Stormwater Management Plan

Streaky Bay Stormwater Management Plan Review

District Council of Streaky Bay

19 February 2024

Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
V1	DRAFT	Johanna Theilemann	Kylie Hyde	19 February 2024

Project Details

Project Name	Streaky Bay Stormwater Management Plan Review
Client	District Council of Streaky Bay
Client Project Manager	Darren Walker/Lachlan Smith
Water Technology Project Manager	Alex Barton
Water Technology Project Director	Dr Kylie Hyde
Authors	Alex Barton, Dennis Sabu, Sam Schultz, Dr Glenn Harrington, Dr Nikki Harrington
Document Number	22030162_R01V01

1/198 Greenhill Road
Eastwood SA 5063
Telephone (08) 8378 8000
Fax (08) 8357 8988
ACN 093 377 283
ABN 60 093 377 283

Quality ISO 9001 SAI GLOBAL
Environment ISO 14001 SAI GLOBAL
OHS ISO 45001 SAI GLOBAL

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1 INTRODUCTION

1.1 Background

This Stormwater Management Plan (SMP) for the township of Streaky Bay has been prepared by Water Technology and Innovative Groundwater Solutions in accordance with the Stormwater Management Planning Guidelines produced by the Stormwater Management Authority (July 2007).

This SMP provides an overview of:

- The existing catchments and issues relating to current stormwater management; and
- The opportunities to improve stormwater management to address both flood protection and the sustainable management of this resource and the environment.

This SMP:

- Serves as an update and replacement of the previous SMP developed by Tonkin Consulting in 2011;
- Builds upon and updates the recommendations, options and assessments considered by the 2011 SMP; and
- Introduces detailed flood modelling for the Streaky Bay township and considers qualitative guidance for the towns of Wirrulla, Poochera and Scale Bay.

The Streaky Bay SMP has been developed in association with the District Council of Streaky Bay and in consultation with the community, Eyre Peninsula Landscape Board and the Department for Environment and Water. Consultation activities and the development of the SMP have been performed in an integrated approach to ensure that the issues and opportunities have been recognised in a consistent and considered manner.

1.2 Stormwater Management Planning Guidelines

The Streaky Bay SMP review has considered the requirements of the Stormwater Management Authority's Stormwater Management Planning Guidelines (2007). The SMP review incorporates the following:

- An identification of objectives and outcomes for management of stormwater in the catchment;
- An identification of strategies to meet specified management objectives for the catchment;
- A description of all known existing stormwater assets, including identification of current condition and ownership (where known); and
- An identification of stormwater management problems and opportunities for achieving outcomes for public and environmental benefit in the catchment.

1.3 Project Objectives

The objectives of the Streaky Bay SMP review were to:

- Build on the 2011 Streaky Bay SMP and existing documentation regarding stormwater management;
- Engage with stakeholders and the community to develop a long-term vision for stormwater management in the region, and to identify existing risks and potential opportunities;
- Document existing stormwater management strategies; and.
- Identify appropriate, fit for purpose upgrades and/or new management strategies, with associated costings and priorities so that they can be implemented when funds become available.

1.4 Catchment Areas

The primary catchment area for the Streaky Bay SMP is the Streaky Bay township, where qualitative and quantitative assessments are warranted. In addition to Streaky Bay, a qualitative assessment of stormwater characteristics was undertaken for the regional towns of Wirrulla, Poochera and Sceale Bay, all within the boundary of the District Council of Streaky Bay. The locations of all four study areas in the context of the District Council of Streaky Bay area is shown in Figure 1-1.

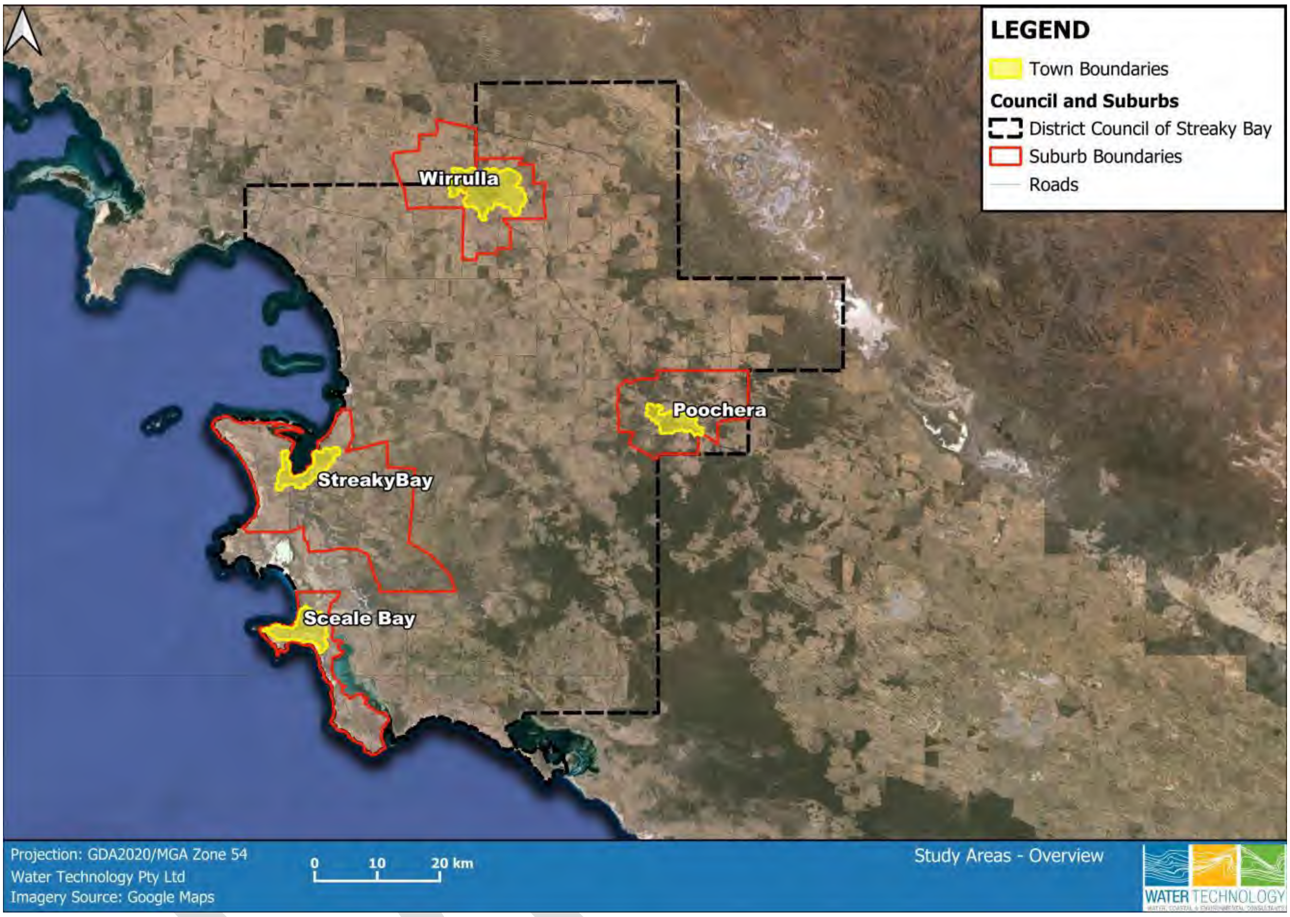

Figure 1-1 Study Areas

1.4.1 Streaky Bay

Streaky Bay, on the far west coast of the Eyre Peninsula, is a coastal township which supports some 2,000 residents and surrounding rural communities. The District Council of Streaky Bay (DCSB) has a vision 'to be the most liveable district on the Eyre Peninsula'. A robust SMP that provides strategies to minimise the risk of stormwater on the community and receiving environment, and capitalises on the opportunities this precious resource provides, will contribute to achieving this vision.

Streaky Bay's climate is semi-arid to arid, with an annual average rainfall of 379 mm. The relatively low annual rainfall places higher consideration for water sensitive urban design and water reuse for this region. Further, consideration of water quality assets needs to be adapted to the semi-arid coastal environment and fit for purpose in this location. This highlights the value of stormwater as a potential resource for reuse for both potable and non-potable uses.

Approximately half of the Streaky Bay township (predominately the urban and industrial areas) currently drains to the bay foreshore, with the remaining catchment (predominately farming land use) draining to adjacent natural terminal land locked depressions.

1.4.2 Wirrulla

Wirrulla is an inland town located approximately 65 km northeast of Streaky Bay and is located at the border of the District Council of Streaky Bay and Ceduna. The town has a population of approximately 100 people (2016 Census). Wirrulla is located in the arid climate zone and has an average annual rainfall of about 306 mm with no watercourses in the vicinity of the town.

It is understood that a formalised drainage network does not exist for Wirrulla. The risk of inundation of properties in the town is high during significant storm event due to absence of kerbs and gutters along roads to redirect stormwater falling within the local catchment.

1.4.3 Poochera

Poochera is a small regional inland town located approximately 60 km east of Streaky Bay, along the Eyre Highway. As per the 2016 Australian census, the town had a population of 59 people. The land use in this region is typically agricultural farmlands wit Poochera town acting as a strategic grain-receival centre for farmers in the vicinity. Poochera is located in the arid climate zone and has an average annual rainfall of about 326 mm.

The town sits at a comparably lower elevation than the surroundings, making the chances of stormwater inundation higher during significant storm events. Whilst there are kerbs along some of the main roads, there are inner streets with no kerbing, and the properties along these streets are at a higher risk of inundation during larger storm events.

1.4.4 Sceale Bay

Sceale Bay is a coastal town located on the western coast of Eyre Peninsula, approximately 25 km south of Streaky Bay. The land use is in the region is similar to Streaky Bay with agricultural lands dominating the land use, and the town located at the periphery of the farmlands and the bay. Sceale Bay receives about 379 mm of annual rainfall in average and is within the semi-arid – arid climate zone.

The general topography of the town slopes in the direction of the bay, with a drainage channel flowing to the bay through the northwest Sceale Bay town. Main streets are equipped with kerbs to reduce stormwater ingress on properties.

2 SUMMARY OF STORMWATER MANAGEMENT PLAN 2011

The former Streaky Bay Stormwater Management Plan (SMP) was developed by Tonkin Consulting and was finalised in January 2011. The 2011 Streaky Bay SMP investigated the Streaky Bay urban catchment and issues relating to stormwater management in the area.

The 2011 Streaky Bay SMP made a range of recommendations as detailed in Table 2-1. These previously recommended infrastructure options have informed this updated SMP and the associated mitigation recommendations. The recommendations have been considered in conjunction with the community consultation process and the views of council on priority infrastructure. The updated recommendations are detailed in Section 5.6.

Table 2-1 District Council of Streaky Bay Stormwater Management Plan Recommendations (January 2011)

Priority	Item	Design ARI (yrs)	Budget Capital Cost	Status
High	Side-entry pit upgrades	5	$90,000	Not Completed
High	Alfred Terrace trapped low point protection works	20	$300,000	Not Completed
High	Blancheport Rise overflow route	100	$50,000	Not Completed
High	Bockelberg Street to Williams Crescent Drain	5	$270,000	Not Completed
High	Betts Road flow path	100	$50,000	Not Completed
Med	Jubilee Road stormwater drainage (Stage 1)	5	$370,000	Not Completed
Med	Back Beach Road vegetated swales / raingardens	20	$50,000	Not Completed
Med	Foreshore vegetated swales / raingardens	5	$40,000	Not Completed
Low	East Terrace / Redding Street drain (Jubilee Stage 2)	20	$300,000	Completed
Low	Elizabeth St to Mudge Tce Drain (Jubilee Stage 3)	20	$110,000	Not Completed
Low	Elizabeth St to Wallschutzky Road dam Stormwater Collection	-	$1,035,000	Not Completed
Low	Connection of Wallschutzky Road dam to School Stormwater Dam	-	$780,000	Completed
Low	Bay Road – Eyre Terrace Drain	-	$570,000	Not Completed

3 ENGAGEMENT SUMMARY

Engagement for the Streaky Bay SMP review was undertaken in line with the best practice frameworks of International Association of Public Participation (IAP2). The engagement summary report can be found in Appendix F. The outcomes of engagement were used to inform:

- Project team consideration of community perspectives in developing stormwater management mitigation options and recommendations;
- Project team use of qualitative information from the community to inform data gaps and impacts; and
- Consideration of public preferences for stormwater management and mitigation options to be factored into decision making.

Visiting Streaky Bay in person was a valuable process to see the stormwater assets, localities and features, understand resident and Councillor perspectives, and collect photographs for the technical team to use in their assessment. It is understood that stormwater is an issue of community concern, that runoff occurs, and that several properties are frequently impacted by stormwater. Perspectives were heard that there is a preference for stormwater management solutions that maximise reuse, use water sensitive design, or deliver co-benefits for social, economic and environmental outcomes.

A summary of the attendees at the State Agency and Councillor briefings is shown in Table 3-1 and Table 3-2.

Table 3-1 Attendees from State Agencies in Relation to Stormwater Management

#	Organisation	Name
1	Landscapes SA	Libby Hunt
2	DEW – Coastal Protection Board	Sharee Detmar
3	DEW – Organisation DEW Crown Land Management	Barry Fryar
4	DCSB (Council) – CEO	Damian Carter
5	DCSB (Council) - General Manager – Infrastructure	Lachlan Smith
6	DCSB (Council) - General Manager – Prosperity	Penny Williams
7	Water Technology	Tahlia Rossi
8	Water Technology	Roxanne Frost

Table 3-2 DCSB for Councillor Briefing Stakeholders

#	Position	Name	Attendee status
1	Mayor (Flinders Ward)	Travis Barber	Attendee
2	Deputy Mayor (Eyre Ward)	Gregory Limbert	Attendee
3	Elected Member – Eyre	Guy La China	Attendee
4	Elected Member - Flinders	Clifford Pudney	Attendee
5	Elected Member - Flinders	Sally Trezona	Attendee
6	Elected Member - Flinders	Philip Wheaton	Attendee
7	DCSB CEO	Damian Carter	Attendee

#	Position	Name	Attendee status
-	Manager, Infrastructure	Lachlan Smith	Apology
-	Manager, Prosperity	Penny Williams	Apology
-	Elected Member – Eyre	Graham Gunn	Apology
-	Elected Member – Eyre	Neville Trezona	Apology
	Water Tech project team	Tahlia Rossi	Presenter
	Water Tech project team	Roxanne Frost	Presenter

4 EXISTING DRAINAGE RISKS

Local and regional flooding has been identified by both council and the community as a key risk associated with the existing drainage infrastructure. The existing assets do not currently provide adequate flood protection to all parts of the town, resulting in various inundation events occurring in the past.

A key objective of the update to the SMP is to identify flood risks within the District Council of Streaky Bay. The existing risks associated with current infrastructure and future potential is outlined in this section.

Streaky Bay has a formalised under-ground stormwater drainage network and two detention basins located on Wallschutzky Road and north of Alec Baldock Drive. Anecdotal information collected through the community consultation process and council records indicate a history of stormwater related issues within the Township. As part of the 2011 SMP Tonkin identified a number of key areas of concern including:

- The low-lying residential and industrial areas along Mudge Terrace and Jubilee Road.
- The 'Killas' property on Wells Street, which is situated in a depression.
- Properties along Alfred Terrace and Bockleberg Street which receive runoff from the Viterra Silos to the north.
- Properties within the block bordered by Williams Court and Hospital Drive, which intercept the stormwater flow path.
- Doctors Beach, which receives outflow from the Streaky Bay Area School detention pond / wetland system.

Flood modelling and mapping, which has not previously been undertaken for Streaky Bay, has been completed for this study. The methodology and results of this mapping is shown in Appendix A and Appendix B respectively. The 1% AEP flood depths are also shown in Figure 4-1. The results of the flood modelling and mapping have provided input to the opportunities for flood and water quality mitigation outlined in Section 5.

As seen in Figure 4-1, inundation levels across Streaky Bay vary, with higher depths in the southeast and western regions. Flows across the township area has relatively small catchments and therefore have relatively minor flow paths.

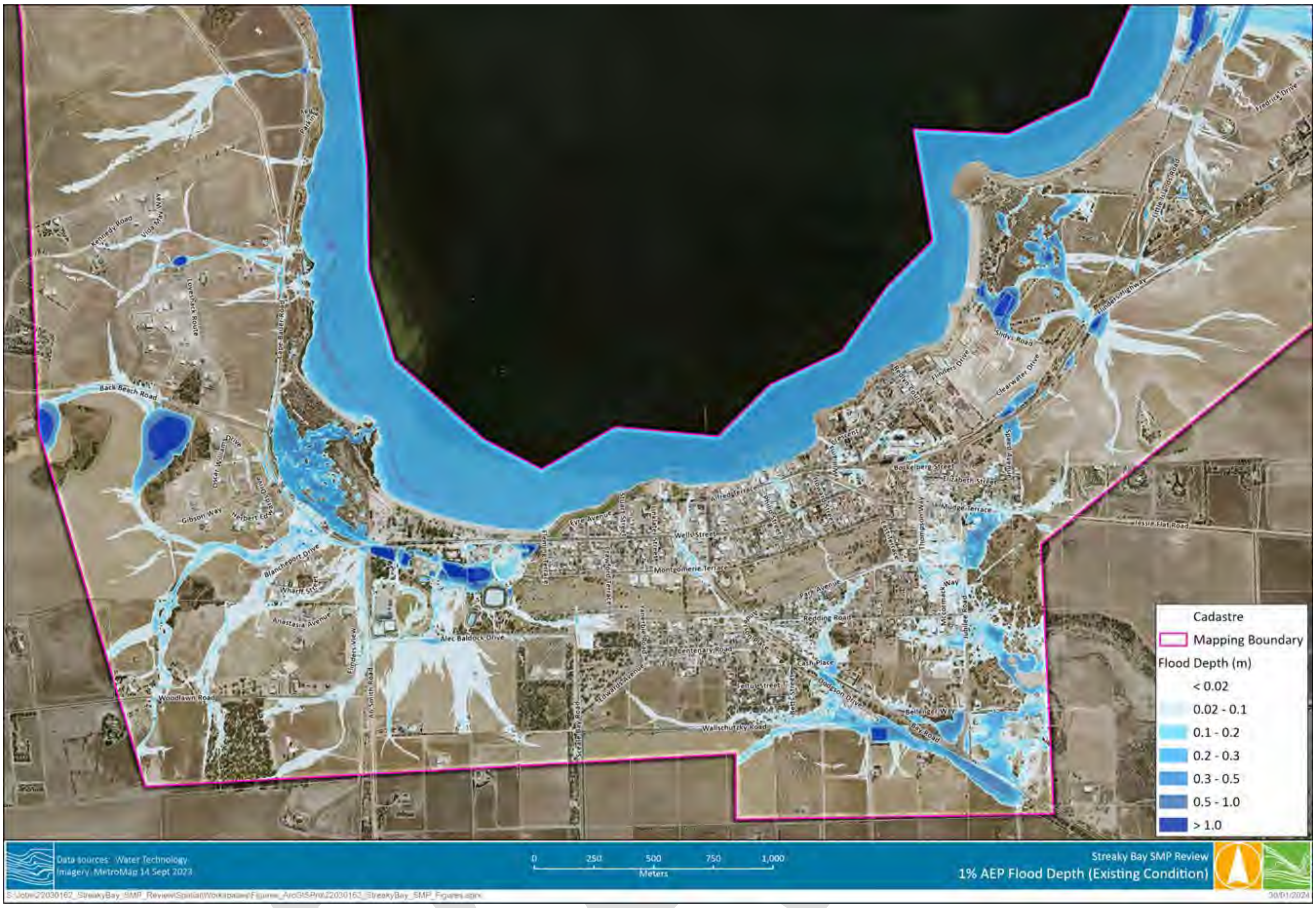

Figure 4-1 1% AEP Flood Depth

Flood risk across the catchment is a product of the depth and velocity. Australian Rainfall and Runoff 2019 outlines flood risk in terms of safety design criteria. Figure 4-2 defines the flood hazard classes generally used across Australia in the definition of flood risk for people and property. The results from this modelling help to inform decisions regarding future development planning and the risk to life and property.

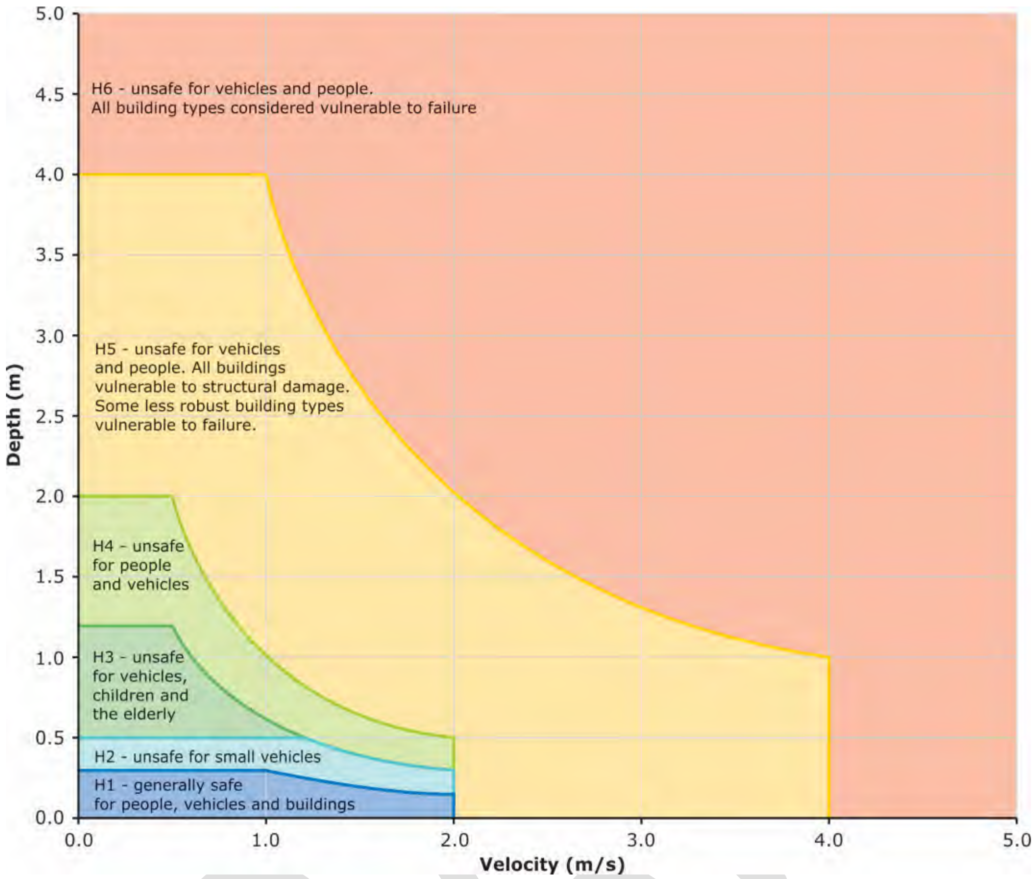

Figure 4-2 Combined Flood Hazard Curves (ARR 2019)

4.1 Local and Regional Flooding

Flood mapping of the District Council of Streaky Bay has not previously been undertaken and therefore all previous assessments have been based on hydrological assessments alone.

Council has recently had all drainage assets within Streaky Bay digitised, with the existing assets shown in Figure 4-4. Due to the topography of the region, flooding related issues are generally due to rainfall events of a short duration (less than 1 day). As Streaky Bay does not have any significant creeks or rivers, the majority of local flooding is associated with stormwater flows. A single watercourse, Orlante Creek, is present in Streaky Bay within the Samphire wetland as shown in Figure 4-3.

Figure 4-3 Watercourse Location in Streaky Bay

4.1.1 Existing Stormwater Assets

The existing stormwater assets within Streaky Bay are shown in Figure 4-4. The Streaky Bay stormwater management system is currently comprised mainly of pits and pipes within a gravity drainage network. Additional basins and pump stations are associated with water capture and transfer.

Outside of the pit and pipe network, stormwater is largely conveyed overland, either north towards the bay or east towards a terminal non-perennial water body. No formalised waterways have been identified via council GIS data or State Government GIS data.

The current condition of assets was assessed and provided by The District Council of Streaky Bay and is shown in Appendix E Table E-1. No further assessment on the condition of assets has been undertaken as part of this SMP review.

The flood modelling undertaken for Streaky Bay also included assessment of the pipe network capacity. The pipe capacity % full in both the 1% AEP and 20% AEP events is shown in Figure 4-5 and Figure 4-6. This shows how much of the network is fully utilised in a flood event and provides guidance to the mitigation options. The capacity % can be used to inform the cost/benefit analysis in upgrades to pipe as protection against the 1% AEP event in many cases is unfeasible for pipe networks alone. From the results we can see that some pipes are running full in the 20% AEP event, meaning further investigation may be warranted at these locations.

Figure 4-4 Streaky Bay - Existing Stormwater Assets

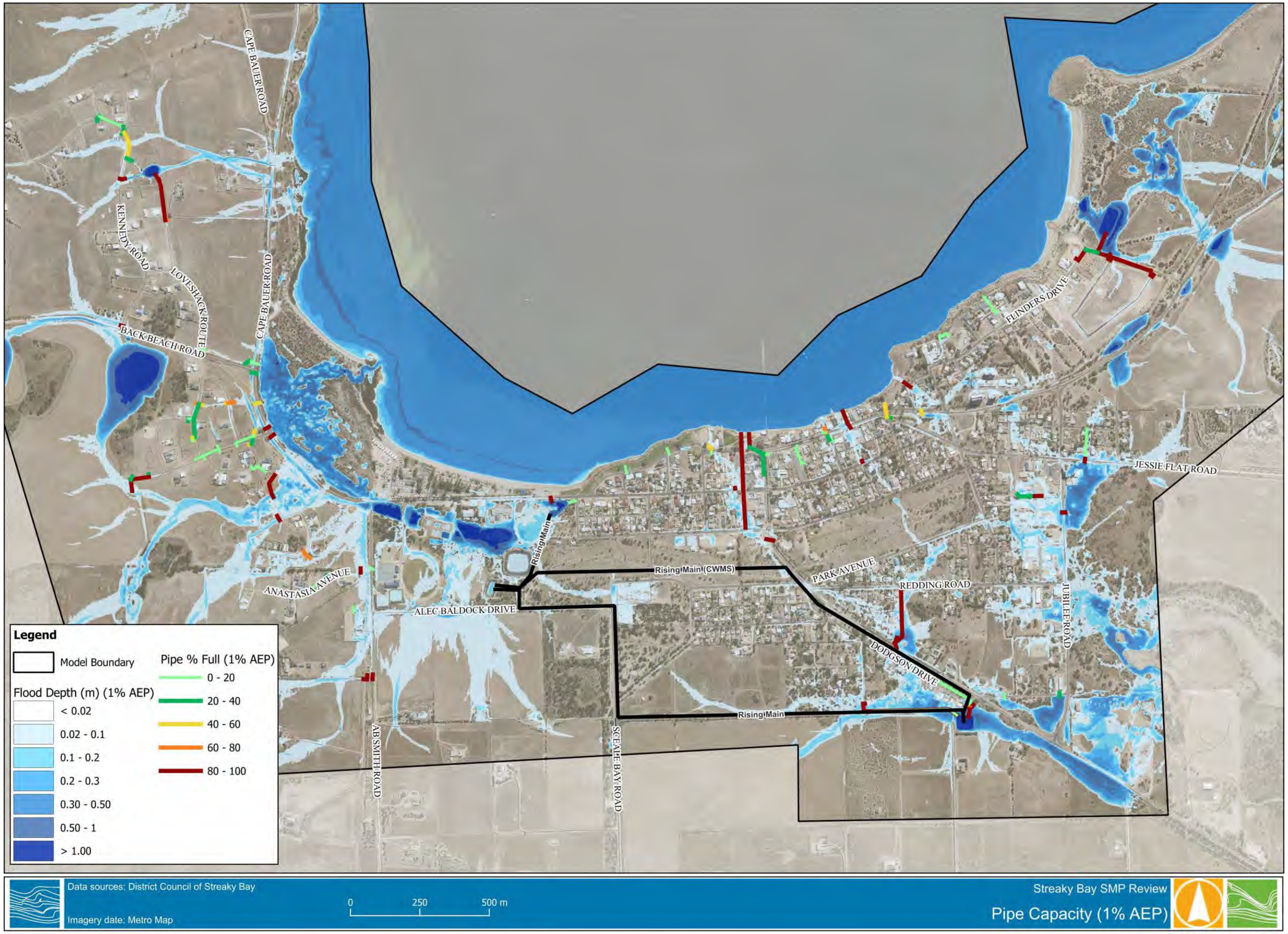

Figure 4-5 1% AEP Pipe Capacity

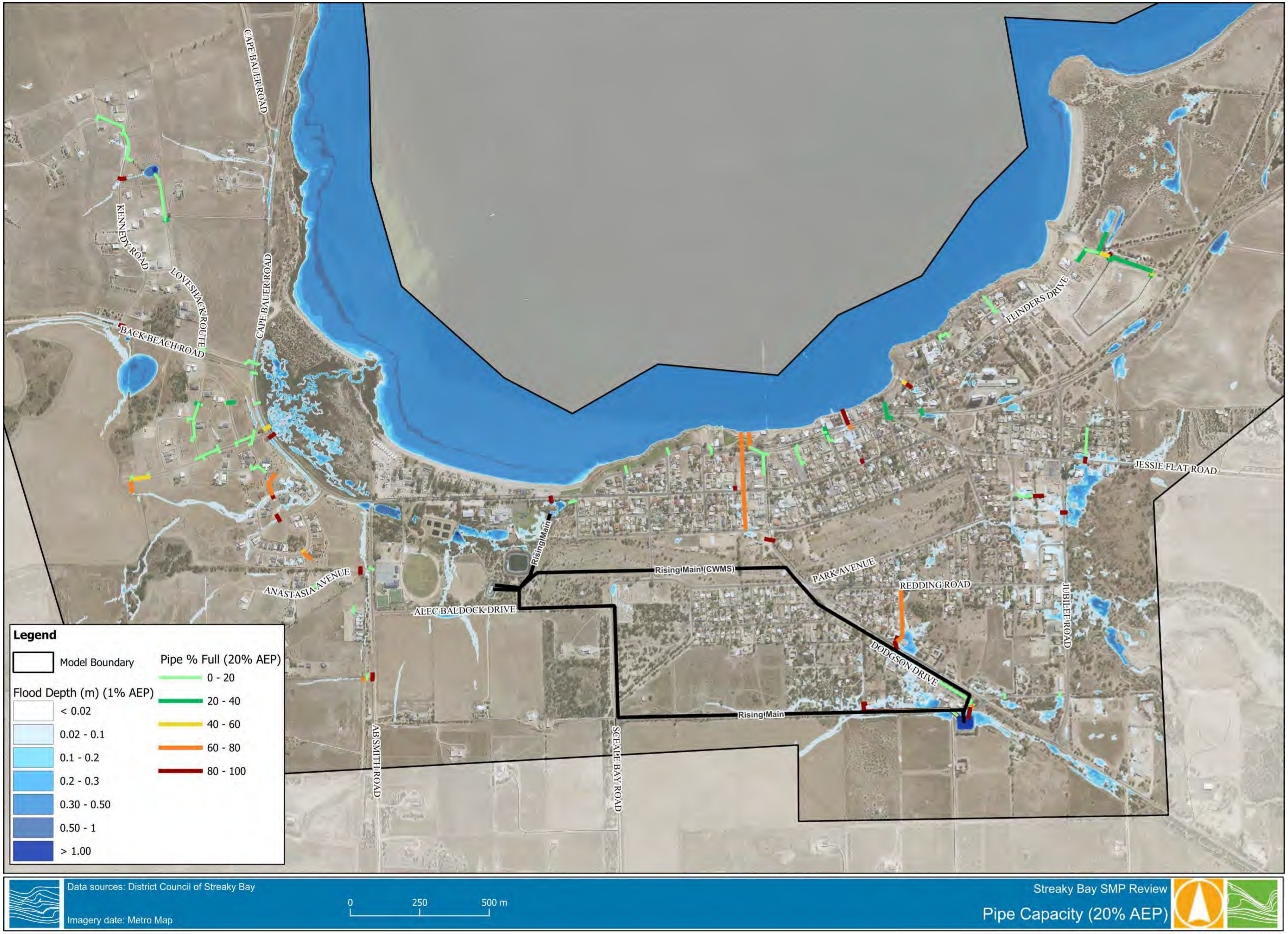

Figure 4-6 20% AEP Pipe Capacity

4.1.2 Key Areas at Risk of Flooding – Historical Observations

Council records and photographs of inundation captured during the May 2022 storm event in Streaky Bay were utilised to identify critical areas which are at a higher risk of flooding. Images of inundation were also used to validate the flood modelling, confirming flow paths and localised inundation areas.

The Bureau of Meteorology (BOM) rainfall station at Streaky Bay (18079) recorded 73.7 mm rain over the month of May 2022, with the highest daily rainfall of 27.8 mm observed on May 30th.

It should be noted that January 2022 received a higher rainfall total of 135.4 mm, however photographs were not available for analysis of this event. Figure 4-7 shows the key areas which were inundated during the May 2022 flood event.

Figure 4-7 Inundated Areas Overview – May 2022 Flood Event

Several sections of Bay Road, Jubilee Road and Wells Street were subjected to inundation, along with localised pooling of water observed on Alfred Terrace, Montgomerie Terrace and Hospital Drive.

Figure 4-8 shows photographs captured on the days of the inundation on respective location specific maps. No significant damage was associated with this event.

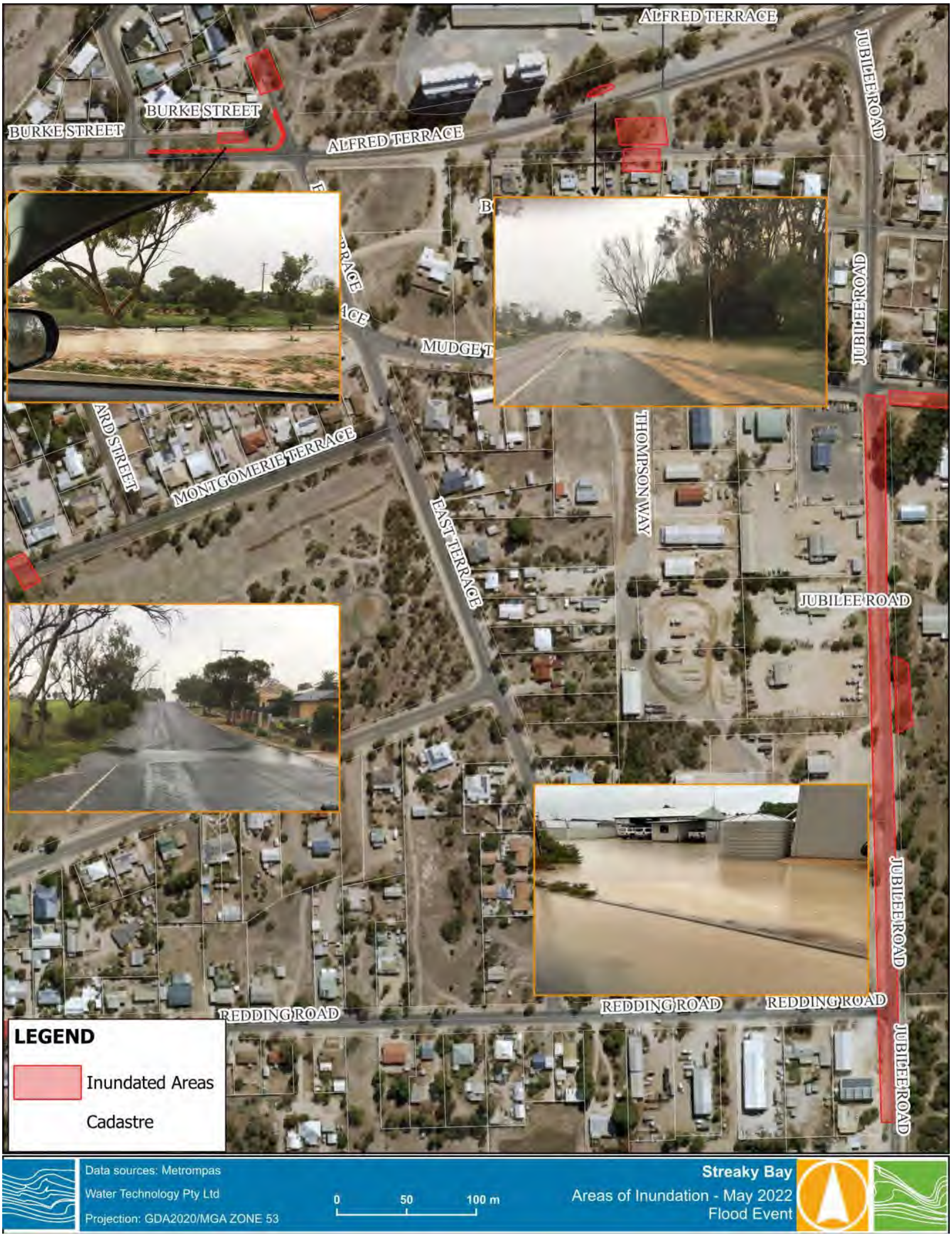

Figure 4-8 Inundated Areas around Jubilee Road – May 2022 Flood Event

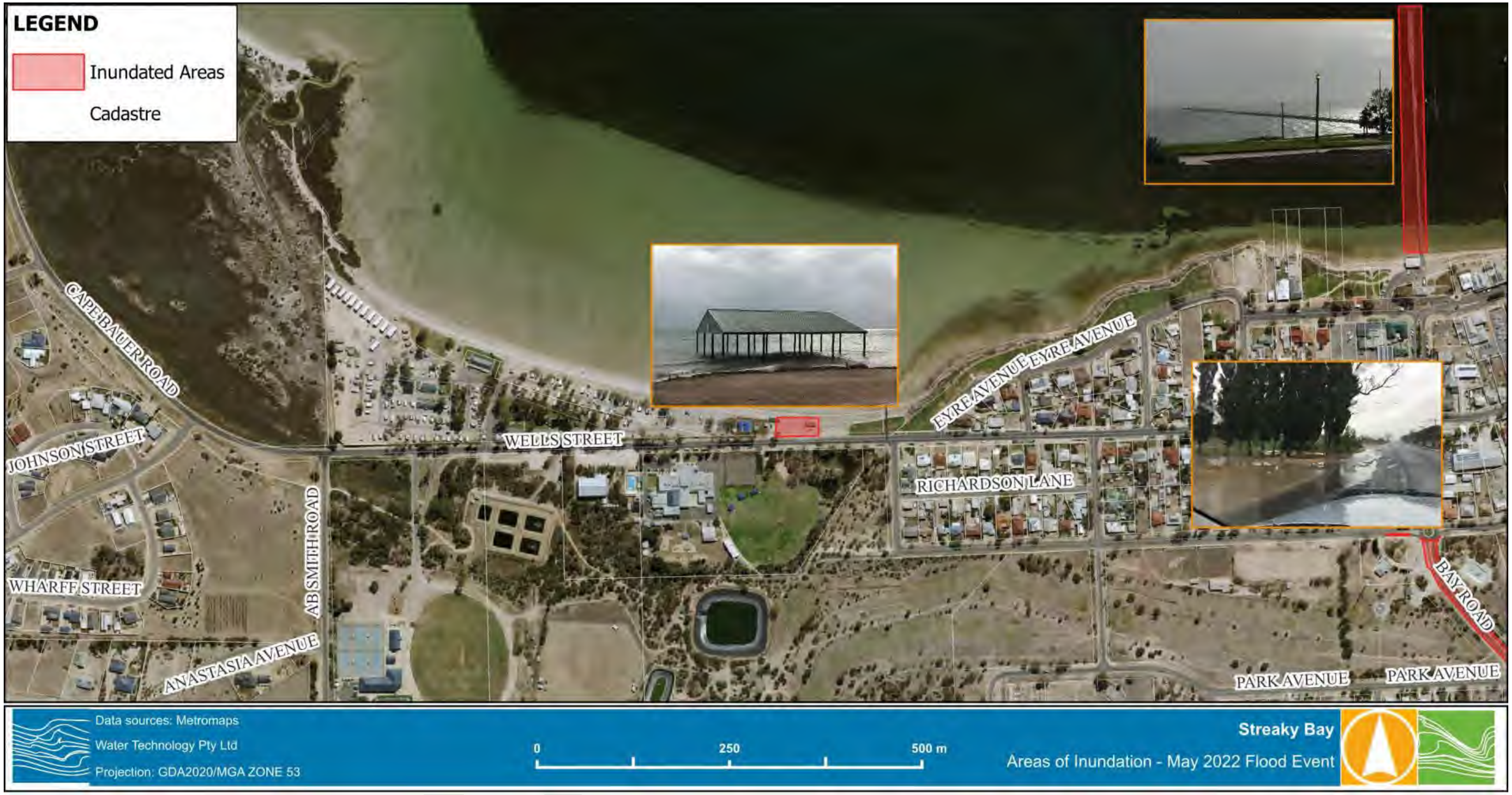

Figure 4-9 Inundated Areas around Wells Street – May 2022 Flood Event

The May 2022 storm event cannot be classified in terms of AEP due to the lack of sub-daily rainfall data in the region, however, it is estimated that based on the 24-hour rainfall alone the event was likely to be approximately a 63.2% AEP event. The observed inundation can primarily be linked to the undersized stormwater infrastructure in Streaky Bay.

4.2 Impacts of Future Development on Flooding

The potential impacts of future development on flooding in Streaky Bay require consideration during the urban planning process. Land use planning must consider flood risk beyond the 1% AEP flood event as well as projected changes to flooding driven by climate change.

As detailed flood mapping has been undertaken as part of the SMP update, this data can now be used to inform future development, urban planning and setting of floor levels.

The Streaky Bay Master Plan has recently been updated. A comparison between the 2010 and 2023 Master Plans is shown below.

A high-level review of the draft Master Plan for the District Council of Streaky Bay that was released as a draft for endorsement in December 2023 indicates that the flood mapping and proposed mitigation options contained in this SMP are generally in accordance with the draft master plan.

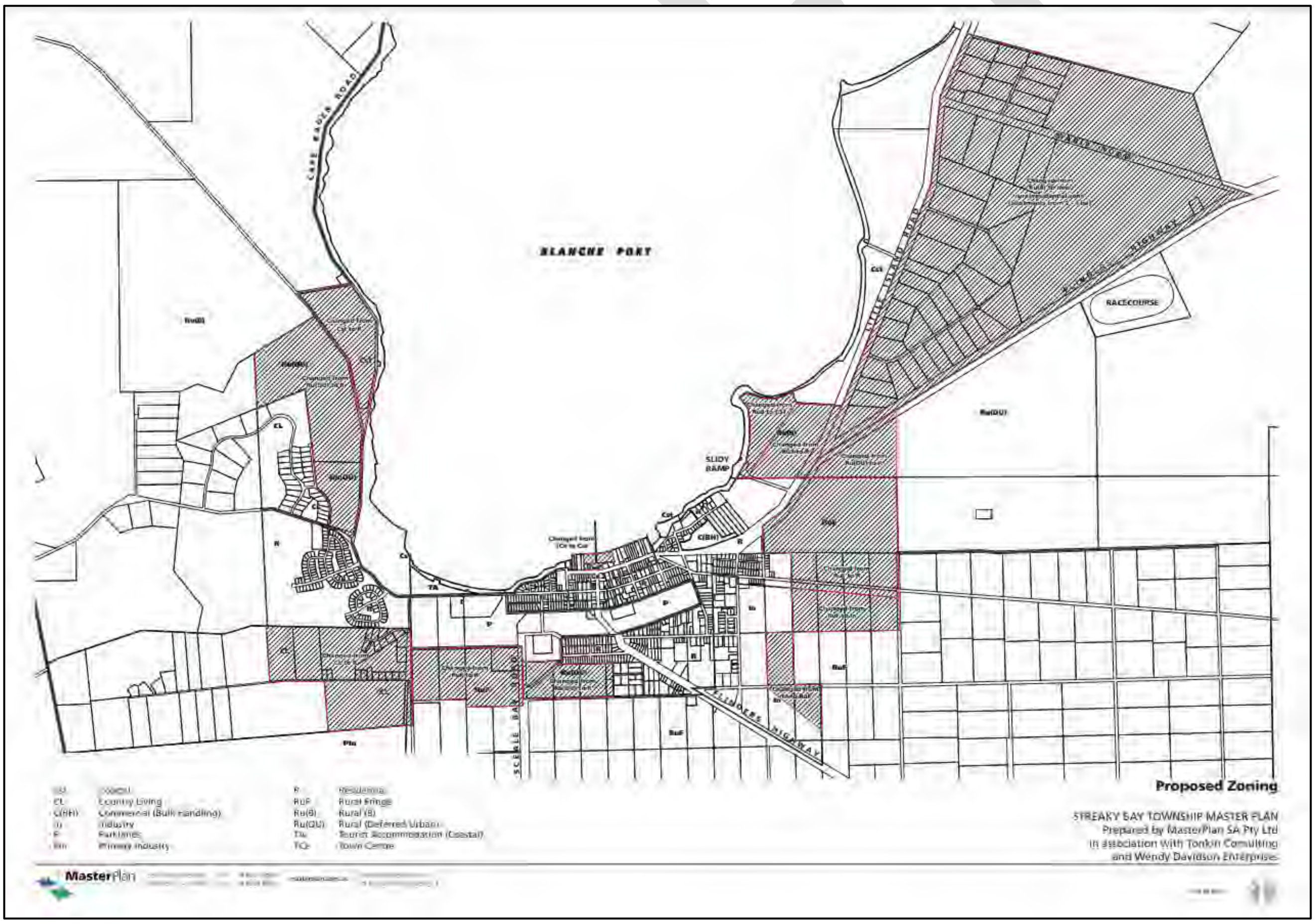

Figure 4-10 Proposed Zoning – Streaky Bay - 2010

Source: Streaky Bay Master Plan 2010

Figure 4-11 Proposed Zoning – Streaky Bay - 2023

Source: Streaky Bay Master Plan - Draft (December 2023)

Figure 4-12 Proposed Zoning Legend – Streaky Bay - 2023

5 OPPORTUNITIES FOR FLOOD AND WATER QUALITY MITIGATION

5.1 Introduction

There are many options available to the District Council of Streaky Bay to mitigate flood risks, water quality concerns and harness opportunities for water reuse. All of these options need to consider the current infrastructure in place, the current risks to the community and the environment and the feasibility of implementation (with many factors including cost, ongoing maintenance and climate variability). Options which mitigate current risks but don't limit future opportunities should be considered.

To be able to most effectively address the community concerns of the quality of the stormwater discharged to the bay in addition to the flooding, consideration has been given to how to detain, retain and utilise the stormwater as close as possible to where it is generated. These solutions do require consideration of land available, depth to groundwater, vegetation species compatibility and robustness during various size storm events. The other alternative approach is to collect, direct and discharge to the bay.

Mitigation measures identified are presented throughout this section with a summary of the options presented in Figure 5-7 and Table 5-1. The options represent the optioneering stage shown in Figure 5-1 which are based on the results from the modelling and assessment (detailed in Appendix A) and the first phase of community engagement (detailed in A8Appendix Fppendix F). Options require further on-site investigation and design to produce an accurate cost benefit analysis prior to deciding to proceed.

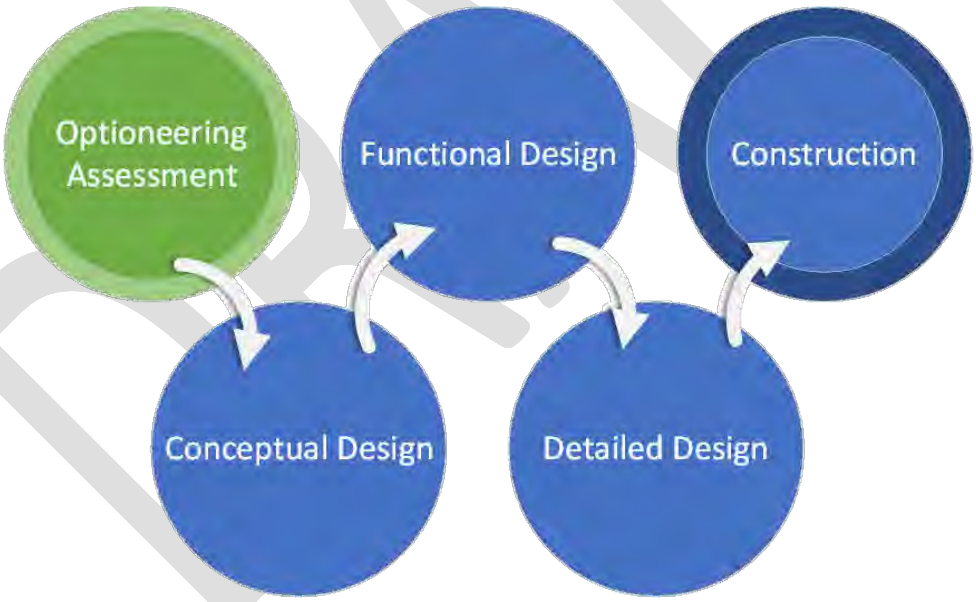

Figure 5-1 Asset Development Process

Once several preferred options have been selected by Council in consultation with the community, conceptual, functional and detailed designs can be progressed prior to moving into construction. The highest priority areas for mitigation strategies include:

- Wallschutzky Road
- Mudge Tce
- Alfred Tce between Philip St and Howard St
- Back Beach Road

- Jubilee Road
- Wells Street (Killa's Service Station)

5.2 Flood Mitigation Measures

Mitigation measures aim to reduce flooding with increases to asset capacity, increases to system storage and formalisation of drainage networks. Mitigation measures can range from hard structural elements such as pits or pipes, to softer natural based measures including increases in vegetation and formalisation of waterways. A range of mitigation measures have been identified across Streaky Bay throughout the 2011 SMP, Community Consultation, flood modelling and Council preferences and are described below.

5.2.1 Wallschutzky Road

Flooding issues at Wallschutzky Road were identified via the community consultation phase of the SMP review. This option includes a diversion channel along bay road to capture flows from north and southwest with and open channel along Wallschutzky Road and Bay Road.

The detention pond at Wallschutzky Road could be resized and repurposed to be a wetland to provide pre-treatment to the existing stormwater re-use scheme in Streaky Bay. A sedimentation pond could be used in conjunction with the wetland to reduce the sediment load on the wetland. Any achieved additional capacity in the system could be utilised to detain flood waters from the larger storm events and provide flood protection.

5.2.2 East of Jubilee Road

A flood management system including pipes, channels, detention basins and wetlands is proposed at the location of a low-lying salt marshland area that lies to the east of Jubilee Road. The marsh area is located in the vicinity of some of the most inundated areas in the town and could provide an effective remedy to the flooding in these parts.

The trapped low point East of Jubilee Road is a terminal lake and would be ideal for the management of flood water and potentially provide treatment for water quality.

An opportunity exists to direct, detain and potentially retain water in the landscape in a location where the water is naturally directed. If feasible and shown to be practical, this could result in a broad range of benefits including a community resource / facility, stormwater management and flooding mitigation.

Further assessment will be required to identify the suitability of the site for a wetland.

5.2.3 Bay Road

The flood modelling indicates significant inundation along sections of Bay Road (near Streaky Bay Crash Repairs) with localised pooling between Bay Road and Dodgson Drive. The diversion of flood waters flowing from the direction of Wallschutzky Road, and from Redding Road to the saltmarsh located east of Jubilee Road could reduce the magnitude flooding at these locations.

It is proposed that diversion channels be constructed to convey the flows from Redding Road and Wallschutzky Road into a channel along Bay Road, which crosses Jubilee Road and discharges into the marsh. Appropriate flow control infrastructure including culverts should be installed along all major crossings to prevent inundation at crossings.

5.2.4 Jubilee Road

Sections of Jubilee Road between Jessie Flat Road and Redding Road, along with several commercial properties located on Jubilee Road are subjected to inundation. It is understood from the modelling that there is a trapped low point along Jubilee Road – approximately halfway between Jessie Flat Road and Redding Road, which causes localised pooling of floodwaters coming from the direction of Jessie Flat Road. A drainage channel of sufficient capacity is proposed to divert these flows away from the low point. With consideration to the impacts on properties South of the low point, it is proposed that the channel convey flows into the marsh area which will be guided by further assessment of the ecological system at the location.

The sections of Jubilee Road located south of Redding Road/Flinders Highway (near Miller's Auto) are also prone to significant inundation. The commercial establishments along this section are located in a low-lying area, or a local depression. Majority of flow from the northwestern direction pool here and are not effectively conveyed across the road culvert located across Jubilee Road/ Flinders Highway. To alleviate the inundation along these sections, the flows need to be diverted from the depression. The private lands and native vegetation in the area limits the practicality of adopting flow management strategies that require significant work. Upsizing the culvert under Jubilee Road/ Flinders Highway and formalisation of a channel towards the salt marsh could potentially improve conveyance and reduce inundation depths subject to further investigation and design.

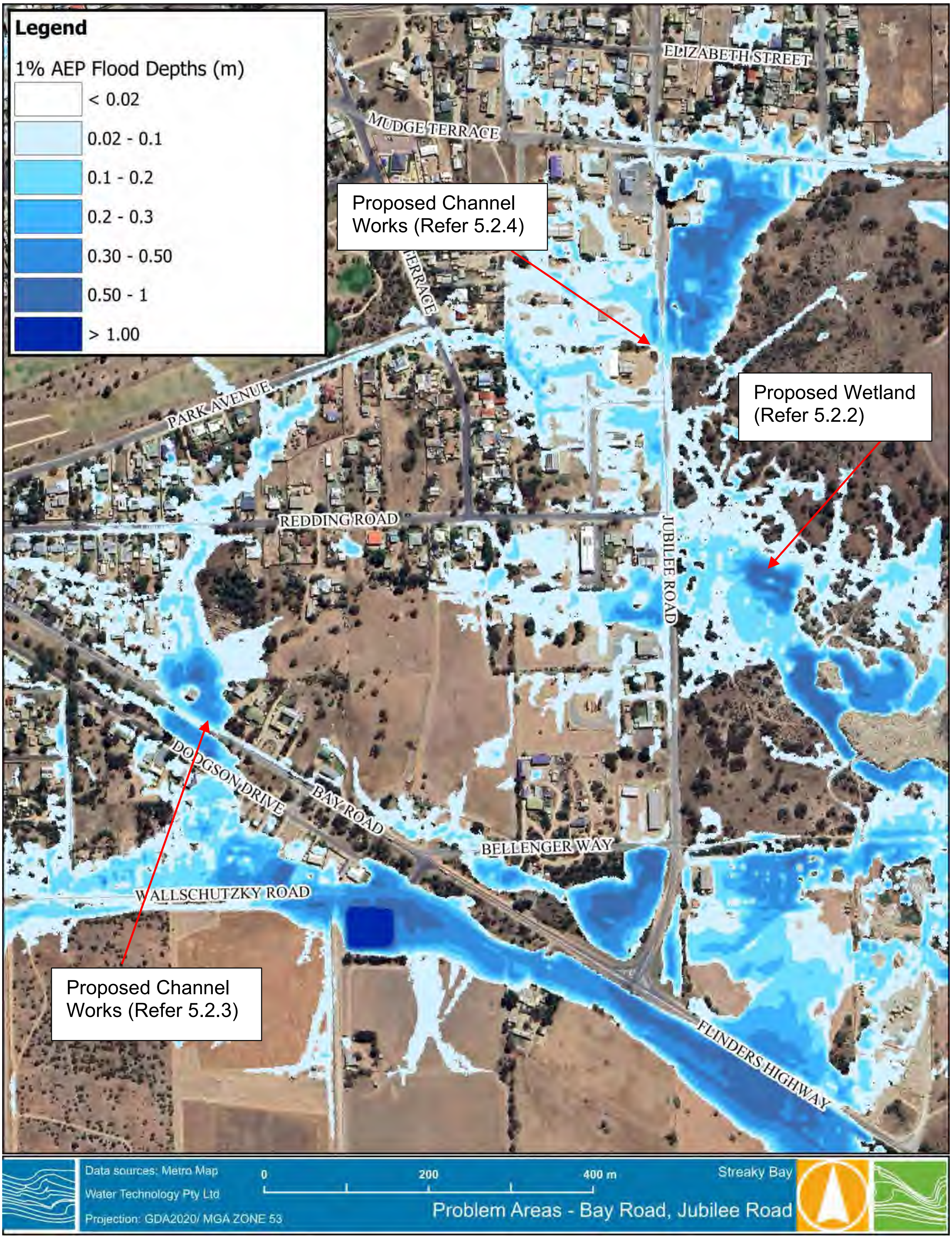

Figure 5-2 Areas along Bay Road and Jubilee Road subject to inundation

5.2.5 Alfred Terrace Culvert Upgrade

Sections of Alfred Terrace near Streaky Bay Fish Factory and properties along this road are identified as being inundated in the flood modelling results. The road low point on Alfred Terrace, and undersized pit inlets and pipes at this location reduces the conveyance of overland flows into the downstream network. The pit inlets and pipes at the low point could be upgraded to improve network capacity.

The culvert across Alfred Terrace on Philip Street intersection can be upgraded to convey more flows along this area directly into the bay through pipes along Philip Street, thereby reducing the magnitude of flow from the west into the low point on Alfred Terrace.

5.2.6 Wells Street Stormwater Infrastructure Upgrades

Similar to what is observed on Alfred Terrace, a low point on Wells Street also results in flood impacts where localised pooling is observed. It is proposed that pits and pipes are upgraded along this section with additional grated pits provided to convey the upstream flow into the bay.

Figure 5-3 Areas along Wells Street and Alfred Terrace subject to inundation

5.2.7 Future Development Considerations – Jubilee Road Industrial Precinct

Jubilee Road has been identified as an area for future development. There is likely to be increased runoff from these areas with the increase in impervious area. Proper consideration should be given to stormwater detention and quality during the planning stages of these developments. It is proposed that the subdivisions formalise their own stormwater management strategies to ensure that the development does not lead to additional stormwater runoff downstream of the site, while also achieving the required water quality targets on site. The onsite detention and treatment of additional flows generated as a result of development is an effective way to achieve the pre-development conditions.

The possibility of discharging some of the post-development runoff from the Jubilee Road industrial precinct into the proposed wetland in the salt marsh can be explored with additional assessment.

5.2.8 Williams Crescent

Properties located on either side of Hospital Drive are prone to nuisance flooding. Options to mitigate this include:

- Detaining water on the silo site;
- Formalising kerbing and a drainage path/channel to the east of Hospital Drive within the Grain Silo property; and
- Directing flows through a culvert under Hospital Drive to pipes under Burke Street and to the outlet at Williams Crescent.

These works may alleviate the flooding of 9 residential properties and parts of the Silo site.

In addition to stormwater works, it is proposed that the Side Entry Pits (SEPs) on Williams Crescent and Lions Pioneer Park be upgraded to handle higher stormwater discharges. The existing drainage channel could also be increased in size.

It would be opportune for council to initially initiate discussion with the owners of the silo site to determine if internally site drainage could be detained or reused on site prior to the development of council led mitigation measures.

5.2.9 Blancheport Development

The residences along Blancheport Drive and Johnson Street are in the direct flow path of overland flows draining into the Samphire Wetland. A retention basin is proposed in the vacant land west of the development to capture overland flows and discharge them controllably into the Samphire Wetland through a channel/pipe laid between Johnson Street and Herbert Edwards Drive. This would provide flood protection to more than 10 properties on Johnson Street and Blancheport Drive but will potentially require land acquisition between Johnson Street and Herbert Edwards Drive.

5.2.10 Little Islands Road

There are overland flow paths across Little Islands Road at multiple locations (between Fredrick Drive and James Court) which could potentially cause inundation to any future developments proposed between the two roads. Due consideration should be provided to the nature of the development before adopting flow management strategies at these locations. The construction of retention basin and channels draining into the bay could make the area suitable for large residential developments.

5.2.11 Bockelberg Street

Several properties south of Bockelberg Street, along Florence Street and Mudge Terrace are subjected to nuisance flooding. The primary cause of inundation is the absence of any stormwater infrastructure in the area. It is proposed that an easement be formalised along which stormwater pipes are connected to convey stormwater flows into a detention basin located near the Grain Silos. This would reduce inundation along Bockelberg Street properties as well as detain flows generated in the periphery of the Grain Silos. The acquisition of private land for formalising the easement and detention basin may be required.

5.3 Water Quality Mitigation Measures

5.3.1 Wetlands and Sedimentation Ponds

Wetlands are considered to be an effective method for mitigation due to their effectiveness in both stormwater detention and water quality treatment.

The quality of stormwater entering the bay from the town is a major cause of concern for residents. The existing wetland on Wells Street (School Wetland) plays a fundamental role in the treatment and storage of stormwater generated in the area south and southeast of the wetland. The treatment effectiveness at the School Wetland is shown in Table A-12.

The wetlands proposed as part of mitigation provides flood mitigation benefits in addition to stormwater quality improvement. The locations of the proposed wetlands are discussed in Section 5.1.

In addition to the currently proposed locations, there will need to be additional ones to cater for the stormwater generated from any future development. Also, the stormwater generated in the northeastern and northwestern parts of the town currently doesn't undergo any treatment and is either detained or released directly into the bay. Detailed water quality investigation of individual areas of the town is required to propose the most suitable locations.

Sedimentation Pond – Back Beach Road

The stormwater discharged into the Samphire Wetland does not currently undergo any sediment treatment, which could adversely affect the health of the wetland in the long-term due to excess sediment load. The redirection of some of the stormwater flows through a sedimentation basin located on Cape Bauer Road to provide pre-treatment before discharging into the wetland can improve overall water quality entering the wetland and the bay. Back Beach Road has been identified as an area for future development, and implementing the sedimentation basin could reduce the impact of future development on the Samphire Wetland.

5.3.2 Vegetated Swales

Vegetated swales may be considered as an alternative to concrete drains proposed at different locations in the town. Swales replace the impervious concrete lining with vegetated cross sections and provide a level of water quality treatment in addition to conveyance of stormwater. For instance, the drains proposed along Back Beach Road can be replaced by vegetated swales to achieve a higher level of stormwater treatment before discharging into the bay. A typical grassed swale channel is shown in Figure 5-4.

Figure 5-4 Grass swale in Rymill Park – (Source: Chapter 11 - Swale and Buffer Strips, Water Sensitive Urban Design Technical Manual Greater Adelaide Region)

The selection of vegetated swales as replacements for concrete drains will need to be adopted on a case-by-case basis, depending on Council's budget. The maintenance costs for swales are comparably higher than concrete drains and would also depend on the vegetation available.

5.4 Managed Aquifer Recharge

The implementation of Managed Aquifer Recharge (MAR) is a potential mitigation option which presents the opportunity to achieve stormwater reuse in conjunction with flood protection. However, given the flashy nature of stormwater generation, the low rainfall in Streaky Bay, and the water quality requirements to be achieved prior to injection to an aquifer, an above ground detention / storage and treatment system would need to be included as part of a MAR scheme.

The potential for MAR in Streaky Bay was investigated at 2 locations - one within the township and another at Robinson Lens (about 9km southeast of the town). Appendix A discusses the findings from the MAR investigation in detail. In summary:

- There is limited recent information available about the nature of the aquifer within the township of Streaky Bay. Based on historical data available, it appears that there could be an aquifer that is suitable for injection and extraction but it would need further investigation. The main areas of concern are the available storage volume in the aquifer and the water quality of the aquifer being highly saline due to the proximity to the coast
- The Robinson Lens aquifer is not recommended to proceed with any further investigation due to its distance from the township and its potential need to remain as an alternative water supply source if required in the future

5.5 Coastal Mitigation Options

5.5.1 Coastal Issues

As discussed in this SMP, the local stormwater network conveys stormwater and overland flows through to the coastal environment of the Streaky Bay receiving waters. It is therefore important to consider the intersection of stormwater processes with the local coastal processes – including impacts on coastal erosion, coastal sediment transport pathways, and coastal water quality of the receiving environment within the bay. Such impacts can include:

- Uncontrolled overland flows across the foreshore parks and beaches can exacerbate coastal / foreshore erosion.
- Stormwater discharge from beach outlets can generate localised scour channels across the beach and generate coastal erosion. The increase in hard surfaces combined with the more rapid delivery of water through more hydraulically "efficient" stormwater systems creates greater flow concentrations that can erode beaches – with regular flows hampering natural beach recovery processes.
- Stormwater flows from beach outlets can interfere with longshore sediment transport processes and generate sediment fans in the nearshore zone that can smother seagrass beds and other aquatic habitat.
- By their very nature stormwater systems tend to convey urban pollutants to the coast producing pollution discharge onto beaches or into the nearshore coastal waters.

5.5.2 Dune Aquifer Recharge Options

A common problem facing coastal councils is not only the stormwater from building development, but also that generated by roads, car parks and parkland immediately behind the beach. Rather than discharge these flows onto beaches, it is often possible to use the stormwater to recharge the aquifers in the local dune system. This not only overcomes potential beach/dune scour problems but also enhances the opportunity to "drought-proof" the dune and back-beach parkland areas and maintain healthy dune vegetation cover. This therefore has the dual benefit of maximising water resources while improving the resilience of the foreshore to coastal erosion.

In their most basic form, dune aquifer recharge systems can be simply constructed. Rather than directing road and car park drainage into stormwater systems, the overland flow can simply be directed to flow across the hind dune or foreshore park area into shore-parallel back beach swales that have been sized to cope with the design runoff volumes (this has previously been discussed in Section 5.3.2, and has a similarly beneficial application in a foreshore setting). These back-beach swales "flood" during heavy rainfall when the parkland is not being used but quickly drain to the aquifer soon after the rainfall event.

Similarly, for situations where the potential flow rate (even during severe events) is likely to be modest, there may be the opportunity to construct a drop structure at the back of the beach which has a permeable base or infiltration trench so that flows can be dissipated into the water table underlying the beach. Common applications of this approach include installation of an upright chamber with a grated opening at the top to allow for surcharge and an infiltration trench or rubble rock base to allow dissipation of water into the beach/dune groundwater. An example of this type of stormwater management option at Stockton Beach in NSW is provided in Figure 5-5, which was designed to both reduce the impact overland flows exacerbating beach erosion and improve groundwater recharge of the local dune system. Where such a structure is employed, it is important to provide a surcharge facility so that flows beyond the structures dissipating capability can be catered for.

Figure 5-5 Installation of a constructed back-beach aquifer recharge trench at Stockton Beach, NSW (source: NSW State Government).

5.5.3 SQIDs

Appropriately designed SQIDs (Stormwater Quality Improvement Devices) like GPTs (Gross Pollutant Traps) and trash racks can play an effective role in coastal water quality management. Where stormwater outfalls discharge at beaches, headlands, and estuarine locations, SQIDs can be installed at appropriate downstream locations in the network in order to reduce sediment loads and manage the quantity of gross pollutants reaching sensitive coastal aquatic environments. Removal of gross pollutants can also increase the natural character and aesthetic value of the foreshore, while reducing potential public health and safety risks and maintaining high social and recreational value of the coastal zone.

5.5.4 Adaptation Options for Coastal Hazards and Sea Level Rise

A key issue for the stormwater network over the coming decades will be to manage the impacts of sea level rise on its core drainage function. As sea levels rise, the potential for saline backflows propagating through the network and inundating low lying land will increase in both magnitude and frequency. Future adaption measures may include relocating or raising the invert level of coastal outlets. However, in the short term, common adaptation measures include the installation of one-way valves at outlets, such as tidal flaps and rubber “duck bills” (see Figure 5-6).

End treatments such as tidal flaps and duckbills can also mitigate the impacts of coastal hazards on foreshore outlets. Stormwater outlets at beaches (such as that on Wells Street) and open coast headland settings are commonly exposed to periodic wave attack, which can result in a water hammer like effect on the flow in pipes and culverts as the wave impacts on the exposed ocean end. This can lead to joints being blown apart and/or “blow holes” developing at weak points in the pipe/culvert.

Figure 5-6 Left: Example of a duckbill outlet treatment at Collaroy Beach, NSW. Right: Example of one-way tidal flaps at an estuarine stormwater outlet in Coffs Harbour, NSW

5.6 Proposed Mitigation Measures Summary

A summary of the proposed structural mitigation measures for both water quality mitigation and flood mitigation are shown in Figure 5-7 and Table 5-1.

Figure 5-7 1% AEP Flood Depth with potential Mitigation Option Locations

Table 5-1 Conceptual Mitigation Options Based On Flood Modelling, Discussions with Council and the 2011 SMP.

Option ID	Priority	Category	Project/Activity Type	Trigger	Proposed Asset	Description	Evidence based justification	Capital Cost ($)	Benefit*
2	High priority	Water Quality	Wallschutzky Road Wetland	Community Consultation	Wetland/Sed Pond	Opportunity to provide pre-treatment for water reuse scheme	Flood Modelling, Community Consultation	$900k per hectare	To meet best practice stormwater objectives Harvesting opportunities
3	High priority	Major Flooding	Wallschutzky Road	Community Consultation	Formalised Drainage Diversion channel	Diversion channel along bay road to capture flows from north and southwest. Open channel along Wallschutzky Road and Bay Road. Diversions towards marsh and storage pond	Flood Modelling, Community Consultation	>$1m	Protection of >10 properties from flooding Protection of township access
4	High priority	Major Flooding	Mudge Tce Mitigation, Jubilee Road. Channel Formalisation.	Community Consultation, 2011 SMP, Flood Modelling	Open Channel, Pipes, Culverts	Trapped low point SE of Mudge Tce and Jubilee Road needs to be drained. Currently acting as terminal lake. Consideration to downstream flooding need to occur. Council is responsible for the development of an area for the diversion and capturing of stormwater. overflows.	Flood Modelling, Community Consultation	>$1m	Protection of >10 properties from flooding
7	High Priority	Minor/Major Flooding	Alfred Tce between Philip St and Howard St	2011 SMP	Culvert Upgrade	Improved culvert capacity in Alfred Tce at Philip St. Additional pits to capture south side flow.	Flood Modelling, 2011 SMP	$300k - $600k	Reduction of flood levels at Alfred Tce and Reduction of hazard to vehicles.
11	Requirement for Future Development. High Priority.	Water Quality	Sedimentation pond Back Beach Road	Flood Modelling	Sedimentation pond	North corner of Cape Bauer Road and Back Beach Road for pre-treatment	Flood Modelling, Site visit	$900k per hectare	Water quality protection for existing wetlands
12	High Priority	Minor flooding	Redding Road, Culvert under Jubilee Road	Flood Modelling	Mixed	Entire area is low lying and inundated. Options in this area are likely to be low impact and high cost. Constraints: private land, native vegetation prevents large scale mitigation works unless buy back of mitigation land is considered. Potential upsize of culverts and formalisation of channel toward terminal marshland.	2011 SMP	N/A	Benefits will be based on future design investigation and will depend on magnitude of works

Option ID	Priority	Category	Project/Activity Type	Trigger	Proposed Asset	Description	Evidence based justification	Capital Cost ($)	Benefit*
18	**High Priority**	Minor Flooding	Wells Street (Killa's Service Station)	Flood Modelling/Council	Pit/Pipe Upgrade	Additional grated pits and pipe upgrade to convey higher flows at Killas.	Flood Modelling	TBD	Reduction in flooding for <10 properties
21	**Requirement for Future Development. High Priority.**	Future Development	Jubilee Road (Eastern Side) as Industrial precinct	Council	On site detention requirement. Retardation back to pre-development flows. Water quality treatment to state best practice standards. Significant inundation may limit development in this area without significant investment	RB and/or Water quality treatment. System may be terminal; groundwater infiltration may be required.	Masterplan	TBD	Facilitation of development
16	Medium Priority	Water Quality	Foreshore vegetated swales	2011 SMP	Infiltration to aquifer beneath dune system	Consideration on a site-by-site basis.	2011 SMP	TBD	To meet best practice stormwater objectives
19	Requirement for Future Development. Medium Priority.	Future Development	Loveshack Route (area between Loveshack Route and Cape Bauer Road will be subdivided into residential allotments and additional roadways increasing run off potential)	Council	On site detention requirement. Retardation back to pre-development flows. Water quality treatment to state best practice standards	Retardation basin and/or Water quality treatment	Masterplan	TBD	Facilitation of development

Option ID	Priority	Category	Project/Activity Type	Trigger	Proposed Asset	Description	Evidence based justification	Capital Cost ($)	Benefit*
20	Requirement for Future Development. Medium Priority.	Future Development	Anastacia Avenue (this will be subdivided all the way to Wallschutzky Road) consideration for increased run off	Council	On site detention requirement. Retardation back to pre-development flows. Water quality treatment to state best practice standards	Waterway formalisation, RB and/or water quality treatment, review and change in kerb system and direction of runoff to where intended to go	Masterplan	TBD	Facilitation of development
6	Medium Priority	Minor/Major Flooding	Williams Crescent Drain, Hospital Drive, Burke St	2011 SMP/ Flood modelling	Pipe & Pits	Formalised flow path U/S of hospital drive. Into pipe to connect to end of Burke St into Williams Cres.	Flood Modelling, 2011 SMP	$300k - $600k	Protection of properties from nuisance flooding. Improved flow conveyance from upstream.
9	Medium priority	Major Flooding	Blancheport Rise overflow route	Flood Modelling, 2011 SMP	RB with channel or pipe outfall between Johnson St and Herbert Edward Dr. Natural waterway option.	RB upstream of Johnson St	Flood Modelling, 2011 SMP	$500k per hectare	Protection of >10 properties from flooding
14	Medium Priority	Minor Flooding/Development Potential	RB little Islands Road north-east of Fredrick Dr	Flood Modelling	RB	Formalised RB and formalised waterway to unlock area for development. Downstream capacity needs to be assessed.	Flood Modelling	$500k per hectare	Enable future development
15	Medium Priority	Minor Flooding/Development Potential	RB little Islands Road south of James Ct	Flood Modelling	RB	Formalised RB and formalised waterway to unlock area for development. Downstream capacity needs to be assessed.	Flood Modelling	$500k per hectare	Enable future development
17	Medium Priority	Stormwater Management	Managed Aquifer Recharge	Council	MAR System	Potential target aquifers, their physical and water WQ characteristics, suitability for storage of the volumes/quality of stormwater		TBD	Stormwater Management. Climate Resilience
5	Low Priority	Minor/Major Flooding	Bockelberg Street, Elizabeth St, Florence St Drain	2011 SMP/Flood Modelling	Pipe & Easement. Capture with basin U/S at silo site.	Easement over western side of property subject to inundation with pipe.	Flood Modelling, 2011 SMP	$100k - $500k	Protection of several properties from nuisance flooding

Option ID	Priority	Category	Project/Activity Type	Trigger	Proposed Asset	Description	Evidence based justification	Capital Cost ($)	Benefit*
10	Low Priority	Minor flooding	Back Beach Road vegetated swales / raingardens	Flood Modelling, 2011 SMP	Drain or Swale	Formalised Drains or Roadside Swales along road	Flood Modelling, 2011 SMP	$500/m	Reduction of flood hazard on Back Beach Road
13	Low Priority	Minor Flooding/Development Potential	RB Alec Baldock Drive	Flood Modelling	RB	Formalised RB and formalised waterway to unlock area for development. Downstream capacity needs to be assessed.	Flood Modelling	$500k per hectare	Enable future development
1	Further Investigation Required	Water Quality	Distributed water quality treatment into bay	Community Consultation	Wetland/Proprietary Products	Best locations will be selected based on areas that have highest pollutant input.	MUSIC model of Current Arrangement is not meeting best practice. Therefore, additional wetlands should be considered	$900k per hectare	To meet best practice stormwater objectives
8	Further modelling to understand impact and reduction	Minor flooding	Side-entry pit upgrades	2011 SMP	SEP Upgrade	Only to be investigated in areas where there are trapped low points. i.e. William Cres connection to bay. i.e. connection of lions pioneer park pit to Burke St	2011 SMP	Not likely cost effective across entire network. Further investigation required for total cost estimation. Approx. $20k/location	Reduction of nuisance flooding.

6 QUANTITATIVE ASSESSMENT OF POOCHERA, SCEALE BAY AND WIRRULLA

Desktop Assessments were undertaken for Poochera, Sceale Bay and Wirrulla to investigate the hydrological conditions of the towns and any opportunities for stormwater reuse. Poochera and Wirrulla are located inland in arid-semi arid climate zone, while Sceale Bay is located along the coastal arid zone, making any opportunities for stormwater reuse critical.

6.1 Assumptions

- The details regarding the site topography for all towns have been assumed based on a Hydrologically Enforced 1 Second Digital Elevation Models (DEMs). It should be noted that the 1 Second DEM only provides a coarse topographical model, and as such the findings derived using this DEM might not be accurate.
- Assumptions regarding stormwater infrastructure in the towns have been made by utilising Google Satellite Imagery and Google Street View. It should be noted that the Street View imagery for some parts of the towns is up to 15 years old and might not represent the current site conditions.

6.2 Poochera

6.2.1 Overview of Existing Conditions

Poochera is an inland regional town located along the Eyre highway. Poochera receives a mean annual rainfall of 326 mm and is located within the arid climate zone.

The town slopes in a north-westerly direction as seen in Figure 6-1. The local catchments located to the northwest and south of the town drain northwest. The drainage lines from the catchment south of Poochera, is expected to drain across Eyre highway, Main Street, and the railway (Figure 6-1), and potentially cause inundation at these crossings during any major storm event. Whilst the drainage line flows along West Terrace, there are kerbs along West Terrace which could reduce the impacts of stormwater on private properties.

Details for the drainage network, culvert information and bridge structure information were not available for the township of Poochera.

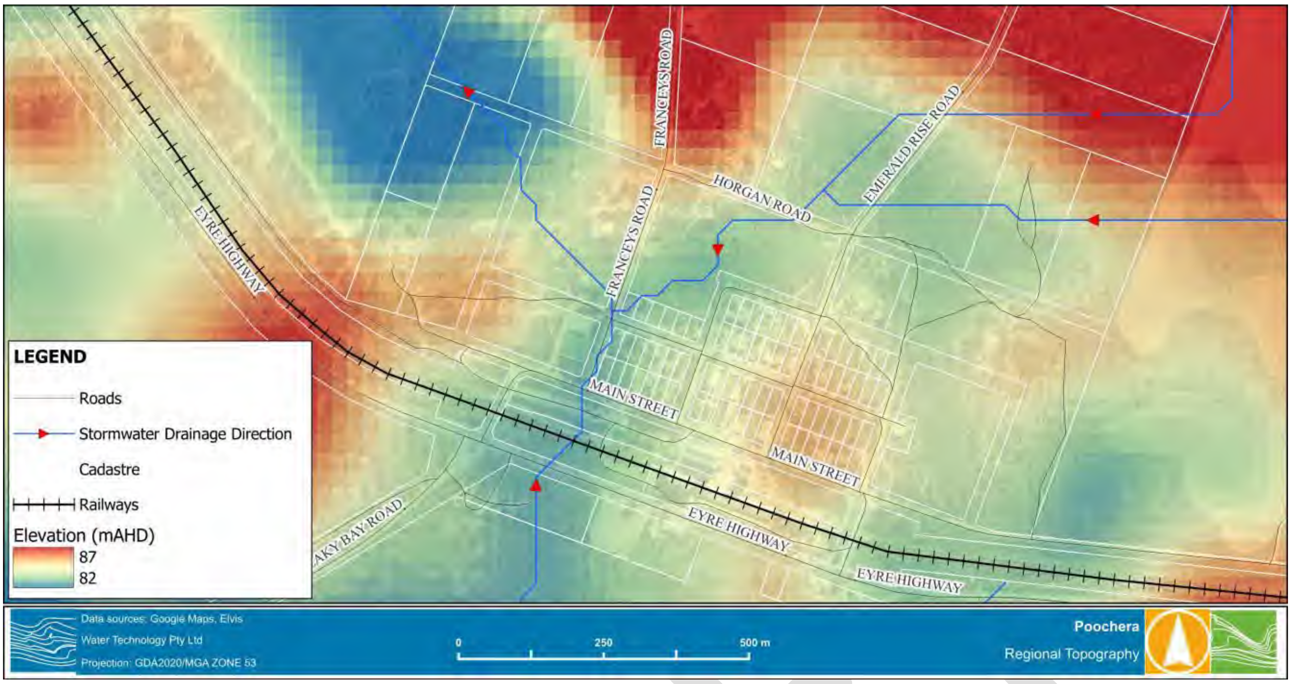

Figure 6-1 Regional Topography – Poochera

In the absence of mains water and watercourses in the vicinity of the town, Poochera is vastly dependent on rainwater storage for water needs.

6.2.2 Opportunities for Water Quality

Opportunities for water quality infrastructure for a town of this size are unlikely to provide a cost/benefit ratio above 1. Due to the size of the town, proprietary products are most likely to be a cost-effective solution to water quality issues. Due to the arid region, options for standard water quality measures may be limited due to the requirement to adopt alternative plant species suited to the environment.

6.2.3 Opportunities for Flood Mitigation

A quantitative assessment of the region indicates that the availability of data is a considerable limitation to advice for mitigation options. No information on the drainage assets within the town was available. No defined watercourses were defined within the Watercourses in South Australia dataset. Water Technology undertook an to define the drainage direction as shown in Figure 6-1, indicating two main flow paths through the town from the north and south. Options for mitigation within this township could include:

- Flood storage
- Formalisation of kerb and channel drainage
- Embankments

6.2.4 Next Steps

The township of Poochera has extremely limited data. To enable provision of viable water quality and flood mitigation options, further data is required. It is recommended that council considers obtaining LiDAR for the region to enable a detailed assessment of the topographical features. Further, feature survey of all drainage and water quality assets within the township should be undertaken.

Once data of sufficient quality for modelling is obtained, it would be beneficial to undertake Hydrological and Hydraulic modelling to best understand the flood risk to the township.

6.3 Sceale Bay

6.3.1 Overview of Existing Conditions

Sceale Bay is a coastal town located in the arid climate zone, and 30 km south of Streaky Bay. The town slopes in a northeasterly direction towards the bay as seen in Figure 6-2.

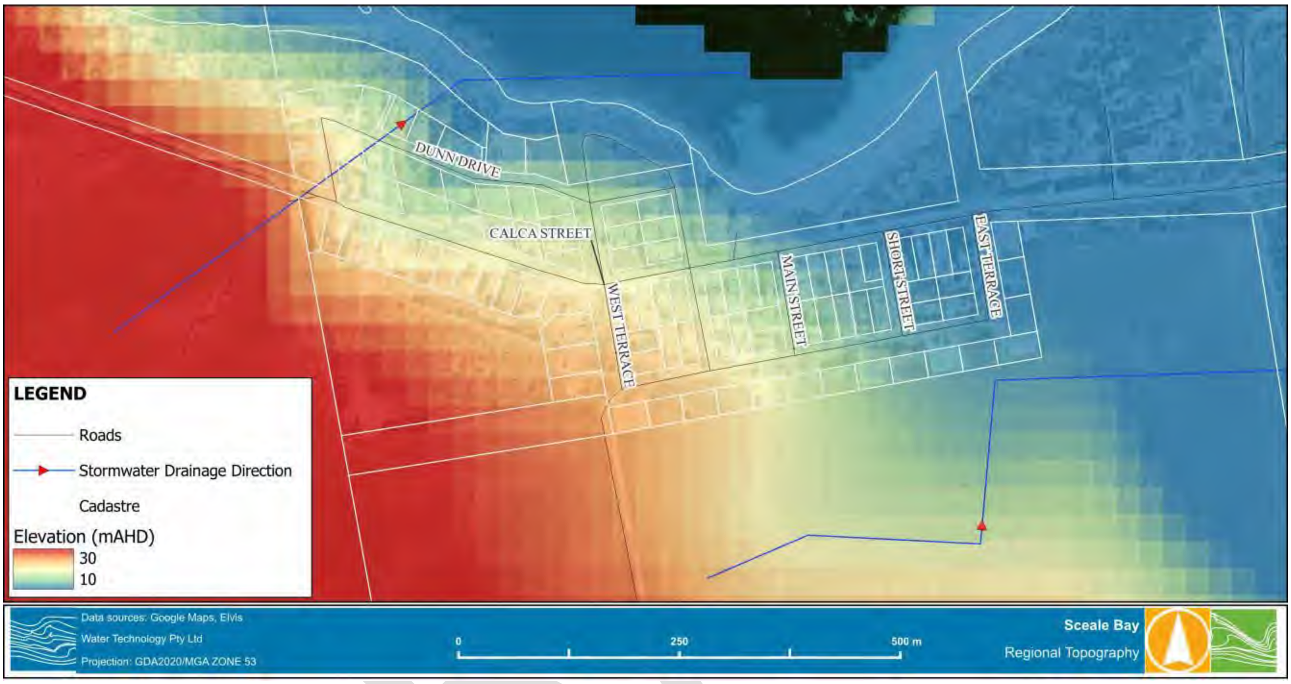

Figure 6-2 Regional Topography – Sceale Bay

The existing drainage channel from the town catchment flows into the bay traversing Calca St and Dunn drive. A sag has been incorporated on Dunn drive to accommodate crossing of overland flows. Kerbs and gutters are also present along some main streets to assist stormwater conveyance.

The primary source of water in Sceale Bay is rainwater collection and storage, in the absence of mains water.

There are low-lying areas/swamps about 2 km to the east of the town centre. The James Baird Lake is located 7 km to the east of Sceale Bay.

6.3.2 Opportunities for Water Quality

Due to its proximity to the bay, the local catchments in the town of Sceale Bay mostly discharge directly into the bay. The direct discharge of the urban stormwater into the bay has significant water quality implications. But due to the relatively smaller number of benefitted stakeholders, structural water quality management measure will be non-feasible. Non-structural controls like stormwater drains cleaning, street and parking lot sweeping can reduce the amount of pollutant load reaching the bay.

6.3.3 Opportunities for Flood Mitigation

The absence of topographic data and existing flood maps in the region limits the level of advice that can be provided on the impacts of a flood event and effectiveness of mitigation measures.

There are no defined water courses in the town vicinity except for the drainage path to the northeast of Sceale Bay as seen in Figure 6-2.

General options for flood mitigation within this township could include:

- Flood storage
- Formalisation of kerb and channel drainage
- Levees/ Flood protection

6.3.4 Next Steps

Any level of hydrological/ hydraulic assessment and flood study in the town would require topographical survey of high resolution. An asset database with details of existing stormwater assets would also be beneficial to evaluate any capacity restraints on the existing system.

6.4 Wirrulla

6.4.1 Overview of Existing Conditions

Wirrulla is an inland regional town located about 65 km northeast of Streaky Bay. The town centre is located at a lower elevation than surrounding areas, and slopes in the southwest direction as seen in Figure 6-3.

Figure 6-3 Regional Topography - Wirrulla

Stormwater runoff from the eastern and western local catchments of the town are expected to flow across the railway and Eyre Highway (see Figure 6-3). Sections of Eyre Highway and the railway line near intersection with Gawler Ranges Road which are at lower elevations are likely to get inundated during a storm event. There aren't kerbs or gutters present along roads for stormwater drainage and conveyance which could also result in localised pooling and inundation to residential properties.

There is no mains water available in Wirrulla and the town is mostly reliant on rainwater tanks for water needs.

6.4.2 January 2022 Storm Event in Wirrulla

In the week ending on January 25, 2022, heavy rainfall was recorded in parts of Eyre Peninsula. BoM records describe the event as below:

"In the middle of the week, a low-pressure system was located over inland South Australia, with an associated trough extending north. Widespread moderate falls were recorded over South Australia, particularly around the Eyre Peninsula. Rainfall totals in excess of 200 mm were recorded in the Eastern Eyre Peninsula District in South Australia."

Figure 6-4 shows rainfall totals in South Australia for the week ending on 25th January 2022.

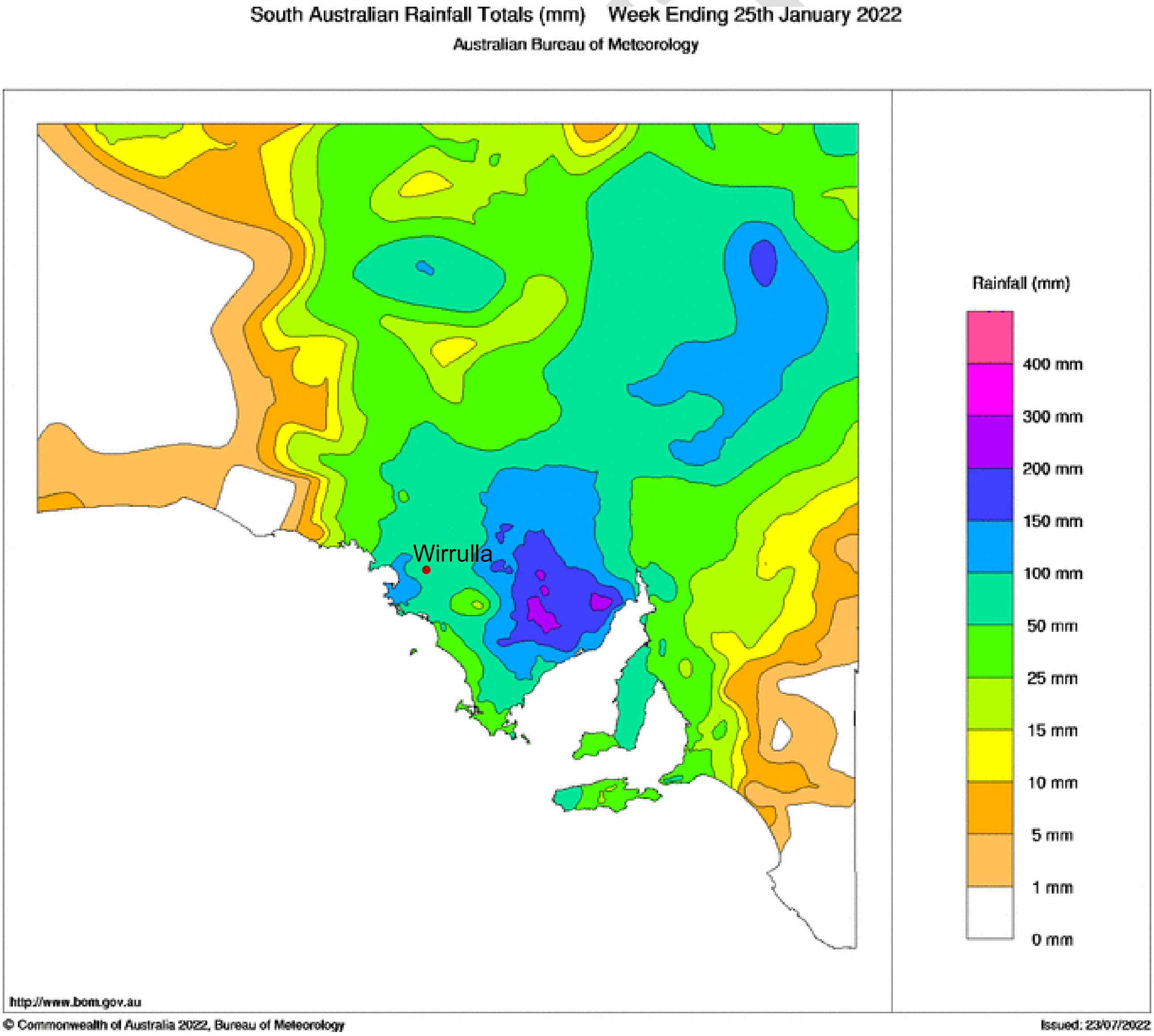

Figure 6-4 Rainfall Totals – Week ending 25th January 2022

BoM Rainfall station at Wirrulla (18094) recorded 127 mm of rainfall across 21-22 January 2022. 115 mm of rainfall was observed on 21st January which is the highest daily rainfall observed in Wirrulla and contributed to 20% of the annual rainfall in 2021. There have only been two instances of Wirrulla receiving more than 100 mm of rainfall in 100 years period of record (1938 and 2022).

It is understood that during the storm event, most of the town experienced significant inundation. The stormwater flows associated with the significantly high rainfall observed over the two days is likely to have exceeded the capacity of the existing stormwater infrastructure. Newspaper images from the 2022 storm event are included as inset images in Figure 6-3.

6.4.3 Opportunities for Water Quality

The feasibility of structural water quality improvement systems including wetlands or bioretention are limited in Wirrulla, non-structural controls like stormwater drains cleaning, street and parking lot sweeping are options which can be explored.

6.4.4 Opportunities for Flood Mitigation

There are no major watercourses flowing through Wirrulla. The overland flow paths in the town are shown in Figure 6-35. The practicality of flood mitigation advice which can be provided for the town is limited by the limited level of topographic data. Some general flood mitigation options include:

- Flood storage
- Formalisation of kerb and channel drainage
- Levees/ Flood protection

6.4.5 Next Steps

Further stormwater water quality management in the town could be adopted together with stormwater reuse strategies. Wirrulla receives a mean annual rainfall of only 307 mm, which makes opportunities for stormwater reuse critical.

Investigation into flood impacts on the town would depend on the availability of topographic data. A feature survey of all existing stormwater assets would also be beneficial for all future flood studies.

7 SUMMARY AND CONCLUSIONS

[To be completed after council review]

8 REFERENCES

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APPENDIX A
HYDROLOGICAL AND HYDRAULIC ASSESSMENT AND INTEGRATED STORMWATER MANAGEMENT

A-1 Hydrological and Hydraulic Assessment

Hydrological and hydraulic modelling of the regional catchment area for Streaky Bay were undertaken using RORB and TUFLOW modelling suites respectively. As Wirrulla, Poochera and Sceale Bay are undergoing a qualitative assessment, modelling was not undertaken for these towns. The model details, and the results from modelling are discussed in this section.

The hydrological and hydraulic modelling scenarios as agreed at the outset of the Streaky Bay SMP review project are shown in Table A-1 below.

Table A-1 Hydrological and Hydraulic Modelling Scenarios for Streaky Bay

Scenario (AEP)	Existing Climate	Climate Change 2100 (Increased Rainfall Intensity)	Climate Change 2100 (Sea Level Rise)
0.2%			
0.5%			
1%	✓	✓	✓
2%			
5%			
10%			
20%	✓	✓	✓

A-1-1 Hydrological Modelling

Hydrologic modelling for the town of Streaky Bay was undertaken in RORB. The catchment delineation was based on the available *EyrePeninsulaCoastal2018_1m_DEM* made available to Water Technology by the District Council of Streaky Bay in April 2023 and the *Hydro_Enforced_1_Second_DEM* elevation data (Elvis).

The Streaky Bay regional catchment has an area of 27.4 km^2. The regional catchment was sub-divided into 52 sub-catchments. The key details regarding the Streaky Bay catchment are listed in Table A-2.

Table A-2 RORB Catchment Details for Streaky Bay

Catchment	Streaky Bay
Catchment Area (km^2)	27.4 km^2
Number of sub catchments	52
Average sub catchment area (km^2)	0.53
Number of Reaches	94
Average Reach Length (km)	0.52
Impervious fractions	Calculated based on land use

A-1-2 Model Description

Sub-area and Reach Delineation

Sub-area boundaries and reaches were delineated using the hydrological processing algorithms in QGIS and revised as necessary. Delineation was based on the EyrePeninsulaCoastal2018_1m_DEM made available to Water Technology by the District Council of Streaky Bay in April 2023 and the Hydro_Enforced_1_Second_DEM. Nodes were placed at the centroid of each sub-area and the junction of any two reaches. Nodes were then connected by RORB reaches, each representing the length, slope and reach type. The RORB model has 52 sub-areas ranging in area from 0.17 – 0.99 km2. The sub-catchments and reach network are shown in Figure A-3 and Figure A-2 below. Print nodes were placed upstream and downstream of the subject site to extract flow hydrographs.

The RORB model was constructed using RORBWIN V6.45.

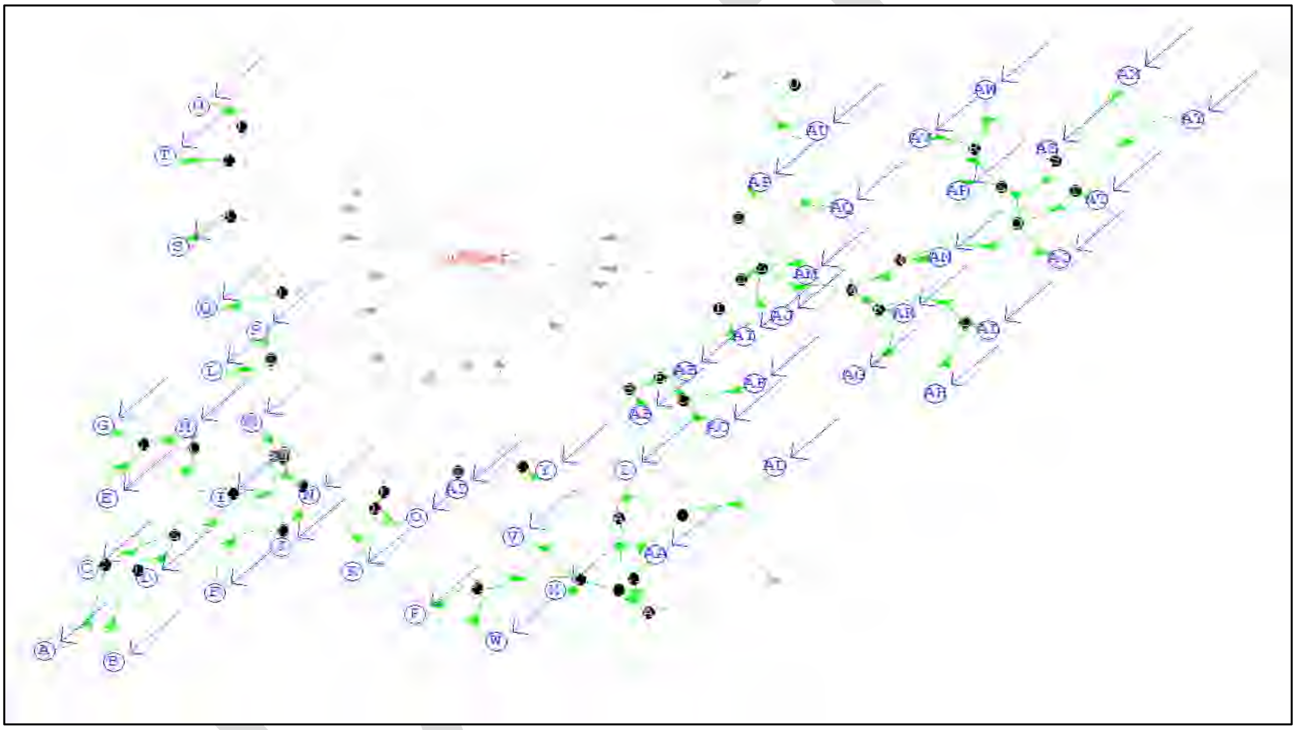

Figure A-1 Streaky Bay – RORB Model Configuration

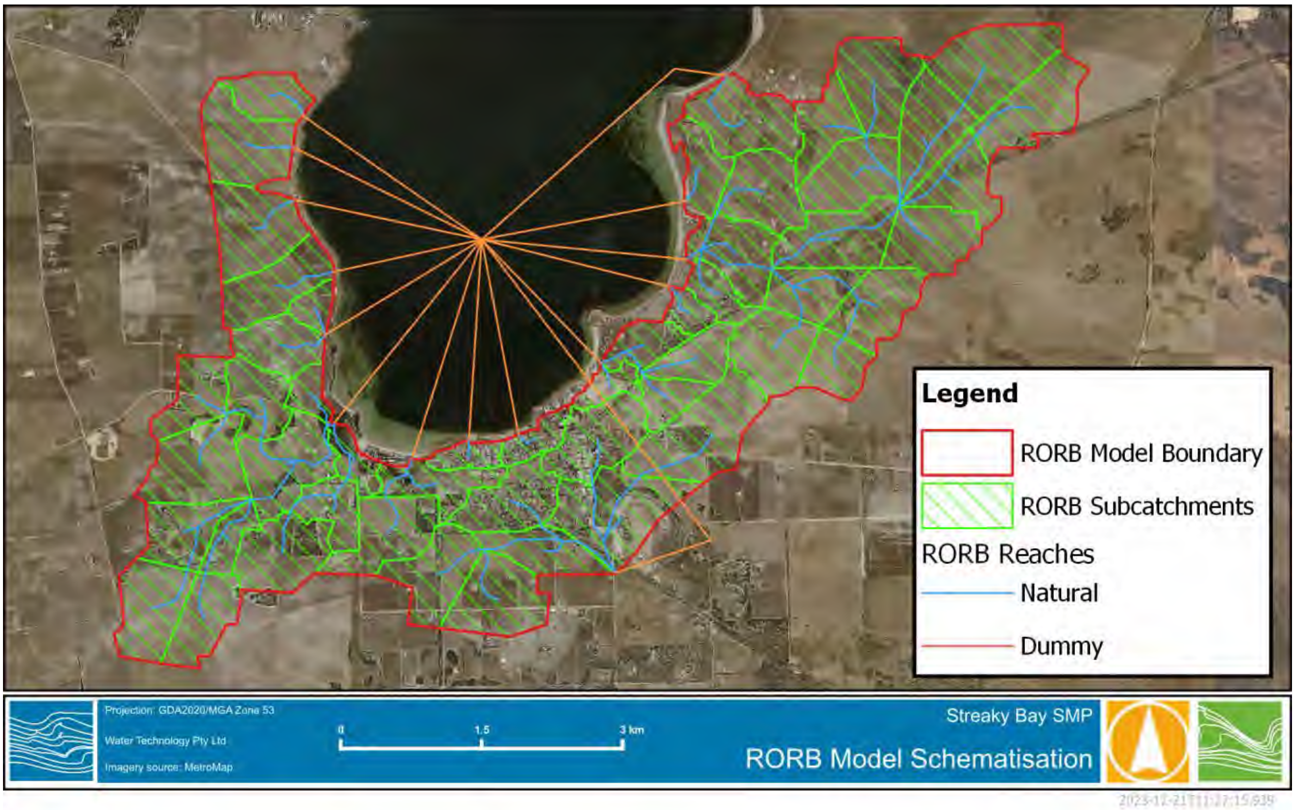

Figure A-2 Streaky Bay – Catchment Delineation and RORB Model

Fraction Impervious

Fraction Impervious (FI) values were applied based on land use data available from the SA Government[1]. The values were then compared to the most recent imagery of the region to ensure accurate representation of FI across the catchments. These are summarised in Table A-3 below.

Table A-3 Adopted Fraction Impervious Values Based on Land Use

Land Use	Fraction Impervious
Sealed roads	1.0
Unsealed roads	0.2
Rural residential	0.1
Agricultural	0.05
Industrial	0.7

Temporal Patterns

Temporal patterns from ARR2019 were utilised in the analysis and extracted from the AR&R data hub. The ARR2019 temporal patterns are based on historical storms using the extensive network of pluviograph data

[1] SA land use generalised, https://data.sa.gov.au/data/dataset/land-use-generalised

collected by the Bureau of Meteorology (BoM). The ARR2019 design temporal patterns are broken into several AEP groupings, or bins. These are:

- Very Rare – Rarest 10 within region
- Rare – Suitable AEP range 3.2% AEP and rarer
- Intermediate – Suitable for AEP range 3.2% - 14.4%
- Frequent – Suitable for AEP range more frequent than 14.4%

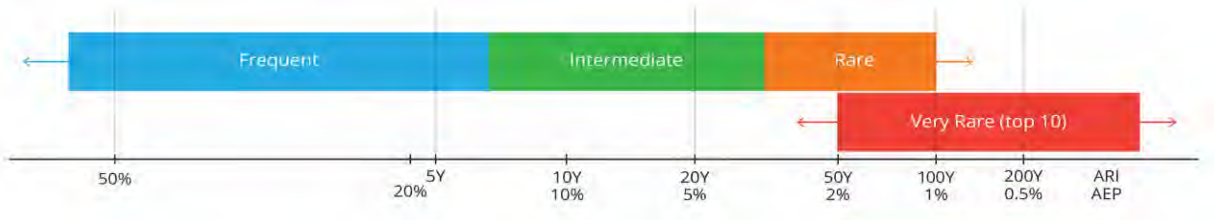

Figure A-3 Temporal Pattern Bins

RORB's internal "filter embedded burst" feature was used for all ensemble runs to ensure any embedded bursts were smoothed out and would not influence results.

IFD Depths

The Intensity-Frequency-Duration (IFD) design rainfall intensities (mm/h) obtained from Bureau of Meteorology (BoM) website were used to run the RORB 1% AEP and 20% AEP events. The IFD depths corresponding to each AEP event are shown in the table below:

Table A-4 IFD Depths for AEP Events

AEP	Critical Duration (h)	IFD depths (mm)
1%	6	66.5
20%	9	36.2

Regional kc

kc is the primary routing parameter in RORB. The Pilgrim *kc* prediction equation method is based on South Australian data and recommended for catchments with area less than 100 km^2. This value was used in this project, and a *kc* value of 5.52 was adopted.

Table A-5 Calculated Kc Parameters

kc Equations	K_c
Default RORB Eqn.	11.52
South Australia (A<100 km^2) (Pilgrim, 1987)	**5.52**

Routing Parameter – m

The RORB 'm' value is typically set at 0.8 as recommended in the RORB User Manual. This value remains unchanged and is an acceptable value for the degree of non-linearity of catchment response (Australian Rainfall and Runoff, 1987).

Design Losses

The ARR Datahub provides recommended initial and continuing losses for the subject site, as shown below in Table A-6.

Table A-6 Design Loss Parameter Estimates

Source	IL (mm)	CL (mm/h)
ARR 2016 (SA)	27	4.7

Spatial Patterns

The ARR2019 guidelines recommend non-uniform spatial patterns for catchment areas of more than 20 km^2. The catchment containing the study area is 1.8 km^2, therefore a uniform spatial pattern was applied in design modelling.

A-1-3 Design Flows – Existing Conditions

Peak flows for the 1% and 20% Annual Exceedance Probability (AEP) flood event were calculated within the RORB model for durations between the 1- and 18-hour duration events. An ensemble of the 10 available temporal patterns applicable to the 1% and 20% AEP events were simulated. The box and whisker plots below show the upper and lower limits of the calculated peak flows for each of the 10 temporal patters for each duration, along with the corresponding mean and median for each storm duration at the model outlet.

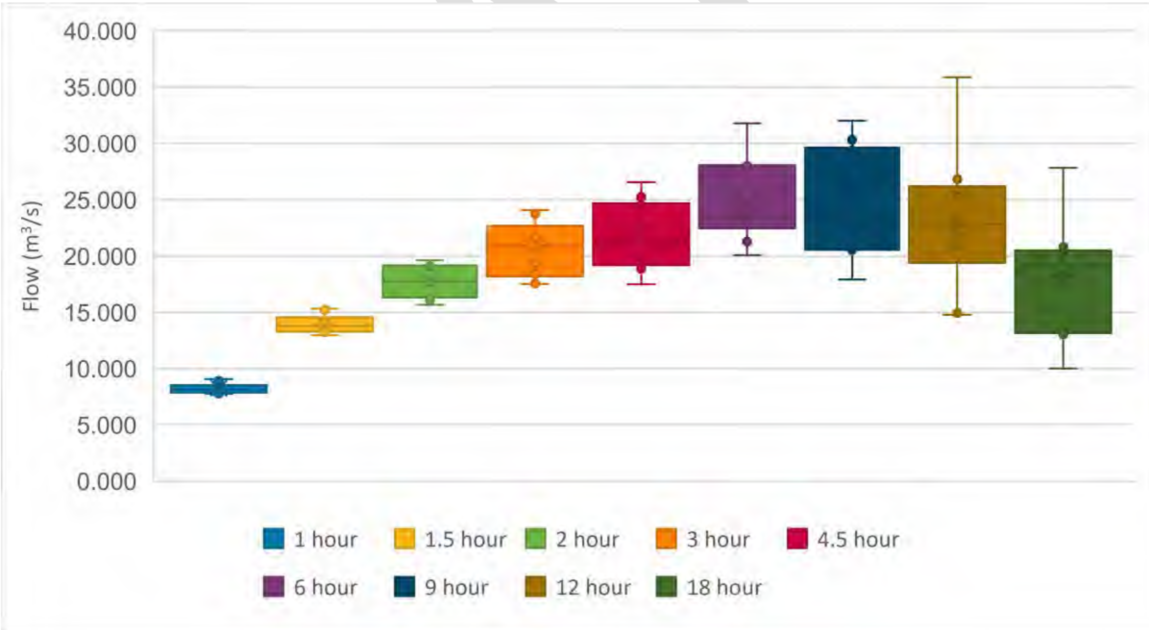

Figure A-4 1% AEP Temporal Pattern and Peak Flows

The event which yielded the highest median peak flow was 6-hour duration. Within the ensemble of temporal patterns, the temporal pattern which was centrally loaded and gave the peak flow closest (above) the mean was TP21. This rainfall event gave a peak flow of 23.79 m^3/s.

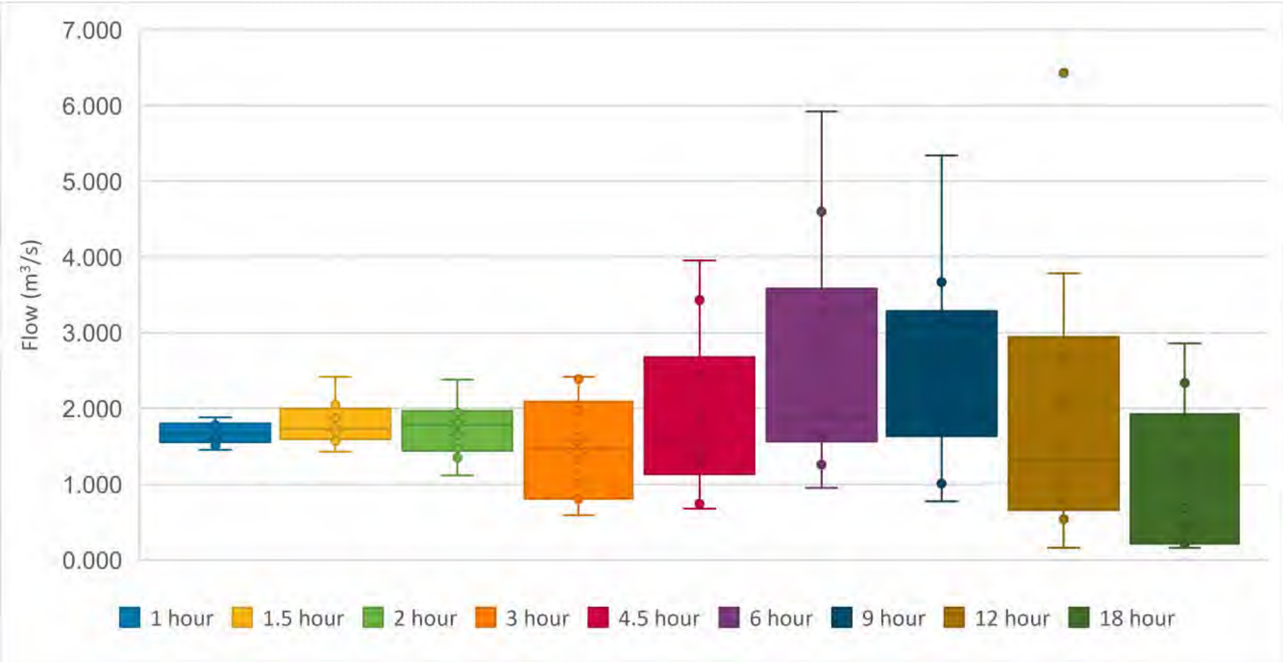

Figure A-5 20% AEP Temporal Pattern and Peak Flows

The event which yielded the highest median peak flow was 9-hour duration. Within the ensemble of temporal patterns, the temporal pattern which gave the peak flow closest (above) the mean was TP10. This rainfall event gave a peak flow of 2.65 m³/s.

A-1-4 Flow Verification – Regional Estimations

The catchment is ungauged, in the place of observed data the adopted design flows were compared against a range of other flow estimate methods including Rational Method and Regional Flood Frequency Estimation (RFFE) as shown in Table A-7.

The Rational Method for South Australia (Engineering and Water Supply Department 1986) produced a peak flow of 31.2 m³/s for the critical duration of 6 hours, slightly higher than the peak estimated by RORB. The RFFE Method (rural) provides an update to the Probabilistic Rational Method described in the previous version of ARR. It is a software implementation of the ARR Revision Project 5, a full description of the method is provided in ARR project reports (http://www.arr.org.au/revision-projects/project-list/project-5/).

Overall, the RORB estimates produced similar flows to the flow estimate methods, providing greater confidence in the results.

Whilst these estimation methods are considered to have high uncertainty, they demonstrate that based on the adopted catchment RORB parameters, reasonable flows based on catchment area and IFD parameters have been produced. It is also noted that the estimation methods used rely on the now superseded ARR1987 methods and rainfall IFDs. Additionally, results would have increased unreliability given these methods' inability to handle multiple model outlets.

Table A-7 Design Flow Comparison

Method	1% AEP Flow (m^3/s)	20%AEP Flow (m^3/s)
Rational (Engineering and Water Supply Department)	31.2	10.3
RFFE (Rural)	4.87 (95% C.I: 0.52 – 53.46)	0.88 (0.17 – 4.68)
RORB Montecarlo	27.3	2.83
RORB Ensemble	24.1	2.65

A-2 Hydraulic Modelling

A two-dimensional hydraulic modelling approach was employed for this investigation using the Australian Rainfall and Runoff (ARR) 2019 guidelines and TUFLOW hydraulic flood modelling software. Simulations were completed using TUFLOW Build 2023-03-AB Single Precision with HPC (Highly Parallelised Computations) solution scheme on a GPU solver.

A new hydraulic model was constructed using land use, cadastral, topography and aerial photography datasets to identify different land uses which are represented from a hydrologic and hydraulic perspective as surface roughness and initial and continuing loss values.

This hydraulic model has been constructed separately from the RORB model, with the RORB outputs used as runoff excess across the catchment, as well as hydrographs to be used as inflows in key locations.

A-2-1 Model Approach

The TUFLOW model set-up is presented in Figure A-6 highlighting the model extent and boundary conditions.

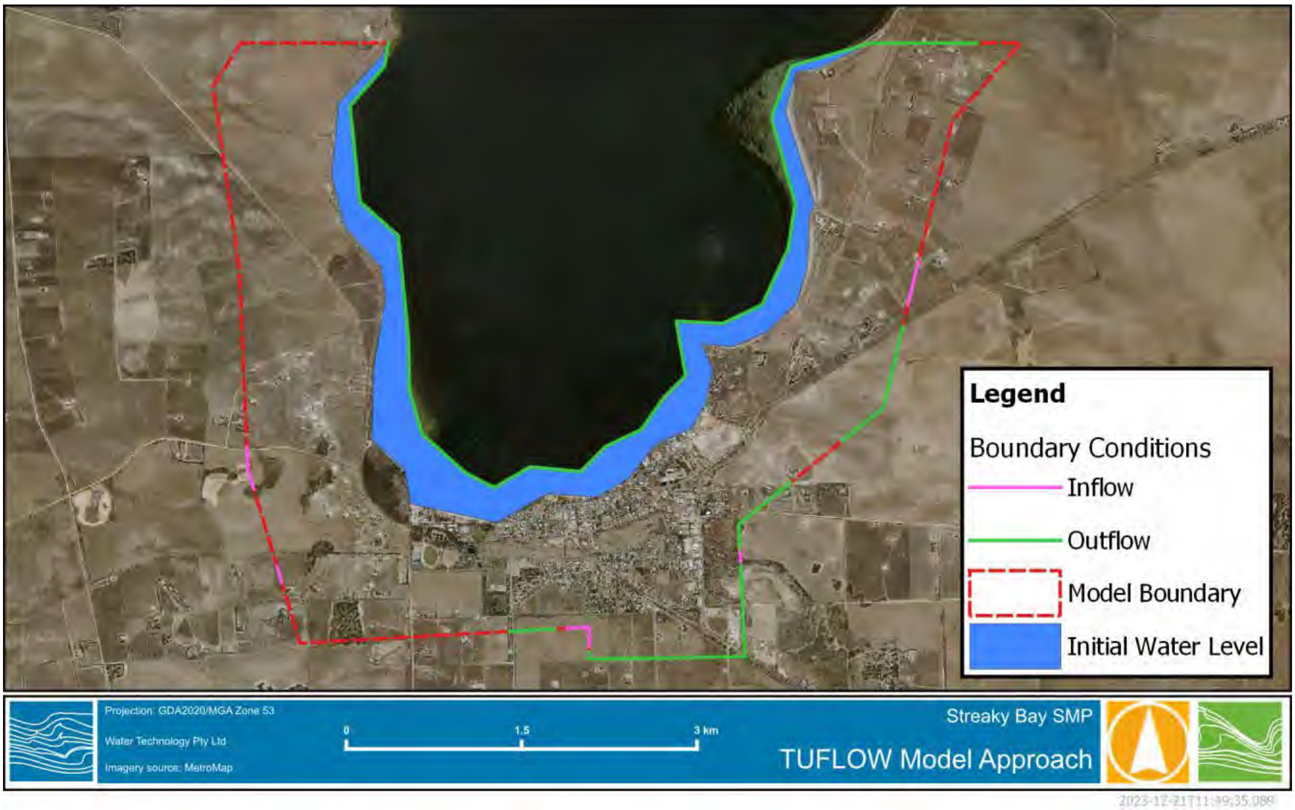

Figure A-6 TUFLOW Model Approach

A-2-2 Critical Duration and Temporal Pattern Assessment

The RORB modelling identified the median peak flow for each of the modelled durations (10 minute to 18-hour duration events) and identified the critical duration and median temporal pattern. The surface runoff and inflow hydrographs from the 1% AEP, 6-hour, TP21 event was adopted in the TUFLOW modelling, as well as the 20% AEP, 9-hour, TP10 event.

A-2-3 Digital Elevation Model, Losses, and Hydraulic Roughness

The Digital Elevation Model (DEM) was generated from 1 m resolution LiDAR, captured in 2018, as well as a survey completed in 2023 that captured increased area around Bay Road on the southern border of the model.

Figure A-7 summarises the Manning's 'n' hydraulic roughness used for the hydraulic modelling as per the land use types within the model. Losses were incorporated into the model previously in the RORB model, and so were not included in the TUFLOW. These values were adopted based on Water Technology's experience and industry guidelines.

Table A-8 Model Parameters

Land use types	Manning's 'n' (roughness)
Building footprints	0.5
Residential parcel (remainder)	0.05
Rural residential	0.15

Land use types	Manning's 'n' (roughness)
Open space (minimal vegetation)	0.04
Open space (moderate vegetation)	0.06
Sealed road	0.025
Unsealed road	0.125
Lakes	0.08
Wetlands	0.065
Industrial/commercial	0.35

A-2-4 Boundary Conditions

Inflows to the model have been sourced from the RORB model outputs. These include five hydrographs generated from upstream catchments at the locations specified in Figure 6-6, as well as the excess rainfall run-off calculated at the sub-catchments within the model extent. The five inflow hydrographs are located near Black Beach Road, Woodlawn Road, and the Flinders Highway.

An initial water level has been set along the coastline, set at 0.1 mAHD. This allows water to exit the model and drain into the ocean as required.

Various boundaries have also been placed around the southern and eastern borders of the model to allow water to flow downhill and out of the model.

A-2-5 1D Network

The stormwater drains and pipes for the model were supplied by the District Council of Streaky Bay. For culverts, or open channel flow, the supplied network was supplemented with SX/CN lines in the constructed model. This stormwater network is shown in Figure A-7 below.

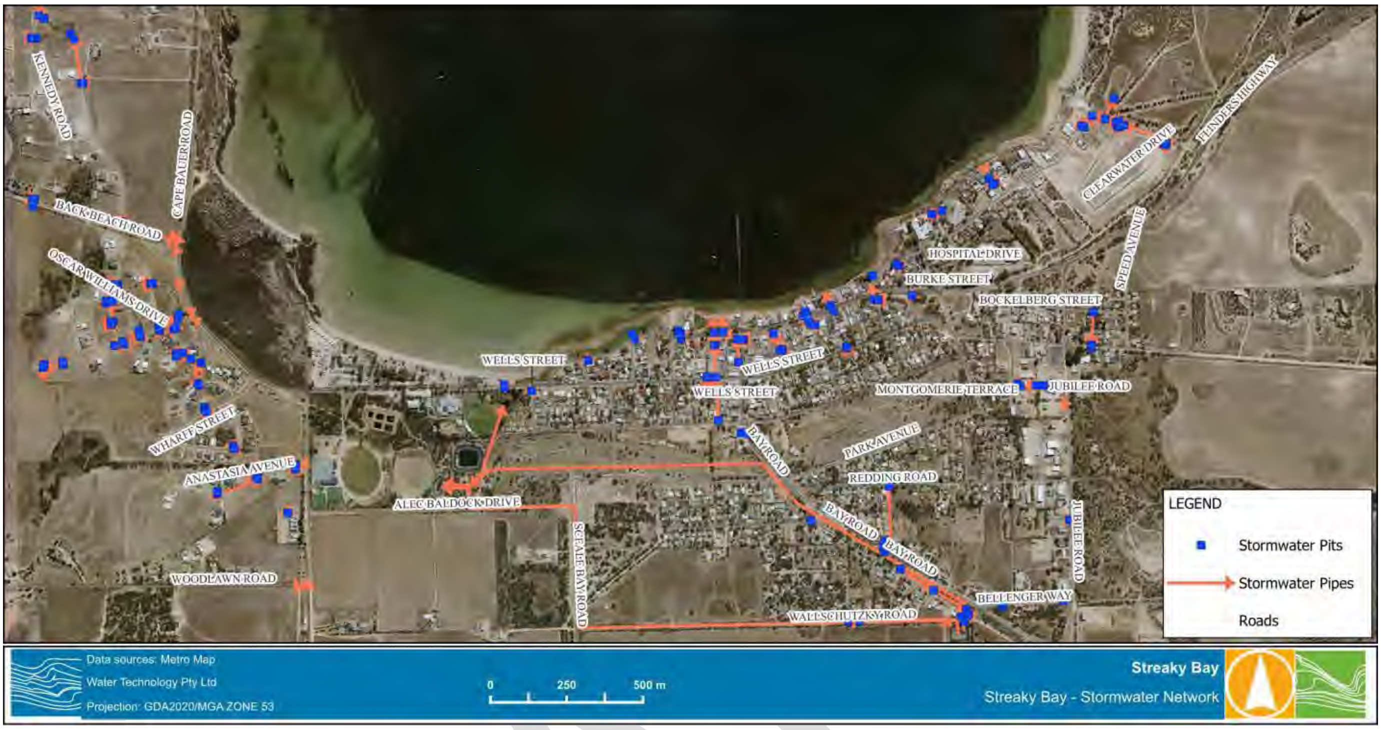

Figure A-7 Streaky Bay – Existing Stormwater Network

A-2-6 TUFLOW Model Checks

- The following checks were undertaken on the TUFLOW model parameters and outputs.
  - 2D timestep: The adaptive 2D timestep drops to a minimum of 0.45 seconds. A 'Classic' TUFLOW model would be expected to have a timestep no less than ¼ of the grid size (5 m), i.e. 1.25 seconds, with a healthy HPC model no lower than a tenth of this figure. Hence, the adopted timestep is within the recommended range.
  - Model mass errors: The mass errors for all models are less than 1% and are within the recommended range.
  - Errors and warning messages: No errors were found within the model and all warnings were reviewed and either acceptable or fixed, if required.

A-2-7 Climate Change and Sea Level Rise

Climate Change modelling, consistent with Australian Rainfall and Runoff (2019) guidelines was undertaken for the following scenarios:

- climate change (rainfall % increase)
- climate change (rainfall % increase) and increase to sea level rise

The climate change increase factor was determined via extrapolation of the interim climate change guidelines shown in Table A-9 provided on the Australian Rainfall and Runoff Data Hub[2]. The climate change factor was added to the IFD data provided from the Bureau of Meteorology as detailed on page 56. RCP 8.5 is the worst-

[2] ARR Data Hub, https://data.arr-software.org/, Accessed February 2024

case emission scenario as determined by the IPCC[3] and generally accepted as the standard scenario across the industry and has therefore been used in this assessment.

Table A-9 Rainfall Increases (%) for Streaky Bay for RCP8.5

Year	RCP 8.5
2030	3.9%
2040	5.7%
2050	7.6%
2060	9.7%
2070	12.1%
2080	14.9%
2090	18.1%
2100	**21.98%**

To account for sea level rise, the scenario of climate change (rainfall % increase) and increase to sea level rise was also modelled. This included a tailwater level consistent with a sea level rise increase of 0.84m[4] [5] for 2100.

A-2-8 Flood Modelling Results

The full flood modelling results for the present-day infrastructure scenarios are detailed in the appendices:

- Appendix B – Existing Conditions Flood Mapping
- Appendix C - Climate Change Flood Mapping
- Appendix D - Climate Change SLR Flood Mapping

Existing Conditions

The flood depth mapping for the existing conditions 1% AEP case is shown in Figure A-8. Flooding across Streaky Bay can generally be characterised as overland flow and stormwater flooding due to the lack of defined watercourses within the town. Flow paths on the western, eastern and north of the golf course drain towards the ocean while the area southeast of the golf course within the mapping boundary drains south toward terminal lake and groundwater systems.

The existing flood mapping results have informed the potential mitigation options in Section 5.

[3] Climate Change 2014 Synthesis Report, Intergovernmental Panel On climate change
[4] Coastal Risk Australia 2100, https://www.coastalrisk.com.au/viewer, Accessed February 2024
[5] IPCC Sixth Assessment Report, Intergovernmental Panel on Climate Change, 9 August 2021

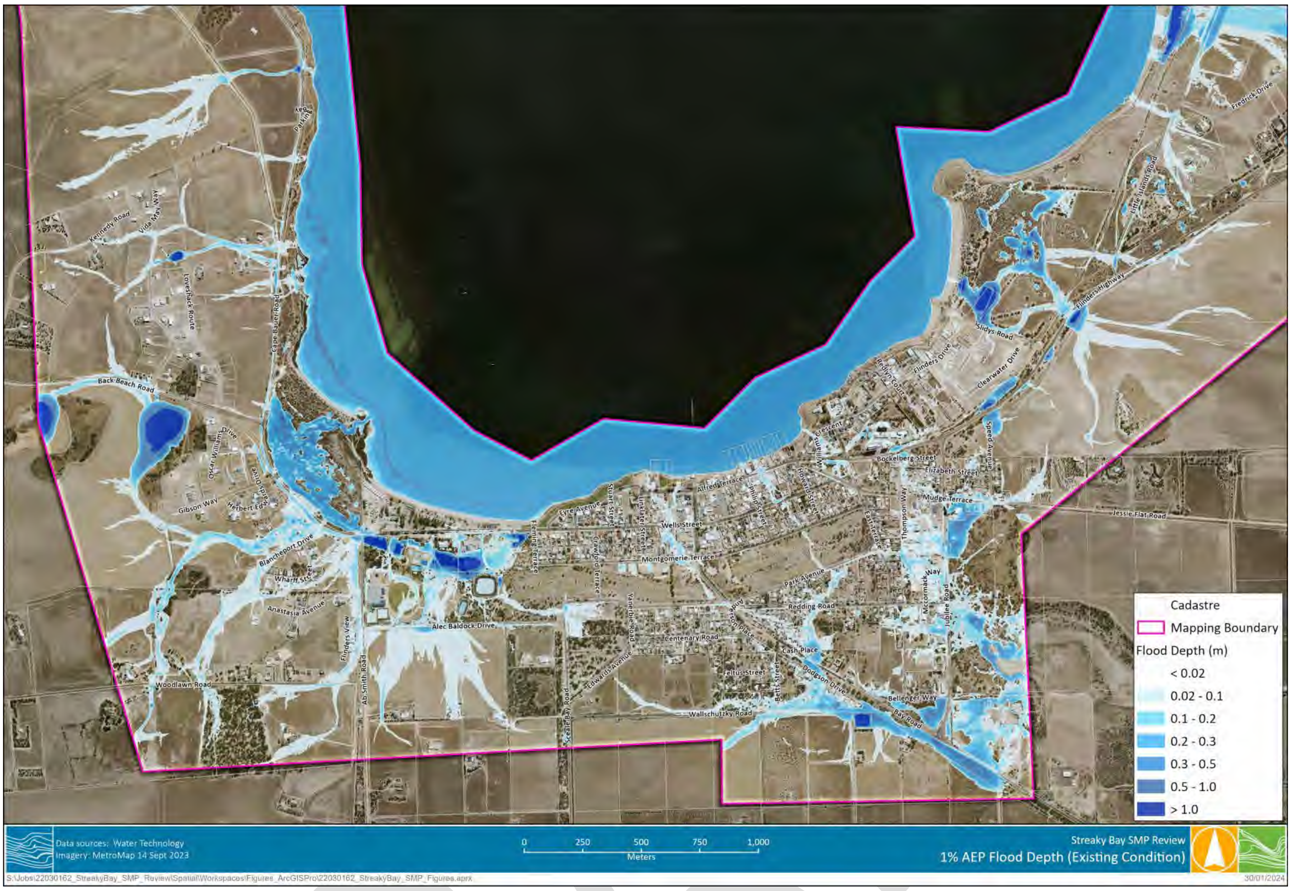

Figure A-8 1% AEP Flood Depth (Existing Conditions)

Climate Change (Increased Rainfall Intensity & SLR)

The flood depth mapping for the existing infrastructure with 1% AEP 2100 climate change for both increased rainfall intensity and sea level rise are shown in Figure A-9 and Figure A-10. Depth increases in are seen across the catchment when compared to the existing scenario. Consideration for the future climate scenario should be considered in future planning situations including within mitigation options that have a planning time horizon greater than 80 years.

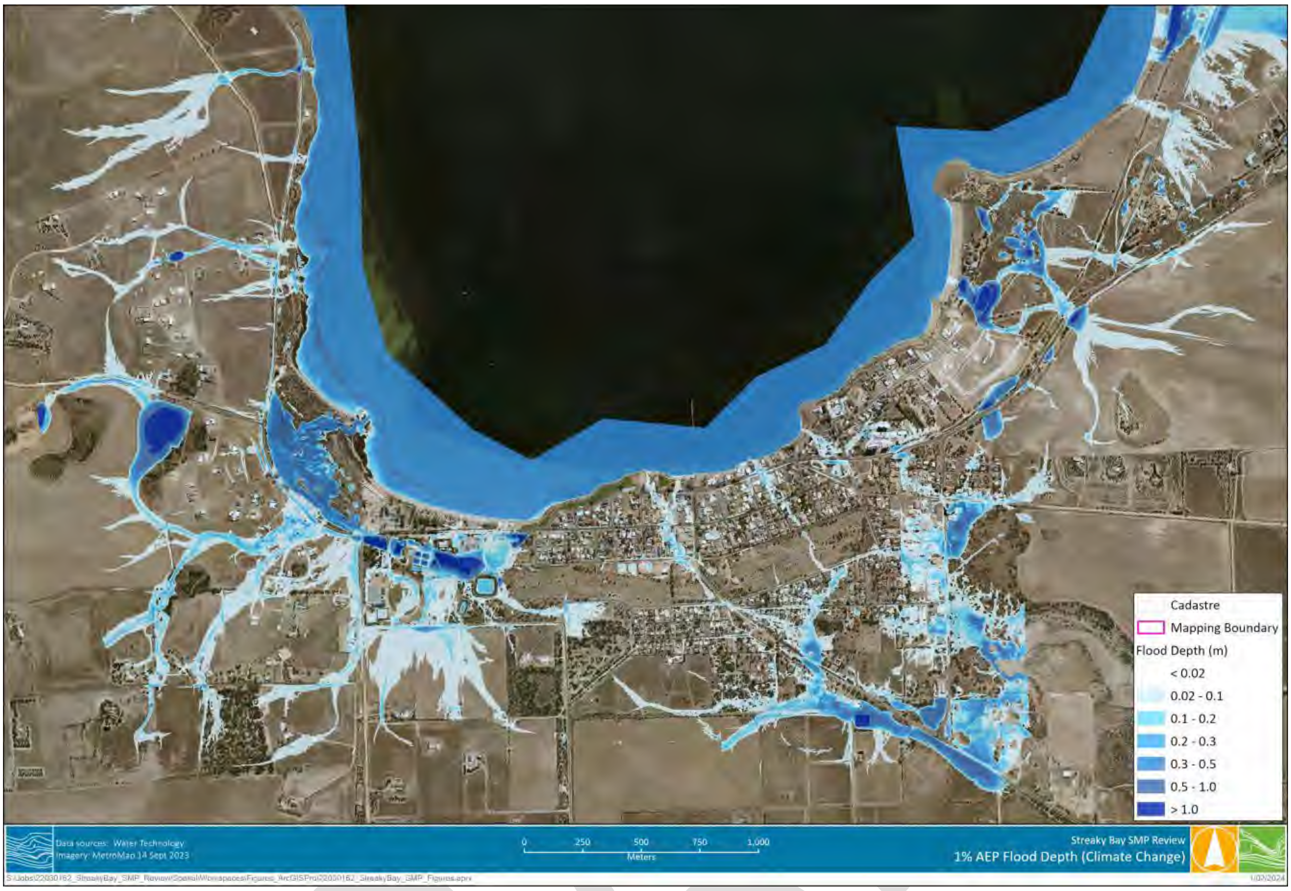

Figure A-9 Future Conditions (Climate Change) – 1% AEP Flood Depths

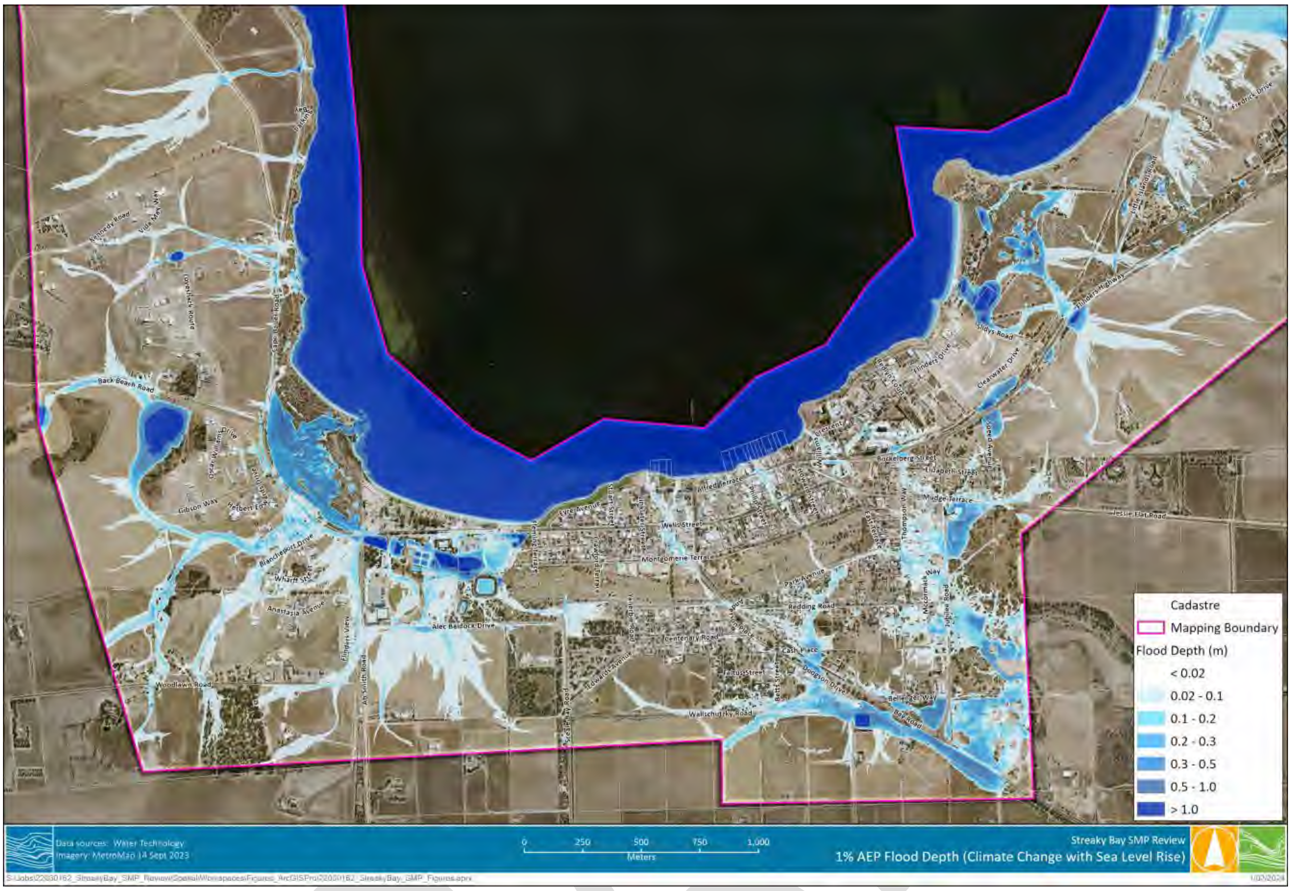

Figure A-10 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Depths

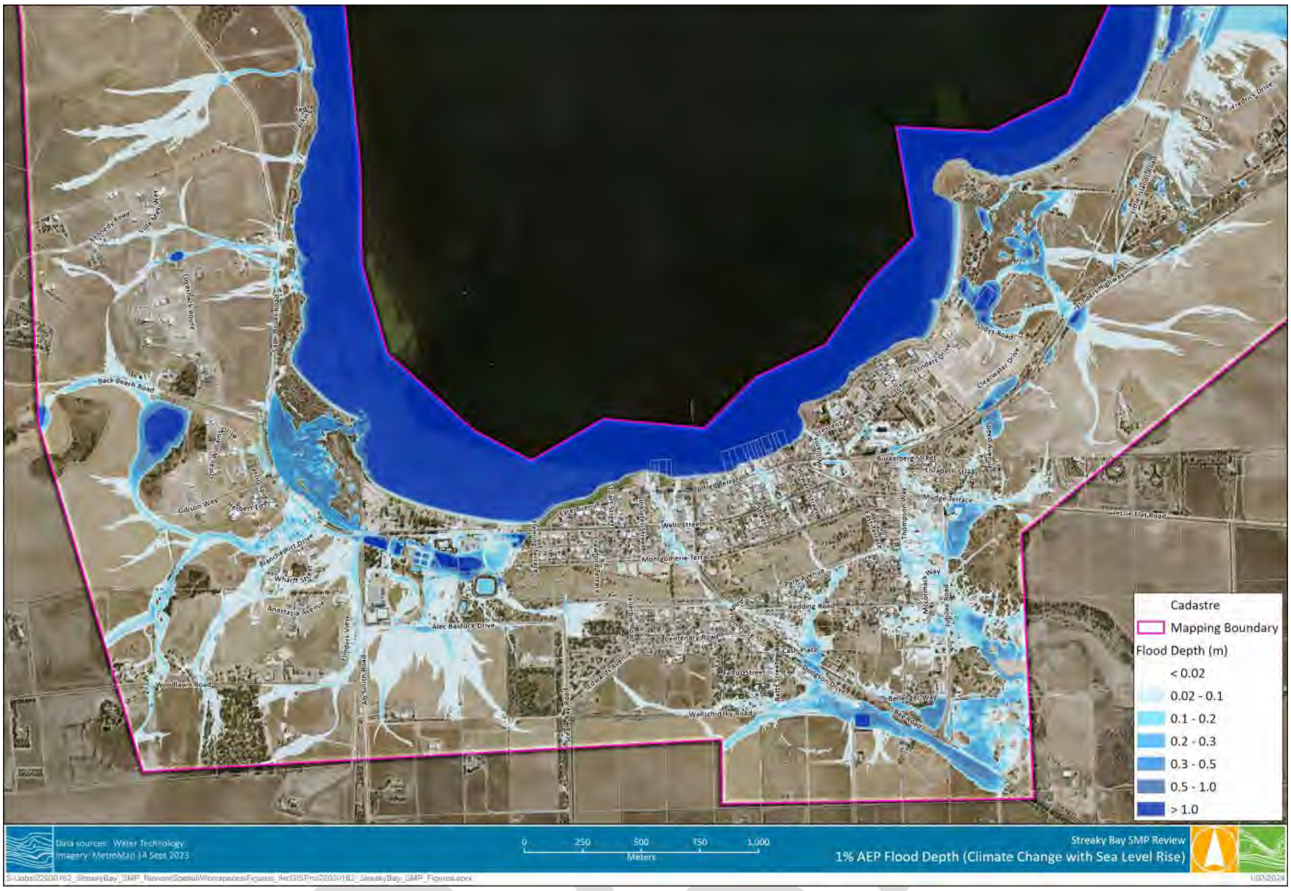

Figure A-11 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Depths

A-3 Integrated Stormwater Management

A-3-1 Overview

Stormwater management is particularly important to the Streaky Bay community due to the proximity of the town to the bay, and limited amount of annual precipitation.

- The current concerns about water quality which were identified during stakeholder consultation were:
  - Stormwater discharged into bay often has discolouration, pollutants, silt, sediment, debris, etc.
  - Impacts of stormwater on seagrass health in the bay
  - Concern about weed dispersion
  - Concern about erosion control

- The Stormwater Management Plan is aimed at evaluating the intensity of stormwater quality issues in Streaky Bay, and identifying the critical locations where quality management measures are to be implemented. Some of the primary considerations in undertaking the stormwater quality investigations were:
  - Erosion control
  - Biodiversity enhancement
  - Native species & planting with drought resilience
  - Social benefits and wellbeing – exemplars, educational, cultural considerations-
    - Farming community's connection to water / waterholes
    - Public education of wetlands, water cycle / stormwater management – e.g., interpretive signage, education programs etc.
- Water Sensitive Urban Design (WSUD) measures have been proposed at various locations, with the intention to:
  - Manage more frequent, minor flooding
  - Enable stormwater capture & reuse to assist with drought management
  - Improve water quality entering the Bay
  - Link WSUD to larger strategies, such as tree canopy targets, urban cooling, active transport links etc.
  - Evaluate current and future potential for roof downpipes connected to rainwater tanks on lots

A-3-2 Key Areas of Interest

The key areas of interest from a stormwater quality perspective were identified during stakeholder engagements for detailed investigation. Some of the critical areas are:

- Several low-lying areas, with marsh/wetland species of varying ecological quality.
- The Samphire Wetland – It is understood that the wetland was established on a former landfill site on Cape Bauer Road. The samphire wetland:
  - Provides a coastal interface between the bay and township and can potentially act as a treatment component to the stormwater being discharged into the bay.
  - Supports biodiversity include samphire plants (saltmarsh), frogs, birds, etc.
  - Is of local environmental value to the community – e.g., recreational walking, birdwatching etc.
- Along the southeastern part of Streaky Bay – where the low-lying swamp area to the east of Jubilee Road could potentially be converted into a wetland.
- School Wetland – to evaluate and quantify the stormwater quality benefits provided by the Wetland located on Wells Street.

A-3-3 MUSIC Modelling – Existing Conditions

Stormwater Quality modelling for Streaky Bay was undertaken using eWater MUSIC (Model for Urban Stormwater Improvement Conceptualisation) software. MUSIC enables the user to quantify stormwater volumes and quality as well as to develop conceptual designs for treatment systems.

MUSIC modelling was undertaken with the objective of understanding the quality of stormwater discharged into the bay, and at other critical locations. The water pollutant reductions observed at each critical area were compared to the minimum pollutant reduction standards recommended by Water Sensitive SA - South Australian MUSIC Guidelines with relevance to State Government's Water Sensitive Urban Design (WSUD). The performance targets are listed in the table below.

Table A-10 Performance Targets for WSUD

Pollutant Type	Recommended Reduction Target (%)
Retention of typical annual Urban Load of Total Nitrogen (TN)	45
Retention of typical annual Urban Load of Total Phosphorus (TP)	60
Retention of typical annual Urban Load of Total Suspended Solids (TSS)	80

Figure A-12 shows the final MUSIC Model setup. The below sub-sections A-3-4 to A-3-3 discuss each modelling component in detail.

Figure A-12 MUSIC Model Setup – Existing Conditions

A-3-4 Climate Data

In the absence of pre-established MUSIC climate templates in the Streaky Bay region, a new climate template was developed using 6-minute timestep data available from the Bureau of Meteorology (BoM) website at rainfall station Minnipa Pirsa (018195). The BoM station is located approximately 100 km from Streaky Bay but falls within the Eyre rainfall region. The monthly Potential Evapo-transpiration (PET) values were assumed based on the Monthly Average areal potential evapotranspiration values from the Burau of Meteorology (BoM) website. The daily rainfall and evapotranspiration values are graphically shown in Figure A-13.

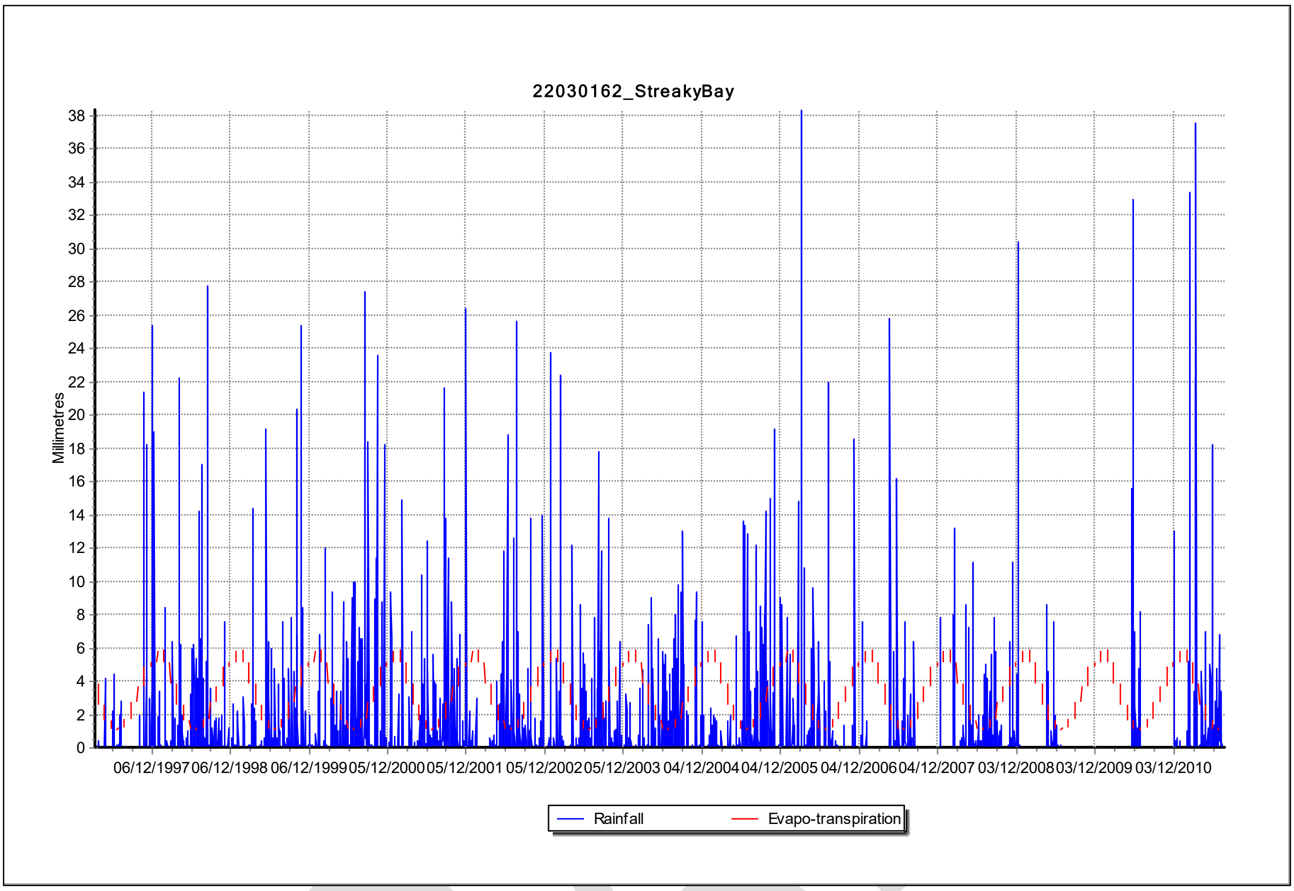

Figure A-13 Time-Series Graph – MUSIC Climate Data

A-3-5 Catchment Nodes

The Streaky Bay catchment area was sub-divided into smaller catchment nodes based on the land use type, topography, direction of stormwater flows and locations of interest. The impervious fraction was assumed from satellite imagery, land use data and Table 4.4 of Water Sensitive SA - South Australian MUSIC Guidelines. Other modelling parameters were finalised based on Water Sensitive SA - South Australian MUSIC Guidelines and listed as below:

- Pervious Area Properties – for Sandy loamy soil types
  - Soil Storage Capacity (mm): 98
  - Field Capacity (mm): 70
  - Infiltration Capacity Coefficient – a: 250
  - Infiltration Capacity Exponent – b: 1.3
- Groundwater Properties
  - Daily Recharge Rate (%): 60
  - Daily Baseflow Rate (%): 45
  - Daily Seepage Rate (%): 0

A summary of MUSIC catchments area details is in Table A-11.

Table A-11 MUSIC Catchments Summary

Catchment Node	Description	Area (ha)	Fraction Impervious (%)
C1	Open Space, Residential Development	17.8	20
C2	Open Space, Residential Development	110.9	25
C3	Streaky Bay Golf Course/ Reserve	32.8	10
C4	School area, Sports Club	23.5	25
C5	Rural Residential, Open Space	105.7	10
C6	Open Space, Cemetery	22.3	15
C7	Town Centre, Commercial	69.7	90
C8	Town Centre, Commercial	41.6	80
C9	Town Centre, Commercial	70.7	80
C10	Rural Residential, Open Space	21.6	15
C11	Open Space	30.9	15
C12	Rubbish dump	10.5	10

A-3-6 Wetlands Storages

The Streaky Bay Stormwater Management Plan (January 2011) suggested several Water Sensitive Urban Design (WSUD) assets, but these haven't been implemented yet. The stormwater storages considered as part of the existing conditions modelling are:

- Wallschutzky Dam - located at the corner of Wallschutzky Road and Dodgson Drive
- School Storage Basin - located on Alec Baldock Drive
- School Wetland – located on Wells Street
- Detention Basin – located on Slidys Road

A-3-7 Water Quality Results

The water quality levels are major points of interest were evaluated using the MUSIC model. The key locations of investigation were Samphire Wetland, School Wetland and the junction at the Bay Outfall (as labelled in Figure A-12). In addition to these individual locations the overall water quality in Streaky Bay has also been investigated. The water quality results at all locations are listed below in Table A-12.

Table A-12 Stormwater Treatment Details at Critical Locations

Location	% Reduction - Total Suspended Solids (kg/yr)	% Reduction - Total Phosphorous (kg/yr)	% Reduction - Total Nitrogen (kg/yr)
Samphire Wetland	0.0	0.0	0.0
School Wetland	93.4	80.2	55.1
Bay Outfall	25.0	21.9	15.5
Overall	23.8	21.3	15.1

The overall level of water quality observed in Streaky Bay indicates that stormwater is not treated to the minimum water quality standards. Whilst the sections of the town draining into the School Wetland achieve the necessary levels of treatment, the parts of the town which drain directly into the bay is not subjected to treatment prior to being discharged.

The Samphire Wetland receives a high pollutant load from the residential catchment nodes draining into that section of the bay. The stormwater generated in Catchment Nodes C7 and C9 (parts of the town centre located north and east of the golf course) is another source of high pollutant concentration.

A-4 Opportunities for Reuse

A-4-1 Recommended Stormwater Reuse Strategies

The MUSIC modelling indicates that an average of 370 ML of stormwater runoff is generated annually in the Streaky Bay township. Whilst a fraction of the stormwater would be utilised by rainwater storage systems (not accounted for in the MUSIC model), there are still opportunities for implementing new stormwater reuse schemes or supplementing the existing stormwater reuse systems. There are also opportunities for passive irrigation including tree pits, nature strips, kerb cutouts or irrigating the local oval/ sports fields.

Whilst the stormwater re-use investigation results from MUSIC modelling provide high level information on the amount of stormwater available for re-use, detailed investigations are necessary to evaluate the feasibility of different options. There are opportunities for a centralised stormwater reuse scheme for the whole town, or decentralised strategies focused on certain parts of the town which would benefit from reuse. Depending on the nature and extent of the strategy, detailed assessments will need to be undertaken to size the stormwater re-use components.

A-5 Managed Aquifer Recharge

Managed Aquifer Recharge (MAR) is the process of taking surplus surface water, for example stormwater or treated wastewater, and storing it underground in a suitable aquifer. The stored water may either be left in the aquifer for environmental purposes (e.g., to mitigate declining groundwater levels) or purposely recovered at a later time for beneficial use, the latter of which is often termed Aquifer Storage and Recovery (ASR).

While the opportunities for implementing MAR in a water stressed town such as Streaky Bay may seem attractive, there are many challenges and risks that need to be planned from the initial design stage. First and foremost is the issue of capturing and storing stormwater so that it can then be recharged to the aquifer through either injection wells or infiltration galleries i.e. engineered drainage basins that have a highly permeable sand or gravel bed to facilitate rapid infiltration down to the water table. Given the flashy nature of stormwater runoff, ensuring sufficient temporary storage volumes prior to MAR would be critical.

The next most critical issue is water quality as this presents both practical and regulatory challenges. From an operational perspective, using surface water with high suspended solid loads (i.e., high turbidity) can lead to physical clogging of the MAR infrastructure – either the screened section of injection wells, or the graded sand/gravel beds of infiltration galleries. It is also common for chemical and/or biological clogging to reduce the efficiency of MAR injection wells, so whilst this can be managed through regular maintenance programs, careful analysis of all water quality attributes for both the source water and receiving aquifer is vital.

Under the Environment Protection Act (1993) the "*Discharge of Stormwater to Underground Aquifers*" is an EPA-licensable activity (Schedule 1, section 4(2)), but only in the council area of the City of Mount Gambier and in Metropolitan Adelaide. Likewise, "*Discharges to Marine or Inland Waters*" is an EPA-licensable activity under Schedule 1, section 8(7) of the Act, but only if the discharge either raises the temperature of the receiving waters by > 2°C or contains antibiotic or chemical water treatments and the total volume of the discharge exceeds 50kL/day.

The Act (Part 4, section 25 – *General environmental duty*) requires that (1) *"a person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm."* Similar requirements for pollution of "waters" are specified in Division 1 (Clause 9) of the Environment Protection (Water Quality) Policy 2015.

If temporary storage of the surface water and all of the water quality considerations outlined above can be overcome, then the main challenge becomes identifying a suitable aquifer for MAR. Ideally the receiving aquifer should have ample storage capacity (i.e. large thickness of unsaturated sediments/rock), a high transmissivity and storage coefficient to facilitate rapid infiltration, similar water quality to the MAR source water, and no nearby discharge features (e.g., lakes, wetlands or coastal springs). The latter is important for two reasons; firstly, because this presents a risk of losing the injected/infiltrated water before it is required to be abstracted from the aquifer for beneficial use, and secondly because any such loss may present a risk to receiving ecological habitats due to a change in either groundwater flux or quality.

The remainder of this chapter discusses the suitability of two potential local aquifer systems for receiving surplus stormwater runoff in Streaky Bay.

A-5-1 Local Hydrogeology and Data Availability

The main aquifer across the Streaky Bay area is the Quaternary Bridgewater Formation, a succession of coastal sand dunes comprising partially consolidated mixed quartz-skeletal carbonate sands (aeolianites). The Bridgewater Formation has been mapped across large parts of Southern Australia (Murray-Wallace, 2018). The Semaphore Sand Member occurs along the coast, and Quaternary playa sediments, described as Unnamed units, are associated with playa lakes (Figure A-14). In the study area, the Bridgewater Formation is described by Berens et al. (2011) as being typically around 10 m thick, and underlain by Tertiary sequences including the Garford, Pidinga and Pantoulbie Formations.

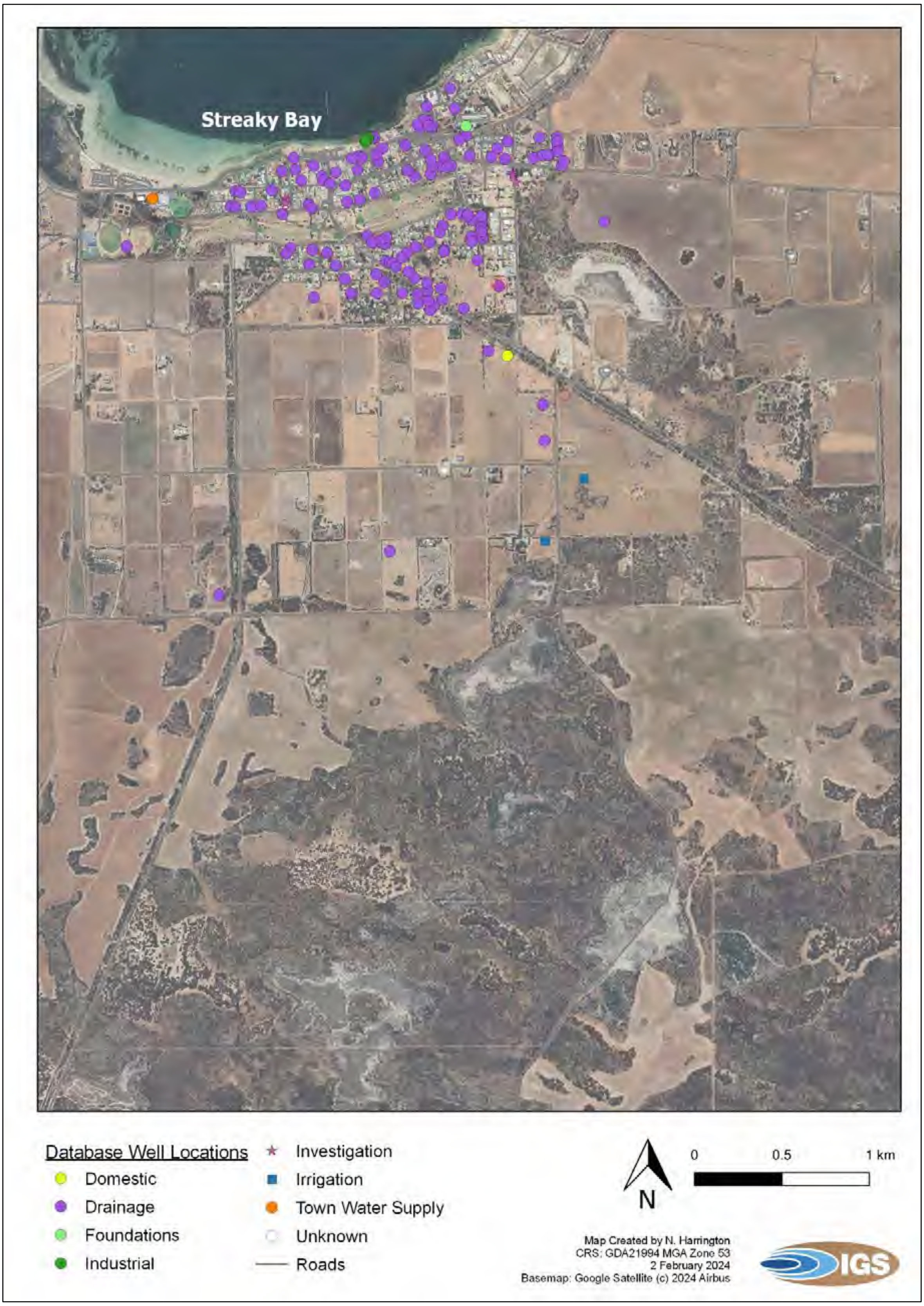

Figure A-14 Registered Wells in the Streaky Bay Area as Recorded in the South Australian Government WaterConnect Database and their Recorded Purpose

A review of drillhole data available on the South Australian Government's WaterConnect database (Groundwater Data Default (waterconnect.sa.gov.au)) indicated that the majority of wells around Streaky Bay were drilled between 1955 and 1985, a feature that was also noted by Berens et al. (2011). Interestingly, most of the wells located around the Streaky Bay township are listed on the WaterConnect database as being for drainage purposes (Figure A-14). The majority are less than 25 m deep, with a median total depth of 11.6 m. The latest yield, water level and salinity (TDS; Total Dissolved Solids or EC; Electrical Conductivity) measurements were generally collected at the time of drilling, meaning that most of this data is more than 30 years old (Figure A-15 to Figure A-19) and that the status of the wells has not been updated since then. That said, groundwater levels and salinities are not expected to have changed to a large degree since these measurements were taken and they are therefore appropriate for a high-level assessment of MAR feasibility.

Groundwater wells in the Robinson Lens area were drilled in either the late 1970s or mid 1990s for the purposes of Town Water Supply and observation of the freshwater lens. A recent field assessment of the Robinson Lens groundwater resource was carried out by IGS (2023), and the groundwater level and salinity data presented in this report for Robinson Lens were obtained during that sampling program.

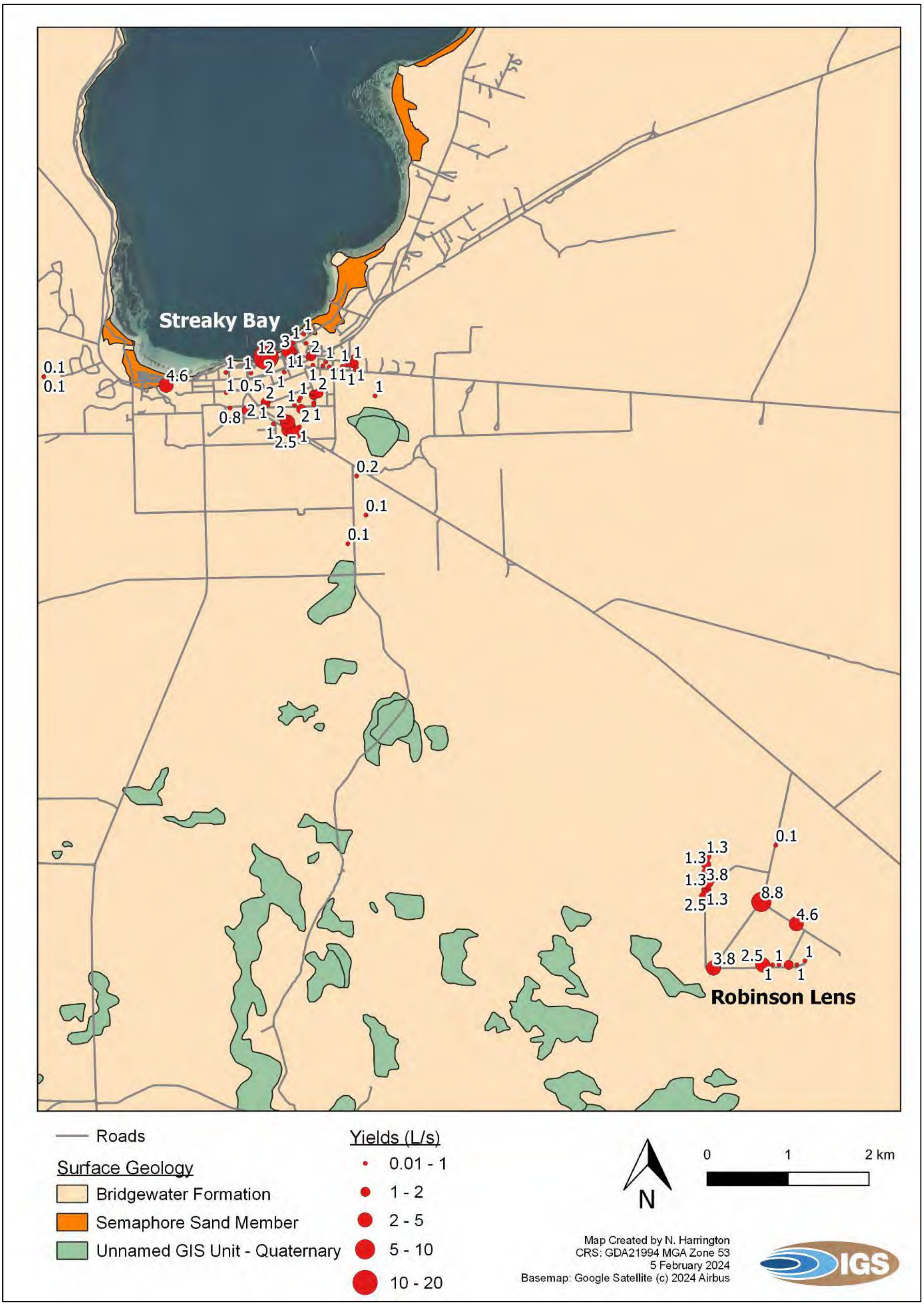

Figure A-15 Overview of Surface Geology and Well Yields (L/s) Across the Study Area

The majority of data in the following four figures came from WaterConnect and was obtained during the time period between 1955 and 1995.

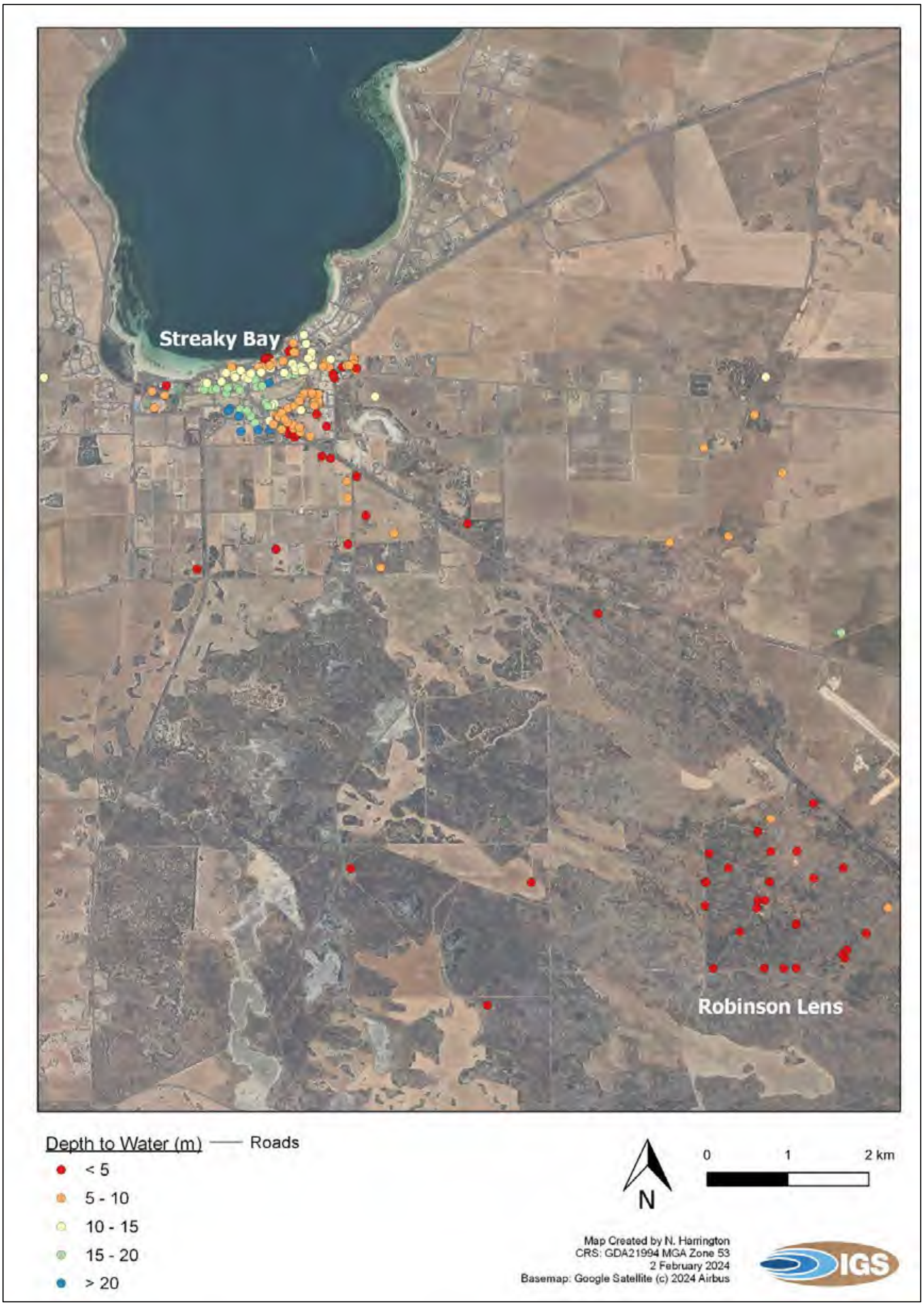

Figure A-16 Latest Depths to Groundwater as Listed on the WaterConnect Database (Main Dataset) and from a recent Groundwater Monitoring Program carried out at Robinson Lens (IGS, 2023)

Figure A-17 Latest Depths to Groundwater as Listed on the WaterConnect Database for the Streaky Bay Township Area

Figure A-18 Latest Groundwater Salinities (TDS) as Listed on the WaterConnect Database (main dataset) and from a recent Groundwater Monitoring Program carried out at Robinson Lens (IGS, 2023)

Figure A-19 Latest Groundwater Salinities (TDS) as Listed on the WaterConnect Database for the Streaky Bay Township Area

A-5-2 Potential MAR Location 1: Streaky Bay Township Area

Available lithological logs for the Streaky Bay township area describe clayey fine-grained limestones, sandy limestones, calcareous sands and sandstones and clastic limestones to depths between 5 m and 25 m. Reported yields are generally low, between 0.01 L/s and 12 L/s, with a median of 1 L/s. However, as described above, the majority of these reported yield values (n = 86) appear to have been obtained at the time of well construction and hence represent airlift yields of largely open holes. Airlift yields of open holes are likely to underestimate the potential performance of a constructed production (or injection) well or infiltration gallery. The Bridgewater Formation is known to be heterogeneous with variable aquifer potential and the potential to produce large quantities of sand in poorly constructed production wells. This means that careful consideration would need to be given to the construction of MAR wells and infiltration galleries to minimise physical clogging. However, its sandy and calcareous nature mean that it is likely to have significant permeability and hence relatively good potential for the effective infiltration of stormwater.

Depths to groundwater around the Streaky Bay township area range between less than 5 m in the low-lying areas adjacent the coast and to the south east of the town, and more than 15 m to 20 m in the higher elevation areas around the golf course and to the south of this in the Centenary Road area (Figure A-16 and Figure A-17). The latter, higher elevation areas may have sufficient available storage to support MAR.

Groundwater salinities are similar to that of seawater (>30,000 mg/L Total Dissolved Solids (TDS)) near the coast, and at some locations below the town, with the remainder of groundwater beneath and around Streaky Bay having only slightly lower salinities (10,000 mg/L to 30,000 mg/L) (Figure A-18 and Figure A-19).In the higher elevation areas around the golf course and Centenary Road area, which may have sufficient available storage for MAR (depths to groundwater greater than 15-20 m), the last measured groundwater salinities were between approximately 14,000 mg/L and 34,000 mg/L TDS.

The high groundwater salinities observed below and around Streaky Bay are consistent with the presence of the seawater interface somewhere inland of the town. Seawater occurs in the aquifer at some depth, extending inland to an unknown distance from the coast. Depending on their depths, groundwater wells may sample the dense pure seawater sitting at the bottom of the aquifer, less dense fresher rainfall recharge sitting above this, or a mixture of the two at the interface between them, leading to the observed range in groundwater salinities.

The presence of seawater in the aquifer below the town means that, whilst there is available storage for MAR in the higher elevation areas, any fresher water that is artificially recharged would ultimately become mixed with seawater, and any water subsequently extracted for beneficial use would have a higher salinity (somewhere between that of the recharged water and seawater). Potential mitigation strategies for this may include allowing only very short timeframes between recharge and abstraction, and abstraction at very low rates to avoid advective mixing. Furthermore, any potential MAR site would be within approximately 1 km of groundwater discharge features, i.e. the coast and the inland salt lake located to the east of Jubilee Road. This requires that short timeframes between recharge and abstraction be implemented to (a) allow for recovery of the water for beneficial use before it is lost from the aquifer and (b) prevent potential impacts to the associated ecological systems caused by changes in groundwater flux or quality.

As mentioned above, the water level and salinity data used in this analysis are generally more than 30 years old and were collected at different times. Whilst the data is expected to provide an accurate indication of the ranges of water levels and salinities occurring in the study area, sufficient for this high-level assessment, a comprehensive sampling program would be required to further explore and confirm the feasibility of MAR. Groundwater salinities in particular are expected to vary to some degree both seasonally and inter-annually with variations in rainfall recharge, something that cannot be explored using the existing dataset.

A-5-3 Potential MAR Location 2: Robinson Lens

The Robinson Lens is a shallow limestone aquifer located between 7-9 km southeast of Streaky Bay on the southern side of Flinders Highway. Most wells are completed in either the aeolianite and sandy clay of the Bridgewater Formation or the underlying Garford Formation, which is described in the well logs as comprising mudstone and carbonate with shell and skeletal fragments, minor sandstone and grit horizons.

The lens was the primary water supply to the township for about 70 years (1937-2007) with groundwater extracted from shallow production wells and two underground trenches. Declining groundwater levels and increasing salinities through the late 1990s prompted a comprehensive investigation into the lens dynamics (Brown and Harrington, 2002) and extraction finally ceased in 2007 when groundwater salinity reached unacceptable limits for domestic and municipal purposes.

The District Council of Streaky Bay recently engaged Innovative Groundwater Solutions (IGS) to determine whether groundwater levels in the lens have recovered since the cessation of extraction. A desktop study followed by a field campaign in September 2023 identified a significant rise in water levels of at least 1.0 m across the study area between 2003 and 2023, consistent with reduced groundwater extraction and many years of above average rainfall over this period (IGS, 2023). Salinity mapping recognised fresh recent recharge overlying older more saline waters.

The historical production trenches within Robinson Lens have been decommissioned and backfilled in recent years, however the two main transects of production wells remain in good working condition and there is existing pipe infrastructure. Despite the opportunities this provides, and the comparatively lower groundwater salinities in this area (Figure A-16 and Figure A-17), several other factors mean the lens is not a desirable target for MAR. Firstly, the distance from the stormwater source is problematic for piping and injection into the aquifer. Secondly, the shallow depth to water table in the recovered aquifer means there is limited storage available for the introduction of stormwater (Figure A-18 and Figure A-19); any additional recharge is likely to be quickly removed through transpiration by deep-rooted Sheoak and *Eucalyptus sp*. vegetation that has dominated since production ceased. Thirdly, the fact that Robinson Lens has previously been used as a potable water supply, and one day could again be used for this purpose, means that tertiary water treatment would likely be required prior to injection.

WATER TECHNOLOGY
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APPENDIX B
EXISTING CONDITIONS FLOOD MAPPING

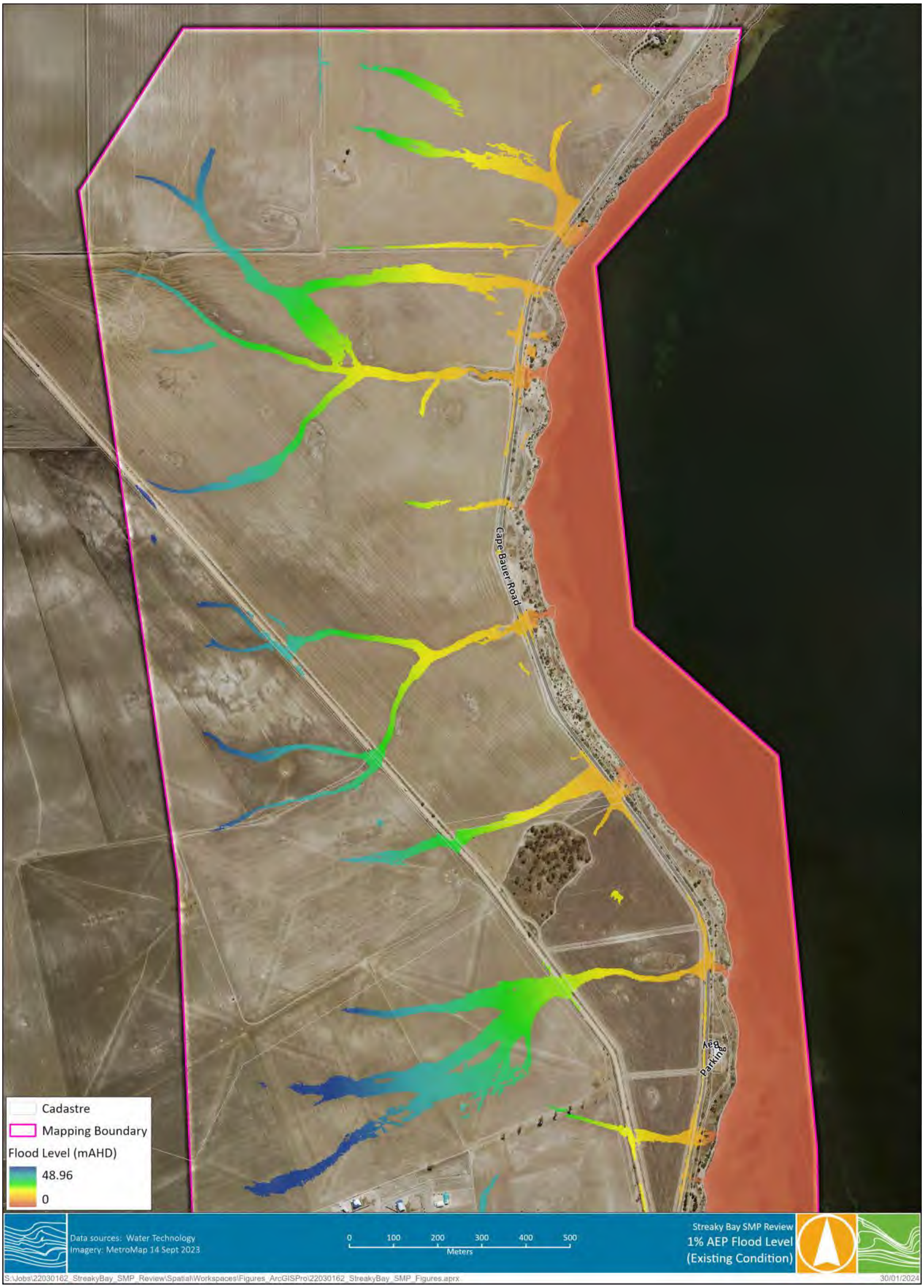

Figure B-1 Existing Conditions - 1% AEP Flood Levels

Figure B-2 Existing Conditions - 1% AEP Flood Depths

Figure B-3 Existing Conditions - 1% AEP Flood Velocity

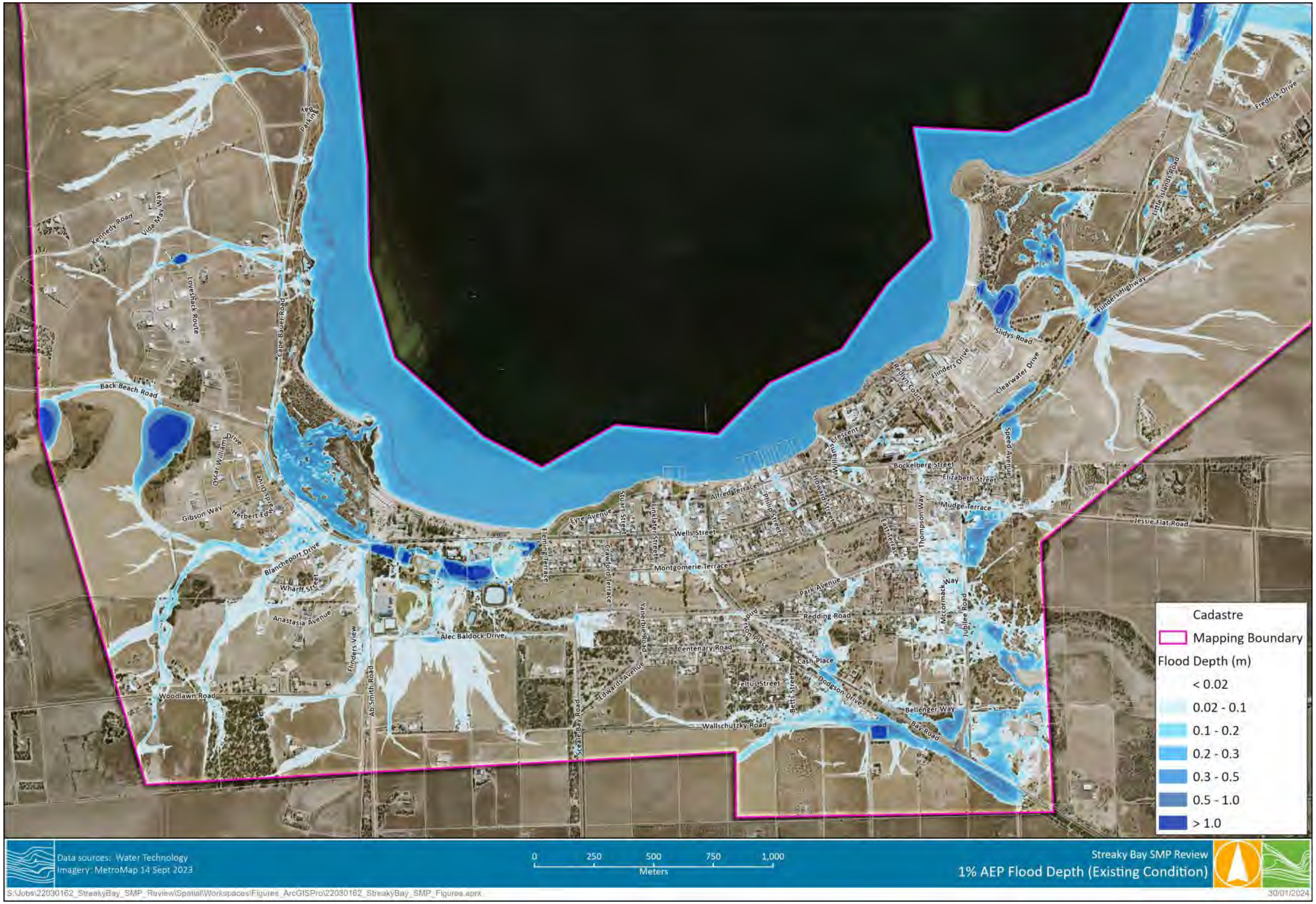

Figure B-4 Existing Conditions - 1% AEP Flood Depths

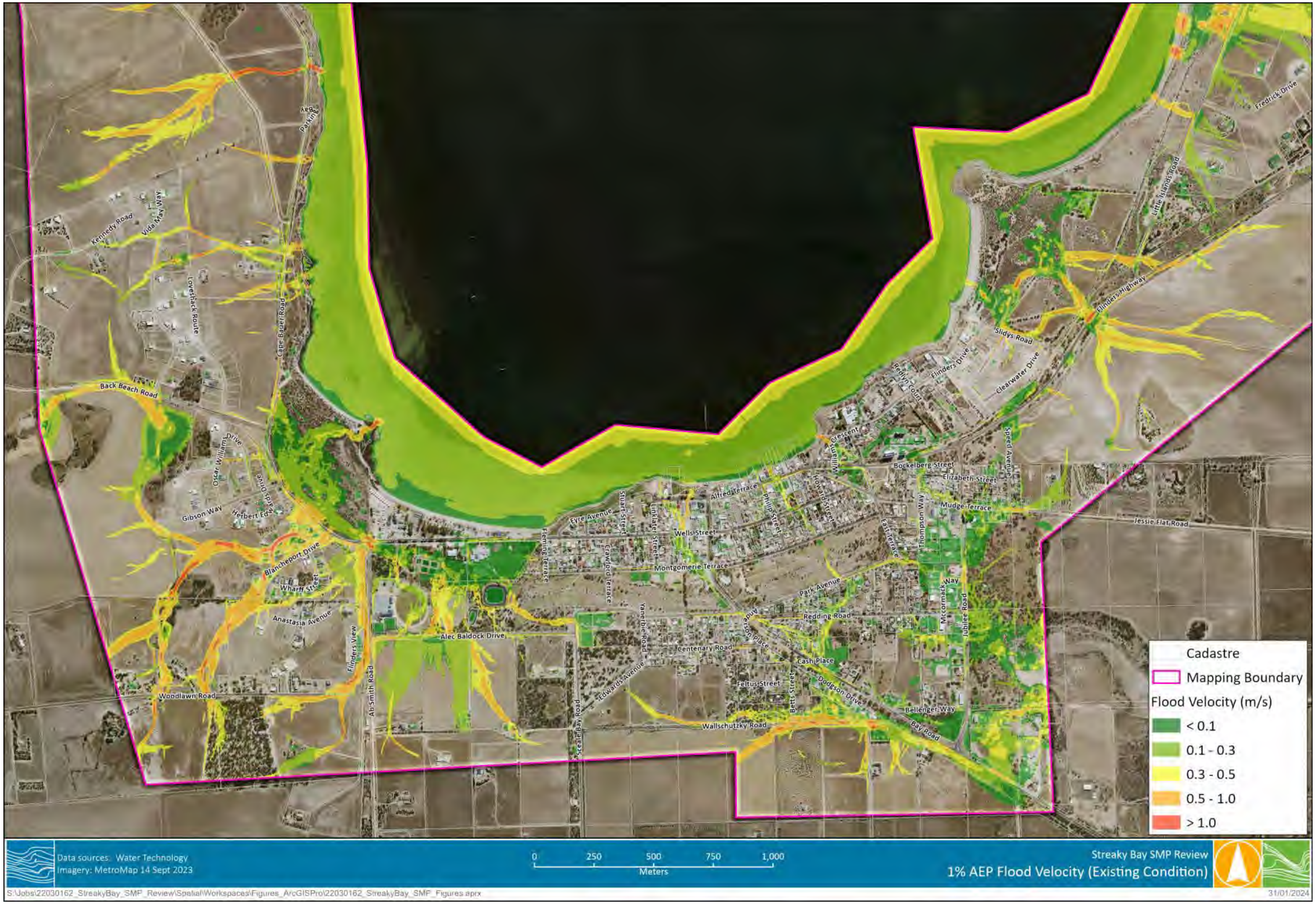

Figure B-5 Existing Conditions - 1% AEP Flood Velocities

Figure B-6 Existing Conditions - 1% AEP Flood Hazard

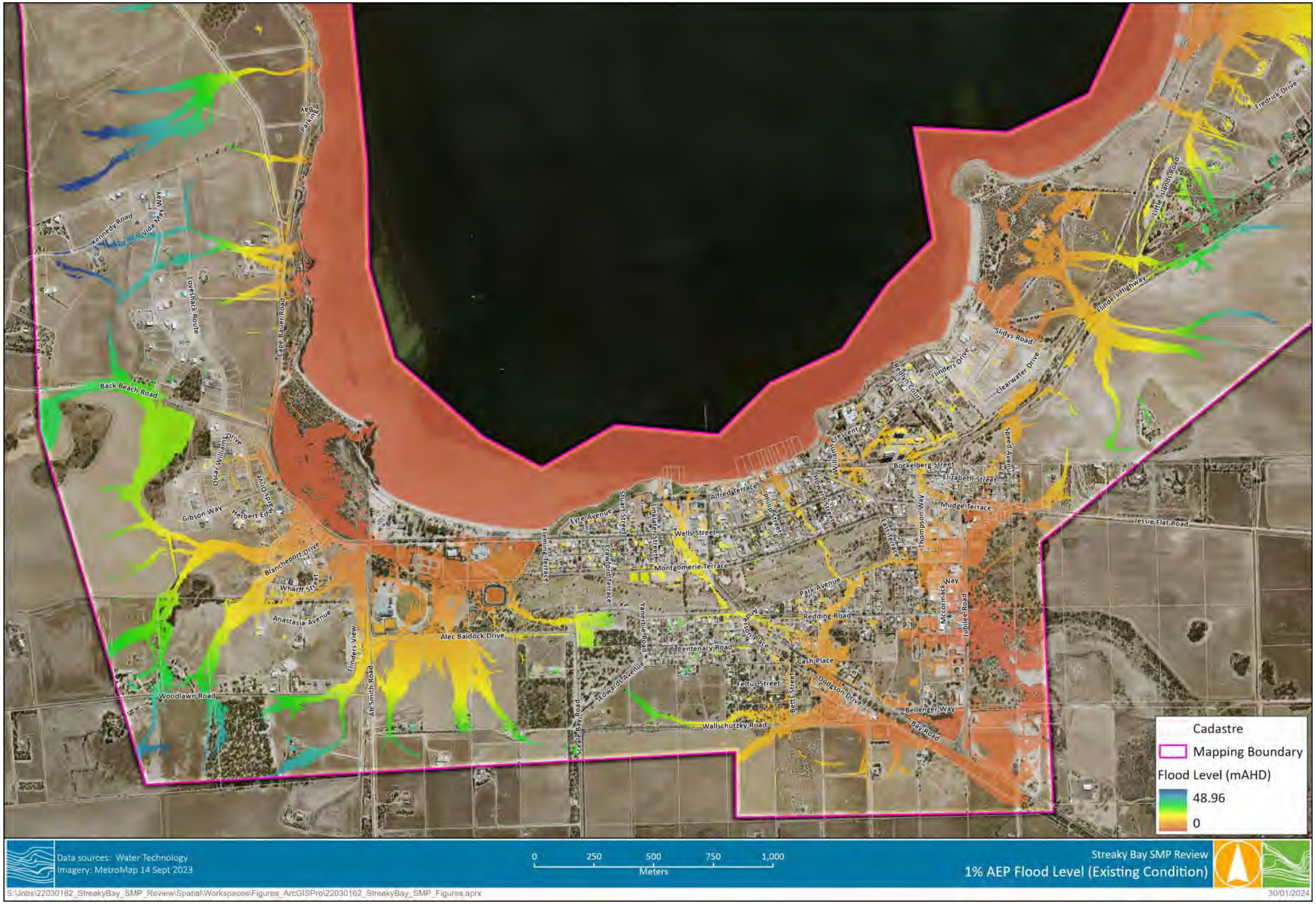

Figure B-7 Existing Conditions - 1% AEP Flood Levels

Figure B-8 Existing Conditions - 1% AEP Flood Depths

Figure B-9 Existing Conditions - 1% AEP Flood Velocities

Figure B-10 Existing Conditions - 1% AEP Flood Hazards

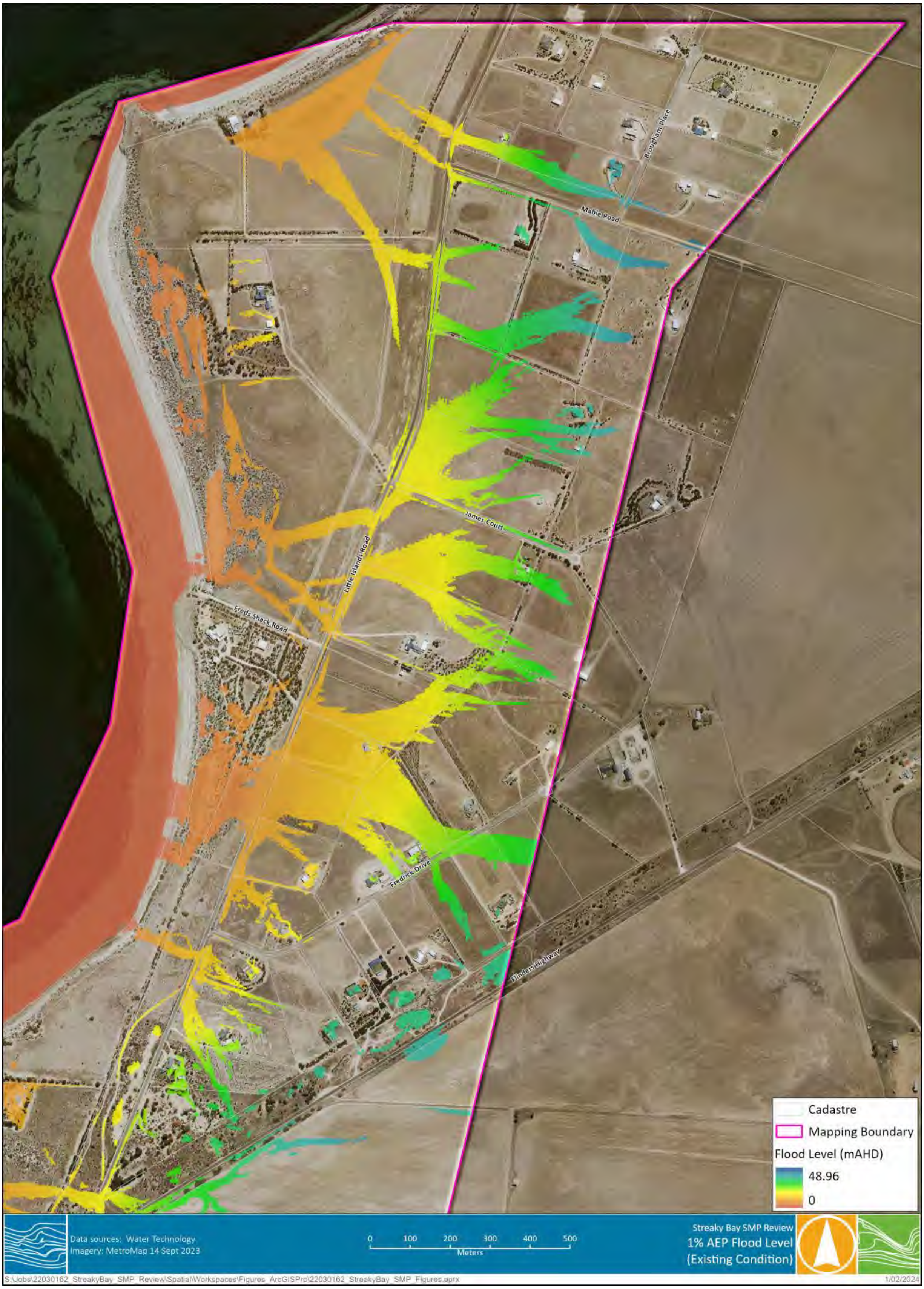

Figure B-11 Existing Conditions - 1% AEP Flood Levels

Figure B-12 Existing Conditions - 20% AEP Flood Hazards

Figure B-13 Existing Conditions - 20% AEP Flood Levels

Figure B-14 Existing Conditions - 20% AEP Flood Depths

Figure B-15 Existing Conditions - 20% AEP Flood Velocities

Figure B-16 Existing Conditions - 20% AEP Flood Hazards

Figure B-17 Existing Conditions - 20% AEP Flood Levels

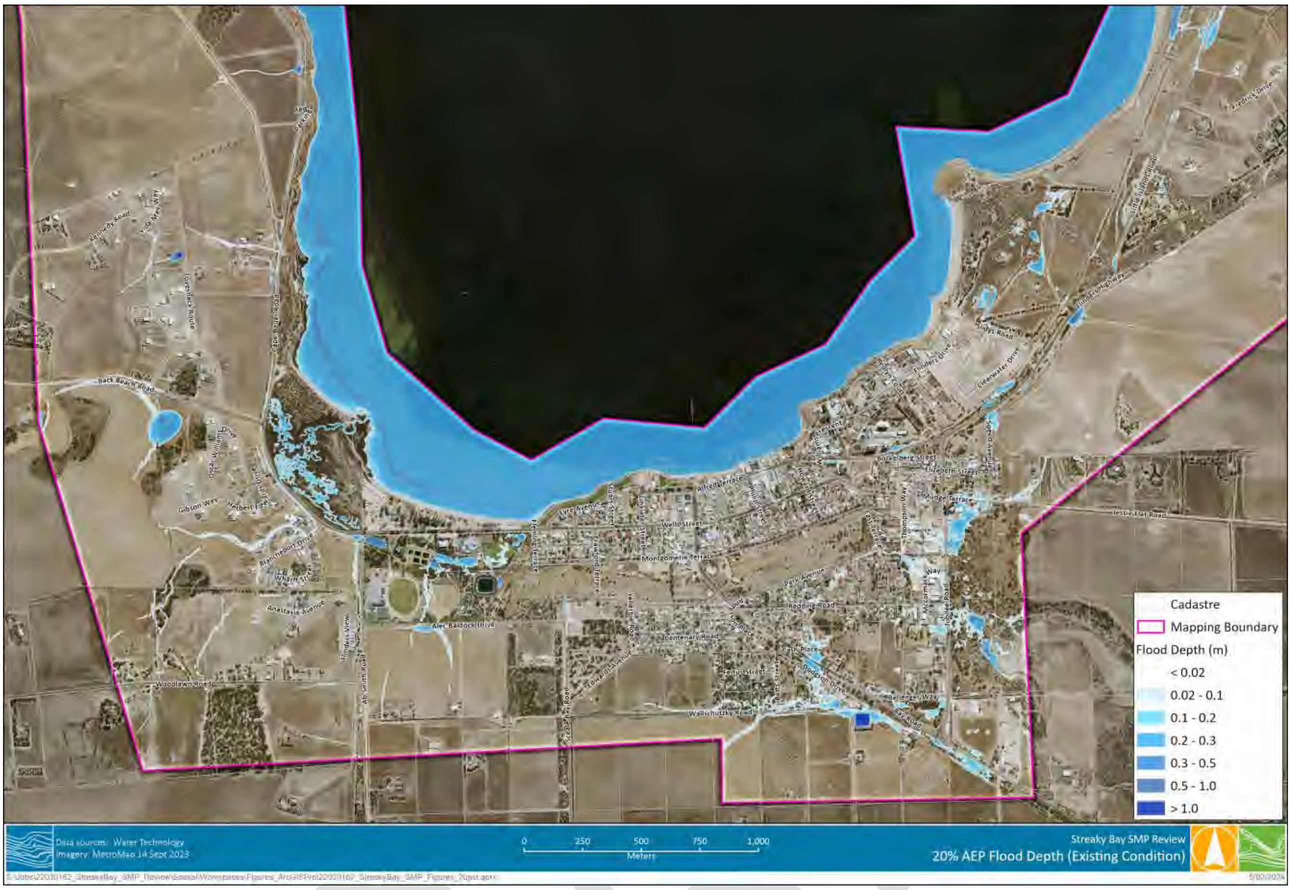

Figure B-18 Existing Conditions - 20% AEP Flood Depths

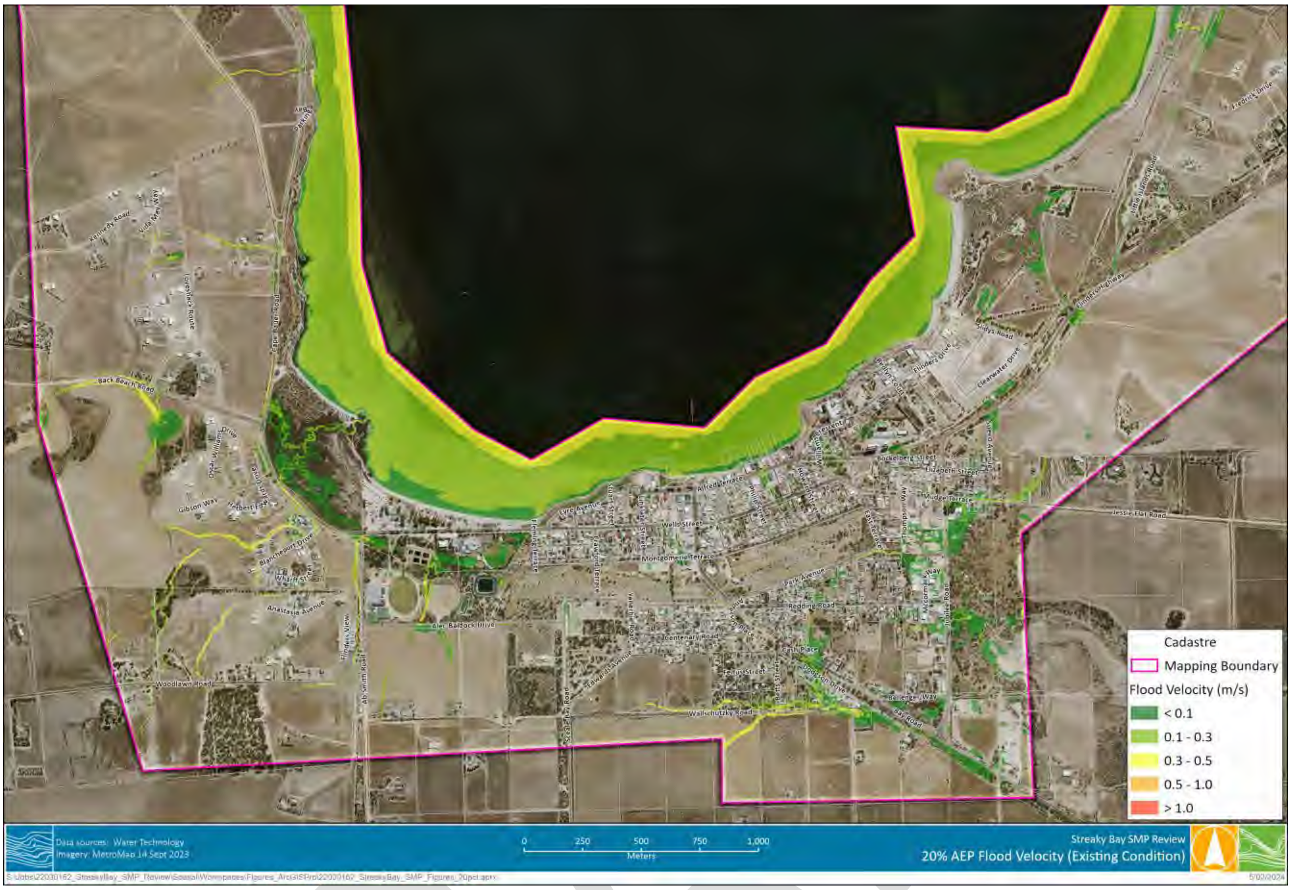

Figure B-19 Existing Conditions - 20% AEP Flood Velocities

Figure B-20 Existing Conditions - 20% AEP Flood Hazards

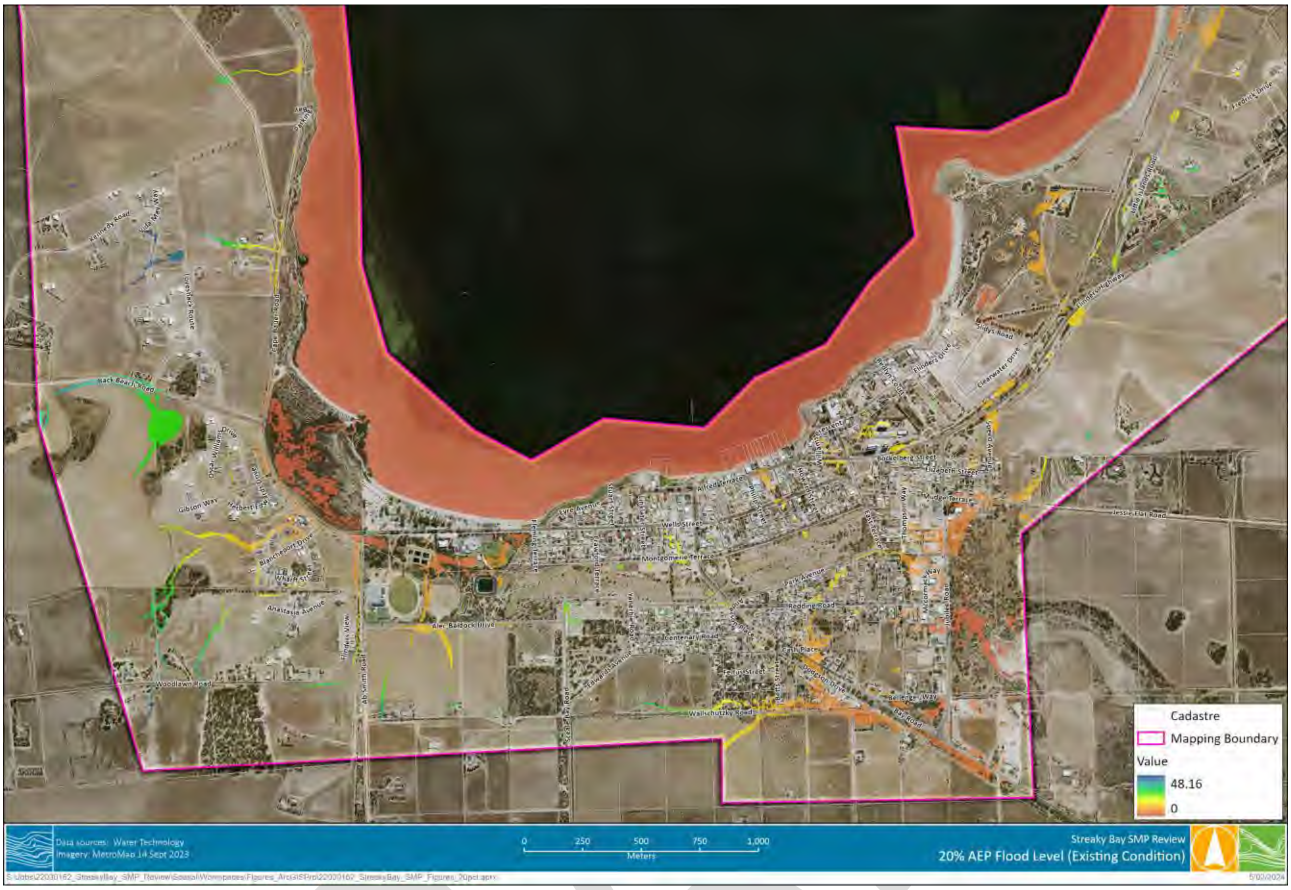

Figure B-21 Existing Conditions - 20% AEP Flood Levels

Figure B-22 Existing Conditions - 20% AEP Flood Depths

Figure B-23 Existing Conditions - 20% AEP Flood Velocities

APPENDIX C
CLIMATE CHANGE FLOOD MAPPING

Figure C-1 Future Conditions (Climate Change) – 1% AEP Flood Hazards

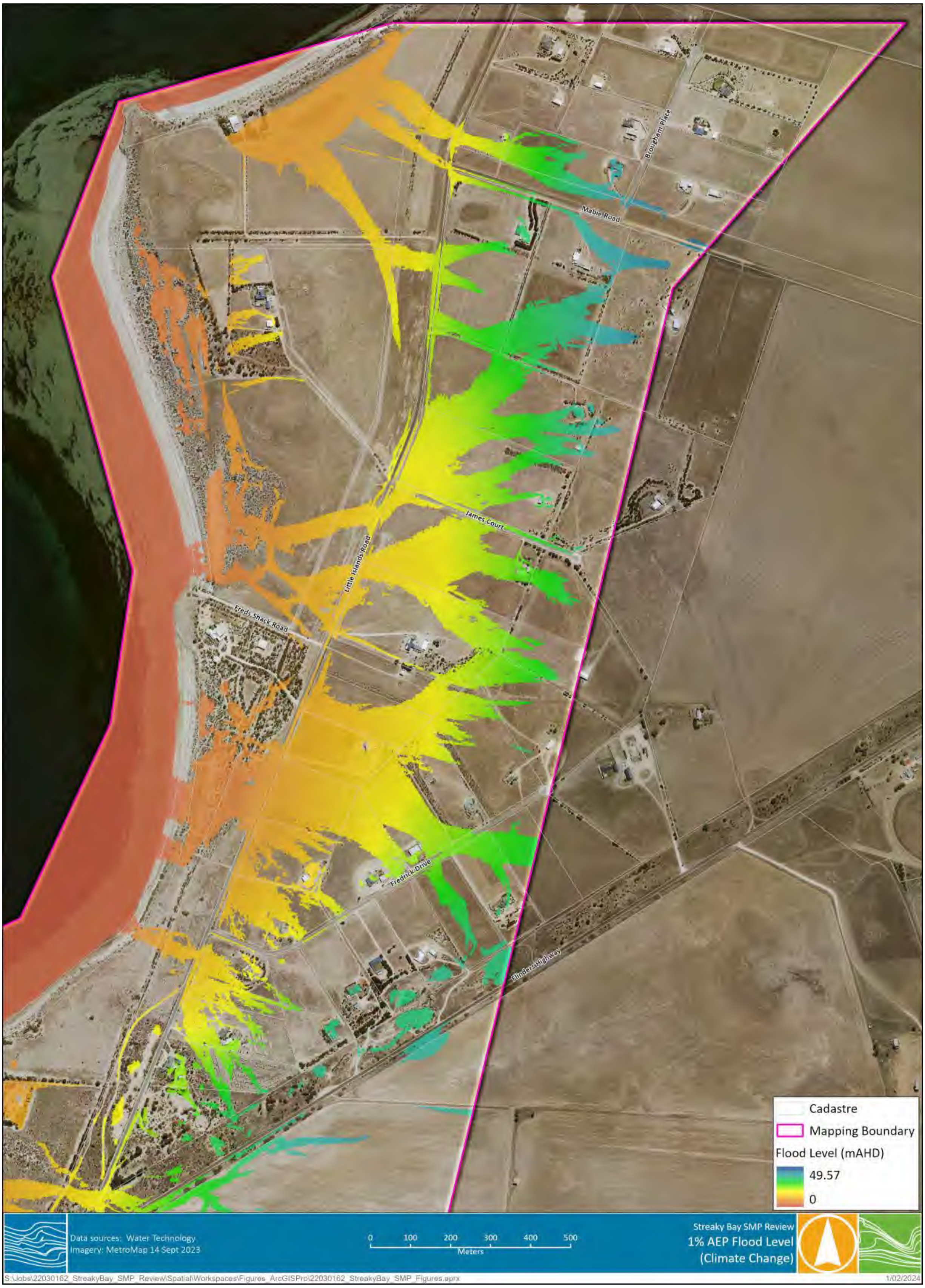

Figure C-2 Future Conditions (Climate Change) – 1% AEP Flood Levels

Figure C-3 Future Conditions (Climate Change) – 1% AEP Flood Depths

Figure C-4 Future Conditions (Climate Change) – 1% AEP Flood Velocities

Figure C-5 Future Conditions (Climate Change) – 1% AEP Flood Hazards

Figure C-6 Future Conditions (Climate Change) – 1% AEP Flood Levels

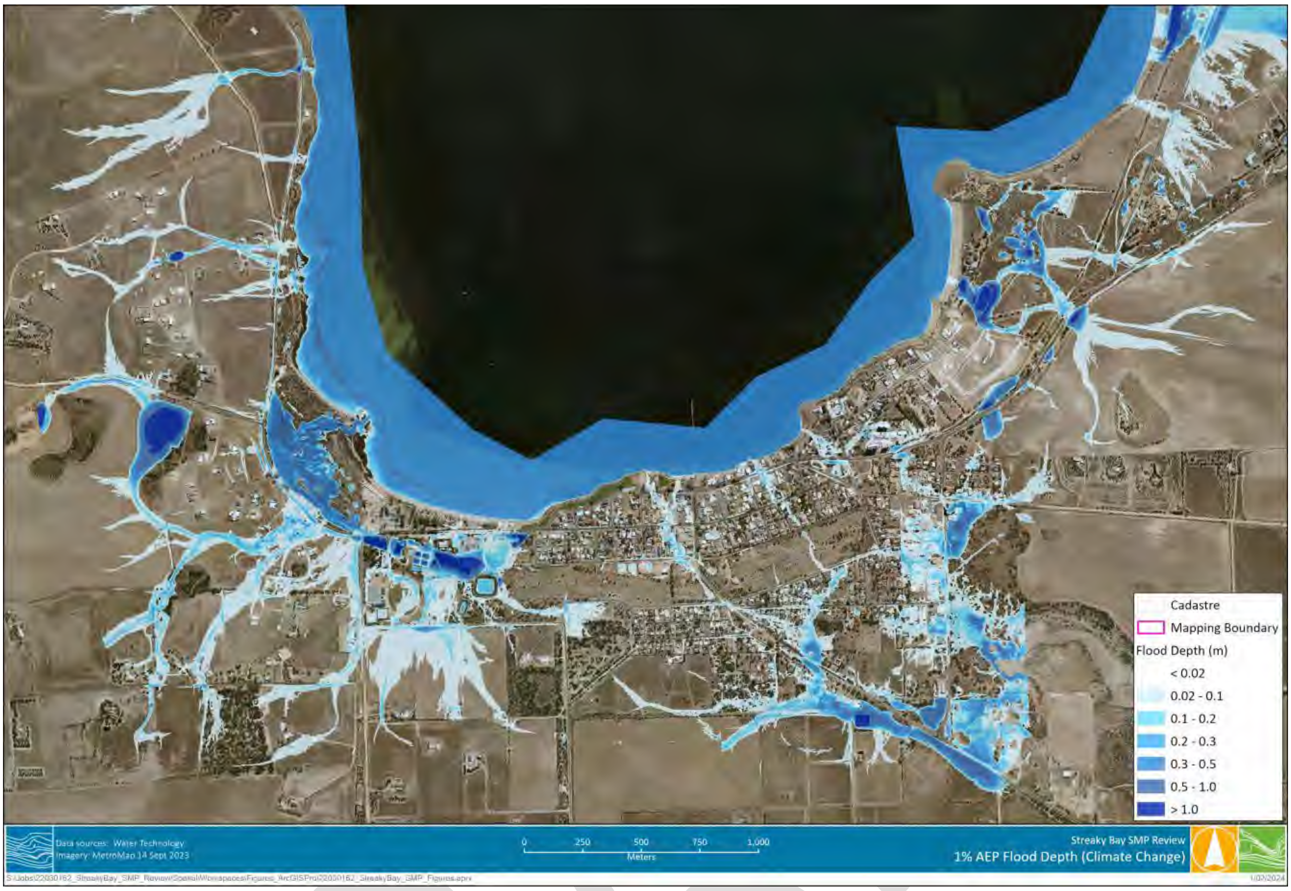

Figure C-7 Future Conditions (Climate Change) – 1% AEP Flood Depths

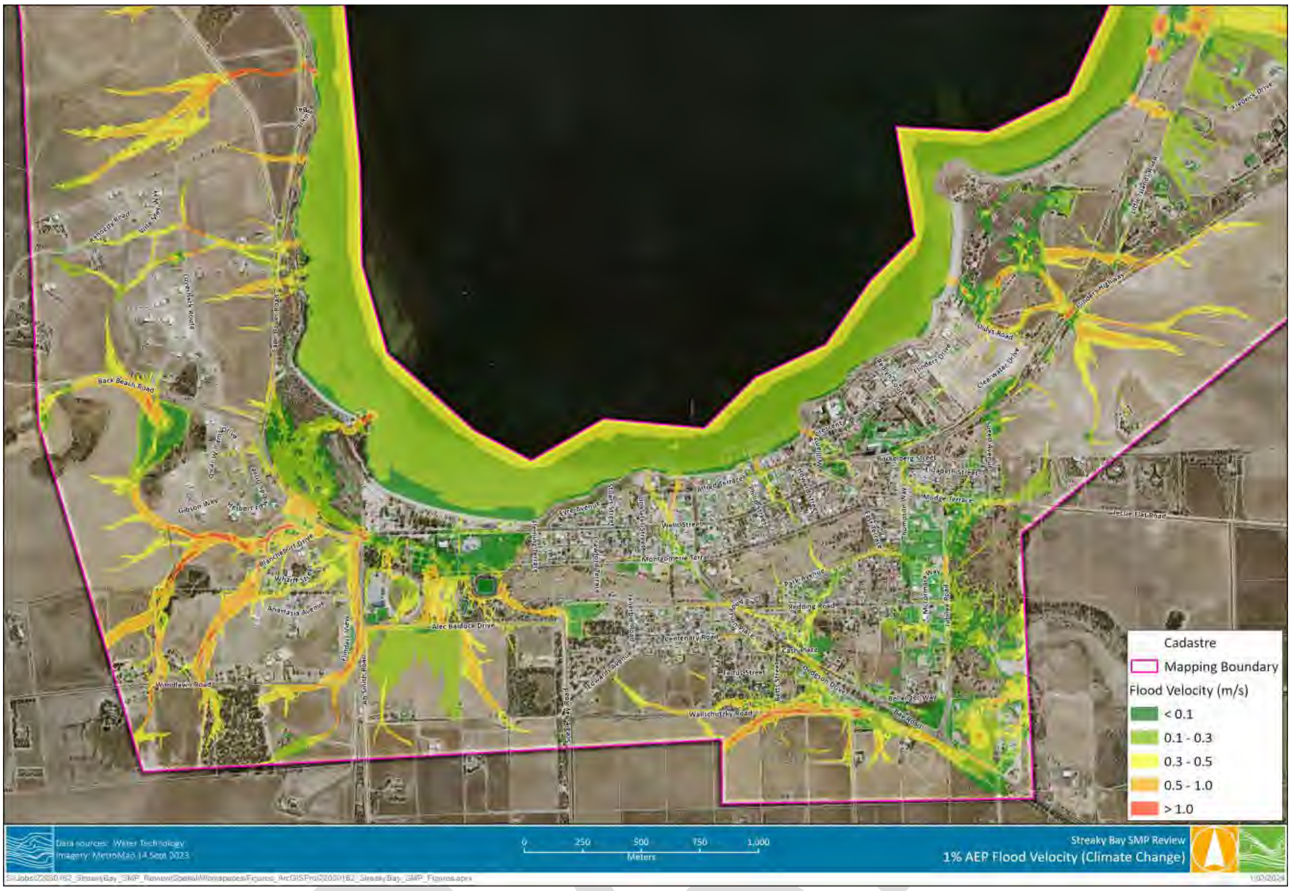

Figure C-8 Future Conditions (Climate Change) – 1% AEP Flood Velocities

Figure C-9 Future Conditions (Climate Change) – 1% AEP Flood Hazards

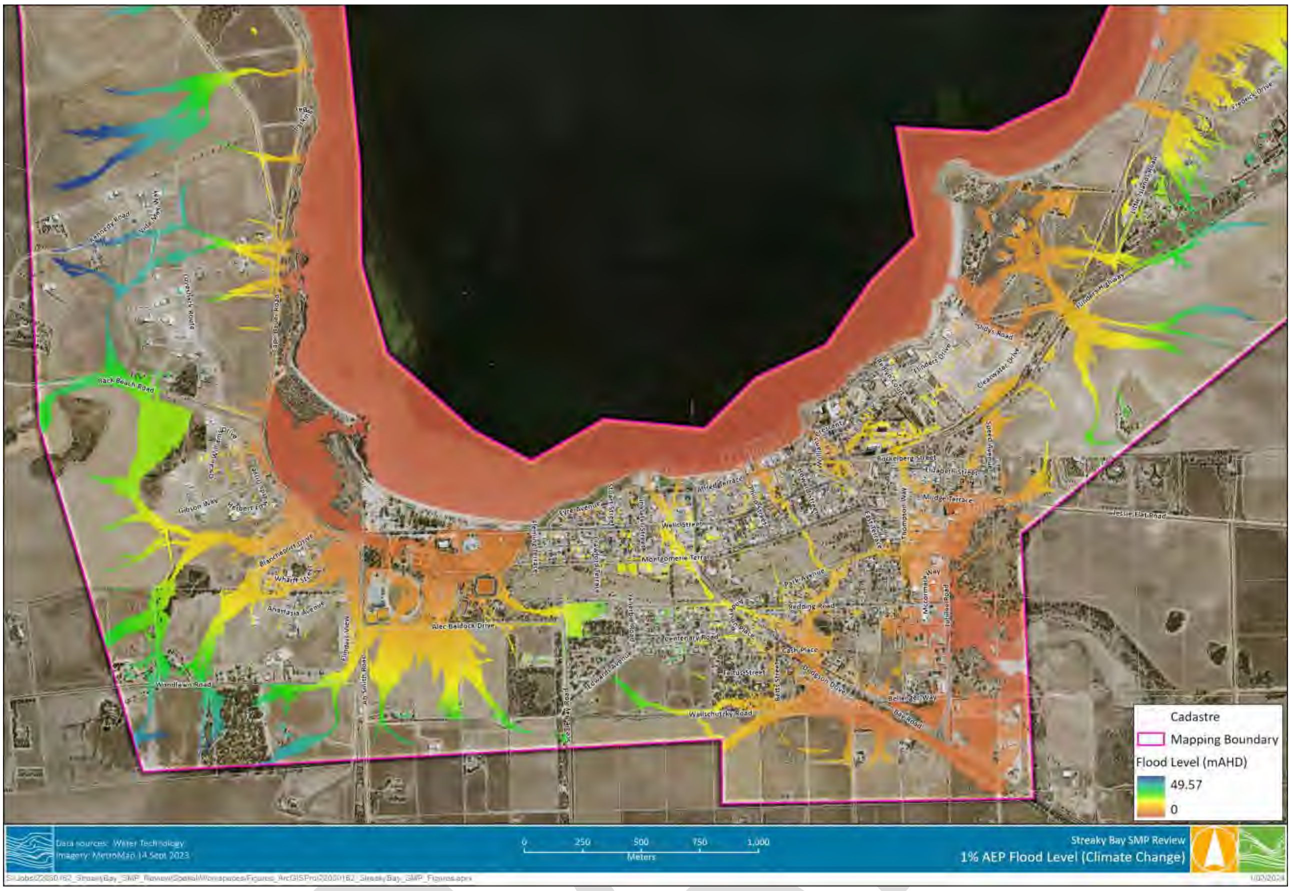

Figure C-10 Future Conditions (Climate Change) – 1% AEP Flood Levels

Figure C-11 Future Conditions (Climate Change) – 1% AEP Flood Depths

Figure C-12 Future Conditions (Climate Change) – 1% AEP Flood Velocities

APPENDIX D
CLIMATE CHANGE SLR FLOOD MAPPING

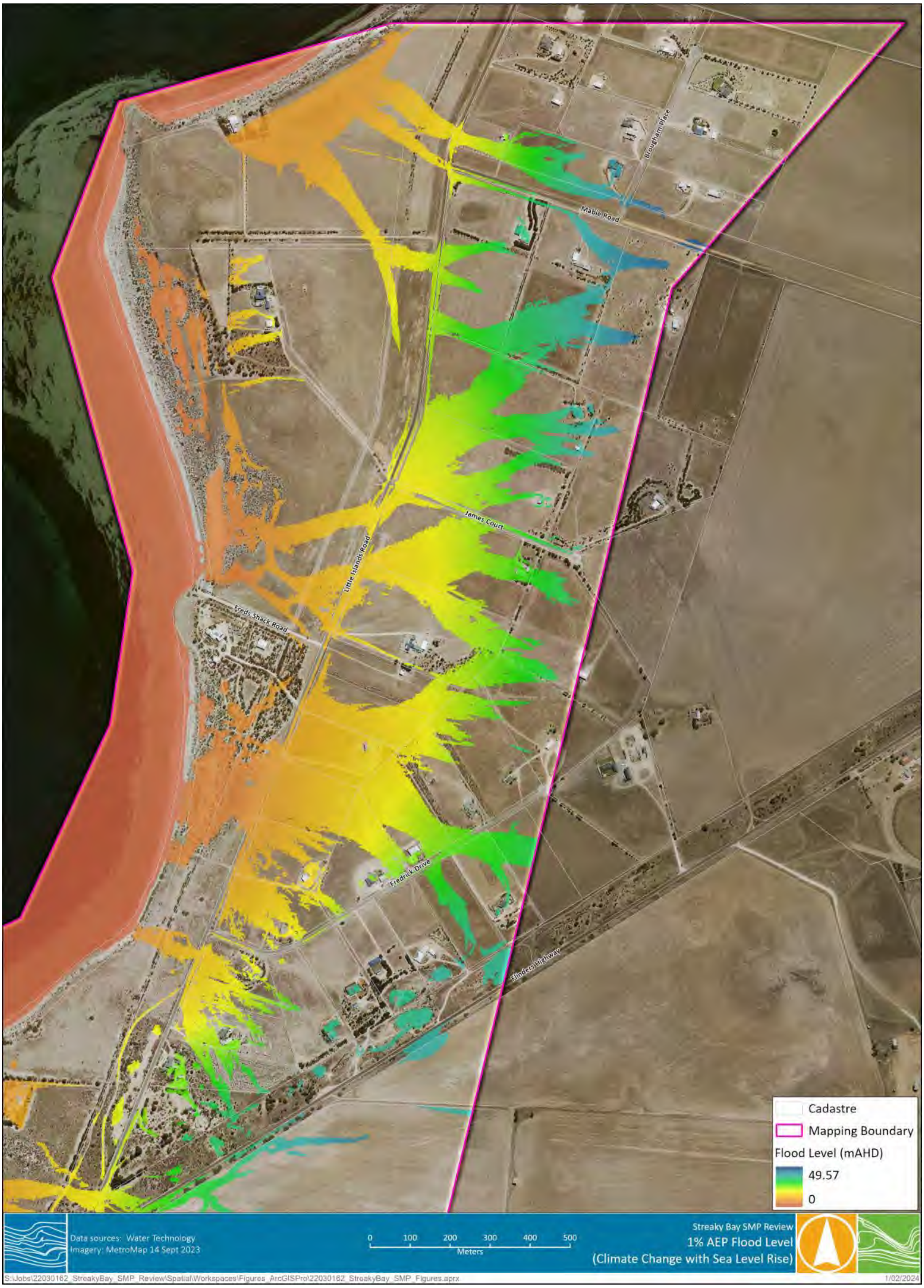

Figure D-1 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Levels

Figure D-2 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Depths

Figure D-3 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Velocities

Figure D-4 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Hazards

Figure D-5 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Levels

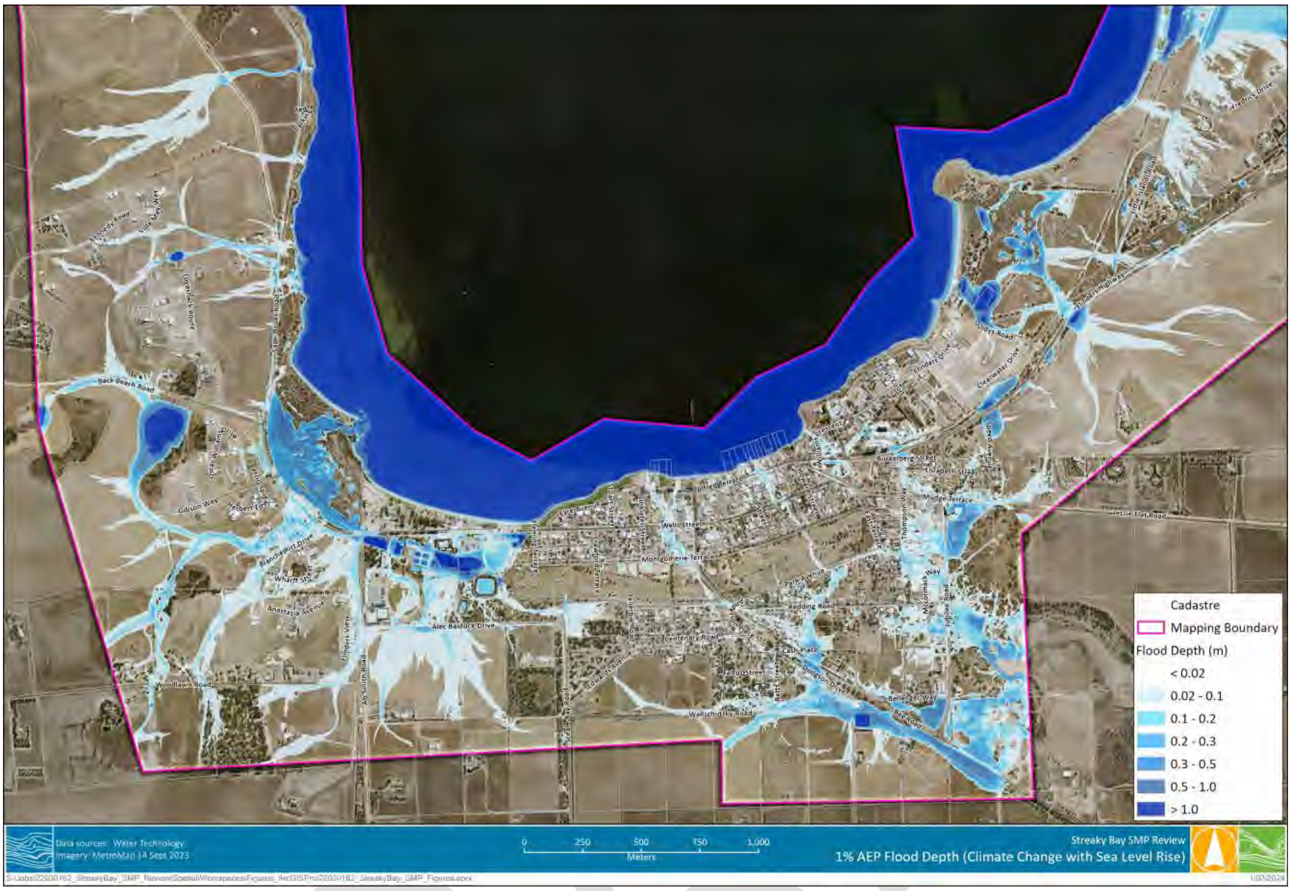

Figure D-6 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Depths

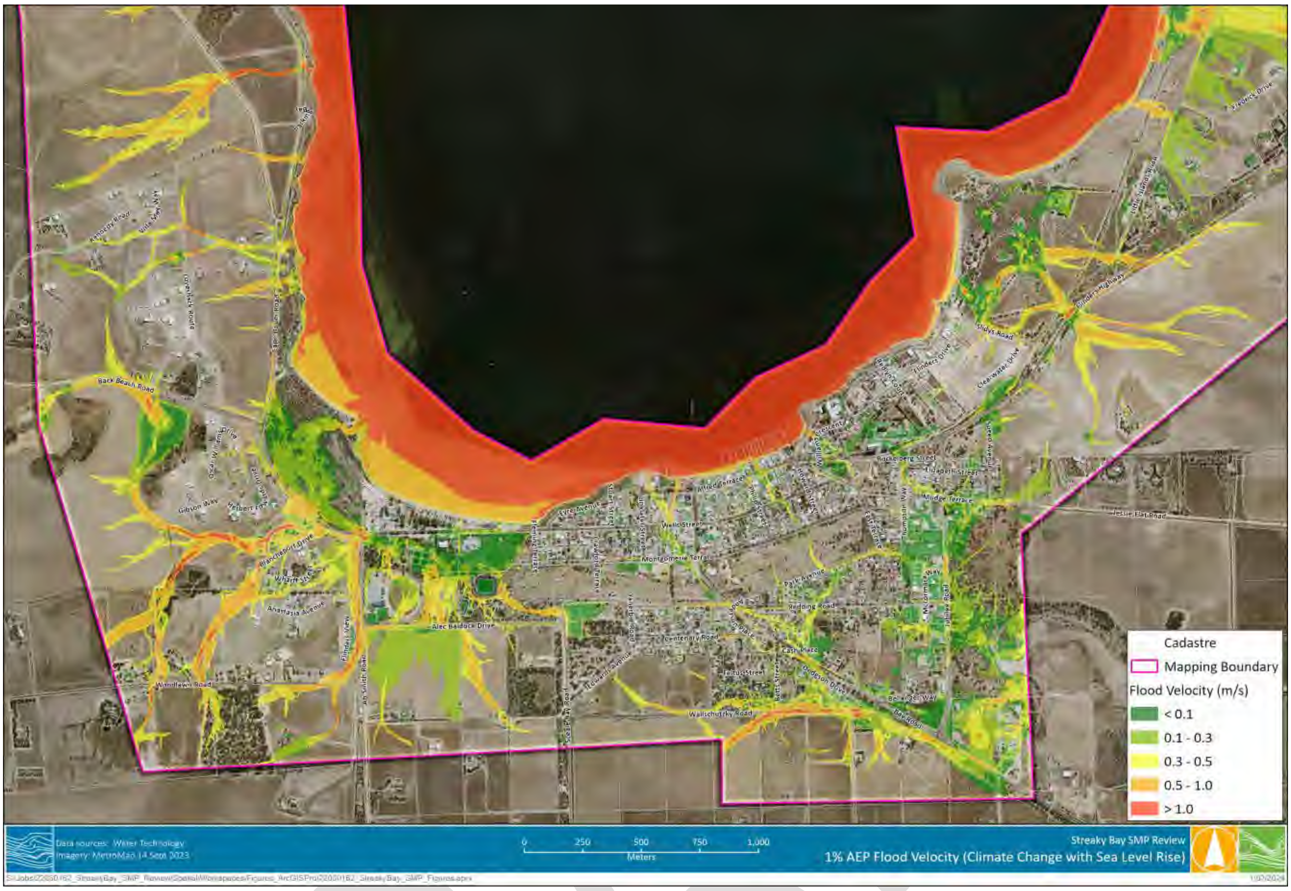

Figure D-7 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Velocities

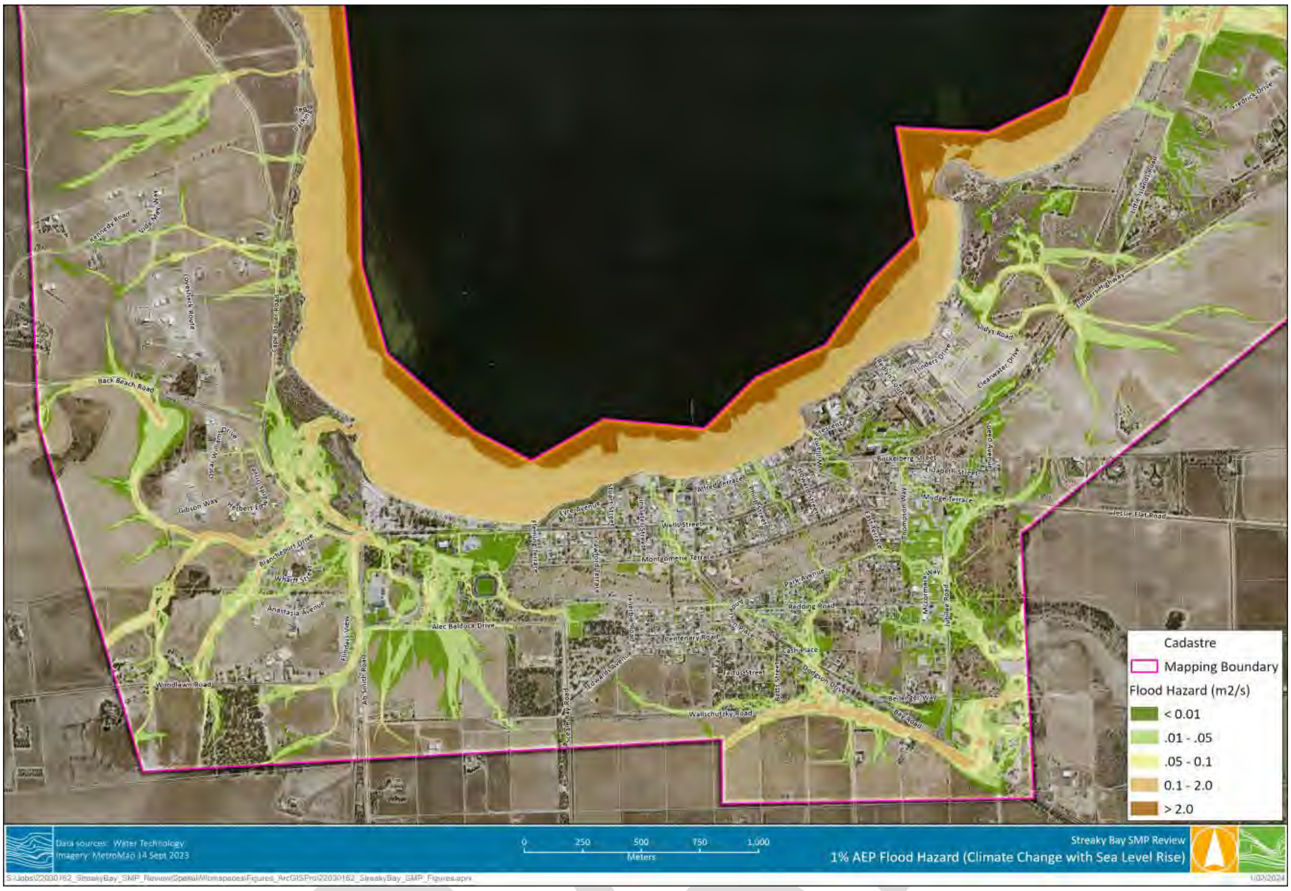

Figure D-8 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Hazards

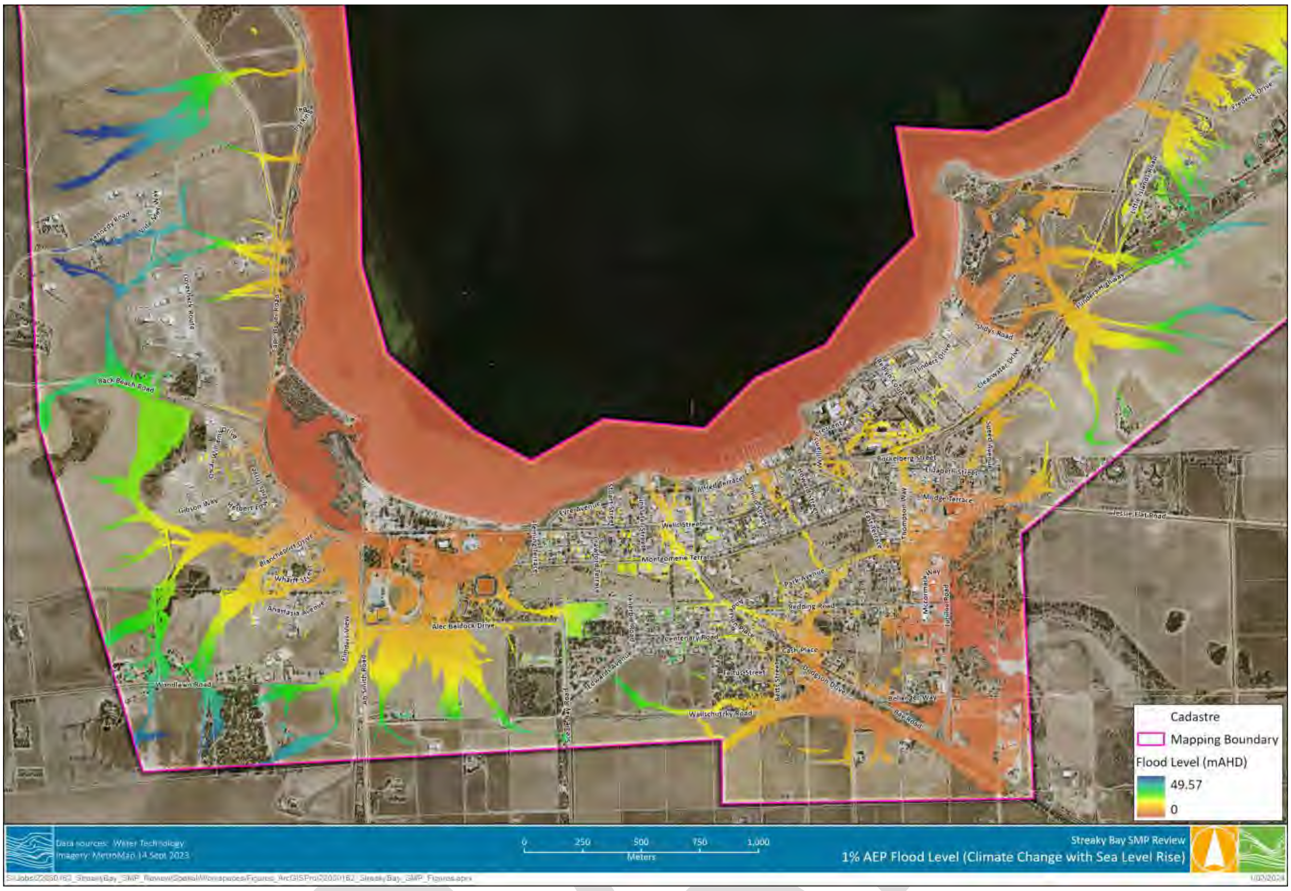

Figure D-9 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Levels

Figure D-10 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Depths

Figure D-11 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Velocities

Figure D-12 Future Conditions (Climate Change with Sea Level Rise) – 1% AEP Flood Hazards

Figure D-13 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Depths

Figure D-14 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Velocities

Figure D-15 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Hazards

Figure D-16 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Levels

Figure D-17 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Depths

Figure D-18 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Velocities

Figure D-19 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Hazards

Figure D-20 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Levels

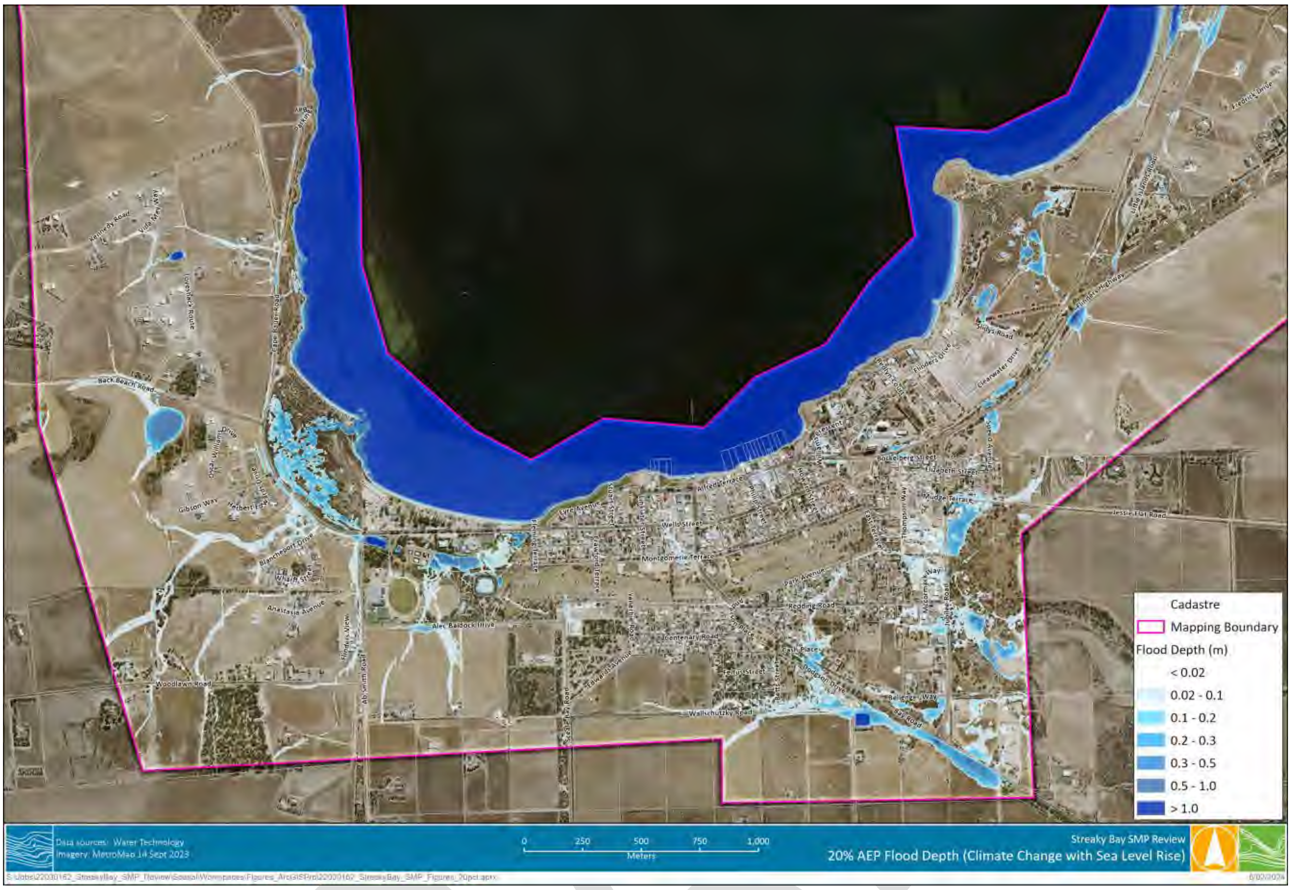

Figure D-21 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Depths

Figure D-22 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Velocities

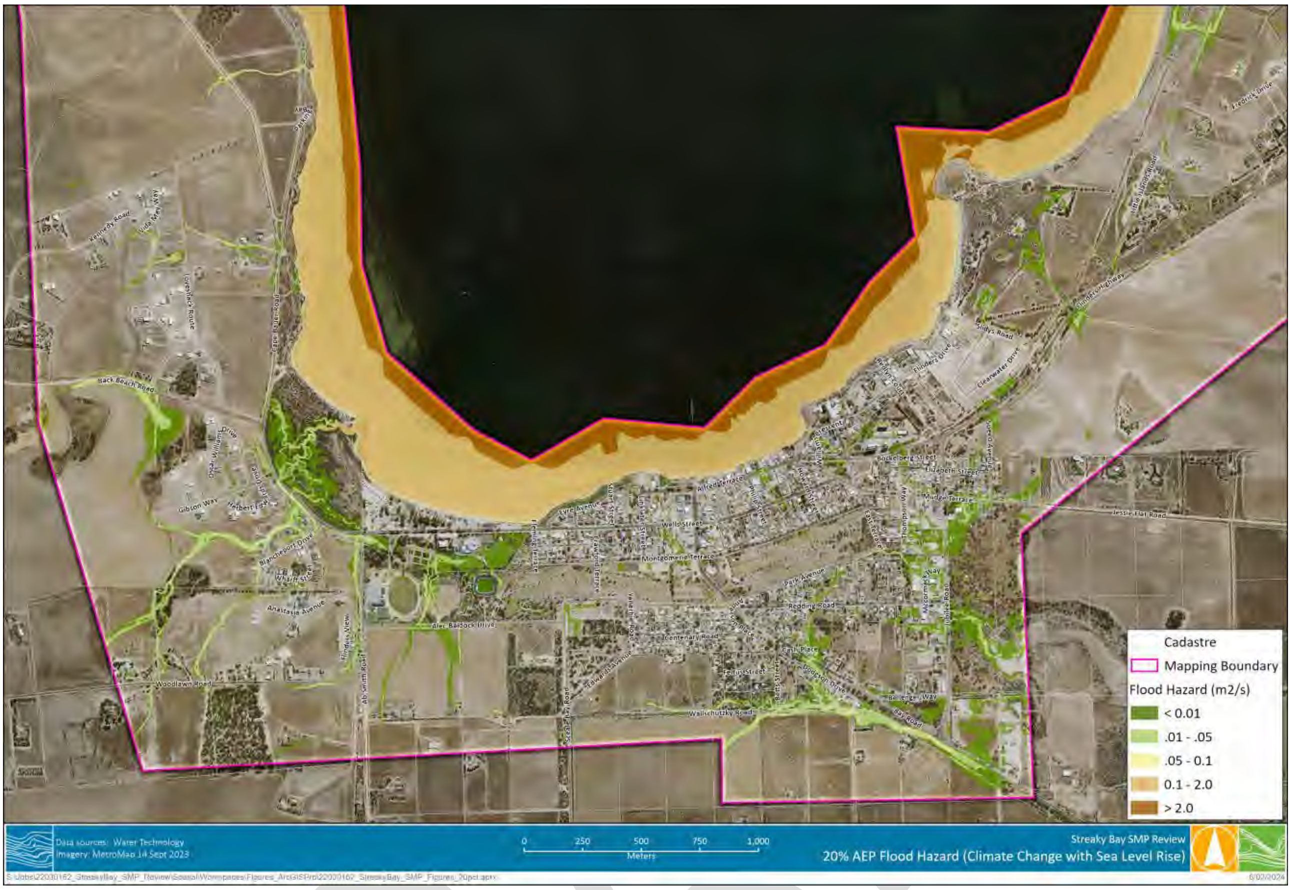

Figure D-23 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Hazards

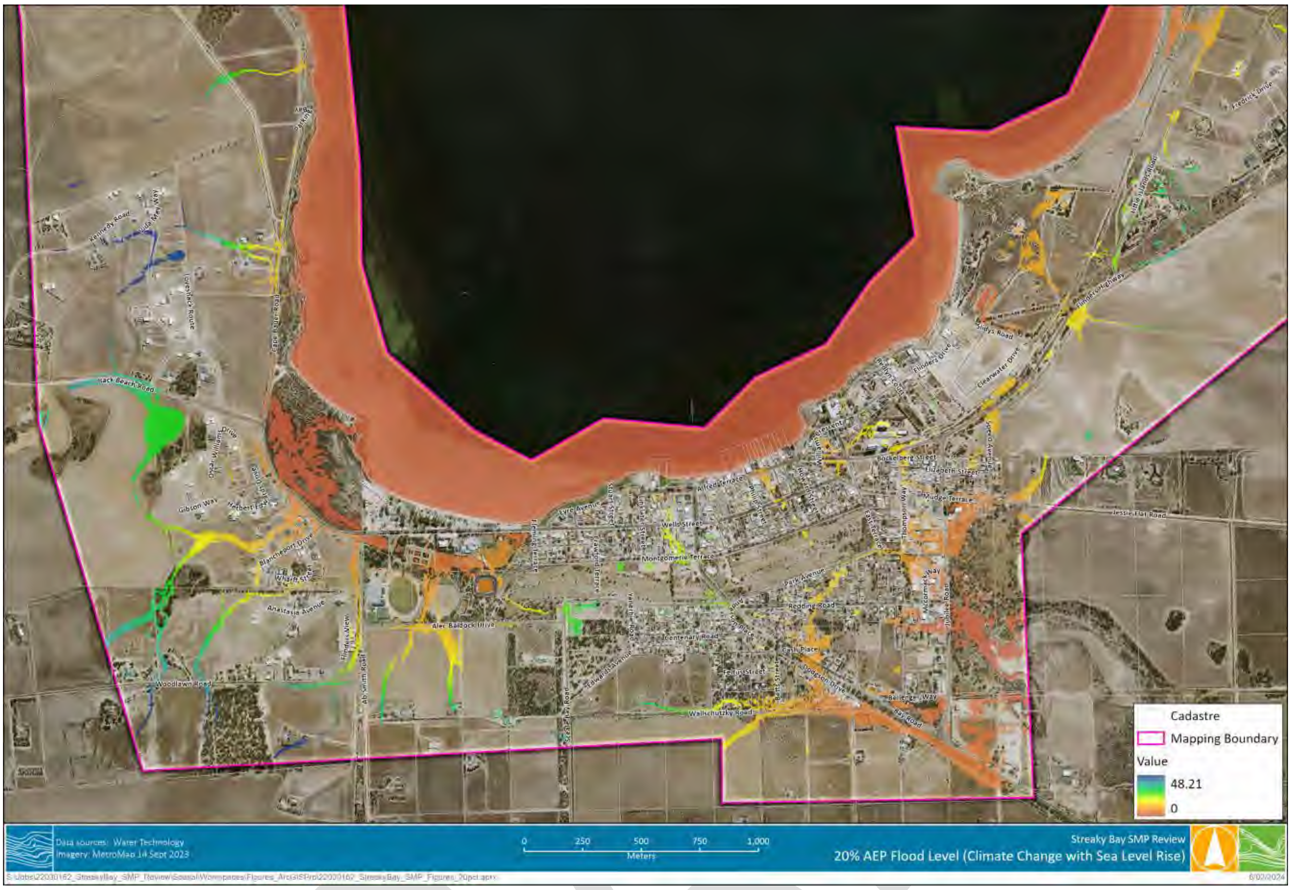

Figure D-24 Future Conditions (Climate Change with Sea Level Rise) – 20% AEP Flood Levels

APPENDIX E
CURRENT ASSET CONDITION

Table E-1 Asset Condition Assessment (District Council of Streaky Bay, 2022)

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0188	Culvert in Wells Street (SW0188)	Wells Street	Culvert	1992	Pipe	Poor
SW0204	Grated Drain in Bay Road (SW0204)	Bay Road	Grated Drain	1992	Grated Drain	
SW0205	Grated Drain in Bay Road (SW0205)	Bay Road	Grated Drain	1992	Grated Drain	
SW0206	Grated Drain in Bay Road (SW0206)	Bay Road	Grated Drain	1992	Grated Drain	
SW0207	Grated Drain in Bay Road (SW0207)	Bay Road	Grated Drain	1992	Grated Drain	
SW0054	Open Drain in Burke Street (SW0054)	Burke Street	Open Drain	1992	Open Drain	
SW0331	Open Drain in Dodgson Drive (SW0331)	Dodgson Drive	Open Drain	2019		
SW0332	Open Drain in Dodgson Drive (SW0332)	Dodgson Drive	Open Drain	2019		
SW0333	Open Drain in Dodgson Drive (SW0333)	Dodgson Drive	Open Drain	2019		
SW0097	Open Drain in East Terrace (SW0097)	East Terrace	Open Drain	1992	Open Drain	
SW0146	Open Drain in Elizabeth Street (SW0146)	Elizabeth Street	Open Drain	1992	Spoon Drain	Fair
SW0090	Open Drain in Eyre Avenue (SW0090)	Eyre Avenue	Open Drain	1992	Spoon Drain	Poor
SW0091	Open Drain in Eyre Avenue (SW0091)	Eyre Avenue	Open Drain	1992	Spoon Drain	Poor
SW0092	Open Drain in Eyre Avenue (SW0092)	Eyre Avenue	Open Drain	1992	Spoon Drain	Fair
SW0183	Open Drain in Eyre Avenue (SW0183)	Eyre Avenue	Open Drain	1992	Spoon Drain	Poor

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0222	Open Drain in Eyre Avenue (SW0222)	Eyre Avenue	Open Drain	1992	Spoon Drain	Poor
SW0048	Open Drain in Jubilee Road (SW0048)	Jubilee Road	Open Drain	1992	Spoon Drain	
SW0098	Open Drain in Jubilee Road (SW0098)	Jubilee Road	Open Drain	1992	Spoon Drain	Fair
SW0153	Open Drain in Jubilee Road (SW0153)	Jubilee Road	Open Drain	1992	Spoon Drain	Fair
SW0190	Open Drain in Jubilee Road (SW0190)	Jubilee Road	Open Drain	1992	Spoon Drain	
SW0137	Open Drain in Philip Street (SW0137)	Philip Street	Open Drain	1992	Spoon Drain	Fair
SW0128	Open Drain in Wells Street (SW0128)	Wells Street	Open Drain	2013	Spoon Drain	Fair
SW0130	Open Drain in Wells Street (SW0130)	Wells Street	Open Drain	1992	Spoon Drain	Poor
SW0142	Open Drain in Wells Street (SW0142)	Wells Street	Open Drain	1992	Spoon Drain	Fair
SW0213	Pipe in AB Smith Road (SW0213)	AB Smith Road	Pipe	2006	Pipe	
SW0094	Pipe in Alfred Terrace (SW0094)	Alfred Terrace	Pipe	1992	Pipe	
SW0095	Pipe in Alfred Terrace (SW0095)	Alfred Terrace	Pipe	1992	Pipe	Poor
SW0133	Pipe in Alfred Terrace (SW0133)	Alfred Terrace	Pipe	1992	Pipe	
SW0135	Pipe in Alfred Terrace (SW0135)	Alfred Terrace	Pipe	1992	Pipe	Fair
SW0139	Pipe in Alfred Terrace (SW0139)	Alfred Terrace	Pipe	1992	Pipe	

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0143	Pipe in Alfred Terrace (SW0143)	Alfred Terrace	Pipe	1992	Pipe	
SW0144	Pipe in Alfred Terrace (SW0144)	Alfred Terrace	Pipe	1992	Pipe	Fair
SW0184	Pipe in Alfred Terrace (SW0184)	Alfred Terrace	Pipe	1992	Pipe	Fair
SW0201	Pipe in Alfred Terrace (SW0201)	Alfred Terrace	Pipe	2013	Pipe	
SW0202	Pipe in Alfred Terrace (SW0202)	Alfred Terrace	Pipe	1992	Pipe	Fair
SW0214	Pipe in Alfred Terrace (SW0214)	Alfred Terrace	Pipe	1992	Pipe	
SW0347	Pipe in Alfred Terrace (SW0347)	Alfred Terrace	Pipe	1992	Pipe	
SW0362	Pipe in Alfred Terrace (SW0362)	Alfred Terrace	Pipe	1992	Pipe	
SW0363	Pipe in Alfred Terrace (SW0363)	Alfred Terrace	Pipe	1992	Pipe	
SW0122	Pipe in Anastasia Avenue (SW0122)	Anastasia Avenue	Pipe	2006	Pipe	Excellent
SW0123	Pipe in Anastasia Avenue (SW0123)	Anastasia Avenue	Pipe	2006	Pipe	Excellent
SW0124	Pipe in Anastasia Avenue (SW0124)	Anastasia Avenue	Pipe	2006	Pipe	Excellent
SW0125	Pipe in Anastasia Avenue (SW0125)	Anastasia Avenue	Pipe	2006	Pipe	Excellent

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0126	Pipe in Anastasia Avenue (SW0126)	Anastasia Avenue	Pipe	2006	Pipe	Excellent
SW0127	Pipe in Anastasia Avenue (SW0127)	Anastasia Avenue	Pipe	2006	Pipe	Excellent
SW0256	Pipe in Back Beach Road (SW0256)	Back Beach Road	Pipe	2008	Pipe	Excellent
SW0359	Pipe in Back Beach Road (SW0359)	Back Beach Road	Pipe	2012	Pipe	
SW0360	Pipe in Back Beach Road (SW0360)	Back Beach Road	Pipe	2012	Pipe	
SW0096	Pipe in Bay Road (SW0096)	Bay Road	Pipe	1992	Pipe	Poor
SW0154.3	Pipe in Bay Road (SW0154.3)	Bay Road	Pipe	1992	Pipe	
SW0155	Pipe in Bay Road (SW0155)	Bay Road	Pipe	1992	Pipe	
SW0185	Pipe in Bay Road (SW0185)	Bay Road	Pipe	1992	Pipe	
SW0186	Pipe in Bay Road (SW0186)	Bay Road	Pipe	1992	Pipe	
SW0203	Pipe in Bay Road (SW0203)	Bay Road	Pipe	1992	Pipe	
SW0327.1	Pipe in Bay Road (SW0327.1)	Bay Road	Pipe	2019	Pipe	
SW0327.2	Pipe in Bay Road (SW0327.2)	Bay Road	Pipe	2019	Pipe	
SW0327.3	Pipe in Bay Road (SW0327.3)	Bay Road	Pipe	2019	Pipe	
SW0327.4	Pipe in Bay Road (SW0327.4)	Bay Road	Pipe	2019	Pipe	
SW0327.5	Pipe in Bay Road (SW0327.5)	Bay Road	Pipe	2019	Pipe	

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0099	Pipe in Bellenger Way (SW0099)	Bellenger Way	Pipe	1992	Pipe	Excellent
SW0100	Pipe in Bellenger Way (SW0100)	Bellenger Way	Pipe	1992	Pipe	
SW0336	Pipe in Betts Street (SW0336)	Betts Street	Pipe	2012	Pipe	
SW0337	Pipe in Betts Street (SW0337)	Betts Street	Pipe	2012	Pipe	
SW0275	Pipe in Blancheport Drive (SW0275)	Blancheport Drive	Pipe	2006	Pipe	Excellent
SW0277	Pipe in Blancheport Drive (SW0277)	Blancheport Drive	Pipe	2006	Pipe	Excellent
SW0249	Pipe in Bockelberg Hill Drive (SW0249)	Bockelberg Hill Drive	Pipe	2004	Pipe	Excellent
SW0250	Pipe in Bockelberg Hill Drive (SW0250)	Bockelberg Hill Drive	Pipe	2004	Pipe	Excellent
SW0084	Pipe in Cape Bauer Road (SW0084)	Cape Bauer Road	Pipe	1992	Pipe	
SW0085	Pipe in Cape Bauer Road (SW0085)	Cape Bauer Road	Pipe	1992	Pipe	
SW0086	Pipe in Cape Bauer Road (SW0086)	Cape Bauer Road	Pipe	2004	Pipe	Fair
SW0087	Pipe in Cape Bauer Road (SW0087)	Cape Bauer Road	Pipe	2004	Pipe	Excellent
SW0088	Pipe in Cape Bauer Road (SW0088)	Cape Bauer Road	Pipe	2004	Pipe	Excellent
SW0154.1	Pipe in Cash Place (SW0154.1)	Cash Place	Pipe	1992	Pipe	
SW0154.2	Pipe in Cash Place (SW0154.2)	Cash Place	Pipe	1992	Pipe	
SW0154.4	Pipe in Cash Place (SW0154.4)	Cash Place	Pipe	1992	Pipe	

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0325	Pipe in Cash Place (SW0325)	Cash Place	Pipe	2019	Twin 450mm RCP	
SW0328	Pipe in Cash Place (SW0328)	Cash Place	Pipe	2019	Twin 450mm RCP	
SW0364	Pipe in Centenary Road (SW0364)	Centenary Road	Pipe	1992	600mm pipe (Size assumed)	
SW0344	Pipe in Clearwater Drive (SW0344)	Clearwater Drive	Pipe	2016	Pipe	
SW0345	Pipe in Clearwater Drive (SW0345)	Clearwater Drive	Pipe	2016	Pipe	
SW0346	Pipe in Clearwater Drive (SW0346)	Clearwater Drive	Pipe	2016	Pipe	
SW0351	Pipe in Clearwater Drive (SW0351)	Clearwater Drive	Pipe	2016	Pipe	
SW0352	Pipe in Clearwater Drive (SW0352)	Clearwater Drive	Pipe	2016	Pipe	
SW0157	Pipe in Dodgson Drive (SW0157)	Dodgson Drive	Pipe	1992	Pipe	
SW0160	Pipe in Dodgson Drive (SW0160)	Dodgson Drive	Pipe	1992	Pipe	
SW0161	Pipe in Dodgson Drive (SW0161)	Dodgson Drive	Pipe	1992	Pipe	
SW0171.1	Pipe in Dodgson Drive (SW0171.1)	Dodgson Drive	Pipe	1992	Pipe	
SW0093	Pipe in Eyre Avenue (SW0093)	Eyre Avenue	Pipe	1992	Pipe	
SW0131	Pipe in Eyre Avenue (SW0131)	Eyre Avenue	Pipe	1992	Pipe	
SW0361	Pipe in Fleming Terrace (SW0361)	Fleming Terrace	Pipe	2013	Pipe	
SW0176	Pipe in Flinders Drive (SW0176)	Flinders Drive	Pipe	1992	Pipe	
SW0177	Pipe in Flinders Drive (SW0177)	Flinders Drive	Pipe	1992	Pipe	Excellent

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0356	Pipe in Flinders Drive (SW0356)	Flinders Drive	Pipe	2016	Pipe	
SW0089	Pipe in Flinders View (SW0089)	Flinders View	Pipe	2006	Pipe	Excellent
SW0082	Pipe in Gibson Way (SW0082)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0083	Pipe in Gibson Way (SW0083)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0102	Pipe in Gibson Way (SW0102)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0103	Pipe in Gibson Way (SW0103)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0104	Pipe in Gibson Way (SW0104)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0111	Pipe in Gibson Way (SW0111)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0112	Pipe in Gibson Way (SW0112)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0113	Pipe in Gibson Way (SW0113)	Gibson Way	Pipe	2004	Pipe	Good
SW0115	Pipe in Gibson Way (SW0115)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0116	Pipe in Gibson Way (SW0116)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0178	Pipe in Gibson Way (SW0178)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0179	Pipe in Gibson Way (SW0179)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0248	Pipe in Gibson Way (SW0248)	Gibson Way	Pipe	2004	Pipe	Excellent
SW0114	Pipe in Herbert Edwards Drive (SW0114)	Herbert Edwards Drive	Pipe	2004	Pipe	Excellent
SW0117	Pipe in Herbert Edwards Drive (SW0117)	Herbert Edwards Drive	Pipe	2004	Pipe	Excellent
SW0118	Pipe in Herbert Edwards Drive (SW0118)	Herbert Edwards Drive	Pipe	2004	Pipe	Excellent
SW0271	Pipe in Herbert Edwards Drive (SW0271)	Herbert Edwards Drive	Pipe	2004	Pipe	Excellent

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0302	Pipe in Howard Street (SW0302)	Howard Street	Pipe	2012	Pipe	
SW0303	Pipe in Howard Street (SW0303)	Howard Street	Pipe	2012	Pipe	
SW0305	Pipe in James Court (SW0305)	James Court	Pipe	2016	Pipe	
SW0119	Pipe in Johnson Street (SW0119)	Johnson Street	Pipe	2004	Pipe	Excellent
SW0180	Pipe in Johnson Street (SW0180)	Johnson Street	Pipe	2004	Pipe	Excellent
SW0273	Pipe in Johnson Street (SW0273)	Johnson Street	Pipe	2004	Pipe	Good
SW0151	Pipe in Jubilee Road (SW0151)	Jubilee Road	Pipe	1992	Pipe	
SW0152	Pipe in Jubilee Road (SW0152)	Jubilee Road	Pipe	1992	Pipe	Fair
SW0278	Pipe in Jubilee Road (SW0278)	Jubilee Road	Pipe	1992	Pipe	Fair
SW0280	Pipe in Jubilee Road (SW0280)	Jubilee Road	Pipe	1992	Pipe	Fair
SW0254	Pipe in Kennedy Road (SW0254)	Kennedy Road	Pipe	2008	Pipe	Excellent
SW0257	Pipe in Kennedy Road (SW0257)	Kennedy Road	Pipe	2008	Pipe	Excellent
SW0258	Pipe in Kennedy Road (SW0258)	Kennedy Road	Pipe	2008	Pipe	Excellent
SW0260	Pipe in Kennedy Road (SW0260)	Kennedy Road	Pipe	2008	Pipe	Excellent
SW0262	Pipe in Kennedy Road (SW0262)	Kennedy Road	Pipe	2008	Pipe	Excellent
SW0263	Pipe in Kennedy Road (SW0263)	Kennedy Road	Pipe	2008	Pipe	Excellent
SW0264	Pipe in Kennedy Road (SW0264)	Kennedy Road	Pipe	2008	Pipe	Excellent
SW0265	Pipe in Kennedy Road (SW0265)	Kennedy Road	Pipe	2008	Pipe	Excellent
SW0266	Pipe in Kennedy Road (SW0266)	Kennedy Road	Pipe	2008	Pipe	Excellent
SW0306	Pipe in Little Islands Road (SW0306)	Little Islands Road	Pipe	2016	Pipe	

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0307	Pipe in Little Islands Road (SW0307)	Little Islands Road	Pipe	2016	Pipe	
SW0308	Pipe in Little Islands Road (SW0308)	Little Islands Road	Pipe	2016	Pipe	
SW0309	Pipe in Little Islands Road (SW0309)	Little Islands Road	Pipe	2016	Pipe	
SW0310	Pipe in Little Islands Road (SW0310)	Little Islands Road	Pipe	2016	Pipe	
SW0311	Pipe in Little Islands Road (SW0311)	Little Islands Road	Pipe	2016	Pipe	
SW0312	Pipe in Little Islands Road (SW0312)	Little Islands Road	Pipe	2016	Pipe	
SW0313	Pipe in Little Islands Road (SW0313)	Little Islands Road	Pipe	2016	Pipe	
SW0314	Pipe in Little Islands Road (SW0314)	Little Islands Road	Pipe	2016	Pipe	
SW0315	Pipe in Little Islands Road (SW0315)	Little Islands Road	Pipe	2016	Pipe	
SW0340	Pipe in Little Islands Road (SW0340)	Little Islands Road	Pipe	2016	Pipe	
SW0341	Pipe in Little Islands Road (SW0341)	Little Islands Road	Pipe	2016	Pipe	
SW0342	Pipe in Little Islands Road (SW0342)	Little Islands Road	Pipe	2016	Pipe	
SW0252	Pipe in Love Shack Route (SW0252)	Love Shack Route	Pipe	2008	Pipe	Excellent
SW0253	Pipe in Love Shack Route (SW0253)	Love Shack Route	Pipe	2008	Pipe	Excellent
SW0267	Pipe in Love Shack Route (SW0267)	Love Shack Route	Pipe	2008	Pipe	Excellent

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0268	Pipe in Love Shack Route (SW0268)	Love Shack Route	Pipe	2008	Pipe	Excellent
SW0269	Pipe in Love Shack Route (SW0269)	Love Shack Route	Pipe	2008	Pipe	Excellent
SW0343	Pipe in Love Shack Route (SW0343)	Love Shack Route	Pipe	2012	Pipe	
SW0136	Pipe in Montgomerie Terrace (SW0136)	Montgomerie Terrace	Pipe	1992	Pipe	
SW0147	Pipe in Mudge Terrace (SW0147)	Mudge Terrace	Pipe	1992	Pipe	Fair
SW0148	Pipe in Mudge Terrace (SW0148)	Mudge Terrace	Pipe	1992	Pipe	Fair
SW0105	Pipe in Oscar Williams Drive (SW0105)	Oscar Williams Drive	Pipe	2004	Pipe	Excellent
SW0106	Pipe in Oscar Williams Drive (SW0106)	Oscar Williams Drive	Pipe	2004	Pipe	Excellent
SW0107	Pipe in Oscar Williams Drive (SW0107)	Oscar Williams Drive	Pipe	2004	Pipe	Excellent
SW0108	Pipe in Oscar Williams Drive (SW0108)	Oscar Williams Drive	Pipe	2004	Pipe	Excellent
SW0109	Pipe in Oscar Williams Drive (SW0109)	Oscar Williams Drive	Pipe	2004	Pipe	Excellent
SW0110	Pipe in Oscar Williams Drive (SW0110)	Oscar Williams Drive	Pipe	2004	Pipe	Excellent
SW0175	Pipe in Oscar Williams Drive (SW0175)	Oscar Williams Drive	Pipe	2004	Pipe	Excellent
SW0247	Pipe in Oscar Williams Drive (SW0247)	Oscar Williams Drive	Pipe	2004	Pipe	Good
SW0255	Pipe in Oscar Williams Drive (SW0255)	Oscar Williams Drive	Pipe	2004	Pipe	Excellent

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0272	Pipe in Oscar Williams Drive (SW0272)	Oscar Williams Drive	Pipe	2004	Pipe	Excellent
SW0138	Pipe in Philip Street (SW0138)	Philip Street	Pipe	1992	Pipe	
SW0304.1	Pipe in Phillips Street (SW0304.1)	Phillips Street	Pipe	2012	Pipe	
SW0304.2	Pipe in Phillips Street (SW0304.2)	Phillips Street	Pipe	2012	Pipe	
SW0208	Pipe in Redlyn Court (SW0208)	Redlyn Court	Pipe	1992	Pipe	Excellent
SW0209	Pipe in Redlyn Court (SW0209)	Redlyn Court	Pipe	1992	Pipe	Excellent
SW0210	Pipe in Redlyn Court (SW0210)	Redlyn Court	Pipe	1992	Pipe	
SW0348	Pipe in Slidys Road (SW0348)	Slidys Road	Pipe	2016	Pipe	
SW0349	Pipe in Slidys Road (SW0349)	Slidys Road	Pipe	2016	Pipe	
SW0350	Pipe in Slidys Road (SW0350)	Slidys Road	Pipe	2016	Pipe	
SW0353	Pipe in Slidys Road (SW0353)	Slidys Road	Pipe	2016	Pipe	
SW0354	Pipe in Slidys Road (SW0354)	Slidys Road	Pipe	2016	Pipe	
SW0355	Pipe in Slidys Road (SW0355)	Slidys Road	Pipe	2016	Pipe	
SW0357	Pipe in Slidys Road (SW0357)	Slidys Road	Pipe	2016	Pipe	
SW0358	Pipe in Slidys Road (SW0358)	Slidys Road	Pipe	2016	Pipe	
SW0149	Pipe in Thompson Way (SW0149)	Thompson Way	Pipe	1992	Pipe	
SW0150	Pipe in Thompson Way (SW0150)	Thompson Way	Pipe	1992	Pipe	
SW0259	Pipe in Vida May Way (SW0259)	Vida May Way	Pipe	2008	Pipe	Excellent
SW0261	Pipe in Vida May Way (SW0261)	Vida May Way	Pipe	2008	Pipe	Excellent

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0101	Pipe in Wallschutzky Road (SW0101)	Wallschutzky Road	Pipe	1992	Pipe	
SW0158	Pipe in Wallschutzky Road (SW0158)	Wallschutzky Road	Pipe	1992	Pipe	
SW0159	Pipe in Wallschutzky Road (SW0159)	Wallschutzky Road	Pipe	1992	Pipe	Good
SW0162	Pipe in Wallschutzky Road (SW0162)	Wallschutzky Road	Pipe	1992	Pipe	
SW0163	Pipe in Wallschutzky Road (SW0163)	Wallschutzky Road	Pipe	1992	Pipe	
SW0338	Pipe in Wallschutzky Road (SW0338)	Wallschutzky Road	Pipe	2012	Pipe	
SW0339	Pipe in Wallschutzky Road (SW0339)	Wallschutzky Road	Pipe	2012	Pipe	
SW0129	Pipe in Wells Street (SW0129)	Wells Street	Pipe	1992	Pipe	
SW0132	Pipe in Wells Street (SW0132)	Wells Street	Pipe	1992	Pipe	Poor
SW0187	Pipe in Wells Street (SW0187)	Wells Street	Pipe	1992	Pipe	
SW0120	Pipe in Wharff Street (SW0120)	Wharff Street	Pipe	2006	Pipe	Excellent
SW0121	Pipe in Wharff Street (SW0121)	Wharff Street	Pipe	2006	Pipe	Excellent
SW0145	Pipe in Williams Crescent (SW0145)	Williams Crescent	Pipe	1992	Pipe	Fair
SW0189	Pipe in Williams Crescent (SW0189)	Williams Crescent	Pipe	1992	Pipe	
SW0322	Pipe in Woodlawn Road (SW0322)	Woodlawn Road	Pipe	2018	Pipe	
SW0323.1	Pipe in Woodlawn Road (SW0323.1)	Woodlawn Road	Pipe	2018	Pipe	

Spatial ID	Asset Description	Road Name	Drain Type	Con Year	Asset Desc	Condition Rating
SW0323.2	Pipe in Woodlawn Road (SW0323.2)	Woodlawn Road	Pipe	2018	Pipe	
SW0077	Pipe in Zippel Court (SW0077)	Zippel Court	Pipe	1992	Open Drain	
SW0317.1	Rising Main in Alec Baldock Drive (SW0317.1)	Alec Baldock Drive	Rising Main	2012	Rising Main	
SW0317.2	Rising Main in Wallschutzky Road (SW0317.2)	Wallschutzky Road	Rising Main	2012	Rising Main	
SW0301	Swale in Back Beach Road (SW0301)	Back Beach Road	Swale	2012	Open Drain	
SW0326.1	Swale in Bay Road (SW0326.1)	Bay Road	Swale	2019	Swale	
SW0326.2	Swale in Bay Road (SW0326.2)	Bay Road	Swale	2019	Swale	
SW0326.3	Swale in Bay Road (SW0326.3)	Bay Road	Swale	2019	Swale	
SW0211	Swale in Centenary Road (SW0211)	Centenary Road	Swale	2019	Swale	Fair
SW0334	Swale in Kennedy Road (SW0334)	Kennedy Road	Swale	2008	Swale	
SW0335	Swale in Kennedy Road (SW0335)	Kennedy Road	Swale	2008	Swale	
SW0212	Swale in Oscar Williams Drive (SW0212)	Oscar Williams Drive	Swale	2004	Open Drain	

APPENDIX F
PHASE 1 ENGAGEMENT SUMMARY

Phase 1 Engagement Summary

Streaky Bay Stormwater Management Plan

District Council of Streaky Bay

19 February 2024

Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
01	Draft			31 October 2023
01a	Council Review			20 December 2023
02	Final	Johanna Theilemann	Dr Kylie Hyde	19 February 2024

Project Details

Project Name	Streaky Bay Stormwater Management Plan
Client	District Council of Streaky Bay
Client Project Manager	Lachlan Smith
Water Technology Project Manager	Alex Barton
Water Technology Project Director	Melinda Lutton
Authors	Tahlia Rossi, Roxanne Frost
Document Number	22030162_R02_V02_Phase_1_Engagement_Summary

1/198 Greenhill Road
Eastwood SA 5063
Telephone (08) 8378 8000
Fax (08) 8357 8988
ACN 093 377 283
ABN 60 093 377 283

ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present.

> For this project, we acknowledge and respect the Wirangu people as the First Nations people of the ancestral lands of Streaky Bay. We acknowledge the Barngala and Nauo people, and other tripes who have utilised the area and travelled through the region as part of their cultural activities.

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2 INTRODUCTION

2.1 Project context

Water Technology has been engaged by the District Council of Streaky Bay (DCSB) to provide review and update of the existing Streaky Bay Stormwater Management Plan (SMP), finalised in 2011. In the decade since it's development, changes to both the landscape and community priorities have occurred, along with significant advancements in data availability and hydraulic modelling capabilities.

An updated SMP will address the changed needs of the community and stakeholders, provide an opportunity for alignment with other strategic documents (i.e. the District Management Plan and Streaky Bay Township Masterplan), and set the priorities for management actions over the short to medium timeframe.

The scope of this project was identified in the proposal as to:

- Build on the previous work and existing documentation regarding stormwater management.
- **Engage with stakeholders and the community to develop a long-term vision for stormwater management in the region, and to identify existing risks and potential opportunities.**
- Document existing stormwater management strategies.
- Identify appropriate, fit for purpose upgrades and/or new management strategies, with associated costings and priorities so that they can be implemented when funds become available.

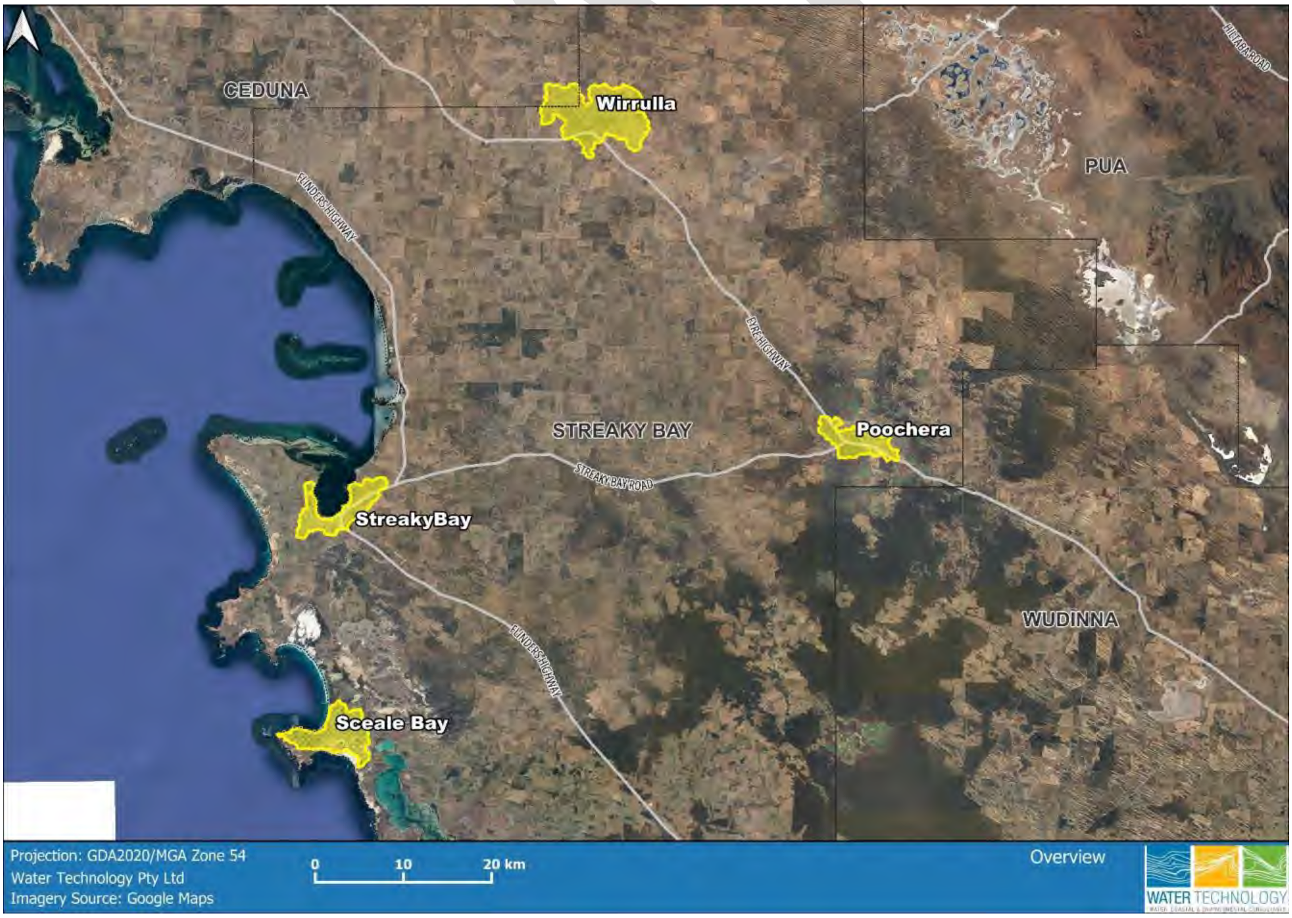

Figure 2-1 Geographic reach of Streaky Bay Stormwater Management Plan across townships

2.2 Local stormwater context

Streaky Bay, on the far west coast of the Eyre Peninsula, is a coastal township which supports some 2,000 residents and surrounding rural communities. The DCSB has a vision *'to be the most liveable district on the Eyre Peninsula'.* A robust SMP that provides strategies to minimise the risk of stormwater on the community and receiving environment, and capitalises on the opportunities this precious resource provides, will contribute to achieving this vision.

Approximately half of the Streaky Bay township (predominately the urban and industrial areas) currently drains to the foreshore, with the remaining catchment (predominately farming land use) draining to adjacent natural low-lying areas.

Streaky Bay's climate is semi-arid to arid, with annual average rainfall around 377 mm. It is understood that periods of drought have put pressure on street trees and canopy loss has occurred. This highlights the value of stormwater as a potential resource.

The township has a formalised under-ground drainage network and two detention basins. Stormwater issues have been identified in the following areas:

- The low-lying residential and industrial areas along Mudge Terrace and Jubilee Road.
- The 'Killas' property on Wells Street, which is situated in a depression.
- Alfred Terrace and Bockleberg Street properties which receive runoff from the Viterra Silos to the north.
- Properties within the block bordered by Williams Court and Hospital Drive, which intercept the stormwater flow path.
- Doctors Beach, which receives outflow from the Streaky Bay Area School detention pond / wetland system.
- Bay Road / Dodgson Drive, this area acts as a catchment area for the surrounding streets and filters to a single point that allows entry into the Wallschutzky Stormwater Catchment Pond

These areas are considered target locations for engagement, as residents and businesses operating in these areas are likely impacted by stormwater issues and should be engaged about proposed mitigation options.

Figure 2-2 Focus area in Streaky Bay with known stormwater issues

2.3 Understanding of community sentiments about stormwater

WSUD and aquifer recharge are stormwater management options reported to be of interest to the community

It is understood from discussions with Council that stormwater is an issue the community are interested in. Concerns have been raised in relation to:

- Localised flooding impacts on properties.
- Environmental impacts of stormwater being discharged into the ocean.

This will enable us to focus community sessions to further understand concerns and priorities for the community to be addressed in the SMP review.

It is understood additional areas of interest to the community include the occurrence of drought in the region, resulting in reduced tree canopy cover and die off of street trees.

There is a desire for stormwater to be reused as a drought and climate adaptation solution, and interest in options such as increased use of water sensitive urban design, and aquifer recharge will be investigated through the SMP review (noting managed aquifer recharge is being investigated under a separate consultancy project by another consultant).

2.4 Engagement purpose

The purpose of engagement was defined in Water Technology's engagement plan as to:

> *Engage with stakeholders and the community to develop a long-term vision for stormwater management in the region, and to identify existing risks and potential opportunities.*

Further to this purpose statement, the driver for conducting engagement as a part of the SMP is to:

- Enable public participation in government decision-making in relation to issues that impact the public.
- Apply best practice engagement planning and implementation to comply with engagement ethics.
- Provide opportunities for the public and stakeholders to be heard and contribute to SMP development.

3 ENGAGEMENT DESIGN

3.1 Objectives

The specific objectives of engagement activities related to the SMP development are to:

- Inform the public and stakeholders about the scope of SMP review project and subsequent activities.
- Understand from the public and stakeholders existing stormwater and flood related issues and impacts.
- Understand from the public and stakeholders perspectives and preferences for stormwater management.

These objectives guide engagement design and reporting.

3.2 Overview of activities completed

#	Activity	Date	Overview
Phase 1 Engagement – information gathering on stormwater issues & opportunities ***August – September 2023***			
1	**Online state government agencies meeting**	Mon 14th August 2pm – 3pm	Present project scope and discuss stormwater management issues, challenges, opportunities, and previous / parallel work for consideration in SMP review.
In person engagement (visit to Streaky Bay 19th – 20th September 2023)			
3	**DCSB councillors briefing**	Tues 19th September 1:30 – 3pm	Present project scope and planned engagement activities for feedback; discuss stormwater management issues, challenges, opportunities, and previous / parallel work for consideration in SMP review.
4	**Community workshop**	Tues 19th September 5:30 – 7pm	Conduct public workshop to provide consultation opportunity to those with a keen interest in stormwater management in Streaky Bay. This will include presenting the project scope and purpose, and activities to collect input on stormwater issues, challenges, and opportunities from participations.
5	**In-person Walk the Catchment - open site visit**	Wed 20th September	Conduct site visit alongside Council staff and business owners and/or residents to understand physical and lived experience aspects of stormwater management issues, challenges, and opportunities.

3.3 Advertisement for public participation

Council advertised this workshop widely, including in the public newsletter, posters around the main street, and directly to residents in stormwater interest areas by letter drop boxing a flyer invitation. Additionally, project information is listed via the Council website. Links and images of advertisement material is shown below.

Join Us for a Public Consultation on the Stormwater Management Plan | District Council of Streaky Bay

Stormwater Management Plan Development | District Council of Streaky Bay

Figure 3-1 Poster used for public advertising of engagement event created by DCSB

3.4 Gaps

3.4.1 Wirangu Committee meeting

The meeting with the Wirangu Committee was identified as an opportunity to discuss stormwater and broader water and environmental management considerations with Wirangu representatives. The Committee was not available when consultants were visiting Streaky Bay.

Either a meeting virtually over MS Teams or as a part of the phase 2 engagement activities in Streaky Bay in early 2024 is recommended to ensure Wirangu perspectives are included.

3.4.2 Workshop attendance

This was identified as a possible occurrence in the engagement plan, stating:

Attendees to engagement activities may be a narrow representation of the general public, given busyness of daily life for people, project timeframes, and scope of the project. Engagement activities have been designed to be available to a range of Streaky Bay residents. Assessment of sample size, demographic and geographic representation will be included in post engagement reporting.

While the workshop was advertised broadly, including letter box invitations to stormwater interest area residents, attendance was limited to a handful of residents. While stormwater may not be a topic that the residents of this region are engaged with, it is important that the opportunity was provided for all to be consulted as a part of Phase 1 engagement.

It is understood consultation fatigue is common when there are a large number of activities and projects occurring that benefit from public input. It is understood a range of engagement activities in Streaky Bay and surrounds had been recently undertaken in relation to additional Council projects, including master planning.

While there were few in number that attended the workshop and site visit, those who did attend had a particular interest or concern over stormwater and its impacts on their property, or specific ideas about what they wish to see in future stormwater management in this region. Therefore, the discussions enabled through the consultation were productive.

Encouraging a diverse range of community representatives is a widespread consultation challenge (e.g. age, gender and other demographic factors). For phase 2 engagement, methods used, time of day, and location of engagement activities to ensure inclusivity of consultation. Further information about phase 2 engagement is listed in the summary and will be discussed with Council prior to detailed phase 2 planning.

3.4.3 Opportunities for residents to have a say

Additional opportunities were provided to residents who may have not been able to join the workshop time, including joining the site visit walk on the Wednesday 20th September, contacting DCSB for specific input / meeting request, and responses via a stormwater survey distributed by Council.

3.5 Use of engagement findings in Water Technology's SMP review

During engagement activities, notes were taken to capture all comments and feedback received. Photographs of maps, sticky notes, and dot voting materials were taken to include in report and assist with transcription of notes.

Following the engagement activities, two project team meetings were held to present a summary of the findings from activities to the project manager, project director and technical modelling staff working on this project. This assisted the project team to make best use of findings from engagement and understand council, state agency and residents' perspectives. The following sections present a summary of key findings.

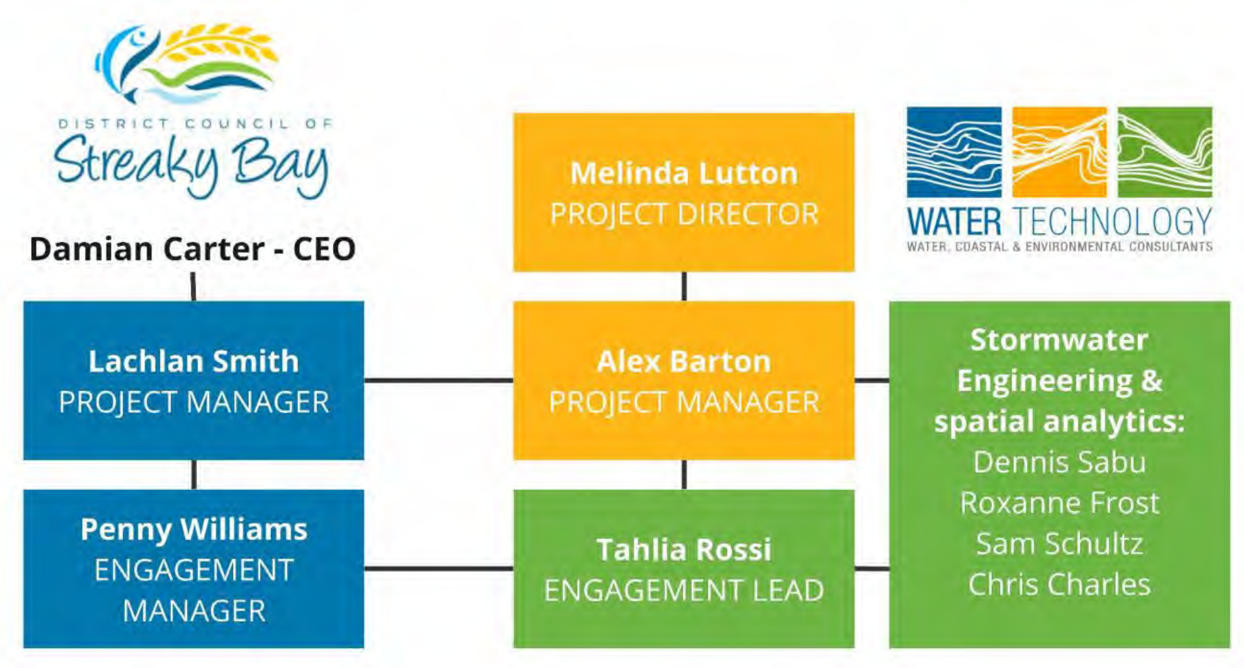

Figure 3-2 Project team and roles

4 STATE AGENCY STAKEHOLDER MEETING SUMMARY

4.1 State agency meeting approach

This meeting was held via MS Teams on **Monday 14th August 2023**, from 2pm to 3pm, with 8 attendees.

The **purpose** was to present project scope and discuss stormwater management issues, challenges, opportunities, and previous / parallel work for consideration in SMP review. State agencies will be the referral / approval body for stormwater management plan sign off, so important to engage them in the review and development of this plan.

The questions used to guide the discussion included:

- What environmental values need protecting?
- Key stormwater issues in Streaky Bay?
- Key opportunities to optimise stormwater management?
- Mitigation options that may be 'off the table'?
- What benefits should mitigation solutions deliver (environmental, social, economic, cultural)?
- Previous studies, parallel / relevant projects underway for the team to consider?

4.2 State agency stakeholders engaged

The attendees of this meeting are listed in the table below.

Table 4-1 Attendees from state agencies in relation to stormwater management

#	Organisation	Name
1	Landscapes SA	Libby Hunt
2	DEW – Coastal Protection Board	Sharee Detmar
3	DEW – Organisation DEW Crown Land Management	Barry Fryar
4	DCSB (Council) - CEO	Damian Carter
5	DCSB (Council) - General Manager – Infrastructure	Lachlan Smith
6	DCSB (Council) - General Manager – Prosperity	Penny Williams
7	Water Technology	Tahlia Rossi
8	Water Technology	Roxanne Frost

4.3 Key findings

Key considerations for the SMP include:

- SMP to be used by council to develop *WSUD and Stormwater Management Guidelines,* including retrofit solutions (for households and developers)
- Drought resilience important to consider (e.g., potential stormwater capture / reuse)
- Haven't observed coastal erosion or scouring, but should be considered for how to capture silt and sediment entering Bay *(assuming from inland maybe?)*
- WSUD is paramount in SMP – Council and State see high potential, including:

- To manage high frequency / low intensity flooding
- To enable stormwater capture & reuse to assist with drought management
- To improve water quality entering the Bay
- To link WSUD to larger strategies, such as tree canopy targets, urban cooling, active transport etc.
- Current and future potential for roof downpipes connected to rainwater tanks on lots – not SA water.

- Significant investment in flooding over the next 10 years, in a sustainable way / sustainable growth
- Any discharge into Crown Land to be noted – this will be referred to DEW for approval
- Future growth areas and stormwater management is of concern to Council and State-
  - New lots, development assessment process considerations - avoid impact – design, sizing etc. needs master planning!
  - These areas are outside of coastal zone (positive for water quality)
  - Developers permitted to 'tack on' new SW piping into existing trunk mains, but not sized for capacity?
  - Already existing stormwater issues, additional development will add pressure / more issues
  - There are 'private subdivisions' – stormwater management in these areas (Council wants to encourage WSUD)
  - Onsite capture of stormwater – e.g., '(avoid) stormwater currently sheeting across roads after rain'.
- Mudge Terrace an area with significant flooding.

Key environmental values or challenges that the SMP should support, protect, or enhance include:

- Several low-lying areas, with marsh/wetland species of varying ecological quality. These are priority areas / areas of concern to improve / project. E.g., Schools Rd, Wells St., Doctors Beach etc. *(check during site visit)*
- The samphire wetland / saltmarsh established on the site of a previous landfill site in Streaky Bay, which:
  - Is the coastal interface between Bay and township – function to filter stormwater?
  - Supports biodiversity include samphire plants (saltmarsh), frogs, birds, etc.
  - Is of local environmental value to the community – e.g., recreational walking, birdwatching etc.
  - Site was a historical landfill site, now remediated into a wetland, however, site should not be disturbed / no earthworks be done on the site etc.
- Other locations where wetlands can be formalised / improved (e.g. 'Swamp and Jubilee, Schools Rd')
- Weed dispersion through stormwater is a concern and current challenge to manage
- Concerns about water quality, including:
  - Stormwater discharged into Bay is a matter of local concern to community – discolouration, pollutants, silt, sediment, debris, etc.
  - Impacts of stormwater on seagrass health in the Bay
  - Concern about weed dispersion
  - Concern about erosion control

- Possible Gross Pollutant Traps (GPTs) or similar?
- Benefits SMP should support-
  - Erosion control
  - Biodiversity enhancement
  - Native species & planting with drought resilience
  - Links with social benefits and wellbeing – exemplars, educational, cultural considerations-
    - Farming community's connection to water / waterholes
    - Public education of wetlands, water cycle / stormwater management – e.g., interpretive signage, education programs etc.

Studies & parallel work to consider:

- Coastal flood mapping available from Coastal Protection Board
  - Climate Ready Coasts program (to be completed by July 2024)
  - Coastal flooding considerations, prioritised areas
  - Impact of king tides? Potential for increased flooding?
- Street Tree Condition and Risk Assessment
- Separate consultancy project commissioned by Council to investigate Managed Aquifer Recharge **(this separate project has commenced)**

These notes were discussed and provided to the entire project team for consideration, including technical staff conducting modelling.

5 COUNCILLOR BRIEFING SUMMARY

5.1 Councillor meeting approach

Roxanne and Tahlia attended the end of the DCSB Councillor meeting on **Tuesday 19th September 2023**, from 2pm to 3pm, with the majority of elected members present, as well as a representative of the Infrastructure Management team.

The **purpose** was to present project scope, initial results, and engagement activities; and discuss stormwater management issues, challenges, opportunities, and considerations in our SMP review process.

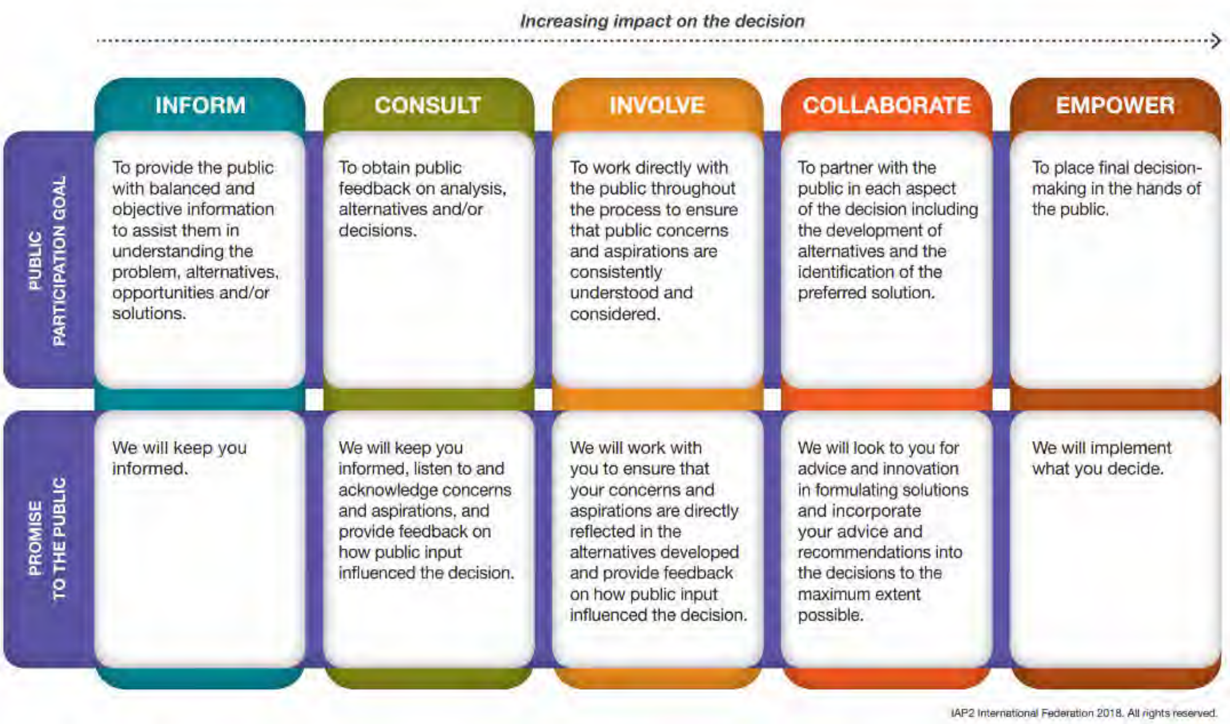

Figure 5-1 IAP2 Spectrum of Public Participation (Source: IAP2 Essentials of Engagement Learner Guide)

The IAP2 level of engagement was **inform / consult**, and the **engagement promise** to attendees was:

We want to keep you informed about the work we are completing and understand Councillors and Council staff perspectives on local context & key considerations.

The presentation included:

- Introduction of project team and project scope
- Summary of initial modelling results
- Overview of engagement activities
- Q&A discussion and next steps

A copy of slides used in the workshops are provided in Appendix A.

5.2 Councillors present

Table 5-1 DCSB for Councillor Briefing stakeholders

#	Position	Name	Attendee status
1	Mayor (Flinders Ward)	Travis Barber	Attendee
2	Deputy Mayor (Eyre Ward)	Gregory Limbert	Attendee
3	Elected Member – Eyre	Guy La China	Attendee
4	Elected Member - Flinders	Clifford Pudney	Attendee
5	Elected Member - Flinders	Sally Trezona	Attendee
6	Elected Member - Flinders	Philip Wheaton	Attendee
7	DCSB CEO	Damian Carter	Attendee
-	Manager, Infrastructure	Lachlan Smith	Apology
-	Manager, Prosperity	Penny Williams	Apology
-	Elected Member – Eyre	Graham Gunn	Apology
-	Elected Member – Eyre	Neville Trezona	Apology
	Water Tech project team	Tahlia Rossi	Presenter
	Water Tech project team	Roxanne Frost	Presenter

5.3 Key findings

5.4 Summary of key discussion points

- Alignment of SMP with growth strategy (Town masterplan) and tree strategy
- Summer rains – problem areas critical during November to January
  - Councillors noted that that soil water infiltration appears to be very poor after drier periods
- Samphire Wetland is old dump area
- Key flooding areas
  - Bay Road, jubilee etc are key areas.
  - Alfred Ter and William Cr houses flooding
  - Future Swamp from north of quarry (Mudge Ter)
    - Possible recreational space
- School wetland to be discussed with involved community members
- Compromised earth dams in study area
- Query if mangroves are a possibility for water quality improvement in wetland areas
- Street rain gardens to be considered
- Possibility to improve stormwater capture at campground before joining coastline
- Wastewater reuse currently:

- Oval
- Golf course
- Current irrigation uses

- MAR only to be high level

These notes were discussed and provided to the entire project team for consideration, including technical staff conducting modelling.

Figure 5-2 Cover of slides used to present in Councillor Briefing

6 COMMUNITY WORKSHOP SUMMARY

6.1 Community workshop approach

Roxanne and Tahlia facilitated this public community workshop on **Wednesday 19th September 2023**, from 5:30pm to 7pm, with 8 attendees.

The **purpose** was to present project scope, initial results and engagement activities; and discuss stormwater management issues, challenges, opportunities, and considerations in our SMP review process.

The IAP2 level of engagement was **inform / consult**, and the **engagement promise** to attendees was:

We want to hear from you, and your concerns, suggestions and experiences will be documented & presented to Council / the project team for consideration in SMF drafting.

The presentation included:

- Introduction of project team and project scope
- Stormwater 101
- Summary of initial modelling results
- Defining issues and opportunities
- Identifying key priorities
- Next steps

A copy of slides used in the workshops are provided in Appendix A.

6.2 Key findings

The majority of the workshop time was spent discussing issues and opportunities. Participants shared and added sticky notes onto the maps provided of Streaky Bay. This is shown in Figure 6-2. \

Figure 6-1 Cover of slides used to present in community workshop

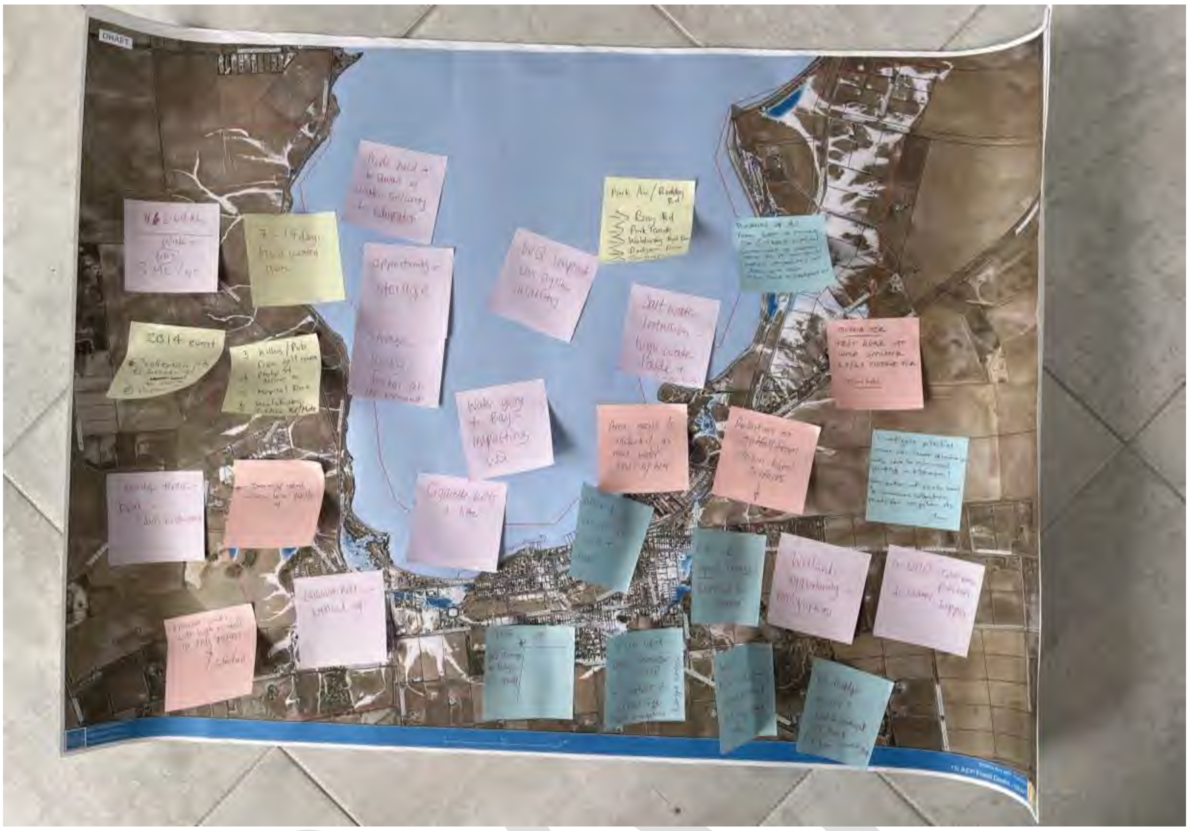

Figure 6-2 Copy of maps with sticky notes from participants, detailing stormwater issues and opportunities

These comments have been collated from the maps and categorised in key topics in Table 6-1.

Table 6-1 Summary of participant comments on stormwater issues and opportunities

Category	Comments

General information	**Flooding**
	• 2014 rain event – significant and memorable event. Caused flash flooding and stormwater issues.
	    • Playground at school experienced flooding depth of approximately 6ft (unverified)
	    • Wetland normally has 2 stormwater entry points but experienced 8 during 2014 rain event (unverified)

	Water supply • Water is piped from Adelaide by SA Water for $2.69 kL • Not uncommon for residents to use 3ML / year • Approximately 600 connections to water supply in Streaky Bay
	Geology • The soil type cases fast runoff and little absorption unless it has been lightly raining recently • There are caves underneath some areas • There is a high water table / saltwater intrusion in some areas.

Category	Comments
	• Observation form community member is that bore at oval has a very high water table and has a high salinity
	Locations with issues: Johnston St to the swamp, Doctors Beach, Killas / Pub from golf course, Philip St / Alfred Tc, Hospital Dr, Wallschutzky, Jubillee Rd / Mudge.
Stormwater issues	**Specific locations** • Park Avenue / Reddy Rd, Bay Rd, Parklands, Wallschutzky Rd Dam, Dodgson Dr, Swamp • *Site visit gives a more comprehensive list*
	Implementation • Lack of action on known / long standing stormwater issues • Frustration of residents affected by stormwater issues in their locality
	Water security and affordability • Long term water scarcity and water security in the region • Price of potable water and remoteness of the town to continue to be supplied by SA Water into the long term (need / want local resilience and collection) • Streaky bay recently connected to SA Water • Community impression is that there was general outlook was complacent about water security since connection to SA Water • Rumours that State was considering cutting off supply from Murray Darling basin and considering desalination options
	Flooding • Flash flooding in heavy rainfall events • Community observed that flash flooding occurred when 25mm-40mm shown on rain gauge over a 1-day period (unverified) • Lack of insurance available due to flood risk (un-insurable properties) • Repeat damage to the same properties due to flooding
	Stormwater system • Lack of storage – *perspective from some attendees that a lack of storage is the most pressing limiting factor of the stormwater system and stormwater management* • Erosion and sediment transport / siltation of small ponds and wetlands • Damage to lining of dams reducing effectiveness of small storages
	Planning / compliance / management issues • Residential developments approved in high-risk areas • Rainwater collection tanks overflow to roads without regulation / management • Previous stormwater infrastructure management were not stringent enough, resulting in developments that have been built without appropriate infrastructure • Concerns about stormwater management in terms of flooding of the approximate 600 onsite wastewater systems in new developments
	Water quality

Category	Comments

	• Water quality impact on oyster industry (unable to set up aquaculture in the bay – has been tested but didn't meet WQ requirements) – economic impacts
	• *Stormwater runoff impacts on water quality in the Bay is not clear-*
	    • Some perspectives that it simply 'isn't an issue'
	    • Some perspectives that it's a major / pressing issue impacting seagrass and marine life with visible / anecdotal evidence that there has been a rapid decline in seagrass in the last 20 years
	• '50% of stormwater runoff goes into the bay' (unverified)
	• *From Council - 'EPA and Landscapes Board have not reported WQ issues and say it's a Council / local issue to manage'.*

Stormwater opportunities / priorities	**Increased drainage / Storage** • Investigate potential areas for lower drainage with zero to minimal pumping requirements – storage! • Connection of such areas to common collection points for irrigation etc. • Mudge Tce – test bore at sump opposite 25/27 Mudge Tce (for accelerated drainage) * • 'Fix Mudge Tce' – need to be able to mitigate a 2014 rainfall event
	Increase use of WSUD assets • Appetite for WSUD as functional design features • Interest in the co-benefit delivery of WSUD to improve urban landscapes and increase biodiversity • Interest in being able to maximise re-use • Provide flood mitigation / reduce flood peaks / impacts • 'Send stormwater through parks, gardens and wetlands' • Community observed large reduction in tree canopy cover (unverified)
	Improve marine water quality • Reduction of outfall from town's hard surfaces (water quality and stormwater runoff / discharge into the bay) • Increase WSUD treatment of stormwater through wetland systems before entering the Bay • Local community noted a change in fish population in certain areas of the bay. No biological studies have been undertaken to date
	Benefit water security • Passive irrigation of street trees through stormwater • Increased capture and storage for irrigation / reuse purposes
	Community awareness • Increase public awareness of water security through education

*Issues raised from Council about this suggestion.

6.2.1 Prioritising stormwater management issues

An activity was completed to indicate how participants ranked the severity of each category of stormwater issue. With few participants, the results are not definitive to develop a trend, but this still indicates sentiment of those in the room. This is shown in Figure 6-3. If these were to be ranked in order from **most concern** to least concern, this order is summarised in Figure 6-4. This shows major flooding is of most concern, and MAR is of least concern, as referenced by Figure 6-4 showing the ranking of stormwater issues based on concern.

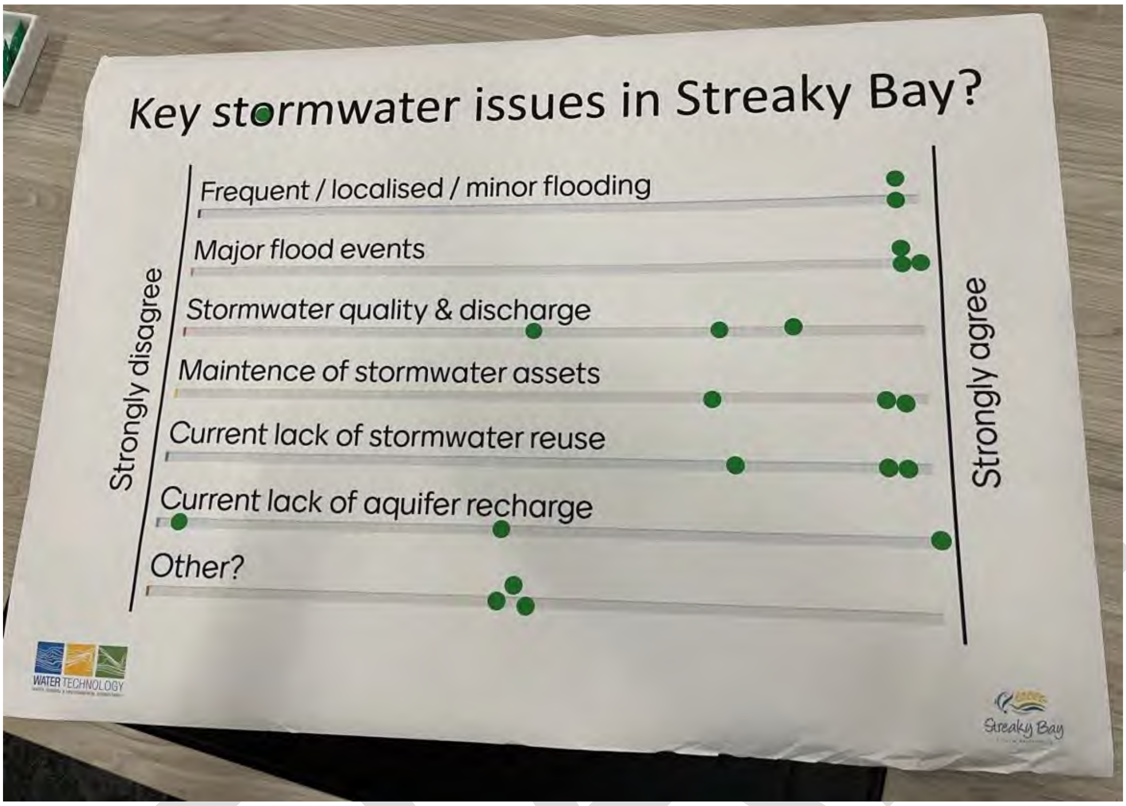

Figure 6-3 Ranking importance of stormwater issues – indicative sentiments

1. Major flood events
2. Frequent / localised / minor flooding
3. Current lack of stormwater reuse
4. Maintenance of stormwater assets
5. Stormwater quality and discharge
6. Current lack of aquifer recharge

Figure 6-4 Ranking of perceived stormwater issues, from highest to lowest priority to address

7 WALK THE CATCHMENT SITE VISITS

7.1 Site visit walk approach

Site walks were conducted for project team staff to understand the location, condition and nature of stormwater assets and issues. This was undertaken by Roxanne Frost and guided by Lachlan Smith, DCSB Asset Manager. Members of the public were notified of the date/time of these site visit walks, and were invited to join at a particular location of interest to them, to share first hand stories and experiences of stormwater issues with Roxanne and Lachlan. The site walk itinerary is summarised in Table 7-1.

Table 7-1 Wednesday 20th September 2023

Time	Detail	Location
9.00 am – 10.00 am	Site visit	Wetlands / wells street / samphire
10.30 am – 11.30 am	Site visit	Bay road
1.00 pm – 2.30 pm	Site visit	Main street businesses
3.00 pm – 4.30 pm	Site visit	General drive around

7.2 Participants

Roxanne Frost from Water Technology and Lachlan Smith from DCSB conducted these site visits, and at various locations 8 residents joined to discuss stormwater management in their locality.

7.3 Key findings

The key findings from these site visits and discussing stormwater with residents include;

- **Wetland / Wells Street -** Wetland volume compromised with installation of new speed hump. Stormwater pipe now allowing water to freely flow out to bay instead of retaining water. Consider possible remediation measures.
- **Samphire Wetland -** New developments south of Samphire wetland has very little stormwater infrastructure and not sedimentation collection infrastructure to protect wetland. Erosion occurring at several locations.
- **Bay Road –** Crash repairs has experienced flooding in the past but no recent flooding reported. New skate park, stormwater infrastructure possibly insufficient. Possible location for detention basin on golf course at low point on Montgomerie Ter. Currently residents are experiencing flood inundation.
- **Mudge Terrace -** Severe flooding issues. Council could obtain some land for detention basin. Soil in area reported as “always wet”. Land use at silos possibly contributing to flooding at Mudge Terrace. Hospital Drive residents currently experiences flooding and must sandbag during most storm events.
- **Main Street businesses –** Killa’s business currently flooding downstream neighbours. Owner has tried to resolve issues by building infiltration basin on property. Council stormwater reserve to the east of property to be formalised and utilised by Killa’s business. Hotel downstream wants to resurface parking area in near future. Killa’s owner reported that all roof water is currently being captured but that stormwater tank overflows and floods downstream.
- **Additional inspections around vicinity –** Clearwater Cove development east of silos has large retention basin that is not nearly fully utilised. If stormwater from silos can be redirected to this infrastructure it could alleviate flooding at Mudge Terrence.

Photos and corresponding notes have been provided in Appendix B.

8 COUNCIL-LED SURVEY

Questions proposed by Council are listed below. Please review and made comment if you suggest these are edited before being circulated to the public.

1. **How familiar are you with the current stormwater management issues in your community or area of interest?**
   - Very familiar
   - Somewhat familiar
   - Not familiar at all
2. **Have you personally experienced any stormwater-related problems in your area, such as flooding, erosion, or water quality concerns?**
   - Yes
   - No
   - Not sure
   - If yes, what is your location
   - If yes, briefly explain your issue
3. **What specific stormwater management challenges do you believe are most pressing in our community? Please rank the following issues in order of importance (1 being the most important, 5 being the least):**
   - Flooding
   - Erosion
   - Water quality and pollution
   - Stormwater runoff into the ocean
   - Lack of green infrastructure (such as water treatment wetlands)
   - Insufficient drainage maintenance
   - Other – Comment
4. **Are you aware of any successful stormwater management practices or initiatives in other communities that you believe could be beneficial to our area?**
   - Yes
   - No
   - Not sure
   - If yes, what are they
5. **General Feedback**
   - Text Box

9 SUMMARY

The best practice frameworks of International Association of Public Participation (IAP2) have been used to design engagement for this project. The outcomes of engagement are being used to inform:

- Project team consideration of community perspectives in developing stormwater management mitigation options and recommendations.
- Project team to use qualitative information from community to inform data gaps in impacts.
- Consideration of public preferences for stormwater management and mitigation options to be factored into decision making presentations to Council and in reporting.

Visiting Streaky Bay in person was a valuable process to see the stormwater assets, localities and features, understand resident and Councillor perspectives, and collect photographs for the technical team to use in their assessment. It is understood that stormwater is an issue of community concern, that runoff occurs, and that several properties are frequently impacted by stormwater. Perspectives were heard that preference the use of stormwater management solutions that maximise reuse, use of water sensitive design, or deliver co-benefits for social, economic and environmental outcomes.

The next engagement activities scheduled for this project are listed below. These activities will enable circulation of draft stormwater management solutions for community and stakeholder feedback before the finalisation of the updated Stormwater Management Plan.

Table 9-1 Phase 2 planned engagement activities in accordance with the engagement plan

#	Activity	Date	Overview
3	**Meeting with Wirangu Committee**	TBC	Opportunity to discuss stormwater and broader water and environmental management considerations with Wirangu representatives for team consideration in SMP review.
		Council led engagement	
6	**Online public survey**	Between August – October 2023	Provide opportunity for all to participate in consultation (particularly those unable to attend workshop), to better understand community stormwater management sentiment and mitigation preferences, including issues, challenge, and opportunities.
		Phase 2 Engagement – feedback on draft mitigation options - *March 2024 (TBC)*	
7	**Councillor briefing**	TBC	Provide update on SMP review progression and findings from Phase 1 engagement. Forum will be used to discuss key decision points that may have arisen in the project and seek feedback for SMP finalisation.
8	**Community drop-in sessions x2**	TBC	Visual presentation of SMP mitigation options and how key findings from phase 1 engagement have been considered, with opportunity for feedback collection / preference indication (if applicable).
9	**Invited stakeholders workshop**	TBC	Final discussion and feedback on SMP mitigation options with local and state government representatives and other stakeholders to enable SMP review draft document to be finalised (ahead of Council's official document review).

APPENDIX A
WORKSHOP SLIDES

APPENDIX B
SITE VISIT PHOTOS AND COMMENTARY

B-1 Wetland / Wells Street

Wetland volume compromised with installation of new speed hump. Stormwater pipe now allowing water to freely flow out to bay instead of retaining water. Consider possible remediation measures.

B-2 Samphire Wetland

New developments south of Samphire wetland has very little stormwater infrastructure and not sedimentation collection infrastructure to protect wetland. Erosion occurring at several locations.

B-3 Bay Road

Crash repairs has experienced flooding in the past but no recent flooding reported.

New skate park, stormwater structure possibly insufficient

Possible location for detention basin on golf course at low point on Montgomerie Ter. Currently residents are experiencing flood inundation.

22030162_R02_V02_Phase_1_Engagement_Summary

B-4 Mudge Street Terrace

Severe flooding issues. Council could obtain some land for detention basin. Soil in area reported as "always wet"






Land use at silos possibly contributing to flooding at Mudge Terrace.

Hospital Drive residence currently experiences flooding and must sandbag during most storm events

B-5 Main Street Businesses

Kildas business currently flooding downstream neighbours. Owner has tried to resolve issues by building infiltration basin on property. Council stormwater reserve to the east of property to be formalised and utilised by Kildas business. Hotel downstream wants to resurface parking area in near future. Kildas owner reported that all roof water is currently being captured but that stormwater tank overflows and floods downstream.

22030162_R02_V02_Phase_1_Engagement_Summary

B-6 General Drive Around

Clearwater development east of silos has large retention basin that is not nearly fully utilised. If stormwater from silos can be redirected to this infrastructure it could alleviate flooding at Mudge Terrence




School ponds

Wallschutzky Road pond

Melbourne

15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800

Sydney

Suite 3, Level 1, 20 Wentworth Street
Parramatta NSW 2150
Telephone (02) 9354 0300

Brisbane

Level 5, 43 Peel Street
South Brisbane QLD 4101
Telephone (07) 3105 1460

Adelaide

1/198 Greenhill Road
Eastwood SA 5063
Telephone (08) 8378 8000

Perth

Ground Floor, 430 Roberts Road
Subiaco WA 6008
Telephone (08) 6555 0105

New Zealand

7/3 Empire Street
Cambridge New Zealand 3434
Telephone +64 27 777 0989

Wangaratta

First Floor, 40 Rowan Street
Wangaratta VIC 3677
Telephone (03) 5721 2650

Geelong

51 Little Fyans Street
Geelong VIC 3220
Telephone (03) 8526 0800

Wimmera

597 Joel South Road
Stawell VIC 3380
Telephone 0438 510 240

Gold Coast

Suite 37, Level 4, 194 Varsity Parade
Varsity Lakes QLD 4227
Telephone (07) 5676 7602

watertech.com.au

Melbourne

15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800

Sydney

Suite 3, Level 1, 20 Wentworth Street
Parramatta NSW 2150
Telephone (02) 9354 0300

Brisbane

Level 5, 43 Peel Street
South Brisbane QLD 4101
Telephone (07) 3105 1460

Adelaide

1/198 Greenhill Road
Eastwood SA 5063
Telephone (08) 8378 8000

Perth

Level 1, 21 Adelaide Street
Fremantle WA 6160
Telephone (08) 6555 0105

New Zealand

7/3 Empire Street
Cambridge New Zealand 3434
Telephone +64 27 777 0989

Wangaratta

First Floor, 40 Rowan Street
Wangaratta VIC 3677
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