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Brown Hill Keswick Creek
STORMWATER PROJECT

Brown Hill Keswick Creek Stormwater Project

Business Case Final Report

December 2021

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1.0 Executive Summary

Infrastructure Australia Strategic Fit

Infrastructure Australia (IA), an independent statutory body that is the key source of research and advice for governments, industry and the community on nationally significant infrastructure needs, recently (August 2021) noted that the events of recent years (global pandemic, bushfires, droughts, floods, other extreme weather events and cyber threats) have highlighted Australia's vulnerability to natural and non-natural threats and their social, environmental and economic impacts. It estimates that by 2050, the annual economic cost of natural disasters in Australia could more than double – from an average of $18 billion per year to more than $39 billion per year[1]. IA further notes:

> *Failure of a single asset can amplify impacts for people, economies and the natural environment and increase the risk of cascading, systemic failures. There is opportunity to improve infrastructure investment decision-making by developing agreed methodologies and guidance on how to better value resilience through the infrastructure lifecycle.*

In 2005 the State Government and the Local Government Association (LGA) released the Urban Stormwater Management Policy for South Australia. In 2006 they entered into the Stormwater Management Agreement which sets out the roles and responsibilities of state and local government and provides governance arrangements for stormwater management on a catchment basis throughout the state.

A key element of strategies described in the Urban Stormwater Management Policy is the development of Stormwater Management Plans (SMP) for catchments to ensure that stormwater management is addressed on a total catchment basis with Green Adelaide and the 8 Regional Landscape Boards, local government authorities and relevant state government agencies working together.

The Brown Hill Keswick Creek (BHKC) Stormwater Project is a collaborative effort between the Cities of Adelaide, Burnside, Mitcham, Unley and West Torrens (the Constituent Councils) to mitigate significant flood risks arising from four major watercourses in metropolitan Adelaide; the Brown Hill, Keswick, Glen Osmond and Park Lands Creeks**. The project focusses on building the collaboration and organisational resilience sought by IA to deliver infrastructure for resilience.**

Most importantly and in the context of IA Guidelines the project is a package of related interventions designed to address a common flood problem that will be delivered in a coordinated manner by the Constituent Councils to obtain benefits that could not be achieved by delivering the interventions individually.

This Business Case for the Brown Hill Keswick Creek Stormwater Project has been prepared with the cooperation of the project's Constituent Councils and all major stakeholders likely to be impacted by a 1-in-100 year flood event. Professional advice has also been sought on the project costs, property valuations and flood damage estimates to private property which have all be incorporated into the Economic Impact Assessment (EIA) and Benefit Cost Analysis (BCA).

The total damage estimates associated with a one in 100 year flood is $418.5 million and completing the proposed project will reduce that damage estimate to $7.5 million, a net benefit of $411 million. 57% of the damage estimates are direct property damage, but indirect benefits (business interruption, traffic disruption, social and environmental impacts) add significantly to the total.

There are 3 project scenarios currently under evaluation including:

[1] Infrastructure Australia, A Pathway to Infrastructure Resilience, Advisory Paper 1: Opportunities for Systemic Change

1. Current Funding Model – Committed funding from the Stormwater Management Authority (SMA) and the Constituent Councils of $140 million, for partial delivery of the BHKC Stormwater Project over a 20-year timeframe concluding in 2037.

2. Current Delivery Schedule - Committed funding from the Stormwater Management Authority (SMA) and the Constituent Councils of $140 million plus $104.9 million to be sought from other sources, making total funding of $244.9 million for completion of the BHKC Stormwater Project over a 20-year timeframe concluding in 2037.

3. Accelerated Delivery Schedule – Committed funding from the Stormwater Management Authority (SMA) and the Constituent Councils of $140 million plus $88.0 million to be sought from other sources, making total funding of $228.1 million for completion of the BHKC Stormwater Project over a 15-year timeframe concluding in 2032.

In the Current Delivery Schedule, which is based on a 20-year program of works concluding in 2037, the project will proceed in 4 stages as follows at an escalated cost (assumed to be 5% p.a. until 2030 and then 2.5% per annum thereafter) of $186.8 million before escalation or $244.9 with escalation:

1. The first stage of the project (Detention Storages - cost of $34.5 million) is almost completed. Once completed 20% of the flood protection benefits are achieved.

2. The second stage of the project (Lower Brown Hill Creek Upgrades - cost of $51.5 million before price escalation, $58.8 million after assumed escalation) under the current delivery schedule is targeted for completion in 2027, and once completed 40% of the flood protection benefits are achieved.

3. The third stage of the project (Keswick Creek Flow Diversions- cost of $70.5 million before price escalation, $100.9 million after assumed escalation) under the current delivery schedule is targeted for completion in 2032, and once completed 80% of the flood protection benefits are achieved.

4. The fourth stage of the project (Upper Brown Hill and Glen Osmond Creek Upgrades - cost of $30.5 million before price escalation, $50.7 million after assumed escalation) under the current delivery schedule is targeted for completion in 2037, and once completed 100% of the flood protection benefits are achieved.

In the Accelerated Delivery Schedule, the project will proceed in 4 stages over the next 11 years (completion 2032) at an escalated cost of $228.1 million:

1. The first stage of the project (Detention Storages - cost of $34.5 million) is almost completed, with one year of construction still to be finished. Once completed 20% of the flood protection benefits are achieved.

2. The second stage of the project (Lower Brown Hill Creek Upgrades - cost of $51.5 million before price escalation, $58.4 million after assumed escalation) under the accelerated delivery schedule is targeted for completion in 2027, and once completed 40% of the flood protection benefits are achieved.

3. The third stage of the project (Keswick Creek Flow Diversions- cost of $58 million before price escalation, $89.4 million after assumed escalation) under the accelerated delivery schedule is targeted for completion in 2029, and once completed 80% of the flood protection benefits are achieved.

4. The fourth stage of the project (Upper Brown Hill and Glen Osmond Creek Upgrades - cost of $30.5 million before price escalation, $45.8 million after assumed escalation) under the accelerated delivery schedule is targeted for completion in 2032, and once completed 100% of the flood protection benefits are achieved.

The BHKC Stormwater Project and associated works have the strong support of key stakeholders including Adelaide Airport Limited, the South Australian Government's Stormwater Management Authority, the South Australian Government's Department for Infrastructure and Transport and the North South Corridor project, the Local Government Association Mutual Liability Scheme and Members of Parliament.

For the preparation of the Business Case there has been detailed consultation with all key stakeholder organisations including:

- Adelaide Airport Limited
- Ashford Hospital
- Australian Rail Track Corporation (ARTC)
- City of Adelaide – Constituent Council
- City of Burnside – Constituent Council
- City of Mitcham – Constituent Council
- City of Unley – Constituent Council
- City of West Torrens – Constituent Council
- Department of Defence - Keswick Army Barracks
- Department of Infrastructure & Transport - North South Corridor Project
- FM Global – Insurer for Ashford Hospital
- LGASA Mutual Pty Ltd
- Metropolitan Fire Service (MFS)
- SA Ambulance Service
- State Emergency Service (SES)
- Stormwater Management Authority

The outcomes of these consultations, including flood impacts, costs and mitigation benefits, are detailed in Section 3 of this report.

Societal – Socio Economic Impact

An Economic Impact Assessment (EIA) has been undertaken to estimate the Gross State Product and employment impacts of the construction phase of the project. The modelling indicates that total damage estimates associated with a 1-in-100 year flood is $418.5 million, while completing the proposed project will reduce that damage estimate to $7.5 million – and net benefit of $411 million. 57% of the damage estimates are direct property damage, but indirect benefits (business interruption, traffic disruption, social and environmental impacts) add significantly to that.

Probability based or expected value modelling for the EIA over the extended period results in the following outcomes:

- Present value of the Current Delivery Schedule Economic Impact - $134.8 million (Gross State Product)[2]. The construction process will generate an average of 73 jobs per annum over the period 2022-2037.

- Present value of the Accelerated Delivery Schedule Economic Impact - $145.5 million. The construction process will generate an average of 112 jobs per annum over the period 2022-2032.

The above Gross State Product and employment outcomes are important in the context of current pandemic impacts on businesses and State unemployment levels with the Accelerated Delivery Schedule bringing these benefits forward. The scale of the work packages is tailored to maximise participation from local Tier 2 and Tier 3 contractors who do not typically benefit from major road infrastructure projects.

[2] Uses discount rate of 3.8% real, plus assumption of 2.5% general inflation.

Through stakeholder consultation and research, detailed facts and assumptions (contained in this report) have been used to facilitate a Benefit Cost Analysis (BCA) for the project. Modelling results for the **BCA** are detailed in the following table:

	BCA	NPV ($m)	Funding ($m)		Completion Date by Stage	
With current project funding	1.28	$15.9	SMA	$51.35	Stage 1 Flood Detention	2022
			Constituent Councils	$51.35	Stage 2 Lower BHC	2027
			Other	$0	Stage 3 Flow Diversions	Not completed
			Total	$102.7	Stage 4 Upper BHC and Glen Osmond	Not completed
Current delivery schedule	1.86	$120.0	SMA	$70.0	Stage 1 Flood Detention	2022
			Constituent Councils	$70.0	Stage 2 Lower BHC	2027
			Other	$104.9	Stage 3 Flow Diversions	2032
			Total	$244.9	Stage 4 Upper BHC and Glen Osmond	2037
Accelerated delivery schedule	1.94	$132.5	SMA	$70.0	Stage 1 Flood Detention	2022
			Constituent Councils	$70.0	Stage 2 Lower BHC	2027
			Other	$88.0	Stage 3 Flow Diversions	2029
			Total	$228.0	Stage 4 Upper BHC and Glen Osmond	2032

Note: BCR = Benefit Cost Ratio; NPR = Net Present Value

Having established the Business Case for the project, this report also provides the proposed funding model and delivery strategy along with the proposed procurement model, local content and indigenous participation in the works.

Deliverability

Governance of the BHKC project is exercised through an Owners Executive Committee (OEC) which includes the Chief Executives of the five Constituent Councils or their delegates. A Memorandum of Agreement dated December 2008 provides terms of reference for the conduct of the project. Meetings of the OEC take place quarterly.

The five Constituent Councils established the Brown Hill and Keswick Creeks Stormwater Board in February 2018 as a regional subsidiary under the Local Government Act 1999, to co-ordinate implementation of the flood mitigation works outlined in the Brown Hill Keswick Creek Catchment Stormwater Management Plan 2016 that was approved and gazetted in February 2017. The Board meets 8 times each year.

In accordance with the requirements of the Local Government Act 1999, the Brown Hill and Keswick Creeks Stormwater Board has established an Audit and Risk Committee. The objective of the Audit and Risk Committee is to ensure the Board acts in compliance with its Charter and meets its legislative and probity requirements as required by the Local Government Act 1999 and other relevant legislation. Meetings of the Audit and Risk Committee take place quarterly.

2.0 Introduction and Project Overview

2.1 Infrastructure Australia Strategic Fit

Infrastructure Australia (IA), an independent statutory body that is the key source of research and advice for governments, industry and the community on nationally significant infrastructure needs, recently (August 2021) noted that the events of recent years (global pandemic, bushfires, droughts, floods, other extreme weather events and cyber threats) have highlighted Australia's vulnerability to natural and non-natural threats and their social, environmental and economic impacts. It estimates that by 2050, the annual economic cost of natural disasters in Australia could more than double – from an average of $18 billion per year to more than $39 billion per year[3]. IA further notes:

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In 2005 the State Government and the Local Government Association (LGA) released the Urban Stormwater Management Policy for South Australia. In 2006 they entered into the Stormwater Management Agreement which sets out the roles and responsibilities of state and local government and provides governance arrangements for stormwater management on a catchment basis throughout the state.

A key element of strategies described in the Urban Stormwater Management Policy is the development of Stormwater Management Plans (SMP) for catchments to ensure that stormwater management is addressed on a total catchment basis with Green Adelaide and the 8 Regional Landscape Boards, local government authorities and relevant state government agencies working together.

The Stormwater Management Authority (SMA) was established in 2007 under the Local Government Act 1999 and is responsible for the operation of the Stormwater Management Agreement. The SMA has issued the Stormwater Management Planning Guidelines to provide a template for consistent management of stormwater through multi-objective planning, including reuse where feasible.

The Brown Hill Keswick Creek (BHKC) Stormwater Project is a collaborative effort between the Cities of Adelaide, Burnside, Mitcham, Unley and West Torrens (the Constituent Councils) to mitigate significant flood risks arising from four major watercourses in metropolitan Adelaide; the Brown Hill, Keswick, Glen Osmond and Park Lands Creeks. **The project focusses on building the collaboration and organisational resilience sought by IA to deliver infrastructure for resilience.**

Most importantly and in the context of IA Guidelines the project is a package of related interventions designed to address a common flood problem that will be delivered in a coordinated manner by the Constituent Councils to obtain benefits that could not be achieved by delivering the interventions individually.

2.2 Brown Hill Creek Catchment

Brown Hill Creek flows through the suburbs of Crafers West, Brown Hill Creek, Mitcham, Torrens Park, Hawthorn, Unley Park, Millswood, Goodwood, Forestville, Everard Park, Ashford, Kurralta Park, Plympton, North Plympton, Netley and Adelaide Airport before flowing into the Patawalonga. It can be conveniently divided into two sections:

- Lower Brown Hill Creek – which is downstream from Anzac Highway to its confluence with Keswick Creek at Adelaide Airport (which is also the western extent of the catchment study area); and

[3] Infrastructure Australia, A Pathway to Infrastructure Resilience, Advisory Paper 1: Opportunities for Systemic Change

- Upper Brown Hill Creek – being the section upstream of Anzac Highway to its source in the rural area of the Mitcham hills.

Brown Hill Creek has a catchment area of 32.0 km^2 (upstream from Adelaide Airport) of which about 18 km^2 is rural land.

2.3 Keswick Creek Catchment

Keswick Creek is fed by:

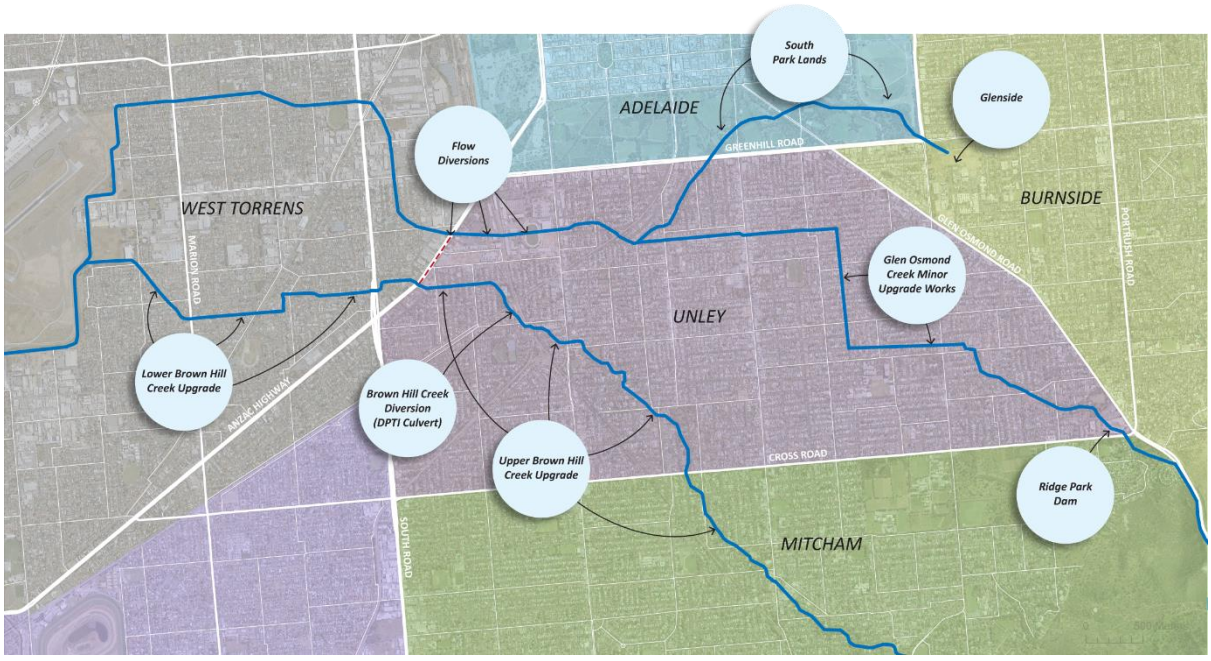
- Glen Osmond Creek – which originates in the valley in which the South Eastern Freeway is located from the Heysen Tunnels to the Old Toll Gate and then passes through the suburbs of Leawood Gardens, Mount Osmond, Urrbrae, Myrtle Bank, Fullarton, Parkside, Unley and Wayville.

- Parklands Creek – which originates as several minor watercourses that flow off the hills face in the suburbs of Glen Osmond and Beaumont. These watercourses enter the minor (underground) drainage system and continue as underground drains on several routes down through the suburbs of Hazelwood Park, Linden Park, St Georges, Glenunga and Glenside. These drains come together at Conyngham Street, Glenside prior to becoming Parklands Creek as the drain enters the South Park Lands via a culvert under the Greenhill Road / Fullarton Road intersection. Parklands Creek leaves the South Park Lands near Peacock Road and flows through Unley before joining with Glen Osmond Creek to form Keswick Creek just downstream of Simpson Parade, Wayville.

Keswick Creek then flows through the suburbs of Wayville, Keswick, Mile End South, Richmond, Cowandilla, Brooklyn Park and Adelaide Airport prior to joining with Brown Hill Creek. The Keswick Creek catchment area is 36.7 km^2.

The following map shows the creeks and planned project works, overlayed on the Council areas.

Map 1 – Project Catchment, Creeks and Planned Works



The **Brown Hill Keswick Creek Catchment Stormwater Management Plan 2016 (the SMP)** highlights the devastating impact that a major flood event would have on the inner southern and south-western suburbs of Adelaide. The SMP outlines a comprehensive program of flood mitigation works that will protect the community and businesses from the effects of flooding while also

delivering social and environmental benefits such as urban greening, improving the quality of stormwater discharges to coastal waters, and the beneficial use of stormwater.

The SMP has been endorsed by all of the Constituent Councils and has the acceptance of the community. The SMP was approved by the Stormwater Management Authority (the SMA) and gazetted in February 2017. The Councils then established the Brown Hill and Keswick Creeks Stormwater Board (the Board) as a regional subsidiary under the Local Government Act 1999 to coordinate implementation of the SMP.

With respect to flood protection, the key objectives of the SMP are to substantially reduce the number of properties within the catchment that would be affected by very large flood events and to minimise damage to critical infrastructure. Currently a 1-in-100-year flood in the catchment would affect over 3,900 properties and cause potential damages currently estimated to be more than $480m.

The SMP was the culmination of detailed hydrological analysis and flood modelling for the catchment over the preceding 10 years. In developing a flood mitigation strategy over this 10-year period the Councils investigated and consulted with the community on a range of technical solutions and options that would achieve the six broad objectives of the SMP:

1. Protection from flooding.
2. Quality of runoff and effect on receiving waters.
3. Beneficial reuse of stormwater runoff.
4. Protection of watercourses and riparian ecosystems.
5. Effective planning outcomes.
6. Management of stormwater infrastructure.

During the early stages of developing the SMP the catchment was delineated into 'upper' and 'lower' sub-catchments that would enable the full suite of options to be investigated:

- Past studies had shown that upgrading each of the creeks separately would be a less economic solution and therefore the options to mitigate flooding generated from the mainly urban sub-catchment of Lower Brown Hill and Keswick Creeks included a combination of (1) flood detention storages to reduce the flows entering the lower reaches of the watercourse; (2) diversion of high flows to reaches of the watercourse that can offer greater flow capacity; and (3) upgrading select sections of the existing watercourse to achieve greater flow capacity.

- The options to mitigate flooding from the mainly rural sub-catchment of Upper Brown Hill Creek (upstream of Anzac Highway) included a combination of (1) a detention dam at one of two alternative sites in the foothills that would limit the upgrade works required to the existing watercourse; (2) high flow bypass culverts along suburban streets that would limit the upgrade works required to the existing watercourse; and (3) upgrading the existing watercourse (including bridge upgrade works) to achieve greater flow capacity. Of the eight sub-options that were investigated for Upper Brown Hill Creek, the Councils endorsed a flood mitigation option referred to as Option D which focusses on upgrading the existing watercourse.

The whole of catchment flood mitigation strategy that is documented in the SMP reflects the extensive community consultation process that was undertaken and the Councils' recognition of community opposition to a dam in the upper reaches of Brown Hill Creek, and the preference to pursue a feasible and whole of catchment community supported 'no dam' solution which focusses on upgrades to the existing watercourse.

2.4 Program of Works

The flood mitigation works outlined in the SMP comprise detention storages in the upper reaches of the catchment, diversion of high flows away from flooding hotspots, and upgrades to the flow capacity of the channels. Fundamental to the successful delivery of this program of flood mitigation works is the principle of 'working progressively in an upstream direction' to ensure that the

downstream reaches of the creek system are ready to cater for the ultimate design flow before the works in the upper catchment are undertaken.

The program of works can be delineated into four stages (also referred to as sub-projects):

1. Flood Detention; this involves the construction of detention storages in the upper catchment (Ridge Park, Glenside, South Park Lands) that will reduce the downstream flow rates.

2. Lower Brown Hill Creek Upgrades; this will involve doubling the flow capacity of a 3.3 kilometre long section of channel beginning at the south-eastern corner of the Adelaide Airport and ending at Anzac Highway. The channel is primarily situated within a 12-metre wide reserve owned by City of West Torrens and comprises sections of earthen and concrete lining. In its current form the channel does not offer any environmental value or opportunity for community use.

3. Keswick Creek Flow Diversions; this will involve construction of a large underground drain to divert flows from Keswick Creek to the upgraded section of Lower Brown Hill Creek, before these flows have the opportunity to 'break-out' of the channel (upstream of the Royal Adelaide Showgrounds) and continue overland through the south-western suburbs.

4. Upper Brown Hill and Glen Osmond Creek Upgrades; this will involve upgrading the flow capacity of the creek channel and road crossings to prevent 'break-outs' and flooding of private property and the road network.

The program of works is depicted in the following diagram.

Diagram 1 – Program of Works

There are 3 project scenarios currently under evaluation including:

1. Current Funding Model – Committed funding from the Stormwater Management Authority (SMA) and the Constituent Councils of $140 million, for partial delivery of the BHKC Stormwater Project over a 20-year timeframe concluding in 2037.

2. Current Delivery Schedule - Committed funding from the Stormwater Management Authority (SMA) and the Constituent Councils of $140 million plus $104.9 million to be sought from other sources, making total funding of $244.9 million for completion of the BHKC Stormwater Project over a 20-year timeframe concluding in 2037.

3. Accelerated Delivery Schedule – Committed funding from the Stormwater Management Authority (SMA) and the Constituent Councils of $140 million plus $88.0 million to be sought from other sources, making total funding of $228.0 million for completion of the BHKC Stormwater Project over a 15-year timeframe concluding in 2032.

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1. The first stage of the project (Detention Storages - cost of $34.5 million) is almost completed. Once completed 20% of the flood protection benefits are achieved.

2. The second stage of the project (Lower Brown Hill Creek Upgrades - cost of $51.5 million before price escalation, $58.8 million after assumed escalation) under the current delivery schedule is targeted for completion in 2027, and once completed 40% of the flood protection benefits are achieved.

3. The third stage of the project (Keswick Creek Flow Diversions- cost of $70.5 million before price escalation, $100.9 million after assumed escalation) under the current delivery schedule is targeted for completion in 2032, and once completed 80% of the flood protection benefits are achieved.

4. The fourth stage of the project (Upper Brown Hill and Glen Osmond Creek Upgrades - cost of $30.5 million before price escalation, $50.7 million after assumed escalation) under the current delivery schedule is targeted for completion in 2037, and once completed 100% of the flood protection benefits are achieved.

In the Accelerated Delivery Schedule, the project will proceed in 4 stages over the next 11 years (completion 2032) at an escalated cost of $228.1 million:

1. The first stage of the project (Detention Storages - cost of $34.5 million) is almost completed. Once completed 20% of the flood protection benefits are achieved.

2. The second stage of the project (Lower Brown Hill Creek Upgrades - cost of $51.5 million before price escalation, $58.4 million after assumed escalation) under the accelerated delivery schedule is targeted for completion in 2027, and once completed 40% of the flood protection benefits are achieved.

3. The third stage of the project (Keswick Creek Flow Diversions- cost of $58 million before price escalation, $89.4 million after assumed escalation) under the accelerated delivery schedule is targeted for completion in 2029, and once completed 80% of the flood protection benefits are achieved.

4. The fourth stage of the project (Upper Brown Hill and Glen Osmond Creek Upgrades - cost of $30.5 million before price escalation, $45.8 million after assumed escalation) under the accelerated delivery schedule is targeted for completion in 2032, and once completed 100% of the flood protection benefits are achieved.

The total cost of the 3 outstanding projects (2 – 4 above) is $152.5 million in 2021 dollars ($210.4 million for the escalated Current Delivery Schedule and $193.6 million for the escalated Accelerated Delivery Schedule).

The SMP proposed a funding model that includes a 1/3 funding contribution from each tier of Government. The current commitment from the South Australian Government's Stormwater Management Authority is for a total of $70 million over a 20-year timeframe (this is the basis of the Current Funding Model). The Constituent Councils are matching the contributions made by the Stormwater Management Authority, which brings the total funding commitment to $140 million over 20 years. There is currently no funding commitment from the Federal Government, and there is a current funding shortfall of $88-104.9 million (depending on the timeframe over which the flood mitigation works are delivered).

The Brown Hill Keswick Creek Stormwater Project is seeking a $70 million contribution from the Federal Government, ideally to be provided in seven equal instalments over a 7 year period commencing in 2022, to guarantee the completion of the overall project and accelerate the delivery of Stages 2 and 3 of the project which will provide flood protection for Federal Government land holdings (Adelaide Airport and Keswick Army Barracks) and critical transport routes including the North South Corridor and ARTC's interstate rail lines.

A balance of $18 million will be sought from other grant programs on an individual sub-project basis making up the total funding requirement of $228 million for the Accelerated Delivery Schedule.

The catchments of both Brown Hill and Keswick Creeks arise on the western slopes of the Mount Lofty Ranges and flow westwards across inner south-eastern and western suburbs of Adelaide before discharging to the sea in the vicinity of the Adelaide Airport. The lower portion of the catchment, across the south-western suburbs of Adelaide, is at the greatest risk of flooding with Adelaide Airport and Ashford Hospital being the dominant land holdings in the catchment.

The underlying flood risk would be exacerbated if the Torrens to Darlington section of the North South Corridor Project proceeds significantly ahead of the BHKC Stormwater Project's flood mitigation works, as the design for the lowered Motorway is required to incorporate a physical barrier on its upstream (eastern) side to prevent floodwater ingress.

The Brown Hill Keswick Creek system spans the Federal electorates of Sturt, Adelaide, Boothby and Hindmarsh, and the BHKC Stormwater Project includes flood mitigation works throughout the Cities of Adelaide, Burnside, Mitcham, Unley and West Torrens.

Hudson Howells has been engaged to provide Economic and Benefit Cost Analysis services for the Brown Hill Keswick Creek Stormwater Project. Hudson Howells has also prepared this Business Case for the pursuit of additional funding from the Federal Government, and accelerated funding from the South Australian Government.

In relation to modelling the economic impacts of a 1-in-100 year flood, the modelling variations have included:

- A range of scenarios and sensitivities.
- Additional regional scenarios to be modelled including impacts on the North South Corridor Project and Adelaide Airport.
- An alternative scenario to consider the impacts of climate change. The major impact of climate change on flooding in the catchment area will be to increase the probability of more severe floods occurring on a more frequent base. For example, the 1-in-100 year flood becoming a 1-in-50 year flood. The methodology agreed to undertake this analysis included:
    - Undertake desktop research of the modelling of climate change on flood severity.
    - Conduct interviews with climate change experts to fill in gaps and expand the evidence about possibilities and probabilities.
    - Adjust the modelling to allow for the changed probabilities, and undertake sensitivity analysis for forecasting uncertainty.

3.0 Consultation and Impact on Key Stakeholders

The development of the Stormwater Management Plan 2016 included comprehensive consultation with the community and key stakeholders. The Stormwater Management Plan 2016 was approved by the Constituent Councils and gazetted by the South Australian Government in February 2017.

The BHKC Stormwater Project and associated works have the strong support of key stakeholders including Adelaide Airport Limited, the South Australian Government's Stormwater Management Authority, the South Australian Government's Department for Infrastructure and Transport and the North South Corridor project, the Local Government Association Mutual Liability Scheme and Members of Parliament.

For the preparation of the Business Case there has been further detailed consultation with the stakeholders listed in this section. A briefing paper was prepared and provided to the respective organisation prior to each interview, together with an interview guide tailored to the type of organisation being engaged with (please refer to Appendices 1 to 4).

The vast majority of consultation was undertaken by depth interviews (face-to-face and MS Teams). A few organisations preferred to provide information in writing via email, although in each case a telephone interview accompanied this.

The stakeholder organisations consulted included:

- Adelaide Airport Limited
- Ashford Hospital
- Australian Rail Track Corporation (ARTC)
- City of Adelaide – Constituent Council
- City of Burnside – Constituent Council
- City of Mitcham – Constituent Council
- City of Unley – Constituent Council
- City of West Torrens – Constituent Council
- Department of Defence - Keswick Army Barracks
- Department of Infrastructure & Transport - North South Corridor Project
- FM Global – Insurer for Ashford Hospital
- Local Government Association SA Mutual Pty Ltd
- Metropolitan Fire Service (MFS)
- SA Ambulance Service
- State Emergency Service (SES)
- Stormwater Management Authority

The objectives of the stakeholder engagement were to:

- Determine an estimate of the financial impacts of a 1-in-100 year flood on each stakeholder organisation.
- Determine an estimate of disruptions to business continuity.
- Determine impacts on insurability and/or insurance premiums.
- Determine environmental impacts.
- Determine social impacts.
- Determine benefits that would be derived from the implementation of the 1-in-100 year flood mitigation infrastructure.

A summary of the key stakeholder findings by organisation follows with the five constituent councils being grouped.

3.1 Five Constituent Councils

The consultation findings from the five Constituent Councils are summarised below. It is noted that these findings focus on flood impacts/damages that are not otherwise covered by Advisian's estimates of direct damages to private property.

Councils identified the following impacts from flooding:

- Damage to infrastructure and assets including government, transport and communication infrastructure.
- Damage to community assets including property.
- Increased demand or impact to facilities including health services, aged care and schools.
- Impacts to business and economic loss.
- Loss of life or injury to people.

The Adelaide Park Lands (Park 16 and Park 20) are impacted by flooding and the ongoing cost of this (remediation and operational) is $300,000 pa (1 in 5 years). In particular, St Andrews Hospital is impacted by flooding and there is an ongoing operational and maintenance cost for South Terrace, Adelaide. This occurs around six times per year with the cost estimated at $20,000 to $30,000 per event. This cost will be eliminated once the flood management infrastructure is in place.

There is also another issue in that the St Andrew's hospital floor level is lower than the 1-in-100 year flood level and the hospital cannot insure against this. Having the hospital unable to function is a major social issue. The City of Adelaide estimates that the affected public space area (Park Lands) impacted by an event would be in the order of 300,000m^2 to 600,000m^2 for Park 16 through to Park 20. Council uses a figure of $1.60 per m^2 so if the mid-point of 450,000 m^2 is used, this equates to $720,000.

With regard to insurance, one Council noted that it is not insured for damages to roads, footpaths, kerbing etc from flood damage. Council is however insured for bridges and culverts to the value specified in Council's asset register.

Council infrastructure flood damage estimates are based upon known flooding breakout points most likely to cause damage based upon flood depth. The BHKC flood mapping was reviewed with assumptions made and one of the five Councils has estimated a value of $1.3M for the damages to council infrastructure in a 1-in-100 year flood event.

Assumptions:

- 1-in-100 year flood mapping
- Damages to 15m either side of a bridge
- Actual replacement costs used for culverts. Assumed $395k replacement cost (average) used when data not readily available.
- UR for road $101/m^2, assumed road width 7.6m.
- UR for kerb $250 linear meter.
- UR for footpath $90m^2, assume 1.5m footpaths
- For inundation 0-0.1m damages equate to 5% total replacement cost
- For inundation 0.1-0.3m damages equate to 10% total replacement cost
- For inundation 0.3-0.6m damages equate to 15% total replacement cost
- For inundation 0.6-1.0m damages equate to 20% total replacement cost
- For inundation 1.0m+ damages equate to 25% total replacement cost

- Excluded DIT roads

A council noted that the Insurance Council of Australia has identified BHKC as one of the top identified areas being underinsured with a number of properties unable to get insurance. This occurs because insurers make decisions based on postcode, not at the specific street level, potentially leaving those outside the floodplain area unable to get insurance despite their property not being at risk of flooding.

3.2 Adelaide Airport Limited (AAL)

Hudson Howells have considered the types of impact it would expect for a 1-in-100 year flood event on Adelaide Airport's aviation operations in conjunction with the flood mapping data provided in the Stormwater Management Plan 2016

Adelaide Airport Limited's critical infrastructure has been designed and constructed to withstand a 1-in-100 year flood event, however, some operations may be impacted for a short period of time:

- The flooding could make both runways unavailable apart from the portion from the fire station to the 05 end (runway marked reference number) due to runway seal and strip inundation. This length would not be suitable for domestic or international traffic.
- The loss of precision approach capability due to flooding of the glide path and approach lights. This would likely be needed with the expected poor weather conditions associated with heavy rainfall.
- Loss of the helipad, however helicopters could operate from other areas if not flooded. The helipad is lit so this capability would be lost without temporary lighting.
- Adelaide Airport Limited should still have an Aviation Rescue Fire Fighting service although there would be some flooding surrounding the fire station.
- Taxiing aircraft would be difficult due to flooding on Taxiway B and D and portions of A5/A4 but aircraft could potentially be towed through these areas. This would not entirely stop movements but would severely slow them.

In summary, a 1-in-100 year flood event could have a major but short term impact on Adelaide Airport Limited's aviation operations for both domestic and international traffic.

3.3 Australian Rail Track Corporation (ARTC)

ARTC has not undertaken previous studies to determine the impact of a 1-in-100 year flood. The worst case scenario is a freight train derailment. In this scenario the ballast supporting the track is washed away and the train is derailed. The track would be closed for a minimum of 4 to 5 days with this freight corridor handling all Melbourne to Adelaide to Perth rail freight (there are also two passenger trains to Melbourne each week that would potentially be impacted). There would be significant delays in freight movements under this scenario. For example access to rail transport for grain would be cut off. There would be a service delays and lost revenue for freight that is time critical. The company that runs the trains would also suffer a *force majeure*. The estimated ARTC financial impact is a minimum of $1m to $1.5m based on a 4.5 day repair effort. In addition there would be losses associated with the locomotive and railcars of $1m to $1.5m. The track is adjacent to the passenger train network with a derailment expected to foul the passenger train network which would therefore need to be closed.

The mid-level case would be a track closure due to a loss of ballast and sleepers causing the track to subside (no derailment). It is estimated this would cost around $100,000 to repair with no significant operational impact (short term impact only).

The best case would be that the flood event resulted in water pooling around the track with trains needing to operate at slower speeds until the water subsides.

There are two other potential impacts:

- Trains could be carrying hazardous freight and the locomotive uses diesel which could spill during a derailment.
- The potential for employees to be injured during a derailment.

The proposed flood mitigation infrastructure, when implemented, would potentially result in a reduction of insurance premiums.

3.4 Ashford Hospital

It is estimated that a 1-in-100 year flood event would shut the hospital down for six months (whole hospital as it is dependent on the ground floor and the chillers are in the basement). Under this scenario revenue loss is estimated at $60 million plus with equipment / infrastructure easily $10 million (one of the hospital's Angio labs is $1 million on its own).

The Ashford Hospital is located between the Brown Hill and Keswick creeks. Flood modelling predicts that flood waters will impinge on the property boundary for a 1-in-100 year event and greater events. Modelling has been generated up to a 1-in-500 year event.

For the 1-in-100 year event, the flood depth along ANZAC Highway is estimated to be 10 – 25 cm at the door. Consideration will need to be given to any weep holes/vents in the walls if these are below 25 cm of the finished floor level.

FM Global (insurer) recommends physical protection for up to a 1-in-500 year event, based on the mapping this is approximately 35 cm at the entry door off ANZAC Highway and the corner of Alexander Avenue and Reid Street.

There is a significant social impact if the hospital is closed as it handles 350 theatre cases per week and also handles public hospital overflow work. The hospital also has an emergency department which would be closed.

3.5 Department for Infrastructure & Transport - North South Corridor Project

DIT noted that the proposed lowered North South Corridor (NSC) motorway would need to be protected in the event of a 1-in-2,000 year flood. At this stage there has been no modelling undertaken in relation to the impact that the motorway construction will have on upstream properties in the event of a major flooding event although this work will be undertaken by the NSC Project team. However it is acknowledged that establishing a physical barrier on the upstream (eastern) side of NSC to prevent floodwater ingress to the lowered motorway, in the absence of infrastructure upgrades that would provide safe passage of overland flows across the NSC, would have an adverse impact on flood risk to the upstream properties. The completion of the Lower Brown Hill Creek Upgrades and the Keswick Creek Flow Diversions would contain high flows (up to the 1-in-100 year) within the creek channels and would minimise the overland flows approaching the NSC in events greater than a 1-in-100 year. At the time of writing this report no other engineering solution had been made available for providing safe passage of overland flows across the NSC corridor.

It is not currently possible to determine the impact that a 1-in-100 year flood event would have during the construction phase of the project. It is expected that this information will be provided by the motorway construction tenderers. However it is noted that the Stormwater Management Plan 2016 floodplain mapping shows spill across the NSC in all events, down to a 1 in 10 year event. As such the NSC is exposed to risk for small events during construction.

There was general agreement on the importance of project alignment with the NSC project and the BHKC Stormwater project and there is support to collaborate from both project teams as reinforced by the following extract from a letter of support provided by the Department for Infrastructure and Transport's North-South Corridor Program Delivery Office and dated January 2021.

The NSC project involves joining the recently completed Darlington and Torrens to Torrens projects with tunnelled sections at the northern and southern ends, with sections of open motorway in the mid-section. Further details can be found in the website link https://dit.sa.gov.au/nsc/torrens to darlington. The 10.5km section of corridor crosses both Keswick and Brown Hill creeks which both form critical pieces of drainage infrastructure in terms of the delivery of the project, and which also present flood risks that need to be managed to protect the Motorway.

We understand that significant upgrades are proposed for both Keswick Creek and Brown Hill Creek, which will ultimately benefit this project, but which may present considerable interim risk if the construction of the motorway were to proceed significantly ahead of the flood protection works. It is expected that there would be considerable benefits to both projects if their development and delivery through reference design, detailed design, then construction was coordinated in the same or similar timeframe. An integrated solution would potentially deliver costs savings to both projects and a reduction in flood risks to the community that would need to be considered. We note that the reference design for the NSC project has commenced and is expected to be complete later this year.

The NSC project will include lengths of roadside barriers and other infrastructure which cross the Brown Hill and Keswick creek floodplains which will impact previous and currently proposed updates to floodplain maps and hazard assessments, so the ability to work together and share information will also save time and effort on both sides in updating flood data for use by the BHKCSMB and other agencies.

3.6 FM Global – Insurer for Ashford Hospital

The engineering team has performed a risk assessment looking at the available flood mapping data. Underwriting then estimates the potential loss based on this assessment (engineering advice) and adjusts the premium. In the case of Ashford Hospital there could also be a re-insurance component which would impact on the premium. While it is anticipated that the flood management infrastructure would have a positive impact on Ashford's insurance premium, it is difficult to estimate what the exact amount would be.

FM Global was not able to provide the property valuation used by underwriting as this is commercially sensitive. Ashford Hospital was approached and provided this information which was considered for the economic modelling.

3.7 Department of Defence - Keswick Army Barracks

It is noted that the Department of Defence is disinclined to share information regarding events at its sites. Therefore the damages estimates focus on property only and not operational impacts. The limited information provided is listed below.

This is a list of buildings on the Keswick Barracks site:

- 18 – Storehouse Metal
- 112 – Offices Brick
- 183 – 144 Sig Sqn Workshop Brick
- 184 – Pol Store Brick
- 185 – Vehicle Shelter Brick
- 186 – Sergeants Mess Brick
- 188 – Storehouse Brick
- 192 - Tool Shed
- 194 – Ablutions Brick
- 195 – Not specified

- 198 – Offices Brick
- 208 – Pol Store Container
- 209 – Store C/Bond
- 211 – Vehicle Shelter C/B
- 212 – Pol Connax
- 222 – C/B

A flooding event (maybe November 2018) to Bld 198 and Bld 196 damaged carpet. No stores or other equipment were damaged from Defence's memory. Apparently it happened during the night and was mostly gone in the morning.

There was a major flooding of the Defence Bank branch in late December 2016. As a result there was a need to replace all carpet and some furniture in the branch next to building 198, Keswick. Building 198 itself had major flooding at this time.

- Bdg 112 required significant cleaning and all furniture replaced at the time.
- Bdg 211 – 144 Sig Sqn bays. Water up to bay doors.
- Bdg 183 – Water accessed the rear area of the building being the Q Store/Comms bay areas.
- Defence Bank Building – drowned.
- Bdg198 – Lecture rooms beside the creek/Defence Bank area flooded.
- Bdg209 – flooded.
- The carpark beside the stables/gymnasium was under water as well with a high tide mark close to the 6/13 compound corner.

Most of the flooding occurred at night and did not disrupt day to day operations other than to clean up.

3.8 LGASA Mutual Pty Ltd

Risk is spread right across the sector (68 member councils in South Australia). Reinsurance is spread across Australia under the national local government reinsurance program. The cost to South Australia is weighted so there is a financial advantage in mitigating exposure. Premiums are not driven by claims and events.

In a catastrophic event the State Government would need to look after the community and reinstate the infrastructure. LGASA Mutual noted that it is very difficult for commercial organisations to get flood cover and it is also difficult for residents to buy flood cover, so they are uninsured in the event of a flood.

LGASA Mutual has provided a letter of support for the project as summarised below.

LGASA Mutual manages the LGA Workers Compensation Scheme and the LGA Mutual Liability Scheme which includes assisting the LGA and the sector with managing climate risk and their emergency management functions.

The BHKCS Project is considered significant to the State of South Australia due to the flood mitigation work that it will achieve across built up areas in Adelaide.

For LGASA Mutual, the BHKCS Project is a key initiative addressing our member's exposure to climate risk and the project will reduce the need for our members and the LGA's Local Government Functional Support Group (created under the State Emergency Management Plan) to respond to and recover from major flooding events.

As you would appreciate, with a changing climate forecast into the future, the occurrence of storm events causing flooding risk in the BHKC catchment is expected to increase significantly if this project is not completed. As a result, this project has been a priority of our impacted members and the State for a considerable period.

The current state of the world insurance market is extremely tight leading to large increases in premiums and insurers walking away from insuring several risks, including those associated with catastrophic events such as floods. This is limiting the availability of insurance and/or resulting in large increases in premiums. As a result of recent weather and fire events in Australia and South Australia, it has also become evident of the extent of under-insurance and non-insurance within the community. In addressing the flood risk in the BHKC catchment, this project is expected to put downward pressure on insurance premiums for assets in the catchment for businesses, residents, and government.

In addition, events such as floods lead to a large level of damage to uninsurable assets such as critical infrastructure as well as the significant cost required for community recovery in general. This can place increasing pressure on already strained council, government, and community resources.

Given the significance of the BHKCS Project to our members and the communities they serve as well as greater Adelaide, LGASA Mutual supports the BHKCS Project and would ask that you (prospective funders) consider their application for funding favourably.

3.9 Metropolitan Fire Service (MFS)

The following section outlines potential impacts on MFS built assets (fire stations). It appears from the maps that stations at Brooklyn Park and Glen Osmond may be affected. In terms of replacement value (based on a recent property valuation) these stations would cost $3.8m (Glen Osmond) and $2.4m (Brooklyn Park) to replace. If appliances (fire trucks) were also lost replacement cost would be an additional $1.3m per station.

In addition MFS Emergency Management – Special Operations team has provided some initial feedback below.

From the attached briefing paper and interview guide it would appear the scope of the initial information gathering is very broad in terms of infrastructure and operational impact of 1-in-100 year flooding in these catchments.

The immediately obvious situation is where they impact physically on our assets (Fire Stations) and their operations and the cost associated with repairs, relocation of resources and impacts on service to the community.

The other significant cost and risk to the community (and this has been a significant issue in Queensland Floods Commission of Inquiry (floodcommission.qld.gov.au)) that can be more difficult to quantify, but is potentially a far greater cost and risk than any obvious impact upon our assets is the damage to and impacts upon fire safety systems with the following impacts (not exhaustive):

- *Damage to Fire Indicator Panels (usually located on ground floors) resulting in unwanted alarms or non-functioning systems*
- *Damage to and failure of pump and sprinkler control systems and supporting secondary power systems (usually on ground floors, and often in basements)*
- *Damage to detection, smoke hazard and air management systems*

The follow on impacts for the fire service include (again not exhaustive):

- *Increased call rates for system faults and impact upon resource availability for other emergencies*
- *Potential delayed response as a result of detection and alarm system failure and subsequently greater property damage or loss prior to fire service arrival and intervention*

- *Community Safety and Resilience Department Staff impact in supporting contractors to recommission fire safety systems*

The above impacts can occur for a significant period after the flood events if there is significant infrastructure damage and other service delivery impacts include the difficulty associated with accessing water from fire plugs (often silted up post flooding events) and safety issues associated with the impact of heavy vehicles on flood affected roads as well as general access and egress.

While individual properties may be able to answer all the questions covered in the attached "Interview Guide", particularly as they relate to installed fire safety systems, we (via CSRD) may be able to provide an indication of the total number of premises with significant fire safety systems that may be impacted in the above listed areas in the event of the 1-in-100 year flood events to provide a scale/scope of impact if not an actual cost.

3.10 SA Ambulance Service (SAAS)

SAAS has two owned properties and four leased properties which would be impacted. SAAS headquarters is located at 216 Greenhill Road, Eastwood which houses the 000 calls. SAAS also has a rescue retrieval centre at Adelaide Airport. The headquarters replacement value is $100 million with the rescue retrieval centre replacement value being $13 million. Leasehold improvements are estimated at $2.2 million.

One of the most significant impacts would be on personal injury/loss with 1,000 cases per day. A 1-in-100 year flood would generate a massive workload with evacuations from hospitals and aged care facilities. Also, those injured by the flood would generate work for SAAS.

Another impact is the inability to get to an emergency case including potential injury and loss of life. The length of time for a person to be retrieved has a major impact on this. There would potentially be a loss of transport legs and routes if the flood cut of transport routes completely. This could mean that one hospital could be cut off from another hospital leading to the accessible hospital being overwhelmed. This aligns with the information provided by Ashford Hospital as highlighted in Section 3.4 above.

SAAS has a 000 contingency plan but it's a short term solution. A protracted event would compromise SAAS's ability to handle call volumes. Also, if critical infrastructure is knocked out then ambulance despatch, which relies on 4G network, could be impacted.

SAAS has a risk management plan.

3.11 State Emergency Service (SES)

There would be no direct impacts to SES. However it is expected there would be major impacts on volunteers who live in floodplain areas. There is also the issue of dealing with people who have been displaced if their homes are unsafe and the challenge of finding temporary accommodation.

As noted above, SES is manned by volunteers. If this labour was costed, the cost of flood associated work is estimated to be $10 million over the past 10 years. These costs are associated with flood events of a smaller scale than a 1-in-100 year flood, but the flood management infrastructure would eliminate these smaller scale events.

3.12 Stormwater Management Authority

It is noted that linking the BHKC stormwater project to the NSC project is extremely important as hydrology is critical to the NSC project. It is also important to demonstrate the impact of flooding on Adelaide Airport.

It is further noted that the Stormwater Management Authority's contribution of $70 million over 20 years ($3.5 million per annum) represents a significant proportion of their overall funding ($5.792

million for 2021/22 and subject to annual indexation). This means that other important stormwater management projects across South Australia are essentially being deferred as a result of the prolonged delivery of the BHKC project.

4.0 Societal Impact - Economic and Benefit Cost Assessment

4.1 Property Flood Damage Estimates

4.1.1 Flood Damages Estimates for Stormwater Management Plan (2016)

In 2003 a field survey was undertaken to measure the Finished Floor Level (FFL) of over 7,500 dwellings that are located within the flood-affected areas of the BHKC catchment. Using this FFL data, together with property data from the early 2000's and the floodplain mapping output, the process for determining the flood damages estimates for the 2016 SMP was:

- Allotments were identified as flood-affected if water was shown to pass over the ground level at the location of the property centroid.
- Where the flood level at the centroid was below the FFL, a 'below-floor' multiplier was applied to the 'improved value' of the property to calculate its damage estimate, which acts as a sliding scale to reflect that greater flood damages are incurred for greater flood depths.
- Where the flood level at the centroid was above the FFL, an 'above-floor' multiplier was applied to the 'improved value' of the property to calculate its damage estimate. Given the impact on property and contents the damage from 'above-floor' flooding is greater than for 'below-floor' flooding; the 'above-floor' damage multipliers are in the order of 3 to 5 times larger than the corresponding multipliers in the curve for 'below-floor' damages.
- The 'improved value' of the property was calculated by subtracting the 'site value' from the 'capital value' of the property, based on the Valuer General's data.
- There was some indexing of the flood damages to account for the age of the property data used. ABS statistics for the South Australian price index for Road and Bridge Construction (as a general reflection of the cost of construction) were used to determine an escalation factor of 64% between 2003 and 2016, which was applied to the original 2003 multipliers.
- The above process was automated using the damages analysis tool in Worley Parsons' waterRIDE software, which is configured as an adaptation of the original 'GIS Flood Cost Estimator Tool' used in 2003.

Table 1 summarises the number of properties that were identified as being subject to flooding in the 2016 SMP, and Table 2 shows the corresponding flood damages estimates by property category as estimated in the 2016 SMP.

Table 1 – Number of flood-affected properties by Council area from the 2016 SMP

Local Government Area	**Number of properties within 100-year floodplain before mitigation works**	
	Below-floor Inundation	Above-floor Inundation
City of Adelaide	0	0
City of Burnside	7	74
City of Mitcham	13	17
City of Unley	315	539
City of West Torrens	582	542
TOTAL	**917**	**1,172**

Table 2 – Base Case flood damages by property category from the 2016 SMP

ARI[1]	Base Case floodplain ($'000)	Mitigation Case floodplain ($'000)
5 (assumed)	0	0
10	4,823	0
20	10,622	0
50	44,957	398
100	107,220	815
500	409,358	166,724
PMF[3] (assumed)	1,000,000	1,000,000

[1] Average Recurrence Interval
[2] Excludes the flood damages estimates for the Adelaide Airport.
[3] Probable Maximum Flood

4.1.2 Updated Flood Damages Estimates Using Latest Valuer General's Data

The latest Valuer General's property data from 2021 has been obtained. This data has captured the additional allotments that have been created by infill development throughout the BHKC catchment area and has also provided the latest 'site value' and 'capital value' assessments for each property.

Advisian (the new consulting arm of Worley Parsons) was engaged to update the flood damages estimates using the new data, and the Valuer General's dataset required GIS processing to ensure that it was suitable for use with the damages analysis tool in Worley Parsons' waterRIDE software. Where applicable the floor level survey data from 2003 has been re-assigned to allotments (i.e. where the VG's data shows that the dwelling age is 2003 or earlier).

Where new allotments have been created (making the floor level of the old dwelling redundant) or floor level data was otherwise missing, a floor level has been assigned that is 150mm above the ground level at the centroid of the allotment. In the absence of surveyed FFLs for all new properties this is considered to be a reasonable assumption which reflects the allotment filling that is typically required by modern day planning controls. The assumption is also understood to be consistent with other Stormwater Management Plans where surveyed FFLs are not available.

The analysis, presented in Table 3, has shown that there is a much larger number of properties now situated within the BHKC floodplain, and this reflects the significant infill development that has occurred since the early 2000's. There are slightly fewer properties that are expected to be subject to above-floor flooding, and this is considered representative of the number of new dwellings with assumed higher FFLs. To provide greater certainty for the proportion of properties that would be subject to above-floor versus below-floor flooding, further survey of FFLs would be required.

The analysis has also shown that the number of properties prone to flooding during a 100-year ARI event reduces from 3,935 to 63 once the flood mitigation works are completed.

Table 3 – Number of flood-affected properties by Council area based on 2021 VG's Data

Local Government Area	Number of properties within 100-year Base Case floodplain		Number of properties within 100-year Mitigation Case floodplain	
	Below-floor Inundation	Above-floor Inundation	Below-floor Inundation	Above-floor Inundation
City of Adelaide	14	4	0	1
City of Burnside	176	61	0	0
City of Mitcham	74	17	12	4
City of Unley	1,015	377	23	21
City of West Torrens	1,586	611	2	0
TOTAL	**2,865**	**1,070**	**37**	**26**

Advisian has calculated the up-to-date 'improved value' for each flood-affected property using the Valuer General's data (by subtracting the 'site value' from the 'capital value' of the property) and applied the original 2003 multipliers (with no indexation) to determine the updated 2021 flood damages estimates that are presented in Table 4.

Table 4 – Base Case flood damages by property category based on 2021 VG's Data

ARI[1]	Base Case floodplain ($'000)	Mitigation Case floodplain ($'000)
5 (assumed)	0	0
10	7,328	0
20	20,353	0
50	69,321	1,527
100	137,612	2,394
500	564,031	273,019
PMF[3] (assumed)	1,000,000	1,000,000

[1] Excludes the flood damages estimates for the Adelaide Airport.

4.1.3 Updated Damages Estimates Using NSW Benchmark and Property Valuers Data

For comparison, a separate analysis has been undertaken using the standardised method for estimating flood damages for residential property in NSW. The process for determining the flood damages estimates using this method is:

- Identify properties where the floodwaters pass over the centroid of the allotment.
- Flood depth is determined relative to the finished floor level, and a standard 'depth vs $ damage' value is applied to the allotment. There are unique 'depth vs $ damage' values for different residential property types, and the 'low-set slab-on-ground' property type is applicable to the BHKC catchment. This method does not rely on a multiplier or 'improved value' for each individual property.

A property valuer has completed a detailed investigation and independent assessment of the replacement value of properties in the Brown Hill Keswick Creek catchment and Advisian has also determined updated flood damages estimates using this data (instead of the 'improved values' from the Valuer General's data).

The SMP, 2021 VG and NSW method values exclude property value for Adelaide Airport, but include values for Ashford Hospital and Keswick Barracks, while the replacement value estimates excluded values for Adelaide Airport, Ashford Hospital and Keswick Barracks.

The alternative values summarized for all properties in aggregate in Table 5.

Table 5 – Comparative analysis of SMP Values to Replacement Values

ARI	Flood damages for Base Case floodplain ($'000) – All Properties			
	SMP values	*2021 VG Values*	*NSW Method for Residential Value*	*Replacement Values*
5 (assumed)	0	0	0	0
10	4,823	7,328	9,238	4,757
20	10,622	20,353	21,579	16,807
50	44,957	69,321	88,385	91,576
100	107,220	137,612	170,397	185,003
500	409,358	564,031	669,243	909,254
PMF (assumed)	1,000,000	1,000,000	1,000,000	1,000,000

The analysis has shown that the method used in the SMP to estimate the flood damages to residential property involved much lower estimates than the revised levels in the first instance because of property value increases. The standardized method used in NSW produces much higher results across the board. It is expected that this is because the method used in the SMP relies on the 'improved value' of the property and calculates this value using data from the Valuer General's office. This replacement valuation methods results in lower values for the lower level ARI floods, but much higher damage value for more significant floods.

4.1.4 Use in Economic Modelling

The economic modelling for the Business Case uses the replacement value data summarised in Table 6.

Table 6 –Flood damages estimates used for economic modelling

ARI[1]	Base Case floodplain ($'000)	Mitigation Case floodplain ($'000)
5 (assumed)	0	0
10	4,758	0
20	16,806	0
50	91,576	2,220
100	185,003	3,703
500	909,255	440,148
PMF[3] (assumed)	1,000,000	1,000,000

[1] Excludes the flood damages estimates for the Adelaide Airport.

4.2 Benefit Cost Assessment

4.2.1 Scope of Analysis

This section provides an analysis of the benefit cost outcomes of the Brown Hill Keswick Creek Stormwater Project under varying project and funding assumptions. It differs from the previous analysis as reported in the SMP with the main points of difference being:

- It includes an up-to-date assessment of flood damages to the Adelaide Airport and a detailed assessment of flood damages to other key stakeholders including the Ashford Hospital.
- It updates the number and underlying value of properties at risk to 2021.
- It updates costs to current estimates based on the Reference Designs (30% design gateway) for the remaining sub-projects.
- It uses the replacement value property damage estimates.
- It includes in the base analysis estimated additional indirect impacts on the operations of commercial and social businesses, and estimates for a range of social impacts.

It is noted that the analysis includes some broad estimates of flood damage factors due to a lack of detailed research and limited detailed information in these areas. Where evidence is limited, estimates have been included that can be considered conservative, and then tested using sensitivity analysis.

4.2.2 Context

The Stormwater Management Plan 2016 draws the following conclusions for the benefit cost outcomes of the BHKC Stormwater Project.

Table 7 - Estimated catchment damage by scale of flood as estimated in 2016

Design Flood	Flood Damages ($'million)		
	Base Case	Mitigation Case	Reduction
10 year ARI	4.8	0	4.8
20 year ARI	10.6	0	10.6
50 year ARI	45.0	0.4	44.6
100 year ARI	122.2	0.8	121.4
500 year ARI	434.4	181.7	252.7
PMF	1,000	1,000	0
AAD	5.96	1.92	4.04

Source: SMP p 166

Table 8 - NPV of Project (6% real discount rate)

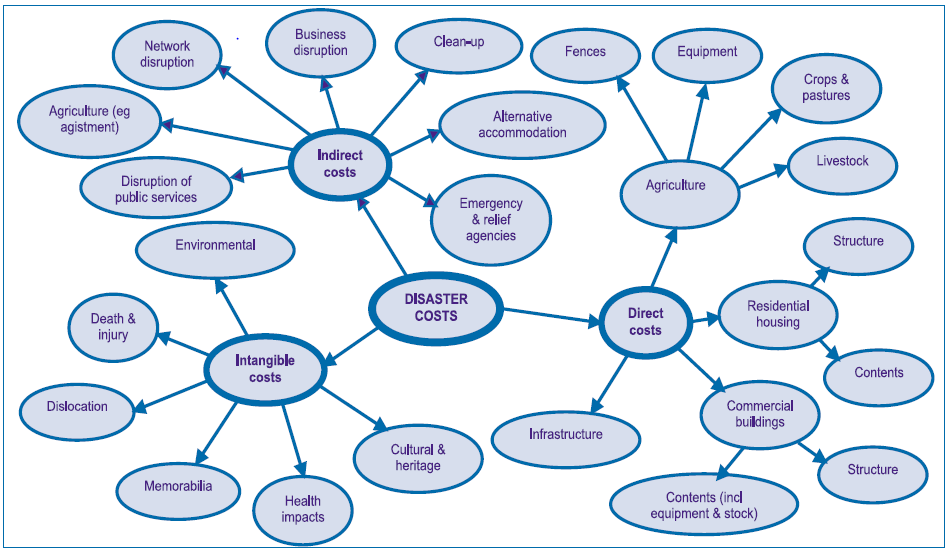
	Base case 1	Mitigation case 1
AAD	$8.066 M	$2.130 M
PV benefits		$49.296 M
PV costs		$98.369 M
BCR		0.50
Net PV		-$49.073 M

The SMP contains further analysis including assessment of staging options for the project. The analysis draws on floodplain modelling and damage assessment that is based on estimates of capital improved value and applies Consequence Assessment Multipliers that include direct and indirect tangible costs for each level of flood.

4.2.3 Other Literature

There is other literature nationally and internationally that can be classified as either methodology oriented, designed to inform stakeholders in disaster management of the issues involved in measuring value, and case studies of flood impact for particular areas and times. The latter are hard to translate from one region to another. However the former give some perspectives of what should be considered and included in a benefit cost analysis.

The first issue in any benefit cost assessment is to consider a list of benefits and costs. The benefits of flood mitigation are depicted in (Gentle, Kierce, & Nitz, 2001) as follows:



From this report:

- "There is no simple relationship between indirect and direct costs (defined below) of a disaster. Previous disaster reports indicate that, as a broad estimate, indirect costs are usually in the range of 25 to 40 per cent of direct costs."

- "The intangible cost category attempts to capture all losses not considered as a direct or indirect tangible cost. Intangible costs are typically those for which no market exists. These costs are difficult to estimate, as there is no systematic or agreed method available to measure them. The largest impact is normally found in the residential sector, which includes health effects, household disruption and loss of memorabilia. Although presently available methods are generally poor at reliably estimating many intangible costs and benefits, they should not be ignored in assessing mitigation proposals."

- "The largest gap in the estimation of disaster costs is the inability to adequately estimate intangible costs. Evidence suggests that they are at least comparable with direct costs, and possibly much larger. Research is needed to develop reliable methods to overcome this gap."

This report was updated in 2017 but without much advancement on estimating intangible costs.

Deloitte Access Economics produced a report for the Australian Business Roundtable for Disaster Resilience & Safer Communities, entitled "The economic cost of the social impact of natural disasters," March 2016. The findings included:

- "The total economic cost of the 2010–11 Queensland floods is estimated to be $14.1 billion (in 2015 dollars), with $7.4 billion in intangible social impacts and $6.7 billion in tangible impacts."

- "The case studies demonstrate that the total economic cost of natural disasters has been underestimated by at least 50%."

A study by the Australian Institute for Disaster Resilience entitled "Integrating intangible values in economic analyses of flood mitigation: a case study of the Brown Hill and Keswick Creeks Catchment in Adelaide" (2017) concluded that:

- "One of the shortcomings of standard benefit-cost analyses (BCAs) is that they rarely include intangible values (Hammond et al. 2015, Hansson, Danielson & Ekenberg 2008). For floods,

only DEFRA/EA (2005) and Joseph and colleagues (2015) have estimated the dollar values of intangible impacts, but these values have not been incorporated into BCAs."

- "In this study, conservative (lower-bound) values for intangible values were used but since no survey was conducted to estimate them, there is a high level of uncertainty attached to these figures."

- "The results show that the most substantial intangible values are morbidity and road traffic delay. However, intangible losses remain relatively small compared to tangible losses, representing only between 6 per cent and 21 per cent of total losses."

This last study is therefore quite different in its conclusion with respect to the importance of intangible damages. There are a number of reasons for this, including:

- It uses lower-bound values and did not consult with key stakeholders in the catchment.

- It assumed values primarily to people living in the area that is immediately impacted by flooding and does not include impacts on a range of other people impacted (for example patients in hospitals, impacts on air passengers, commuters and public transport users).

- It excludes some elements of possible social impact including general stress, volunteer time and risk in damage control.

4.2.4 Assumptions for Estimating Damage Cost of Floods

Given the above context, the following outlines the assumptions to be used in this updated benefit cost analysis of the Brown Hill Keswick Creek Stormwater Project. The following provides the base information for a 1-in-100 year flood. Other floods are adjusted proportionally to the information for private properties. The following table details the benefit and cost categories and current assumptions (noting that not all assumptions are used in all sensitivities).

Category	Assumptions
Direct flood damages and interruption to on-airfield operations at Adelaide Airport	
Property damage	While within the consultation with Adelaide Airport indicated that there would be limited property damage, the Use Consequence Values for Each Region (Appendix C) as provided by the BHKCSP – indicated $34.2 million repair cost for 1-in-100 ($3.8 million for 1:10 etc.). This document was dated 2004. The allowance for damage has been included with this value updated based on ABS change in building costs index.
Furnishing and equipment damage	Assumed included in the above.
Value in interruption to operations	This study uses the Hudson Howells' December 2013 study of operational impact, updated to study from 2018 – forecast of GSP contribution of airport for 2031 is $3.5 billion (c.f. 2013 study $1.94 billion). 1-in-100 year flood (medium impact) in 2013 was $10 million (2.5 days interruption – some precincts impacted by 80% some by 50%). Therefore indicative value will be in the order of $18 million. This includes lost tourism value as well as operations at airport. Note the SMP used this as a low, but it was only operational damage. This included the direct and induced impact or contribution associated with flood impacts on the airport precinct.
Other flood damage	Other damages associated with interruption to airport services will include: • Passengers incurring extra costs due to reorganising travel.

Category	Assumptions
	• Passengers missing key events due to flight delays (e.g. flights for weddings or birthdays, missing major sporting events, losing days of leave). • Spoilage of freight and loss of contracts through non delivery. • Reputational damage to AAL and state tourism In the absence of other information, it is conservatively assumed that this would be valued at 40% of the actual spend on tickets (which in turn are estimated at 55% of the on site turnover).
Direct flood damages and Service Interruption at Ashford Hospital	
Property damage	In the absence of a valuation, it is assumed there is $6 million of damage to property in a 1-in-100 year flood (note that if this increases or decreases it will be offset by a change in institutional properties below).
Furnishing and equipment damage	The consultation indicated that a 1-in-100 flood would result in an equipment value loss of $10 million (all located in the basement).
Value in interruption to operations	From consultation 1-in-100 flood would result in $60 million lost revenue. From a CBA perspective it is assumed that 50% 'transfers' to other facilities and 50% is lost (noting that Ashford handles 350 theatre cases per week).
Other flood damage	Other damages associated with interruption to Ashford Hospital services will include: • Cost of transferring at risk patients to alternative locations during shut down including stress and uncertainty while in a vulnerable situation. • Potential health risks associated with the need to transfer, including increased risk of death due to interrupted treatment during flood or in transport. Current estimates regarding the value of a life is $4 million, (noting that Ashford handles 350 theatre cases per week and handles public hospital overflow work). The hospital also has an emergency department that would be closed, and users would need to find an alternative, which will create more travel and overflow. • Additional costs to visitors etc. during lock down of having to go to hospitals of further distance from home. It is presumed that these costs are significant, and it is conservatively assumed that this would be valued at 50% of the actual net revenue lost. This is considered conservative as even one death as a consequence of the flood (out of 9,100 theatre cases overs 6 month) would be valued at $4 million.
Direct Flood Damages and Service Interruption to Keswick Army Barracks	
Property damage	The spreadsheet supplied by Unley Council indicates CIV of $28.7 million and max flood height of 2.2 metres impacting 29% of the area (We assume that this is for 1-in-100 year flood). It is indicatively assumed that the improved value is 30% of value, upgraded to replacement value, and that property damage is 20% of that.
Furnishing and equipment damage	An additional 10% is added for furnishings and equipment damage.
Other flood damage	While activities will be interrupted during a major flood, it is conservatively assumed that they can be deferred at little cost and as such are minimal.

Category	Assumptions
Direct Flood Damages to Private Property	
Commercial	
Property damage	Used data from Tables 1 and 2 from Section 4.1 of this report.
Value in interruption to operations	This is assumed to be half the ratio of lost value in operations to property damage in Hudson Howells' Adelaide Airport Flood analysis and applied to property and operational damage as above to allow for indirect and induced business damage.
Other flood damage	Other damages would include lost future development opportunities for businesses during the downtime, payment of overtime to "catch up" on orders or activity etc. Assumed as 20% of lost value in interruption to operations.
Industrial	
Property damage	Used data from Tables 1 and 2 from Section 4.1 of this report.
Value in interruption to operations	This is assumed to be half the ratio of lost value in operations to property damage in Hudson Howells' Adelaide Airport Flood analysis and applied to property and operational damage as above to allow for indirect and induced business damage.
Other flood damage	Other damages would include lost future development opportunities for businesses during the downtime, payment of overtime to "catch up" on orders or activity etc. Assumed as 20% of lost value in interruption to operations.
Institution/Other	
Property damage	Used data from Tables 1 and 2 from Section 4.1 of this report.
Value in interruption to operations	This is assumed to be half the ratio of lost value in operations to property damage in Hudson Howells' Adelaide Airport Flood analysis and applied to property and operational damage as above to allow for indirect and induced business damage.
Other flood damage	Other damages would include lost future development opportunities for businesses during the downtime, payment of overtime to "catch up" on orders or activity etc. Assumed as 40% of lost value in interruption to operations (higher than commercial and industrial due to public good nature of operations).
Residential	
Property damage	Used data from Tables 1 and 2 from Section 4.1 of this report.
Other flood damage	While no operational interruption value is assigned, it is assumed that there is other damage equal to 30% of the property and furnishings. This relatively high value is attributed to: • Loss of personal items with limited financial value, but in some cases irreplaceable. • Stress and costs involved in managing any displacement during and after the flood. • Lost time (e.g. not being able to go to work).
Flood Damages to Local Government Property (Non-Building)	
Direct. Damage to non building infrastructure, including outdoor recreational areas, footpaths, local government managed roads, bridges etc.	While the SMP applied Consequence Assessment Multipliers are cited as including some damage in this context, it is assumed it is underestimated, and so the following is considered additional: 1. Unley – provided an estimate of $1.3 million in damages to infrastructure for 1-in-100 year flood.

Category	Assumptions
	2. Burnside – Consultation revealed that the replacement cost of assets impacted by 1-in-100 year flood is $136 million. Assuming that this infrastructure is proportional to the relative number of properties (which presumes that Council infrastructure assets and damage are correlated to the number of properties) indicates a damage bill of 0.16% of property value. 3. Mitcham - assumed that it is proportional to private property in region. 4. Adelaide – in consultation have feedback that 300,000 to 600,000 sqm of parklands of are flooded (at 1-in-100) at $1.60 per sqm - $0.72 million. 5. West Torrens - assumed proportional to Unley and estimated based on private property numbers.
Other	Flooding will deny access to parks (including the parklands), will make footpaths inaccessible creating risks etc. Therefore it is assumed that other damage equals the impact to reflect inconvenience of users of the infrastructure (note this implies a BCR of 1 in doing the repair so is conservative).
Flood Damages and Interruption to Construction of Lowered Motorway for North South Corridor Torrens to Darlington Project	
Direct	The 10.5 km Torrens to Darlington (T2D) Project involves tunnels and roads subject to flooding. There are two expected costs associated with a flood: • Financing costs in delays – the project is $9.9 billion over 8 years or a spend of $3.39 million per day. Therefore a 4-day delay incurs financing and other costs which at an assumed rate of 10% is $1.35 million (1-in-100). • A delay in finishing which means travel time savings and road benefits are not achieved as quickly (4 days). The core data for project benefits is that the route involves 110,000 trips per day, the project saves up to 24 minutes, and saving freight operators up to $8.80 per trip. Assuming that freight transport represents 5% of the daily trips, and that freight trips average 1.2 passengers per vehicle while passenger transport averages 1.5 passengers, and valuing time at the median wage this amounts to $9.6 million. This is then increased by 50% as traffic will be diverted to alternative routes and as such will increase congestion more broadly. DIT consultation noted: • The proposed lowered NSC motorway would need to be protected in the event of a 1-in-2,000 year flood. • There would be cost efficiencies from coordination of the BHKC work with the motorway work.
Other	Other costs will include increased risk of accidents due to greater congestion in the surrounding network and increased political pressure on the project (e.g. 4 days extended inconvenience for residents in surrounding areas). This has been assumed to be 30% of the direct costs.
Flood Damages and Service Interruption to Interstate (ARTC) Rail Lines	

<table>
<tr><th>Category</th><th>Assumptions</th></tr>
<tr><td>Direct</td><td>ARTC have not undertaken an assessment of flood risk. Consultation suggests that a worst case would be a freight train derailment, leading to track closure of 4-5 days, and lost revenue and service delays. They estimate $1-$1.5 million based on 4-5 days closure, but losses associated with locomotive and rail cars of $1-$1.5 million. They outline a mid level case and best case which is of considerably lower impact. It is assumed the worst case is associated with the 1-in-100 year flood.</td></tr>
<tr><td>Other</td><td>ARTC note three other potential impacts:
Trains could be carrying hazardous freight and the locomotive uses diesel which could spill during a derailment.
The potential for employees to be injured during a derailment.
The track is adjacent to the passenger train network with a derailment expected to foul the passenger train network which would therefore need to be closed.
In addition there is the impact of delays on freight, creating inconvenience and rescheduling of acidity related to delivery. It is considered these costs could be of some degree of seriousness and as such, are assumed to be 50% of the direct costs incurred.</td></tr>
<tr><td colspan="2">Flood Damages and Interruption to Arterial Road and Freight Network</td></tr>
<tr><td>Direct</td><td>The nominated number of arterial road users in the flood affected areas include the following.<table><tr><th>Road Name</th><th>Daily number of vehicles</th><th>Daily number of commercial vehicles</th></tr><tr><td>South Road</td><td>49,100</td><td>4,100</td></tr><tr><td>Marion Road</td><td>35,000</td><td>1,750</td></tr><tr><td>Tapleys Hill Road</td><td>50,100</td><td>2,600</td></tr><tr><td>Sir Donald Bradman Drive</td><td>26,900</td><td>950</td></tr><tr><td>Anzac Highway</td><td>35,000</td><td>1,550</td></tr><tr><td>TOTAL</td><td>196,100</td><td>10,950</td></tr></table>Source: Location SA Map Viewer, Traffic Volume Estimates at 28 January 2020
The assumptions relating to impact of a flood on the completion of the NSC project are applied to these other road use numbers, with an estimated flood damage created in terms of delays (1/2 hour delay) of $33.71 million in the case of 1-in-100 year flood.</td></tr>
<tr><td>Other</td><td>Other costs will include increased risk of accidents due to greater congestion in the surrounding network and inconvenience for residents in surrounding areas. This has been assumed to be 30% of in the direct costs.</td></tr>
<tr><td colspan="2">Interruption to Emergency and Essential Services</td></tr>
<tr><td>Direct</td><td>The consultation responses are summarised as follows.
MFS response:
There is the possibility of damage to at risk buildings (Brooklyn Park – replacement value of $2.4m and Glen Osmond $3.8m and equipment at $1.3m).</td></tr>
</table>

Category	Assumptions
	○ Possible damage to fire management systems in buildings that would cause delays in getting to emergencies. • SA Ambulance ○ Two owned and four leased at risk buildings – replacement value of own buildings $113 million. ○ Operational impacts: ▪ Personal injury/loss with 1,000 cases per day, and massive workload with evacuations from hospitals and aged care facilities. ▪ Injuries/deaths in flood. ▪ Extra time in getting cases to accessible hospitals, and overload at those hospitals, increasing costs and risk to patient health (life). • SES – note no direct impact but pointed to: ○ Will have major impacts on volunteers who live in floodplain areas, volunteer labour costed at $1 million a year for flood associated work linked to smaller scale than 1-in-100 year flood. ○ Also noted costs associated with finding temporary accommodation for those in flood affected properties. Therefore the assumed impact is estimated as: • Property and equipment damage are assumed to be included in the institutional assessment above. • Direct operational costs for these institutions, additional to the estimate in the institutional assessment are assumed to be: ○ Tripling of workload of ambulances for 6 days over a 1-in-100 year flood, requiring extra resources (addressing movements to and from aged care and hospitals, call outs to injured persons etc.) with two paramedics per call out, call outs lasting a total of 3 hours and average cost (wage and equipment etc.) of $100 per hour ○ Doubling for MFS and Police. ○ Add $2 million of volunteer time and support costs for SES call outs.
Other	The major costs associated with these issues is the risk to people's health and life in delays in getting emergency services as required. If just one life is lost as a consequence of these assumed extra 4,000 emergency call outs, then the additional damage is valued at $4 million and given responses of the organisations this is a reasonable probability. There is also the patient stress. It is indicatively assumed that these costs are double the direct costs.
Other Social and Environmental (Intangible) Costs of Flooding	
Social and Environmental (Intangible) Costs of Flooding	Many of the social costs are included in the above assumptions. Damages (particularly environmental) that have not been addressed in the above include: • Damages regarding uncontrolled runoff to open sea causing damage to fish stocks and sea grasses.

Category	Assumptions
	• Contamination of land and waterway from the spread of hazardous materials through flood disruption. • Feedback from the insurance industry points to validation of all of these damages and notes that rising insurance premiums have led to significant amounts of underinsurance. Therefore, while the existence of insurance impacts on who bears the cost of damages above (more specifically related to property damage) there are additional costs related to the margins on insurance policies, as well as social impacts of underinsurance. There are also expected to be some benefits from the infrastructure delivery in terms of design that improves options for recreational use etc. Therefore this would be an opportunity cost of not doing the project. It is assumed that this damage cost would be an additional 10% of the damage for residential property.

4.2.5 Modelling Results

The following table represents the damage estimates for the various categories of flood based on the above assumptions. For the climate change estimates it is assumed that climate change adds 20% to estimated damages.

Table 9 – Benefit Cost Analysis Modelled Results

	Damage re no project							Damage re full project						
	1:5	1:10	1:20	1:50	1:100	1:500	PMF	1:5	1:10	1:20	1:50	1:100	1:500	PMF
Direct flood damages and interruption to on-airfield operations at Adelaide Airport														
Property damage	$0.00	$5.18	$14.71	$28.75	$46.59	$76.43	$84.06	0	$0.00	$0.00	$0.00	$0.02	$31.28	$84.06
Furnishing and equipment damage														
Value in interruption to operations	$0.00	$2.00	$5.70	$11.13	$18.04	$29.59	$32.55	$0.00	$0.00	$0.00	$0.00	$0.01	$12.11	$32.55
Other	$0.00	$0.44	$1.25	$2.45	$3.97	$6.51	$7.16	$0.00	$0.00	$0.00	$0.00	$0.00	$2.66	$7.16
Total Adelaide Airport	$0.00	$7.18	$20.41	$39.88	$64.64	$106.02	$116.61	$0.00	$0.00	$0.00	$0.00	$0.03	$43.40	$116.61
Direct flood damages and service interruption to Ashford Hospital														
Property damage	$0.00	$0.00	$0.03	$1.80	$6.00	$24.05	$10.82	0	0	$0.00	$0.00	$0.00	$9.85	$10.82
Furnishing and equipment damage	$0.00	$1.11	$3.16	$6.17	$10.00	$16.40	$18.04	0	$0.00	$0.00	$0.00	$0.00	$6.71	$18.04
Additional Business impacts	$0.00	$3.33	$9.47	$18.51	$30.00	$49.21	$54.12	0	$0.00	$0.00	$0.00	$0.01	$20.14	$54.12
Other	$0.00	$1.67	$4.74	$9.25	$15.00	$24.61	$27.06	$0.00	$0.00	$0.00	$0.00	$0.01	$10.07	$27.06
Total Ashford Hospital	$0.00	$4.45	$12.67	$26.47	$46.00	$89.67	$82.99	$0.00	$0.00	$0.00	$0.00	$0.02	$36.70	$82.99
Direct flood damages and service interruption to Keswick Army Barracks														
Property damage	$0.00	$0.00	$0.01	$0.52	$1.72	$6.90	$3.11	$0.00	0	$0.00	$0.00	$0.00	$2.90	$3.11
Furnishing and equipment damage	$0.00	$0.00	$0.00	$0.05	$0.17	$0.69	$0.31	$0.00	$0.00	$0.00	$0.00	$0.00	$0.29	$0.31
Additional Business impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Other	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Keswick Army Barracks	$0.00	$0.00	$0.01	$0.57	$1.89	$7.59	$3.42	$0.00	$0.00	$0.00	$0.00	$0.00	$3.19	$3.42
Direct flood damages to private property														
Commercial														
Property and furnishings damage	$0.00	$0.85	$3.31	$36.77	$72.90	$391.32	$430.38	$0.00	$0.00	$0.00	$0.00	$0.03	$160.17	$430.38
Additional Business impacts	0	$0.16	$0.64	$7.12	$14.11	$75.76	$83.32	$0.00	$0.00	$0.00	$0.00	$0.01	$31.01	$83.32
Other	$0.00	$0.03	$0.13	$1.42	$2.82	$15.15	$16.66	$0.00	$0.00	$0.00	$0.00	$0.00	$6.20	$16.66
Total Commercial property	$0.00	$1.04	$4.08	$45.31	$89.83	$482.23	$530.36	$0.00	$0.00	$0.00	$0.00	$0.04	$197.39	$530.36
Industrial														
Property and furnishings damage	$0.00	$0.25	$0.53	$3.27	$5.62	$36.21	$39.82	$0.00	$0.00	$0.00	$0.00	$0.00	$10.54	$39.82
Additional Business impacts	0	$0.05	$0.10	$0.63	$1.09	$7.01	$7.71	$0.00	$0.00	$0.00	$0.00	$0.00	$2.04	$7.71
Other	$0.00	$0.01	$0.02	$0.13	$0.22	$1.40	$1.54	$0.00	$0.00	$0.00	$0.00	$0.00	$0.41	$1.54
Total Industrial Property	$0.00	$0.31	$0.65	$4.03	$6.93	$44.62	$49.08	$0.00	$0.00	$0.00	$0.00	$0.00	$12.99	$49.08
Institutional/Other														
Property and furnishings damage	$0.00	$0.00	$0.03	$1.44	$4.82	$19.32	$21.25	$0.00	$0.00	$0.00	$0.00	$0.00	$8.13	$21.25
Additional Business impacts	0	$0.00	$0.01	$0.28	$0.93	$3.74	$4.11	$0.00	$0.00	$0.00	$0.00	$0.00	$1.57	$4.11
Other	$0.00	$0.00	$0.00	$0.06	$0.19	$0.75	$0.82	$0.00	$0.00	$0.00	$0.00	$0.00	$0.31	$0.82
Total Institutional Property	$0.00	$0.00	$0.03	$1.78	$5.94	$23.81	$26.18	$0.00	$0.00	$0.00	$0.00	$0.00	$10.01	$26.18
Residential														
Property and furnishings damage	$0.00	$3.66	$12.95	$50.10	$101.66	$462.40	$508.55	$0.00	$0.00	$0.00	$2.22	$3.67	$261.31	$508.55
Additional Business impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Other	$0.00	$1.10	$3.88	$15.03	$30.50	$138.72	$152.57	$0.00	$0.00	$0.00	$0.67	$1.10	$78.39	$152.57
Total Residential Property	$0.00	$4.75	$16.83	$65.12	$132.16	$601.13	$661.12	$0.00	$0.00	$0.00	$2.89	$4.77	$339.70	$661.12
Total General Property	$0.00	$6.11	$21.59	$116.24	$234.86	$1,151.79	$1,266.74	$0.00	$0.00	$0.00	$2.89	$4.81	$560.09	$1,266.74
Flood damages to Local Government Infrastructure														
Direct	$0.00	$0.24	$0.55	$2.27	$5.59	$17.20	$25.69	$0.00	$0.00	$0.00	$0.02	$0.23	$9.53	$25.69
Other	$0.00	$0.24	$0.55	$2.27	$5.59	$17.20	$25.69	$0.00	$0.00	$0.00	$0.02	$0.23	$9.53	$25.69
Direct flood damages and interruption to construction of lowered motorway for North South Corridor Torrens to Darlington project														
Direct	$0.00	$0.29	$0.67	$2.74	$6.74	$20.73	$30.97	$0.00	$0.00	$0.00	$0.03	$0.28	$11.49	$30.97
Other	$0.00	$0.09	$0.20	$0.82	$2.02	$6.22	$9.29	$0.00	$0.00	$0.00	$0.01	$0.08	$3.45	$9.29
Direct flood damages and service interruption to interstate (ARTC) rail lines														
Direct	$0.00	$0.03	$0.07	$0.28	$0.70	$2.15	$3.22	$0.00	$0.00	$0.00	$0.00	$0.03	$1.19	$3.22
Other	$0.00	$0.01	$0.03	$0.11	$0.28	$0.86	$1.29	$0.00	$0.00	$0.00	$0.00	$0.01	$0.48	$1.29
Direct flood damages and interruption to arterial road and freight network														
Direct	$0.00	$0.30	$0.69	$2.84	$7.00	$21.52	$32.16	$0.00	$0.00	$0.00	$0.03	$0.29	$11.93	$32.16
Other	$0.00	$0.15	$0.35	$1.42	$3.50	$10.76	$16.08	$0.00	$0.00	$0.00	$0.01	$0.14	$5.96	$16.08
Interruption to emergency and essential services														
Direct	$0.00	$0.16	$0.56	$2.17	$4.40	$20.01	$22.01	$0.00	$0.00	$0.00	$0.10	$0.16	$11.31	$22.01
Other	$0.00	$0.32	$1.12	$4.34	$8.80	$40.03	$44.02	$0.00	$0.00	$0.00	$0.19	$0.32	$22.62	$44.02
Other Social and environmental costs of	$0.00	$0.95	$3.37	$13.02	$26.43	$120.23	$132.22	$0.00	$0.00	$0.00	$0.58	$0.95	$67.94	$132.22
Total	$0.00	$20.50	$62.84	$215.45	$418.46	$1,631.97	$1,812.39	$0.00	$0.00	$0.00	$3.88	$7.57	$798.80	$1,812.39

Table 9 indicates that based on the above assumptions, the total damage estimates associated with a 1-in-100 year flood is $418.5 million and completing the proposed project will reduce that damage estimate to $7.5 million, a net benefit of $411 million. 57% of the damage estimates are direct property damage, but indirect benefits (business interruption, traffic disruption, social and environmental impacts) add significantly to the total.

Based on the probability estimates related to the flood category of a 1-in-100 year flood has a 1% chance of occurring in any year, a 1-in-5 a 20% chance – and assuming a Possible Maximum Flood (PMF) has a 0.05% chance of occurring in any given year, the probability weighted average annual value of flood damage is:

- If only considering the property damage (and what is included in the multiplier):

- $10.00 million p.a. for no project - Present Value over 100 years with a 6% discount rate (as used in the SMP) of $166.2 million, but if using a more appropriate discount rate of 3.8% real discount rate[4] (and an allowance of 0.5% for density growth, meaning the value of damages grow each year by 0.5% in real terms) - $291.2 million.

- $1.60 million p.a. for the completed project - Present Value over 100 years with a 6% discount rate (as used in the SMP) of $26.6 million, but if using a more appropriate discount rate of 3.8% real discount rate - $46.6 million.

- If considering the full range of damages, based on the assumptions above:

  - $17.86 million p.a. for no project - Present Value over 100 years with a 6% discount rate (as used in the SMP) of $296.7 million, but if using a more appropriate discount rate of 3.8% real discount rate - $520.0 million.

  - $2.66 million p.a. for completed project - Present Value over 100 years with a 6% discount rate (as used in the SMP) of $44.2 million, but if using a more appropriate discount rate of 3.8% real discount rate - $77.4 million.

In summary, the damage value for the completed project is approximately 15% of that which would occur if the project had not commenced.

In terms of modelling the benefit cost analysis, the project will proceed in 4 stages:

1. The first stage of the project (Flood Detention - cost of $34.5 million) is almost completed. Once completed 20% of the flood protection benefits are achieved.

2. The second stage of the project (Lower Brown Hill Creek Upgrades - cost of $51.3 million in 2021 dollars) under the current delivery schedule is targeted for completion in 2027, and once completed 40% of the flood protection benefits are achieved.

3. The third stage of the project (Keswick Creek Flow Diversions- cost of $70.6 million in 2021 dollars) under the current delivery schedule is targeted for completion in 2032, and once completed 80% of the flood protection benefits are achieved.

4. The fourth stage of the project (Upper Brown Hill and Glen Osmond Creek Upgrades - cost of $30.5 million in 2021 dollars) under the current delivery schedule is targeted for completion in 2037, and once completed 100% of the flood protection benefits are achieved.

However, an accelerated schedule is also under consideration which will bring forward benefits and save nominal costs with the following description (it is expected construction cost increases will exceed general inflation into the future).

The modelling allocates the expenditures to the periods as identified in the construction schedule for these two alternatives.

The modelling assumes that costs will escalate at 5% per annum until 2030 (in part related to increased building costs associated with supply constraints and infrastructure project escalation in relation to pandemic responses, but also noting that construction costs have generally increased

[4] SA Treasury Guidelines indicate the use of 3.8% as the appropriate real rate for a Low risk project, 5.0% for high and 2.7% for very low (Guidelines for the evaluation of public sector initiatives Part B: Investment Evaluation Process, Table 3, Page 22). While this was written in 2014, it is unlikely there has been a significant shift since then). Using 3.8% as the base is conservative as this project could easily be considered "Very Low" risk. Note that Infrastructure Australia recommend calculating present values using a real discount rate of 7%. This has been a recommendation applied for a number of decades and is quite blunt. It ignores project context risk, and it ignores that real interest rates are lower today than they were 10 or 15 years ago.

above inflation (the producer price index for engineering construction has averaged increases of 2.7% over the last 5 years, and 2.1% over the last 10, compared to CPI inflation average 1.8% over both the last 5 years and the last 10 years). From 2030 construction costs are assumed to escalate with inflation, set at 2.5% (the middle of the RBA acceptable inflation range). This means that the total case requirement to complete the project will be:

- $244.9 million in the Current Delivery Schedule case.
- $228.0 million in the Accelerated Delivery Schedule case.

The project benefits have also been modelled against base cases as follows:

- If it was to finish at the end of the first stage, with no further spend.

- If it was finished at the end of the currently committed funding (the Current Funding Model), which effectively means that the Upper Brown Hill and Glen Osmond Creek Upgrades and Keswick Creek Flow Diversions would not be completed.

It is assumed in the modelling that on completion of each stage of construction there will be maintenance costs of 0.3% of the cost of the stage. Project administration costs are also included (as per project financial assessment).

Modelling the outcomes of these scenarios using a 3.8% real discount rate (and a 2.5% annual inflation rate (note, tested at 2.7% real discount rate and 7% real discount rate in Sensitivities 5 and 6) produces the following summary results.

Base Case – Based on damages and assumptions as above, discount rate reduced from 6% to 3.8%

This assessment includes all damages outlined in the table above. It should be noted that the estimated outcomes are consistent with (calibrated against) the literature which suggests that social and environmental factors could be equal to the property damage.

The SMP analysis used a 6% real discount rate and did not allow for population/ density/activity growth in the flood risk areas. Infrastructure Australia recommend calculating present values using a real discount rate of 7%. This has been a recommendation applied for a number of decades, and is quite blunt. It ignores project context risk, and it ignores that real interest rates are lower today than they were 10 or 15 years ago. As noted earlier, the latest Treasury guidelines indicate 3.8% for a low risk project, and it has been assumed that there is 0.5% in the underlying population/density/activity.

Table 10 - Calculations with No Further Spend as Base Case

	No further spend	Current Project Funding	Current Delivery Strategy	Accelerated Project
Indicative Flood Damage PV ($m)	$357.05	$284.83	$111.89	$89.05
Avoided damage ($m)	$0.00	$72.22	$245.16	$268.00
PV of extra spend ($m)		$56.32	$131.75	$137.99
NPV ($m)		$15.90	$113.41	$130.02
BCR		1.28	1.86	1.94

Table 11 - Calculations with Current Funding Model as Base Case

	Current Project Funding	Current Delivery Strategy	Accelerated Project
Indicative Flood Damage PV ($m)	$284.83	$111.89	$89.05
Avoided damage ($m)		$172.94	$195.78
PV of extra spend ($m)		$75.43	$81.66
NPV ($m)		$97.51	$114.12
BCR		2.29	2.40

Sensitivity 1 – For comparison with the Stormwater Management Plan 2016, revised valuation methodologies and extra information for Ashford Hospital and Adelaide Airport, ignoring other indirect and intangible costs (6% real discount rate, no population/density increase)

Table 12 - Calculations with No Further Spend as Base Case

	No further spend	Current Project Funding	Current Delivery Strategy	Accelerated Project
Indicative Flood Damage PV ($m)	$113.27	$93.61	$53.33	$43.97
Avoided damage ($m)	$0.00	$19.66	$59.94	$69.30
PV of spend ($m)	0	$52.06	$113.39	$123.18
NPV	0	-$32.40	-$53.45	-$53.88
BCR		0.38	0.53	0.56

Table 13 - Calculations with Current Funding Model as Base Case

	No further spend	Current Project Funding	Current Delivery Strategy
Indicative Flood Damage PV ($m)	$93.61	$53.33	$43.97
Avoided damage ($m)		$40.28	$49.64
PV of extra spend ($m)		$61.33	$71.13
NPV		-$21.05	-$21.48
BCR		0.66	0.70

4.2.6 Further Sensitivity Assessment

A full range of sensitivities has been undertaken to allow for alternative comparisons regarding the benefit cost assessment and is detailed below.

Table 14 – Sensitivity Analysis

		Using Stage 1 completion as base			Using committed funding as base	
		Current Project Funding	Current Delivery Schedule	Accelerated Project	Current Delivery Schedule	Accelerated Project
Replacement cost valuation method, ignoring other indirect and intangible (6% real discount rate, no population/density increase)	NPV ($m)	-$32.40	-$53.45	-$53.88	-$21.05	-$21.48
	BCR	0.38	0.53	0.56	0.66	0.70
Replacement cost valuation method, ignoring other indirect and intangible (3.8% real discount rate plus 0.5% density assumption)	NPV ($m)	-$16.40	$3.77	$10.16	$20.17	$26.56
	BCR	0.71	1.03	1.07	1.27	1.33
Replacement cost valuation method, plus 20% intangible (3.8% real discount rate plus 0.5% density assumption)	NPV ($m)	-$8.42	$30.87	$39.79	$39.29	$48.20
	BCR	0.85	1.23	1.29	1.52	1.59
Replacement cost valuation method, plus base assumptions as described for other indirect and intangible (3.8% real discount rate plus 0.5% density assumption)	NPV ($m)	$15.90	$113.41	$130.02	$97.51	$114.12
	BCR	1.28	1.86	1.94	2.29	2.40
Replacement cost valuation method, plus base assumptions as described for other indirect and intangible (2.7% real discount rate plus 0.5% density assumption)	NPV ($m)	$46.93	$231.07	$253.14	$184.14	$206.21
	BCR	1.80	2.62	2.73	3.20	3.35
Replacement cost valuation method, plus assumptions as described for other indirect and intangible (7% real discount rate plus 0.5% density assumption)	NPV ($m)	-$18.31	-$10.66	-$5.58	$7.64	$12.72
	BCR	0.64	0.90	0.95	1.14	1.19
Replacement cost valuation method, plus low assumptions as described for other indirect and intangible (3.8% real discount rate plus 0.5% density assumption)	NPV ($m)	$8.03	$86.71	$100.83	$78.67	$92.79
	BCR	1.14	1.66	1.73	2.04	2.14
Replacement cost valuation method, plus high assumptions as described for other indirect and intangible (3.8% real discount rate plus 0.5% density assumption)	NPV ($m)	$24.51	$142.63	$161.96	$118.12	$137.45
	BCR	1.44	2.08	2.17	2.57	2.68
NSW valuation method, plus base assumptions as described for other indirect and intangible (3.8% real discount rate plus 0.5% density assumption)	NPV ($m)	30.34	162.44	183.62	94.04	110.19
	BCR	1.54	2.23	2.33	2.25	2.35
Sensitivity 4 with climate change	NPV ($m)	$106.23	$157.98	$200.39	$132.10	$153.27
	BCR	1.91	2.14	2.45	2.75	2.88

4.2.7 Outcomes by Local Government Area

The current commitment to works is $140 million and is being jointly funded 50% by the Constituent Councils and 50% by the Stormwater Management Authority (i.e. the South Australian Government). The proportional commitment by Councils to capital expenditure is:

- Adelaide 8%.
- Burnside 12%.
- Mitcham 10%.
- Unley 21%.
- West Torrens 49%.

The Local Government Area (LGA) benefit cost assessment is considered on a council-by-council basis with the following assumptions:

- Property and equipment damage by Council is estimated based on the proportion of properties at risk in each Council..

- Additional business interruption and other damages (social environmental) are distributed between the Constituent Councils and other parts of the state. For example, the induced economic impact will be based on the location of companies that supply the impacted business and the place of residence of employees, while transport interruption impacts will not only derive from residents of the area, but will extend to people who use the road or tram etc. and travel through the area. To provide an indicative estimate of the benefit that accrues within each Council area:

    - Additional business impacts are distributed proportionally to the number of buildings in each council area.

    - Other benefits are distributed across the councils based on the proportion of the state's population that resides in each council area but weighted to allow for higher frequency of use of the relevant area within each council by residents within the council (weighted by 3 – so for example the population of Burnside was (2016 Census) 3.1% of the state's population, and this is weighted, and it is assumed that Burnside incurs 9.3% of the social damage).

Table 15 provides an estimated distribution of the project benefits (in present value terms at 3.8% discount rate) by LGA for the total project and also for the comparison of the scenarios being considered in this assessment.

Table 15 – Flood Mitigation Benefits by Council area (PV 3.8% discount rate)

	Total Project	Using No Further Spend as base case			Using Current Funding Model as base case	
		Current Funding Model	Current Delivery Schedule	Accelerated Delivery Schedule	Current Delivery Schedule	Accelerated Delivery Schedule
City of Adelaide	$6.64	$1.08	$3.68	$4.02	$2.59	$2.94
City of Burnside	$22.54	-$10.82	$12.48	$13.65	$23.31	$24.47
City of Mitcham	$14.38	-$6.90	$7.96	$8.70	$14.87	$15.61
City of Unley	$81.35	$13.27	$45.06	$49.26	$31.78	$35.98
City of West Torrens	$163.41	$26.66	$90.51	$98.94	$63.84	$72.28
Other areas	$154.32	$48.93	$85.47	$93.44	$36.54	$44.51
State	$442.64	$72.22	$245.16	$268.00	$172.94	$195.78

Table 16 presents these results as a benefit cost assessment for each council. The BCA of the total project includes the costs of works done to date plus the additional works to be completed that will be funded by the Constituent Councils. The evaluation for no further spend (i.e. completion of Stage 1) as a base uses the additional council works as a base.

Table 16 – BCA by Council

		Total Project	Using No Further Spend as base case		
			Current Funding Model	Current Delivery Schedule	Accelerated Delivery Schedule
City of Adelaide	NPV ($m)	$2.24	-$1.17	$0.66	$0.63
	BCR	1.51	0.48	1.22	1.19
City of Burnside	NPV ($m)	$15.95	-$14.20	$7.96	$8.56
	BCR	3.42	-3.20	2.76	2.68
City of Mitcham	NPV ($m)	$8.88	-$9.72	$4.20	$4.47
	BCR	2.62	-2.45	2.11	2.05
City of Unley	NPV ($m)	$69.82	$7.36	$37.15	$40.36
	BCR	7.06	2.24	5.70	5.54
City of West Torrens	NPV ($m)	$136.50	$12.86	$72.05	$78.18
	BCR	6.07	1.93	4.90	4.77

4.3 Construction Phase Economic Impact Assessment

Another aspect of interest in the Brown Hill Keswick Creek Stormwater Project is the economic activity that the construction phase infrastructure spend creates, and this has been a particular focus in economic recovery from the global pandemic, and as such the earlier activity can be brought forward the better. In order to estimate the impact from 2022 on, the following steps have been undertaken.

- An economic model has been created for South Australia for 2022, defined at 28 industry sectors, and based on the latest ABS national input output tables. A state input output table has been constructed using the location quotient method based on SA Labour Force Data and the state accounts.

- The construction spend as identified, plus estimated for project administration and ongoing maintenance spend distributed as an exogenous input into the SA economic model with construction and maintenance assuming 80% of the spend is allocated to engineering construction and 20% to services to construction, while project administration is allocated 60% to professional services, 20% to public administration and 20% to general business serivces1

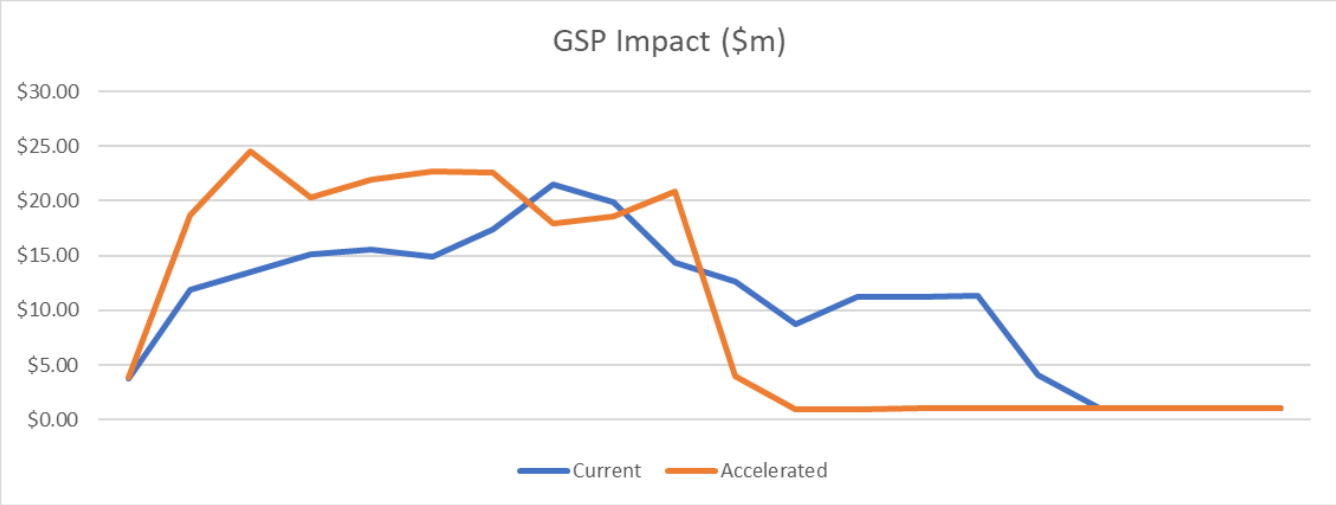
- The model produces estimates of direct and induced impacts (i.e. inclusive of multiplier or flow on impacts. The model applies both production and consumption induced impacts). In summary of modelled outcomes include:

    - Present value of the Current Delivery Schedule Economic Impact - $134.8 million (Gross State Product)[5]. The construction process will generate an average of 73 jobs per annum over the period 2022-2037 (or 1,175 person years of employment).

    - Present value of the Accelerated Delivery Schedule Economic Impact - $145.5 million. The construction process will generate an average of 112 jobs per annum over the period 2022-2032 (or 1,231 person years of employment).

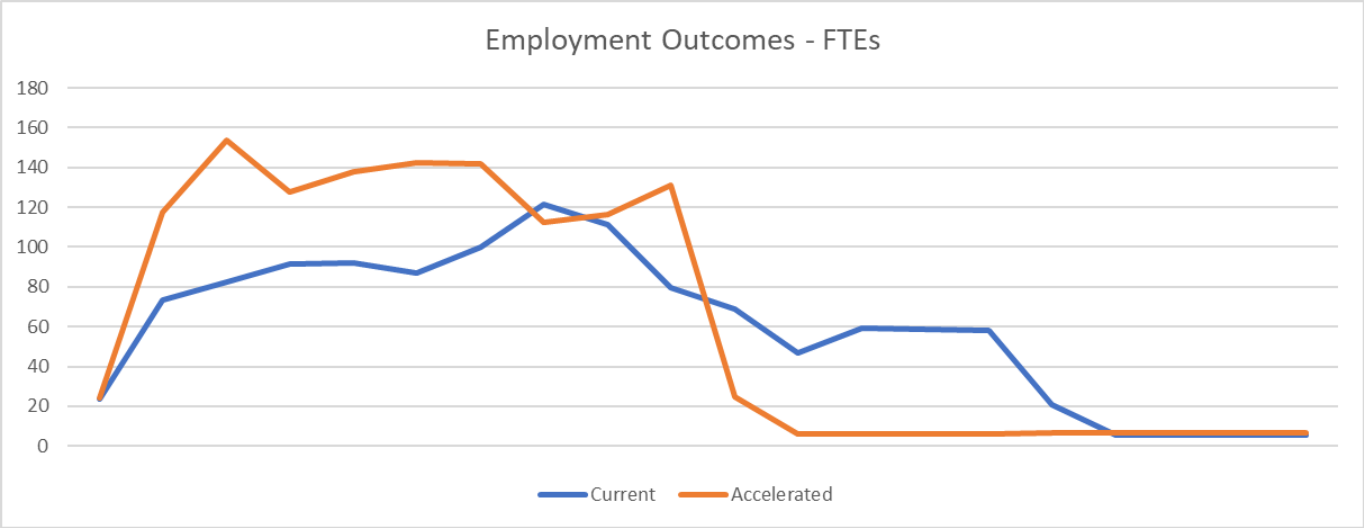
The following Charts summarise these impacts over time.

Chart 1 – GSP Impact



[5] Uses discount rate of 3.8% real, + assumption of 2% general inflation, relative to 5% cost escalation factor

Chart 2 – Employment Outcomes



5.0 Deliverability - Funding Model and Delivery Strategy

5.1 Delivery Strategy

Governance of the BHKC Stormwater Project is exercised through an Owners Executive Committee which includes the Chief Executives of the five catchment councils or their delegates. A Memorandum of Agreement dated December 2008 provides terms of reference for the conduct of the project.

Project phase	Proposed entity	Level of engagement (if any) undertaken to date
Planning and business case	Brown Hill and Keswick Creeks Stormwater Board	All key stakeholders referenced in Section 3.3 have been consulted. Hudson Howells has been appointed to undertake economic modelling and prepare a Business Case.
Delivery	Brown Hill and Keswick Creeks Stormwater Board	The five Constituent Councils established the Brown Hill and Keswick Creeks Stormwater Board in February 2018 as a regional subsidiary under the Local Government Act 1999, to co-ordinate implementation of the flood mitigation works outlined in the Brown Hill Keswick Creek Catchment Stormwater Management Plan 2016 that was approved and gazetted in February 2017.
Operations	Brown Hill and Keswick Creeks Stormwater Board	The Board is responsible for the ongoing operation and maintenance of the flood mitigation infrastructure constructed in accordance with the Brown Hill Keswick Creek Catchment Stormwater Management Plan 2016.

5.1.1 Schedule

The principles for determining the schedule for the delivery of the project are as follows:

- The Stage 1 works are completed prior to the delivery of subsequent stages of work, as the Stage 1 works serve to mitigate the flows that enter the downstream reaches of the creek system.
- The principle of 'working progressively in an upstream direction' is applied to the subsequent stages of work to ensure that the downstream reaches of the creek system are ready to cater for the ultimate design flow before the works in the upper reaches are undertaken.
- The construction phase for each work package occurs in the drier months from September through to April, to minimise the risks (costs and delays) associated with working on the creek system during winter months.
- The detailed design for each work package is completed prior to the completion of construction for the preceding work package, to ensure continuity of construction in the target (drier) months.

The schedule for the accelerated delivery of the project offers the following benefits:

- The Lower Brown Hill Creek Upgrades and Keswick Creek Flow Diversions sub-projects can be coordinated in the same or similar timeframe to the North South Corridor project.

- The Keswick Creek Flow Diversions sub-project can be undertaken in parallel with the Lower Brown Hill Creek Upgrades sub-project. This is because the new underground box culverts for the Keswick Creek Flow Diversions can be constructed 'off-line' (i.e. not subject to inflows) until the connections are made to Keswick Creek and Brown Hill Creek at the upstream and downstream ends, respectively. The completion of these two sub-projects will achieve 80% of the flood protection benefits for the project.

The key milestones are included in the Table 17.

Table 17 – Completion dates for project stages

	Current Funding Model	Current Delivery Schedule	Accelerated Delivery Schedule
Stage 1 – Flood Detention	2022	2022	2022
Stage 2 – Lower Brown Hill Creek Upgrades	2027	2027	2027
Stage 3 – Keswick Creek Flow Diversions	2032	2032	2029
Stage 4 – Upper Brown Hill Creek and Glen Osmond Creek Upgrades	N/A	2037	2032

5.1.2 Risk Management

In accordance with the requirements of the Local Government Act 1999, the Brown Hill and Keswick Creeks Stormwater Board has established an Audit and Risk Committee. The objective of the Audit and Risk Committee is to ensure the Board acts in compliance with its Charter and meets its legislative and probity requirements as required by the Local Government Act 1999 and other relevant legislation. Meetings of the Audit and Risk Committee take place quarterly.

In relation to the delivery of the flood mitigation works the following major and moderate project risks have been identified.

Major risks:

- Funding: Support from the Federal Government is sought for full scheme implementation and to promote technical and cost efficiencies in the delivery of the project, as distinct from the partial scheme implementation and piecemeal approach that is able to be achieved with the current funding commitments from the South Australian Government and Constituent Councils (e.g. funding one works package project at a time).

- Land ownership: Infrastructure assets are located on state, federal and privately owned land as well as on councils' land, requiring management of issues relating to access and third-party responsibilities and liabilities.

- Timing: Construction timing is critical in terms of achieving flood protection in the timeliest manner, as well as efficient works delivery.

- Political and Stakeholder: Flood risks arising from the Brown Hill Keswick Creek system are well known and there is potential for negative publicity and stakeholder dissatisfaction if a major flood event occurs prior to the completion of the project.

Moderate risks:

- Program governance: Financial and community impacts of delivery (design and construction) will require a high level of coordination and collaboration between councils, contractors and stakeholders – these risks have been addressed through the establishment of the Board and its Audit and Risk Committee.

- Delivery and contracting strategy: It will be necessary to limit the project's exposure to the risk of delays, design variations and construction cost escalation inherent in what would be a multi-interface project – this will require attention to risk allocation between the project and delivery contractor(s).

- Community engagement: Ratepayers will hold their own council accountable even though the project may be controlled by the five councils – hence effective links between each council and the project entity will be critical.

- Cultural heritage: Earth disturbing works on creek systems have the inherent risk of encountering an Aboriginal Site or Remains – this requires close consultation with Kaurna Traditional Owners throughout the design phase and implementation of a Cultural Heritage Management Plan that includes cultural heritage monitoring and a designated 'Place of Keeping' for artefacts or remains that may be encountered during the works.

- Climate Change: Future changes in rainfall intensity and patterns could result in higher creek flows and/or increased frequency of major flood events – the detailed design of the proposed works will include validation of performance standards achieved, redundancy in channel capacity (i.e. freeboard) and other factors of safety (i.e. provisions to improve Council drainage systems in the future).

A risk register has been developed for the project which provides the basis for ongoing risk assessments, and development of risk mitigation strategies by the Board and its agents. The mitigation strategies that are currently in place have resulted in there being no residual risks categorised as 'major' other than project funding. The risk register also identifies the additional controls that will be implemented during the delivery phase of the project, which will further reduce residual risk.

5.1.2 Approvals

Construction involving watercourses constitutes a 'Water Affecting Activity' and all work packages of the project will require a permit under the Natural Resources Management Act 2004. The application process for the Water Affecting Activity Permits (WAAP) was commenced as part of the Reference Designs. Once issued the permits are valid for 12 months and will therefore be finalised on an individual work package basis.

The creek corridor is heavily vegetated and the Reference Design process has involved specialist input from an arborist, with a view to minimising the impact on the tree protection and structural root zones of trees that warrant retention. The greatest priority has been placed on the retention and protection of remnant and indigenous native trees. There are also a number of introduced native and exotic tree species that can be regarded as specimen trees and may be deemed to warrant retention in some cases. It is proposed that non-legislated and legislated weed species within the creek corridor are removed during the works.

Some trees within the creek corridor that will require removal are controlled as third-party assets (owned and managed by a local government body or privately owned tree). In each case, written

authority to undertake tree damaging activity (tree removal or pruning) is required from the asset owner/manager.

In cases where trees requiring such management are controlled under the provisions of the Planning, Development & Infrastructure Act 2016, Development Approval from the relevant planning authority will also be required. In these cases, an application will need to be submitted through the Plan SA Portal. These Development Applications will be submitted on an individual work package basis.

As the Board is a subsidiary of the Constituent Councils it enjoys the same immunities under Schedule 3 of the Development Regulations 2008 as if it were a Council. Much of the works comprising the project fall within the definition of "construction, reconstruction, alteration, repair or maintenance" of a "drain" and the Board is not required to obtain development approval for the works constituting the works to the drain as it is not "development". However there are certain elements of the works which are expected to require Development Approval from the relevant planning authority, such as retaining walls and fencing, and these Development Applications will be submitted on an individual work package basis.

5.2 Procurement Model and Local Content

5.2.1 General Project Procurement

The five Constituent Councils established the Brown Hill and Keswick Creeks Stormwater Board in February 2018 as a regional subsidiary under the Local Government Act 1999, to co-ordinate implementation of the flood mitigation works outlined in the Brown Hill Keswick Creek Catchment Stormwater Management Plan 2016 that was approved and gazetted in February 2017.

The Board recognises the importance of responsible procurement practices and is committed to providing best value to the community ensuring fairness, transparency and accountability. The Board's Procurement Policy establishes a framework of principles relating to the procurement activities undertaken by the Board pursuant to the requirements of section 49 of the Local Government Act 1999 (Act).

The Board's Procurement Policy includes a commitment to maximising the positive impact its activities have on the local community, its economy, and the environment. Where all other considerations are equal, the Board, wherever reasonably practical, engages local contractor or supplier to promote local employment opportunities and economic growth.

5.2.2 Indigenous Participation

Brown Hill Creek is known to be culturally significant to the traditional owners of the Adelaide Plains, the Kaurna People. The Board has an established working relationship with the Kaurna Yerta Aboriginal Corporation and a Reference Group has been established to oversee the delivery of the project and to promote cultural awareness and indigenous participation in the works. The project costings include allowances for the best-practice management of cultural heritage.

It is the desire of the Board and Kaurna that funding be secured for the implementation of a Heritage, Economic Workforce Participation Package for the project. The HEWPP would provide an employment pathway for indigenous jobseekers by:

- Establishing and applying best-practice targets for indigenous participation during the construction phase, to incentivise tenderers to maximise the engagement of indigenous staff and enterprises.
- Implementing best-practice cultural heritage management practices on-site and promoting cultural awareness for construction staff and the wider community.
- Implementing structured and non-structured (on-the-job) training for program participants who are seeking a career pathway in the construction industry.

- Providing support and mentoring for program participants.

- Providing opportunities for broader recognition and appreciation of the cultural significance of Brown Hill Creek through the inclusion of art, sculpture and language in the design and construction of the works.

This initiative would be an extension of the HEWPP that has been successfully implemented by the City of Burnside (a Constituent Council) for the delivery of the Kensington Gardens Reserve Redevelopment, a stormwater management and public open space improvement project that received funding from the South Australian and Federal Governments. The Kensington Gardens Reserve Redevelopment has achieved an indigenous participation rate of nearly 30% based on total workforce hours and is widely regarded as a leading example of project engagement with Kaurna Traditional Owners.

5.2.3 Work Packages

The proposed packaging of works offers a range of benefits and these have informed the procurement strategy for the project:

- The scale of the work packages is tailored to maximise participation from local Tier 2 and Tier 3 contractors who have lower overheads and experience working for Local Government. These contractors do not typically benefit from major road infrastructure projects.

- Due to the sequential nature of the delivery program when 'working progressively in an upstream direction', interfaces between work packages are easily managed and therefore consecutive work packages could be undertaken by different contractors. This will promote competitive market tension.

- Multiple work packages can be under construction at any given time, particularly for the Keswick Creek Flow Diversions which will be constructed 'off-line' from creek flows.

- Relocation of existing underground services and the upgrade of road and pedestrian bridges can occur in advance of the channel upgrades as 'early works'.

5.2.4 Procurement Method

The Lower Brown Hill Creek Upgrades and Upper Brown Hill Creek Upgrades will be delivered using a Detailed Design then Construct (DD then C) procurement method.

An Early Contractor Involvement (ECI) process will be undertaken for the Keswick Creek Flow Diversions to tailor the design solution to achieve the most efficient construction methodology. The trenchless crossing of the rail line in Wayville and the optimisation of the box culvert alignment in Anzac Highway and Goodwood Road are key items of work that warrant Contractor input. The works will then be delivered under a Design and Construct (D&C) contract.

Long lead items such as service relocations and precast culverts are anticipated to be procured as Principal Supplied Items.

5.3 Funding Model

As detailed earlier in this Business Case, in the Current Delivery Schedule, the project will proceed in 4 stages over the next 16 years (completion 2037) at an escalated cost of $244.9 million:

1. The first stage of the project (Detention Storages - cost of $34.5 million) is almost completed. Once completed 20% of the flood protection benefits are achieved.

2. The second stage of the project (Lower Brown Hill Creek Upgrades - cost of $58.8 million) under the current delivery schedule is targeted for completion in 2027, and once completed 40% of the flood protection benefits are achieved.

3. The third stage of the project (Keswick Creek Flow Diversions- cost of $100.9 million) under the current delivery schedule is targeted for completion in 2032, and once completed 80% of the flood protection benefits are achieved.

4. The fourth stage of the project (Upper Brown Hill and Glen Osmond Creek Upgrades - cost of $50.7 million) under the current delivery schedule is targeted for completion in 2037, and once completed 100% of the flood protection benefits are achieved.

In the Accelerated Delivery Schedule, the project will proceed in 4 stages over the next 11 years (completion 2032) at an escalated cost of $228.1 million:

1. The first stage of the project (Detention Storages - cost of $34.5 million) is almost completed. Once completed 20% of the flood protection benefits are achieved.

2. The second stage of the project (Lower Brown Hill Creek Upgrades - cost of $58.4 million) under the accelerated delivery schedule is targeted for completion in 2027, and once completed 40% of the flood protection benefits are achieved.

3. The third stage of the project (Keswick Creek Flow Diversions- cost of $89.4 million) under the accelerated delivery schedule is targeted for completion in 2029, and once completed 80% of the flood protection benefits are achieved.

4. The fourth stage of the project (Upper Brown Hill and Glen Osmond Creek Upgrades - cost of $45.8 million) under the accelerated delivery schedule is targeted for completion in 2032, and once completed 100% of the flood protection benefits are achieved.

The Stormwater Management Plan 2016 proposed a funding model that includes a 1/3 funding contribution from each tier of Government. The current commitment from the South Australian Government's Stormwater Management Authority is for a total of $70 million over a 20-year timeframe. The Constituent Councils are matching the contributions made by the Stormwater Management Authority, which brings the total funding commitment to $140 million over 20 years. There is currently no funding commitment from the Federal Government, and there is a current funding shortfall of $88 and $104.9 million (depending on the timeframe over which the flood mitigation works are delivered).

The total cost of the 3 outstanding projects (2 – 4 above) is $152.5 million in 2021 dollars ($210.4 million for the escalated Current Delivery Schedule and $193.6 million for the escalated Accelerated Delivery Schedule).

A regional subsidiary has been established by the Constituent Councils with the following guidelines:

- The regional subsidiary has been assigned ongoing responsibility for the management of BHKC Stormwater Project assets designed for stormwater management purposes as documented in the SMP.

- If a member council of the regional subsidiary wishes to enhance an asset (presumably located within its area) for a benefit or purpose outside the ambit or terms of the SMP, it will be at that council's own cost.

- The cost of ongoing maintenance of assets (including both preventative and reactive) will be apportioned equally between the councils (i.e. one fifth charged to each).

- Other operational costs of the regional subsidiary, including governance, professional advice, administration etc. (but not depreciation) will be also apportioned on a one fifth per council basis.

- The councils will transfer funds to the regional subsidiary each year to cover planned operational costs except depreciation.
- The regional subsidiary will not borrow money for capital works, working capital or other purposes.
- Each council will transfer funds to the regional subsidiary each year to cover its share of planned capital works construction costs in accordance with the cost sharing arrangements between councils and the agreed cost sharing arrangements between spheres of government.

6.0 Support Sought

6.1 The Case for Change and the Consequences of Inaction

The last major flood event in the catchment occurred in 1930 and since that time there has been significant urbanisation and establishment of businesses, essential services and critical infrastructure in areas that are prone to flooding. The existing flood risk acts as an impediment to further investment in the growth and prosperity of the stakeholders within the catchment and presents as a major concern for emergency response planning; a major flood could simultaneously impact the Adelaide Airport, interstate rail lines and the major arterials roads across the south-western suburbs, including the North South Corridor. The impacts of a major flood would extend far beyond the duration of the event, which itself could occur over several days, and it would be many months (or even years) before a return to 'business as usual' in the catchment.

The following general observations were made in the Stormwater Management Plan 2016:

- Rapid response flash flooding is more likely to cause deaths and injury than slower response riverine flooding. This contrast was evident in the 2010/11 Queensland flooding where the flash flood that swept through the Lockyer Valley claimed a number of lives but the subsequent flooding of Brisbane, where sufficient time was available for evacuation, did not.

- There is risk of injuries both during a flood event and also during the recovery period as residents return to their homes to clean up and make repairs.

In reference to the Brown Hill Keswick Creek catchment, the Stormwater Management Plan included the following comments:

- The urban floodplain of Brown Hill and Keswick Creeks is densely populated. During a major flood there will be many people in close proximity to areas that are classified as high and extreme hazard. Many of these areas will have deep fast-flowing floodwaters and therefore flooding presents a serious risk to the safety of people in parts of the floodplain.

- During a major flood there will be a considerable amount of debris carried by floodwaters. This can originate from damaged structures such as fences, sheds, decks and other landscape features, in addition to fallen trees. This debris can alter the course of the floodwaters by blocking narrow sections of the creeks, culverts and bridges. This may cause rapid changes in the direction and level of floodwaters presenting further danger to people.

- There is no available evidence of any physical injuries caused by the comparatively minor 2005 flood event in Brown Hill Creek, although examples were given of near misses that could have had worse outcomes. These were the collapse of a bridge parapet, the risk of electrocution and the case of a council worker who was apparently saved from being swept away after stumbling into floodwaters.

- A major flood will cause significant erosion and scour of the existing creek banks. This has the potential to threaten the stability of structures built close to the creek and can also change the lie of the land that people are familiar with, causing them to become disorientated.

- The difference between life and death near fast-flowing floodwaters could be as simple as a slip or a poor decision to enter floodwaters. Serious injury or deaths during a major flood event in the Brown Hill Keswick Creek catchment must be considered as possible, or even likely. The consequences of not acting on the flood risk now could have serious community, health and life/death implications.

6.2 Potential Funding Partners

As detailed above, the Brown Hill Keswick Catchment Stormwater Management Plan 2016 proposed a funding model that includes a 1/3 funding contribution from each tier of Government. The current commitment from the South Australian Government's Stormwater Management Authority is for a total of $70 million over a 20-year timeframe. The Constituent Councils are matching the contributions made by the Stormwater Management Authority, which brings the total funding commitment to $140 million over 20 years. There is currently no funding commitment from the Federal Government, and there is a current funding shortfall of $88 -104.9 million (depending on the timeframe over which the flood mitigation works are delivered).

The total cost of the 3 outstanding projects (2 – 4 above) is $152.5 million in 2021 dollars ($210.4 million for the escalated Current Delivery Schedule and $193.6 million for the escalated Accelerated Delivery Schedule).

The Brown Hill Keswick Creek Stormwater Project is seeking a $70 million contribution from the Federal Government, ideally to be provided in seven equal instalments over a 7 year period commencing in 2022, to guarantee the completion of the overall project and accelerate the delivery of Stages 2 and 3 of the project which will provide flood protection for Federal Government land holdings (Adelaide Airport and Keswick Army Barracks) and critical transport routes including the North South Corridor and ARTC's interstate rail lines.

A balance of $18 million will be sought from other grant programs on an individual sub-project basis making up the total funding requirement of $228 million for the Accelerated Delivery Schedule.

7.0 Conclusion

This Business Case for the Brown Hill Keswick Creek Stormwater Project has been prepared with the cooperation of the project's Constituent Councils and all key stakeholders likely to be impacted by a 1-in-100 year flood event. Professional advice has also been sought on the project costs, property valuations and property damage estimates which have all be incorporated into the Economic Impact Assessment (EIA) and Benefit Cost Analysis (BCA).

Econometric modelling for the **EIA** results in the following outcomes:

- Present value of the Current Delivery Schedule Economic Impact - $134.8 million (Gross State Product)[6]. The construction process will generate an average of 73 jobs per annum over the period 2022-2037.

- Present value of the Accelerated Delivery Schedule Economic Impact - $145.5 million. The construction process will generate an average of 112 jobs per annum over the period 2022-2032.

The above Gross State Product and employment outcomes are important in the context of current pandemic impacts on businesses and State unemployment levels with the Accelerated Delivery Schedule bring these benefits forward.

Modelling for the **BCA** has been undertaken with two base cases:

- Comparison of the project outcomes compared with a base case of the project finishing at the end of Stage 1 (in 2022), with no further spend and effectively meaning that Stages 2-4 (inclusive) would not be completed in the base case. The Benefit Cost Ratios under this scenario are:

    - With Current Funding Model: 1.28 (NPV $15.9 million)
    - With the Current Delivery Schedule: 1.86 (NPV $120.0 million)
    - With the Accelerated Delivery Schedule: 1.94 (NPV $132.5 million)

- Comparison of the project outcomes compared with the Current Funding Model as a base case, which effectively means that Stage 4 would not be completed in the base case.

    - With the Current Delivery Schedule: 2.29 (NPV $97.51 million)
    - With the Accelerated Delivery Schedule: 2.40 (NPV $114.12 million)

These outcomes provide a very strong business case for the Brown Hill Keswick Creek Stormwater Project and clearly demonstrate the benefits of risk avoidance and the potential consequences of not acting now.

The current commitment from the South Australian Government's Stormwater Management Authority is for a total of $70 million over a 20-year timeframe. The Constituent Councils are matching the contributions made by the Stormwater Management Authority, which brings the total funding commitment to $140 million over 20 years. There is currently no funding commitment from the Federal Government, and there is a current funding shortfall of $88 -104.9 million (depending on the timeframe over which the flood mitigation works are delivered).

Appendices

Provided under separate cover including:

- Appendix 1 - Stakeholder Consultation Briefing Paper.
- Appendix 2 – Key Stakeholder Consultation Interview Guide.
- Appendix 3 – Constituent Councils' Consultation Interview Guide.
- Appendix 4 – Insurers' Consultation Interview Guide.