Clare and Gilbert Valleys Council

Stage 2 SMPs for 7 Townships

SADDLEWORTH STORMWATER MANAGEMENT PLAN

APPROVED FINAL

July 2020

CLARE & GILBERT VALLEYS COUNCIL

Government of South Australia
Stormwater Management Authority

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The report contains recommendations for stormwater management. Council will seek funding and resources for these recommendations from a range of sources. The availability and timing of funding and resources will determine the order and staging of the works.

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1 Introduction

1.1 Background

The Clare and Gilbert Valleys Council (Council) engaged Australian Water Environments (AWE) to prepare a Stormwater Management Plan (SMP) for Saddleworth. The SMP builds upon the outcomes of the recently completed floodplain mapping for the town prepared by AWE (2013).

The purpose of SMPs is outlined by the Stormwater Management Authority (SMA), as follows - to manage stormwater on a total catchment basis with the relevant Natural Resources Management Board (NRMB), local government authorities and state government agencies. The aim is to work together to develop, implement and fund a coordinated and multi-objective approach to stormwater management in the area. This allows for consistent management that addresses existing problems and identifies opportunities for providing a range of benefits through multi-objective planning, including stormwater reuse where feasible.

This SMP investigates ways to alleviate existing stormwater and flooding problems and provides flood protection for public and private assets. It aims to assess flood mitigation options, investigate opportunities for stormwater reuse, including Managed Aquifer Recharge (MAR), without compromising flow management or flood mitigation infrastructure. The SMP also explores opportunities for environmental enhancement in the design of stormwater infrastructure. Environmental enhancement may be in the form of improved water quality and reduced roadside erosion, and increased biodiversity. The SMP will assess stormwater management options and rank their priority in accordance with the format recognised in the SMA SMP Guidelines with verification against Council wide assessment criteria.

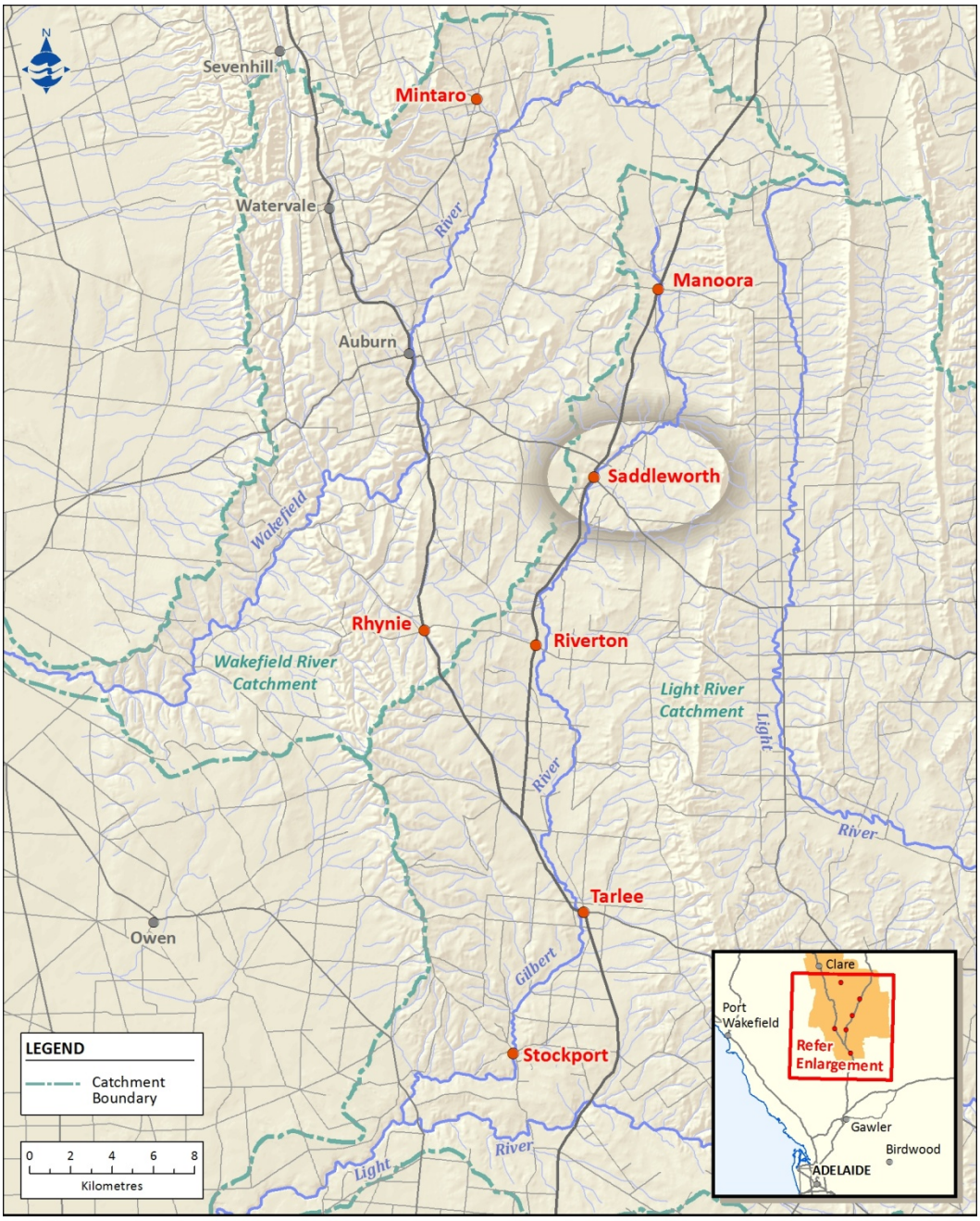
This SMP has been developed in conjunction with developing SMPs for six additional townships for the Council, including: Tarlee, Manoora, Riverton, Stockport, Mintaro, and Rhynie. These towns are located approximately 80 km – 130 km north of Adelaide, refer Figure 1-1 on the following page.

Saddleworth, Manoora, Riverton, Tarlee and Stockport are located along the Gilbert River, which is a major tributary of the Light River catchment, while Mintaro and Rhynie are within the Wakefield River catchment. Over time, the catchments have been cleared for farming and viticulture purposes, and dry land agriculture is the current dominant land use.

This report has been prepared on the basis of the best information, research and knowledge currently available to the Council. The report contains a range of recommended actions for consideration. The availability and timing of funding and resources will determine the order and staging of these actions.

Assistance in the form of funding and/or resources will be sought from the following:

- ***Australian Government - grants and subsidies***
- ***State Government of South Australia - grants and subsidies***
- ***Private sector – developer contributions***
- ***Council – administration, implementation and funding***
- ***Community – volunteer support***



14009 D100 v5 Location Plan 140618
Last Updated: 18/06/2014

FIGURE 1-1: LOCATION

1.2 History and Nature of the Problem in the Region

The region has experienced flooding since its settlement, and this has become more apparent over recent years. Flooding in many of the townships has been caused by over bank flows from the rivers (e.g. Gilbert River and Wakefield River tributaries) and from runoff from adjacent hills and slopes. Inadequate stormwater systems/infrastructure within the towns is also contributing to flooding problems. Flooding events have been known to cause inundation and property damage, disruption

to road and rail infrastructure. Council is also concerned over the quality of water in these river systems and the impacts the towns may be having on water quality.

1.3 Consultation and Development of the Plan

Council was successful in applying for funding from the SMA's Stormwater Management Fund to assist in preparing the floodplain mapping and this SMP.

The SMP was developed under the direction of a Steering Committee comprising representatives from Council, SMA/Department of Planning, Transport and Infrastructure, Northern and Yorke NRMB and the Bureau of Meteorology (BoM).

The community has also provided input in developing the SMP by confirming the nature and extent of flood and stormwater issues and were given the opportunity to provide comment on the proposed management strategies through a series of community meetings.

1.4 Legislative Context

The Local Government (Stormwater Management Agreement) Amendment Act 2016 came into operation April 2016. This established the Stormwater Management Authority and new financing and governance arrangements for stormwater management and flood mitigation throughout South Australia. The SMA implements the Stormwater Management Agreement and operates as the planning, prioritising and funding body in accordance with the Agreement. The SMA is charged with:

- Working with Councils to facilitate and coordinate catchment stormwater management planning;
- Allocation of State funding to projects in coordination with Council and other sources of financing; and
- Facilitating cooperative action by all relevant public authorities in the planning, construction and maintenance of stormwater management works.

The framework established by the Stormwater Management Act requires councils to prepare stormwater management plans on a catchment basis, and to implement infrastructure works in accordance with the catchment plans.

The process and content by which stormwater management plans are developed have been formalised by the State Government via the SMA in a guideline entitled *Stormwater Management Planning Guidelines*.

South Australia's legislative framework provides a number of other legislative tools and policy tools to address water management ranging from state-wide legislation to regional and local policy.

One of the key mechanisms for achieving the desired outcomes of integrated water management is to ensure that the objectives of the stormwater management plan meet and contribute to other State and National natural resource management policies and strategies. These strategies in turn assist in the implementation of the desired water management outcomes for townships.

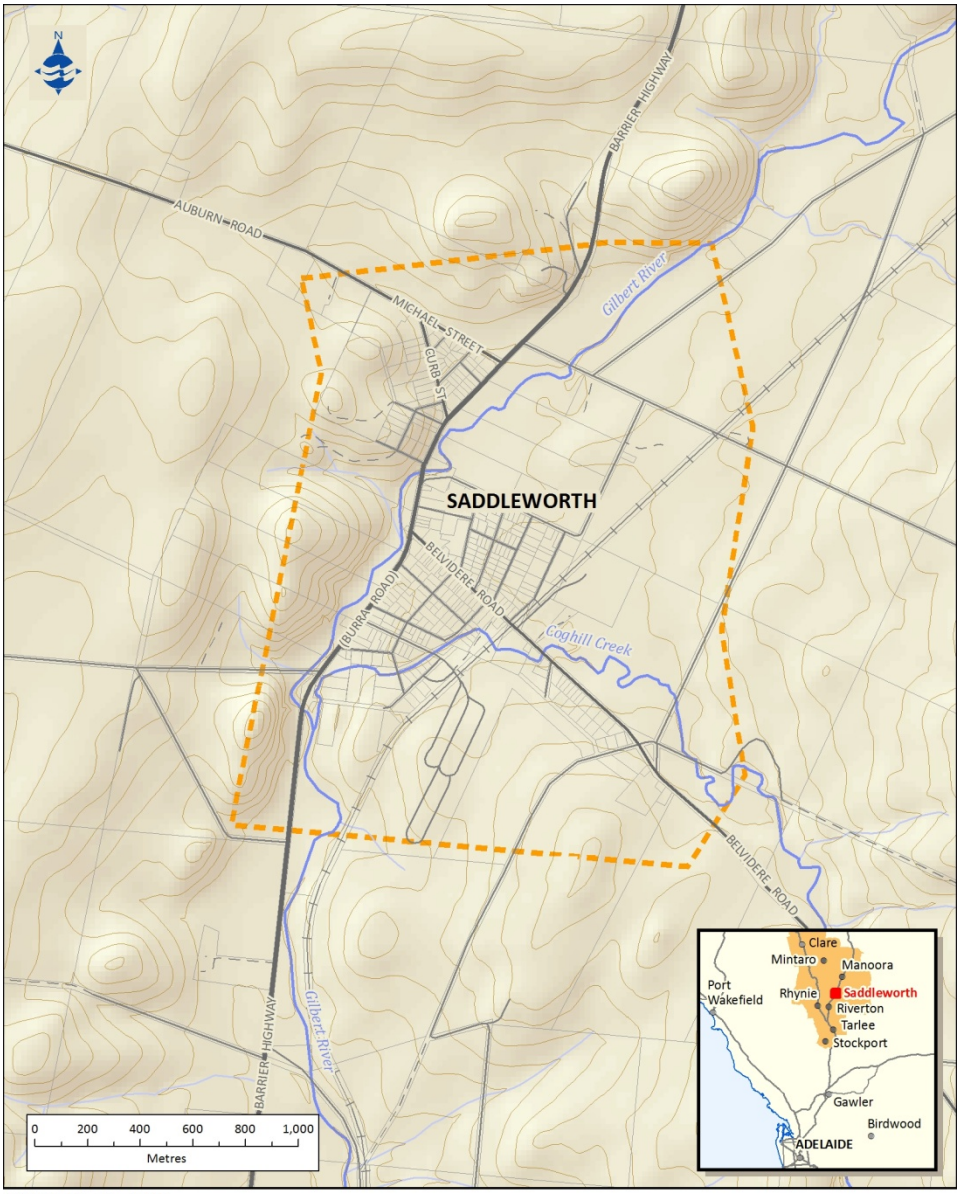
This SMP has been developed in accordance to the requirements of the Stormwater Management Planning Guidelines.

2 Description of the Study Area

2.1 Study Area Boundary

Saddleworth is located just over 100 km north from Adelaide in the Mid North region of South Australia in the Gilbert Valley. The town is situated on the Barrier Highway/Burra Road, and is bisected by the Gilbert River. The northern part of the township is on the western bank and the southern part of the town on the eastern bank.

The area for the stormwater management plan is shown as shaded in Figure 2-1.



14009 D101 v1 Study Area 140219
Last Updated: 21/02/2014

FIGURE 2-1: STUDY AREA FOR SADDLEWORTH

2.2 Climate and Soils

The soils in the region are predominantly red topsoil overlaying a limestone and tend to be free-draining and have an ability to hold water, particularly in the dryer months.

The climate associated with the study area is a temperate climate with dry summers (low rainfall), and rainfall generally occurs in the winter months.

The long term average rainfall information is based on information provided by BOM for the general region and is approximately 540 mm/yr. The average precipitation and evaporation for each month in the general region is shown below in Figure 2-2.

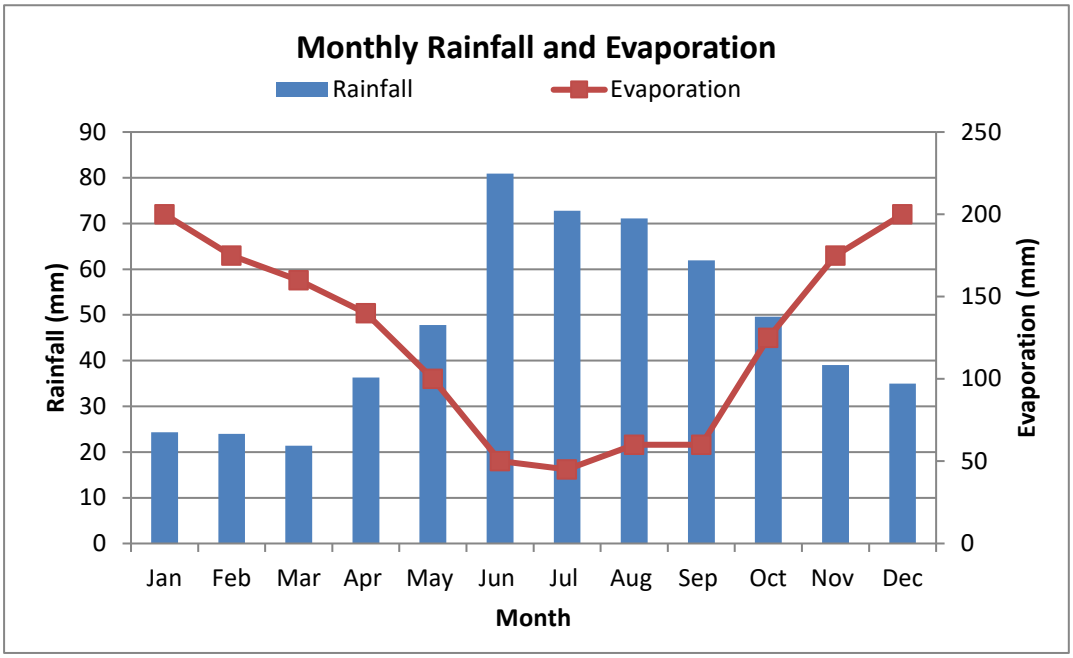


FIGURE 2-2: MONTHLY RAINFALL AND EVAPORATION

2.3 Ecology

The ecological diversity of the region has been significantly altered due to anthropogenic influences and is diminished to pockets of remnant habitats of high ecological value. Overall the ecological health of the systems is highly degraded. The systems have been dramatically modified by the impacts of European settlement and changes in land uses over time. Riverine habitats have been altered from clearance of native riparian and floodplain vegetation; the loss of in-stream complexity due to channelisation, incision and deposition of sediment; stock grazing; and the introduction of exotic plants and animals (DWLBC, 2004). The original flow regime of the watercourses has been modified by vegetation clearance, agricultural development, farm dams and groundwater extraction. The structure and shape of watercourses have also changed over time, as well as the loss of connectivity with the floodplains.

Less than 3% of native vegetation remains in the Gilbert River catchment which provides habitats for a range of plant and animal species including orchids, native mammals, bird species and reptiles, as well as providing valuable seed reserves to re-establish vegetation (Rural Solutions, 2005).

Prior to European settlement, the in-stream vegetation of the Gilbert River comprised of a herbland/sedgeland consisting of common reed *(Phragmites australis)* and salt club rush *(Bolboschoenus cadwellii),* however due to land clearance, increased overland flow and sedimentation from past agricultural practices, the common reed now dominates (DWLBC, 2004). The reeds provide valuable food and shelter for fish, frogs, macroinveterbrates and birds and play an important role in preventing stream erosion by slowing the velocity of water.

The condition of riparian vegetation along the Gilbert River and tributaries is generally poor but there are some areas of good sedgelands (Rural Solutions, 2005).

2.4 Hydrology of the Catchment

The Gilbert River commences just north of Manoora and flows south through the towns of Manoora, Saddleworth, Riverton, Tarlee and Stockport where it joins the Light River just west of Hamley Bridge, before flowing out to the Gulf St Vincent between Dublin and Two Wells. There are a number of tributaries that enter the Gilbert River, including Macaw Creek, Salt Creek, Coghill Creek and other un-named Creeks (Rural Solutions, 2005).

Saddleworth is located in the upper reaches of the Gilbert River catchment and the township is situated mainly on the eastern side of the river. The catchment area for Saddleworth is 118 km^2. Rural land use dominates the catchment area and therefore the catchment is considered to have a pervious landscape. There are no major storages along the Gilbert River and the channel types are considered to be 'natural'.

Saddleworth is bisected by the Gilbert River which runs approximately north-south, with the northern portion of the town situated on the western bank and the southern portion on the eastern bank.

The railway line runs to the east of the Gilbert River and most of the township.

Topographical features of relevance for this SMP include:

- Gilbert River adjacent the town, flowing southwards;
- A significant tributary (Coghill Creek) flows through the study area entering from the east (23.2km^2). This tributary flows east to west crossing several minor roads which then crosses Marrabel Road through a bank of culverts. It then crosses an access track and the railway line, from there is runs along the south eastern edge of the township across several fords. Coghill Creek joins with the Gilbert River to the immediate north of the wastewater treatment lagoons;
- There is a ford across the Gilbert River at Golf Course Road, approximately 150m upstream of the southernmost bridge near the wastewater treatment lagoon. Additionally, there is a ford crossing on Marrabel Road to allow flows from Coghill Creek;
- The stormwater network within Saddleworth is largely limited to short inlet networks conveying flow under the Barrier Highway; and
- There is a small channel on the northern edge of the township adjacent to Michael Street.

2.5 Township Population and Development Pressure

Council's Strategic Directions Report 2012/13 included information on population projections and stormwater management derived from its Water Security Plan (2011). According to that information the population growth in the Council region is expected to grow to 9,795 people by the year 2031 – an average around 0.6 per cent per annum over the 25 years 2006 to 2031 or 15.5 percent in total. This is somewhat higher than projected growth at the state level over this period (11.0 percent).

The projected population growth for Saddleworth along with the other 6 townships in the project is shown in the table below:

TABLE 2-1: PROJECTED POPULATION

Town	2006 population	2031 population	Average % growth
Saddleworth	425	450	0.22%
Manoora	277	280	0.04%
Tarlee	288	318	0.38%
Riverton	723	1000	1.1%
Rhynie	362	370	0.08%
Mintaro	223	246	0.37%
Stockport	234	259	0.02%

According to Council's Strategic Directions Report 2012/13, Saddleworth has scope for future ongoing investment/support related to the agricultural and horticultural industry and the population growth in the region should primarily be channelled into Saddleworth, Clare and Riverton by utilising the benefit of existing community infrastructure and appropriately zoned land. The remaining towns were to retain their small scale village character, but still to allow for modest growth.

2.6 Existing Stormwater Assets

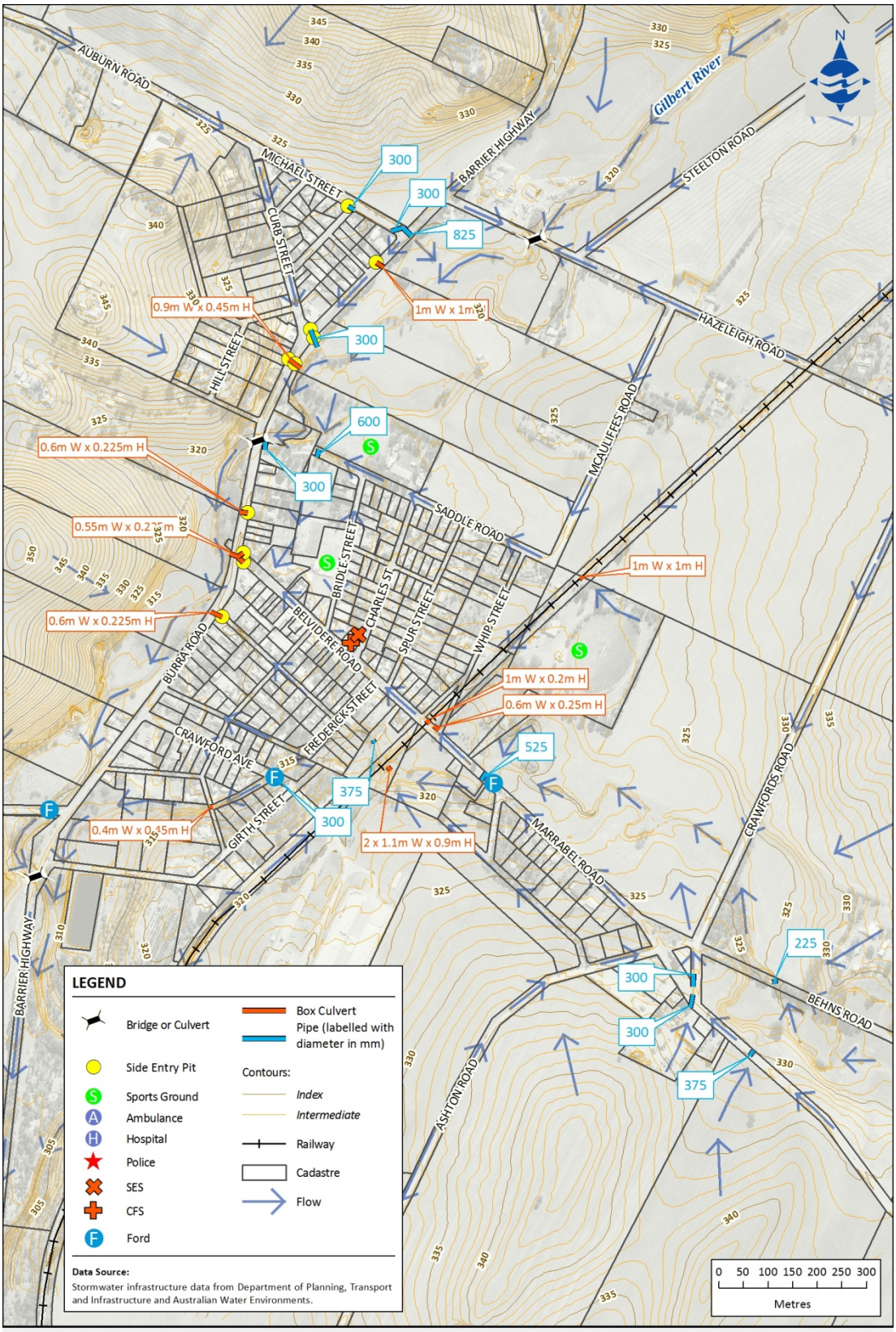
There is limited formal stormwater infrastructure in Saddleworth, including:

- Short inlet networks under road crossings (e.g. Barrier Highway, Belvidere Street) as well as crossing the railway line;
- Ford crossings (e.g. ford across the Gilbert River on Golf Course Road and across Coghill Creek on Marrabel Street);
- Short sections of underground drainage network and stormwater inlets, particularly on Barrier Highway near the intersections with Michael, Patrick, Curb and Belvidere Streets; and
- Small section of channel on the northern edge of the township, adjacent to Michael Street.

Informal stormwater infrastructure includes:

- Roadway, road verges and roadside swales;
- An overland flow path from Mcauliffes Road parallel to Saddle Road and through to Bridle Street; and
- Burra Road (Barrier Highway) and the railway line both act as barriers to flows resulting in drainage problems and associated flooding.

Existing stormwater assets at Saddleworth are shown on the following page in Figure 2-3.



14009 D106 v5 Saddleworth Stormwater Assets 150123
Last Updated: 14/10/2015

FIGURE 2-3: EXISTING STORMWATER ASSETS

3 Identification of Problems and Opportunities

3.1 Economic, Social and Environmental Issues

3.1.1 Economic

In 2010, the region experienced several floods which affected houses, sheds, fences, traffic disruption and accessibility, as well as causing significant damage to Council infrastructure, such as bridges and roads. This all resulted in significant economic costs (Council infrastructure: $2.5 million in bridge damage and $3 million to roads).

3.1.2 Social

The social impacts of flooding and poor stormwater management are often difficult to quantify in monetary terms. These impacts are related to the physical and mental health of individuals, environmental impacts and disruption to essential community services and operations. They can include aspects such as the following:

- Loss of life, personal injury and associated losses and expenses;
- Destruction of memorabilia (e.g. family photos);
- Loss of heritage and cultural features;
- Loss of amenity, recreational value and aesthetics;
- Increased medical costs and reduced life expectancy associated with increases in levels of sickness in a community following a disaster;
- Emotional stress and mental illness associated with experiencing damage to family homes and businesses, including:
    - Replacement of damaged property, particularly if there is no flood insurance or it is insufficient;
    - Living in temporary accommodation;
    - Children attending a different school;
    - Death of pets; and
    - Loss of business goodwill.

3.1.3 Environmental Values

The condition of watercourses in the catchment and downstream has been described earlier in this report in chapter 2. In summary, the downstream (receiving) environment is the Gilbert River, which merges downstream with the Light River, which finally flows through the estuarine environment comprising samphire and mangrove vegetation as the river enters Gulf St Vincent. Erosion and sedimentation caused by stormwater and flooding in Saddleworth can result in a decline in water quality and ecological health of downstream environments. Therefore, measures to control erosion and sedimentation arising from stormwater and flooding in Saddleworth can help protect water quality and ecological health of these downstream environments.

There is not much water quality data available, however this SMP includes water quality principles to protect downstream environments. The water quality targets for both new and existing developments in the region are designed to reduce the impact on the receiving environments whilst preserving environmental values.

Although there is no available water quality data at present, visual assessment suggests the watercourses in the area of the SMP are in a moderate condition, despite the region as a whole being dramatically modified since European settlement.

Environmental values are those that the community place on the environmental services. The strategy underpinning the determination of the environmental values for the SMP is the National Water Quality Management Strategy (NWQMS). The NWQMS) aims to enable Council and community groups to protect the health of water bodies and waterways. Environmental values for this SMP can be guided by the objectives of this Strategy which include the following (but not limited to):

- To ensure the water quality monitoring of waterways and regulation for the discharging of pollutants into waterways adheres to the agreed water quality objectives;
- Provide a strategic direction for the management of all watercourses as well as protecting ecosystems and not compromising the economical well being of the community; and
- Prioritise funding for environmental management which will ultimately lead to improved water quality.

As part of developing this SMP, environmental values were ascribed for the region, as shown in the table on the following page. These values reflect the community's value of the watercourses. Management actions need to safeguard these values.

Whilst the system downstream of the town is highly disturbed, there are areas within the SMP which may respond well to efforts to improve the system. Other stakeholders, such as the NRMB, are also working towards achieving an improved system and therefore it is recommended that such efforts be undertaken in a coordinated manner.

This SMP provides opportunities to control erosion and sedimentation arising from stormwater and flooding in Saddleworth which can help protect water quality and ecological health of the downstream environments. To this end it can support the actions of others in advocating a higher end state value downstream.

TABLE 3-1: SURFACE WATERCOURSES ENVIRONMENTAL VALUES

Environmental Values	Supporting Details
Aquatic Ecosystems	Supporting highly disturbed systems (HD)
	Highly disturbed systems (**HD**). These are degraded systems likely to have lower levels of naturalness. These systems may still retain some ecological or conservation values that require protecting. Targets for these systems are likely to be less stringent and may be aimed at remediation and recovery or retaining a functional but highly modified ecosystem that supports other environmental values also assigned to it (e.g. primary industries).
Primary Industries	**Irrigating** crops such as vines, crops, etc
	Water for **farm use** such as in fruit packing or milking sheds, etc
	Stock watering
	Human consumption of wild or stocked fish or crustaceans
Recreation & Aesthetics	**Visual appreciation** with no contact with water such as picnicking, bushwalking, sightseeing
Cultural & Spiritual	**Cultural and spiritual** values including the cultural values of traditional owners

3.2 Riverine and Local Flooding

3.2.1 Floodplain Mapping

AWE (2013) undertook floodplain mapping for the town, including riverine and direct rainfall. This is summarised below and also shown in 100 year ARI event inundation maps in Appendix A.

3.2.2 Riverine Flooding

20 Year ARI Event

At Saddleworth the Gilbert River is largely confined within the channel, however upstream of the township it encroaches on the floodplain in some areas. There is a breakout upstream of the bridge over Saddle Road which runs south along Bridle Street and properties to the west, rejoining the river near Belvidere Road.

Upstream of the railway line the eastern tributary flows across the floodplain. Throughout the township the tributary is largely confined to its channel.

100 Year ARI Event

In a 100 year ARI event the Gilbert River inundates the floodplain upstream and downstream of Hazeleigh Road.

In a 100 year ARI event the extent of the breakout is much greater upstream of Saddle Road and all of the area from the Gilbert River to east of Bridle Street and Newark Street is inundated.

The eastern tributary extent is similar to the 20 year ARI event, with additional ponding behind the railway line and Marrabel Road.

500 Year ARI Event

In the 500 year ARI event most land south of Belvidere Road between the Gilbert River and the railway line is inundated. The eastern tributary breaks out where it crosses Newark Street.

3.2.3 Local Flooding Assessment

Runoff causing local flooding issues was assumed to be caused by rainfall falling directly on the townships and the immediate surrounding slopes. This whole area was typically contained within the Digital Elevation Model (DEM) contained within the TuFlow model for each town. In some cases, inflows from small catchment areas that lay outside the DEM could also cause local flooding issues, and in these cases the external catchment inputs were modelled in RORB and hydrographs included as boundary conditions to the TuFlow Model.

There are low lying areas west of Bridle Street and west of Newark Street which become inundated. Runoff pools behind the railway line south of Hazeleigh Road. It then flows along an overland flow path from Mcauliffes Road parallel to Saddle Road and through to Bridle Street.

Localised flooding issues are also experienced to the northeast of Saddleworth around Curb Street and Michael Street. Local runoff is blocked by the Barrier Highway causing flooding of adjoining property.

3.3 Properties and People at Risk of Flooding

Flood maps (based on the 100 year ARI event) and aerial photography were used to identify properties/dwellings at risk of flooding. The number of people at risk of flooding in a 100 year ARI event was determined by analysing the number of dwellings at risk of flooding and the average number of people per dwelling.

The population and number of properties in Saddleworth at risk of riverine flooding in a 100 year ARI event are shown in the table below:

TABLE 3-2: POPULATION AND PROPERTIES AT RISK IN A 100 YEAR ARI EVENT – RIVERINE FLOODING

Population at risk of flooding	**Riverine Flooding: No. of properties at risk of flooding in each flood hazard zone**			
	Low	**Med**	**High**	***Total***
164	46	13	23	*82*

There are 13 properties that are inundated from the direct rainfall (local storm) but are not at threat from riverine flooding. These are all located west of the Barrier Highway near the hotel. A breakdown of the level of risk of these properties is shown in the following table:

TABLE 3-3: ADDITIONAL PROPERTIES AT RISK IN A 100 YEAR ARI EVENT – DIRECT RAINFALL FLOODING ONLY

Direct Rainfall No. of properties at risk of flooding in each flood hazard zone			
Low	**Med**	**High**	***Total***
4	6	3	*13*

3.4 Impacts of Future Development on Flooding

It is important to understand if future development is planned in the area and what impacts this may have on flooding. Any redevelopment of these will need to take into account of the flood extent and depth maps prepared for this SMP to reduce the risk of being flooded, as well as to reduce any impact they may have on flood paths and flood behaviour.

As outlined previously in chapter 2.5 of this SMP, future population growth in the region should primarily be channelled into Saddleworth as well as Clare and Riverton, due to existing community infrastructure and appropriately zoned land. The township of Saddleworth has a range of zonings which allow for various forms of development, such as residential, rural living, industrial, etc. Some of this land has not yet been built upon and therefore future development will need to have consideration of the land's flood risk. Some allotments in the township are currently affected by flooding, such as those adjacent to the main watercourse channels and those affected by sheet flow from surrounding slopes.

3.5 Exploring Opportunities

This SMP explores opportunities for better managing the risk of flood, including structural and non-structural flood mitigation measures. Non-structural measures include aspects such as flood warning and preparedness and better integration between stormwater management and Council's Development Plans.

Harvesting of stormwater as an alternative source of water is desirable option for many towns, for purposes such as greening of public open space, irrigating sports ovals and other recreational areas. The SMP describes options for water harvesting including aquifer storage, and the likely effectiveness of any scheme.

Whilst harvesting of stormwater is to be promoted, any scheme should also have regard to water dependent ecosystems downstream.

In addition, the design of stormwater infrastructure has consideration of potential environmental enhancement and benefits to watercourses and receiving environments, such as through erosion protection works and a wetland to improve water quality.

4 Stormwater Management Objectives

4.1 Approach

The development of stormwater management objectives has had consideration of the earlier floodplain mapping and technical assessments, consultation activities and the requirements of the SMA Guidelines.

The project has been overseen by a steering committee including representatives from Council, DPTI/SMA, the Northern and Yorke NRMB, and more recently from BOM. Regular meetings have been held throughout the project to discuss progress, issues arising, and to confirm the approach to technical investigations and community consultation.

Consultation with the community was undertaken in August 2013 to identify issues and opportunities for stormwater and flood management. This information helped to determine the objectives of the SMP. A summary of the issues raised by the community is shown on the following page in Figure 4-1, and in Appendix B.

Flood Detention Dam

Formalise/improve drainage

Check/improve drainage paths

Road blocks drainage - lower or increase capacity

Check effectiveness of existing levee.

Stream rehabilitation focus area

Formalise/improve drainage along Saddle Road

Oval has existing bore but uses wastewater now.

Cut off drain/bank to protect Whip Street and Saddle Road

Check/improve culvert capacities

Improve drainage performance.

Check for existing bores in town to support watering of school and tennis courts

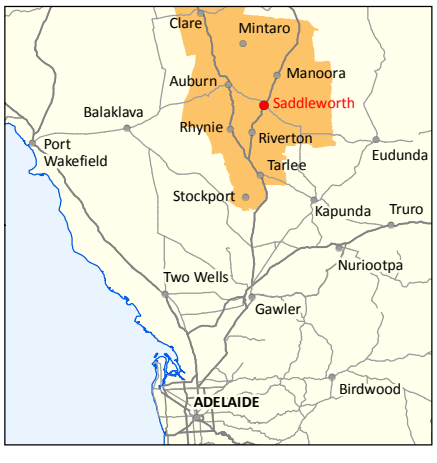
Reeds in channel affect flows and cause sedimentation.

Maximise reuse of wastewater

Railway line and Barrier Highway can causea barrier to flows.

Check options for harvesting from Saddle Road or Hill Street or Bridle Street to water school

Explore opportunities to slow water flow velocities.



LEGEND

- Ford
- Contours:
  - *Index*
  - *Intermediate*
- Railway
- Road Edge
- Cadastre

- Flood control/management
- General comment
- Water reuse
- Water quality/biodiversity/ erosion control

Data Source:
Aerial Imagery, Road Edge and Contours from Aerometrex; Road Names and Cadastre from Clare & Gilbert Valleys Council; Railway Alignment from DTEI.

0 50 100 150 200 250 300
Metres (Scale 1:9,000 A3 Sheet)

Government of South Australia
Stormwater Management Authority

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Australian WATER Environments

Stormwater Management Plan
For Seven Townships In The
Clare And Gilbert Valleys Council

Saddleworth

Issues and Opportunities Raised by the Community

14009 D002 v7 Saddleworth issues and opportunities 150610
Last Updated: 10/06/2015

Figure 4-1

4.2 Stormwater Management Objectives

With consideration of the above technical information, consultation feedback and SMA Guidelines, the following stormwater management objectives have been developed for Saddleworth:

- Reduce the impact of nuisance local flooding;
- Provide an acceptable level of protection of assets from local and regional flooding;
- Manage stormwater to benefit the community and explore opportunities for the beneficial use of stormwater runoff;
- Develop an appropriate, and sustainable, stormwater management system which has consideration of operational and maintenance requirements and costs;
- Continue to improve maintenance processes to optimise the water quality and water quantity management services performed by the stormwater network;
- Minimise adverse impacts on downstream environments resulting from stormwater management and water harvesting activities;
- Use the planning system to achieve desirable outcomes for new developments, open spaces, recreation and local amenity;
- Manage rural catchment contributions such that the management, control and harvesting of both rural and urban runoff is efficient and effective; and
- Seek opportunities to protect water quality and ecological health of the downstream environments.

A brief description of these objectives follows.

4.2.1 Local Flooding

The following criteria were adopted:

Formal Infrastructure to Remain Effective

Formal infrastructure i.e. culverts, fords and stormwater inlets should be functional and able to cope with their design flows.

Informal Infrastructure to Remain Effective

The informal infrastructure (such as the roadway, road verges and unlined roadside swales) should remain effective with only standard maintenance activities.

Stormwater Flows should be Contained in the Road Reserve

Stormwater flows should not inundate and cause damage to areas outside of the road easement. If significant flows leave the road reserve there is potential for damage to private property.

All Built Roads are Required to be Trafficable

Council's roads are required to be trafficable against the following ARI events:

- 5 year ARI event for local arterial and collector roads; and
- 2 year ARI event for the remaining roads.

The road was assumed to be trafficable when small conventional vehicles can safely traverse the sections of deepest flowing water. The deepest water is expected to occur in the roadside swales. A small vehicle is expected to be able to safely traverse flows that are less than or equal to 0.3m deep.

The velocity of the flowing water is also important in determining whether the flow can be safely traversed. The combination of depth and velocity (i.e DxV) reflects the hazard of the flows. To provide safe access for small conventional vehicles the hazard must be low (SCARM, 2000). Low hazard has previously been defined for floodplain mapping projects in South Australia as flows with a depth less than 0.3m and a velocity less than 0.3m/s i.e. a maximum DxV of 0.09 m^2/s. This value of the DxV relationship is also supported by the data in SCARM (2000) which specifies low hazard flows to have a DxV value of less than or equal to $0.09m^2/s$.

New Developments to not Increase Peak Flow Rates

The SMP is to seek ways to support Council's Development Plan which specifies that water discharged from a development site should:

(a) be of a physical, chemical and biological condition equivalent to or better than its pre-developed state; and

(b) not exceed the rate of discharge from the site as it existed in pre-development conditions.

4.2.2 Regional Flooding

Areas within Saddleworth experience flooding from the Gilbert River during events of 20 year ARI event or higher. Flows are affected by the Barrier Highway and the railway line, resulting in drainage problems and flooding in streets.

SMP objectives include providing protection to properties within the identified township boundary from the 100 year ARI event. The SMP can assist with achieving this by providing guidance on:

- Formalising drainage paths to ensure flows can occur without causing flooding in the township;
- Assessing the need to increase the capacity of drainage infrastructure so it can better handle flows (i.e. culvert crossings, ford crossings, bridges); and
- Other structural and non-structural options for mitigating the impacts of the recognized flooding from the Gilbert River (e.g. including regrading of the river bed at locations where fall allowing drainage is very limited, provision of levees along the river banks where localised breakages that pose a risk to properties may occur and/or flood warning systems, among other potential measures).

The SMP is to seek ways to support Council's Development Plan relating to flood hazards. It specifies the following principles of development control:

- *Principle 4 - Development should not occur on land where the risk of flooding is likely to be harmful to safety or damage property.*
- *Principle 5 - Development should not be undertaken in areas liable to inundation by tidal, drainage or flood waters unless the development can achieve all of the following:*
  - *a) it is developed with a public stormwater system capable of catering for a 1 in 100 year average return interval flood event; and*
  - *b) buildings are designed and constructed to prevent the entry of floodwaters in a 1 in 100 year average return interval flood event.*

In terms of flooding and mitigating peak flows, Council's Development Plan also includes information on stormwater and includes the following principles of development control:

- *Principle 31 - Development should include stormwater management systems to protect it from damage during a minimum of a 1 in 100 year average return interval flood.*
- *Principle 33 - Development should have adequate provision to control any stormwater over-flow run-off from the site and should be sited and designed to improve the quality of stormwater and minimise pollutant transfer to receiving waters.*
- *Principle 34 - Development should include stormwater management systems to mitigate peak flows and manage the rate and duration of stormwater discharges from the site to ensure downstream systems are not overloaded.*
- *Principle 38 - Where not detained or disposed on site, stormwater should be drained to a public stormwater disposal system.*

The SMP is to seek ways to support the above principles of development control.

4.2.3 Water Quality and Ecological Protection

Stormwater runoff should not impair the health of receiving environments, such as the Gilbert River and downstream environments such as the saltmarsh coastal environment of Gulf St Vincent. The SMP can assist this by estimating the quality of runoff and developing mitigation strategies aimed at protecting water quality.

Desirable end-state values for watercourses and riparian ecosystems have been identified earlier in this SMP in section 3.1.3. This also included objectives aimed at protecting the health of waterbodies and waterways. This issue is expanded below.

The SMP aims to reduce the pollutant load of stormwater and will be guided by the State Government's targets for stormwater quality (pollutant reduction), as outlined below:

- 80% reduction in Total Suspended Solids
- 60% reduction in Total Phosphorus
- 45% reduction in Total Nitrogen
- 90% reduction in litter/gross pollutants

(Water Sensitive Urban Design, 2013)

In addition, the SMP will help support the following Council objectives:

Council's Development Plan provides objectives to protect natural resources, such as:

> *Objective 2 - Protection of the quality and quantity of South Australia's surface waters, including inland and underground waters.*

The Development Plan also includes principles of development controls that aim to manage the quality of stormwater runoff, such as:

> *Water Sensitive Design*
>
> *Principle 11 - Development should have adequate provision to control any stormwater over-flow runoff from the site and should be sited and designed to improve the quality of stormwater and minimise pollutant transfer to receiving waters.*
>
> *Water Catchment Areas and Water Quality*
>
> *Principle 24 - The quality of water leaving the site of a development should be of a physical, chemical and biological condition equivalent to or better than pre-development conditions, and the rate of water discharged from the site should not exceed the rate of discharge from the site in pre-development conditions.*
>
> *Stormwater*
>
> *Principle 35 - Development should include stormwater management systems to minimise the discharge of sediment, suspended solids, organic matter, nutrients, bacteria, litter and other contaminants to the stormwater system.*
>
> *Principle 36 - Stormwater management systems should preserve natural drainage systems, including the associated environmental flows.*

The SMP aims to support the Northern and Yorke NRMB's resource condition targets for a range of NRM issues - the most relevant issues and their targets are outlined below:

- Integrity of native vegetation communities:
  - By 2030, maintain the condition of the region's 1,200,000 ha of remnant native vegetation, and improve the condition of 15% from 2008 levels.
- Integrity of inland aquatic ecosystems (rivers and other wetlands):
  - By 2030, inland and estuarine water-dependent ecosystems are maintained or improved in condition from 2008 levels.
  - By 2030, core refuge areas are protected by a 20% reduction in the extent of priority degrading watercourse management issues.
- Integrity of estuarine, coastal and marine habitats:
  - By 2030, there is no reduction in the extent and a steady improvement in the condition of coastal, estuarine and marine ecosystems, compared to 2008.
  - By 2030, the extent and diversity of coastal landscapes is maintained and their condition improved, compared with 2008.

- Nutrients in aquatic environments, Turbidity/suspended particulate matter in aquatic environments, Surface water salinity in freshwater aquatic environments:
    - By 2030, water quality is maintained, within climatic limitations and natural conditions, below levels set for aquatic ecosystems in the Environment Protection (Water Quality) Policy.
- Significant native species and ecological communities:
    - By 2030, there has been no loss of species or ecological communities and their viability and conservation status has improved from 2008 levels.

The Northern and Yorke NRMB's Regional Plan (Volume D) also contains information and requirements relating to managing works around watercourses, known as Water Affecting Activities (WAA's). A permit is required to undertake any of the WAAs listed in Section 5 of the NRM Plan either in the non-prescribed areas, or in relation to prescribed water resources where no water allocation plan exists. The purpose of this permit is to ensure activities support the NRMB's aims of protecting water resources. However, Council may decide to develop Best Operating Practices that have been approved by the Board which will replace the need for a WAA permit, such as for the construction of a culvert or managing vegetation along a watercourse.

4.2.4 Stormwater Reuse

Through the SMP, opportunities for harvesting and reusing stormwater will be explored and will build upon Council's earlier work. The reuse of stormwater for watering street trees was identified as a desirable outcome by the community.

The SMP is intended to describe options for MAR and stormwater harvesting without causing harm to downstream water dependent ecosystems. The SMP will describe the likely effectiveness of the reuse scheme so that Council can plan for its future development should funds become available.

Supporting Documents

Opportunities for stormwater harvesting and reuse at Saddleworth will help to support the Government strategies described below.

The South Australian Government's Stormwater Strategy (2011) has targets for the Greater Adelaide region however it also provides the basis for stormwater management in regional areas of the State. It supports the State Government's water security plan "*Water for Good" (2009)* target of harvesting 15 GL a year in regional areas by the year 2050.

Regional Development Australia Yorke and Mid North in partnership with the Clare & Gilbert Valleys Council, the Northern and Yorke NRM Board, the Clare Wine Grape Growers Association, SA Water and the Department for Water prepared the Water Security Plan (2011) with the aim of water proofing the region. This is to be done by diversifying the availability of water resources via assessing the future water requirements of the region; identifying future potential water sources, including those created through stormwater capture and wastewater treatment and reuse; and identifying the appropriate strategies to secure water fit for purpose over the next 20 years to 2030. One of the key recommendations included investigating opportunities to capture and recycle stormwater in Saddleworth, as well as in Clare, Auburn, and Riverton. It also recommends investigating and assessing the potential for MAR in these towns.

Council should continue to ensure development is sited and designed to capture and re-use stormwater, where practical, as outlined in its Development Plan.

4.2.5 Desirable Planning Outcomes

New Development

As outlined previously in chapter 2.5 of this SMP, future population growth in the region should primarily be channelled into Saddleworth as well as Clare and Riverton, due to existing community infrastructure and appropriately zoned land. The township of Saddleworth has a range of zonings which allow for various forms of development, such as residential, rural living, industrial, etc. Some of this land has not yet been built upon and therefore future development will need to have consideration of the land's flood risk. Some allotments in the township are currently affected by flooding, such as those adjacent to the main watercourse channels and those affected by sheet flow from surrounding slopes.

Flood maps produced in this SMP provide information on flood extents and heights. This information is useful in Council setting minimum finished floor levels to adequately provide protection from floods.

Future development also needs to have consideration of how it may affect flood paths. To ensure adequate drainage is achieved, it may be necessary to provide detention onsite for a single allotment, or a detention basin placed within a larger subdivision, so not to exacerbate the town's drainage system.

Open Space, Recreation and Amenity

Areas of open space, recreation and amenity are important to the community and options to safeguard and enhance these values are explored in this SMP, such as investigating watercourse rehabilitation works, water quality improvements, and stormwater reuse options.

5 Stormwater Management Plan Strategies

5.1 Approach

The development of stormwater management strategies has been based on the stormwater management plan objectives, modelling and technical investigations, and feedback received from the Steering Committee, Elected Members and the local community. A summary of the community feedback on draft strategies is provided in Appendix B.

The recommended strategies in this report are assigned a unique label and number, such as:

Flood management: F1, F2, etc

Water Quality: WQ1, WQ2, etc

Reuse: R1, R2, etc

Preparedness and planning: P1, P2, etc

Combined strategies (not predominantly one of the above): C1, C2, etc.

Strategies for managing flooding and stormwater runoff, and opportunities for improving water quality, the local amenity and potential reuse are outlined as follows.

In addition to the proposed measures outlined below, the road network's function of conveying high flows will continue.

It is noted that the availability and timing of funding and resources will determine the order and staging of the recommended works.

5.2 Non-Structural Flood Management Measures

Recommended non-structural measures include flood preparedness and planning/ development controls.

In addition to structural measures aimed at controlling flooding, there is a range of non-structural measures that can assist in achieving this outcome and minimise the impacts of flooding in the future. Non-structural measures are typically highly cost effective and can be implemented over much shorter timeframes. Both structural and non-structural approaches should be incorporated within an overarching management plan for Saddleworth.

Examples of non-structural measures are described below.

5.2.1 Flood Preparedness (P1)

Flood preparedness is a cost effective non-structural means of reducing damages as a result of a flood. Flood preparedness is basically about helping people to be aware of the flood risk and how best to respond to it. Flood preparedness programs in this context are considered in four phases: flood awareness, flood warning, response and recovery. They form the key elements of a total flood warning system (Commonwealth of Australia, 2009).

Flood Awareness

A flood awareness program for people in Saddleworth is an important aspect of reducing the risk of flood damage. A community awareness program, similar to the Clare township's 'Floodsafe' program which assists the community in being better prepared and able to respond to flood risks and events is recommended. This program is based on the SA State Emergency Service's (SES) highly successful community education and awareness raising 'Floodsafe' program. A program such as this may include awareness activities such as informing the community through discussions with individual households, the Council's newsletters, public presentations, articles in local media, information included on Council's website, and information about a flood emergency kit.

A coordinated education program is one means of ensuring this information is effectively disseminated. The development of such programs is essential for ensuring that landholders can take full advantage of flood warnings.

Flood Warning

Research has demonstrated that flood warning can substantially reduce the damage costs associated with flooding. Generally, the greater the warning time, and the more prepared the community are then the greater the savings may be. A well informed community can reduce the costs associated with a flood by around 20% with only 2 hours warning whilst with 12 hours warning costs can be reduced by around 60% (BTE, 2001). At Saddleworth, there is approximately 6 hours from the onset of rainfall in the catchment to the time of peak flooding from the Gilbert River. This provides time for the community to prepare for an impending flood event.

Flooding from the local catchments is likely to occur over much shorter timeframes (less than two hours). Nevertheless, warnings based on forecast and recorded rainfalls can be provided to help alert towns people of a potential impending flooding issue from the local catchment.

A flood warning service would be useful for the Gilbert River, such as the system currently provided by BOM for other areas e.g. the Gawler River. This may require more flow information, additional river and rain gauging stations in the Gilbert River catchment to significantly improve the ability to warn the people of Saddleworth of impending high flows or intense rainfall.

Flood Response

The flood response phase (and to a lesser extent the recovery phase) is highly influenced by the experience or knowledge of people of the likely behaviour and nature of a flood event. There are a range of actions people can do with their property before and during a flood that can substantially reduce the damage costs. Many of these measures are very simple and easily implemented. To be effective landholders potentially affected by flooding need to be aware of their options and response strategies.

The response of emergency services during a flood is obviously also a key factor in reducing flood damages and threats to public safety. Integrated disaster response plans are an important means for helping to ensure emergency services can effectively respond. Whilst not wishing to suggest that current response services are deficient (because they are not), the regular review of these plans and the conduct of "dry run" flood response exercises can be effective ways of ensuring emergency response staff and volunteers are aware of the issues, hazards, and opportunities that might be presented to them during a real flood event. Such initiatives should be effectively supported.

Flood Recovery

The recovery phase post flood is critical to reducing social disruption and long lasting health issues associated with trauma (and in extreme cases disease) as well as ensuring communities can get back to "normal" as soon as possible and thereby contain the overall damage costs.

A flood preparedness program is included in the list of recommendations as option P1 in Table 6-1. This includes a total flood warning system and a community awareness/education program (to be implemented every 5 years).

5.2.2 Development/Planning Controls (P2)

The Development Plan is a statutory document that controls and manages all forms of development within the Clare and Gilbert Valleys area. It sets out a range of development zones, maps and rules (Objectives and Principles) to help ensure that development occurs in a well managed way and takes account of relevant environmental, infrastructure, urban design, heritage and community requirements (Strategic Directions Report 2012/13).

Planning controls within Council's Development Plan provide a framework to plan and build in a manner that incorporates stormwater management. Council already has information in its Development Plan to help guide development in terms of stormwater runoff volumes, water quality and reuse aspirations. To improve the effectiveness of the Development Plan Council may consider including specific water quality targets identified in the State Government's targets and the NRM Board's resource condition targets as described earlier in this SMP.

It is recommended that Council includes flood maps in its Development Plan to demonstrate land at risk of flooding and to guide appropriate development.

In relation to stormwater reuse, the Development Plan may be improved by including the reuse targets outlined in the State Government's Stormwater Strategy and "Water for Good" plan and also support the region's "Water Security Plan" (2011).

It is also recommended that Council enforces its current flood hazard requirements in its Development Plan, such as not allowing development on land where the risk of flooding is likely to be harmful to safety or damage property. This should include ensuring finished floor levels are 300 mm above the 100 year ARI event level in designated flood areas. In addition, to avoid buildings being constructed too low outside of these areas and thus potentially being at risk of flooding, it is also recommended that finished floor levels of new developments are 300mm above surrounding land levels.

There are a variety of planning and legislative controls available to minimise the various risks to the receiving environments, with the fundamental requirement that stakeholders have a duty of care to not adversely impact on the environment. For example, the Development Plan has a section on Water Sensitive Design which, amongst other provisions, requires:

Water discharged from a development site should:

> *(a) be of a physical, chemical and biological condition equivalent to or better than its pre-developed state*
>
> *(b) not exceed the rate of discharge from the site as it existed in pre-development conditions.*

Improvements to water quality, erosion protection works, pond/wetland system, and actions to reduce the risk of flooding (which are discussed in this chapter), will help to achieve better planning outcomes associated with open space, recreation and amenity.

Development / planning controls are included in the list of recommendations as option P2 in Table 6-1.

5.3 Management of Flood and Local Runoff

Flood management strategies have been developed that focus on improving the conveyance of flows within the main river channel, especially at road crossings where existing obstructions to flow may lead to excessive backwater effects and breakouts affecting main roads and private property. Some additional strategies would also provide physical barriers to prevent large flows from entering private property and prevent the loss of trafficability in main roads. Measures to manage local runoff have been focused on improving the performance of the underground drainage network, as well as the improving the efficacy and safety of overland/within the road reserve flow paths. The suggested measures are based on a level of protection for the 100 year ARI event for riverine flooding and 20 year ARI event for the management of local runoff.

In addition to the proposed measures outlined below, the road network's function of conveying high flows will continue.

The recommended measures are described below and shown in Figure 5-1.

Any works on private land will most likely require Council to have access to maintain infrastructure. This will require an access agreement with the landholder which made be in the form of a land management agreement, an easement or land acquisition, refer also Section 7.3.

The difference in flood inundation pre and post measures is shown in Figure 5-2.

Further information on the properties protected in different ARI events is provided in section 5.4 of this report.

5.3.1 Levee along River and Replace Bridge on Hazeleigh Road (F1)

It is recommended that a levee (1.15m high including 300 mm freeboard) be provided along the western bank of the Gilbert River near the intersection of Steelton Road and Hazeleigh Road to protect the adjacent property. The bridge on Hazeleigh Road is in poor condition as the piers/pylons appear degraded, and they also constrict the flow of water under the bridge. Therefore, it is recommended that this bridge is replaced with a new free span structure, i.e. a new bridge that does not have as many piers/pylons in the river compared to the existing bridge. This is expected to protect 2 properties. The catchment area associated with these works is greater than 40ha.

This measure is included in the list of recommendations as option F1 in Table 6-1.

5.3.2 Levees along Saddle Road and Barrier Highway (F2)

It is recommended that a levee be provided along the northern verge of Saddle Road (upstream of Barrier Highway) (varying in height from 0.5m to 1.5m, including 300 mm freeboard). This may involve works on privately owned land. The levee should extend eastwards along Saddle Road before turning to the north on an alignment along the eastern side of the school oval (but staying within the school grounds). Culverts with non-return gates would need to be installed through the levee to ensure drainage could occur from behind the levee (ie local drainage from Saddle Road).

The existing levee on the western side of the river protecting the single dwelling east of the Barrier Highway needs to be raised (by typically 0.5 m to provide freeboard allowance once the other levees have been installed in order to maintain the present level of protection). Increasing the height of this horseshoe levee arrangement (ie it currently exists) is not ideal but continues to afford the landholder flood protection whilst also providing safe access during a flood. Landholders of this and other flood prone properties in Saddleworth should be encouraged to prepare flood preparedness plans which also highlights the importance of the recommended Total Flood Warning Systems for the Gilbert River. Council may also consider making a purchase offer for this property should it come onto the market in the future.

A levee along the western side of the Barrier Highway (downstream of the bridge) varying in height from 0.2m to 0.85m, including 300 mm freeboard) is also required.

This may involve works on privately owned land. These works are expected to protect 67 properties. The catchment area associated with these works is greater than 40ha.

This measure is included in the list of recommendations as option F2 in Table 6-1.

These levee works are proposed in lieu of raising the bridge on the Barrier Highway. Raising the bridge and road sections either side of it would achieve similar outcomes but was not supported by residents during the community consultation processes, nor DPTI during the project Steering Committee process.

5.3.3 Two Levees along the Riverbank North of Intersection of The Barrier Highway and Golf Course Road (F3)

Two levees are recommended to be placed along the riverbanks at 150m north from the intersection of the Barrier Highway and Golf Course Road. The height of these are to be a minimum of 1m to a maximum of 1.5m. This may involve works on private land. The levees are expected to protect 2 properties. The catchment area associated with these works is greater than 40ha.

This measure is included in the list of recommendations as option F3 in Table 6-1.

5.3.4 Works in Vicinity of Marrabel Road (F4)

A levee along the eastern side of the recreation ground is recommended, north of Marrabel Road (0.4m high, including 30mm freeboard). The ford crossing on Marrabel Road is to be modified and the road regraded accordingly (approximately 0.75m lower at invert) over a section of road 63m long to create approaching/exit ramps at 1:16. A levee (0.25m high to provide a freeboard of 250 mm) is to be placed around the property situated south west from the crossing.

It is also recommended that a section of the creek downstream from the ford crossing is widened by lowering the land on the right overbank by approximately 0.75m in order to match proposed ford crossing invert level. Additionally, the creek bed level is to be lowered and regraded by a maximum of 0.4m to match new invert of ford crossing and provide positive fall between Marrabel Road and the railway line. This is expected to protect 4 properties. The catchment area associated with these works is greater than 40ha. This may involve works on private land.

This measure is included in the list of recommendations as option F4 in Table 6-1.

5.3.5 Two Levees and Culverts in Vicinity of Newark Street (F5)

It is recommended that two levees be provided on the northern bank of the creek – one upstream (0.5m - 0.7m high) and one downstream (0.3m high) of Newark Street. This may involve works on private land. Also, two additional culverts (0.45m high x 1.2m wide) are to be provided under the watercourse crossing on Newark Street. This is expected to protect 3 properties. The catchment area associated with these works is greater than 40ha.

This measure is included in the list of recommendations as option F5 in Table 6-1.

5.3.6 Inspect Drainage along Hazeleigh Road (F6)

In response to some community concern, it is recommended that the intersections along Hazeleigh Road are inspected for any drainage problems.

This measure is included in the list of recommendations as option F6 in Table 6-1.

5.3.7 Measures to Address Local Runoff (F7)

The following drainage works are designed to alleviate the flooding from local storms, particularly the 13 properties located west of the Barrier Highway near the hotel. Recommended measures to address local runoff include:

- Additional stormwater infrastructure and channel enlargement on Saddleworth Road/Michael Street and Barrier Highway:
    - Provide an additional pipes (4x300mm) at driveway cross over west of Curb Road;
    - Provide a grassed swale along northern side of Michael Street: 4m wide (top), 0.5m wide (bottom), 0.5m high, 1:3 side slopes;
    - Provide ford crossing and a culvert crossing on Michael Street (3 x 0.45 diameter RCP);
    - Enlarge channel on Michael Street on southern side (approximately 0.5m deeper to match capacity of channel further downstream);
    - Provide 0.25m high kerb and gutter along southern side of Michael Street between Thomas Street and Barrier Highway;
    - Enlarge/duplicate culvert crossings (0.8 diameter RCP), and provide additional stormwater inlets (2 x double side entry pit) on Barrier Highway between Curb Street and Michael Street; and
    - Check that the size of the culvert located on Michael Street (near the 80km/hour road speed sign) is adequate as it needs to be a minimum of 0.6 x 1.5m box culvert.
- Provide additional inlets and pipes on Mary Street and Curb Street:
- Add a culvert crossing on Saddle Road, enlarge existing swale by approximately 0.4 – 0.5m deeper, and regrade section of Saddle Road (approximately 25m section of road along southern kerb and gutter) to improve stormwater drainage;
- Enlarge/duplicate culvert crossings on Barrier Hwy; and
- Provide a box culvert crossing (0.9m x 0.45m) on the corner of Hill Street and Barrier Highway.

These works are expected to protect 9 properties, and reduce flooding of Michael Street, Mary Street, Curb Street, Thomas Street and the Barrier Highway. Four properties would continue to experience flooding, but the depth of flooding is relatively shallow (less than 150 mm) and should not result in over floor flooding, however landholders front yards would be inundated.

An overview of these works is provided in Figure 5.2 a more detailed map illustrating the infrastructure require west of the Barrier Highway is provided in Figure 5.1 that follows.

These measures are included in the list of recommendations as option F7 in Table 6-1.

FIGURE 5-1 : LOCAL DRAINAGE WORKS REQUIRED WEST OF BARRIER HIGHWAY

5.3.8 Other Options Explored

During the Council and community consultation meetings there were a number of people indicating that farm dams upstream of the towns should be assessed for their potential to reduce peak flow rates.

Aerial photography was used to identify potential dams and to estimate their approximate size. In most cases it was found that existing dams were either too small or not located in an area of the catchment that would allow them to be effective with respect to flood mitigation.

Opportunities were also considered for the construction of new flood control dams upstream of the townships. This assessment process revealed that the volumes of storage required were large and the rounded topography made it impractical to size a dam that would be effective for major floods.

Landholders also identified that land management practices have improved and are continuing to improve further with respect to minimum tillage / direct drilling / contour bank techniques that are all effective in retaining more water on farm. These techniques along with farm dams all contribute to reducing peak flows but the effectiveness of these systems diminishes with the larger, less frequent floods. The volumes of water associated with the 20 year ARI event are simply too great for these measures to be effective. Their effectiveness is usually limited to floods up to the 5 or occasionally 10 year ARI event.

5.4 Effectiveness of Flood Mitigation Works

5.4.1 Difference in Flood Inundation Pre and Post Mitigation Measures

The flows of a 100 year ARI event were modelled with the recommended management measures in place. The difference of flood inundation is shown in Figure 5-3. This figure shows areas that were once inundated are either now shallower or dry. As a result of changing the flow paths, some areas that were once dry are now seen to be wet or flooded in the 100 year ARI event, but these are located outside of areas where this could cause harm.

The number of properties at risk of flooding in the 100 year ARI event is 95 (82 from riverine and 13 direct rainfall flooding). The recommended measures are expected to protect all riverine affected properties. Of the properties affected by direct rainfall, all should be protected by the measures from over floor flooding, but four of these properties will still be subjected to flooding of surrounding yards and garden sheds/garages.

A breakdown of the number of properties protected in a range of ARI events (with the recommendations in place) is provided in the following table.

TABLE 5-1: BREAKDOWN OF DWELLINGS/COMMERCIAL BUILDINGS PROTECTED IN DIFFERENT ARI EVENTS: RIVERINE FLOODING

ARI event	20 year ARI	50 year ARI	100 year ARI
Number of properties protected	19	67	82

TABLE 5-2: DWELLINGS/COMMERCIAL BUILDINGS PROTECTED IN DIFFERENT ARI EVENTS: LOCAL OVERFLOOR FLOODING

ARI event	20 year ARI	50 year ARI	100 year ARI
Number of properties protected	-	10	13

5.4.2 Trafficability of Road Network

Objectives of this SMP include Council's built roads are to be trafficable under the following scenarios:

- 5 year ARI event for local arterial and collector roads; and
- 2 year ARI event for the remaining roads.

The 5 year ARI event (based on local flooding/direct rainfall) was modelled to assess the trafficability of roads following the implementation of recommended works. This showed that the recommended measures will improve the trafficability of the road network.

However, there are a few locations where water would overtop the road in the 2 year ARI event and the 5 year ARI event, as listed below:

- A small section of Saddle Road would be overtopped during the 2 year ARI event and become not trafficable, except for emergency vehicles;
- Shallow water (<50mm) would overtop a section of Minden Street, however restricted traffic movement would still be possible;
- Water would overtop the ford on Crawford Avenue during the 2 year ARI event preventing safe traffic movement; and
- The ford on Marrabel Road would be overtopped by flood waters during the 5 year ARI event but it would remain trafficable with care for conventional vehicles.

The trafficability of the roads is shown in Figure 5-4.

5.4.3 Impact of Mitigation Measures on Downstream Stream Stability

It is important to understand the impact of the proposed mitigation measures on downstream environments, such as higher flow velocities that may cause erosion issues.

In a 100 year ARI event, the proposed works are expected to reduce the velocity of flows leaving the town by 0.3% compared to the existing situation. This will help protect downstream environments by reducing the risk of stream instability and erosion.

5.5 Erosion Protection and River Amenity

The erosion protection works and a riverside pond outlined below provide a range of benefits and are included in the recommendations in Table 6-1 as option C1.

5.5.1 Erosion Protection

To address scouring, it is recommended that erosion protection works are undertaken in the main river channel, at the southern culvert crossing on Barrier Highway. Such works would reduce scouring and the transport of sediment downstream, thus helping to protect downstream receiving environments. The community raised their particular concern with the erosion issue at the southern culverts and hence these should be given a priority by Council.

5.5.2 Riverside Park/Pond

To help improve water quality, biodiversity, local amenity and provide recreational opportunities, it is recommended that a ponding environment be created in the main river channel behind the War Memorial (near Barrier Highway and Belvidere Road). This could become an attractive riverside park for the community and visitors to enjoy the river and surrounds.

This would involve providing a rock chute and pool on main river channel. The recommended dimensions of pond area are: 13.5m wide x 250m long x 3m deep (for a surface area of 0.34 ha and an approximate volume of 10ML). This may require works on privately owned land.

These works will improve amenity as well as reduce flow rates, improve the river channel's stability and biodiversity. These will also have benefits to the health of downstream receiving environments.

This may involve works within privately owned land.

5.6 Regular Maintenance of Drainage Infrastructure and Watercourses

The effectiveness of stormwater drainage infrastructure and watercourses is influenced by whether or not they are maintained and free of blockages. It is recommended that Council maintain the drainage paths and infrastructure in a manner to ensure they perform as designed, i.e. to enable efficient flow of water.

Council will continue to improve maintenance processes to optimise the water quality and water quantity management services performed by the stormwater network.

In relation to fences across watercourses, it is also recommended that Council, in conjunction with the NRM Board, assesses the suitability of stream fencing that may be in place, and identifies the need for any upgrade/modification to existing fences as appropriate. It is anticipated that this work would be done in partnership with landholders and the NRM Board.

These actions are included in the list of recommendations as option F8 in Table 6-1.

Further information and recommendations on the maintenance of watercourses and stormwater infrastructure located in private and public land is provided in section 7.3 of this report.

Council to check that the culvert near the 80km sign on Michael Street is a minimum of 0.6 x 1.5m.

Provide 3x single side entry pit inlets and 0.375 dia. pipe to prevent stormwater pooling.
Catchment area less than 40ha.

Enlarge swale (to match capacity of swale further downstream) on Michael Street. The swale needs a levee around the corner of Michael Street and Barrier Highway.

Provide a ford or culvert crossing on Michael Street.

Current culvert under Michael Street needs a flap gate.

Provide a levee along west bank of the Gilbert River north of intersection of Steelton Rd and Hazeleigh Rd.

Provide additional culvert.

Duplicate existing culvert crossing on Barrier Highway (2 x 0.9m dia. RCP).

Provide grassed swale along Michael Street.

Provide kerb and gutter around southern corner of Michael Street.
Catchment area less than 40ha.

Provide 3x single side entry pits and pipe network.
Catchment area less than 40ha.

Remove existing bridge on Hazeleigh Road (structure is currently in poor condition and piers appear degraded and pose a constriction to flow) and replace with free span bridge structure.

Provide additional inlet pipework.
Catchment area less than 40ha.

Add two pipes (1 x 0.45 and 1 x 0.6 dia.) and two double pits on Barrier Highway.

Existing levee around the property needs to be increased (by approximately 1m) to be above WSE.

Provide a levee along northern side of Saddle Road.

Proposed box culvert on corner of Hill Street and Barrier Highway.
Ensure culvert is maintained and free of debris.
Catchment area less than 40ha.

Provide 2x 0.525-0.6 dia. RCP culvert (with a flap gate) crossing on Saddle Road and under proposed levee
Enlarge existing grass swale.

Provide a levee along weste rn side of Barrier Highway.

Regrade Saddle Road (approx. 25m section of road along southern kerb and gutter).

Provide rock chute on main river channel and earthworks to create pool and improve amenity at the site.

Provide additional culverts under the watercourse crossing on Newark St.

Provide a levee adjacent to the recreati on ground and north of Marrabel Road.

Provide levees along the river banks.

Upgrade current culverts to 4 x 600 x 450 box culverts.

Lower land on the overbank to match proposed road levels – ford crossing on Marrabel Road. Provide levee around south eastern boundary of property.

Lower creek invert by max 0.4m to match new invert of ford crossing and regrade to provide positive fall through section between Marrabel Rd and the Railway Line.

Provide erosion protection where Gilbert River crosses Barrier Highway.

Provide a levee along northern ba nk of the creek near Newark St.

Lower ford crossing invert and regrade Marrabel Road accordingly.

All catchment areas greater than 40ha unless otherwise indicated in the map.

LEGEND

- New Infrastructure
- Upgraded Culvert
- Roadside Swale
- Regraded Road
- Channel Modification
- Levee
- Railway
- Road Edge
- Cadastre

Flood Depth (m):

- *0.05 - 0.10*
- *0.11 - 0.25*
- *0.26 - 0.50*
- *0.51 - 1.00*
- *1.01 - 1.50*
- *1.51 - 2.50*
- *2.51 - 5.00*
- *Greater than 5.00*

Data Source:
Road Edge and Aerial Imagery from Aerometrex; Road names and Cadastre from Clare & Gilbert Valleys Council; Railway alignment from DTEI; Flood Data modelled by Australian Water Environments.

0 50 100 150 200 250 300
Metres (Scale 1:9,000 A3 Sheet)

Government of South Australia
Stormwater Management Authority

CLARE & GILBERT VALLEYS COUNCIL

Australian WATER Environments

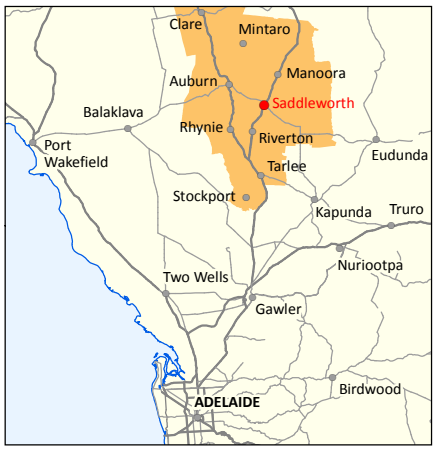
Stormwater Management Plan
For Seven Townships In The
Clare And Gilbert Valleys Council

Saddleworth

Recommended Measures and Effectiveness on Flood Inundation

14009 D113 v6 Saddleworth Flood Management Strategies 151002
Last Updated: 2/10/2015

Figure 5-2



LEGEND

Proposed Remediation Options:

- *New Infrastructure*
- *Upgraded Culvert*
- *Roadside Swale*
- *Regraded Road*
- *Channel Modification*
- *Levee*
- Railway
- Road Edge
- Cadastre

- Wet Previously Dry
- Dry Previoulsy Wet

Wet Previously Wet:

- *Significant increase in flood depth (over 0.5m)*
- *Moderate Increase in flood depth (up to 0.5m)*
- *No significant change in flood depth*
- *Moderate decrease in flood depth (up to 0.5m)*
- *Significant decrease in flood depth (over 0.5m)*

- Proposed Rock Chute

Note:
Flood difference was determined by subtracting mitigation data from the base case scenario therefore negative values represent a greater depth in mitigation data.

Data Source:
Road Edge and Aerial Imagery from Aerometrex; Road names and Cadastre from Clare & Gilbert Valleys Council; Railway alignment from DTEI; Flood Data modelled by Australian Water Environments.

0 50 100 150 200 250 300
Metres (Scale 1:9,000 A3 Sheet)

Government of South Australia
Stormwater Management Authority

CLARE & GILBERT VALLEYS COUNCIL

Australian WATER Environments

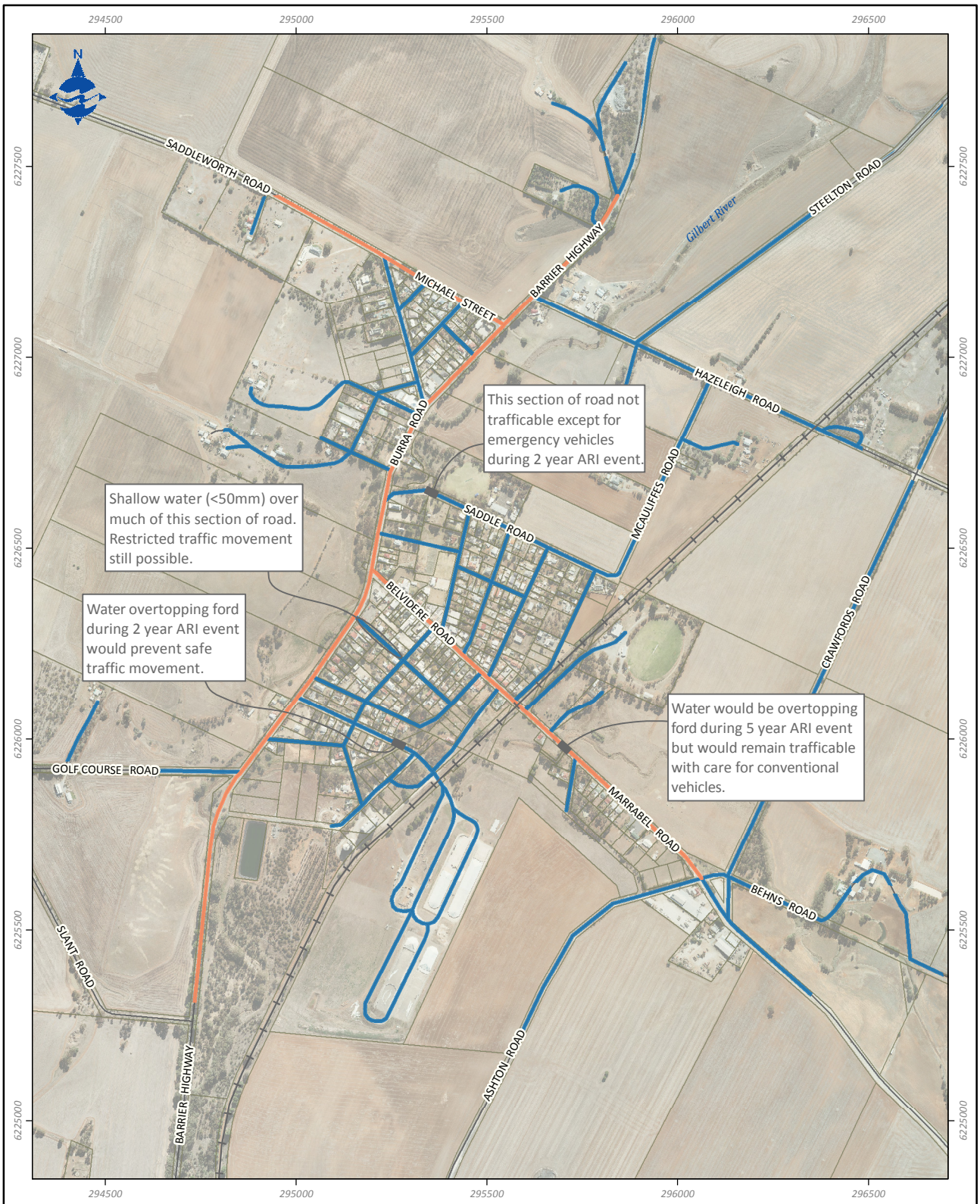
Stormwater Management Plan
For Seven Townships In The
Clare And Gilbert Valleys Council

Saddleworth

100 Year ARI Event Inundation Difference

14009 D120 v5 Saddleworth 1 in 100 ARI Flood Inundation Difference 151002
Last Updated: 2/10/2015

Figure 5-3



LEGEND

Road Trafficability Standard

Post Mitigation Works:

- *5 year ARI event*
- *2 year ARI event*
- Road (outside dtm extent)
- Railway
- Cadastre

Data Source:

Railway alignment from Department of Planning, Transport and Infrastructure; Cadastre and Roads from Clare & Gilbert Valleys Council; Aerial Imagery from Aerometrex.

0 100 200 300 400 500

Metres (Scale 1:15,000 A4 Sheet)

Government of South Australia
Stormwater Management Authority

CLARE & GILBERT VALLEYS COUNCIL

Australian WATER Environments

Stormwater Management Plan
For Seven Townships In The
Clare And Gilbert Valleys Council

Saddleworth

Trafficability of Roads

14009 D255 v1 Saddleworth Trafficability of Roads 150923
Last Updated: 25/09/2015

Figure 5-4

5.7 Water Quality Assessment

A wetland /basin is recommended to be created near Girth Street to provide water quality improvement.

It is also recommended that a pond be created in the main river channel adjacent the Barrier Highway (near the War Memorial) for water quality and other benefits. This option is considered to be a more efficient and cost effective water treatment solution than the Girth Street wetland concept.

This investigation is described below.

5.7.1 Wetland/Detention Basins (WQ1, C1)

Two opportunities for potential wetlands have been identified and assessed for the purpose of improving water quality in Saddleworth – one near Girth Street and one on the river near the War Memorial.

Analysis of the catchment area and land uses was undertaken to determine the likely pollutants at Saddleworth. These attributes were modelled using the computer software program MUSIC (Model for Urban Stormwater Improvement Conceptualisation). This program enables the user to quantify stormwater volumes and quality as well as to develop conceptual designs for treatment systems.

Stormwater issues and opportunities arising from floodplain mapping and community consultation were explored to identify water treatment options. The primary roles of the wetland/detention basin are as follows:

- Provide treatment for the stormwater flows from the western catchment of Saddleworth;
- Improving the local amenity of the Saddleworth landscape;
- Provide storage capacity;
- Potential reuse opportunity; and
- Reduces runoff rates which will help to minimise adverse impacts to watercourses and receiving waters.

The wetland has been sized through a series of iterations in MUSIC software program. The surface area has been adjusted in size to meet the following water quality objectives:

- Total Suspended Solids: 80% reduction
- Total Phosphorus: 60% reduction
- Total Nitrogen: 45% reduction

Girth Street Wetland (WQ1)

A private parcel of flood prone land was identified near Girth Street that may be a suitable location for a wetland to provide water treatment. This wetland basin would be able to capture larger stormwater flows from the western urban catchment of Saddleworth.

The required area of the basin is 7000m^2. The recommended maximum and operating depth is 3m and 1.5m respectively. The operating depth of 1.5m will improve the sediment removal function of the system.

The effectiveness of the wetland in improving water quality compared to the existing water quality at Saddleworth is shown in the following table.

TABLE 5-3: EFFECTIVENESS OF WATER QUALITY TREATMENT

	Average Pollutant Loads (kg/yr)		
	Total Suspended Solid (TSS)	**Total Phosphorus (TP)**	**Total Nitrogen (TN)**
Water quality with no treatment	35,000	78	538
Water quality with treatment	28,000	61	437

A comparison of the improved water quality of the wetland against the State Government targets (Water Sensitive Urban Design, 2013) is shown in the table below.

TABLE 5-4: COMPARISON AGAINST POLLUTANT LOAD REDUCTION TARGETS

	Infiltration Surface Area (m^2)	% Reduction		
		TSS	**TP**	**TN**
State Government target		80	60	45
Wetland system	7,000	96	93	84

The results above (Table 5-3) demonstrate that the size of the proposed detention basin is sufficient to meet State Government water quality objectives for the catchment feeding the wetland but will not have a major impact on total pollutant loads from Saddleworth. The wetland will improve the overall total pollutant loads of the town, as shown below in Table 5-4.

TABLE 5-5: EFFECTIVENESS OF POLLUTANT REDUCTION (KG/YR)

TSS Average Annual Pollutant Reduction (kg/yr)	TP Average Annual Pollutant Reduction (kg/yr)	TN Average Annual Pollutant Reduction (kg/yr)
7,000	17	101

A flow weighted mean concentration (mg/L) was calculated for the outflow from the wetland to understand the quality of water as a result of treatment. The results of this analysis were compared against water quality criterion for TSS, TP and TN identified in the Environment Protection (Water Quality) Policy (2003) for fresh water.

These results are summarised in Table 5-5.

TABLE 5-6: COMPARISON OF WATER QUALITY AGAINST ENVIRONMENT PROTECTION (WATER QUALITY) POLICY CRITERION

Treatment System	Pollutant	Fresh Water Criterion (mg/L)	Flow Weighted Mean Concentration (mg/L)
Wetland	TSS	20	18
	TP	0.5	0.1
	TN	5	1

The expected improvement in water quality and meeting the above Policy (2003) supports Council's Development Plan principles relating to managing and improving the quality of stormwater runoff. It also helps support the NRMB's resource condition targets relating to maintaining and improving water quality in aquatic environments.

The location of the basin is shown in Figure 5-4. It would involve works on privately owned land.

Whilst the system in its own right is effective, its overall contribution to improving water quality for Saddleworth is limited by the relatively small contributing catchment area.

The Girth Street wetland is included as a recommendation in Table 6-1 as option WQ1.

Riverside park/pond (C1)

In response to community interest in improving the local amenity, recreational opportunities and water quality, it is recommended that a pond be created in the main river channel adjacent the Barrier Highway (near the War Memorial). This is described in section 5.2.8 of this report and shown in Figure 5-4.

Analysis of the catchment area and land uses was undertaken to determine the likely pollutants from the two urban catchments directly upstream of the proposed location and drain into the pond.

The MUSIC modelling for the river pond only considered the impacts of the urban development on water quality, and did not include analysis of the catchments further upstream along the Gilbert River.

The expected water quality improvements are described below.

The expected water quality reduction from the river pond is shown in Table 5-6. This demonstrates that the size of the river pond is sufficient to meet state water quality objectives.

TABLE 5-7: COMPARISON AGAINST POLLUTION LOAD REDUCTION TARGETS

	Surface Area (m^2)	% Reduction		
		TSS	TP	TN
State Government target		80	60	45
Wetland system	3,375	80	69	47

The implementation of river pond will improve the overall total pollutant loads. These are summarised below in Table 5-7.

TABLE 5-8: EFFECTIVENESS OF POLLUTANT REDUCTION (KG/YR)

TSS Average Annual Pollutant Reduction (kg/yr)	TP Average Annual Pollutant Reduction (kg/yr)	TN Average Annual Pollutant Reduction (kg/yr)
33,600	38	178

A flow weighted mean concentration (mg/L) was calculated for the outflow from the proposed treatment system to understand the quality of water as a result of treatment. The results of this analysis were compared against water quality criterion for TSS, TP and TN identified in the Environment Protection (Water Quality) Policy 2003 for fresh water. These results are summarised on the following page in Table 5-8.

TABLE 5-9: COMPARISON OF WATER QUALITY AGAINST ENVIRONMENT PROTECTION (WATER QUALITY) POLICY CRITERION

Treatment System	Pollutant	Fresh Water Criterion (mg/L)	Flow Weighted Mean Concentration (mg/L)
Wetland	TSS	20	44.7
	TP	0.5	0.1
	TN	5	1.7

The expected improvement in water quality and meeting the above Policy (2003) supports Council's Development Plan principles relating to managing and improving the quality of stormwater runoff. It also helps support the NRMB's resource condition targets relating to maintaining and improving water quality in aquatic environments.

The proposed riverside pond is shown on the following page in Figure 5-4. This option is considered to be a more efficient and cost effective water treatment solution than the Girth Street wetland concept.

The riverside pond is included as a recommendation in Table 6-1 as option C1.

LEGEND

- Railway
- Road Edge
- Cadastre
- Creek / Watercourse
- Potential Wetland / Pond
- Potential Area for Wetland / Pond

0 50 100 150 200 250 300

Metres (Scale 1:5,000 A3 Sheet)

Government of South Australia
Stormwater Management Authority

CLARE & GILBERT VALLEYS COUNCIL

Australian WATER Environments

Stormwater Management Plan
For Seven Townships In The
Clare And Gilbert Valleys Council

Saddleworth

Stormwater Treatment, Harvest and Reuse

Data Source:
Road Edge and Contours from Aerometrex; Roadnames, Cadastre from Clare & Gilbert Valleys Council; Railway alignment from DTEI;

14009 D124 v7 Saddleworth Stormwater Treatment Harvest and Reuse140724
Last Updated: 28/08/2014

Figure 5-5

5.8 Stormwater Harvesting and Reuse

5.8.1 Overview

Opportunities for harvesting and reusing stormwater were explored in response to the community's aspiration to reuse stormwater, as well as it being a requirement of the SMA as part of preparing stormwater management plans.

The option of a wetland basin near Girth Street provides an opportunity for storage for future reuse, such as for irrigating gardens and public spaces. However, this is not recommended as a priority at this time until more is understood about the demand for reuse and basin configuration.

A preliminary assessment of MAR was also undertaken to determine the feasibility of such a scheme, however it was deemed to be not feasible due mainly to the low stormwater supply yields.

The investigations are summarised below.

5.8.2 Girth Street Wetland

The option of a wetland basin for stormwater reuse capacity and storage was explored. This option would alleviate some of the storage and conveyance issues associated with stormwater runoff volumes from the western catchment.

The first phase of the high level water balance assessment involved determining the average annual yield of stormwater generated from the catchment draining into the detention basin. This is summarised below in Table 5-9.

TABLE 5-10: AVERAGE CATCHMENT STORMWATER RUNOFF YIELDS FOR REUSE

System	Surface Area (m^2)	Average Catchment Stormwater Yields (ML/yr)
Wetland basin	7,000	43

The second phase of the high level water balance assessment determined the indicative harvestable volumes of stormwater based on the flows entering the detention basin. As part of acquiring a permit to construct a water storage such as a detention basin, the total amount of actual water which can be harvested must not exceed the 25% of the median annual flow calculated for the total catchment (Northern and Yorke NRM Plan 2004).

Table 5-10 below summarises the median annual and harvestable volume respectively based on the requirements for obtaining a permit.

TABLE 5-11: STORMWATER RUNOFF YIELDS FOR REUSE

System	Median Annual Volume (ML)	Harvestable Volume (ML)
Wetland basin	40	10

The investigation determined that the wetland basin is a potential option for stormwater reuse and storage. More detailed water balance investigations could be undertaken with consideration of the following:

- Actual reuse demands;
- Existing irrigation regimes;
- Evaporation and rainfall; and
- Detailed design detention basin configuration; and
- Assessment of opportunities for conjunctive use with treated wastewater. Should Council wish to further pursue this option in the longer term. In the short term (i.e. the next 10 years) Council should continue to promote the reuse of treated wastewater within the town for irrigating open space areas.

5.9 Managed Aquifer Recharge

MAR is the process of adding stormwater and/or treated wastewater to aquifers in a controlled environment. The purpose of MAR is to allow for the extraction and storage of reuse water for irrigation and providing alternative water resources particularly in extended dry periods.

The aquifers within the Saddleworth region typically fractured rock aquifers. The fractures act as channels amongst the rock to convey the groundwater in and around the matrix of rock. The rock matrix acts as the storage reservoir of the groundwater. The typical hydrogeologic units which would be targeted within Saddleworth would be the Skillogalee Dolomite and Undalya.

A review of existing bore on *Water Connect* website within the township indicates that typical salinity would be 4700mg/L which would be considered reasonable for the purposes of irrigation. The review of bores listed indicated unknown yield rates, however based on previous investigations undertaken by AWE this would be approximately within the range of 1 - 5L/s. The existing usage for the bores identified was irrigation.

The volume of local stormwater that which could be injected into the aquifer is based on the harvestable volumes calculated (see Table 5-10); the results indicate a total of 10 ML/yr would be available for injection; however this would require more detailed water balance to accurately determine the annual injection rate.

Typically MAR schemes need to be between 100 to 200 ML/yr to be cost effective. Whilst there can be many other factors that support the development of a MAR scheme the limited supply availability was considered to be a major limitation on feasibility.

Furthermore, stormwater needs to be treated before it is used in a MAR scheme, which usually requiring an area of land to enable treatment process to occur. The only open area of land large enough for this purpose is the community oval/showgrounds area. Use of this land would compromise these existing uses and hence is not recommended.

6 Recommendations

6.1 Structural and Non-structural Measures

Recommendations include structural measures aimed at improving stormwater and flood management, opportunities for stormwater harvesting and reuse, as well as several non-structural measures.

Recommendations with their associated costs and benefits are provided on the following page in Table 6-1. This table also identifies if the catchment area of the proposed works is greater than 40ha.

TABLE 6-1: RECOMMENDATIONS

Recommended works	Preliminary construction cost estimate	Benefits	
		Number of properties protected	Other
Stormwater and flooding measures: • **F1:** Provide a levee along River near Steelton Rd and Hazeleigh Rd and replace the bridge on Hazeleigh Rd *(catchment area is greater than 40ha)*	$710,000	2	Improved road trafficability
• **F2:** Levee along Saddle Road and a levee along Barrier Highway *(catchment area is greater than 40ha)*	$100,000	66	Improved road trafficability
• **F3:** Two levees along the riverbank north of intersection of the Barrier Highway and Golf Course Road *(catchment area is greater than 40ha)*	$50,000	2	Improved road trafficability
• **F4:** Works in vicinity of Marrabel Road *(catchment area is greater than 40ha)*	$120,000	4	Improved road trafficability
• **F5:** Two levees and culverts in vicinity of Newark Street *(catchment area is greater than 40ha)*	$60,000	3	Improved road trafficability
• **F6:** Inspect drainage along Hazeleigh Road	-	-	Identify any drainage problems
(F7) Measures to address local runoff: • Additional stormwater infrastructure and channel enlargement on Saddleworth Rd, Michael St and Barrier Hwy. • Additional inlets and pipes on Mary St and Curb St. • Additional culvert crossing, swale enlargement and road regrading on Saddle Rd. • Enlarge/duplicate culvert crossings on Barrier Hwy. • Provide box culvert crossing on the corner of Hill Street and Barrier Highway. *(catchment area is greater than 40ha)*	$1,270,000	9 *(reduce flooding of Michael Street, Mary Street, Curb Street, Thomas Street and Barrier Highway)*	Addresses pooling from local runoff. Improved road trafficability.
C1: Erosion protection works in main river channel at southern culvert crossing on Barrier Highway and creation of a pond in main channel near the War Memorial. *(catchment area is greater than 40ha)*	$100,000	-	Improve water quality of river and enhance the local amenity of the river environment. Potential economic benefits as a result of attracting visitors to the river pond.
Water Treatment – • **WQ1:** Southern wetland (Girth Street wetland) • **C1:** Riverside park pool/amenity (this is addressed above as option C1)	Wetland: $250,000 River pond: (Costs as per the $100,000 identified earlier)		Reduced pollutant loads. Potential to improve aesthetics, community pride and biodiversity.

Recommended works	Preliminary construction cost estimate	Benefits	
		Number of properties protected	Other
F8: Regular maintenance of stormwater drainage infrastructure and watercourses	$10,000		An effective drainage system.
P1: Flood preparedness program • Establish a total flood warning system for Gilbert River • Community education program - e.g. Floodsafe (Community/education officer role and associated materials)	$30,000 $10,000		Provides a warning for flood events which provides time for preparation and therefore reduces the risk and impact of flooding. Reduce risk and impacts of flooding. Gain community support for stormwater management. Build capacity of the community to prepare for floods. Improve community's sense of worth and feeling of security.
P2 – Development / planning controls: • Enforcement and inclusion of flood maps in Council's Development Plan • Ensure siting of developments 300mm above 100 year ARI event level in designated floodplain areas or 300mm above surrounding land level outside these areas. • Water quality targets and the NRM Board's resource condition targets to be included in Council's Development Plan • Stormwater reuse targets to be included in Council's Development Plan			Reduced risk and cost of flooding to properties and people. Protect health of watercourses and receiving waters as a result of detaining flows and reducing runoff rates by the wetland and pond, as well as from erosion protection works in the main channel as these will improve bank stability and reduce erosion. Improvements to water quality, stream stability/erosion control, wetland environments, and actions to reduce the risk of flooding, will help to achieve better planning outcomes associated with improving the values of open space, recreation and amenity for the community. In particular, the community interest in creating a riverside pond would offer scenic and recreation opportunities as well as providing flood management and erosion control benefits.

6.2 Environmental, Social and Economic Opportunities/Benefits

Environmental enhancement opportunities resulting from the recommended actions in this SMP are predominantly based on the improvements to water quality and better management of stormwater flows. There will also benefits to watercourses and receiving waters as a result of detaining flows and reducing runoff rates by the wetland and pond, as well as from erosion protection works in the main channel as these will improve bank stability and reduce erosion. Channel improvements will benefit riparian environments to support native vegetation and wildlife, which would also improve the amenity of the town. These actions will help to protect the receiving environment of the Gilbert River, Light River as well as the estuarine and marine environment associated with Gulf St Vincent.

The improved infrastructure aimed at flood control recommended in this SMP will provide social benefits, including improved road trafficability, public safety, protection of property and continuity of community services. The increased standard of drainage and regular infrastructure maintenance will help to prevent nuisance flooding, particularly near Saddle Road and Whip Street and along the eastern side of Burra Road/Barrier Highway. The suggested works to address local runoff in the north-west corner of the town (near the hotel) will help to protect properties in that area and reduce flooding of Michael Street, Mary Street, Curb Street, Thomas Street and Barrier Highway. This will alleviate community frustration and help maintain business trade in the town.

The proposed rock chute and pool works in the area of land between the river and the War Memorial (near the intersection of Barrier Highway and Belvidere Street) would help to create a riverside park. This would provide a scenic place for the local community and visitors to enjoy the river and surrounds. There is the potential for visitors to this area to also visit the town shops and thereby improving the economic wealth of the town.

A potential wetland system could help improve water quality by providing opportunity for detention and filtration of pollutants. This area would have the potential to become an area of recreation/leisure, enhance the diversity of natural habitats/landscapes, and help recharge the groundwater. Other social benefits arise from creating wetlands by enhancing the local amenity and engendering a sense of community pride and belonging.

Inclusion of water treatment objectives in Council's Development Plan will also help to ensure the protection of these downstream environments.

Non-structural measures, such as flood preparedness programs, flood warning systems and education will improve the community's capacity to prepare for and manage stormwater issues, as well as create a stronger sense of security and resilience within the community. Planning controls (e.g. Council's Development Plan) provide a framework to plan and build in a manner that incorporates stormwater management.

These improvements to water quality, stream stability/erosion control, wetland environments, and actions to reduce the risk of flooding, will help to achieve better planning outcomes associated with improving the values of open space, recreation and amenity for the community. In particular, the community interest in creating a riverside pond would offer scenic and recreation opportunities as well as providing flood management and erosion control benefits.

There are also economic benefits as there won't be the same damage costs as there would be without the stormwater infrastructure. The measures help to prevent flooding which will result in less disruption to business trade and transport routes, and also avoid economic losses arising from stormwater issues. In addition, the improvements to stormwater management may have a positive impact on business confidence and attract future economic investment in the area.

7 Implementation Issues and Funding Opportunities

7.1 Priorities and Timeframes for Implementation

The SMA Guidelines recommend that the highest priorities are for works and measures that reduce flood hazard and protect life and property. In accordance to the multi-objective approach to stormwater management, greater weighting should be placed on strategies that also provide opportunities for stormwater reuse, and improvement to water quality, open space/local amenity, biodiversity and recreation.

A subjective assessment of the recommended strategies has been undertaken to determine their ranking and priorities. This assessment is shown Appendix C.

A detailed 10 year program for implementing the recommended strategies has been developed for Council, refer to the Implementation Plan in Appendix D. It provides information on the priorities, timeframes, costs, benefits and potential funding partners.

Notwithstanding this preferred list of actions and timing, the availability and timing of funding and resources will determine the order and staging of the works.

A summary of the priorities is provided in Table 7-1.

TABLE 7-1: SUMMARY OF PRIORITIES

Priority	Timeframe 0 - 1 yr 1 - 5 yrs 5 - 10 yrs	Recommendations		Capital Cost ($)	Recurrent Cost ($ pa)
1	0 - 1	F8	Regular maintenance of stormwater drainage infrastructure and watercourses	$10,000	$1,000
1	0 - 1	P2	Development / planning controls: • Enforcement and inclusion of flood maps in Council's Development Plan • Ensure siting of developments 300mm above 100 year ARI event level in designated floodplain areas or 300mm above surrounding land level outside these areas • Water quality targets and the NRM Board's resource condition targets to be included in Council's Development Plan • Stormwater reuse targets to be included in Council's Development Plan	-	-
1	0 - 1	P1	Flood preparedness program - • Establish a total flood warning system for Gilbert River • Community education program - e.g. Floodsafe (Community/education officer role and associated materials)	$30,000 $10,000	$10,000 $1,000
1	1 - 5	F2	Levee along Saddle Road and a levee along Barrier Hwy	$100,000	$1,000
1	1 - 5	F7	Measures to address local runoff: • Additional stormwater infrastructure and channel enlargement on Saddleworth Rd, Michael St and Barrier Hwy. • Additional inlets and pipes on Mary St and Curb St. • Additional culvert crossing, swale enlargement and road regrading on Saddle Rd. • Enlarge/duplicate culvert crossings on Barrier Hwy. • Provide box culvert crossing on corner of Hill St and Barrier Hwy.	$1,270,000	$1,000
1	1 - 5	F4	Works in vicinity of Marrabel Road	$120,000	$500
2	0 - 1	F6	Inspect drainage along Hazeleigh Road	-	-
2	5 - 10	C1	Erosion protection works in main river channel at southern culvert crossing on Barrier Highway. Create pond in main channel near War Memorial.	$100,000	$1,500
2	1 - 5	F5	Two levees and culverts in vicinity of Newark Street	$60,000	$500
3	5 - 10	F1	Provide a levee along western bank of river near the intersection of Steelton Rd and Hazeleigh Rd River and replace the bridge on Hazeleigh Road	$710,000	$2,000
3	5 - 10	F3	Two levees along the riverbank north of intersection of the Barrier Highway and Golf Course Road	$50,000	$500
4	5 - 10	WQ1	Water Treatment – Southern wetland/basin	$250,000	$5,000

7.2 Responsibilities for Implementation and Potential Funding Contributions

Council will incorporate stormwater management strategies in its Infrastructure and Asset Management Plan; however, it will need to seek funding contributions from other sources, as described below. The availability and timing of funding and resources will determine the order and staging of the works.

A stormwater management plan that has been approved by the SMA and gazetted is in a good position to attract funding contribution from the SMA to implement the recommendations. The SMA has the discretion to contribute more or less than 50% of the cost of certain works and may elect to contribute to the cost of works in a catchment greater than 40 ha, provided that those works form part of an approved Stormwater Management Plan. To assist in identifying funding opportunities with the SMA, the catchment sizes for the structural measures are provided in Table 6-1.

Council may also be able to secure some funding from the NRM Board, particularly in relation to watercourse rehabilitation and water quality improvement works. The Commonwealth government also offers grants at various times for the purpose of flood disaster planning and relief.

The Yorke and Mid North Regional Development Board may also be another source of funding for implementing some of the recommended actions in this SMP. For example, the Regional Development Fund (RDF) is an annual grant fund administered by South Australia (Regions SA). This funding is to drive economic growth and productivity by investing in regional infrastructure, creating jobs and new opportunities for regional South Australia.

Responsibilities for implementation of recommendations and potential funding opportunities are presented in Table 7.2, with further details in the Implementation Plan (refer Appendix D).

TABLE 7-2: RESPONSIBILITY FOR IMPLEMENTION AND POTENTIAL FUNDING / PARTNERSHIP OPPORTUNTIES

Recommendations		Responsibilities for Implementation and Potential Funding
F8	Regular maintenance of stormwater drainage infrastructure and watercourses	Council, and in partnership with landholders and the NRM Board as appropriate
P2	Development / planning controls	Council
P1	Flood preparedness program	Council, with potential partnership and/or funding from BoM and SMA (flood warning system); and SES (community education program)
F2	Levee along Saddle Road and a levee along Barrier Hwy	Council to lead design, consultation and construction processes, with potential funding from SMA
F7	Measures to address local runoff	Council to lead design, consultation and construction processes, with potential funding from SMA
F4	Works in vicinity of Marrabel Road	Council to lead design, consultation and construction processes, with potential funding from SMA
F6	Inspect drainage along Hazeleigh Road	Council
C1	Erosion protection works in main river channel at southern culvert crossing on Barrier Highway. Create pond in main channel near War Memorial.	Council to lead design, consultation and construction processes, with potential funding from NRM and SMA
F5	Two levees and culverts in vicinity of Newark Street	Council to lead design, consultation and construction processes, with potential funding from SMA
F1	Provide a levee along western bank of river near the intersection of Steelton Rd and Hazeleigh Rd River and replace the bridge on Hazeleigh Road	Council to lead design, consultation and construction processes, with potential funding from SMA/DPTI
F3	Two levees along the riverbank north of intersection of the Barrier Highway and Golf Course Road	Council to lead design, consultation and construction processes, with potential funding from SMA
WQ1	Water Treatment – Southern wetland/basin	Council to lead design, consultation and construction processes, with potential funding from NRM

7.3 Responsibility for Maintenance

The maintenance of watercourses and stormwater infrastructure that is located in **road reserves and council owned land** is normally the responsibility of the council concerned. For **other land** however, there is no legislation specifically identifying this as council's responsibility. Instead, it is the landowners responsibility under the *Natural Resources Management Act* to maintain their land and watercourses in good condition in line with natural resource management practices. Any stormwater infrastructure constructed on **other land** is not the responsibility of the council to maintain unless the council has an interest in the land through an easement etc.

Maintenance of watercourses in good condition may include actions such as removal of weeds and removing any obstacles to flow (e.g. fallen branches, poorly constructed / inappropriate fencing). The NRM Board could also assist landowners by providing information on appropriate natural resource management practices including information on best practice for the maintenance of watercourses.

Information on watercourse management can be found on the following page of the Northern and Yorke NRMB's website:

http://www.naturalresources.sa.gov.au/northernandyorke/water/managing-water-resources/watercourses/Managing_watercourses

Councils may also acquire, through an approved and gazetted stormwater management plan, the legislative responsibility to maintain watercourses in other land, including the power to enter such land (with reasonable notice) and to carry out works and infrastructure in accordance with the approved stormwater management plan. The legislative provision for this is contained in the Local Government (Stormwater Management Agreement) Amendment Act 2016.

It is important that the council puts in place the appropriate administrative arrangements to facilitate ongoing maintenance of any permanent infrastructure established on other land as part of this stormwater management plan. Unless otherwise agreed with the landowner, council must take on responsibility for permanent stormwater infrastructure that is to be placed on other land by taking an interest in the land. Examples of such an interest include an easement, a Land Management Agreement (under the Development Act) with the landowner (which would go on the title of the land), or land acquisition.

Examples of recommended stormwater infrastructure works in private land that may benefit from a formal arrangement with the landowner, such as creating an easement, land acquisition or a Land Management Agreement, are provided below:

- New levee along western side of Barrier Highway
- New levee along northern side of Saddle Road
- New levee along the riverbanks
- New pond and a rock chute on main river channel
- New levee along northern bank of Coghill Creek, near Newark Street
- Lowering of Coghill Creek and regrading works
- New levee at property near Coghill Creek
- Potential wetland (near Girth Street)

8 Review of the Stormwater Management Plan

It is anticipated that this Stormwater Management Plan will be a 'living document' that is periodically reviewed to take account of current knowledge, changing conditions within the catchment and changing community attitudes to the management of stormwater and other water resources making up the urban water cycle.

To ensure that this occurs, it is expected that Council initiates a review of this Plan at least every 5 years and that the proposed works and strategies to be adopted for the subsequent 10 year period will be identified.

The SMA recognises that the Plan may need to be amended to account for modifying or elevating the priority of the recommended actions as a result of unforeseen circumstances, provided that the proposed changes are consistent with the overall strategy and properly integrate with any existing or proposed infrastructure, including any Stormwater Management Plan for an adjoining catchment.

9 References

Australian Water Environments (2013) Floodplain Mapping for Seven Townships, prepared for the Clare and Gilbert Valleys Council

Bureau of Transport Economics (2001) Economic Costs of Natural Disasters in Australia

Clare and Gilbert Valleys Council - Strategic Directions Report 2012/13

Clare and Gilbert Valleys Council (2011) Water Security Plan

Commonwealth of Australia (2009) Flood Preparedness, Manual 20 Australian Emergency Manual Series

Department for Water (2011) Stormwater Strategy - The Future of Stormwater Management, Government of South Australia

Department of Environment, Water and Natural Resources (2013) Water Sensitive Urban Design – Creating more liveable and water sensitive cities in South Australia, Government of South Australia

Department of Water, Land and Biodiversity Conservation (2004) *A River Management Plan for the Light Catchment.* Report, DWLBC 2004/17

Northern and Yorke Natural Resources Management Board (2009) Northern and Yorke Regional NRM Plan – Volume B: Strategic Plan 2009 – 2018, Government of South Australia

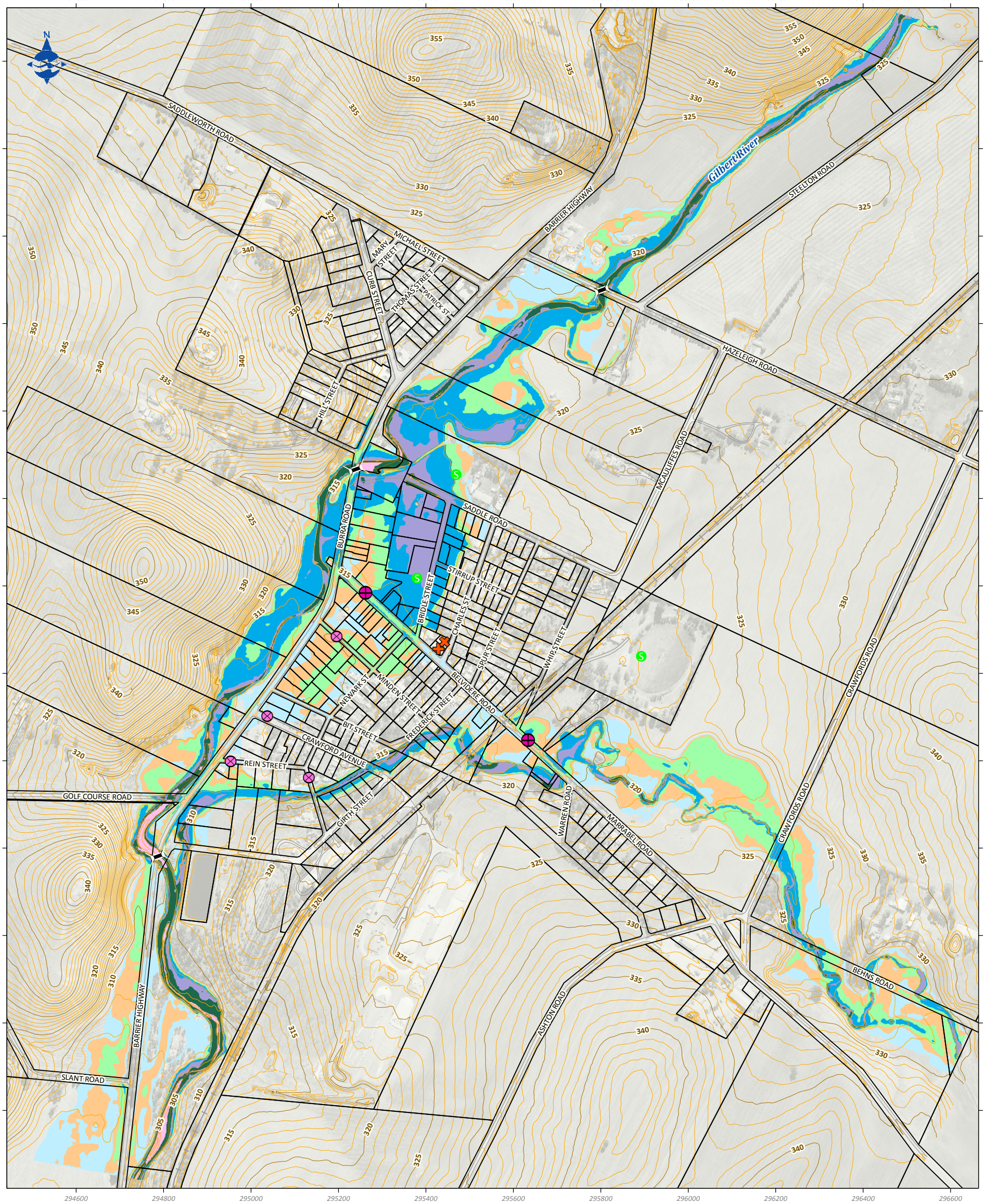
Northern and Yorke Natural Resources Management Board (2009) Northern and Yorke Regional NRM Plan – Volume D: Regulatory and Policy Framework, Government of South Australia

Rural Solutions SA (2005) Gilbert River Salinity Management Plan

SCARM (2000) Floodplain Management in Australia: Best Practice Principles and Guidelines. SCARM Report 73, CSIRO Publishing, Australia.

Water for Good (2009) Government of South Australia

Appendix A : Flood Inundation Maps



LEGEND

- Bridge or Culvert
- Sports Ground
- Ambulance
- Hospital
- Police
- SES
- CFS
- Cadastre

Water Main Crossing

Diameter (mm):

- 63; 80; 100; 150
- 200; 250; 375
- 600; 750

Contours:

- Index
- Intermediate
- Railway
- Road Edge

Flood Depth (m):

- 0 - 0.10
- 0.11 - 0.25
- 0.26 - 0.50
- 0.51 - 1.00
- 1.01 - 1.50
- 1.51 - 2.50
- 2.51 - 5.00
- Greater than 5.00

0 50 100 150 200 250 300

Metres (Scale 1:9,000 A3 Sheet)

Government of South Australia
Stormwater Management Authority

CLARE & GILBERT VALLEYS COUNCIL

Australian WATER Environments

Data Source:

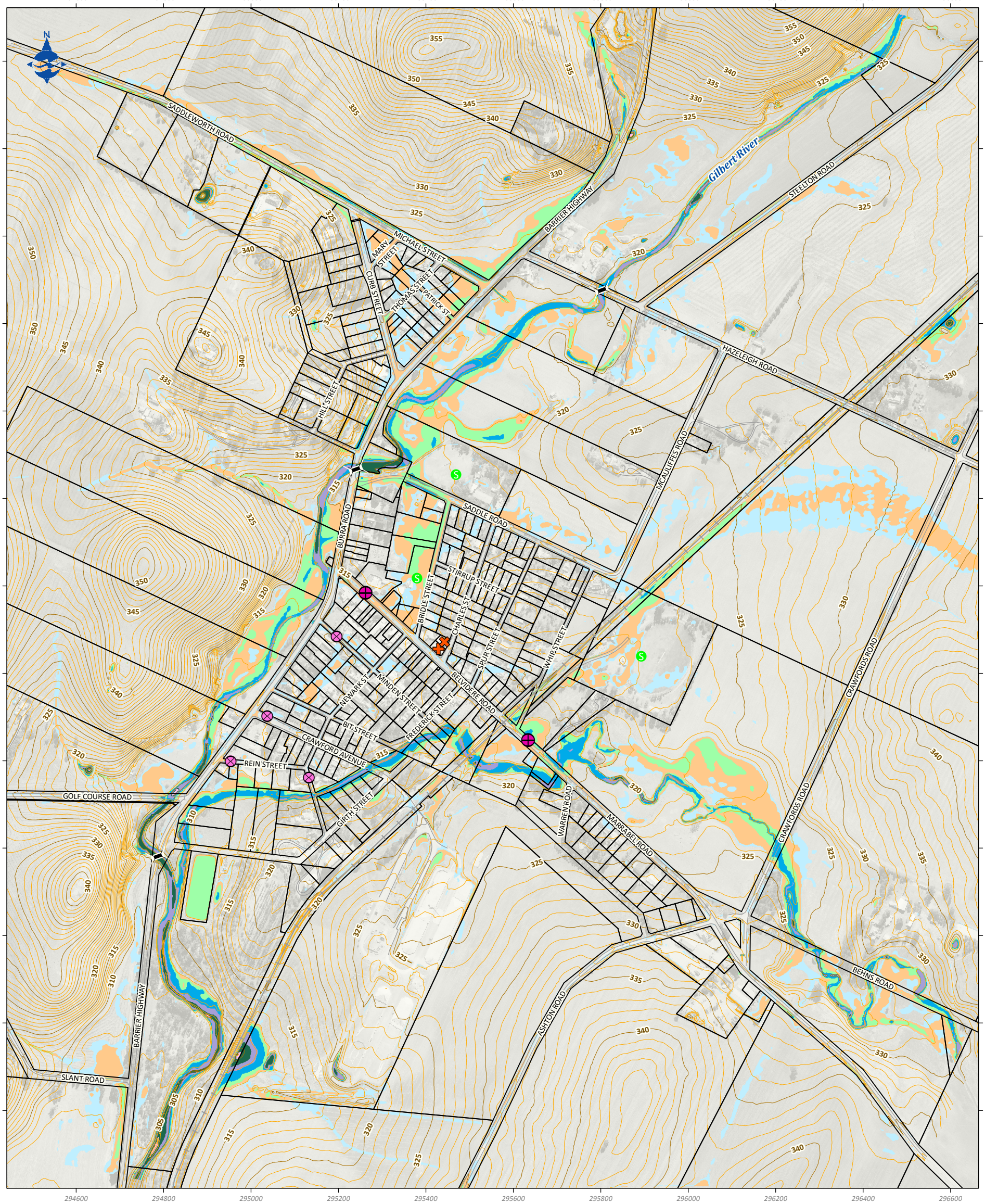
Flood Data, Sports Ground and Railway Extent from AWE; Road Edge, Aerial Imagery and Contours from Aerometrex; Water Mains from SAWater; Bridges from DPTI; Roadnames, Bridges and Cadastre from Clare & Gilbert Valleys Council; CFS from South Australian Country Fire Service; SES from South Australian State Emergency Service; Police Stations from South Australia Police; Hospital from Australian Institute of Health and Welfare; Ambulance from SA Ambulance Service; Watercourses from Geoscience Australia.

Floodplain Mapping for Seven Townships
Clare and Gilbert Valleys Council

Saddleworth (Riverine)

100 Year ARI Event Inundation

12186 D058 v1 Saddleworth Riverine Flood Maps 130405
Last Updated: 31/05/2013



LEGEND

- Bridge or Culvert
- Sports Ground
- Ambulance
- Hospital
- Police
- SES
- CFS
- Cadastre

Water Main Crossing

Diameter (mm):

- 63; 80; 100; 150
- 200; 250; 375
- 600; 750

Contours:

- Index
- Intermediate
- Railway
- Road Edge

Flood Depth (m):

- 0.05 - 0.10
- 0.11 - 0.25
- 0.26 - 0.50
- 0.51 - 1.00
- 1.01 - 1.50
- 1.51 - 2.50
- 2.51 - 5.00
- Greater than 5.00

0 50 100 150 200 250 300

Metres (Scale 1:9,000 A3 Sheet)

Government of South Australia
Stormwater Management Authority

CLARE & GILBERT VALLEYS COUNCIL

Australian WATER Environments

Data Source:
Flood Data, Sports Ground and Railway Extent from AWE; Road Edge, Aerial Imagery and Contours from Aerometrex; Water Mains from SAWater; Bridges from DPTI; Roadnames, Bridges and Cadastre from Clare & Gilbert Valleys Council; CFS from South Australian Country Fire Service; SES from South Australian State Emergency Service; Police Stations from South Australia Police; Hospital from Australian Institute of Health and Welfare; Ambulance from SA Ambulance Service; Watercourses from Geoscience Australia.

Floodplain Mapping for Seven Townships
Clare and Gilbert Valleys Council

Saddleworth (Direct Rainfall)

100 Year ARI Event Inundation

12186 D066 v1_3 Saddleworth Direct Rainfall Flood Maps 130422
Last Updated: 31/05/2013

Appendix B : Community Feedback

Saddleworth Stormwater Management Plan

Community Consultation

Identification of Issues

Consultation with the Saddleworth local community was undertaken early in the project (August 2012) to identify their issues and opportunities for stormwater and flood management. The community meeting also provided the opportunity to confirm the accuracy of the modelled flow paths with the community.

A summary of the main issues raised by the community is provided below.

Stormwater and flooding issues:

- Inadequate drainage in several locations – eg at the hotel and nearby houses;
- Culverts are undersized and poorly maintained;
- The raising of Burra Road (Barrier Highway) over time, and the railway line act as a barrier to drainage flow resulting in drainage issues and flooding;
- Bridge is very silted up, lots of reeds;
- Reeds obstruct flows and trap sediment; and
- During large storm events, stormwater enters the STEDs resulting in sewerage backing up.

Aspirations and Opportunities:

- Redesign and formalise the drainage network to improve their effectiveness in coping with larger flows;
- Maintain stormwater infrastructure (eg culverts) and the river so they are clear of flow obstructions, such as reed infestation and sediment;
- Explore opportunities for a reuse and storage system (MAR?), e.g. for reuse at the school oval, tennis courts, and street trees;
- Tree planting and stream rehabilitation , particularly in the section of river from first bridge to the north of town (including stabilising the river banks);
- Slow water velocities, such as a pond.

Consultation on Draft Strategies

Feedback on the draft strategies was provided by the Project Steering Committee and the Elected Members. A meeting was held in Saddleworth (May 2014) to gain feedback from the local community on the draft strategies. This feedback helped to finalise the recommendations of the SMP.

A summary of the community consultation is provided below.

A meeting was held in Saddleworth on 7th May 2014 and approximately 6 members of the community attended. Feedback forms were made available to the wider community to provide the opportunity for others to comment.

During the meeting AWE presented the key issues and draft suggested measures, including the impact to controlling flood. The feedback is summarised below.

Discussion:

- Concern about trees growing on southern side of bridge (Ash trees) causing congestion in the river.
- Erosion is occurring next to the bridge pylon on eastern side next to the river (downstream of the south bridge, Golf Course Rd) – suggest erosion protection works are required to stabilize the bank.
- Saddleworth Rd has experienced stormwater runoff (mud) from new driveways being put in. This has also been caused by runoff from farm land travelling down Saddleworth Rd. Footpath has been broken up as a result of flooding.
- Culvert on Saddleworth Rd at the 80 km sign is blocked and possibly undersized.
- Exotic trees and sheoaks along the drain near Saddleworth Rd/Michael St are a maintenance issue.
- Concern that the drain along Michael St doesn't cope well with flows.
- Thomas Street possibly needs better drainage.
- Need a non-return valve next to buildings at corner of Barrier Hwy and Hazeleigh Rd.
- Drain near the Institute building often backs up.

Do you think the measures address stormwater and flooding issues?

- Yes
- Suggest a trash rack is put in to capture debris before it enters the town's network.
- Need better maintenance of infrastructure to remove sediment and debris and maintain vegetation.
- Ensure the infrastructure is of sufficient capacity to manage flows.
- The bridge on Hazeleigh Rd needs to be replaced/upgraded as it is deteriorating, and it needs modifying because reeds catch on the bridge and block flows.
- Need to check the capacity of the culvert on Hill Street as it is often blocked (needs better maintenance).

Do you think the measures address water quality, local amenity and reuse options?

- Not sure of measures will result in improvements to water quality.
- Would like a river park to be created at end of Belvidere St (behind the war memorial) adjacent to the river, similar to Riverton's duck pond.
- The proposed wetland is not a high priority at the moment.
- Need to manage reeds in river and exotic trees (eg Ash trees).
- Need to address any erosion of bank near Golf Course Rd.

Are there any issues that Council should be aware of in implementing the suggested measures?

- Sediment in the river needs to be managed in order to do the proposed works.
- The proposed wetland is located on private land and therefore discussions with landowner will need to occur.

What are the most important measures?

The community members present at the meeting were asked to indicate what they thought were the most important suggested measures, as shown in the table on the following page.

Feedback forms

Feedback forms were also available for people to provide comment on the draft strategies. A total of 6 forms were received by Council. Key issues raised:

- Culverts are inadequate and need to be maintained more regularly. Culvert under Hillside Rd is not adequate and needs enlarging. Drainage pipe under Hill St/Barrier Hwy is too small.
- Maintenance required at intersection of Burra Rd and Belvidere Rd as this is an area of instant flooding – the drainage under the road to the river here is inadequate.
- Replace Hazeleigh Rd bridge with a ford and it needs to have a trash rack installed on the north side to capture debris etc.
- Encourage the development of weir type arrangement and improvements to the aesthetics at the river behind the memorial. (Burra Rd and Belvidere Rd). This is privately owned land but Council currently maintains it.
- Encourage detention basin in the catchment and stormwater reuse.
- Not confident about the proposed raising of the bridge height is a good idea. May cause flooding into other areas. May create a 'blind spot' for traffic. Suggest the area under the bridge is lowered and cleaned out instead of raising the bridge deck height.
- Important to address local runoff on Saddleworth Rd, Michael St, Mary St, and Barrier Hwy.
- Recommend community meetings are held at night time (out of business hours) to give better opportunity for people to attend.
- Poor drainage along the railway line and at intersections along Hazeleigh Road.

Table: Community Feedback - Most Important Measures

Recommended measures	Which suggested measures do you think are most important? (percentage of people's preference)
Stormwater and flooding measures: • Provide a levee along the western bank of the Gilbert River near the intersection of Steelton Road and Hazeleigh Road. (Cost $30,000; protection to 2 properties)	0%
• Provide a levee along northern verge of Saddle Road (upstream of Barrier Hwy) and a levee along the western side of Barrier Highway (downstream of bridge). Raise the deck of bridge (by approximately 1.8m) to provide sufficient capacity at the crossing of the Barrier Highway. Widen the section of river under the bridge by approximately 0.75m. (Cost $520,000; protection to 69 properties)	43%
• Provide two levees along the river banks at 150m north from the intersection of the Barrier Highway and Golf Course Road. These are to be between a minimum of 1m to a maximum of 1.5m in height. (Cost $50,000; protection to 2 properties)	0%
• Provide a levee along the eastern side of the caravan park, north of Marrabel Road (0.4m – 0.25m). Modify ford crossing on Marrabel Road and regrade road accordingly (approximately 0.75m). Widen section of creek downstream from the ford crossing (i.e lower creek invert by a maximum of 0.4m to match new invert of ford crossing), and regrade creek between Marrabel Road and the railway line. Provide a levee (0.25m) around the property situated south west from the crossing. (Cost $120,000; protection to 4 properties)	5%
• Provide two levees on the northern bank of the creek upstream and downstream of Newark Street (0.3m and 0.5-0.7m). (Cost $60,000; protection to 3 properties)	0%
Measures to address local runoff: • Additional stormwater infrastructure and channel enlargement on Saddleworth Rd, Michael St and Barrier Highway. • Additional inlets and pipes on Mary St and Curb St. • Additional culvert crossing, swale enlargement and road regrading on Saddle Rd. • Enlarge/duplicate culvert crossings on Barrier Highway. (Cost $60,000; addresses pooling from local runoff)	38%
Water Treatment – Wetland (Cost $250,000; capture flows, improve water quality, local amenity, and biodiversity)	0%
Regular maintenance of stormwater drainage infrastructure (Cost $5,000)	14%
Establishment of a flood warning system for the Gilbert River (Cost $30,000)	0%
Enforcement and inclusion of flood maps in Council's Development Plan	0%
Community education program - e.g. Floodsafe (Cost $10,000)	0%

Appendix C : Assessment of Priorities

Determining priorities - Saddleworth Stormwater Management Plan

Considerations:	Ranking system:
Current flood exposure	Low = 100 year ARI event, Medium = 50 year ARI event, High = 20 year ARI event
Number of properties protected (%age) - based on properties at risk in 1 in 100 ARI	Low = <20%, Medium = 20%-50%, High = >50% properties protected
Cost effectiveness ($ per property)	Low = >$250,000, Medium = $100,000-$250,000, High = <$100,000
Catchment area greater than 40ha	Low = <40ha, High = >40ha
Water quality improvement	Low = <20%, Medium = 20%-50%, High = >50% of proportion of catchment/township benefiting from treatment
Water harvesting and reuse	as per community aspiration
Community aspiration	Low = <20%, Medium = 20%-50%, High = >50% importance

Town: Saddleworth

Recommendation	Current flood exposure	Number of properties protected	Number of properties protected (% of 82)	Cost	Cost per property	Costs effectiveness	Catchment area greater than 40ha	Water quality improvement		Water harvesting and reuse	Community aspiration	Priority - Low Medium High
								Catchment wide benefit	Township only benefit			
F1: levee and bridge on Hazeleigh Road	High	2	Low	$710,000	$355,000	Low	High				Low	L
F2: levee along Saddle Road and a levee along Barrier Highway	High	66	High	$100,000	$1,515	High	High				Medium	H
F3: Two levees along the river bank north of intersection of the Barrier Highway and Golf Course Road	High	2	Low	$50,000	$25,000	High	High				Low	H
F4: Works in vicinity of Marrabel Road	High	4	Low	$120,000	$30,000	High	High				Low	M
F5: Two levees and culverts in vicinity of Newark Street	High	3	Low	$60,000	$20,000	High	High				Low	M
F7: Measures to address local runoff - Additional stormwater infrastructure and channel enlargement on Saddleworth Road/Michael St and Barrier Hwy. Additional inlets and pipes on Mary St and Curb St. Additional culvert crossing, swale enlargement and road regrading on Saddle Rd. Enlarge/duplicate culvert crossings on Barrier Hwy. Provide box culvert crossing on the corner of Hill Street and Barrier Hwy	High	9	Low	$1,270,000	$141,111	Medium	High				Medium	H
F6: Inspect drainage along Hazeleigh Road to identify any problems	High										Low	M
C1: Erosion protection works and river pond	High			$100,000		Medium	High	Low	Medium		Low	M
WQ1: Water Treatment – Southern wetland/basin				$250,000		Low		Low	Low		Low	L
F8: Regular maintenance of stormwater drainage infrastructure and watercourses	High			$10,000		High					Low	H
P1: Flood preparedness program - Flood warning system	High			$30,000		High					Low	H
P2: Development / planning controls	High					High					Low	H
P1: Flood preparedness program - Community education program	High			$10,000		High					Low	M
total				*$2,710,000*								

Appendix D : Implementation Plan

Saddleworth - Implementation Plan

Priority	Timeframe 0 - 1 yr 1 - 5 yrs 5 - 10 yrs	Project/ Activity and Location	Capital Cost ($)	Recurrent Cost ($ pa) (based on 8% of capital cost)	Flood Mitigation Benefit *Measures:* *(P) – Properties Affected* *(properties protected by measures in the 100 year ARI event – except for measures addressing local runoff are for the 20 year ARI event)*	Water Harvesting Benefit *Measures:* *(V) – Volumetric* *(Q) – Qualitative*	Water Quality Benefit *Rating:* *(H) - High* *(M) - Medium* *(L) – Low*			Other Benefits *Rating:* *(H) - High* *(M) - Medium* *(L) – Low* Qualitative description of benefit	Potential funding partners with Council
							Benefit to whole of catchment	Benefit to township only	Qualitative description of benefit		
1	0 - 1	F8: Regular maintenance of stormwater drainage infrastructure and watercourses	$10,000	$1,000	Effective drainage and therefore reducing risk of flooding.	-	-	-	-	Improved sense of security and wellbeing amongst the community.	-
1	0 - 1	P2: Development / planning controls	-	-	Reduced risk and cost of flooding to properties and people.	-	-	-	-	Better planning and development outcomes. Improved sense of security and wellbeing amongst the community.	-
1	0 - 1	P1: Flood preparedness program - establish a total flood warning system for Gilbert River	$30,000	$10,000	-	-	-	-	-	Provides a warning for flood events which provides time for preparation and therefore reduces the risk and impact of flooding. Community awareness raised and people are empowered to protect their properties and response – thereby significantly reducing flood damages. Improved sense of security and wellbeing amongst the community.	BoM, SMA
1	0 - 1	P1: Flood preparedness program - Community education program - e.g. Floodsafe (Community/education officer role and associated materials)	$10,000	$1,000	Reduce the risk of flooding and impacts of flooding.	-	-	-	-	Gain community support for implementation and ongoing management of the stormwater management measures. Build the capacity of the community to prepare for floods as well as reduce risk of flooding. Improve the community's sense of worth and feeling of security.	SES
1	1 - 5	F2: Levy along Saddle Road and a levy along Barrier Hwy	$100,000	$1,000	66 properties protected.	-	-	-	-	Improved road trafficability	SMA
1	1 - 5	F7: Measures to address local runoff: • Additional stormwater infrastructure and channel enlargement on Saddleworth Rd, Michael St and Barrier Hwy. • Additional inlets and pipes on Mary St and Curb St. • Additional culvert crossing, swale enlargement and road regrading on Saddle Rd. • Enlarge/duplicate culvert crossings on Barrier Hwy. • Provide box culvert crossing on the corner of Hill Street and Barrier Highway.	$1,270,000	$1,000	9 properties protected (20 year ARI event) Addresses pooling from local runoff.	-	-	-	-	Addresses pooling from local runoff - reduces flooding of Michael Street, Mary Street, Curb Street, Thomas Street and Barrier Highway. Improved road trafficability.	SMA
1	1 - 5	F4: Works in vicinity of Marrabel Road	$120,000	$500	4 properties protected.	-	-	-	-	Improved road trafficability	SMA
2	0 - 1	F6: Inspect drainage along Hazeleigh Road	-	-	Any drainage problems identified	-	-	-	-	-	-
2	1 - 5	F5: Two levees and culverts in vicinity of Newark Street	$60,000	$500	3 properties protected.	-	-	-	-	Improved road trafficability	SMA

Priority	Timeframe 0 - 1 yr 1 - 5 yrs 5 - 10 yrs	Project/ Activity and Location	Capital Cost ($)	Recurrent Cost ($ pa) (based on 8% of capital cost)	Flood Mitigation Benefit *Measures:* *(P) – Properties Affected* *(properties protected by measures in the 100 year ARI event – except for measures addressing local runoff are for the 20 year ARI event)*	Water Harvesting Benefit *Measures:* *(V) – Volumetric* *(Q) – Qualitative*	Water Quality Benefit *Rating:* *(H) - High* *(M) - Medium* *(L) – Low*			Other Benefits *Rating:* *(H) - High* *(M) - Medium* *(L) – Low* Qualitative description of benefit	Potential funding partners with Council
							Benefit to whole of catchment	Benefit to township only	Qualitative description of benefit		
2	5 - 10	C1: Erosion protection works in main river channel at southern culvert crossing on Barrier Highway, Creation of a pond in main channel near the War Memorial	$100,000	$1,500	-	-	Low	Medium	River pond - Average Annual Pollutant Reduction: • TSS: 33,600 kg/yr • TP: 38 kg/yr • TN: 178 kg/yr Treated water meets the State Government targets (Water Sensitive Urban Design, 2013) , supports Council's Development Plan principles relating to improving stormwater quality, and helps support the NRMB's resource condition targets relating to maintaining and improving water quality in aquatic environments.	Improve amenity at public open area and improvements to river channel. Reduced pollutant loads. Potential to improve aesthetics, community pride and biodiversity values. Economic benefits as a result of attracting visitors.	NY NRMB, SMA
3	5 - 10	F1: Provide a levy along western bank of river near the intersection of Steelton Rd and Hazeleigh Rd River and replace the bridge on Hazeleigh Road	$710,000	$2,000	2 properties protected	-	-	-	-	Improved road trafficability	SMA/DPTI
3	5 - 10	F3: Two levees along the riverbank north of intersection of the Barrier Highway and Golf Course Road	$50,000	$500	2 properties protected.	-	-	-	-	Improved road trafficability	SMA
4	5 - 10	WQ1: Water Treatment – Southern wetland/basin (Girth Street wetland)	$250,000	$5,000	-	10 kL/yr	Low	Low	Wetland - Average Annual Pollutant Reduction: • TSS: 7,000 kg/yr • TP: 17 kg/yr • TN: 101 kg/yr Treated water meets the State Government targets (Water Sensitive Urban Design, 2013) , supports Council's Development Plan principles relating to improving stormwater quality, and helps support the NRMB's resource condition targets relating to maintaining and improving water quality in aquatic environments.	Reduced pollutant loads. Potential to improve aesthetics, community pride and biodiversity values.	NY NRMB