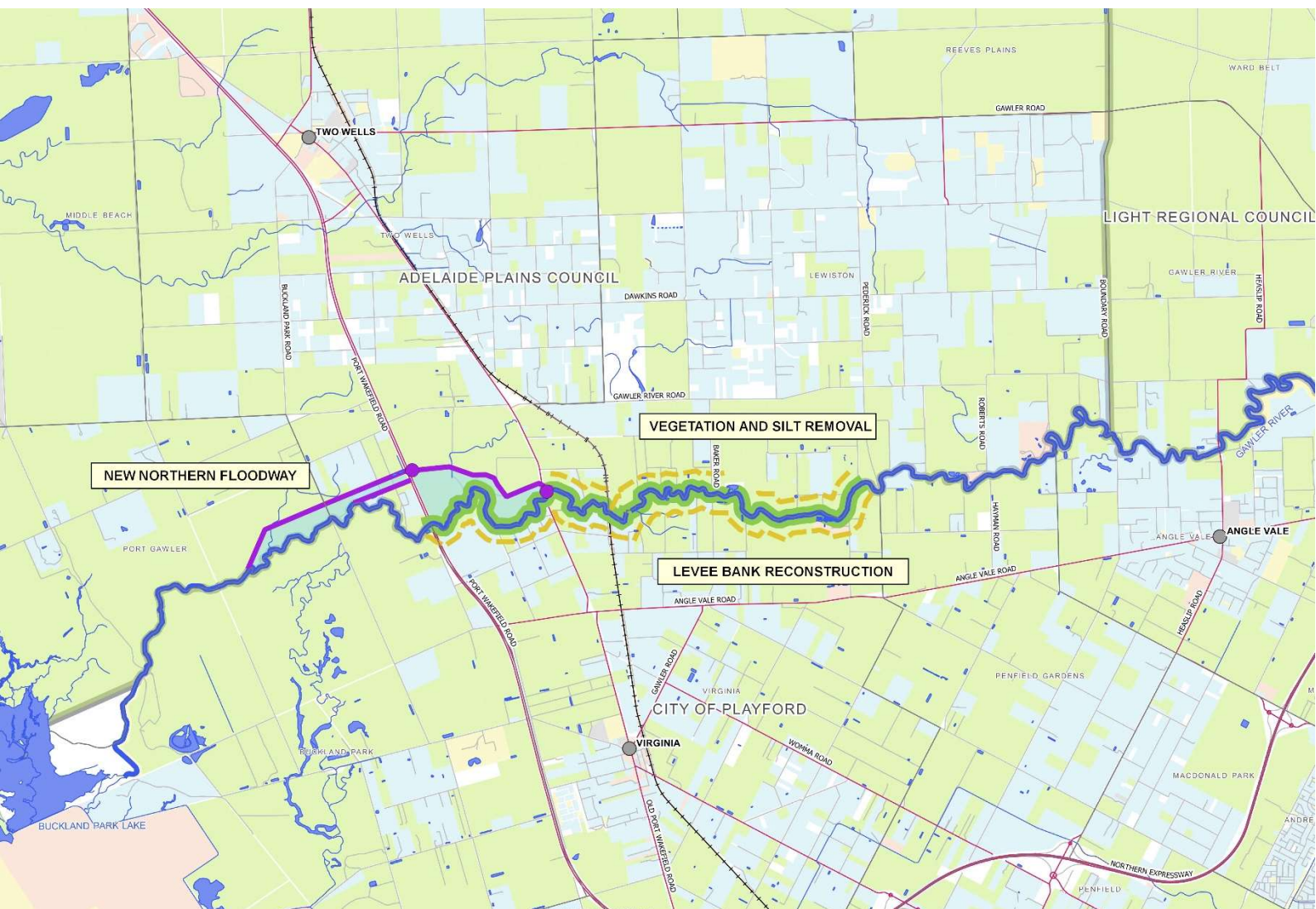


Gawler River Floodplain Management Authority

Ref No. 20180193



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PART 1 Summary Document



Summary

Purpose of this document

This document provides details of the Gawler River Northern Floodway proposal, a key component of the overall Gawler River Flood Mitigation Scheme Mark II. The Northern Floodway specifically addresses flooding within the lower Gawler River.

Outlined within is a summary of the flooding issues experienced within the lower Gawler River and why a flood mitigation solution, specific to the lower Gawler River is required. The benefits of the proposal are explained, largely in non-monetary terms.

The document provides details of the steps required to progress the project, commencing with a definition of the project objectives and further scope confirmation works to firm up the concept. High order capital costs are also provided, along with the budgetary commitment required for each of the project development stages.

The document is intended to serve as a key reference document for potential funding partners and a guide for the project's ultimate implementation.

Funding model

The GRFMA is committed to progressing the Northern Floodway Project as a priority, subject to The Federal and State Governments confirming a commitment to fund all capital costs, including further design and development costs, associated with the Northern Floodway Project. The GRFMA acknowledges that ongoing operational and maintenance costs associated with the Northern Floodway will be its responsibility.

The GRFMA has sought formal commitment from all constituent Councils on progressing the Northern Floodway Project on this funding principle.

The Gawler River

The Gawler River flows in a westerly direction across the Northern Adelaide Plains from the confluence of the North Para and South Para Rivers just downstream of Gawler Township, to the Gulf St Vincent at Port Gawler.

The lower Gawler River floodplain, defined as the areas to the west of Pederick Road at Lewiston, lies within the local government areas of the Adelaide Plains Council and City of Playford. Land use within the floodplain is characterised by a mixture of intensive residential and commercial development in the growth areas of Angle Vale, Virginia and Two Wells, rural living areas, intensive animal husbandry and high value horticulture.

The capacity of the river diminishes markedly from east to west, with a capacity of around 400 m³/s near Gawler, to around 70 m³/s at Port Wakefield Road and less than 10 m³/s near Buckland Park lake, adjacent the coast. The diminishing capacity of the river channel heading downstream leads to flooding of the lower Gawler River and its floodplain on a relatively regular basis.

Levees, both natural and man-made exist along much of the lower river's length, however these are generally in a poor state of repair and are prone to failure during major flood events.



Levee bank failure during 2016 flood event resulting in flooding of horticultural areas.

Flooding of the Gawler River

The Gawler River has been subject to major flooding on average every 10 years over the past 160 years. Earliest accounts date back to the mid-1800s with reports of the North and South Para and Gawler Rivers becoming “sweeping torrents” and washing away several houses at Buchesfeld (west of Gawler township). In recent history, major events have occurred in 1992 (September, October, December), November 2005 and October 2016.

The largest of these events, in October 1992, was estimated to have an average recurrence interval (ARI) of around 35 years¹. An estimated 200 homes were damaged during this event (The Advertiser October 29, 2012). Although no homes were damaged when the Gawler River broke its banks in November 2005, around \$40 million worth of crops were lost along with significant damage to public infrastructure such as roads.

Most recently, the Gawler River catchment experienced significant rainfall between late September and early October 2016 with falls ranging typically between 100 to 140 mm in the upper North and South Para River catchments. This resulted in a major flood event in the lower reaches of the Gawler River, with an estimated ARI of 20 years.

Although no homes were flooded, approximately 250 private properties along with local and state government infrastructure were severely affected by resultant flooding. Extensive loss of horticultural production and a significant damages repair bill in the order of \$50 million resulted from the October 2016 event.

¹ The average recurrence interval (ARI) of a flood event is the number of years on average within which a given flood will be equalled or exceeded. For example, a 100-year ARI event may occur on average once in 100 years. Floods may also be expressed in terms of ‘Annual Exceedance Probability’ (AEP), which describes the probability of occurrence in any given year. A 100-year ARI event, has an AEP of 1%. Refer to Section 9 for further details.

Flooded horticultural areas
near Virginia, 2016

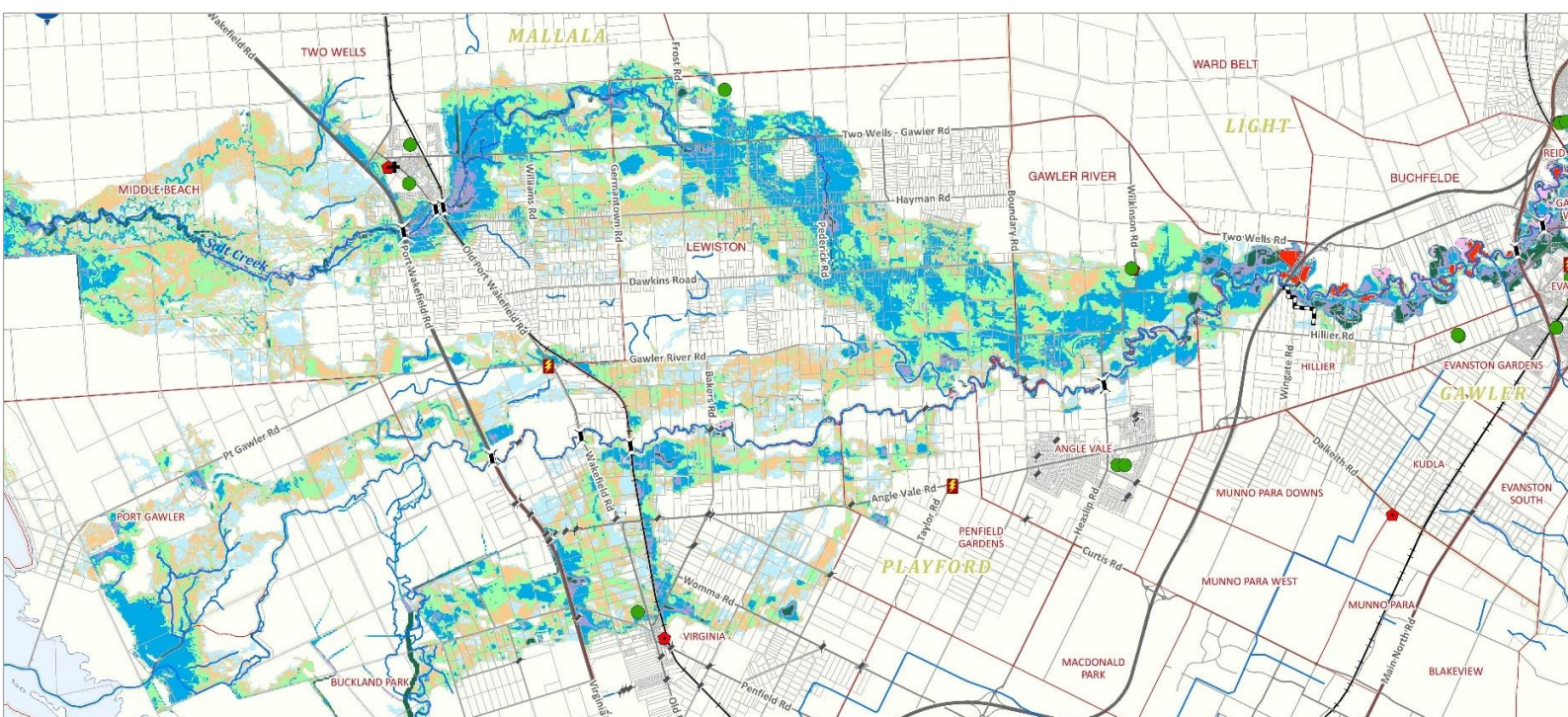


In response to the regularity of flooding, and its impacts on the local communities, the Gawler River Floodplain Management Authority (GRFMA) was formed in 2002 as a Regional Subsidiary under Section 43 and Schedule 2 of the Local Government Act 1999, principally to manage the implementation of a strategy to mitigate flooding.

To date, works have been completed upstream of Gawler to reduce flood flows within the North Para and South Para Rivers, reducing the impacts of flooding within Gawler Township, and to a lesser extent the lower Gawler River. The works include construction of the Bruce Eastick North Para Flood Mitigation Dam (completed in 2007) and alterations to the South Para Reservoir spillway (completed in 2012).

What is the flood risk and estimated economic cost of flooding?

Major overtopping of the banks of the Gawler River is expected to occur for much of the river's length for events larger than a 10-year Average Recurrence Interval (ARI). For the 100-year ARI event, computer modelling indicates a series of major breakouts occur around Boundary Road, where a significant proportion of floodwaters spill to the north towards Lewiston and Two Wells. Further, smaller breakouts occur downstream of Boundary Road, including spill to the south which will impact the Virginia township and associated growth precinct. Floodwaters overtop the major A1 transport route, Port Wakefield Road, to the west of Virginia and west of Two Wells, before flowing around the proposed Buckland Park development area to the sea.



100 year ARI flood extent – current scenario (from AWE 2015)

The modelling indicates over 3000 residential allotments, 200 industrial allotments and 6000 ha of agricultural area would be flood affected in the 100-year ARI event, this being the flood event which might occur on average once in a hundred years or in any given year has a 1% chance of occurring.

Much of the floodplain area is prime horticultural and agricultural land, which continues to expand and forms part of the Northern Food Bowl. The population centres of areas of Angle Vale, Two Wells and Virginia will also continue to grow under the 30-year growth plan for Adelaide, with growth in some areas, including Virginia, currently limited by flood risk.

Flood damage estimates, calculated using the results of the modelling for the existing floodplain scenario were prepared in 2016, following construction of the Bruce Eastick North Para Flood Mitigation Dam, which reduced the impacts of flood events less than the 50-year event, particularly within the Gawler township.

The damage calculations estimate the average annual damage within the floodplain to be \$7.4m, with present value damages of \$109m.

These calculations are based on the existing catchment development state, and do not take into account potential damages arising from expanding residential, commercial and industrial development associated with the 30-growth plan for Adelaide, nor expanding primary production, horticultural and rural lands associated with the Northern Food Bowl. It also only values loss to export crops, if local crops are included the damage estimates would increase.

What is the Northern Floodway?

The Northern Floodway concept was developed as part of the 2016 Flood Review, a study undertaken following the floods of Spring 2016, in consultation with the GRFMA's Technical Reference Panel and a Working Group formed to provide input to the selection of preferred flood mitigation solutions.

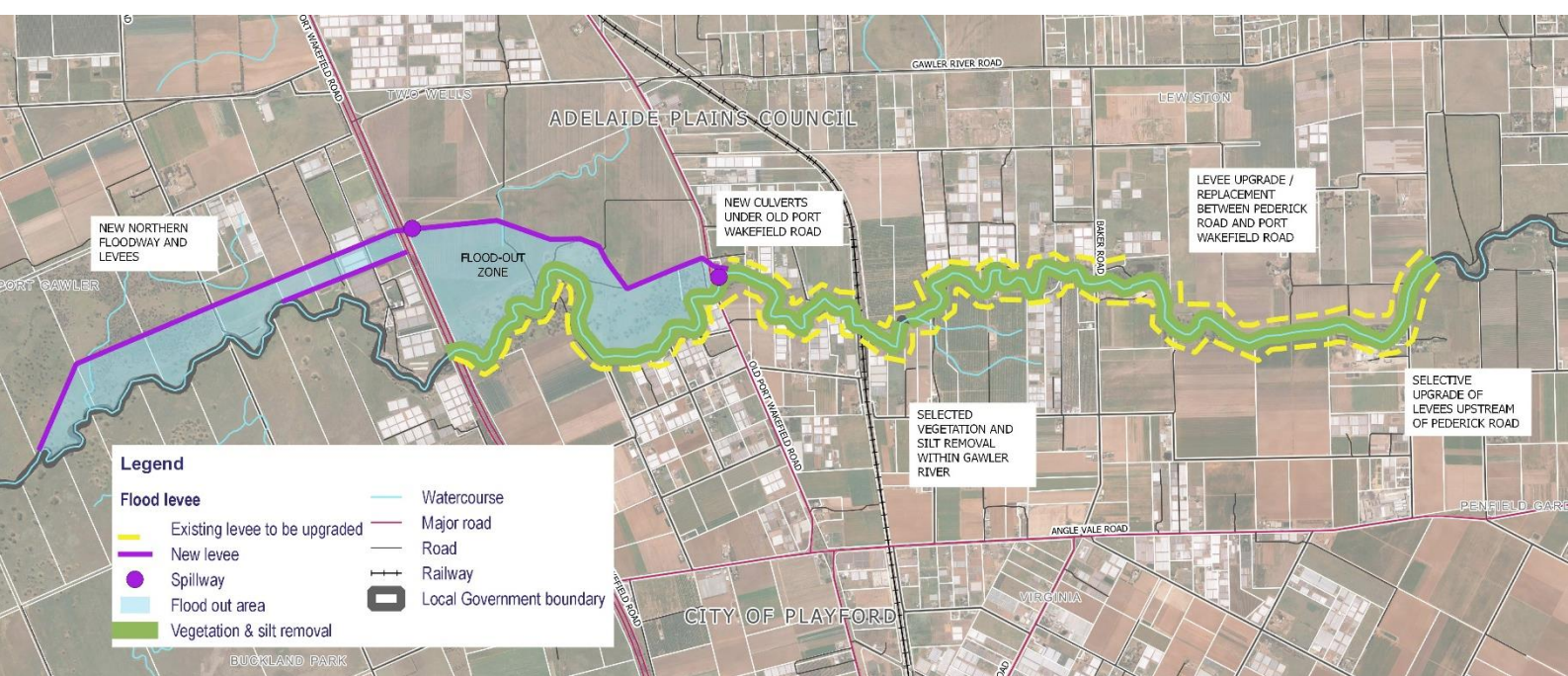
Three recommendations arose from the 2016 Flood Review:

Recommendation 1: “River and levee maintenance should be the responsibility of a single authority that has the necessary resources and access rights to maintain the river in good condition from a flood conveyance as well as biodiversity perspective.”

Recommendation 2: “River condition and levee maintenance repair work should be undertaken as a matter of high priority.”

Recommendation 3: “The GRFMA proceed with developing concept designs for the establishment of a Northern Floodway, in addition to the construction of a new river levee system so that consultation with affected landholders can proceed.”

Recommendations 2 and 3 collectively form the ‘Northern Floodway’ proposal, shown below.



Elements of the Northern Floodway proposal

There are three primary elements forming part of the overall concept:

- Levee improvements (immediate and long term) and ongoing maintenance
- River channel works – including strategic sediment and vegetation removal and revegetation – and ongoing maintenance
- A new levee and floodway system downstream of Old Port Wakefield Road to contain floodwaters within a defined floodway system on the northern side of the river (The ‘Northern Floodway’).

Recommendation 2 acknowledges that there are immediate issues that could be addressed to reinforce the levee system and reinstate channel capacity at known problem locations whilst the longer-term, more significant mitigation strategy is progressed. Whilst the channel and levee works forming part of Recommendation 2 are not considered effective at mitigating large-event flooding in their own right, it is expected that these would provide an immediate benefit during smaller, more frequent events. Recommendation 2 and 3 are complementary, with the investigation and implementation work associated with Recommendation 2 forming the early stages of Recommendation 3.

Throughout this document, the river channel works and immediate levee repair works are referred to as “immediate works” whilst the new Northern Floodway and more extensive levee upgrades are referred to as “long term works”.

Why do we need a Northern Floodway?

To date, flood mitigation within the Gawler River catchment has focussed on works to reduce peak flows within the North Para and South Para Rivers which combine to form the Gawler River. Whilst effective, there is a limit to the amount of flow reduction the dams on these rivers can achieve, even if the capacity of the Bruce Eastick North Para Flood Mitigation Dam is increased.

The naturally diminishing capacity of the Gawler River channel as it flows west means that no single flood mitigation solution to control flooding for the river’s entire length during significant flood events is feasible, as the capacity of the lower reaches of the river is so limited.

The effect of increasing the capacity of the Bruce Eastick North Para Flood Mitigation Dam by raising the dam wall by 10 m was investigated in 2016 (AWE 2016). The modelling indicated that the 100-year ARI flood peak could be reduced from 635 m³/s to 170 m³/s at Gawler, with significant benefits to Gawler township and properties and townships on the northern side of the river. Despite this, due to the channel’s limited capacity further west (around 70 m³/s at Port Wakefield Road), breakouts still occur on the southern side of the river near Virginia and horticultural areas will be subject to flooding, presumably in a similar manner to that which occurred in 2016.

This indicates that even with a larger upstream flood mitigation dam, supplementary flood mitigation works are required in the lower reaches of the river to prevent flooding of property, closure of roads, potential damage to infrastructure and loss of crops.

The Northern Floodway aims to address this flooding, specific to the lower Gawler River. The Northern Floodway will not prevent the large breakout which occurs around Boundary Road and flows north west towards Two Wells during larger events exceeding an ARI of 20 years.

What are the benefits?

To date the Northern Floodway has only been analysed in detail for the 2016 flood event, estimated to represent roughly a 20-year ARI event. Although not tested under larger flood events (50 or 100 years) it is expected that the floodway will also perform well in a 50-year ARI event.

Future modelling is expected to confirm whether the floodway is capable of achieving a 100-year standard with minor refinements, and if so it is anticipated that this level of protection would be a significant selling point for securing community support. The 100-year event is typically the standard level of protection expected as a result of major new flood mitigation proposal and is a benchmark for flood protection in many development plans.

On the basis of investigations undertaken following the 2016 flood event, the following benefits are anticipated to result from the Northern Floodway implementation, during a flood event of similar magnitude to that of 2016:

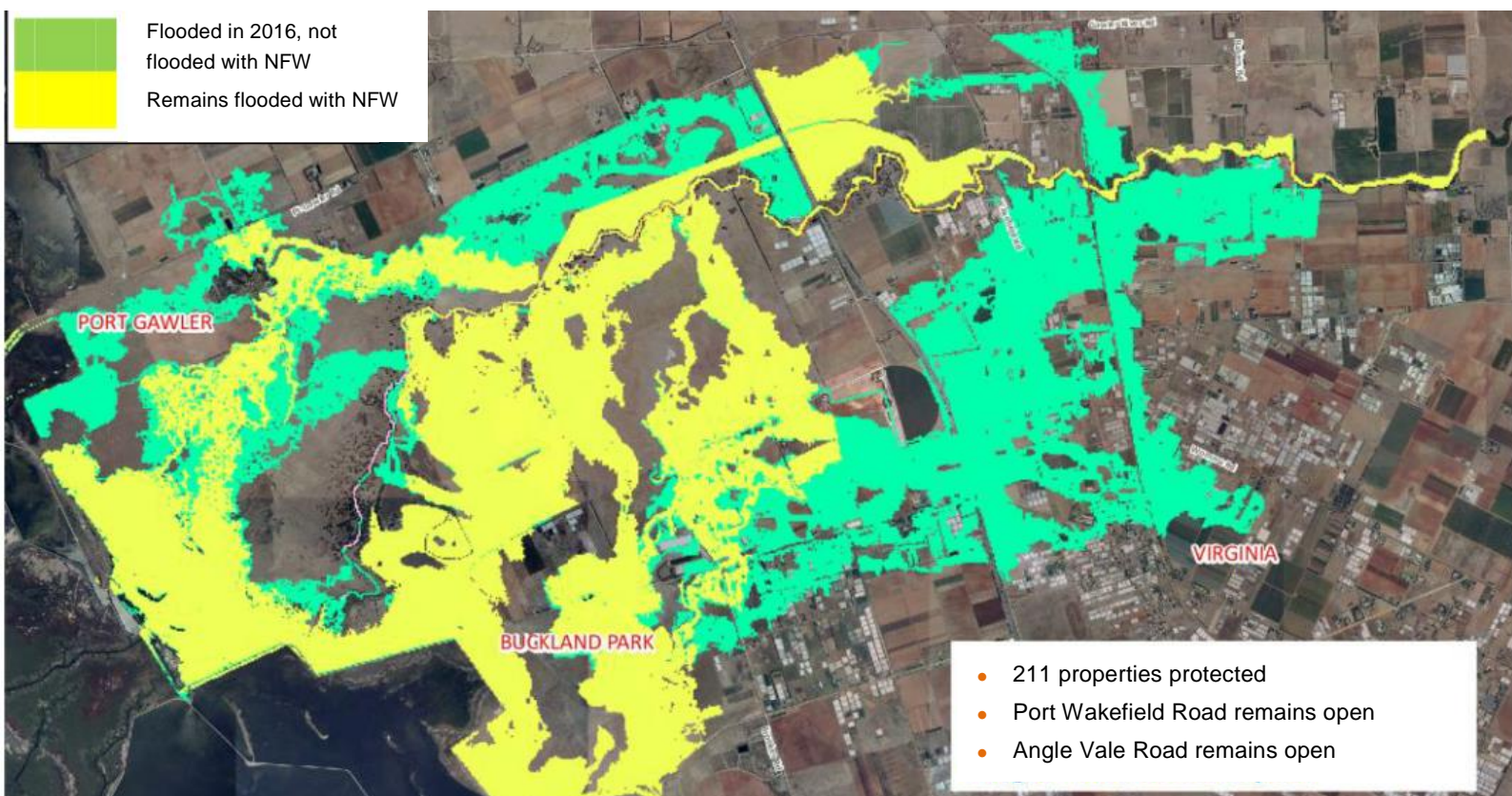
- *Protection of 211 of the 248 properties estimated to be flooded in 2016. Reduced flooding of another 10 properties. Similar protection is expected in the 50-year event.*
- Substantially reduced flood damages through the protection of the high value horticultural lands around Virginia.
- No flooding of the existing Virginia Township or re-zoned residential / deferred urban areas within the Virginia Growth Precinct.
- No overtopping of Port Wakefield Road, maintaining use of the critical A1 transport route.

- Reduced flood hazard and impacts on local emergency access and evacuation routes, such as Angle Vale Road.
- Improved biodiversity within the Gawler River channel system as a result of selected vegetation removal, revegetation with appropriate species and a planned regular maintenance program.

Further modelling will be required to quantify the benefits during other flood events.

Calculations needed to calculate the project's cost benefit ratio have not yet been undertaken to quantify the expected reduction in flood damages.

The reduced extent of flooding during the 2016 event, with the floodway works and upgraded levees in place, is illustrated below (flood free areas shown in green).



The 2016 flood event, modelled with and without the Northern Floodway works (from AWE 2017)

Note: this modelling assumes the Buckland Park development is not completed.

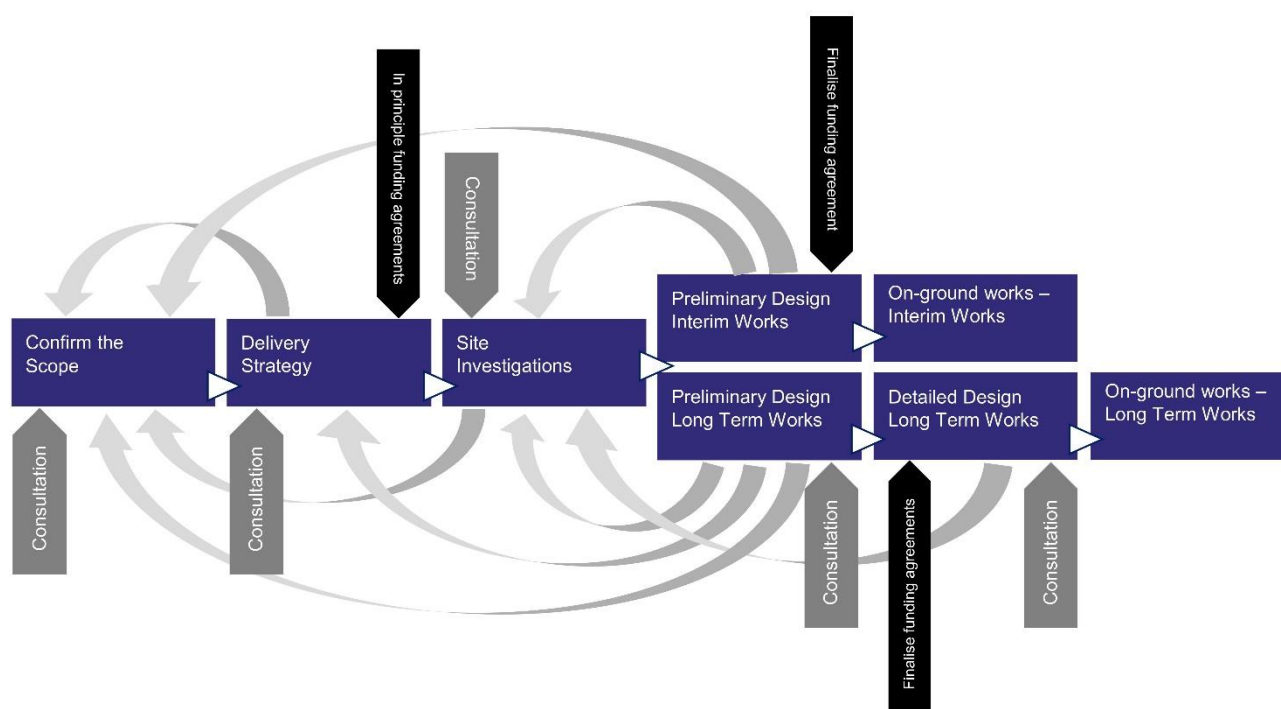
How will the project progress?

To date a desktop only study has been completed to determine the feasibility, and effectiveness, of the Northern Floodway concept. This has relied upon the results of hydraulic modelling to inform the infrastructure requirements such as the need to upgrade existing levees, culverts and bridges, and the need for new levees and floodways. No site investigations have been undertaken to validate the project's feasibility and to date, stakeholder consultation has been limited to the Technical Assessment Panel and Northern Floodway Working Group.

The current estimated project cost of \$27m has been estimated on the basis of the desktop investigation and modelling.

In order to progress the implementation of the Northern Floodway works a number of key investigations and pieces of work will need to be undertaken.

Within this document, the proposed works are structured into a number of key project 'stages', as depicted below. The scope of works required for future stages will be reviewed throughout, or at least at the conclusion of each stage.



Key project development elements

It is proposed to progress the river condition and immediate levee repair works (referred to as 'immediate works') as a matter of priority, subject to funding, establishment of landholder access agreements and approvals to undertake the works. It is anticipated that the necessary funding and approvals could be gained within a shorter timeframe than the body of work required to enable commencement of on-ground works associated with the long-term Northern Floodway and levee replacement.

Extensive consultation will be undertaken throughout all stages of the project's development, along with regular review of risks and review and updating of the project's estimated cost at key milestones.

Confirm the scope

A key first step in progressing both Recommendation 2 and 3 will be to confirm the scope of works necessary to achieve the desired level of flood mitigation. This will be achieved through a combination of additional modelling, site investigations and early engagement with stakeholders.

Tasks will include:

- Additional flood modelling (including climate change scenarios) and estimating reduction in damages (future flood damages avoided)
- Consideration of project staging
- Ground truthing / site walkovers:
 - Further inspection of existing levees (where feasible) to determine those sections in need of immediate remedial works
 - River condition survey, including vegetation assessments and identification of areas of silt build up

- Ground truthing of new levee and floodway proposals
- Redefining or confirming the project scope
- Early consultation / presentation of information
- Confirmation of preliminary cost estimates
- Determination of first order cost–benefit

Delivery strategy

A clearly defined delivery strategy for such a complex project is a must to manage risks, capitalise on opportunities, keep the project on track from a time and budget perspective, and ensure that the support of stakeholders and the broader community is firstly gained, and then maintained over the long term.

Mapping out a framework for delivery of the project will include:

- Clearly defining the project objectives
- Setting the project governance and project management framework
- Appointment of a Project Manager
- Investigating options for access to land for site investigations and immediate works, ownership of assets and land tenure, including property acquisition
- Determining and mapping out planning requirements and approvals
- Investigating procurement options and determining delivery model(s)
- Risk planning and management
- Setting a consultation strategy
- Project execution planning, including development of an implementation plan aligned to project funding.

Site investigations

A range of site investigations will be undertaken at the preliminary design stage to further confirm the scope of works and cost estimates. Whilst some investigations could be deferred to the detailed design phase, undertaking these investigations at preliminary design stage will assist in the management of key project risks such as scope and budget.

Site investigations will require some clearance of vegetation on existing levee banks to allow access for the following:

- Engineering and cadastral survey
- Geotechnical investigations
- Heritage surveys
- Service locating and depthing.

Preliminary design – immediate river condition and levee works

The site walkovers, vegetation assessments and levee surveys are expected to largely inform the scope of works required for the immediate works to improve river condition (vegetation and silt removal and revegetation program) and immediate repair works to prevent failure of levees during the next flood event.

It is anticipated that preliminary level design should provide sufficient information for the works to be procured via a ‘design and construct’ contract, with considerations such as temporary works to be determined by the contractor.

Preliminary design Northern floodway – long term flood mitigation works

Preliminary design of the Northern Floodway, including new levee banks, will achieve notionally 70% design documentation, sufficient to more accurately determine the physical scope of works and footprint, and develop more accurate cost estimates.

The preliminary design will be based largely upon the outcomes of the scope confirmation, and reflective of the site investigations, together with feedback received through the consultation process and any other investigations undertaken as part of the development of the delivery strategy.

Documentation will include preliminary design drawings suitable for cost estimation by a Quantity Surveyor.

Detailed design

Detailed design will include final design activities, any additional site investigations required and documentation of the works to enable tender and construction. Final approvals will be gained throughout the detailed design phase.

At the completion of the detailed design, pre-tender cost estimates will be prepared by a Quantity Surveyor.

Procurement

Extensive documentation will be required, including consideration of staging of the works to suit the available budget. This stage involves preparation of documentation through to award of contracts.

How much will it cost to progress the project to on-ground works?

As summarised above, there is a significant amount of planning, investigative and design work to be done prior to undertaking any on-ground works.

Indicative costs associated with the major stages of work are summarised below.

Stage	Indicative cost
Confirm the Scope	\$165,000
Delivery Strategy	\$145,000
Project Management (assuming full time resource, 2-year contract)	\$240,000-\$300,000
Site investigations	\$395,000
Preliminary Design – immediate works	\$120,000
Preliminary Design – long term works	\$195,000
Detailed Design – long term works	\$255,000
Contractor Procurement – long term works	\$100,000

How much will the Northern Floodway cost?

Order of magnitude estimates for the cost to implement the Northern Floodway works, including the immediate river and levee remedial works, were prepared as part of the 2016 Flood Review project.

The estimate included allowance for design (concept and detailed), tender and administration, land acquisition and construction. A 30% contingency was allowed on the total, reflective of the feasibility level of work that has been undertaken to date.

The current estimate is summarised below. 'Detailed Design' costs differ from the cost provided above (\$125,000 vs. \$255,000) due to additional inclusions in the above design cost estimate.

Element	Indicative cost *
Concept Design	\$350,000
Detailed Design	\$125,000
Tender and administration	\$100,000
Land acquisition	\$9,170,000
Construction	\$11,182,684
Sub-total	\$20,927,684
Contingency	\$6,278,305
Total	\$27,000,000

* From AWE (2017)

Excluding design (concept and detailed) and tender and administration costs, the capital construction cost is \$14.5m, plus \$11.9m land acquisition, including a 30% contingency allowance.

The above costs are for the implementation of immediate works as well as long term works. No breakdown of the costings is available, nor has any consideration been given to staging of the works.

A key step in progressing the implementation of the works will be updating the capital cost estimates (including land acquisition) at a number of milestones, including the scope confirmation stage, agreement on land tenure options (acquisition / compensation costs), preliminary design and detailed design / pre-tender.

At preliminary design stage, the services of a suitably qualified quantity surveyor will be engaged to prepare cost estimates for the various elements of the works. The services of a property consultant will be engaged to assist with the estimation of costs associated with securing the required access to land for the purposes of implementing the on-ground works.

Floodway maintenance

Ongoing maintenance of the Gawler River channel, levees and floodway will be required to maintain the new system to fulfil its intended flood mitigation function. Annual or scheduled maintenance is likely to come at significant cost to maintain the levees in good repair, and prevent the river returning to an overgrown state. Maintenance of the floodway system will be the responsibility of the GRFMA.

Maintenance costs, especially those related to levee maintenance, are likely to be driven by the extent of work undertaken during the construction phase. For example, if all levees are cleared and reconstructed with safe, trafficable crests, maintenance will be far easier and cheaper than maintaining levees with irregular cross sections not able to be safely accessed by vehicle. This is principally because it will enable maintenance tasks (level survey, inspections, weed spraying, repairs) to be undertaken by vehicle, rather than on foot.

Operations and maintenance costs will be estimated following confirmation of the project scope, and again following completion of the preliminary designs.

Implementation Schedule

Following the flood event of 2016, there is a renewed urgency to progress works that will afford a greater level of flood protection to properties in the lower Gawler River floodplain.

Whilst the new Northern Floodway and long-term levee upgrades are generally considered to be the major component of work associated with the overall proposal, the works to be undertaken as part of Recommendation 2 will provide some improved flood conveyance in the short term, at least during smaller events. It is therefore proposed to progress the river condition and immediate repair levee works as a matter of priority, subject to funding, establishment of landholder access agreements and approvals to undertake the works. It is anticipated that the necessary funding and approvals could be gained within a shorter timeframe than the body of work required to enable commencement of on-ground works associated with the Northern Floodway and levee replacement.

Construction may need to be undertaken in stages based on priority of works, legal issues and access availability and available budget. A detailed implementation plan will be prepared as part of the development of the delivery strategy.

Consulting with stakeholders and the community

From a community and landholder perspective there is likely to be a range of opinions and varying degrees of acceptance of the proposal presented. Effective engagement with stakeholders and the broader community will be key to the successful implementation of the project and managing the risk of project delays and cost overruns.

The consultation process will commence early, immediately following the additional modelling and clarification of the project scope. Consultation activities will be tailored to suit the intended audience, noting that these will range from those directly affected by the works to those with an interest in the proposal and from local and state government agencies to general members of the public. The level of support and eagerness to see the proposal implemented will vary due to factors such as reduced flooding, residual flooding (flooding not solved by the Northern Floodway) and impacts to property.

A range of stakeholders will be consulted at various stages throughout the project. These will include:

- Constituent Councils, in particular Adelaide Plains Council and the City of Playford, where the works are located.
- State and federal government agencies, as required to gain approvals
- Emergency services agencies responsible for flood warning and response
- Property owners directly affected by the works
- Property owners currently affected by flooding (but not by the works)
- Wider community / ratepayers
- Commercial developers with an interest in the works
- Other special interest groups that may be identified as part of the development of the consultation strategy.

The consultation strategy to be developed for the project will identify the specific consultation and engagement methods to be employed for each target audience. Owners of land on which construction works are likely to be proposed are a distinct group of the community who deserve special consultation attention.

Next Steps

The GRFMA are committed to progressing the Northern Floodway project development, as a matter of priority. In particular, there is a strong desire to commence works on vegetation and silt removal within the river channel, combined with immediate levee repairs and a strategic revegetation program within the next 12-18 months.

To facilitate the project's progression, the following immediate next steps are required, subject to commitment of funding:

- Confirmation of the project objectives
- Confirmation of the project scope, including vegetation assessments, assessment of existing levee condition and ground truthing of proposed infrastructure alignments
- Further modelling of additional flood scenarios, including an estimate of future damages avoided to inform a benefit cost assessment
- Early consultation with key stakeholders and the wider community via information release
- Review of project cost estimates
- Appointment of a Project Manager

Following this work and commitment to funding the immediate works, the necessary site investigations and approvals can be obtained to prepare concept designs of the immediate river condition and levee works, to enable tendering of the works.

An immediate budget commitment in the order of \$165,000 for the scoping stage and \$120,000-\$150,000 for the first 12-month of Project Management support is required.

Future costs associated with developing the delivery strategy, site investigations, preliminary and detailed designs has been outlined elsewhere.

Part 2 Supporting Document



1 The Gawler River Floodplain Management Authority

The Gawler River catchment has historically experienced significant flooding, both within the Gawler Township and areas downstream. Flooding has occurred with reasonable regularity, on average every 10 years dating back to the earliest records in the mid-1850's.

In recognition of this, the Gawler River Floodplain Management Authority (GRFMA) was formed in 2002 as a Regional Subsidiary under Section 43 and Schedule 2 of the Local Government Act 1999, principally to manage the implementation of a strategy to mitigate flooding. Its purpose is to:

- co-ordinate the construction, operation and maintenance of flood mitigation infrastructure in the Gawler River area ('the Floodplain')
- raise finance for the purpose of developing, managing and operating and maintaining flood mitigation works within the Floodplain
- provide a forum for the discussion and consideration of topics relating to the Constituent Councils' obligations and responsibilities in relation to management of flood mitigation within the Floodplain
- enter into agreements with Constituent Councils for the purpose of managing and developing the Floodplain.

Six constituent Councils form the Regional Subsidiary, including Adelaide Hills Council, Adelaide Plains Council, the Barossa Council, Light Regional Council, Town of Gawler and the City of Playford. The Authority is governed by a Board.

The GRFMA Charter sets down the powers, functions, safeguards and accountabilities and a framework for the financial commitments of the GRFMA and each Constituent Council. The Charter provides for one independent person to be appointed as Chair of the Board, along with two representatives from each constituent Council, being the Chief Executive Officer (or delegate) plus one elected member. Each Council can also appoint a deputy board member. The GRFMA employs an Executive Officer to manage the business of the Authority and coordinate the activities undertaken on behalf of the GRFMA.

A Technical Assessment Panel has been appointed to support the decision making process of the Board, with delegated powers to provide advice and manage the technical aspects of the design, assessment and construction of the various parts of the Scheme. The assessment panel comprises representatives from Councils, DPTI, SA Water and DEWNR, along with the Chair of the Board and the Executive Officer.

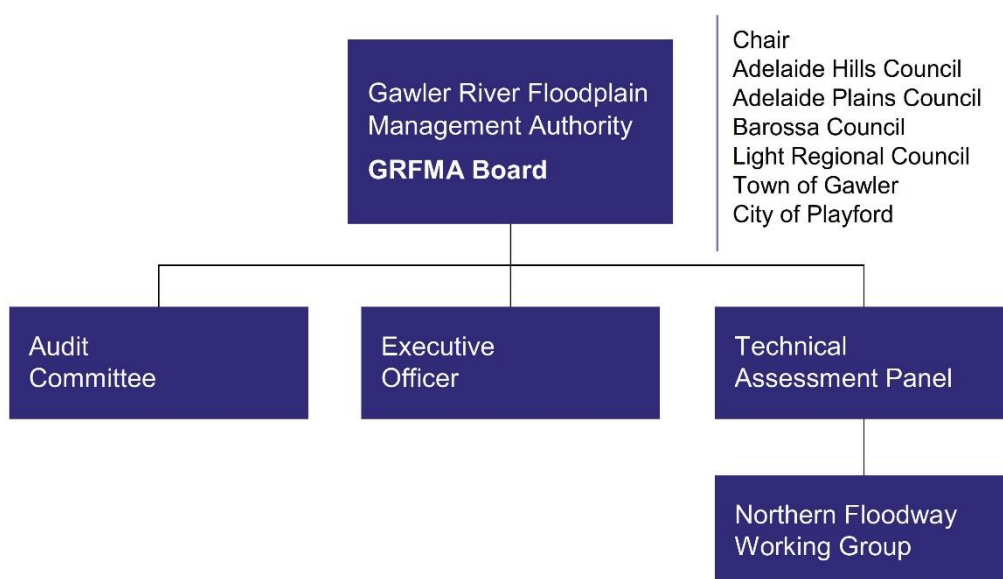


Figure 1.1 Existing Gawler River Flood Management Authority structure

Three significant flood events have occurred in the recent past, including 1992 (three separate floods), 2005 and 2016. Following the 2005 flood event, funding was approved to progress the works described in the GRFMA 2003 business plan, which included:

- The construction of a flood control dam on the North Para River near Turretfield.
- The modification the South Para Reservoir dam wall and spillway to provide 100-year flood control storage on top of full reservoir storage.
- The formalisation of controlled flow paths for floodwaters along the lower reaches of the Gawler River.

Significant works have been completed to date, including the flood mitigation dam on the North Para River (Bruce Eastick North Para Flood Mitigation Dam, completed in 2007) and alterations to the South Para Reservoir spillway (completed in 2012).

More recently, the 2017-2020 Business Plan identified the following priorities:

- Commissioning of a 'fatal flaw screening assessment' for the potential raising of the Bruce Eastick North Para Flood Mitigation Dam by up to 10 metres to provide additional flood protection for a 100-year Average Recurrence Interval (ARI) event to the township of Gawler and further downstream.
- Completion of a review of the 2016 flood event, including recommendations for addressing flooding within the lower reaches of the Gawler River.

Both of these studies were completed in 2017.

The Gawler River 2016 Flood Review report provides the following recommendations for works to be undertaken and provides first order indicative costs of \$27 million:

- proposed Gawler River Northern Floodway
- upgrade and maintenance of the levee system
- management of silt and pest vegetation.

The GRFMA resolved to progress the report recommendations in 2017. Additionally, the GRFMA has resolved not to facilitate any further consideration of raising the height of the existing Bruce

Eastick North Para Flood Mitigation Dam until initiatives recommended in the Gawler River 2016 Flood Review are implemented and outcomes considered.

This document forms a key step in progressing the works recommended in the 2016 Flood Review Report, described throughout as the Northern Floodway.

1.1 Northern Floodway funding model

The GRFMA is committed to progressing the Northern Floodway Project as a priority, subject to The Federal and State Governments confirming a commitment to fund all capital costs, including further design and development costs, associated with the Northern Floodway Project. The GRFMA acknowledges that ongoing operational and maintenance costs associated with the Northern Floodway will be its responsibility.

The GRFMA has sought formal commitment from all constituent Councils on progressing the Northern Floodway Project on this funding principle.

2 The Gawler River

The Gawler River is a river system of the Northern Adelaide Plains, which flows in a generally westerly direction from the confluence of the North and South Para Rivers at Gawler to Gulf St Vincent at Port Gawler. It is a perched river system and thus receives little inflow from adjacent land as it makes its way towards its outfall. Key features of the river and its catchment are shown on Figure 2.1.

Prior to development within the floodplain, flows would have frequently broken out of the river channel and inundated the broader floodplain, giving rise to the fertile soils within the region. Today, much of the river is flanked by levees. In some areas these are naturally formed (a natural feature of perched river systems), in other areas the levees are either man-made, or have been re-engineered in an attempt to prevent flooding of adjacent lands. In many cases, the levees are in poor condition and are prone to breaching and leakage.

The capacity of the river diminishes markedly from east to west, with a capacity of around 400 m³/s near Gawler, to around 70 m³/s at Port Wakefield Road and less than 10 m³/s near Buckland Park lake, adjacent the coast. This diminishing capacity leads to flooding of the lower Gawler River² and its floodplain on a relatively regular basis.

Given the very limited catchment downstream of Gawler, flooding within the Gawler River is mostly driven by flows from the upstream catchments of the South Para and North Para Rivers, which join immediately downstream of the town of Gawler. The upstream catchment is substantial, with an area in excess of 1000 km².

The catchments of the North and South Para River are largely rural in nature, other than the townships of the Barossa Valley and other smaller population centres.

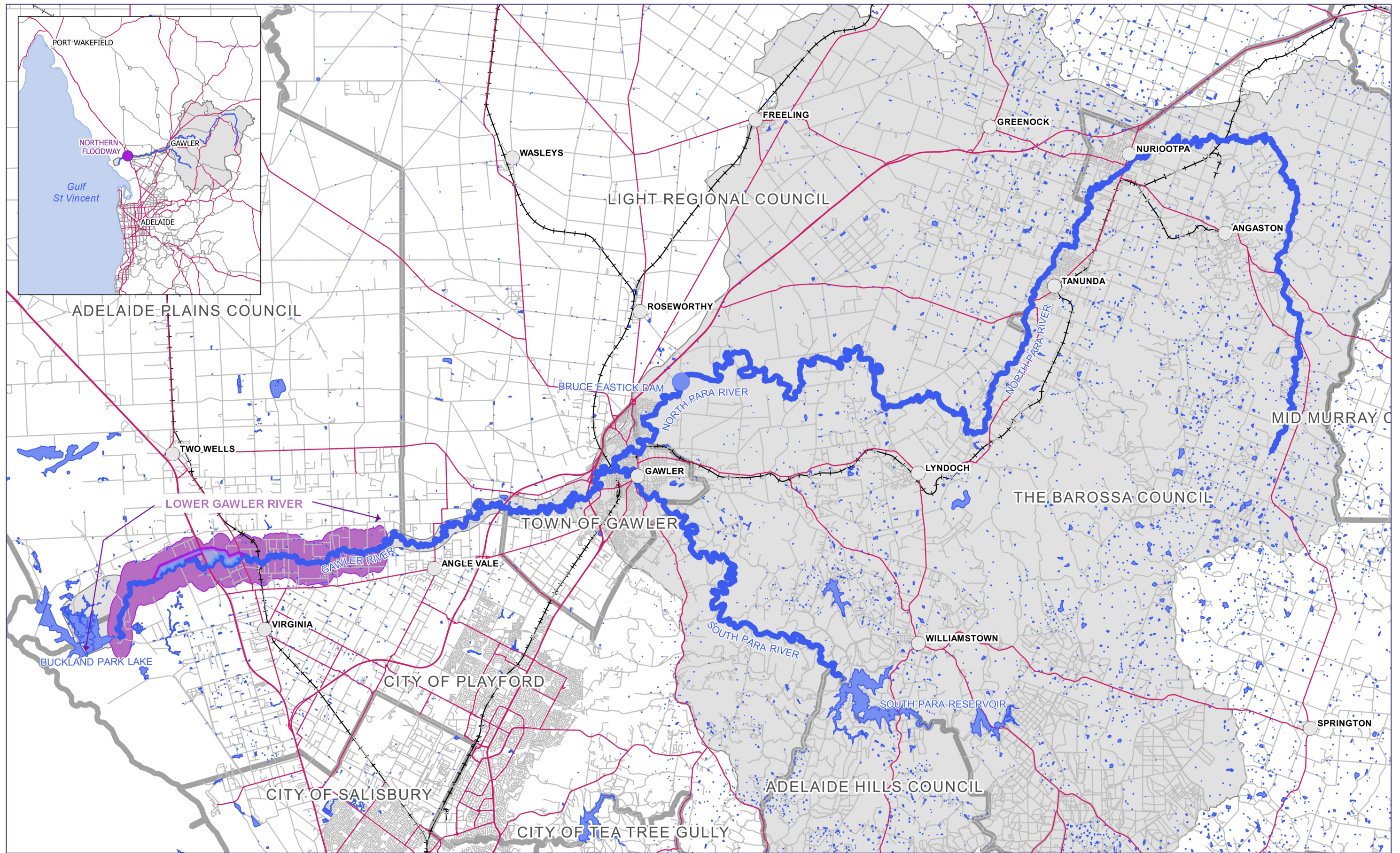
Within the lower Gawler River, on the northern side of the river is the Adelaide Plains Council, including the township of Two Wells and rural living area of Lewiston. Landuse within the flood prone area is characterised by a mixture of rural living, intensive animal husbandry and horticulture with anticipated population growth around Two Wells as part of the 30-year Growth Plan for Greater Adelaide.

South of the river, in the City of Playford, are the townships of Angle Vale and Virginia. The area comprises intense residential and commercial development in the townships, with broad acres predominantly horticulture and farming with associated hot houses, residential dwellings, outbuildings and other structures. Angle Vale and Virginia are also expanding substantially as part of the 30-year Growth Plan for Greater Adelaide.

In addition to residential, commercial and industrial expansion, the 30-year plan also maintains a strong commitment to growing the State's food industry and protecting areas of primary production significance, further reinforced by the recent Northern Food Bowl Protection Areas Development Plan Amendment.

Given the significance of the flood prone areas both north and south of the river for future residential, commercial, industrial and high value horticultural development, the potential cost of damages associated with major flooding events has increased over time, and is expected to continue to do so if no effective flood mitigation works are implemented.

² The lower Gawler River is generally regarded as being downstream of Boundary Road, or the boundary of Light Regional Council and Adelaide Plains Council.



2.1 Flood history

The Gawler River has been subject to major flooding on average every 10 years over the past 160 years. Earliest accounts date back to the mid-1800s with reports of the North and South Para and Gawler Rivers becoming “*sweeping torrents*” and washing away several houses at Buchesfeld (west of Gawler township). Whilst the incidence of major flooding has declined since construction of the South Para reservoir (1958) and an increase in the number of farm dams in the North Para catchment, these have not prevented major floods in very wet years when multiple large rainfall events have occurred. In recent history, major events have occurred in 1992 (September, October, December), November 2005 and October 2016.

The largest of these events, in October 1992, was estimated at 290 m³/s at Gawler, with an Average Recurrence Interval (ARI)³ of around 35 years. An estimated 200 homes were damaged during this event (The Advertiser October 29, 2012).

Although no homes were damaged when the Gawler River broke its banks in November 2005, around \$40 million worth of crops were lost along with significant damage to public infrastructure such as roads.

Most recently, the Gawler River catchment experienced significant rainfall between late September and early October 2016 with falls ranging typically between 100 to 140 mm in the upper North and South Para River catchments. Due to the timing of the storm event, and the wet build up, the falls coincided with high water levels in the South Para Reservoir resulting in reservoir spill, compounding flows downstream within the Gawler River.

This resulted in a major flood event in the lower reaches of the Gawler River, with an estimated ARI of 20 years.

Although no homes were flooded, approximately 250 private properties along with local and state government infrastructure were severely affected by resultant flooding. Extensive loss of horticultural production and a significant damages repair bill reported to be in the order of \$50 million resulted from this event.

³ The average recurrence interval (ARI) of a flood event is the number of years on average within which a given flood will be equalled or exceeded. For example, a 100-year ARI event may occur on average once in 100 years. Refer to Section 9 for further details.



Figure 2.2 Flooding adjacent Port Wakefield Road, Virginia – October 2016

The 2016 event was the first major flood since completion of the flood mitigation dam on the North Para River and works on the South Para reservoir to improve flood storage. The estimated peak flow at Gawler was in the order of $130 \text{ m}^3/\text{s}$, compared to around $270 \text{ m}^3/\text{s}$ had the dam not been constructed.

2.2 Previous studies and investigations

Numerous studies have been undertaken since 1990 aimed at quantifying the extent of the flooding problem, mapping flood risk and assessing potential flood mitigation options for the Gawler River.

Following the flood event of 1992 a Flood Management Plan was prepared for the Gawler River, which outlined a number of options for flood mitigation, including works on the South Para River and a flood mitigation dam on the North Para River, upstream of Gawler (BC Tonkin and Associates 1994).

Following several revisions to the hydrology of the Gawler River catchment, including a major revision in 2007 (DTEI 2007) which predicted a significantly higher 100-year flood peak to that predicted by earlier work, a floodplain mapping study was undertaken which took advantage of more recent advances in aerial survey, hydraulic modelling and mapping techniques (AWE 2008). The study (updated in AWE 2015) produced flood inundation, depth and hazard maps for the Gawler River floodplain for the 50, 100 and 200-year Average Recurrence Interval events.

In 2016 a study of flood mitigation options was completed (AWE 2016) providing a long list and short list of potential structural flood mitigation options.

More recently, following the major flooding event of 2016, alternative flood mitigation options were investigated and form the basis of the current Northern Floodway proposal (AWE 2017).

The key recommendations of this report included:

Recommendation 1: “River and levee maintenance should be the responsibility of a single authority that has the necessary resources and access rights to maintain the river in good condition from a flood conveyance as well as biodiversity perspective.”

Recommendation 2: “River condition and levee maintenance repair work should be undertaken as a matter of high priority.”

Recommendation 3: “The GRFMA proceed with developing concept designs for the establishment of a Northern Floodway, in addition to the construction of a new river levee system so that consultation with affected landholders can proceed.”

Recommendations 2 and 3 are the subject of this prospectus document.

2.3 Quantifying flood risk and the economic cost of flooding

Historically, major overtopping of the banks of the Gawler River occurred for much of the river’s length for events larger than a 10-year ARI. Significant flooding commences within the Gawler township from both the North Para Rivers (AWE 2016). For the 100 year ARI event, flooding within Gawler itself can be expected, but is largely contained within the river valley. Downstream of Gawler, major breakouts commence immediately downstream of the Northern Expressway.

The 2015/16 modelling of the 100-year ARI flood, depicted on Figure 2.3, indicates a series of major breakouts occur around Boundary Road, where a significant proportion of floodwaters spill to the north towards Lewiston and Two Wells. Further, smaller breakouts occur downstream of Boundary Road, including spill to the south which will impact the Virginia township and associated growth precinct. Floodwaters overtop the major A1 transport route, Port Wakefield Road, before flowing around the proposed Buckland Park development area to the sea.

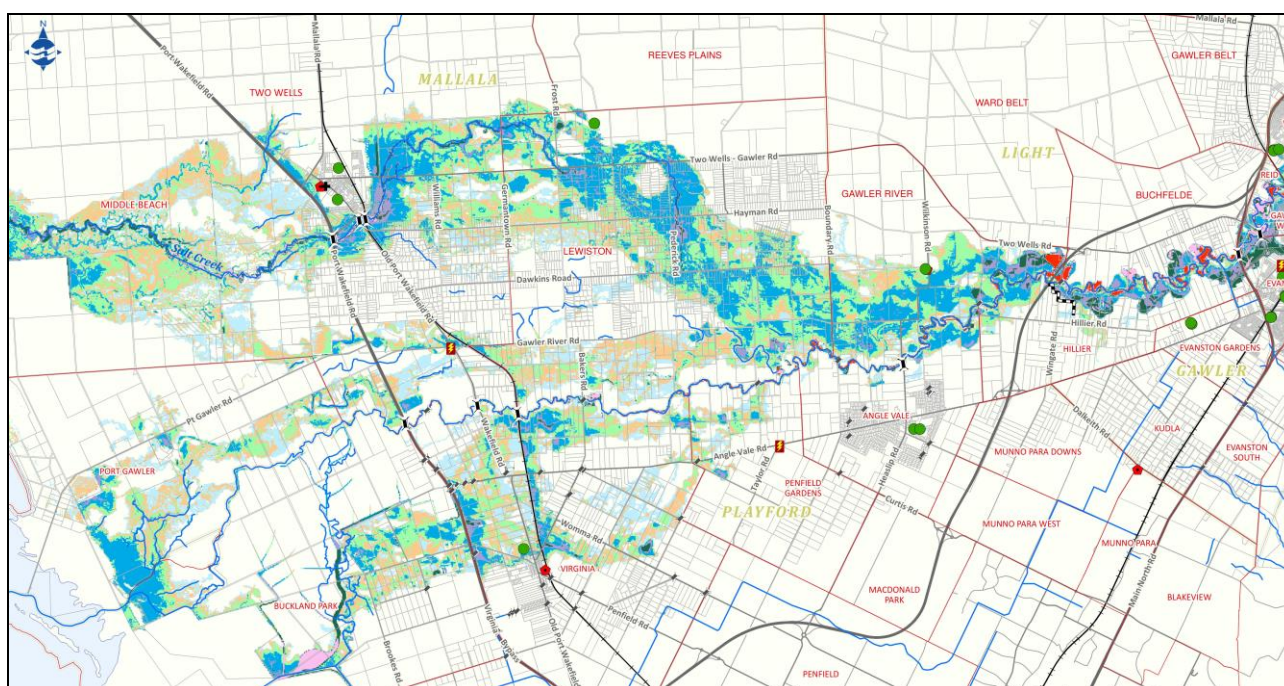


Figure 2.3 100 year ARI inundation (AWE 2015)

Flood hazard assessments undertaken in 2016 quantified the flood risk across the floodplain as low, medium, high or extreme flood risk. Hazard is the product of depth and flow velocity, and can be used to describe the direct risk to people presented by flooding. Figure 2.4 provides an indication of the number of flood affected residential properties classified according to flood risk.

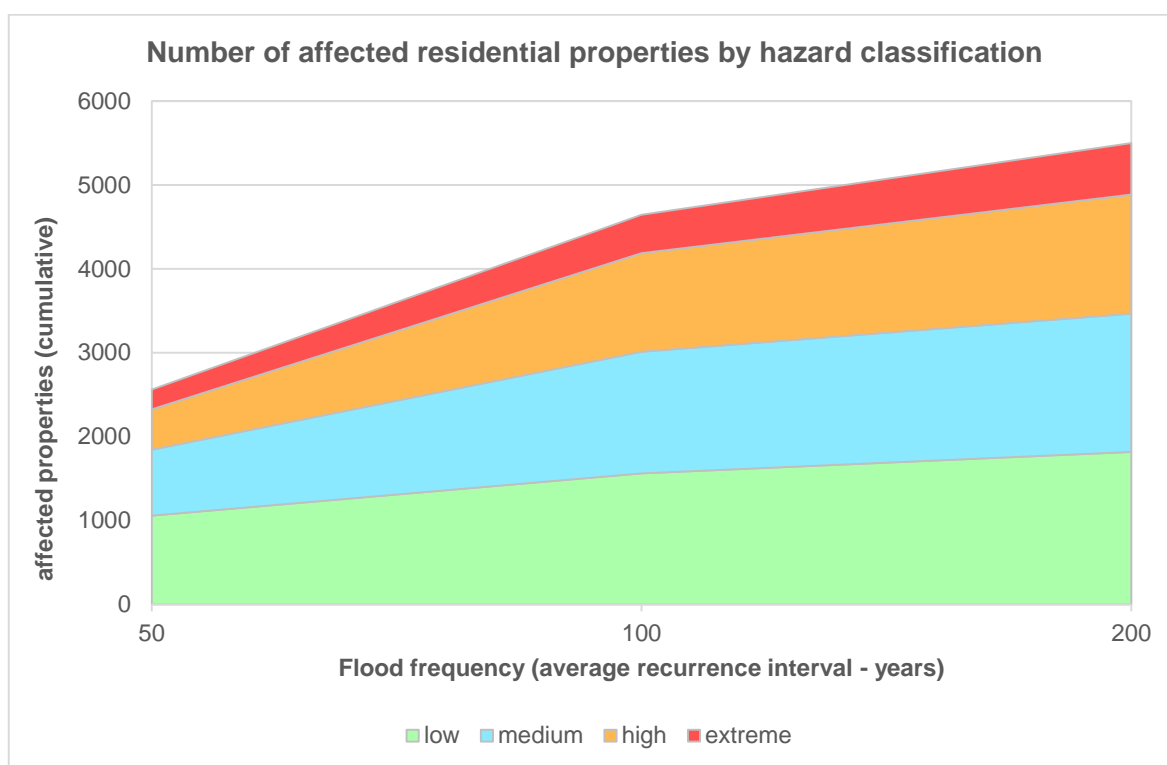


Figure 2.4 Affected residential areas by hazard classification (data from AWE 2015)

Much of the floodplain area is prime horticultural and agricultural land, which continues to expand and forms part of the Northern Food Bowl. The population centres of areas of Angle Vale, Two Wells and Virginia will also continue to grow under the 30-year growth plan for Adelaide, with growth in some areas, including Virginia, currently limited by flood risk.

Flood damage estimates for the existing floodplain condition were prepared in 2016, following construction of the Bruce Eastick North Para Flood Mitigation Dam, which has reduced the impacts of flood events less than the 50-year ARI event, particularly within the Gawler township. These estimates are summarised in Table 2.1.

Table 2.1 Estimated flood damages (AWE 2016)

Flood frequency (ARI)	Estimated damage
10 years	\$15m
20 years	\$24m
50 years	\$102m
100 years	\$182m
200 years	\$212m
Probable maximum flood	\$450m (assumed)

The average annual damage was calculated at \$7.4m, with the present value damages at \$109m.

The costs include direct tangible costs including damage to buildings and contents, public infrastructure, export crops and grazing land; and indirect tangible costs including emergency response, relief costs and grants, clean up and emergency accommodation. Intangible costs such as the value of lost business or social/emotional damage are not included, and therefore the true cost of floods is likely to be greater.

The damage assessment also provided an indication of the number of properties (allotments) affected by floods of various magnitudes as summarised in Figure 2.5. This includes those properties which experience over floor flooding only.

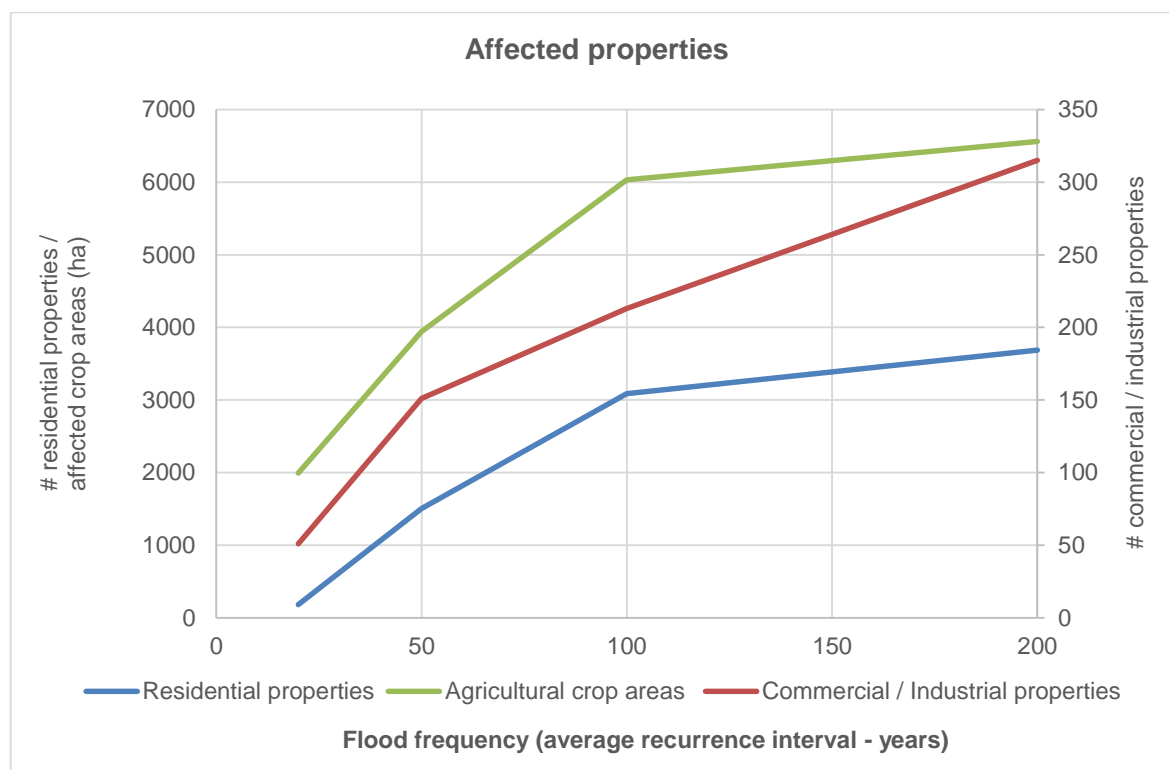


Figure 2.5 *Estimated number of properties affected by over-floor flooding (data from AWE 2015)*

These estimates are based on the existing catchment development state, and do not take into account potential damages associated with the expanding residential, commercial and industrial development associated with the 30-growth plan for Adelaide, nor expanding primary production, horticultural and rural lands associated with the Northern Food Bowl. It also only values loss to export crops, and therefore including local crops increases the damage estimates.

2.4 Managing flood risk

Flood protection, or the management of flood risk within the Gawler River catchment cannot be achieved by any single infrastructure solution, principally due to the significantly diminishing capacity of the river channel heading west across the floodplain, and limits on the size of flood mitigation storage that can be constructed upstream.

Flood mitigation within the overall catchment is based upon a number of elements, some of which are part of the overall flood management plan for the Gawler River, and some which pre-date these plans or have been constructed privately. Works generally fall into the category of:

- Upstream, catchment scale flood mitigation, as part of the Gawler River Flood Mitigation Scheme Mark I (and potential future works):
 - North Para River flood mitigation works – Bruce Eastick North Para Flood Mitigation Dam
 - South Para River flood mitigation works – amendments to the reservoir spillway
- Localised flood mitigation
 - Gawler township – minor works in and around Gawler township
 - Existing lower Gawler River flood levees.

- Lower Gawler River flood mitigation works, as part of the Gawler River Flood Mitigation Scheme Mark II – currently under consideration as the Northern Floodway proposal.
- Non-structural flood management – including development controls and other measures such as flood forecasting and flood warning systems.

North Para flood mitigation works

The Bruce Eastick North Para Flood Mitigation Dam was constructed in 2007, providing detention storage on the North Para River. It currently provides significant detention capacity for events up to a 40-year ARI, but has limited effect on events of 50-year ARI magnitude and greater. The 2016 flood event demonstrated the effectiveness of the dam for a 20-year ARI event, reducing the flood peak at Gawler from an estimated 270 m³/s (no dam) to 130 m³/s (with dam). It is expected that serious flooding through Lewiston and further downstream towards Two Wells could have been expected without the dam.

An assessment by AWE (2016) indicated that raising the existing dam crest by around 10 m, and thereby increasing the dam's capacity, would significantly improve the flood protection within Gawler and some distance downstream in a 100-year ARI event.

A feasibility investigation has been undertaken (AECOM 2017) by the original dam designers, which found that there are no technical fatal flaws identified with raising the dam wall by 10 m, however there are a number of challenges to be addressed.

Whilst the dam will provide substantial flood protection to Gawler and for some distance downstream, it is not anticipated that the dam will provide 100-year ARI flood protection along the entire length of the river. Similarly, the northern floodway will not provide flood protection to upstream areas including Gawler and Two Wells.

Notwithstanding this, further investigations into the dam enlargement have been deferred, pending the outcome of the Northern Floodway project.

South Para flood mitigation works

The South Para Reservoir embankment and spillway was not designed originally for flood attenuation, but for water storage. One of the key recommendations of the 1994 flood management plan was to modify the embankment and spillway to provide active flood storage on top of the reservoir storage.

These works were completed in 2012, and provide 100-year flood storage for the South Para River within the reservoir. The 2016 event was the first major flood event since completion of the works. The works proved effective, with discharge from the reservoir less than would have occurred prior to the spillway works.

Gawler township

A significant length of levees exist within the Gawler township which have been constructed in a piecemeal fashion over time in an attempt to resolve localised flooding issues. The condition and effectiveness of these levees varies.

As part of the Northern Expressway construction, a localised levee system was constructed on the southern side of river, in the vicinity of Wingate Road, aimed at 'funnelling' floodwaters towards the main Gawler River crossing and thereby managing flooding impacts that may otherwise have been caused by the expressway embankment. A side spillway on the northern side of the river, flood bypass channel and second bridge opening also assists in managing floodwaters in the 100-year event at this location. Whilst a secondary consideration, the levee system has resulted in some localised reduction of flooding on the southern side of the river, upstream of the expressway.

Lower Gawler River

Much of the lower Gawler River is flanked by levees, either naturally formed or manmade/re-engineered to provide flood protection to floodplain properties. These levees are generally in a poor state of repair and are prone to breach and/or failure during significant events such as 1992, 2005 and 2016.

An inspection of the levees on the southern side of the river between Heaslip Road and Old Port Wakefield Road was attempted in 2016, following the flood event (Tonkin Consulting 2016). The state of disrepair was such that only around 45% of the roughly 12.5 km of levees were able to be traversed, due to a combination of dense vegetation, lack of access and general safety concerns.

Non-structural measures

Catchment-wide flood management within the Gawler River catchment will ultimately include a combination of structural and non-structural flood mitigation measures.

Non-structural measures such as a total flood warning system and more effective and consistent planning measures to manage new development are the most cost effective non-structural mitigation solutions.

Flood preparedness

Flood preparedness is a key non-structural means of reducing damages as a result of a flood. Flood preparedness involves making people aware of flood risk and how to best respond. There are four key elements to flood preparedness, or a *total flood warning system*:

- **flood awareness:** community awareness programs to enable landholders, residents and business owners to effectively respond to the onset of flooding
- **flood warning:** there is currently an effective flood monitoring system in place for the Gawler River catchment, managed by the Bureau of Meteorology (BOM). This consists of a series of automatic rain gauges and water level recorders, with data accessible in real time via the web. The BOM issue flood watch and flood warning services for the Gawler River catchment. Typically, 12 hours or more of warning can be provided for an impending flood.
- **flood response:** response of emergency services agencies, Councils and the general community during a flood which can impact on flood damages.
- **flood recovery:** assistance to flood-affected residents and businesses once the floodwaters have receded. The recovery phase post flood is critical to reducing social disruption and long lasting health issues associated with trauma.

Development / planning controls

Planning controls typically involve setting floor heights above the predicted flood level for the design flood. If applied correctly this measure will not substantially change the flood behaviour across the floodplain. Increased resilience can be achieved by incorporating a freeboard allowance above the design flood level; the higher the freeboard the greater the resilience.

Development and planning controls are implemented within each Council's development plan.

3 What is the Northern Floodway?

3.1 The proposal

The Northern Floodway concept, and associated works were investigated following the flooding of 2016. The Gawler River 2016 Flood Review Project Report (AWE 2017) made the following recommendations:

Recommendation 1: *“River and levee maintenance should be the responsibility of a single authority that has the necessary resources and access rights to maintain the river in good condition from a flood conveyance as well as biodiversity perspective.”*

Recommendation 2: *“River condition and levee maintenance repair work should be undertaken as a matter of high priority.”*

Recommendation 3: *“The GRFMA proceed with developing concept designs for the establishment of a Northern Floodway, in addition to the construction of a new river levee system so that consultation with affected landholders can proceed.”*

Recommendations 2 and 3 collectively form the ‘Northern Floodway’ proposal.

There are three primary elements forming part of the overall concept:

- Levee improvements (immediate and long term) and ongoing maintenance
- River channel works – including strategic sediment and vegetation removal and revegetation – and ongoing maintenance
- A new levee and Northern Floodway system downstream of Old Port Wakefield Road.

Recommendation 2 acknowledges that there are immediate issues that could be addressed to reinforce the levee system and reinstate channel capacity at known problem locations whilst the longer-term, more significant mitigation strategy is progressed. Whilst the channel works forming part of Recommendation 2 are not considered effective at mitigating large-event flooding in their own right, it is expected that these would provide an immediate benefit during smaller, more frequent events. Recommendation 2 and 3 are complementary, with the investigation and implementation work associated with Recommendation 2 forming the early stages of Recommendation 3.

Levee improvements

Existing levees are mostly in very poor condition due to either poor construction originally, or a lack of maintenance over time. Sections of levee banks have failed during historical floods, including 1992, 2005 and 2016.



Figure 3.1 *Levee breach during 2016 flood event*

In the short term, as part of Recommendation 2, the works will involve repairs to damaged levees (which in some areas may require complete replacement), and those sections of levees considered to be most vulnerable to failure during the next flood.



Figure 3.2 *Example of levees in need of immediate repair*

In the longer term, the majority of levees between Pederick Road and the Railway bridge (and potentially upstream of Pederick Road) will need complete replacement with appropriately engineered flood levees of sufficient height and cross section to fulfil their intended flood mitigation function, whilst also being accessible for safe long-term maintenance.

Ongoing maintenance will include managing weed growth, erosion and bank stability. It is recommended that these actions rest with a single authority with the responsibility and resources necessary.

Channel works

As part of Recommendation 2, the “no regrets” actions anticipated to provide some immediate benefit in terms of reducing flood risk include:

- Sensitive removal of pest and nuisance plants and revegetation as necessary with appropriate native plants species that will not unnecessarily impede flood flows.
- Sensitive removal of accumulated sediment around key structures such as the Railway bridge, Baker Road crossing, Old Port Wakefield Road Bridge and the Port Wakefield Road highway bridges that is impairing the capacity of these crossings to convey flow through them.

Whilst simple in nature, these works are somewhat complicated by the fact that the river is currently under private ownership with property boundaries (and the local government boundary) being near the centre of the river.

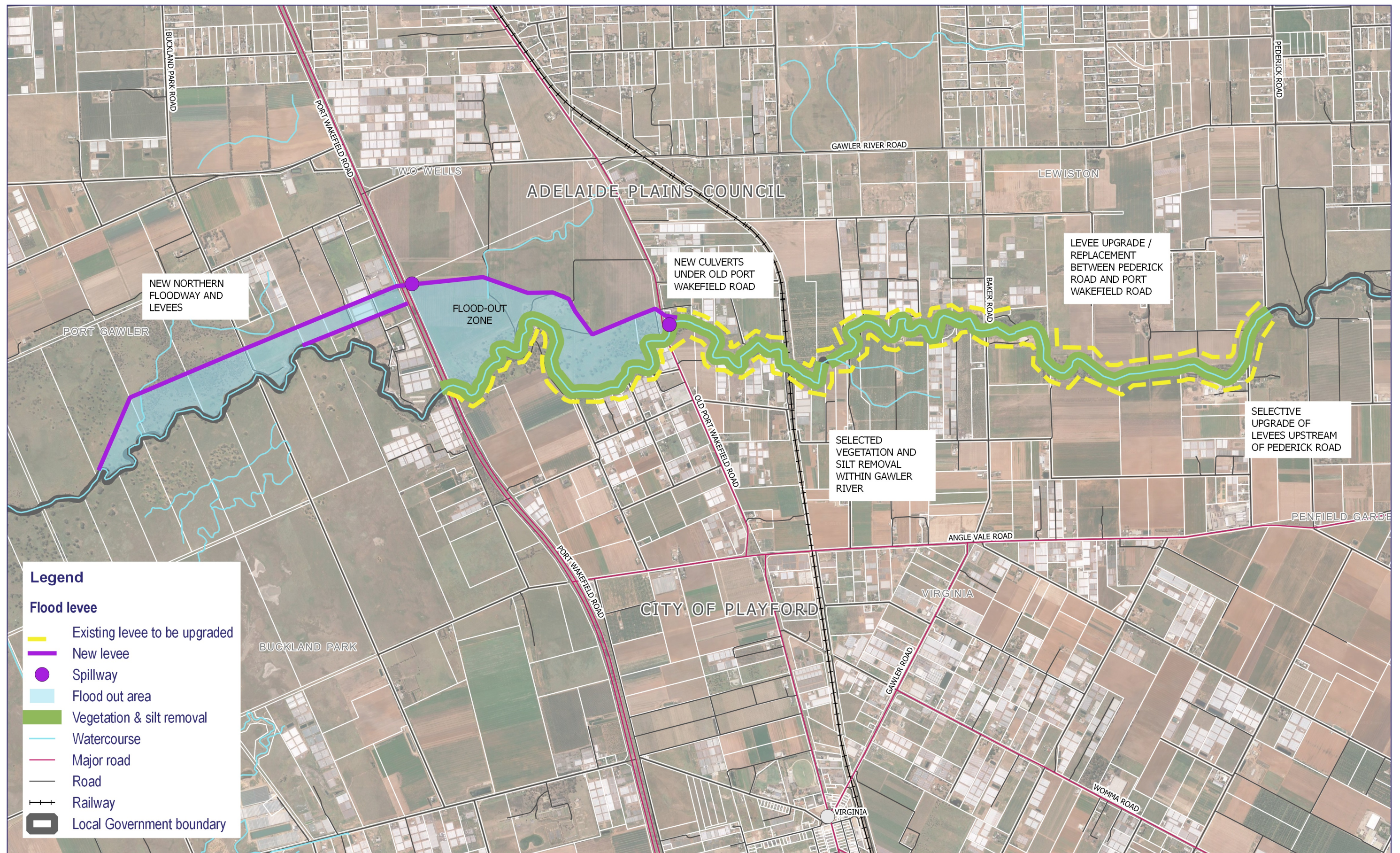
Consideration will also need to be given to the effect that weed and silt removal will have on short and long-term bed and stream bank stability. Successful revegetation with appropriate species will be key to long-term management of this potential issue.

New levee and northern floodway works

The new levee and floodway works referred to as the Northern Floodway is comprised of the following:

- Levee Bank improvements from Pederick Road (and potentially further upstream) to the Rail Bridge east of Old Port Wakefield Road
- A side spillway on the northern bank of the Gawler River upstream of Old Port Wakefield Road to divert water into the floodway
- New culverts under Old Port Wakefield Road to provide sufficient capacity for floodway flows. This includes raising a section of Old Port Wakefield Road to the north.
- A new levee system to contain flows within a designated flow path on the northern side of the river to Port Wakefield Road.
- A second spillway on the levee upstream of Port Wakefield Road to allow overtopping further to the north in large events, but preventing flooding north of Gawler River Road.
- A new levee system on the floodplain to the west of Old Port Wakefield Road to contain flows within a designated flow path north of the river, then directing flows back towards the main river channel towards the western extent of the Buckland Park development area.
- Flows will spread out through the floodplain from this point, or be guided through the Buckland Park residential development, should it be developed.

The proposed works are illustrated in Figure 3.3.



3.2 Why is the floodway needed?

Due to the naturally diminishing capacity of the Gawler River channel as it flows west, it is not feasible to rely on any single flood mitigation solution to control flooding for the river's entire length during significant flood events.

Whilst flood control dams are very effective at reducing flood peaks, there is a limit to their size, and therefore the extent to which they can mitigate flows.

The existing Bruce Eastick North Para Flood Mitigation Dam on the North Para River is extremely effective at reducing flood peaks, at least for events up to and including a 20-year ARI event. This was demonstrated during the 2016 flood in which the estimated flood peak at Gawler was reduced from 270 m³/s to 130 m³/s. Despite this substantial reduction, the 2016 flood also demonstrated that even the reduced flood peak of a 20-year ARI event can cause substantial flooding in the lower reaches of the river.

The effect of increasing the capacity of the Bruce Eastick North Para Flood Mitigation Dam by raising the dam wall by 10 m was investigated in 2016 (AWE 2016). The modelling indicated that in a 100-year ARI event the flood peak could be reduced from 635 m³/s to 170 m³/s at Gawler. Whilst this has a substantial benefit to the Gawler Township and properties and townships on the northern side of the river, breakouts still occur on the southern side of the river near Virginia and horticultural areas will be subject to flooding, presumably in a similar manner to that which occurred in 2016. The peak discharge from the enlarged dam in a 20-year event would not change substantially, and therefore these works would not have prevented the flooding which occurred in 2016.

This indicates that even with a larger upstream flood mitigation dam, supplementary flood mitigation works are required in the lower reaches of the river to prevent flooding of property, closure of roads and potential damage to infrastructure.

The Northern floodway has been assessed as the preferred means of achieving the desired flood protection.

3.3 Are there any alternatives?

A number of possible flood mitigation solutions for the Gawler River have been investigated since the original Flood Management Plan completed in 1994.

In addition to those works already completed (South Para Reservoir works and North Para flood control dam), a summary of the options identified is provided below. Some have been examined in detail by way of modelling and costing, others were discounted early on the basis of expected triple bottom line implications.

Table 3.1 *Flood mitigation alternatives explored over time*

Option	Description
1994 Flood Management Plan (BC Tonkin & Associates)	
Parallel floodway between Gawler and Port Wakefield Road.	Construction of levees both sides of the river to create a 450 m wide floodway on the northern side of the river. Deemed to have high cost due to major earthworks and unacceptable environmental impacts.
Channel enlargement (to either 200 or 400 m ³ /s)	Deemed to have high cost due to major earthworks and unacceptable environmental impacts.

Option	Description
Off-stream storage	Storage on northern side of river upstream of Heaslip Road with low flow discharge to Salt Creek. Would not achieve 100 year ARI standard, unless combined with a second option such as channel widening. Therefore, not considered feasible due to high costs.
2016 Mitigation Options investigation (AWE 2016).	
Channel modifications	Modelling was used to determine the effectiveness of removing dense vegetation from within the river channel. The effect on flood conveyance was found to be minimal. As part of the same exercise, consideration was given to increasing the channel capacity by widening the base and steepening banks. This option was not considered further due to anticipated costs and the environmental impacts.
Flood bypass	Two flood bypass options were identified: <ul style="list-style-type: none"> Following the main breakout flowpath through to Salt Creek. Following an alignment alongside the main river channel for the full length. This option is similar to that investigated in 1994. These options were not considered further due to the substantial earthworks required and the expected social and environmental impacts on properties.
Levees	Whilst strategic levees to protect higher density areas of residential and horticultural development were considered further (refer below), widespread levees along the entire length of the river were not considered further due to the upstream flooding impacts they can cause, risk of failure and flooding impacts caused outside the flood zone when overtopped.
Retarding basin downstream of Gawler	No considered a viable option due to the large land area required, high costs and high social and environmental disruption.
Strategic levees in the lower Gawler River floodplain to protect higher density residential and horticultural development (Gawler, Two Wells, Virginia)	A shortlisted option as part of the 2016 study. Involved three sets of strategic levees to protect areas of higher density development whilst minimising upstream or downstream impacts. The levees targeted Gawler, Two Wells and Virginia. Whilst protecting higher density areas, with a specific focus on residential development, the levees would do little to prevent flooding of agricultural, grazing and horticultural areas. This is a less costly, but less effective option to the Northern Floodway.
2016 Flood Review Report (AWE 2017)	
Channel widening and levee improvement works to contain peak flows within the main river channel between Gawler and Port Wakefield Road.	Investigated in detail by modelling. Similar to options identified previously. To provide 100 year ARI standard, solution involves widening the channel to 20 m between Baker Road and Old Port Wakefield Road, and to 30 m downstream of Old Port Wakefield Road. Also requires levee improvement works. Costs expected to be excessive (four times the Northern Floodway) with significant environmental and cultural impacts.

Option	Description
Desilting and vegetation removal within the river channel and construction of a new outlet channel from Buckland Park lake to the sea.	<p>Similar to that identified in 2016.</p> <p>Involves deepening the river bed by 1 m over a 15 km length, clearing vegetation and constructing a new outlet channel downstream of Buckland Lake.</p> <p>This option was found (by modelling) to have limited effectiveness during large flood events.</p>
Northern Floodway	Preferred option, as identified above.

The two options investigated in detail as part of the most recent work (AWE 2017) both provide a similar level of flood protection, improving flood protection to over 230 properties. The Northern Floodway option provides a similar degree of protection to the channel widening, but can be achieved at a much reduced cost and without the significant environmental, cultural heritage and social implications associated with channel widening.

It is acknowledged that the Northern Floodway is not the preferred option for all parties, however on the balance of the assessments undertaken it provides significant benefits whilst managing cost, environmental and social consequences.

3.4 What are the benefits?

To date the Northern Floodway has only been analysed in detail for the 2016 flood event, estimated to represent roughly a 20-year ARI event. Although not tested under larger flood events (50 or 100 years) it is assumed that the floodway will also perform well in a 50-year ARI event.

Future modelling is expected to confirm whether, with minor amendments, the floodway is capable of achieving a 100-year standard, and if so it is anticipated that this level of protection would be a significant selling point for securing community support (AWE 2017). It is acknowledged that no community consultation has been undertaken to date, and so there is no clear understanding of the community's expectations of flood immunity.

Damage calculations have not yet been undertaken to quantify the expected reduction in average annual flood damages or the post-mitigation present value of damages needed to calculate the cost benefit ratio. In non-monetary terms, purely on the basis of the modelling undertaken for the 2016 flood event, the following benefits are anticipated to result from the Northern Floodway implementation:

- Protection of 211 of the 248 properties estimated to be flooded in 2016. Reduced flooding in a further 10 properties. Similar protection is expected in the 50-year event.
- Substantially reduced flood damages through the protection of the high value horticultural lands around Virginia.
- No flooding of the existing Virginia Township or re-zoned residential / deferred urban areas within the Virginia Growth Precinct.
- No overtopping of Port Wakefield Road, maintaining the critical A1 transport route.
- Reduced flood hazard and impacts on local access and emergency evacuation routes, such as Angle Vale Road, through reduced flooding.
- Improved biodiversity within the Gawler River channel system as a result of selected vegetation removal, replanting with native species and a planned regular maintenance program.

The above benefits relate to the 2016 flood event, of estimated 20-year ARI magnitude. Further modelling will be required to quantify the benefits during other flood events and residual risks for larger events. It is noted that Port Wakefield Road also overtops further north, near Two Wells, during larger flood events.

The expected reduced extent of flooding for the 2016 event with the Northern Floodway constructed is illustrated in Figure 3.4. The areas expected to be flood free are shown in green.

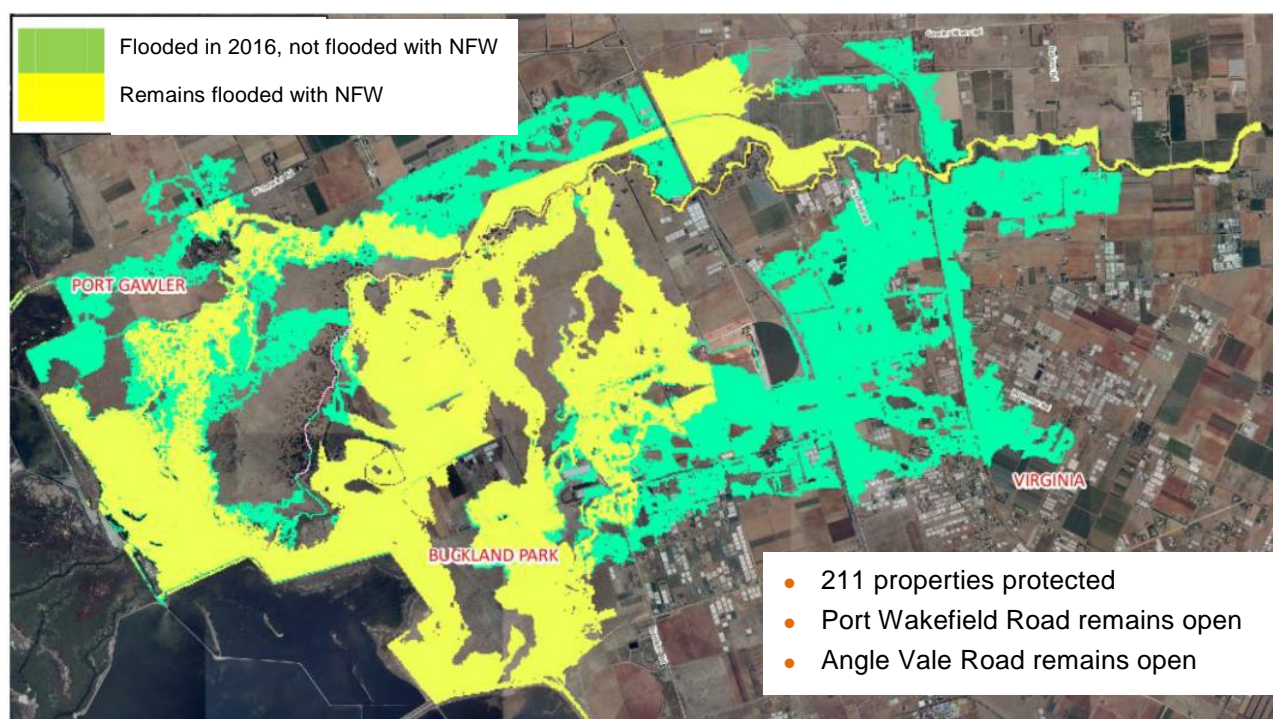


Figure 3.4 Expected reduced extent of flooding for 2016 event with floodway constructed
(Note: this modelling assumes the Buckland Park development is not completed.)

4 Progressing the project

4.1 How will the project progress?

To date a desktop only study has been completed to determine the feasibility and effectiveness of the Northern Floodway concept. This has relied upon the results of hydraulic modelling to inform the infrastructure requirements such as the need to upgrade existing levees, culverts and bridges, and the need for new levees and floodways. No site investigations have been undertaken to validate the project's feasibility, and to date stakeholder consultation has been limited to the Technical Assessment Panel and Northern Floodway Working Group.

The current estimated project cost of \$27m has been estimated on the basis of the desktop investigation and modelling (AWE 2017).

In order to progress the implementation of the Northern Floodway works (Recommendations 2 and 3) a number of key investigations and further work will be undertaken.

This section outlines this work, describing why it is needed and briefly what is required. It is likely that the need for additional studies or investigations may be identified as the project progresses.

The works are structured into a number of key project 'stages', as depicted in Figure 4.1. The scope of works required for future stages will be reviewed throughout, or at least at the conclusion of each stage. Figure 4.1 also indicates some of the key feedback loops likely to occur as the project progresses. The significance of the feedback loops is that it recognises that at points during the project things may be discovered that require some revisiting of previous work.

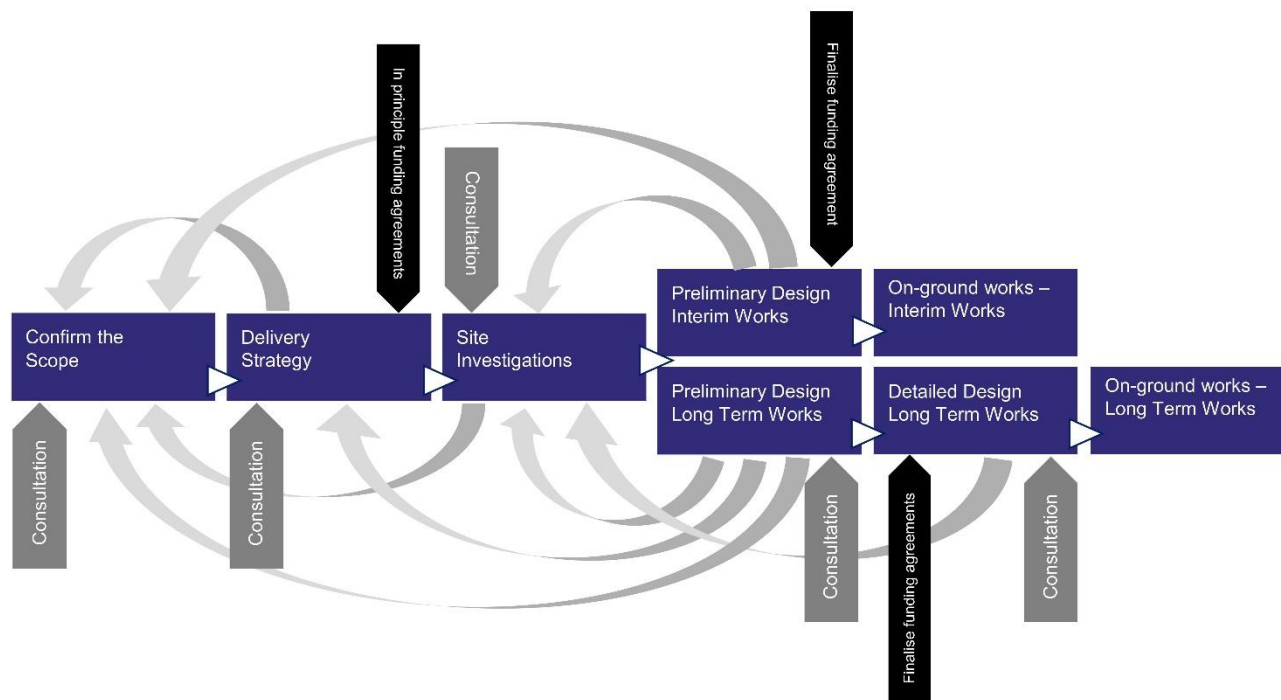


Figure 4.1 Key project development elements

It is proposed to progress the river condition and immediate repair levee works (Recommendation 2) as a matter of priority, subject to funding, establishment of landholder access agreements and approvals to undertake the works. It is anticipated that the necessary funding and approvals for the immediate works could be gained within a shorter timeframe than

the work required to enable commencement of on-ground works associated with the Northern Floodway and levee replacement.

Notwithstanding this, it is expected that the scope confirmation / ground truthing phase will need to be completed, prior to progressing further with either recommendation.

Extensive consultation will be undertaken throughout all stages of the project's development, along with regular review of the risk profile and review and updating of the project's estimated cost at key milestones.

4.2 Confirm the scope

A key first step in progressing both Recommendation 2 and 3 will be to confirm the scope of works necessary to achieve the desired level of flood mitigation. This will be achieved through a combination of additional modelling, site investigations and early engagement with stakeholders.

Tasks will include:

- **Clearly defining the project objectives** – what standard of protection is the project aiming to achieve, and how does this relate to the overall flood mitigation plan for the wider catchment/floodplain. This will include determining stakeholder/community expectations for flood protection.
- **Additional flood modelling**: modelling of additional design flood events from 20-200 years. It is suggested these be modelled with and without the enlarged Bruce Eastick North Para Flood Mitigation Dam. Based on the outcomes of the 100-year ARI modelling, an assessment can be made as to what standard of flood immunity can be achieved with the current concept or minor additional works.
- **Climate change assessment**: current climate change predictive models estimate that whilst the climate is expected to become warmer and drier, the intensity of rarer rainfall and flood events is likely to increase. The additional modelling will include a sensitivity analysis of altering rainfall intensity to determine the impact this has on peak flows and the effectiveness of the flood mitigation solutions.
- **Consider staging**: Consideration will be given as to how the works can be staged such that implementation of some works does not increase the flood risk in other areas until such time as the whole of the works are completed.
- **Damage estimates**: The results of the modelling can be used to estimate the reduction in flood damages (per event, average annual, present value) by completing the works (future flood damages avoided). This will form a key input to the estimation of the project's benefit-cost ratio.
- **Ground truthing / site walkovers**: this will include:
 - **Further inspection of existing levees** (where feasible) to determine those sections in need of immediate remedial works to improve function and reduce the risk of failure and/or overtopping in the short term.
 - **River condition survey**, including vegetation assessments and identification of areas of silt build up. This will inform the scope of works for vegetation removal and silt removal.
 - Preparation of a spatial data layer documenting river and levee condition.
 - **Ground truthing** of new levee and floodway proposals to refine and/or confirm the conceptual alignments and infrastructure upgrade requirements.
- **Redefine/confirm scope** on the basis of the outcomes of the additional modelling and ground truthing.
- **Early consultation** / presentation of information: The approach to consultation is discussed further in Section 5. Prior to consulting in earnest with stakeholders, including the wider

community, it is considered important to achieve the right balance between having sufficient information on the proposed works (e.g. footprint, benefits) whilst consulting early enough such that the community feels that they have an opportunity to provide feedback. The additional modelling and ground truthing is expected to provide sufficient information to enable commencement of the detailed engagement process.

- **Adjust / confirm preliminary cost estimates:** Existing high level capital cost estimates will be refined following confirmation of the scope. This will include splitting the cost estimate in accordance with the proposed staging, in particular costs associated with the river condition works, levee improvements and Northern Floodway works.
- **Determine first order cost–benefit:** based on the outcomes of the additional modelling, damage estimates and revised cost estimates.

4.3 Delivery strategy

A clearly defined delivery strategy for such a complex project is a must to manage risks, capitalise on opportunities, keep the project on track from a time and budget perspective, and ensure that the support of stakeholders and the broader community is firstly gained, and then maintained over the long term.

Governance and project management framework

The GRFMA is currently undertaking a review of its Charter and Governance framework. This review will consider the cost sharing arrangements for the GRFMA operations and confirm the representation, roles and responsibilities of the various groups / panels.

A separate consultation process with Constituent Councils, outside the annual budget process, will be undertaken, as appropriate, by the GRFMA on the solution designs, costings and funding mechanisms required by Local, State and Federal Governments and other funding partners. Councils and the GRFMA will then subsequently agree the most appropriate process to recognise and achieve required contributions.

In order to manage the implementation of the Northern Floodway works, it is intended that a Project Management Group be established to direct the program of works, with a Project Manager appointed to facilitate implementation.

The draft proposed structure is shown in Figure 4.2.

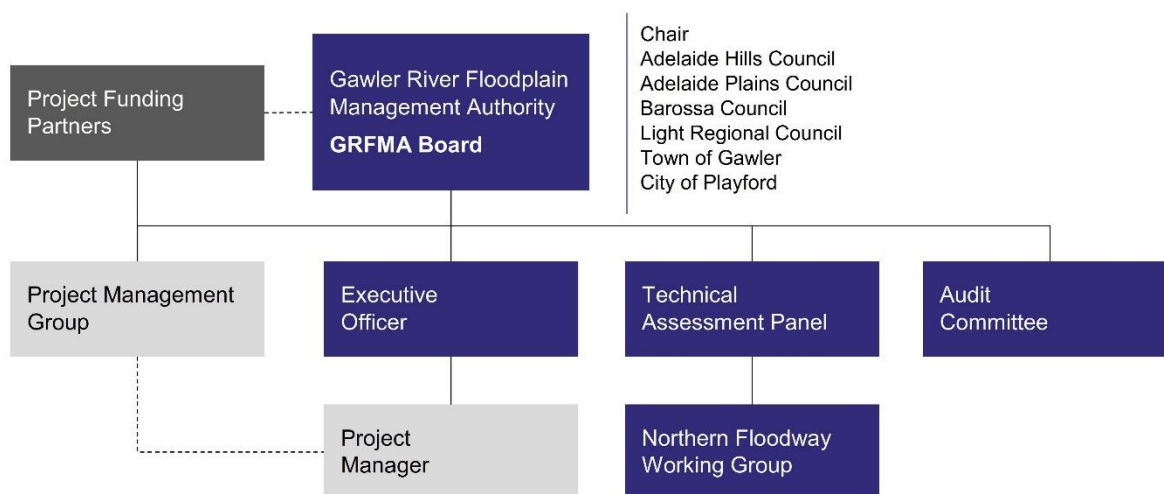


Figure 4.2 Draft proposed GRFMA structure

Ownership and land tenure

A critical aspect of progressing the project will be addressing land tenure considerations to enable the proposed works to be completed/constructed, and to enable the river and levees to be maintained long term in accordance with the endorsed recommendation of the 2016 Flood Review report.

In accordance with Recommendation 1 of the 2016 Flood Review project report “*River and levee maintenance should be the responsibility of a single authority that has the necessary resources and access rights to maintain the river in good condition from a flood conveyance as well as biodiversity perspective.*”

The works are expected to be located entirely within the Adelaide Plains Council and City of Playford local government areas. The local government boundary is approximately down the centre line of the river. Given that the works are split between two local government entities, it is proposed that the ownership and future management of the river and levees will rest with the GRFMA.

With the river currently under private ownership, a change to the land ownership and/or tenure will be required to afford the GRFMA these rights.

Options are likely to include:

- outright purchase and freehold tenure of the main river channel and land required for flood mitigation works ('subject land') with potential lease back options
- establishment of an easement over the subject land
- establishment of land management agreements over the subject land
- a combination of the above.

Outright purchase is likely to be the most costly option, but will afford the GRFMA the greatest control over the land long term. Conversely, establishment of a land management agreement whilst less costly, may not achieve the rights required by the GRFMA for long term management of the river and any associated assets.

Under the GRFMA's Charter, the Authority does have the power to compulsorily acquire land in accordance with the Land Acquisition Act 1969 for the purposes of flood mitigation. Whilst acquisition by negotiation is preferred over compulsory acquisition, it may be that right must be exercised in some cases.

The services of a land access, valuation and property consultant will be sought to examine options and provide recommendations for land access and acquisition. This will include assessment of affected properties (based on the expected footprint), extensive consultation and negotiation with affected landholders, land valuation and an estimation of the costs of acquisition or otherwise.

Planning requirements and approvals

Planning and approval requirements will be determined early in the project to minimise the risk of delays to the project associated within gaining approvals.

It is unlikely that the immediate works will require approval under the *Development Act 1993*, assuming no regulated or significant trees will be removed. Approval is likely to be required under the *Natural Resources Management Act 2004*, with clearance of native vegetation approved under the *Native Vegetation Act 1991*.

The construction of the levee banks and spillway (long term works) is likely to require planning approval under the Development Act.

Given the development straddles local government zone boundaries, an option involves requesting the Planning Minister to have the application assessed by the State Commission Assessment Panel (SCAP). Alternatively, as the proposed development:

- Is not listed within Schedule 10 (Decisions by the Development Assessment Commission (now SCAP)) of the Development Regulations
- Is not captured by Section 49 (Crown development and public infrastructure) of the Development Act

each Council can assess (grant Development Plan Consent) the component of the proposed development that is relevant to its area.

The approvals pathway, and full list of approvals required will be determined as part of a planning study to be completed in the early stages of the project.

Existing zoning

A 50 m Conservation zone within Adelaide Plains Council exists on the northern side of the river (from river centre line), along with a 100 m Metropolitan Open Space System (MOSS) zone within the City of Playford on the southern side of the river (from the river centre line). Outside of the conservation zones, the northern floodway will be constructed within land zoned Primary Production within Adelaide Plains Council.

In each of these zones, land division is allowed for the purposes of flood mitigation works.

Procurement options

As part of the project planning and determination of the delivery framework, procurement options for the on-ground delivery of works will be considered.

Options include:

- Traditional design, tender, construct
- Design and Construct
- Early Contractor Involvement

Different packages of work may be delivered via different procurement models, for example detailed design of immediate works may not be required. The works may be better procured via a design and construct contract, working to a defined scope of works and performance/technical specification. This depends on the potential for innovative approaches in method to improve project value vs. potential additional costs associated with the transferral of risk.

Regardless of the procurement approach adopted for the Northern Floodway works, given the challenges associated with some elements of the work (for example, levee replacement) there would be benefit to seeking input from a construction contractor to address constructability issues and how these might influence the design or project costs. This will be subject to effective management of any potential probity issues.

A part of the procurement investigation, consideration will be given to staging based on priority areas, access limitations, any legal issues associated with land purchase or access and budget availability. Availability of materials for levee construction within the region may also require consideration.

Risk planning and management

The success of such a significant project will be dependent upon effective management of project risks and opportunities. In the early stages of the project a risk planning workshop will be undertaken with a range of project stakeholders to identify key risks and opportunities, and how these will be managed to reduce the likelihood of risks jeopardising the project's success, along with how the design can capitalise on any opportunities.

A risk register will be prepared which will be maintained and updated throughout the project's lifecycle.

Key risks and opportunities are likely to include:

- **Stakeholder / community acceptance:** Extensive consultation will be essential to gain stakeholder and community support for the proposal. Failure to gain this support may jeopardise the project's success.
- **Funding:** The project cost is significant, and will require financial support from all tiers of government (local, state, federal). In particular, the cost apportionment and local government's capacity to fund is considered a key project risk, should the necessary support not be gained from state and federal governments.
- **Project Costs:** To date very high level project cost estimates have been prepared, based upon very limited design detail. As the design is developed to a greater level of detail, estimates will be updated to gain further confidence in the project costs. There is a risk that as further detail is added to the estimates, the cost of the project may increase, placing pressure on any funding commitments.
- **Constructability:** Full consideration of the scope of works required, safe construction methodologies and the availability of materials within the region may influence project cost and overall schedule.
- **Access:** Much of the river and Northern Floodway alignment is under private ownership. In order to progress the project, including immediate works and site investigations, access to private property will need to be negotiated.
- **Land acquisition:** As above. The success of the long-term solution will require some property acquisition for construction of the works and effective ongoing maintenance. Negotiating property acquisition represents a real risk to the project budget and schedule.
- **Scope creep:** It is possible that a range of challenges and complexities may arise as the designs progress. Scope creep will place pressure on the project budget, and if not effectively managed may result in the need to down-scope to reduce project costs, which may in turn reduce the effectiveness of the solution.
- **Funding for ongoing maintenance:** Long-term flood mitigation within the lower Gawler River will be dependent upon effective maintenance of the river channel and levee systems. This will require an ongoing, annual commitment by each of the GRFMA's constituent Councils to fund the necessary maintenance.
- **Level of flood protection:** Optioneering to improve the level of flood protection provided, without substantially increasing costs, should be explored.

Consultation strategy

As part of the project delivery strategy, a Consultation Strategy will be prepared by an independent consultant on behalf of the GRFMA. This document will outline the target audiences for consultation, the planned methods of engagement and consultation, and the key stages at which the consultation will occur.

Further details on the intended consultation is provided in Section 5.

Project execution plan

A Project Execution Plan will be developed for each major package of works, prior to commencing with the design activities. These documents will serve as a guiding document throughout the project's implementation.

4.4 Site investigations

A range of site investigations will be undertaken at the preliminary design stage to further confirm the scope of works and cost estimates. Whilst some investigations could be deferred to the detailed design phase, undertaking these investigations at preliminary design stage will assist in the management of key project risks such as scope and budget.

Levee clearance

As a first step some clearance of dense vegetation along the alignment of existing levee banks will be undertaken, subject to approval, to enable access for surveys and site investigations. Rather than complete clearance, it is anticipated that sufficient slashing be undertaken to enable safe traverse by foot for the purposes of top of levee survey, visual inspection of levee condition and cultural heritage surveys. By minimising clearance to just that necessary to facilitate access for surveys, any immediate impacts on levee stability due to loss of vegetation will be managed.

More substantial clearance of vegetation will be undertaken as part of the reconstruction works, and at this stage consideration will need to be given to the effect that this may have on bank stability.

Engineering survey

A two stage approach to survey will be implemented.

Existing Levee banks: initially, unless sufficient information can be gained from the current digital elevation model, survey of top of bank levels will be undertaken to determine any sections of levee bank most at risk overtopping in the short term. Ultimately, survey of the levee banks' existing cross section will be undertaken to inform the detailed design of the longer term remedial works.

Alignment of new levee banks: Full engineering and cadastral survey of new levee bank alignments to inform the design process. Subject to funding, this could be deferred to the preliminary design stage.

Geotechnical investigations

Geotechnical investigations will be required for the long-term levee replacement and construction of new levees to determine the suitability of local materials for reconstruction of levees. Any levees deemed to not require significant reconstruction may also need testing to ascertain their structural integrity.

Heritage surveys

A cultural heritage investigation will be undertaken to determine any constraints and/or areas requiring management during construction. The services of a cultural heritage consultant will be utilised to initially undertake a desktop assessment, followed by any site investigations that may be deemed necessary.

It is acknowledged that the Kaurna people have recently been officially recognised as the traditional owners of the Adelaide Plains (and beyond), with native title rights granted over parcels of land not under freehold between Myponga Beach in the south and Redhill in the north. This ruling is unlikely to affect the Northern Floodway works, however will be considered as part of the cultural heritage study.

Service locating and deepthing

A services investigation to determine the location of public and private services will be undertaken to identify any significant service clashes that will require attention during the detailed design stage. Early identification of potential service clashes will enable timely engagement with service authorities and management of potential time and cost implications.

Dependent upon an initial Dial Before You Dig Search, physical service locating and depthing may be undertaken.

4.5 Preliminary design – immediate river condition and levee works

Immediate river condition works

The site walkovers, vegetation assessments and documentation of river condition are expected to largely inform the scope of works required for the interim works to improve river condition (vegetation and silt removal).

Preliminary design tasks will include:

- Documentation of the scope of works – extent of vegetation clearance and silt removal, extent of revegetation and species selection
- Consideration of the effect that weed and silt removal will have on short and long-term bed and stream bank stability and identification of management actions (revegetation or engineered solutions).
- Preparation of a technical specification
- Agreement on access requirements and provisions
- Documenting safety in design considerations
- Preparation of cost estimates, by Quantity Surveyor.

It is anticipated that this should provide sufficient information for the works to be procured via a 'design and construct' contract, with considerations such as temporary works to be determined by the contractor.

Immediate levee repair works

The scope of repair works required immediately to reduce the risk of failure during the next flood will be determined by physical inspection and top of levee survey. Repair works are likely to focus on significant low points, existing failures and locations where obvious defects indicate potential failure in the short term. The best chance of identifying high risk areas will be to undertake some clearance of vegetation on the levees to enable the whole length of levees (both sides) to be walked.

Similar to the river condition works, preliminary design will include:

- Documentation of the scope of works – extent of levee repairs required
- Preparation of a technical specification
- Agreement on access requirements and provisions
- Documenting safety in design considerations
- Preparation of cost estimates, by Quantity Surveyor.

It is anticipated that this should provide sufficient information for the works to also be procured via a 'design and construct' contract, with considerations such as temporary works and sourcing of material to be determined by the contractor.

4.6 Preliminary design Northern floodway – long term flood mitigation works

Preliminary design of the Northern Floodway, including new levee banks, will achieve notionally 70% design documentation, sufficient to more accurately determine the physical scope of works and footprint, and develop more accurate cost estimates.

The preliminary design will be based largely upon the outcomes of the scope confirmation, but reflective of the site investigations, feedback received through the consultation process and any other investigations undertaken as part of the development of the delivery strategy.

Documentation will include preliminary design drawings suitable for cost estimation by a Quantity Surveyor.

At preliminary design stage, any options for staging of the works, such as commencement of the new Northern Floodway works ahead of the existing levee upgrade works will be investigated in detail such that they can be considered in the context of project funding and management of any interim flooding implications.

4.7 Detailed design

Detailed design will include final design activities, any additional site investigations required and documentation of the works to enable tender and construction.

Final approvals will be gained throughout the detailed design phase.

At the completion of the detailed design, pre-tender cost estimates will be prepared by a Quantity Surveyor.

4.8 Procurement

Tender documentation, management of the tender process and tender review through to contract award will be required along with consideration of staging and risk allocation.

5 Early and ongoing consultation

From a community and landholder perspective there is likely to be a range of opinions and varying degrees of acceptance of the proposal presented.

Effective engagement with stakeholders and the broader community will be key to the successful implementation of the project and managing the risk of project delays and cost overruns.

The consultation process will commence early, immediately following the additional modelling and clarification of the project scope. Consultation activities will be tailored to suit the intended audience, noting that these will range from those directly affected by the works to those with an interest in the proposal and from government agencies to general members of the public. The level of support and eagerness to see the proposal implemented will vary due to factors such as reduced flooding, residual flooding (flooding not solved by the Northern Floodway) and impacts to property.

5.1 The stakeholders

A range of stakeholders will be consulted at various stages throughout the project. These will include:

- Constituent Councils, in particular Adelaide Plains Council and the City of Playford, where the works are located
- State and federal government agencies, as required to gain approvals
- Emergency services agencies responsible for flood warning and response
- Property owners directly affected by the works
- Property owners currently affected by flooding (but not by the works)
- Wider community / ratepayers
- Other special interest groups that may be identified as part of the development of the consultation strategy
- Commercial developers (e.g. Buckland Park).

The consultation strategy to be developed for the project will identify the specific consultation and engagement methods to be employed for each target audience.

5.2 Consultation activities undertaken to date

To date, no formal consultation with affected landholders or the broader community has been undertaken on the Northern Floodway concept specifically.

During completion of the 2016 Flood Review, a Working Group was established to assist the Technical Assessment Panel throughout the project (referred to as the Northern Floodways Working Group). The group comprised members of the Technical Assessment Panel plus seven landholders.

The terms of reference for the Working Group were as follows:

- Promote dialogue between landholders and the GRFMA's Technical Assessment Panel
- Contribute to the identification of flood mitigation options to be assessed for the lower Gawler River and presented to the GRFMA
- Provide feedback on the merit of the options assessed

- Identify a preferred option (or provide a short list of preferred options up to three) for presentation to the GRFMA
- Have its views and decisions noted and included within the study report.

Consultation with the Working Group throughout the development of options as part of the 2016 Flood Review indicated the following:

- It is anticipated that the Working Group would collectively agree with Recommendation 2 (immediate works)
- It is anticipated that the majority of the Working Group would agree with Recommendation 3 (long term Northern Floodway works), but some landholder members of the group would not.

5.3 Planned consultation

The stakeholder and community consultation process will be developed and facilitated by an independent consultant on behalf of the GRFMA. Following the initial consultation process, focussed on providing a summary of the project, including how and when people will be able to provide feedback, a consultation strategy will be developed for roll-out during the project development and implementation stages.

Broadly, the consultation process will aim to:

- Provide information to stakeholders and the broader community on the Northern Floodway proposal, including:
 - Flooding risk within the lower Gawler River, and why is action needed
 - Options identified previously and why the Northern Floodway is the preferred option
 - What the proposal is
 - How can interested parties provide feedback on the proposal
- Seek feedback on the proposal from key stakeholders and the broader community on:
 - Expectations for flood protection (e.g. level of protection)
 - Level of support for the Northern Floodway proposal
- Seek additional feedback from owners of properties directly affected by the works regarding their specific concerns and perceived opportunities
- Collate and summarise feedback for use during subsequent stages of the project.

The consultation process will likely entail:

- Preparation and distribution of information materials and feedback forms
- Briefings, meetings (both one-on-one and in group settings as appropriate) and open days
- Fact sheets and updates addressing key aspects of the proposal, and progress over time
- Maintenance of a project website.

The early stages of consultation, at the scope confirmation stage will focus on preparation and distribution of information, and seeking of initial feedback. As the project progresses, the nature of consultation will become more detailed and focussed, particularly in regards to landholders and stakeholders directly affected by the works.

6 Implementation schedule

6.1 Proposed staging

Following the flood event of 2016, there is a renewed urgency to progress works that will afford a greater level of flood protection to properties in the lower Gawler River floodplain.

Whilst the new Northern Floodway works and long-term levee upgrades is generally considered to be the major component of work associated with the overall proposal, the works to be undertaken as part of Recommendation 2 will provide some improved flood conveyance, at least during smaller events. It is therefore proposed to progress the river condition and immediate repair levee works as a matter of priority, subject to funding, establishment of landholder access agreements and approvals to undertake the works. It is anticipated that the necessary funding and approvals could be gained within a shorter timeframe than the body of work required to enable commencement of on-ground works associated with the Northern Floodway and levee replacement (Recommendation 3).

This is reflected in the scheduling diagram provided in Section 6.2.

Options to stage the implementation of the new Northern Floodway and long-term levee upgrades will need to be considered in further detail to ensure that any interim flood impacts can be adequately managed. It is generally recommended that works be constructed commencing at the downstream end of the system.

6.2 Project scheduling

A representation of the tasks to be undertaken in order to progress to on-ground works, is provided below. The graphic indicates that a number of tasks can be undertaken in parallel, and that it should be possible to commence immediate river and levee works well ahead of the more substantial Northern Floodway works.

The schedule does not show:

- Negotiating and securing funding
- Sourcing of materials
- Resolution of legal issues
- Iterations to the design process as a result of feedback, access issues, funding shortfalls and the like.

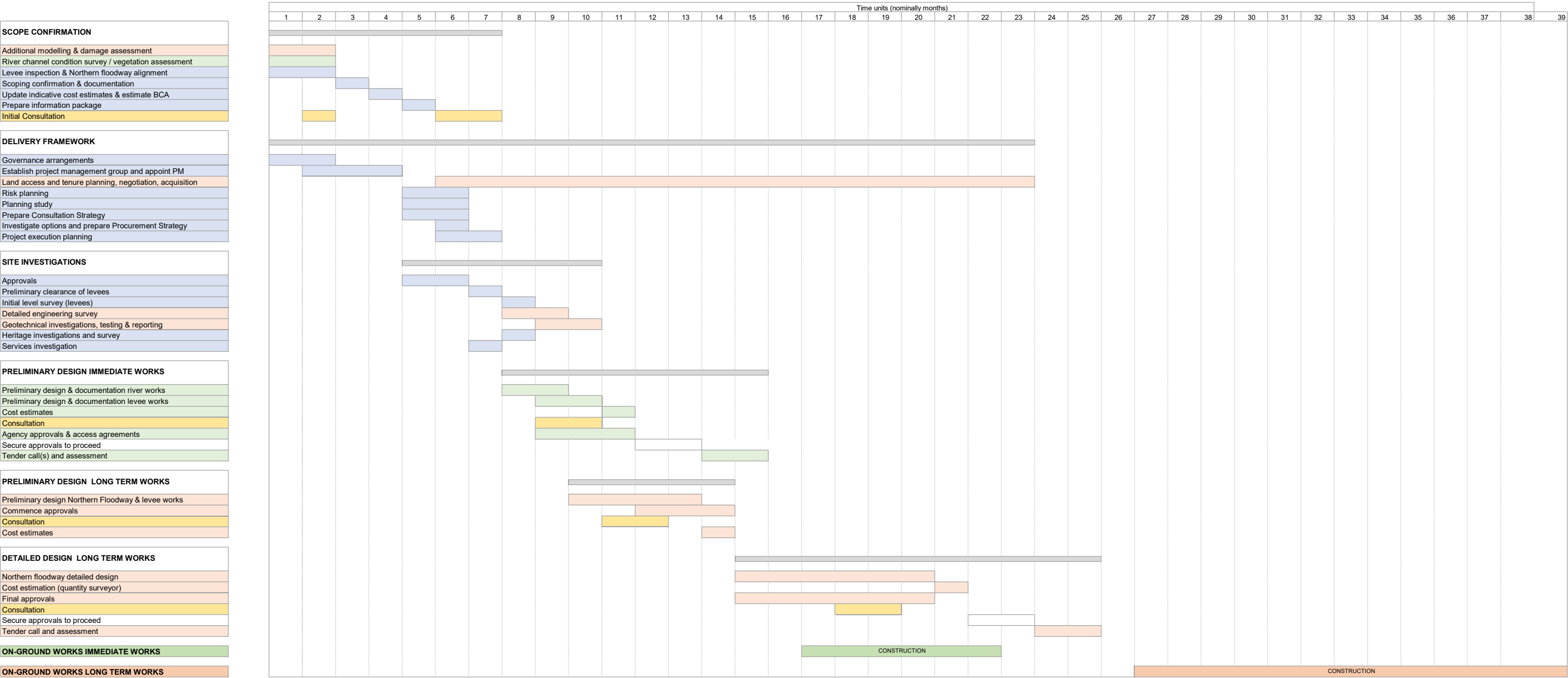


Figure 6.1 Draft Implementation Plan

7 Implementation costs

7.1 Project development – how much will this work cost?

Table 7.1 summarises the indicative (order of magnitude) costs for major elements of work (identified in this report) required to progress to on-ground works.

The scope of investigations and services required, along with associated costs, will be reviewed and updated as the project progresses.

Table 7.1 *Indicative cost of major elements of work required to progress the project*

Item	Indicative Cost
1. CONFIRM THE SCOPE	
Additional modelling & damage assessment	\$30,000
River channel condition / vegetation assessment	\$60,000*
Levee inspection	\$15,000
Scoping confirmation & documentation	\$10,000
Update indicative cost estimates & estimate BCA	\$15,000
Prepare information package	\$15,000
Initial Consultation	\$20,000
Sub-total Confirm Scope	\$165,000
2. DELIVERY FRAMEWORK	
Governance arrangements	Internal cost
Establish project management group and appoint Project Manager	Internal cost
Ongoing Project Management	\$120,000-\$150,000/year
Land access and tenure negotiations (property consultant)	\$100,000
Risk planning	\$10,000
Planning study	\$15,000
Prepare Consultation Strategy	\$10,000
Investigate options and prepare Procurement Strategy	\$10,000
Project execution planning	By Project Manager
Sub-total Delivery Strategy	\$145,000 (excl. PM)
3. SITE INVESTIGATIONS	
Preliminary clearance of levees	\$150,000
Initial level survey (levees)	\$15,000
Detailed engineering survey	\$100,000
Geotechnical investigations	\$100,000
Heritage investigations and survey	\$20,000
Services investigation	\$10,000
Sub-total Site Investigations	\$395,000

Item	Indicative Cost
4. PRELIMINARY DESIGN IMMEDIATE WORKS	
Preliminary design & documentation river works	30,000
Preliminary design & documentation levee works	50,000
Cost estimates	10,000
Consultation	20,000
Tender call(s) and assessment	10,000
Sub-total Preliminary Design Immediate Works	\$120,000
5. PRELIMINARY DESIGN LONG-TERM WORKS	
Preliminary design & documentation Northern Floodway & levee works	100,000
Consultation	80,000
Cost estimates	15,000
Sub-total Preliminary Design Long term works	\$195,000
6. DETAILED DESIGN LONG TERM WORKS	
Northern floodway detailed design & documentation	200,000
Cost estimation (quantity surveyor)	15,000
Final approvals	15,000
Tender call and assessment	25,000
Sub-total Detailed Design long term works	\$255,000
7. CONSTRUCTION SUPERINTENDENCE	\$100,000

* Cost will be dependent upon extent of vegetation assessments. Detailed assessment could be deferred to site investigations stage.

7.2 Capital cost

Order of magnitude estimates for the cost to implement the Northern Floodway works, including the immediate river and levee remedial works, were prepared by AWE as part of the 2016 Flood Review project.

The estimate included allowance for:

- Concept Design
- Detailed Design
- Tender and administration
- Land acquisition
- Construction

A 30% contingency was allowed on the total, reflective of the feasibility level of work that has been undertaken to date.

The current estimate is summarised in Table 7.2.

Table 7.2 Northern Floodway and levee improvements indicative cost estimate

Element	Indicative cost *
Concept Design	\$350,000
Detailed Design	\$125,000**
Tender and administration	\$100,000
Land acquisition	\$9,170,000
Construction	\$11,182,684
Sub-total	\$20,927,684
Contingency	\$6,278,305
Total	\$27,000,000

* From AWE (2017)

** 'Detailed Design' costs differ from the cost provided in Table 7.1 (\$125,000 vs. \$255,000) due to additional inclusions in Table 7.1's design cost estimate.

Excluding design (concept and detailed) and tender and administration costs, the capital construction cost, including land acquisition is \$26,500,000, including a 30% contingency allowance.

The above costs are for the implementation of immediate works as well as long term works.

A key step in progressing the implementation of the works will be updating the capital cost estimates (including land acquisition) at a number of milestones, including:

- Scope confirmation stage
- Agreement on land tenure proposal (acquisition / compensation costs)
- Preliminary design
- Detailed design / pre-tender

At preliminary design stage, the services of a suitably qualified quantity surveyor will be engaged to prepare cost estimates for the various elements of the works. As discussed in Section 4.3 a property consultant will be engaged to assist with the estimation of costs associated with securing the required access to land for the purposes of implementing the on-ground works.

7.3 Operations and maintenance costs

Ongoing maintenance of the Gawler River channel, levees and floodway will be required to maintain the new system to fulfil its intended flood mitigation function. Ongoing maintenance will be the responsibility of the GRFMA.

A preliminary maintenance schedule and indicative costs are provided below.

Table 7.3 Indicative maintenance schedule and costings

Task	Frequency
River channel maintenance	
Inspection of river channel for weed growth, erosion, sediment accumulation and documentation of river condition	Annual
Weed control in priority areas	Annual

Task	Frequency
Additional weed removal	Annual or as budget permits
Additional revegetation	As required
Removal of debris and sediment accumulation – river bed	Biennial (2 yearly)
Removal of debris accumulation at bridge / culvert structures	As required (assume annual)
Levees	
Levee survey and record of settlement	Biannual (twice/year) for first two years, annually year 3-10 Frequency may be able to be reduced after year 10
Levee inspection for defects (rabbit holes, slumping, erosion, cracking)	Annual and following high flow events
Weed control (spraying / slashing)	Annual
Fence inspection and repair	Annual
Top up / repair of levees	As required
Floodway	
Floodway inspection	Annual
Weed control	Annual, dependent on land-use within floodway
Removal of debris accumulation at bridge / culvert structures	As required (assume annual)
Fence inspection and repair	Annual

Annual or scheduled maintenance is likely to come at significant cost to maintain the levees in good repair, and prevent the river returning to an overgrown state.

Maintenance costs, especially those related to levee maintenance, are likely to be driven by the extent of work undertaken during the construction phase. For example, if all levees are cleared and reconstructed with safe, trafficable crests, maintenance will be far easier and cheaper than maintaining levees with irregular cross sections not able to be safely accessed by vehicle. This is principally because it will enable maintenance tasks (level survey, inspections, weed spraying, repairs) to be undertaken by vehicle, rather than on foot.

Whilst costs have not yet been allocated against individual tasks, it is anticipated that the costs could be in the order of \$300,000/year. Operations and maintenance costs will be estimated following confirmation of the project scope, and again following completion of the preliminary designs.

8 References

- AECOM (2017) *North Para Dam Raise Feasibility Assessment Stage 3*. Prepared for the Gawler River Floodplain Management Authority, 13 April 2017.
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9 Glossary of terms

Annual Exceedance Probability	Annual Exceedance Probability (AEP) refers to the probability of a flood event occurring in any year, expressed as a percentage. For example, a large flood which may be calculated to have a 1% chance to occur in any one year, is described as 1% AEP. A 1% AEP flood event is equivalent to a 100-year ARI event.
Average recurrence interval	<p>Flood risk is often described in terms of Average Recurrence Interval (ARI). This is the number of years on average, within which a given flood will be equalled or exceeded. A 100-year ARI flood will be equalled or exceeded once in 100 years on average. It has a 1% probability of occurring in any given year. A 20-year ARI flood will be equalled or exceeded once in 20 years on average, and so on.</p> <p>Due to the random nature of floods, however, a 100-year flood need not occur in every 100 years and conversely, several floods which exceed the 100-year flood could occur within any one period of 100 years.</p> <p>The ARI of an event is <i>approximately</i> equivalent to the inverse of the AEP.</p>
Average Annual Damage	Depending on its size (or severity), each flood will cause a different amount of damage to a floodprone area. Large floods will cause more damage than small floods. The average annual damage is the average damage per year that would occur in a particular area from flooding over a very long period of time. In many years there may be no damage, in some years there will be minor damage (caused by small, relatively frequent flood events) and in some years there will be major damage (caused by large, rare flood events). Average annual damage provides the basis for comparing the economic effectiveness of different management measures against floods of all sizes, i.e. their ability to reduce the AAD.
Catchment	The surface area of land that collects and drains water into a river or other waterway. Catchments can include both rural and urban areas
Flood control dam / flood mitigation dam	A man-made reservoir connected to a waterway that provides a temporary storage for floodwaters, potentially reducing or delaying the likelihood or magnitude of downstream flooding.
Flood damage	“Flood damage” is the tangible and intangible costs of flooding. Tangible costs are quantified in monetary terms (e.g. damage to goods and possessions, loss of income or services in the flood aftermath). Intangible damages represent the increased levels of physical, emotional and mental health problems suffered by flood affected people and attributed to a flooding episode. Intangible damages are difficult to quantify in monetary terms.
Flood hazard	Potential loss of life, injury and economic loss caused by future flood events. The degree of hazard varies with the severity of flooding and is affected by flood behaviour (extent, depth, velocity, duration and rate of rise of floodwaters), topography, population at risk and emergency management.

Floodplain	Land adjacent to a waterway, subject to occasional flooding (up to and including the probable maximum flood). Floodplains can be narrow, steep, wide and/or flat, and can extend several kilometres from the waterway.
Flood preparedness	Flood preparedness refers to measures taken to prepare for and reduce the effects of floods.
Flood warning	Advice on impending flooding provided so people can take action to minimise its negative impacts.
Present value damage	In relation to flood damage, is the sum of all future flood damages that can be expected over a fixed period (e.g. 30 years) expressed as a cost in today's value.