the management of stormwater are summarised in Table 4.2 below.

Table 4.2 Mid North Agricultural Districts Conservation Objectives

Asset	Objective
Rivers, Creeks and Waterhole Assets	By 2030, critical threats to high priority river reaches are strategically managed and abated across all catchments to maintain and improve condition. By 2030, maintain viable populations and sustainable habitat for native fish species (Common Galaxias, Blue Spot Goby) in priority subcatchments.

These objectives relating to rivers, creeks and watercourses have been considered during the development of objectives and targets for the SMP.

4.4 State Government WSUD Guidelines

Several documents have been published which provide guidance for water quality improvements and water sensitive urban design principles in new development. The document *Water sensitive urban design – creating more liveable and water sensitive cities in South Australia* sets out the South Australian Government's position on WSUD in a local context, provides State-wide WSUD 'targets' for new developments and details the role that Government will play in collaboration with other stakeholders to maximise the use of WSUD approaches (Department of Environment, Water and Natural Resources, 2013). Table 4.3 below summarises these across the range of principles.

Table 4.3 State-wide WSUD Performance Principles

Principle	Performance Target
Water Conservation	Demonstrated compliance with South Australian residential building requirements for water efficiency. Non-residential: evidence demonstrating reasonable effort in promoting water efficient techniques in commercial, industrial and other non-residential urban settings. Irrigated open spaces: evidence demonstrating reasonable effort in promoting best practice irrigation management in outdoor irrigated open spaces.
Runoff Quality	The state-wide performance target in this report for improving runoff quality is to achieve the following minimum reductions in total pollutant load, compared with that in untreated stormwater runoff, from the developed part of the site: • Total suspended solids: 80% • Total phosphorus: 60% • Total nitrogen: 45% • Gross pollutants: 90%
Runoff Quantity	**For waterway protection:** Manage the rate of runoff discharged from the site so that it does not exceed the pre-urban development 1 year average recurrence interval (ARI) peak flow. **For flood management:** For development and other relevant infrastructure that will drain runoff to an existing publicly managed drainage system or to a drainage system such as a creek or watercourse on privately-owned land: • The capacity of the existing drainage system is not exceeded; and • There is no increase in the 5 year ARI peak flow and no increase in flood risk for the 100 year ARI peak flow, compared to existing conditions.
Integrated Design	Evidence that relevant stakeholders are engaged at appropriate stages of planning, designing, constructing and managing WSUD measures so as to maximise the potential for WSUD to contribute to 'green infrastructure' and other relevant State, regional, and local objectives.

The WSUD performance principles are recommendations only, meaning there is no legal obligation to meet the requirements, however they will form the basis for the objectives and targets of the SMP.

4.5 Community Consultation

4.5.1 Background

Following the completion of Stage 4 of the Stormwater Management Plan with the State of the Catchment report, a preliminary round of community consultation was held. The purpose of this consultation was to seek feedback from the community on the baseline assessment and the identified stormwater risks and issues, and to determine community values regarding stormwater management within the town.

4.5.2 Consultation Process

Consultation on the first four stages of the Stormwater Management Plan took place in September and October 2023. Consultation activities undertaken include:

- A presentation to Council elected members on the 5th of September 2023 outlining the work undertaken to date on the Stormwater Management Plan and identifying the areas of elevated flood risk; and
- Open house sessions held in Laura, Gladstone and Spalding on the 24th of October 2023.

At the open house sessions, members of the public were invited to come along and discuss any aspect of the stormwater management plan, provide details of stormwater issues and have conversations with Southfront and Council staff. The sessions were promoted on the Council website and social media accounts 2 weeks prior.

Staff from Council and Southfront were present at all open house sessions. Posters were displayed providing information about the State of the Catchment report including an explanation of the purpose of an SMP, the tasks required, the study area and topography, 1% AEP flood maps and identified flood impacts.

Online and paper feedback forms were developed and made available at the open house sessions and on the Council website, allowing respondents to describe their priorities for the management of stormwater and provide details of any stormwater issues they are aware of.

4.5.3 Community Consultation Feedback

In total over 20 people and one Council Elected Member attended the open house drop in sessions across the three towns. The following feedback was provided informally by session attendees (i.e. verbally to staff, not via a feedback form):

- The small channels flowing towards Brogan Road near the golf course rarely flow; and
- Behind the Georgetown town hall, sediments runoff the unsealed carpark towards Fisher Street, where water ponds in the verge and needs to build up before it can reach the stormwater inlet.

In addition, four online feedback forms and twelve paper feedback forms were submitted. Within the forms, respondents were asked to rank the importance of a range of factors, including major flooding, nuisance flooding, water quality, stormwater capture/reuse and climate change. Table 4.4 below summarises the responses across the online and paper feedback forms, which have also been attached to this report in Appendix B.

Table 4.4 Community Response Form Summary

Factor	Number of Responses				
	1 (High Priority)	2	3	4	5 (Low Priority)
Major flooding	12	0	2	1	1
Nuisance flooding	6	5	2	1	2
Water quality	4	1	6	3	2
Stormwater capture and reuse	6	1	5	3	1
Climate change	3	1	1	6	4

The highest priority issue for the community was major flooding, followed by nuisance flooding and stormwater capture and reuse, with water quality and climate change being perceived as lower priorities.

In addition to the rankings above, respondents were asked to provide details of any stormwater related concerns, local flooding problems or ways in which they thought stormwater should be managed within the town. These comments are summarised below.

- A watercourse southwest of town crosses Brogan Road, and the road is repaired annually due to scouring. A culvert under the road is suggested;
- The centre of town has a very poor ability to clear stormwater;
- Significant events are not able to be controlled, especially to the north of town in the diversion channel;
- The dam west of town appears inadequate – it does not hold water and needs to be desilted to be used to irrigate the oval;
- At the corner of Pitts Street and Fisher Street there is inadequate drainage leading to ponding at the corner;
- There are poorly designed gutters which sit lower than the drains;
- The entrance to the bowls club is flooded during heavy downpours; and
- The gutters on both sides of Hurtle Street and on the western side of Fisher Street are damaged, contributing to water ponding.

The community feedback summarised above has been considered in the development of the objectives and targets for the Stormwater Management Plan, as discussed below.

4.6 Stormwater Management Plan Objectives and Targets

Having considered the range of guidelines from the various government bodies and the outcomes from the community consultation, a set of objectives and targets was formulated addressing a range of factors, as summarised in Table 4.5 below.

Table 4.5 SMP Objectives and Targets

ID	Objective		Target	Absolute (Abs) or Aspirational (Asp)
1	**Provide an acceptable level of flood protection for the community and both private and public assets**	a	No above floor inundation of dwellings in a 1% AEP flood event.	Asp
		b	Where appropriate, no above floor inundation of dwellings in a 5% AEP flood event. In some locations, the cost of flood proofing would likely exceed the value of property being protected, and therefore non-structural measures may need to be considered.	Abs
		c	Safe vehicle access (maximum hazard class H1) along major evacuation routes in a 1% AEP flood event.	Asp
		d	Council provide flood risk information to the community and assist with the creation of flood action plans.	Abs
		e	Effective emergency management arrangements are in place and engage all relevant agencies, staff and affected communities.	Abs
2	**Manage the quality of runoff and its effect on receiving waters**	a	Compared to untreated runoff, achieve the following pollutant reductions: • Total suspended solids: 80% • Total phosphorus: 60% • Total nitrogen: 45% • Gross pollutants: 90%	Asp
		b	Educate the community on the importance of water quality within the receiving waters.	Abs
3	**Make beneficial use of stormwater**	a	Opportunities to increase use of recycled stormwater are to be identified and investigated where viable.	Asp
		b	Where possible Council will strive for new developments to retain peak flows to pre-development levels.	Asp
4	**Planning for new developments provides for open space, recreation and amenity**	a	Identify planning and design policies and procedures to be implemented by Council, where they have authority to do so, that could contribute to effectively manage development to minimise the impact of flooding on new and existing development.	Asp
		b	Identify design principles for Council to implement, where they have the authority to do so, which promote integrated planning, design and management of stormwater systems to maximise the potential to achieve multiple outcomes for water management in new development, as well as redevelopment, retrofits, upgrades and extensions.	Asp
		c	Identify design principles for Council to champion which provide for protection and enhancement of natural features and systems where possible, and increase biodiversity, stormwater treatment and passive reuse.	Asp
5	**Improve the condition of receiving watercourses**	a	All new and upgraded stormwater outlets discharging to receiving watercourses are to be designed to control silt	Abs

			deposits and discharging velocities, and mitigate any adverse effects to the physical conditions of the immediate receiving environment.	
6	**Sustainable asset management of stormwater infrastructure**	a	All stormwater assets are identified and recorded in an asset management system and/or asset management plan.	Asp
		b	All proposed stormwater infrastructure is to be designed with consideration of the likely impacts of climate change.	Abs
7	**Effective communication and consultation with catchment stakeholders, businesses and community members**	a	Effectively engage with the community on stormwater management issues and proposed strategies including WSUD and stormwater reuse opportunities where possible.	Abs
		b	Raise awareness to enable businesses and the community to respond efficiently to extreme weather flood warnings.	Abs
		c	Identify opportunities for partnerships with the community and government bodies in the development and implementation of strategies.	Abs

5 Stormwater Management Responses

5.1 Structural Management Measures

Having investigated the stormwater performance of the Study Area, management responses have been developed to meet the stormwater management objectives and targets discussed in Section 4. These are designed to address stormwater management issues identified through the development of this plan.

5.1.1 Flood Mitigation Strategies

Flood mitigation strategies are outlined in this section. These strategies have been developed with a view to maximising the level of flood protection that can be achieved within practical constraints. All flood mitigation strategies have been developed using the hydrology from Scenario B, which incorporates future development and climate change.

In accordance with the Plan's objectives outlined in Section 4, these strategies have aspired to achieve no above floor inundation of properties for all events up to and including the 1% AEP storm. An absolute target of achieving no above floor inundation in the 5% AEP storm was adopted, however it is likely that in some locations, the cost of providing flood immunity would far exceed the value of the property being protected. In these situations, non-structural measures could also be considered.

Each of the proposed works packages has been assigned a project ID which corresponds to the project location. Flood depth and hazard maps have been prepared for each AEP event to demonstrate the performance of the flood mitigation strategies, and are presented in Appendix G and Appendix H. Figure 5.5 below provides a side by side comparison of the pre-mitigation and post-mitigation scenarios in the 5% AEP flood event, demonstrating the impact of the strategies.

The recommended mitigation strategies have been developed holistically considering the stormwater performance of the entire Study Area. While some of the strategies have primarily localised impacts, others also reduce the demand on separate areas. The upgrades should be viewed collectively as a strategic solution to various identified stormwater issues.

Budget cost estimates have also been prepared for the proposed flood mitigation works. The budget cost estimates are exclusive of GST and include allowances of:

- 10% for design;
- 10% for modification to existing services;
- 20% for construction preliminaries; and
- 20% for contingencies on construction.

Note that these allowances have at times been adjusted to reflect the location of the works. These cost estimates are based upon historical cost information and experience, and do not allow for latent or market conditions (i.e. competition, escalation) or land acquisition.

The potential cost of soil remediation and/or disposal of contaminated material has not been considered in preparing these cost estimates. Council may elect to undertake environmental testing of project sites during the design development phase to assist in managing this risk.

D1: Northern Channel Flood Protection
It is recommended that the open channel running through town to the north of North Terrace is upgraded. In even a 0.2 EY storm event, the capacity of this system was found to be insufficient to divert flows from the upstream catchments, resulting in widespread property inundation. The strategy to address this issue is comprised of several components, labelled D1-A, D1-B, D1-C and D1-D as described in detail below.

Though the recommended upgrades are extensive, this channel has been a known problem for the community for a very long time. *Georgetown into the Future Urban Design Framework* (WAX, 2009) discusses a flood event in early 1974 where houses flooded due to blockage along the northern channel. Furthermore, through the community consultation process undertaken for the stormwater management plan, a resident commented that significant events cannot be controlled to the north of town in the diversion channel.

The upgrades recommended will significantly increase the hydraulic capacity of the channel, preventing property inundation due to channel breakouts in up to a 5% AEP event.

D1-A: Northern Channel Upgrade
It is recommended that the existing open channel stretching from Georgetown-Narridy Road to Horrocks Highway is upgraded. The existing channel has a variable cross-section, but in general is narrow and less than a metre deep. It is recommended that an enlarged open channel is constructed with the following minimum dimensions:

- Depth = 1 m
- Base width = 5 m
- Top width = 13 m
- Total length = 560 m

Increased channel depths were required just upstream of the crossings at Hurtle Street and Horrocks Highway, to prevent water breaking out of the channel in these locations. A channel depth of 2 m at Hurtle Street and 1.5 m at Horrocks Highway were found sufficient to prevent spill in the 5% AEP flood event. These increased channel depths and widths will also support the construction of new culvert crossings, as described in D1-B below. Elsewhere a minimum channel depth of 1 m was found to be sufficient.

The alignment of the channel means it will need to pass beneath the 600 mm diameter water main running parallel to West Terrace. The existing channel already crosses this pipeline, however due to the enlarged cross-section associated with the upgrade, additional works may be required to support the pipe. This will need to be investigated in greater detail alongside the design of the open channel.

Figure 5.1 below compares the existing channel cross section with the proposed cross section in between Hurtle Street and Horrocks Highway alongside North Terrace, looking downstream, demonstrating the significant increase in flow area achieved.

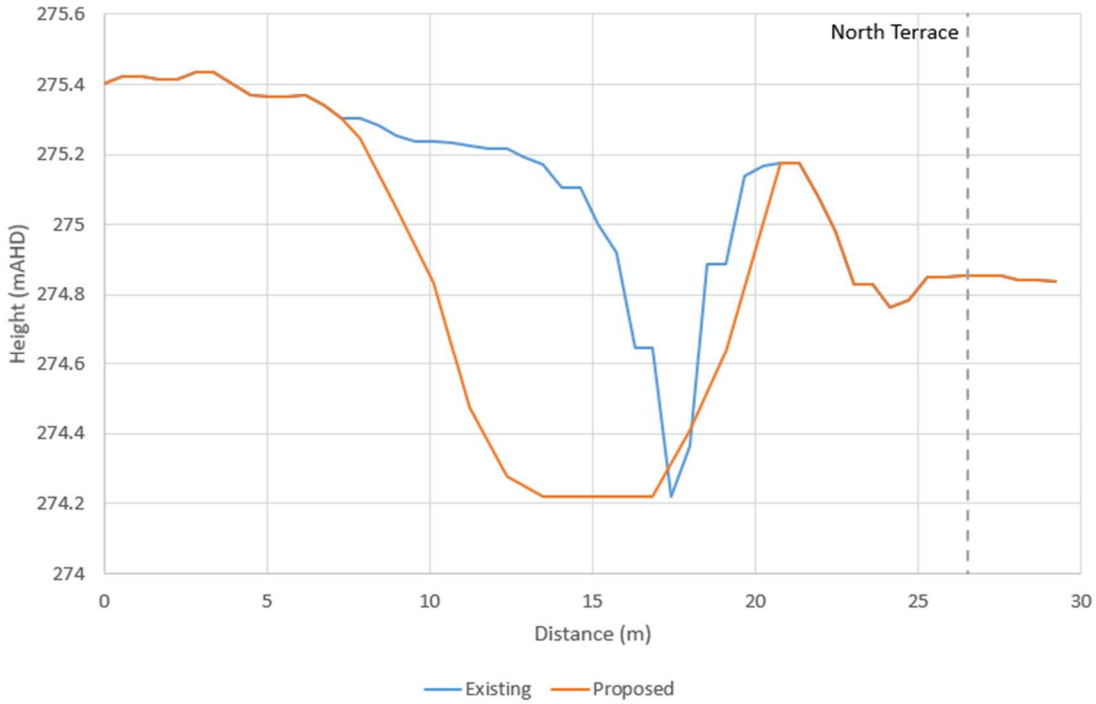


Figure 5.1 Existing vs Proposed Northern Channel Cross Section

The figure demonstrates the restricted size of the existing channel, which was found to spill in all modelled storm events. In this location, the proposed channel maintains the existing channel depth, but widens it significantly, making more efficient use of the land available between North Terrace and the property boundaries on the northern side of the channel.

There is a small, formalised pedestrian channel crossing just upstream of Horrocks Highway, allowing pedestrians to cross the channel without walking along the highway. This would need to be removed in order to upgrade the channel. Council may like to consider providing an alternative means of crossing the channel following the upgrade, if this access is determined to be of value to the community.

D1-B: Northern Channel Culvert Upgrades

The existing northern channel crosses Hurtle Street and Horrocks Highway through culverts. There is a single 1500 mm diameter pipe beneath Hurtle Street and two parallel 900 mm diameter pipes beneath Horrocks Highway. These culverts were found to be insufficient to convey the flow rates delivered by the upgraded channel cross-section, and therefore it is recommended that these are upgraded.

It is recommended to construct two additional 1500 mm diameter pipes beneath Hurtle Street, resulting in three parallel 1500 mm diameter pipes. Localised earthworks may be required around the crossing to support the installation of the new headwalls. As discussed in strategy D1-A above, a channel depth of 2 m on the upstream side of Hurtle Street will create sufficient headwater depth to force flows through the culverts with no spill in the 5% AEP flood event.

At Horrocks Highway, it is recommended to replace the twin 900 diameter pipes with triple 2100 mm wide x 900 mm high box culverts. Box culverts will be required in this location due to limited clearance to the highway. A channel depth of 1.5 m on the upstream side of the crossing will prevent almost all property inundation in the surrounding area in a 5% AEP flood event.

A preliminary search has determined that there is a water main in both Hurtle Street and Horrocks Highway where the channel culvert upgrades are proposed. In an effort to avoid service relocations, the culvert crossings have been designed such that the new culverts are not taller than the existing culverts in these roads.

D1-C: Northern Channel Outfall Upgrade

The existing outfall channel for the northern channel bends to the north from Horrocks Highway, before rounding a bend and heading southeast towards the existing culvert crossing at Caltowie-Georgetown Road. The channel is quite small and not well defined, with flood maps showing water breaking out of the channel and flowing overland instead of in the channel.

It is recommended to excavate a new outfall from Horrocks Highway to the northeast, through an undeveloped corridor of land directly along the boundary of residential properties. The channel will take flows away from Horrocks Highway towards the culvert crossing beneath Caltowie-Georgetown Road. Due to the limited longitudinal gradient available, a 15 m wide channel with a minimum depth of 0.8 m is recommended to convey the 5% AEP peak flow, providing 300 mm freeboard. Some localised earthworks may be required to direct runoff from the local catchment on the Horrocks Highway into the channel.

The alignment of the outfall has been chosen in order to minimise the need to remove trees, with the outfall falling between two rows of established trees approximately 20 m apart.

D1-D: Upstream Detention Storage

Alongside the upgrades to the channel and culvert crossings, some detention storage upstream of Georgetown-Narridy Road will still be required due to the size of the upstream catchment. A detention volume of 1,800 m^3 was found to be sufficient to prevent spill in the 5% AEP flood event and limit flows entering the downstream open channel to a level which can be safely conveyed through the proposed design. This detention volume could be achieved through excavation or by constructing a raised embankment across the channel, or a combination of both. This will need to be determined during detailed design.

It is recommended to duplicate and extend the existing 1200 mm diameter culvert beneath Georgetown-Narridy Road at the intersection of Brogan Road, allowing the pipes to act as the outlet for the detention storage. This will require some additional excavation to lower the invert within the storage area. Whether the existing culvert is in a suitable condition and location to be re-used will need to be determined during detailed design.

An overview of the proposed northern channel strategy is shown below in Figure 5.2.

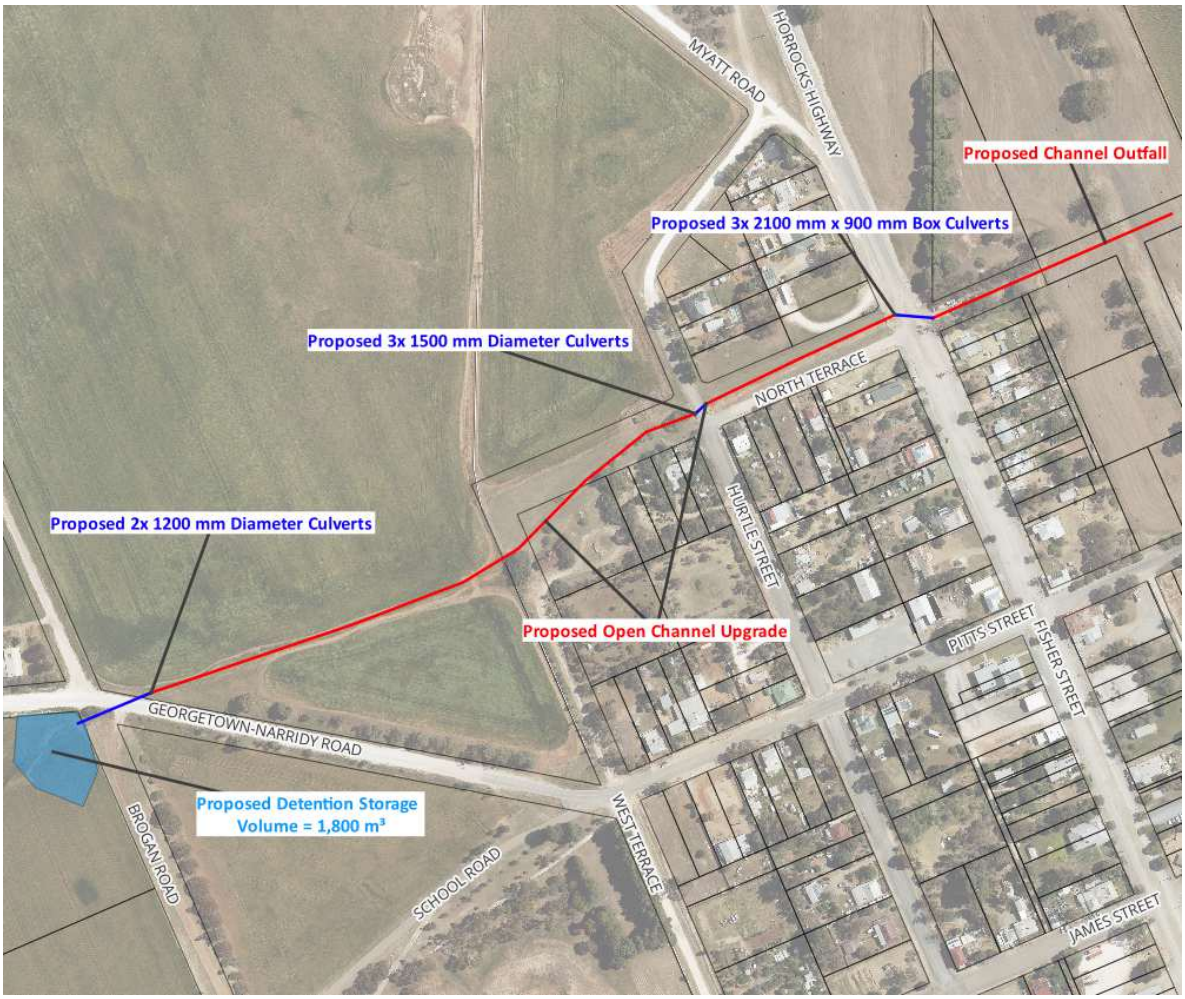


Figure 5.2 Flood Mitigation Strategy D1 Overview

D2: Pitts Street Drainage

A key finding from the community consultation was that the drainage in the centre of town at the corner of Pitts Street and Fisher Street is inadequate for clearing stormwater following heavy rainfall, resulting in deep ponding that takes a long time to clear. It is recommended to construct new stormwater inlets at the intersection of Pitts Street and Fisher Street, and a new 750 mm diameter stormwater drain to the northeast along Pitts Street.

The drain is to outlet into the old railway line corridor, directing runoff to the south before it flows into the Yackamoorundie Creek. It is recommended that earthworks be undertaken to lower this corridor and allow water to freely flow away from Pitts Street, towards the channel proposed as part of upgrade D3 below.

Works are also recommended in the southern verge of Pitts Street to raise the ground by 200 mm, keeping flows on the road and preventing water from moving through properties. It is recommended that this is done between West Terrace and Hurtle Street, and from Hurtle Street to Fisher Street. This would need to be investigated further in detailed design to ensure vehicle access to affected properties is maintained and minimise the need to remove trees. This could alternatively be achieved using a raised kerb, pending site conditions.

D3: James Street Drainage

The flood maps developed for this plan show significant overland flows through properties between West Terrace and Fisher Street in heavy rainfall events, resulting in widespread inundation surrounding the intersection of James Street and Fisher Street. It is recommended that a new stormwater drain in James Street is constructed, alleviating surface inundation.

A 900 mm diameter drain is recommended from West Terrace to Fisher Street, where due to topographical constraints an 1800 mm wide x 600 mm high box culvert is required. The drain is to terminate just east of the bowling club driveway, where earthworks will be required to allow flows from the drain to reach Yackamoorundie Creek. A lateral connection to the low spot on Hurtle Street is also recommended via a 450 mm diameter pipe. This drain alignment and size was found to prevent property inundation in the affected area in up to a 5% AEP flood event.

Some earthworks will be required on the eastern side of West Terrace between Pitts Street and James Street to increase the depth of the existing channel in the verge. In the 5% AEP flood event, a maximum depth of water in the channel of 650 mm was determined, so a channel depth of 1 m will provide 300 mm freeboard. This would further restrict vehicle access to properties, however there appears to be no formalised driveways along this stretch of road. Alternatively, the stormwater drain could run from West Terrace to Hurtle Street through properties directly to the low spots and reducing the need for earthworks and reducing the extent of ponding along West Terrace. However this would require Council acquiring a drainage easement through multiple properties.

It has been assumed that the existing stormwater infrastructure at the intersection of Fisher Street and James Street will need to be removed to allow for the new system. However during detailed design, if this system is found to be in good condition and able to be retained without affecting the proposed upgrade, then this system could further reduce inundation.

Figure 5.3 provides an overview of upgrade strategies D2 and D3.



Figure 5.3 Flood Mitigation Strategies D2/D3 Overview

D4: Brogan Road Culvert

Brogan Road to the east of town crosses several watercourses, including one which flows through the golf course towards Horrocks Highway. At the community consultation conducted in October 2023, the resident at 74 Brogan Road commented that the road at this crossing is frequently washed out, requiring regular repair, and requested the construction of a culvert. It is recommended to construct a 750 mm diameter culvert in this location, which will be sufficient to prevent flows spilling across the road in up to a 18% AEP flood event.

To support the installation of the culvert, earthworks will be required to lower the surface level on both sides of the road, and to grade back to existing levels. Earthworks should be conducted in a way which minimises the impact on trees. This culvert prevents Brogan Road from being washed out in this location except for during infrequent storm events, reducing the frequency of maintenance required.

D5: Golf Course Channel Works

The channel discussed above in strategy D3 stretches crosses Brogan Road and weaves through the golf course before sending water to a large culvert beneath Horrocks Highway. The flood maps show that this channel spills in all modelled flood events between the two roads. Water escapes the northern channel bank and flows overland towards West Terrace, where it moves through residential land before reaching South Terrace and moving towards Horrocks Highway.

It is recommended to undertake earthworks along the alignment of the channel, reinforcing the flow pathway and preventing spill to the north towards residential land. As this land is a golf course, the exact nature of the works should be determined with input from the landowner to minimise the impact on the course. The works should be designed such that the 5% AEP peak flow rate of 2.5 m^3/s is fully contained and does not spill. This could take the form of a raised

bund, a larger channel cross-section or a combination of the two. Within the TUFLOW model, this has been implemented using a raised bund.

The extent of works associated with upgrades D4 and D5 is shown in Figure 5.4.



Figure 5.4 Flood Mitigation Strategies D4/D5 Overview

The improvements provided by the overall flood mitigation strategy in the 5% AEP flood event are demonstrated in Figure 5.5 below, highlighting the significant reduction in flood depth and extent achieved throughout the town.

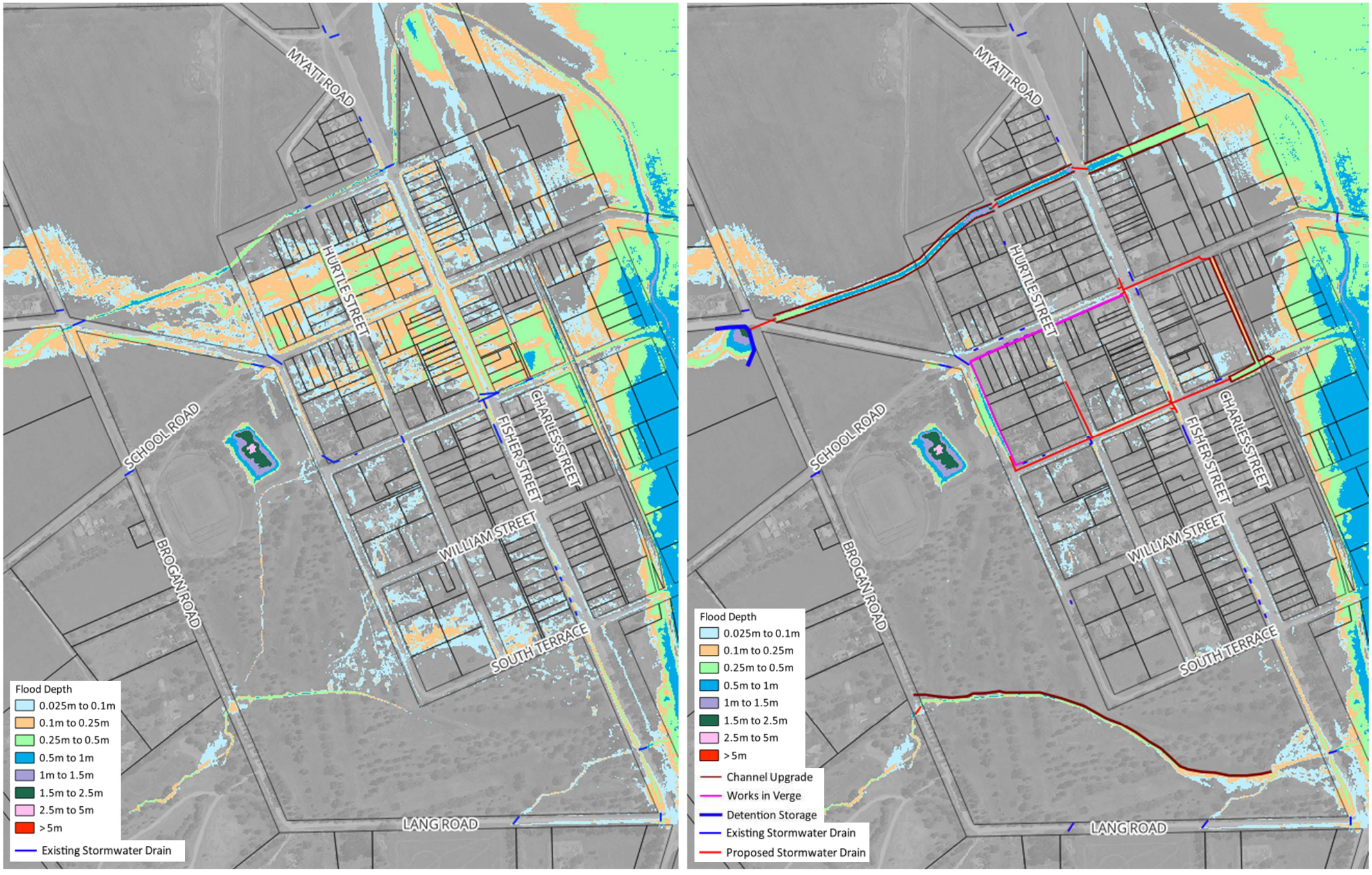


Figure 5.5 Georgetown Pre-Mitigation (Left) and Post-Mitigation (Right) 5% AEP Flood Maps

5.1.2 Flood Mitigation Benefits Evaluation

The benefits associated with the reduction in flooding due to the construction of the recommended structural mitigation strategies have been assessed. This assessment considers the number of affected properties as well as the expected damages in flood events of varying frequency, and the average annual damages value.

Number of Properties Affected

Flood levels at the centroid of each property were determined from the flood grids produced by the TUFLOW model, and these levels have been used to determine the number of affected properties in Scenario C. Table 5.1 below summarises the total number of properties affected by each stage-damage curve range for all modelled AEPs.

Table 5.1 Scenario C Affected Properties by Flood Depth

Flood Depth Range (m)	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
0-0.1	0	0	0	9	25	37
0.1-0.15	0	0	0	0	2	7
0.15-0.25	0	0	0	0	2	9
0.25-0.5	0	0	0	0	0	1
0.5-1.0	0	0	0	0	0	0
1.0-1.5	0	0	0	0	0	0
1.5-2.5	0	0	0	0	0	0
2.5-5.0	0	0	0	0	0	0
Total	0	0	0	9	29	54
Change from Scenario B	-100%	-100%	-100%	-84.7%	-51.7%	-21.7%

The table demonstrates the significant reductions in flood extent and depth provided by the proposed upgrades, with no properties affected in up to a 5% AEP flood event. Though the strategies have been designed for the 5% AEP event, there are still significant improvements in larger events, particularly the 2% AEP event. The reductions are less significant for the 1% AEP and 0.2% AEP floods, which completely overwhelm the proposed mitigation strategies.

Table 5.2 below breaks down the number of affected properties by land use type for each modelled AEP flood event.

Table 5.2 Scenario C Affected Properties by Land Use

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	0	0	0	7	24	42
Commercial	0	0	0	2	5	12
Industrial	0	0	0	0	0	0
Total	0	0	0	9	29	54

As with previous scenarios the majority of affected properties are residential, but in rare events additional commercial properties are affected.

Direct Tangible Flood Damages

Direct tangible flood damages have been estimated for Scenario C, which considers future development and climate change, in conjunction with the proposed strategies. The flood level determined for each property was compared with the appropriate stage-damage curve to determine a damage cost for each property. Table 5.3 shows the resulting direct tangible flood damages by land use as well as the total flood damage for each modelled AEP.

Table 5.3 Scenario C Direct Tangible Flood Damages

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.0m	$0.0m	$0.0m	$0.0m	$0.2m	$1.0m
Commercial	$0.0m	$0.0m	$0.0m	$0.1m	$0.3m	$0.8m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m
Total	$0.0m	$0.0m	$0.0m	$0.1m	$0.5m	$1.8m

Indirect Tangible Flood Damages

INFFEWS recommends considering indirect tangible flood damages of 15% for residential buildings and 55% for commercial and industrial buildings. Applying these factors results in the total tangible flood damages summarised in Table 5.4.

Table 5.4 Scenario C Total Tangible Flood Damages

Land Use	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Residential	$0.0m	$0.0m	$0.0m	$0.0m	$0.2m	$1.1m
Commercial	$0.0m	$0.0m	$0.0m	$0.2m	$0.4m	$1.2m
Industrial	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m	$0.0m
Total	$0.0m	$0.0m	$0.0m	$0.2m	$0.6m	$2.4m

Table 5.5 below demonstrates the improvements provided by the recommended flood mitigation strategies across the range of modelled AEPs.

Table 5.5 Reduction in Total Tangible Flood Damages Due to Flood Mitigation Strategies

Model Scenario	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.2% AEP
Scenario B (Future)	$1.0m	$1.3m	$2.5m	$3.2m	$4.0m	$6.1m
Scenario C (Future/Upgrades)	$0.0m	$0.0m	$0.0m	$0.2m	$0.6m	$2.4m
Change in Flood Damages	-$1.0m **(-100%)**	-$0.6m **(-100%)**	-$0.9m **(-100%)**	-$3.0m **(-93.8%)**	-$3.4m **(-85%)**	-$3.7m **(-60.7%)**

The table demonstrates the significant reduction in property inundation achieved through the recommended flood mitigation strategies. All flood damages are eliminated in up to a 5% AEP event, with only $0.2m of damages in a 2% AEP event and $0.6m of damages in a 1% AEP event. It should be noted that the adopted flood damages estimation methodology for residential buildings, as described in Section 3.5, only considers above floor inundation. In major flood events such as those modelled, there would be damages to fences, driveways and outdoor equipment within residential properties.

Average Annual Damages

The resulting average annual damages value was found to be $23,297, which is a $362,898 reduction from the Scenario B value. The elimination of flood damages in flood events up to the 5% AEP has significantly diminished the average annual damages value, which is weighted more heavily towards frequent events.

5.1.3 Water Sensitive Urban Design Strategy

A Water Sensitive Urban Design (WSUD) strategy has been developed for the town. The recommended measures will improve the quality of stormwater entering the receiving waters and, where possible, enable stormwater harvesting and reuse. The measures aim to achieve the aspirational water quality improvement targets outlined in Section 4, being an 80% reduction in TSS, a 60% reduction in TP, a 45% reduction in TN and a 90% reduction in gross pollutants.

The proposed measures have been modelled within MUSIC to allow for preliminary sizing of components and budget cost estimation. The Scenario 3 MUSIC model, considering future development and existing WSUD infrastructure, has been used as the basis for the upgrades. In addition to the identified measures, it is expected that further WSUD opportunities will be explored over time, particularly alongside land developments and road reconstruction works.

The WSUD measures considered are described in detail in the sections below. Many of the strategies are interconnected with the flood mitigation strategies discussed in Section 5.1.1 Each of the proposed works packages has been assigned a project ID which corresponds to the project location. As with the flood mitigation strategies, budget cost estimates have been prepared for the proposed works and are included in Appendix J.

WQ1: Georgetown Wetland

It was identified in *Georgetown into the Future Urban Design Framework* (WAX, 2009) that the community are in favour of constructing a wetland between Georgetown and Yackamoorundie Creek to capture and treat stormwater runoff. Such a wetland will provide a range of benefits, including stormwater treatment, improved amenity, and allow for a stormwater harvesting and reuse scheme to be implemented, using treated water to irrigate the green spaces throughout the town. Considering the limited underground stormwater infrastructure within Georgetown, a large-scale treatment measure such as a wetland in tandem with various smaller measures was considered a suitable strategy to meet the aspirational water quality improvement targets.

Within the MUSIC model, a series of nodes have been specified to ensure that the town runoff is satisfactorily treated. Runoff from the town and surrounding rural catchments is first routed through a sedimentation basin, followed by the wetland and finally a pond. This allows sediments from the upstream catchment to settle to the floor of the basin and protects the downstream wetland. A high flow bypass has been specified, diverting flows above the 4 EY around the wetland into the receiving waters. The pond downstream acts as storage for treated water which can be used to irrigate the green spaces around the town, as described in WSUD strategy WQ2 below.

The properties of the sedimentation basin have been adopted in line with *South Australia MUSIC Guidelines* (Water Sensitive South Australia, 2021), as summarised in Table 5.6 below.

Table 5.6 Adopted Sedimentation Basin Properties

Parameter	Units	Value
Surface Area	m^2	695
Extended Detention Depth	m	0.35
Permanent Pool Volume	m^3	200
Initial Volume	m^3	200

Exfiltration Rate	mm/hr	0
Evaporation Loss	% of PET	75
Detention Time	hrs	12

The wetland has been located south of Caltowie-Georgetown Road, upstream of the intersection of the northern channel and Yackamoorundie Creek, maximising the contributing catchment area. It was assumed that 6,250 m² of land would be available for the total wetland footprint (including space for macrophyte zone, inlet pond, landscaping, batters etc).

The wetlands have been sized to meet the aspirational water quality improvement targets for the town's stormwater runoff, taking into account the other measures proposed in this section. The assumed wetland properties are summarised in Table 5.7.

Table 5.7 Adopted Wetland Properties

Parameter	Units	Value
Surface Area	m²	5000[1]
Extended Detention Depth	m	0.35
Permanent Pool Volume	m³	1750
Initial Volume	m³	1750
Exfiltration Rate	mm/hr	0
Evaporation Loss	% of PET	125
Detention Time	hrs	72

[1] Assuming 20% of available wetland space will be required for inlet pond/batters/landscaping etc.

Geotechnical and environmental investigations are required to confirm the feasibility of the proposed wetland, based on local subsurface conditions. No allowance has been made for site remediation, should this be required to facilitate the works.

Downstream of the wetland, a storage pond has been specified with a surface area of 1,000 m² and an extended detention depth of 1.0 m. *South Australia MUSIC Guidelines* (Water Sensitive South Australia, 2021) recommends that ponds and lakes are not modelled as effective treatment nodes, as MUSIC is not considered a suitable model for in-lake processes other than water balance assessments. Therefore the treatment effect of the pond has been subtracted from the calculated stormwater pollutant loads leaving the urban catchment.

The final location and form of the proposed sedimentation basin, wetland and storage pond will need to be determined during detailed design, taking into account the topography of the land to ensure low flows from town runoff are treated, and considering the alignment of the Yackamoorundie Creek east of the town.

The pond will store treated water, which can then be used to irrigate the various green spaces throughout Georgetown, as detailed in strategy WQ2 below.

WQ2: Stormwater Harvesting and Reuse Scheme

Opportunities for implementing large-scale stormwater harvesting and reuse within Georgetown have been investigated. A desktop assessment has been undertaken to determine the water demand of various reserves and green spaces in the town, using the methodology outlined in *Code of Practice – Irrigated Public Open Space* (SA Water, 2015). This document provides demand estimates for four turf quality visual standard categories:

- Category 1: Elite sports turf, used for passive recreation, site of national significance
- Category 2: Premier sports turf, used for passive recreation/tourism, site of state/regional significance
- Category 3: Local sports turf, used for passive recreation, site of local community significance
- Category 4: Local neighbourhood park, used for passive recreation

The irrigation requirement of each turf category, assuming Couch of Kikuyu grass is planted, is summarised in Table 5.8 below.

Table 5.8 Long-term Average (30yr) Irrigation Demand

Turf Category	Irrigation Demand (ML/ha/yr)
1 (Elite Sports Turf)	8.8
2 (Premier Sports Turf)	4.7
3 (Local Sports Turf)	3.7
4 (Local Neighbourhood Park)	2.7

While these irrigation demands are provided for metropolitan Adelaide, for the purposes of estimating irrigation requirements at a concept level, they are considered appropriate. This information has been used to quantify the estimated annual irrigation demand of the various green spaces in Georgetown, as quantified in Table 5.9 below.

Table 5.9 Georgetown Estimated Irrigation Demand

Location	Adopted Turf Category	Total Grassed Area (ha)	Irrigation Demand (ML/yr)
Town Oval	3	1.7	6.3
Golf Course	3	9.6[1]	35.5
Bowling Club	3	0.14	0.5
Georgetown Memorial Park	4	0.06	0.2
Total	N/A	11.5	42.5

[1] This has been estimated based on aerial photography and only includes the playing areas.

With the irrigation demand quantified, a stormwater harvesting and reuse scheme could be implemented within the storage pond proposed in strategy WQ1 in the MUSIC model. Water balance calculations suggest 10.1 ML/yr could be supplied from the upstream catchment. This would be sufficient to irrigate the town oval, bowling club and memorial park, as well as part of

the golf course. This harvesting estimate assumes low flows from the upstream catchments west of Brogan Road are able to bypass the golf course channel recommended to be upgraded in flood mitigation strategy D5.

In order to distribute the treated stormwater to the various green spaces around the town, a pump station and a rising main will be required. Specific details regarding the design and operation of the system will need to be refined during the detailed design of the scheme. However for the purposes of scoping, a preliminary cost estimate has been prepared.

This strategy has been designed such that it is not reliant upon the proposed flood mitigation measures having been constructed. Provided strategy D1-D was constructed, it may be worth investigating having a smaller scale harvesting and reuse scheme in the detention basin to irrigate the nearby town oval, rather than extending a rising main from the proposed pond east of town.

WQ3: Streetscape Raingardens

Raingardens are garden beds that use carefully selected native plants and soil to capture and biologically treat stormwater runoff from roofs and roads. Water ponds on the surface of the raingarden, where it soaks through the filter media, leaving sediments and rubbish behind. The plant roots in the soil absorb the nutrients in the stormwater, resulting in cleaner water leaving the raingarden. An example of a raingarden is shown in Figure 5.6.



Figure 5.6 Raingarden During a Rain Event (Resilient East)

It is essential that raingardens are properly maintained in order to ensure they function as intended over a long period of time. This involves promoting healthy vegetation, removing excess collected sediments, ensuring the surface can drain freely and removing any material blocking hydraulic structures. A schematic view of a raingarden is shown in Figure 5.7.

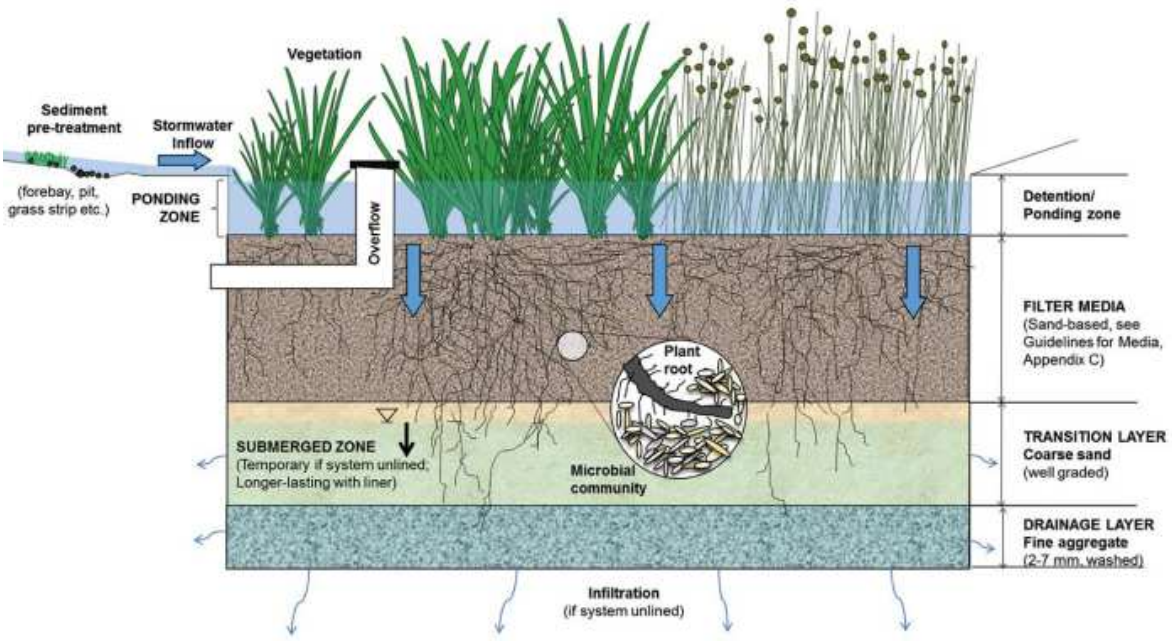


Figure 5.7 Typical Raingarden Composition

Within the MUSIC model, a 15 m² bioretention system has been assumed for each raingarden. Adopted MUSIC modelling parameters for the proposed streetscape bioretention systems are listed in Table 5.10.

Table 5.10 Adopted Raingarden System Properties

Parameter	Adopted Value
Filter Area (m²)	15
Extended Detention Depth (m)	0.15
High Flow Bypass (L/s)	125
Filter Depth (m)	0.5

Raingardens are proposed where new stormwater inlets are recommended through the various flood mitigation strategies, including along Pitts Street, James Street and Fisher Street. Figure 5.8 and Figure 5.9 below show the proposed locations of raingardens throughout Georgetown. The proposed raingardens equate to a filter area of 120 m². These locations will need to be refined during detailed design to consider the most appropriate location and form for the raingardens to take.

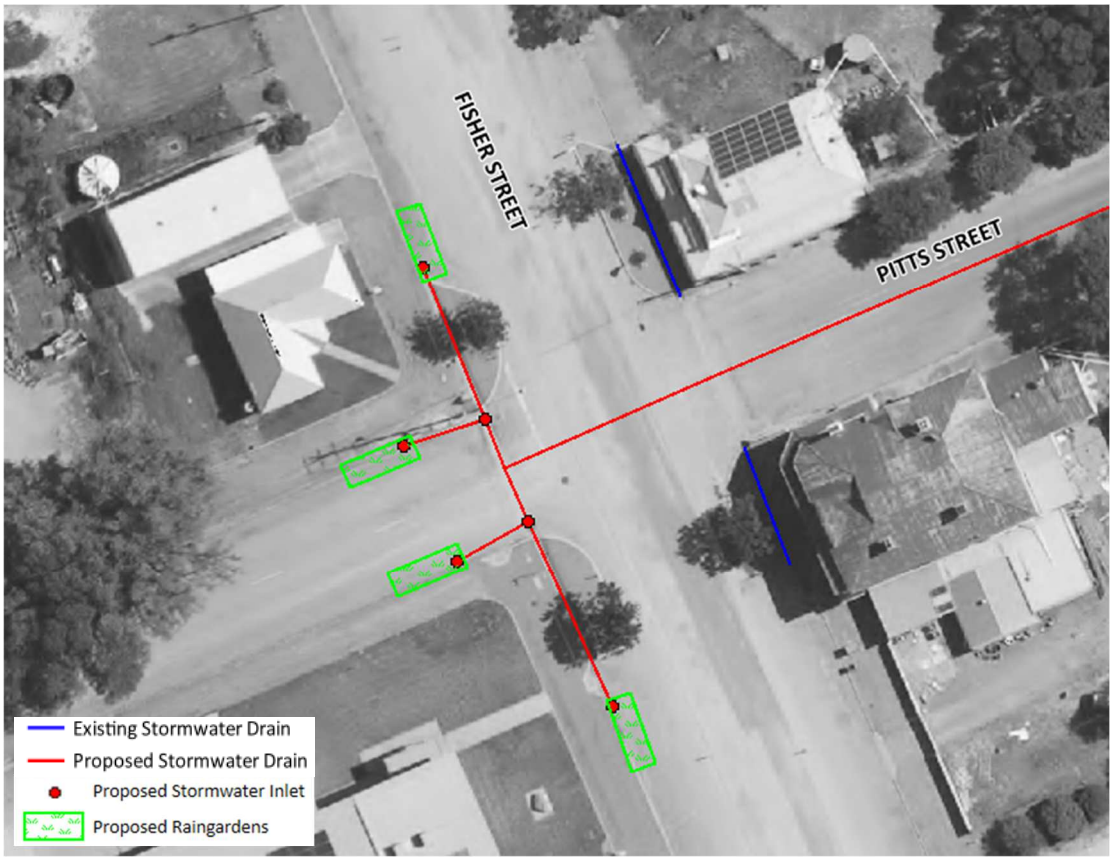


Figure 5.8 Proposed Fisher/Pitts Street Raingardens



Figure 5.9 Proposed Fisher/James Street Raingardens

WQ4: Gross Pollutant Traps

Gross pollutant traps (GPTs) are primary treatment devices that are designed to remove anthropogenic waste, organic matter and coarse sediment from stormwater flows. There are many different proprietary makes and models of GPT, ranging from below ground 'wet sump' devices to above ground trash racks and capture nets on pipe outlets.

The parameters adopted in MUSIC for GPTs have been based on Civilmart Cleansall GPTs. Following the guidance of *South Australian MUSIC Guidelines* (Water Sensitive South Australia, 2021), all GPTs are assumed to only provide effective reductions in gross pollutants and total suspended solids, and have assumed to result in no reduction in total phosphorus and total nitrogen loads.

For all new outlets to the Yackamoorundie Creek, it is recommended for a gross pollutant trap to be included. This includes the new drain in Pitts Street (strategy D2) and the new drain in James Street (strategy D3). It is also recommended that a GPT is installed on the existing culvert beneath Horrocks Highway to the south, which receives runoff from the southern part of town which otherwise receives no treatment. Velocity dissipation measures should also be implemented at any new outlet structure to minimise erosion of the channel.

Depending on the system being installed and the details surrounding its installation, Council may need to apply for a water affecting permit from the Northern and Yorke Landscape Board prior to installing gross pollutant traps. Council should refer to their Water Affecting Activities Best Practice Operating Procedure agreement with the Board when determining if a permit will be required for the works.

WQ5: Rainwater Tanks and Allotment Level Reuse

It has been assumed that for each new house, a 10 kL rainwater tank will be used to irrigate the garden, as discussed in *Georgetown Stormwater Management Plan Modelling Report* (Southfront, 2025). This is considered a conservative approach, as aerial photography shows the majority of houses in Georgetown contain at least one large rainwater tank.

Further to rainwater tanks, it is recommended Council explore the addition of other allotment scale reuse practises as part of its development approval process. This includes encouraging passive irrigation of gardens, such as use of buffer strips, infiltration systems, pervious pavement and green roofs. These elements will reduce the use of potable water for irrigation, reduce the overall volume of stormwater runoff to receiving environments, provide additional opportunities for greening and cooling of the catchment and potentially assist with flood mitigation measures by limiting allotment runoff volumes.

5.1.4 Scenario 4 Water Quality Modelling

The Scenario 3 MUSIC model was modified, incorporating the various WSUD features described above. The results of the Scenario 4 MUSIC model are compared with the untreated runoff pollutant loads determined in Scenario 2 for the total urban catchment in Table 5.11.

Table 5.11 Total Urban Catchment Water Quality Improvement

Parameter	Sources	Residual Load	Reduction	Aspirational Target
Flow (ML/yr)	35.7	22.3	38%	N/A
Total Suspended Solids (kg/yr)	5,430	1,079	80%	80%
Total Phosphorus (kg/yr)	12.3	4.97	60%	60%
Total Nitrogen (kg/yr)	95.9	49.4	48%	45%
Gross Pollutants (kg/yr)	521	34.9	93%	90%

The proposed WSUD strategy was found to meet the aspirational pollutant reduction targets set out in Section 4.6. The majority of the urban catchment receives treatment through biological uptake and filtration in bioretention raingardens or the wetland, resulting in a good level of treatment for the town's runoff.

5.2 Non-structural Measures

To complement the proposed structural options, a number of non-structural options are also recommended. Non-structural options are typically low cost (relative to structural measures) and hence are extremely cost effective with respect to the benefits that they provide.

N1: Rezoning Flood-prone Land
Council should consider rezoning vacant land that is currently shown to be inundated in up to a 1% AEP flood event, or where considered necessary for the storage of stormwater. It is also recommended that Council obtains easements over all proposed open channels and levees for long-term access and maintenance.

N2: SES Community FloodSafe Program
The State Emergency Service (SES) deliver their FloodSafe and StormSafe programs in schools and the community, to help build community resilience and understanding about flood risk. Community FloodSafe is a partnership between local Councils and State and Federal governments. The FloodSafe program uses existing SES volunteers, as well as new community volunteers with good presentation skills, to reach into communities to raise awareness in flood-prone areas. Initiatives include articles in Council newsletters, street corner meetings, community group meetings, internet sites, brochures and school education.

The volunteers talk to community groups, local residents, businesses and schools about what they can do to reduce the risk of flood damage and improve the resilience of their community if a flood should occur. FloodSafe volunteers typically address communities on:

- Local risks and historic flooding in the area;
- Having a flood plan to reduce the risk to business equipment, stock and staff;
- Protecting family and property;
- Understanding BOM Flood Watch and flood warnings;
- Having a home emergency kit; and
- How to call for SES response.

Since its inception in 2009, many metropolitan and regional South Australian councils have joined the FloodSafe program. Council may also elect to make the floodplain mapping of the town available via their website, along with advice to residents on measures they can take to reduce their flood risk and steps to preparing a Personal Flood Action Plan.

N3: Council's Emergency Management Plan
It is recommended that Council develop an Emergency Management Plan, with the purpose of collectively developing skills which provide the community with:

- Knowledge of the emergency risks that exist in the local area;
- Information to support the role that each member of the community can have in an emergency;
- A platform to connect with each other and Council before, during and after an emergency; and
- The ability to support each other to become resilient in an emergency event or disaster.

N4: New Building Floor Levels
It is recommended that Council ensure all new development has a floor level that provides at least 300 mm freeboard to the 1% AEP floodplain. This will mean that over time, the level of flood risk affecting properties will gradually decrease as new development occurs.

N5: Ongoing Maintenance and Monitoring of Council Assets
It is recommended that Council develop a Stormwater Asset Management Plan. The goal of such a plan is to ensure processes are in place for the required maintenance, monitoring and capital renewal of Council assets and to ensure it is done in a financially sustainably way. It is also recommended that Council develop a record of all of their stormwater assets in GIS form, and continually update this with any new infrastructure as it is constructed. It may also be worthwhile for Council to reconcile any drainage easements through private property.

N6: Education and Promotion of WSUD Measures
It is recommended that Council seek to increase uptake of WSUD measures on private property through community education and promotion of WSUD demonstration sites. Council staff and volunteers should seek to educate businesses, community groups, schools and local residents about options for managing the stormwater runoff generated from their property in an environmentally responsible manner. Suitable WSUD measures may include permeable paving, rainwater tanks, raingardens and soakage systems. These could be promoted through Council newsletters, street corner meetings, community group meetings, website and social median updates, brochures and school education.

N7: Development Controls – Beneficial Use of stormwater
It is recommended that Council seek to increase uptake of WSUD measures on private property through community education and promotion of WSUD demonstration sites. Council staff and volunteers should seek to educate businesses, community groups, schools and residents about options for managing the stormwater runoff generated from their property in an environmentally responsible manner. Suitable WSUD measures may include permeable paving, rainwater tanks, raingardens and soakage systems. These could be promoted through Council newsletters, street corner meetings, community group meetings, website and social media updates, brochures and school education.

5.3 Risk Reduction Assessment

The flood risk assessment undertaken for Scenario A and Scenario B in Section 3.7 has been reviewed and updated following the modelling of the recommended stormwater management responses. The updated risk register is shown in Table 5.14.

Table 5.12 below summarises the identified risk ratings for Scenario B and Scenario C.

Table 5.12 Distribution of Risk Ratings across Model Scenarios

Model Scenario	Low Risk	Moderate Risk	High Risk	Extreme Risk
Scenario B	9	4	3	0
Scenario C	9	6	1	0

The table shows the risk reduction provided by the stormwater management measures. The measures were found to slightly reduce the number of high risk locations throughout the town.

5.4 Social and Political Capital Requirements

The level of 'social and political capital' that would be required to implement each of the proposed management responses has been investigated. A rating system has been developed to define the levels of social and political capital, as presented in Table 5.13 below.

Table 5.13 Definitions of Social and Political Capital Levels

Rating	Structural Measure	Non-Structural Measure
Low	Small, simple works being undertaken in low-traffic areas such as local roads, undeveloped reserves or vacant land.	Simple to implement measure unlikely to require behavioural change.
Medium	Moderately sized works being undertaken outside of areas of social, economic or environmental importance.	Moderately complicated measure requiring behavioural change.
High	Complex, expensive or sensitive works requiring land acquisition, or being centred around areas of social, economic or environmental importance.	Complex measure requiring policy changes, significant behavioural change or significant financial investment.

A rating has been assigned for each management response, and these have been incorporated into the summary table provided in the following section.

5.5 Overview of Stormwater Management Responses

The full range of recommended management responses, including those targeting flooding and water quality as well as non-structural measures, have been combined into a single overview table, summarising the key information relating to each. The table presents the management responses in a way which allows for easy comparison of the merits of each option, and is shown in Table 5.15 below.

Table 5.14 - Scenario C Flood Risk Register

ID	Location	Type of Deficiency	1% AEP Impact Details	Risk Category	Consequence	Risk
1	Lang Road	High/Extreme Flood Hazard	Flooding over 1000mm deep across the road	Flooding, Health & Safety	3	High
2	Georgetown Bowling Club	High Flood Hazard	Flooding over 250 mm deep through bowling club field, 100 mm deep through surrounding properties	Flooding, Health & Safety, Social/Stakeholder	2	Moderate
3	Lehmann Road	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
4	Caltowie-Georgetown Road	High/Extreme Flood Hazard	Flooding over 500mm deep across the road	Flooding, Health & Safety	2	Moderate
5	Georgetown-Narridy Road	-	-	Flooding, Health & Safety	1	Low
6	Properties between Fisher Street and Hurtle Street north of Pitts Street	-	Widespread property flooding over 100 mm deep	Flooding, Health & Safety, Social/Stakeholder	2	Moderate
7	Stormwater Inlet on southwestern corner of intersection of James Street and	Low Freeboard, Inlet Capacity	Ponding over 250 mm deep along road	Flooding	1	Low
8	Stormwater Inlet on northwestern corner of intersection of James Street and	Inlet Capacity	Ponding over 250 mm deep along road	Flooding	2	Moderate
9	Pitts Street between West Terrace and Fisher Street	Gutter Flow Depth/Width	Flow pathway over 100 mm deep along road	Flooding	1	Low
10	Hurtle Street north of Pitts Street	Gutter Flow Depth/Width	Flow pathway over 100 mm deep along road	Flooding	1	Low
11	Fisher Street between North Terrace and James Street	Gutter Flow Depth/Width	Ponding over 250 mm deep along road	Flooding	1	Low
12	West Terrace between Pitts Street and James Street	Gutter Flow Depth/Width	Flow pathway over 500 mm deep along road	Flooding	1	Low
13	Corner of Hurtle Street and James Street	Gutter Flow Depth/Width	Ponding over 100 mm deep along road	Flooding	1	Low
14	James Street between Hurtle Street and Fisher Street	Gutter Flow Depth/Width	Flow pathway over 100 mm deep along road	Flooding	1	Low
15	Pitts Street between Fisher Street and Charles Street	Gutter Flow Depth/Width	Shallow flow pathway less than 100 mm deep along road	Flooding	1	Low
16	Receiving waters	Water quality of town runoff	Risk of ecological harm	Environmental, Social/Stakeholder, Reputational/Political	2	Moderate

Table 5.15 - Summary of Stormwater Management Responses

ID	Description	Objectives Addressed	Structural?	Type of Action	Benefit Provided	Capital Cost	Estimated Annual Operating Cost	Social/Political Capital Required	Stakeholder Responsible for Funding/Implementing	Post-measure Residual Risk
D1	Northern Channel Flood Protection	1,6	Yes	Works	Flood mitigation, drainage service	$2,110,000	N/A	High	Northern Areas Council	Low
D2	Pitts Street Drainage	1,6	Yes	Works	Flood mitigation, drainage service	$660,000	N/A	Medium	Northern Areas Council	Low
D3	James Street Drainage	1,6	Yes	Works	Flood mitigation, drainage service	$1,420,000	N/A	High	Northern Areas Council	Low
D4	Brogan Road Culvert	1,6	Yes	Works	Drainage service	$40,000	N/A	Low	Northern Areas Council	Low
D5	Golf Course Channel works	1,6	Yes	Works, land acquisition	Flood mitigation	$360,000	N/A	High	Northern Areas Council	Low
WQ1	Georgetown Wetland	2,6	Yes	Works, integrated program	Water quality improvement	$1,180,000	$10,000	High	Northern Areas Council	N/A
WQ2	Stormwater Harvesting and Reuse Scheme	3,6	Yes	Works, integrated program	Water quality improvement	$930,000	$7,000	High	Northern Areas Council	N/A
WQ3	Streetscape Raingardens	2,6	Yes	Works, integrated program	Water quality improvement	$200,000	$5,600	Medium	Northern Areas Council	N/A
WQ4	Gross Pollutant Traps	2,5,6	Yes	Works, integrated program	Water quality improvement	$730,000	$6,000	Low	Northern Areas Council	N/A
WQ5	Rainwater Tanks and Allotment Level Reuse	2,3,4,6,7	No	Community education program	Stormwater reuse, water quality improvement, information and knowledge	N/A	N/A	Medium	Northern Areas Council	N/A
N1	Rezoning Flood-prone Land	4,7	No	Policy change, community education program	Flood mitigation, information and knowledge	N/A	N/A	High	Northern Areas Council	N/A
N2	SES Community FloodSafe Program	7	No	Community education program	Flood mitigation, information and knowledge	N/A	N/A	Medium	Northern Areas Council, State Emergency Service	N/A
N3	Council's Emergency Management Plan	1,7	No	Investigation, policy change	Flood mitigation, information and knowledge, administration efficiency	N/A	N/A	Medium	Northern Areas Council	N/A
N4	New Building Floor Levels	4,7	No	Policy change	Flood mitigation	N/A	N/A	Medium	Northern Areas Council, Developers	N/A
N5	Ongoing Maintenance and Monitoring of Council Assets	6	No	Policy change	Flood mitigation, drainage service, information and knowledge, administration efficiency	N/A	N/A	High	Northern Areas Council	N/A
N6	Education and Promotion of WSUD Measures	2,4,7	No	Community education program	Stormwater reuse, water quality improvement, ecological improvement, information and knowledge	N/A	N/A	Medium	Northern Areas Council, Businesses, Organisations, Communities	N/A
N7	Development Controls - Beneficial Use of Stormwater	3,4,7	No	Policy change	Stormwater reuse, water quality improvement	N/A	N/A	Medium	Northern Areas Council, Businesses, Organisations, Communities	N/A

5.6 Prioritisation of Management Responses

The recommendations outlined in this Stormwater Management Plan will require implementation to be scheduled over many years, in order to be accommodated sustainably within the Northern Areas Council's budget and the budgets of other potential funding partners.

Each of the actions within the SMP has been assigned one of five priority levels, each of which have an associated time frame:

- Very High (0-2 years);
- High (2-5 years);
- Moderate (5-10 years);
- Low (10-20 years); and
- Very Low (20-30 years).

A Multi-Criteria Analysis (MCA) approach has been followed to assign priorities to all proposed stormwater management responses. This approach allows relative priorities to be assigned to all recommended structural works, taking into account financial, environmental and social factors. The criteria and weightings adopted have been developed with consideration of the stormwater management objectives and targets developed for this SMP, which were developed following discussions with key stakeholders.

A diverse range of stormwater management strategies have been recommended in this plan to cater to the unique requirements of the town. Having regard to the diversity of these strategies and the need for a flexible and optimal decision making framework for this plan, a separate MCA approach has been developed for the flood mitigation strategies and for the water sensitive urban design strategies.

The two MCA approaches are linked through the inclusion of a criterion that recognises flood mitigation projects that are required as a precursor to the implementation of WSUD actions. Consolidation of scores from the two MCA approaches has also been undertaken to inform the prioritisation of works and reinforce the value of achieving multiple objectives for stormwater management projects in the town.

The priority rating of responses is flexible and likely to change over time. It is anticipated that certain responses will be 'brought forward', particularly when opportunities for external grant funding arise. A number of flood mitigation projects eligible for funding from the Stormwater Management Authority have been identified. It is recommended that Northern Areas Council liaise with the Stormwater Management Authority to identify a time frame for the delivery of these projects that meets the forward budget limitations of both parties.

The SMP brief asks for a reasonable and credible estimate of the benefit provided by each response, quantified where possible. Considering the nature of flooding in the town, with urban runoff being the dominant flooding mechanism in the more frequent events and major watercourses governing flooding in the rarer events, this was not considered possible. As the strategies have been developed holistically looking at both urban and rural flooding mechanisms, no single strategy can be attributed all of the flood reduction achieved in a given area across the range of modelled AEPs. The overall benefit provided by the entire strategy is described in Section 5.1.2.

In lieu of considering the economic benefit of each individual strategy, alternative metrics have been adopted to assess the benefit provided by each. This includes a metric looking at residual nuisance flooding along roads in minor storm events and a metric looking at the reduction in major flood risk in rare storm events. These are qualitative, and have been assessed by comparing the pre-mitigation and post-mitigation flood maps for a range of storm events.

It should be noted that the non-structural measures are not included within the assessment as they do not necessarily fit within the MCA criteria.

5.6.1 Flood Mitigation Strategies Multi-Criteria Analysis

The criteria and weightings used in the MCA to prioritise the flood mitigation strategies are summarised in Table 5.16.

Table 5.16 Flood Mitigation Strategies MCA Performance Matrix

Criterion	Weighting	Performance Score				
		5	4	3	2	1
Capital Cost	20	<$100k	$100-500k	$500k-1m	$1m-2m	>$2m
Reduced Street Drainage Nuisance	20	Very High	High	Moderate	Low	Very Low
Reduced Major Flooding Risk	30	Very High	High	Moderate	Low	Very Low
Precursor to WSUD Strategy	10	Multi-objective WSUD	-	Water Quality Only	-	None
Community Buy-In	20	Very High	High	Moderate	Low	Very Low
Total	100					

Performance values used in the assessment of proposed stormwater management responses have been defined as follows:

- Capital Cost

Reference has been made to the construction cost estimates outlined in this plan to determine this value. Projects with a greater capital cost are assigned lower scores than projects with a smaller capital cost.

- Reduced Street Drainage Nuisance

This value was assigned based on judgement of the improvements demonstrated by the 18% AEP floodplain mapping of the flood mitigation strategies. Projects that limit property and roadway ponding in the vicinity to a depth of less than 0.1 metres were assigned the highest value, with progressively lower values assigned where the residual impact was larger.

- Reduced Major Flooding Risk

This value was assigned based on judgement of the improvements demonstrated by the 5% AEP and rarer floodplain mapping of the flood mitigation strategies. This criterion has been assigned

a higher weighting due to the significant social, financial and environmental impacts associated with major flooding.

➤ Precursor to WSUD Strategy

Several of the recommended flood mitigation strategies are required as a precursor to, or directly facilitate, the implementation of a water sensitive urban design strategy. Projects that facilitate multi-objective WSUD outcomes have been assigned higher values than projects that provide only water quality improvement (e.g. gross pollutant traps). This criterion has been assigned a lower weighting as WSUD strategies are considered separately.

➤ Community Buy-In

All projects were assigned a default maximum rating for this criteria, then revised down for projects that require acquisition of land or easements through private property, and for projects that impact the existing use of public open space. Projects which address issues raised in the community consultation have been assigned higher ratings. Projects that negatively impact existing sites of high recreational value or that support organised sport were assigned the lowest ratings.

Performance values input into the MCA can be found in Appendix J.

Weighted scores for each stormwater management response have been determined using the above MCA framework, and are presented in Table 5.17 from highest to lowest. Note that each strategy can achieve a maximum score of 5 and a minimum score of 1.

Table 5.17 Flood Mitigation Strategies MCA Results

Strategy ID	Description	Weighted Score
D1	Northern Channel Flood Protection	3.4
D2	Pitts Street Drainage	2.9
D3	James Street Drainage	2.7
D4	Brogan Road Culvert	2.6
D5	Golf Course Channel Works	1.8

Using the results of the MCA analysis as a baseline, and factoring in discussions with Council staff regarding known problem areas, strategies have been classified into one of the five priority levels as discussed in Section 5.6.

5.6.2 WSUD Strategies Multi-Criteria Analysis

The criteria and weightings used in the MCA to prioritise the WSUD strategies are summarised in Table 5.18.

Table 5.18 WSUD Strategies MCA Performance Matrix

Criterion	Weighting	Performance Score				
		5	4	3	2	1
Capital Cost	20	<$50k	$50-250k	$250-500k	$500k-1m	>$1.0m
Annual Maintenance Cost	20	<$5k	$5-10k	$10-15k	$15-20k	>$20k
Pollutant (TSS) Reduction (average annual load)	20	>5 tonnes	2-5 tonnes	1-2 tonnes	0.5-1 tonnes	<0.5 tonnes
Stormwater Capture and Reuse	20	Capture and Reuse	-	Capture Only	-	None
Community Buy-In	20	Very High	High	Moderate	Low	Very Low
Total	100					

Performance values used in the assessment of proposed stormwater management responses have been defined as follows:

- Capital Cost

Reference has been made to the construction cost estimates outlined in this plan to determine this value. Projects with a greater capital cost are assigned lower scores than projects with a smaller capital cost.

- Maintenance Cost

Values were assigned based on maintenance cost estimates from historical experience and industry sources.

- Pollutant (TSS) Reduction

Projects have been assigned a value that is reflective of their expected pollutant removal performance, as defined by the average annual load reduction of total suspended solids reported by the MUSIC model.

- Stormwater Capture and Reuse

Several of the recommended WSUD strategies result in the capture and/or reuse of stormwater. Projects that facilitate stormwater capture and reuse have been assigned higher performance scores than projects that facilitate stormwater capture only.

- Community Buy-In

All projects were assigned a default maximum rating for this criteria, then being revised down for projects that require acquisition of land or easements through private property, and for

projects that impact the existing use of public open space. Projects that impact existing sites of high recreational value or that support organised sport were assigned the lowest ratings.

Performance values input into the MCA can be found in Appendix J.

Weighted scores for each stormwater management response have been determined using the above MCA framework, and are presented in Table 5.19 from highest to lowest. Note that each strategy can achieve a maximum score of 5 and a minimum score of 1.

Table 5.19 WSUD Strategies MCA Results

Strategy ID	Description	Weighted Score
WQ3	Streetscape Raingardens	3.6
WQ2*	Stormwater Harvesting and Reuse Scheme	3.2
WQ1	Georgetown Wetland	3.0
WQ4	Gross Pollutant Traps	3.0

* Strategy WQ2 requires strategy WQ1 having been implemented.

5.6.3 Implementation Plan

An implementation plan for the recommended responses is presented in Table 5.20. This table describes the additional work and investigations that would be required to implement any given response, suggests an implementation time frame based on the MCA analysis, and details the responsible party and any funding sources available.

5.6.4 Responsibilities for Implementation and Funding Opportunities

Northern Areas Council is responsible for the implementation of all actions identified within this Stormwater Management Plan. It is expected that Council will continue to liaise with relevant State Government departments and agencies to satisfy a variety of regulatory requirements.

There may be opportunities to secure funding from the Northern and Yorke Landscape Board and the Department of Environment and Water, particularly for water quality improvement works. The South Australian Environment Protection Authority also occasionally provide grants for Water Sensitive Urban Design projects, such as the Rain Garden 500 program in 2016.

Actions that are potentially eligible for Stormwater Management Authority funding (typically co-funding on a 50/50 basis with Local Government for projects with a contributing catchment area greater than 40 hectares) have been highlighted. Note that the authority has the discretion to contribute more or less than 50% of the cost of certain works and may elect to contribute to the cost of works where the contributing catchment area is less than 40 hectares, provided those works form part of an approved Stormwater Management Plan.

Projects not eligible for funding from the Stormwater Management Authority may still be eligible for other external funding opportunities, such as the National Flood Mitigation Infrastructure Program. This program, established by the National Emergency Management Agency, delivered $100 million across 2020-21 and 2021-22 to state and territory governments for the construction or improvement of flood mitigation infrastructure.

5.6.5 Monitoring Implementation Plan Progress

It is recommended that a structured approach is taken to programming in the proposed strategies and actions in this Stormwater Management Plan. Following the endorsement of the Plan, it is recommended Council review their capital works plan to schedule in the strategies recommended alongside previously identified projects.

It is recommended that Council consolidate and continually update their stormwater GIS layers as new infrastructure is constructed. This will not only ensure that the best available information is recorded for future use, but will also enable Council to effectively plan for the long-term management of their stormwater assets from maintenance to renewal. It is also recommended that where strategies will require ongoing maintenance, such as cleaning GPTs and replacing raingarden filter layer material, Council factor this into their budgeting and planning to ensure these assets continue to perform as designed into the future.

It is recommended that Council develop a strategy for reporting progress on the implementation of recommended strategies to key stakeholders including the local community. This will ensure the community remains informed about flood mitigation and water quality improvement works being undertaken by Council, and can be seen as an opportunity to educate the community on the benefits of these types of works. This could include articles on the Council website, updates in the Council newsletter or posts on Council's social media accounts.

Table 5.20 - Stormwater Management Response Implementation Plan

ID	Description	Further Investigation Required?	Land Acquisition Required?	Planning or Policy Changes Required?	Potential Approvals/ Licences Required	Priority	Nominated Time Frame	Responsible Authority	Potential Funding Sources
D1	Northern Channel Flood Protection	Yes	No	No	Water Affecting Activity Permit	Very High	0-2 years	Northern Areas Council	Stormwater Management Authority
D2	Pitts Street Drainage	Yes	No	No	Water Affecting Activity Permit	High	2-5 years	Northern Areas Council	Stormwater Management Authority
D3	James Street Drainage	Yes	No	No	Water Affecting Activity Permit	Moderate	5-10 years	Northern Areas Council	Stormwater Management Authority
D4	Brogan Road Culvert	Yes	No	No		Low	10-20 years	Northern Areas Council	
D5	Golf Course Channel works	Yes	Yes	No		Moderate	5-10 years	Northern Areas Council	
WQ1	Georgetown Wetland	Yes	No	No	Water Affecting Activity Permit	Moderate	5-10 years	Northern Areas Council	
WQ2	Stormwater Harvesting and Reuse Scheme	Yes	No	No		Moderate	5-10 years	Northern Areas Council	
WQ3	Streetscape Raingardens	Yes	No	No		High	2-5 years	Northern Areas Council	
WQ4	Gross Pollutant Traps	Yes	No	No	Water Affecting Activity Permit	Low	10-20 years	Northern Areas Council	
WQ5	Rainwater Tanks and Allotment Level Reuse	Yes	N/A	Yes		Low	10-20 years	Northern Areas Council	
N1	Rezoning Flood-prone Land	N/A	N/A	Yes		Moderate	5-10 years	Northern Areas Council	
N2	SES Community FloodSafe Program	N/A	N/A	Yes		Very High	0-2 years	Northern Areas Council, State Emergency Service	Stormwater Management Authority
N3	Council's Emergency Management Plan	N/A	N/A	Yes		High	2-5 years	Northern Areas Council	
N4	New Building Floor Levels	N/A	N/A	Yes		Moderate	5-10 years	Northern Areas Council	
N5	Ongoing Maintenance and Monitoring of Council Assets	N/A	N/A	Yes		Low	10-20 years	Northern Areas Council	
N6	Education and Promotion of WSUD Measures	N/A	N/A	Yes		Low	10-20 years	Northern Areas Council	Stormwater Management Authority
N7	Development Controls – Beneficial Use of Stormwater	N/A	N/A	Yes		Low	10-20 years	Northern Areas Council	Stormwater Management Authority

5.7 Review of SMP Objectives and Targets

Table 5.21 below provides an assessment of the degree to which each of the identified Stormwater Management Plan objectives and targets have been met by the recommended management measures.

Table 5.21 Assessment of SMP Objectives and Targets

Objective /Target	Achieved?	Discussion
Provide an acceptable level of flood protection for the community and both public and private assets		
1a	Partially	The flood mitigation measures were found to reduce the number of dwellings facing above-floor inundation in a 1% AEP flood from 22 to 2 (a 91% reduction). This target was aspirational, and the flood mitigation measures were developed targeting the 5% AEP flood event.
1b	Yes	No above floor inundation of dwellings in a 5% AEP flood event was achieved through the recommended flood mitigation measures.
1c	Yes	The upgrades result in a maximum hazard class H1 (safe for vehicle access) along Fisher Street and Horrocks Highway to the north, and Georgetown-Narridy Road to the west, providing safe evacuation routes out of town.
1d	Yes	Council have throughout the project communicated with the community to describe the flood risk racing the town. The recommended FloodSafe program run by SES will enable the community to be prepared for a flood.
1e	Yes	The recommendations of this SMP include for Council to develop a Community Emergency Management Plan.
Manage the quality of runoff and its effects on receiving waters		
2a	Yes	The proposed water quality improvement strategy meets the aspirational pollutant reduction targets.
2b	Yes	The plan recommends for the education and promotion of WSUD measures throughout the wider community.
Make beneficial use of stormwater		
3a	Yes	Opportunities to implement a stormwater harvesting and reuse scheme alongside the proposed wetlands have been investigated.
3b	Yes	It has been recommended for Council to promote the use of WSUD measures to reduce the stormwater runoff leaving development sites.
Planning for new developments provides for open space, recreation and amenity		
4a	Yes	This SMP recommends strategies to enforce development control for new development floor levels.
4b	Yes	A campaign to educate the community about the benefits of WSUD infrastructure is recommended as part of this SMP.
4c	Yes	Development controls to improve opportunities to beneficially reuse stormwater have been recommended through this SMP.

Objective /Target	Achieved?	Discussion
Improve the condition of receiving waters		
5a	Yes	Gross pollutant traps have been proposed at the end of line for systems discharging to the receiving waters.
Sustainable asset management of stormwater infrastructure		
6a	Yes	A recommendation of this SMP is for Council to develop a Stormwater Asset Management Plan, and develop a GIS database for their stormwater infrastructure.
6b	Yes	All proposed structural management measures have been designed against future development and climate change.
Effective communication and consultation with catchment stakeholders, businesses and community members		
7a	Yes	Through the development of this SMP the community were consulted on the stormwater risks facing the town.
7b	Yes	The SES FloodSafe program recommended will help prepare the community for a potential flood event.
7c	Yes	The stormwater management responses summary table and implementation plan suggest external agencies such as the Stormwater Management Authority that Council may be able to partner with in the development of management measures.

6 References

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Appendix A

Flood Risk Consequence Matrix



Flood Risk Consequence Matrix

Consequence						
Level	**General**	**Flooding**	**Health & Safety**	**Cost**	**Environmental**	**Social/Stakeholder**
1 Insignificant	Undetectable or below guidelines, no disruption to normal operation, no increase in normal operation costs	Nuisance road ponding in the 18% AEP flood, negligible property inundation in the 1% AEP flood	Insignificant impact to health & safety	Insignificant loss of assets and resources and insignificant impact on budget	Insignificant impact to the environment & negligible effect on customers	Insignificant damage to Council and stakeholder perception/confidence
2 Minor	Some manageable operation disruption, some increase in operating costs	Shallow road ponding in the 18% AEP flood, properties inundated up to 250mm deep in the 1% AEP flood	Minor impact to health & safety resulting in no injuries	Loss of assets and resources, <5% deviation from program budget	Breach of a control system causing minor environmental impact, minor effect on customers	Minor negative perception and short-term damage to an insignificant audience
3 Moderate	Significant modification to normal operation but manageable, operation costs increased, increased monitoring	Properties inundated over 250mm deep, trafficability of roads limited in the 1% AEP flood	Moderate impact to health & safety resulting in minor injuries requiring medical assistance	Moderate loss of assets and resources, 5% deviation from program budget resulting in limiting project scope	Intermittent non-compliance with regulations causing moderate impacts to the environment, moderate effect on customers	Moderate negative perception and short-term damage to a specific audience in Council or stakeholder agencies
4 Major	Systems significantly compromised and abnormal operation if at all, high level of monitoring required	Many properties inundated over 500mm deep, roads inundated over 1m deep in the 1% AEP flood	Major impacts to health & safety resulting in serious injury and hospitalisation	Major loss of assets and resources, 15% deviation from program budget, resulting in possible closure of the project	Failure to comply with regulations & causing major environmental hard resulting in temporary shutdown of the project, adverse effect on customers	Negative Council and stakeholder perception and short-term damage to Council and stakeholder confidence
5 Catastrophic	Major impact, complete failure of systems, risk to public health & environment	Widespread property inundation over 1m deep, emergency services infrastructure impacted, road access completely cut off in 1% AEP flood	Significant impact to health & safety resulting in death	Significant loss of assets and resources, 30% deviation from program budget, resulting in closure of the project	Sustained non-compliance to regulation & causing significant impact to the environment causing project closure	Significant impact to Council and stakeholder perception and long-term damage to Council and stakeholder confidence

Appendix B

Community Consultation Responses



Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

This feedback form should be read in conjunction with the summary brochure and State of the Catchment reports which explain the work undertaken to date on the Stormwater Management Plans.

1 Which of the following describes your interest in the Stormwater Management Plans? Please tick all that apply.

- ☑ Local resident
- ☑ Interest or experience of flooding
- ☑ Interest in local environment
- ☑ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding		✓			
Water quality			✓		
Stormwater capture and reuse			✓		
Climate change				✓	

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

- CENTRE OF TOWN HAS VERY POOR ABILITY TO CLEAR STORM WATER.
- SIGNIFICANT EVENTS ARE NOT ABLE TO BE CONTROLLED. ESPECIALLY NORTH OF TOWN (DIVERSION)
- CATCH AND RELEASE IN TOWN DAM APPEARS INADEQUATE. TOWN DAM DOES NOT HOLD WATER AND NEED CLEANING OF SILT SO THAT IT COULD BE USED ON THE OVAL.

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

OUR PROPERTY (20 ACRES) SW OF TOWN DOES NOT ADD MUCH TO THE STORM WATER IN TOWN. HOWEVER THE NATURAL WATER COARSE CROSSES BLOGAN RD. THIS IS REPAIRED ANNUALLY. I WOULD SUGGEST A CULVERT UNDER THE ROAD AT THE CROSSING POINT.

5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name .....

Suburb GEORGETOWN .....

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: ... .

Email: ... .

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

Submissions should be completed by 30 October, 2023. Please return this feedback form to one of the following:

- Northern Areas Council, PO Box 120, 94 Ayr Street Jamestown, SA 5491
- Gladstone District Office, 14 Fifth Street Gladstone, SA 5473
- Spalding District Office, 11 Main Street Spalding, SA 5454
- Via email to admin@nacouncil.sa.gov.au

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

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1 Which of the following describes your interest in the Stormwater Management Plans? Please tick all that apply.

- ☑ Local resident
- ☑ Interest or experience of flooding
- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	1				
Nuisance flooding	1				
Water quality					
Stormwater capture and reuse	1				
Climate change					

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

- Ensuring that the stormwater harvesting in gladstone currently in place is not impacted by any changes made, eg. The harvesting point at the railway line.
- Problems occur in regards to the blockages in the Rocky River through Boyodee, which divert the water out of the creek in various locations, changing the true flow of water.

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

- I believe these blockages need to be considered and attended to in regards to the plan.

- The floodway along high street does not need to be made larger as it currently acts as a good watering source for the trees and grass along this area in its current ways.

5 To help us understand who participated in the consultation please provide the following details:

Name: ...

Street name: .

Suburb ... Gladstone SA 5473

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .....

Email: .....

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

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Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

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- ☑ Local resident
- ☑ Interest or experience of flooding
- ☑ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding			✓		
Water quality			✓		
Stormwater capture and reuse			✓		
Climate change ?					

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

Pisant Creek clearing a
Port Broughton will be Good

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

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5 To help us understand who participated in the consultation please provide the following details:

Name: ....

Street name: ....

Suburb .....

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: ....

Email: ....

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

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- ☑ Local resident
- ☑ Interest or experience of flooding
- ☑ Interest in local environment
- ☑ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☑ Other (please specify) Work being done to help improve the look of our town.

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding	✓				
Water quality	✓				
Stormwater capture and reuse	✓				–
Climate change	✓				–

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

The corner of Cross St + High St dam catchment area has become a continual eyesaw in the centre of our town + visitors to our town plus locals have to drive past it. The project wasn't ever completed as the water has no clear channel to follow down High St + doesn't get harvested for re-use. It is also a safety hazard with no protective guard rails – only flimsy posts which are continually knocked over.

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

Before the project began we were assured that the catchment area would be landscaped but we only have weeds left to grow to a metre or more & only sprayed when we complain. Then they are left to rot down naturally & it's not a very welcoming sight in any town.

5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name: .....

Suburb ..... Gladstone 5473. .....

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .....

Email: .....

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

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1 Which of the following describes your interest in the Stormwater Management Plans? Please tick all that apply.

- ☑ Local resident
- ☐ Interest or experience of flooding
- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding	✓				
Water quality				✓	
Stormwater capture and reuse				✓	
Climate change				✓	

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

1) Supporting the call for urgent attention to the flood water problem adjacent my sister's property at 24 West Tce Laura
2) PTO

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

2) The spoondrain adjacent my property needs replacing. It has lifted at joins & is consistantly silted up, which when we have heavy rainfall spreads stormwater into my property

5 To help us understand who participated in the consultation please provide the following details:

Name: ...

Street name: .

Suburb ..... Laura 5480

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: ....

Email: .....

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

Submissions should be completed by 30 October, 2023. Please return this feedback form to one of the following:

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

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1 Which of the following describes your interest in the Stormwater Management Plans? Please tick all that apply.

- ☑ Local resident
- ☑ Interest or experience of flooding
- ☐ Interest in local environment
- ☑ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☑ Other (please specify) toilet sewage/sewers in small towns without systems + drainage/recycling water - better facilities for recycle of garden water.

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest. (Probably more a Gov issue)

	1	2	3	4	5
Major flooding				4	
Nuisance flooding					5
Water quality			3		
Stormwater capture and reuse		2			
Climate change	1				

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

1) Big rains, storms + flooding - All this lovely water is wasted - it just flows out to the rivers + ends up at the sea. Last November there was enough rain to fill all our tanks but it all went out + down the Broughton River. - 2) The rivers need to be cleared of reeds which are blocking up the flow of water.

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

I think the Government should give more grants to Regional towns to support more people to be able to afford 1) Solar 2) Sewage recycle systems 3) Rain Water tanks — This would also help with climate change.

5 To help us understand who participated in the consultation please provide the following details:

Name: ..

Street name: ..

Suburb ..... Spalding 5454

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .....

Email: .....

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

Submissions should be completed by 30th October, 2023. Please return this feedback form to one of the following:

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

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- ☑ Local resident
- ☐ Interest or experience of flooding
- ☑ Interest in local environment
- ☑ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	1				
Nuisance flooding			1		
Water quality	1				
Stormwater capture and reuse	1				
Climate change				1	

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

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5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name: .... Spalding phone rings twenty

Suburb times (because of scammers) leave a message and we'll get back to you

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .....

Email: .....

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

Submissions should be completed by 30th October, 2023. Please return this feedback form to one of the following:

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Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

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- ☑ Local resident
- ☑ Interest or experience of flooding
- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding	✓				
Water quality	✓				
Stormwater capture and reuse	✓				
Climate change					✓

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

would like to see proper storm water drainage in the main Street to stop the water flowing through the main st (spalding)

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

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5 To help us understand who participated in the consultation please provide the following details:

Name: .. ..

Street name: ....

Suburb ..... Spalding .....

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .. ..

Email: ... .

Thank you for taking the time to complete the feedback form. Your feedback is invaluable and will be considered in developing the Stormwater Management Plans.

Submissions should be completed by 30th October, 2023. Please return this feedback form to one of the following:

- Northern Areas Council, PO Box 120, 94 Ayr Street Jamestown, SA 5491
- Gladstone District Office, 14 Fifth Street Gladstone, SA 5473
- Spalding District Office, 11 Main Street Spalding, SA 5454
- Via email to admin@nacouncil.sa.gov.au

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

This feedback form should be read in conjunction with the summary brochure and State of the Catchment reports which explain the work undertaken to date on the Stormwater Management Plans.

1 Which of the following describes your interest in the Stormwater Management Plans? Please tick all that apply.

- ☑ Local resident
- ☐ Interest or experience of flooding
- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☑ Other (please specify) BECAUSE I WAS TOLD FRESHWATER CREEK COULD FLOOD MY INSURANCE WENT FROM $130 TO $821 PER MONTH

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding					✓
Nuisance flooding					✓
Water quality			✓		
Stormwater capture and reuse					✓
Climate change	✓				

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

FROM THE BOTTOM OF FRESHWATER CREEK IT WOULD HAVE TO RAISE 30 MTRS TO FLOOD OUR HOUSE ACCORDING TO OLD LOCALS IT HASN'T FLOODED IN 100 YEARS PLEASE EXPLAIN?

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

REFER TO N° 3.

5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name: .....

Suburb SPALDING 5454

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .....

Email: .....

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- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding			✓		
Nuisance flooding		✓			
Water quality			✓		
Stormwater capture and reuse			✓		
Climate change		✓			

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

I'M NOT SURE IF ITS POSSIBLE TO RE-LOOK AT FLOOD MANAGEMENT PLAN, FOR THE MAIN CBD AREA OF THE TOWN OF SPALDING - IT STILL FLOODS BAD EVEN AFTER 1 (1 HOUR) EVENT, AS HAPPENED LAST NOV. 2022 - MAYBE A SECOND DIVERSION CHANNEL (NOT SO BIG AS THE FIRST)

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

MAIN ST (AND TOWN) FLOODING IN TOWN OF SPALDING, EVEN AFTER A 1 HOUR EVENT. (I KNOW ITS HEAVY RAIN IN THAT HOUR, BUT STILL!

5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name: .....

Suburb SPALDING SA 5454

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: .. ..

Email: .....

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Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

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- ☐ Interest or experience of flooding
- ☑ Interest in local environment
- ☑ Interest in improving water quality
- ☑ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	✓				
Nuisance flooding	✓				
Water quality	✓				
Stormwater capture and reuse	✓				
Climate change				✓	

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

.....

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.....

.....

.....

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

We need stormwater pipes (drains).

5 To help us understand who participated in the consultation please provide the following details:

Name: ..

Street name: .....

Suburb ..... Spalding

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone: ...

Email: ....

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Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

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- ☑ Interest or experience of flooding
- ☐ Interest in local environment
- ☐ Interest in improving water quality
- ☐ Interest in water conservation and/or stormwater harvesting and reuse
- ☐ Other (please specify) .....

2 Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

	1	2	3	4	5
Major flooding	1				
Nuisance flooding		2			
Water quality					5
Stormwater capture and reuse			3		
Climate change				4	

3 Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

Main street from shop to Burra turn.
Maintenance program.
Wider channel to run water away quicker at
South End of town.

Laura, Gladstone, Georgetown and Spalding
Stormwater Management Plans

Community Response Form

4 Do you have any other comments to make?

Outside of our yard getting flooded I have some ideas but no-one wants to know, whether they are simple or more complex ones.
After last flooding footpath not fixed, still gravel etc in gutters (street sweeping did not remove)
Culvert Bridge never maintained - full of weeds + debris

5 To help us understand who participated in the consultation please provide the following details:

Name: .....

Street name: .....

Suburb .....Spalding.....

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

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Email: .....

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Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

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For the best experience, it is recommended to complete this form on a computer or laptop device.

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- [x] Local resident
- [ ] Interest or experience of flooding
- [ ] Interest in local environment
- [ ] Interest in improving water quality
- [ ] Interest in water conservation and/or stormwater harvesting and reuse
- [ ] Other

Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

Major flooding

○ 1 ○ 2 ◉ 3 ○ 4 ○ 5

Nuisance flooding

○ 1 ○ 2 ○ 3 ◉ 4 ○ 5

Water quality

○ 1 ○ 2 ○ 3 ◉ 4 ○ 5

Stormwater capture and reuse

○ 1 ○ 2 ○ 3 ◉ 4 ○ 5

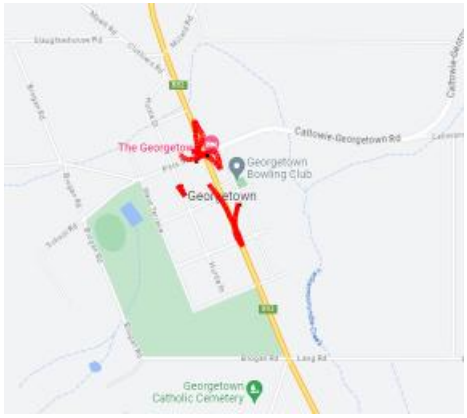
Climate change

○ 1 ○ 2 ○ 3 ◉ 4 ○ 5

Please select the town you are a resident of:

- ○ Laura
- ○ Gladstone
- ◉ Georgetown
- ○ Spalding
- ○ Other

Please mark on the map any locations where you have noticed a flooding or stormwater issue.



Clear drawing

Please provide details of any issues you recorded.

Poorly designed guttering lower than drains that can not drain. Inadequate drainage for moderate rainfall at Pitts/Fisher st corner leading to the corner flooding.

Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

Greater consideration to what happens with heavy rainfall, and multiple opportunity for water to escape when drains block

Do you have any other comments to make?

To help us understand who participated in the consultation please provide the following details:

Name

Street Name

Suburb

georgetown

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone Number

Email Address

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

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- [ ] Interest or experience of flooding
- [ ] Interest in local environment
- [ ] Interest in improving water quality
- [ ] Interest in water conservation and/or stormwater harvesting and reuse
- [ ] Other

Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

Major flooding

(●) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

Nuisance flooding

( ) 1 (●) 2 ( ) 3 ( ) 4 ( ) 5

Water quality

( ) 1 ( ) 2 (●) 3 ( ) 4 ( ) 5

Stormwater capture and reuse

( ) 1 ( ) 2 ( ) 3 (●) 4 ( ) 5

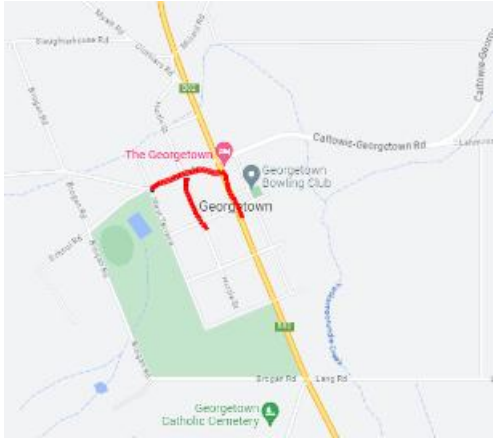
Climate change

( ) 1 ( ) 2 ( ) 3 ( ) 4 (●) 5

Please select the town you are a resident of:

- ( ) Laura
- ( ) Gladstone
- (●) Georgetown
- ( ) Spalding
- ( ) Other

Please mark on the map any locations where you have noticed a flooding or stormwater issue.



Clear drawing

Please provide details of any issues you recorded.

Flooding and large volumes of water from the carport behind the community hall, flood Fisher Street and drag dirt from the carpark

blocking drains.

Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

The gutters on hurtle Street both sides and fisher street western side need replacing. The damaged gutters contribute to standing water and flooding.

Do you have any other comments to make?

To help us understand who participated in the consultation please provide the following details:

Name

Street Name

Suburb

Georgetown

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone Number

Email Address

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

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- [ ] Other

Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

Major flooding

(●) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

Nuisance flooding

(●) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

Water quality

( ) 1 (●) 2 ( ) 3 ( ) 4 ( ) 5

Stormwater capture and reuse

(●) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

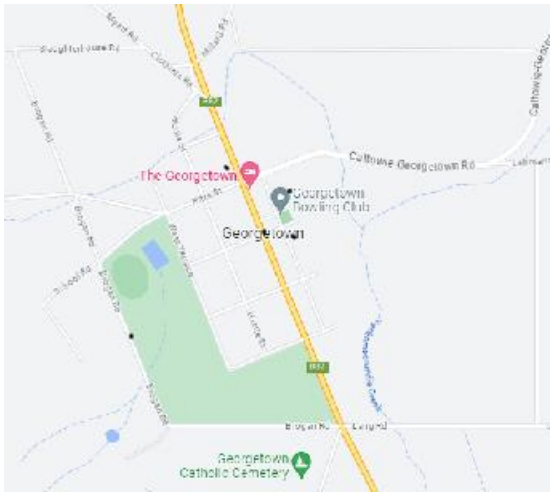
Climate change

( ) 1 ( ) 2 (●) 3 ( ) 4 ( ) 5

Please select the town you are a resident of:

- ( ) Laura
- ( ) Gladstone
- (●) Georgetown
- ( ) Spalding
- ( ) Other

Please mark on the map any locations where you have noticed a flooding or stormwater issue.



Clear drawing

Please provide details of any issues you recorded.

Bowls Club entrance is flooded during heavy down pours.
Brogan Road has water flowing over it following a heavy downpour and is following a natural water course.
Parts of Fisher Street has water almost to the gutters and takes a long time to recede.

Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

Do you have any other comments to make?

No

To help us understand who participated in the consultation please provide the following details:

Name

Street Name

Suburb

Georgetown

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone Number

Email Address

Laura, Gladstone, Georgetown and Spalding Stormwater Management Plans

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- [x] Local resident
- [ ] Interest or experience of flooding
- [ ] Interest in local environment
- [ ] Interest in improving water quality
- [ ] Interest in water conservation and/or stormwater harvesting and reuse
- [ ] Other

Please score the following stormwater management considerations from 1 to 5, with 1 being the highest priority in your opinion and 5 being the lowest.

Major flooding

- (●) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5

Nuisance flooding

- ( ) 1 (●) 2 ( ) 3 ( ) 4 ( ) 5

Water quality

- ( ) 1 ( ) 2 ( ) 3 (●) 4 ( ) 5

Stormwater capture and reuse

- ( ) 1 ( ) 2 (●) 3 ( ) 4 ( ) 5

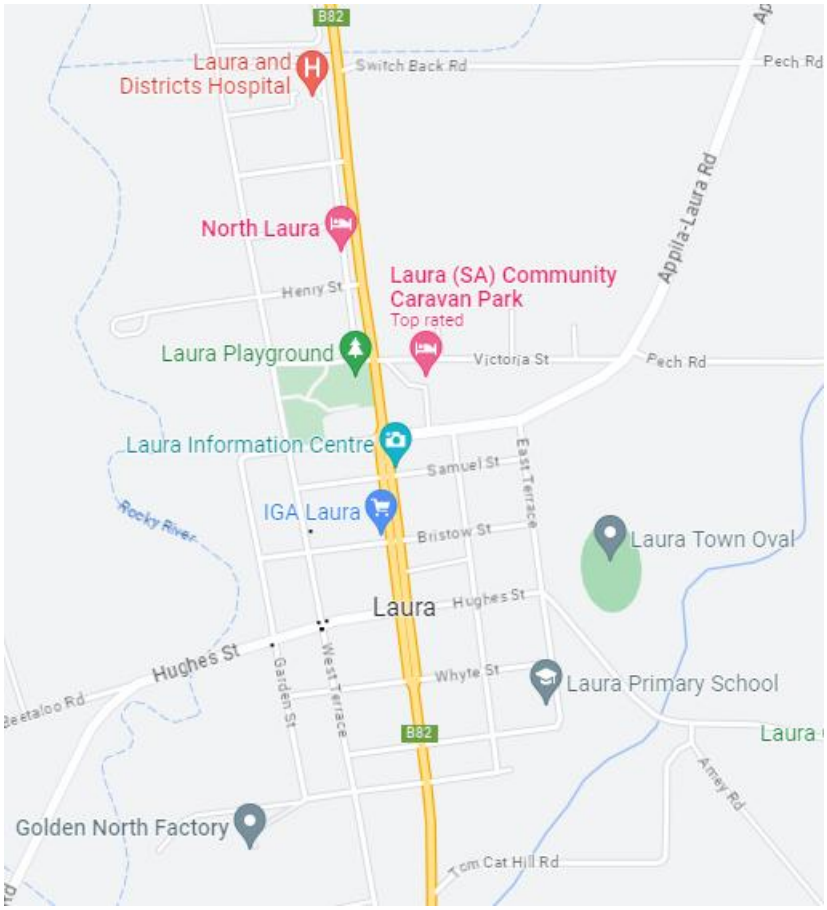
Climate change

- ( ) 1 ( ) 2 ( ) 3 ( ) 4 (●) 5

Please select the town you are a resident of:

- (●) Laura
- ( ) Gladstone
- ( ) Georgetown
- ( ) Spalding
- ( ) Other

Please mark on the map any locations where you have noticed a flooding or stormwater issue.



Clear drawing

Please provide details of any issues you recorded.

Water fails to flow on West Terrace due to their being no proper drains. Any drop of leaves/branches/seeds will clog the "gutter"and cause the water to back up. Their needs to be a proper delving of the drains each year to ensure that there is aproper channel which allows the water to run.

The intersection of Hughes Street and West Terrace has large puddles on t least three corners when it rains. Whic is compounded by both heavy and light traffic cutting the corners and creating large potholes, which then fill with water. There needs to be either traffic management systems put in place to prevent corner cutting or the road surface needs ot be extended and strengthened to prevent heavy traffic from tearing up the unprotected surface. Water flows from both West Terrace and Highes Street into this intersection so it may be necessary to have drainage along Hughes Street into the Rocky River.

Are there any specific stormwater related issues or concerns you would like to see the Stormwater Management Plans address? For example a specific local flooding problem or any ways in which you think stormwater should be managed within the towns? Please explain your response.

As above

Do you have any other comments to make?

To help us understand who participated in the consultation please provide the following details:

Name

Street Name

Suburb

Laura

If you are open to being contacted regarding your response, please provide your phone number and/or email address.

Phone Number

Email Address

Appendix C

Scenario A Flood Mapping



Appendix D

Scenario A Flood Hazard Mapping



Appendix E

Scenario B Flood Mapping



Appendix F

Scenario B Flood Hazard Mapping



Appendix G

Scenario C Flood Mapping



Appendix H

Scenario C Flood Hazard Mapping



Appendix I

Cost Estimates



Indicative Construction Cost Estimate

Project	Georgetown SMP
Job Number	22035
Title	Northern Channel Upgrade (D1-A)
Estimator	QB
Reviewer	DJ
Date	20-Jan-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Open channel excavation and shaping	m^3	4995	$ 95.00	$ 474,525.00
	Subtotal				**$ 474,525.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 71,178.75
	Design	item	1	10%	$ 47,452.50
	Services modifications	item	1	10%	$ 47,452.50
	Contingencies on construction	item	1	20%	$ 128,121.75
	Grand Total				**$ 768,730.50**

Notes

All figures are exclusive of GST (10%)

Cost estimates prepared by Southfront are based upon historical cost information and experience, and do not allow for latent or market conditions (ie. competition, escalation). Southfront recommend that a professional quantity surveyor be engaged if assurance of cost and project budget estimates allowing for these factors is required.

Indicative Construction Cost Estimate

Project	Georgetown SMP
Job Number	22035
Title	Northern Channel Culvert Upgrades (D1-B)
Estimator	QB
Reviewer	DJ
Date	20-Jan-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Remove and dispose of existing large diameter RCP	m	28	$ 130.00	$ 3,640.00
	Remove and dispose of existing large headwall	item	4	$ 10,000.00	$ 40,000.00
	Remove and dispose of pedestrian crossing	item	1	$ 5,000.00	$ 5,000.00
	Headwall approach excavation and shaping	m^3	120	$ 95.00	$ 11,400.00
	Supply, lay, backfill and reinstate 1500 mm diameter RCP	m	20	$ 2,490.00	$ 49,800.00
	Supply, lay, backfill and resinstate 2100mm x 900mm box culvert	m	52	$ 3,200.00	$ 166,400.00
	Subtotal				**$ 276,240.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 41,436.00
	Design	item	1	10%	$ 27,624.00
	Services modifications	item	1	10%	$ 27,624.00
	Contingencies on construction	item	1	30%	$ 111,877.20
	Grand Total				**$ 484,801.20**

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Indicative Construction Cost Estimate

Project	Georgetown SMP
Job Number	22035
Title	Northern Channel Outfall Upgrade (D1-C)
Estimator	QB
Reviewer	DJ
Date	20-Jan-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Open channel excavation and shaping	m^3	2100	$ 95.00	$ 199,500.00
	Subtotal				**$ 199,500.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 29,925.00
	Design	item	1	10%	$ 19,950.00
	Services modifications	item	1	0%	$ -
	Contingencies on construction	item	1	20%	$ 49,875.00
	Grand Total				**$ 299,250.00**

Notes

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Indicative Construction Cost Estimate

Project	Georgetown SMP
Job Number	22035
Title	Upstream Detention Storage (D1-D)
Estimator	QB
Reviewer	DJ
Date	21-Jan-25

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Basin excavation and shaping	m^3	1800	$	95.00	$	171,000.00
	Supply, lay, backfill and reinstate 1200 mm diameter RCP	m	100	$	1,810.00	$	181,000.00
	Supply and install large headwall (>750mm diam)	item	2	$	4,510.00	$	9,020.00
	Subtotal					**$**	**361,020.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	54,153.00
	Design	item	1		10%	$	36,102.00
	Services modifications	item	1		5%	$	18,051.00
	Contingencies on construction	item	1		20%	$	93,865.20
	Grand Total					**$**	**563,191.20**

Notes

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Indicative Construction Cost Estimate

Project	Georgetown SMP
Job Number	22035
Title	Pitts Street Drainage (D2)
Estimator	QB
Reviewer	DJ
Date	21-Jan-25

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Supply, lay, backfill and reinstate 750 mm diameter RCP	m	180	$	940.00	$	169,200.00
	Supply, lay, backfill and reinstate 600 mm diameter RCP	m	6	$	790.00	$	4,740.00
	Supply, lay, backfill and reinstate 450 mm diameter RCP	m	24	$	590.00	$	14,160.00
	Supply, lay, backfill and reinstate 375 mm diameter RCP	m	30	$	490.00	$	14,700.00
	Supply and install double side entry pit	item	6	$	4,500.00	$	27,000.00
	Supply and install 900 x 900mm junction box	item	2	$	3,865.00	$	7,730.00
	Supply and install 1200 x 1200mm junction box	item	3	$	6,440.00	$	19,320.00
	Supply and install small headwall (<750mm diam)	item	1	$	3,865.00	$	3,865.00
	Open channel excavation and shaping	m^3	400	$	95.00	$	38,000.00
	Raised footpath/verge construction and shaping	m^2	270	$	350.00	$	94,500.00
	Subtotal					**$**	**393,215.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	58,982.25
	Design	item	1		10%	$	39,321.50
	Services modifications	item	1		5%	$	19,660.75
	Contingencies on construction	item	1		30%	$	153,353.85
	Grand Total					**$**	**664,533.35**

Notes

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Indicative Construction Cost Estimate

Project	Georgetown SMP
Job Number	22035
Title	James Street Drainage (D3)
Estimator	QB
Reviewer	DJ
Date	21-Jan-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Supply, lay, backfill and resinstate 1800mm x 600mm box culvert	m	107	$ 2,300.00	$ 246,100.00
	Supply, lay, backfill and reinstate 900 mm diameter RCP	m	296	$ 1,270.00	$ 375,920.00
	Supply, lay, backfill and reinstate 525 mm diameter RCP	m	25	$ 690.00	$ 17,250.00
	Supply, lay, backfill and reinstate 450 mm diameter RCP	m	123	$ 590.00	$ 72,570.00
	Supply, lay, backfill and reinstate 375 mm diameter RCP	m	5	$ 490.00	$ 2,450.00
	Supply and install double side entry pit	item	7	$ 4,500.00	$ 31,500.00
	Supply and install 900 x 900mm junction box	item	2	$ 3,865.00	$ 7,730.00
	Supply and install 1200 x 900mm junction box	item	1	$ 5,150.00	$ 5,150.00
	Supply and install 1200 x 1200mm junction box	item	1	$ 6,440.00	$ 6,440.00
	Supply and install large scale junction box	item	1	$ 10,000.00	$ 10,000.00
	Supply and install large headwall (>750mm diam)	item	1	$ 4,510.00	$ 4,510.00
	Open channel excavation and shaping	m^3	900	$ 95.00	$ 85,500.00
	Remove and dispose of existing small diameter RCP	m	82	$ 65.00	$ 5,330.00
	Remove and dispose of existing small pit	item	2	$ 260.00	$ 520.00
	Subtotal				**$ 870,970.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 130,645.50
	Design	item	1	10%	$ 87,097.00
	Services modifications	item	1	5%	$ 43,548.50
	Contingencies on construction	item	1	25%	$ 283,065.25
	Grand Total				**$ 1,415,326.25**

Notes

All figures are exclusive of GST (10%)

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Indicative Construction Cost Estimate

Project	Georgetown SMP
Job Number	22035
Title	Brogan Road Culvert (D4)
Estimator	QB
Reviewer	DJ
Date	21-Jan-25

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Supply, lay, backfill and reinstate 750 mm diameter RCP	m	14	$	940.00	$	13,160.00
	Remove and dispose of existing small headwall	item	2	$	5,000.00	$	10,000.00
	Headwall approach excavation and shaping	m^3	50	$	25.00	$	1,250.00
	Subtotal					**$**	**24,410.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	3,661.50
	Design	item	1		10%	$	2,441.00
	Services modifications	item	1		5%	$	1,220.50
	Contingencies on construction	item	1		20%	$	6,346.60
	Grand Total					**$**	**38,079.60**

Notes

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Indicative Construction Cost Estimate

Project	Georgetown SMP
Job Number	22035
Title	Golf Course Channel Works (D5)
Estimator	QB
Reviewer	DJ
Date	21-Jan-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Open channel excavation and shaping	m^3	2500	$ 95.00	$ 237,500.00
	Subtotal				**$ 237,500.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 35,625.00
	Design	item	1	10%	$ 23,750.00
	Services modifications	item	1	0%	$ -
	Contingencies on construction	item	1	20%	$ 59,375.00
	Grand Total				**$ 356,250.00**

Notes

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Indicative Construction Cost Estimate

Project	Georgetown SMP
Job Number	22035
Title	Georgetown Wetland (WQ1)
Estimator	QB
Reviewer	DJ
Date	3-Feb-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Bulk excavation for sedimentation basin (permanent pool volume)	m^3	200	$ 95.00	$ 19,000.00
	Bulk excavation for wetland (permanent pool volume)	m^3	1750	$ 95.00	$ 166,250.00
	Geofab liner	m^2	5000	$ 75.00	$ 375,000.00
	Wetland growing medium (100mm thick) and plantings)	m^2	5000	$ 20.00	$ 100,000.00
	Bulk excavation for storage pond (permanent pool volume)	m^3	1000	$ 95.00	$ 95,000.00
	Subtotal				**$ 755,250.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 113,287.50
	Design	item	1	10%	$ 75,525.00
	Services modifications	item	1	5%	$ 37,762.50
	Contingencies on construction	item	1	20%	$ 196,365.00
	Grand Total				**$ 1,178,190.00**

Notes

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Indicative Construction Cost Estimate

Project	Georgetown SMP
Job Number	22035
Title	Stormwater Harvesting and Reuse Scheme (WQ2)
Estimator	QB
Reviewer	DJ
Date	3-Feb-25

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Supply and install packaged submersible pump station	item	1	$	100,000.00	$	100,000.00
	Supply and install rising main	m	1000	$	245.00	$	245,000.00
	Supply, install and plumb filtration and UV disinfection	item	1	$	100,000.00	$	100,000.00
	Supply and install shed	item	1	$	100,000.00	$	100,000.00
	Supply and install 30 kL storage tank	item	1	$	18,000.00	$	18,000.00
	Electrical connection allowance	item	1	$	12,000.00	$	12,000.00
	Pour concrete base slab for shed and tank	m^2	75	$	290.00	$	21,750.00
	Subtotal					**$**	**596,750.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	89,512.50
	Design	item	1		10%	$	59,675.00
	Services modifications	item	1		5%	$	29,837.50
	Contingencies on construction	item	1		20%	$	155,155.00
	Grand Total					**$**	**930,930.00**

Notes

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Indicative Construction Cost Estimate

Project	Georgetown SMP
Job Number	22035
Title	Raingarden (WQ3)
Estimator	QB
Reviewer	DJ
Date	3-Feb-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Excavation (cut to disposal of Waste Fill)	m^3	20	$ 120.00	$ 2,400.00
	HDPE liner	m^2	30	$ 95.00	$ 2,850.00
	Perforated PVC pipe	m	20	$ 90.00	$ 1,800.00
	600mm square field inlet	item	1	$ 3,750.00	$ 3,750.00
	Filter media	m^3	7.5	$ 115.00	$ 862.50
	Screenings and transition layer	m^3	1.5	$ 90.00	$ 135.00
	Submerged zone	m^3	7.5	$ 115.00	$ 862.50
	Rock scour protection	m^2	3	$ 195.00	$ 585.00
	150mm high barrier kerb (or similar concrete edging)	m	20	$ 120.00	$ 2,400.00
	Plantings and temporary irrigation	m^2	15	$ 25.00	$ 375.00
	Subtotal				**$ 16,020.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 2,403.00
	Design	item	1	10%	$ 1,602.00
	Services modifications	item	1	5%	$ 801.00
	Contingencies on construction	item	1	20%	$ 4,165.20
	Total				**$ 24,991.20**
	Number of Raingardens				**8**
	Grand Total				**$ 199,929.60**

Notes

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Indicative Construction Cost Estimate

Project	Gladstone SMP
Job Number	22035
Title	D2 Gross Pollutant Trap (WQ4)
Estimator	QB
Reviewer	DJ
Date	3-Feb-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Supply and install Ecosol GPT 4600 (max pipe diameter 900mm)	item	1	$ 115,500.00	$ 115,500.00
	Subtotal				**$ 115,500.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 17,325.00
	Design	item	1	10%	$ 11,550.00
	Services modifications	item	1	5%	$ 5,775.00
	Contingencies on construction	item	1	20%	$ 30,030.00
	Grand Total				**$ 180,180.00**

Notes

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Indicative Construction Cost Estimate

Project	Gladstone SMP
Job Number	22035
Title	D3 Gross Pollutant Trap (WQ4)
Estimator	QB
Reviewer	DJ
Date	3-Feb-25

Item	Description	Unit	Quantity	Rate	Total
Civil and Drainage Works	Supply and install GPT to suit large box culvert	item	1	$ 150,000.00	$ 150,000.00
	Subtotal				**$ 150,000.00**
Overheads and Contingencies	Preliminaries	item	1	15%	$ 22,500.00
	Design	item	1	10%	$ 15,000.00
	Services modifications	item	1	5%	$ 7,500.00
	Contingencies on construction	item	1	20%	$ 39,000.00
	Grand Total				**$ 234,000.00**

Notes

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Indicative Construction Cost Estimate

Project	Gladstone SMP
Job Number	22035
Title	Horrocks Highway Gross Pollutant Trap (WQ4)
Estimator	QB
Reviewer	DJ
Date	3-Feb-25

Item	Description	Unit	Quantity		Rate		Total
Civil and Drainage Works	Supply and install GPT to suit large box culvert	item	1	$	200,000.00	$	200,000.00
	Subtotal					**$**	**200,000.00**
Overheads and Contingencies	Preliminaries	item	1		15%	$	30,000.00
	Design	item	1		10%	$	20,000.00
	Services modifications	item	1		5%	$	10,000.00
	Contingencies on construction	item	1		20%	$	52,000.00
	Grand Total					**$**	**312,000.00**

Notes

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Appendix J

MCA Scores



Flood Mitigation Strategies MCA

Project ID	Project Description	Criteria					Score
		Capital Cost	Reduced Street Drainage Nuisance	Reduced Major Flooding Risk	Precursor to WSUD Strategy	Community Buy-In	
		20%	20%	30%	10%	20%	
D1	Northern Channel Flood Protection	1	5	5	1	3	3.4
D2	Pitts Street Drainage	3	3	2	3	4	2.9
D3	James Street Drainage	2	3	2	3	4	2.7
D4	Brogan Road Culvert	5	2	1	1	4	2.6
D5	Golf Course Channel Works	4	2	1	1	1	1.8

Water Sensitive Urban Design Strategies MCA

Project ID	Project Description	Criteria					Score
		Capital Cost	Annual Maintenance Cost	Pollutant (TSS) Reduction	Stormwater Capture and Reuse	Community Buy-In	
		20%	20%	20%	20%	20%	
WQ1	Georgetown Wetland	1	4	3	3	4	3.0
WQ2	Stormwater Harvesting and Reuse Scheme	2	4	1	5	4	3.2
WQ3	Streetscape Raingardens	4	4	3	3	4	3.6
WQ4	Gross Pollutant Traps	2	4	3	1	5	3.0