Prioritising Sustainable Development Goals, characterising interactions, and identifying solutions for local sustainability

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This document includes the supplementary information of this article in Environmental Science and policy. This document is comprised of 3 appendices:

Appendix A. Tables related to methods

Table A.1. Indicative interview prompting questions asked of interviewees.

Selected questions asked of interviewees
1. What are the main challenges to environmental and socio-economic sustainability in the region?
2. What are the current issues in water use in the region?
3. How can we use water more efficiently in the district?
4. Aside from water, what are the things that you consider could contribute to the economic sustainability in the region?
5. What are the opportunities as you see them?
6. Should there be new industries locally?
7. What are the obstacles that prevent these opportunities from being implemented?
8. What are your views on what could be done about those obstacles?
9. Do you believe that there is an ideal timeframe for those opportunities? For example, is it something best implemented now or are there steps needed before it can be implemented? Are there factors that may make the opportunity less feasible down the track?

Table A.2. Seven-point ordinal scale used to characterise and score interactions among Sustainable Development Goal (SDG) targets. This table is adapted from Nilsson (2016). Numbers (e.g., 6.6) represent target numbers in the SDG framework as outlined in Table C.2.

Interaction	Score	Description	Example
Indivisible	+3	A robust form of positive interaction where the progress towards one target is inextricably linked to the progress of another.	Protecting and restoring water-related ecosystems (6.6) is an indivisible form of conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems (15.1).
Reinforcing	+2	One target significantly and directly causes the progress towards another target.	Ensuring sustainable food production systems and implementing resilient agricultural practices (2.4) reinforces approaches to combating desertification and restoring degraded land and soil (15.3).
Enabling	+1	The progress towards one target enables to progress towards another target.	Ensuring sustainable food production systems and implementing resilient agricultural practices (2.4) enables improvements in water quality by reducing pollution (6.3).
Consistent	0	No important positive or negative interaction between two targets.	Maintaining the genetic diversity of seeds and cultivated plants (2.5) is consistent with supporting and strengthening the participation of local communities in improving water and sanitation management (6.b).
Constraining	−1	The pursuit of one target constrains the progress towards another target.	Investment in rural infrastructure (2.a) combined with agricultural mechanisation and automation may constrain the progress towards productive employment and decent work for all women and men (8.5).
Counteracting	−2	The progress towards one target counteracts the progress towards another target.	Doubling agricultural productivity (2.3) may counteract the progress towards adaptive capacity to climate-related disasters (13.1).
Cancelling	−3	The most negative interaction where the progress towards one target makes it impossible to progress towards another target.	Developing infrastructure (9.1) negates attempts to reduce natural habitat degradation (15.5).

Table A.3. Evaluation criteria for the assessment of evidence and validation of assigned scores

Evaluation Criteria	**Evidence** ('limited', 'medium', and 'robust')	**Confidence** ('low', 'medium', and 'high')
Limited/ Low	Limited evidence meant that we did not find any relevant documents for characterising interactions, we may have found just one document of lower relevance and mostly relied upon our own judgement.	We assigned a 'low' confidence score if the evidence was 'limited' and our scores were not well supported by evidence, or if evidence relevancy was 'medium' but the author team was not confident in the scores assigned.
Medium	Medium evidence meant that we found one source with highly relevant information or two sources with moderately relevant information.	We assigned a 'medium' confidence score if our scores were supported by some elements of the literature, with the presence of disagreements, but the author team was confident in the score assigned.
Robust/ High	Robust evidence meant that we found more than one source with highly relevant information or a combination of highly and moderately relevant information sources for characterising interactions.	If we had robust evidence with high consistency among sources and our scores were supported by this evidence, the author team assigned 'high' as a confidence score.

Appendix B. Tables related to results

Table B.1. Results of word frequency analysis used in the word cloud (Figure 4).

Word	Length of word	Count	Weighted Percentage (%)	Mostly related SDGs
water	5	35588	2.80	SDG 6, 15
management	10	11350	0.89	Generic word
land	4	8326	0.65	SDG 15
river	5	6579	0.52	SDG 6, 15
environmental	13	6426	0.50	SDG 6, 15
change	6	6003	0.47	SDG 13
catchment	9	5960	0.47	SDG 6, 15
risk	4	5810	0.46	SDG 13, 15
planning	8	5623	0.44	Generic word
strategy	8	5008	0.39	Generic word
irrigation	10	4719	0.37	SDG 2
climate	7	4374	0.34	SDG 13
community	9	4102	0.32	Generic word
development	11	3698	0.29	Generic word
groundwater	11	3432	0.27	SDG 6, 15
flood	5	3310	0.26	SDG 13, 15
flow	4	3261	0.26	SDG 6
salinity	8	3259	0.26	SDG 6, 15
quality	7	3170	0.25	SDG 6, 15
vegetation	10	3051	0.24	SDG 15
local	5	2813	0.22	Generic word
forest	6	2773	0.22	SDG 15
impacts	7	2766	0.22	Generic word
changes	7	2347	0.18	SDG 13
flows	5	2195	0.17	SDG 6, 15
economic	8	2167	0.17	SDG 8
ecological	10	2079	0.16	SDG 15
farm	4	2079	0.16	SDG 2
soil	4	2044	0.16	SDG 2, 15
social	6	2038	0.16	Generic word
floodplain	10	1916	0.15	SDG 6
communities	11	1771	0.14	Generic word
ecosystem	9	1752	0.14	SDG 6, 15
risks	5	1707	0.13	Generic word
agriculture	11	1682	0.13	SDG 2
biodiversity	12	1667	0.13	SDG 15
industry	8	1622	0.13	SDG 8
strategic	9	1605	0.13	Generic word

Word	Length of word	Count	Weighted Percentage (%)	Mostly related SDGs
investment	10	1595	0.13	SDG 8
agricultural	12	1594	0.13	SDG 2
strategies	10	1593	0.13	Generic word
rainfall	8	1575	0.12	SDG 6, 13, 15
wetlands	8	1550	0.12	SDG 6, 15
rural	5	1537	0.12	SDG 2
waste	5	1532	0.12	SDG 12
rivers	6	1444	0.11	SDG 6, 15
loss	4	1424	0.11	SDG 8, 15
dairy	5	1419	0.11	SDG 2
resilience	10	1409	0.11	SDG 13
protection	10	1393	0.11	SDG 15
habitat	7	1351	0.11	SDG 15
production	10	1332	0.10	SDG 2
cost	4	1319	0.10	SDG 2, 8
adaptation	10	1264	0.10	SDG 13
drainage	8	1243	0.10	SDG 2

Table B.1. Contextualising the main trade-offs between Sustainable Development Goal 2 (i.e., zero hunger) and three other Sustainable Development Goals (SDGs) in the Goulburn-Murray Region. The table summarises quotations from relevant documents.

Affecting SDGs	Affected SDGs	Number of trade-off target interactions	Interaction examples
SDG 2. Zero hunger	SDG 6. Clean water and sanitation	5	"…Land use changes include increased dairy production and increased cropping. These have the potential to increase sediment and nutrient loads in waterways and toxicant impacts on groundwater."(DELWP 2019a) "Yet water security and water-dependent ecosystems in many irrigated areas are threatened by the increase in demand for water to meet food requirements of growing populations…"(Crossman et al. 2010) "…agriculture often has a cost in terms of the impact on land and water resources such as reduced environmental flows and water quality, biodiversity loss, soil erosion and degradation and other impacts." (Bryan et al. 2008)
SDG 2. Zero hunger	SDG 15. Life on land	4	"… generally speaking, salinity is an issue in the Goulburn region due to the widespread conversion of native vegetation land to agricultural land and a shallow water table. Salinity can be an issue in both dryland and irrigated areas due to changes in hydrology as a result of land use change. The spread of dryland salinity in Victoria slowed or receded in many areas during the dry period (known as the Millennium Drought) due to lower groundwater tables however, the area impacted by salinity is likely to increase with a return of wetter conditions"(Aither 2019) "Substantially modified land-cover types (generally associated with agriculture and irrigated pastures) had lower habitat quality and biodiversity value."(Baral et al. 2014) "Overgrazing – intensive grazing of pasture for extended periods or insufficient recovery time resulting in insufficient ground cover (dairy)."(NCCMA 2016a)
SDG 2. Zero hunger	SDG 8. Decent work and economic growth	4	"Advances in decoupling economic growth from environmental degradation may be constrained by a focus limited to doubling agricultural productivity." (ICSU 2017) "In line with national trends, there are fewer and larger farms, with increasing production efficiency. Increasing scale, combined with mechanisation and automation, leads to reduced demand for labour and rural depopulation."(RPG 2020)

Table B.2. Contextualising the main synergies among Sustainable Development Goals (SDGs) in the Goulburn-Murray Region with quotations from relevant documents.

Affecting SDGs	Affected SDGs	Number of synergy target interactions	Interaction examples
6. Clean water and sanitation	15. Life on land	20	"Large-scale water for the environment deliveries to rivers and wetlands, natural inflows and additional protection and restoration works build on 20 years of activity that is addressing historical degradation. It could causes conservation and restoration of terrestrial and fresh water ecosystem."(NCCMA 2018) "One of the effects of poor water quality or salinity is degradation of the environment and wildlife habitats."(Aither 2019)
2. Zero hunger	8. Decent work and economic growth	16	"This region (Goulburn-Murray) is characterised by a relatively high concentration of agriculture and food product manufacturing industries as well as construction associated with rapid population growth in the peri-urban fringe. Agriculture and food manufacturing are key exports for the region… Dairying is a major industry in the valley floodplains and the biggest contributor to the local economy, sheep grazing for wool and meat and beef cattle fattening are also important and dominate the foothills other agriculture includes wine grapes and niche crops."(DELWP 2019a) "The trend for fresh fruit will continue due to higher values and a renewed interest in fresh fruit export. Expansion of annual horticulture is also occurring with vegetable production moving further from Melbourne." (RPG 2020)
13. Climate action	6. Clean water and sanitation	13	"Climate change was the only cause of risk that generated very high risks to water availability for environmental and consumptive uses. Extreme drought caused high risk to environmental and consumptive uses. As a result of climate change and extreme drought, adverse changes to the inflow of water to aquifers was identified as a common threat to the beneficial use of groundwater. Higher temperatures and extended periods of low rainfall can result in increased evapotranspiration and reduced infiltration, resulting in a decline in inflow to aquifers."(DELWP 2019a) "The Goulburn-Murray region has been getting warmer and drier. The region can expect temperatures to continue to increase year round; more hot days and warm spells; fewer frosts; less rainfall in autumn, winter and spring; and more frequent and more intense downpours." (RPG 2020)
6. Clean water and sanitation	2. Zero hunger	10	"Over the last twenty years, there has been an almost 50% net decline in water resources. This is due to a combination of climate change, water recovery as part of the Murray Darling Basin Plan, changes to water policy and competition for water from outside the region. Living with variability in water availability is already a feature of agriculture in the Goulburn-Murray region. Supply and demand determine water price and competing industries buy or sell water at different price points." (RPG 2020) "During drought periods, water trading allows scarce water resources to be allocated to regions and industries in greatest need…Water trading and carryover also play a role in facilitating long-run adjustment. Water markets allow water allocations and entitlements to be traded into expanding industries and regions. Carryover rights give water users some control over the reliability of supply, allowing for adjustment in response to industry changes— such as increased reliability to support more horticultural activity." (Gupta & Hughes 2018) "Following a lengthy drought at the turn of the century concerns were raised about water quality and river health. This led successive governments to introduce policies to systematically reduce water available for irrigated agriculture. The Murray-Darling Basin Plan was developed by the Commonwealth government and is designed to secure water savings from irrigators and to direct those water savings to the stressed natural environment."(Alston et al. 2018) "Food price volatility is higher with insufficient water availability in agriculture."(ICSU 2017) "Past clearing of native vegetation has caused saline water tables to rise, threatening crop production. Groundwater pumping is necessary but leads to discharging salt into the Murray River at levels that can be unacceptable to downstream users."(Walker et al. 2009)

Appendix C. Supplementary materials

Table C.1. List of papers and reports used in the contextual analysis

1.	Abel, N, Cork, S, Gorddard, R, Langridge, J, Langston, A, Plant, R, Proctor, W, Ryan, Shelton, D, Walker, B & Yialeloglou, M 2003, *Natural Values: Exploring Options for Enhancing Ecosystem Services in the Goulburn Broken Catchment*, CSIRO Sustainable Ecosystems, Canberra, Australian Capital Territory.
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Table C.2. Description of the 45 Sustainable Development Goal (SDG) targets across the five priority SDGs, including a short description of each target and reason for inclusion or exclusion of each target. The excluded targets are shown in grey highlights.

SDGs Goals	Targets	Short Description	Reason for inclusion or exclusion of each target
02. ZERO HUNGER	2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	Food security	This target is a lower priority at the current time because the main issue in this region is increasing food production for export to other Australian regions or international markets rather than end hunger.
	2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons	Malnutrition	Malnutrition is not a major issue compared to supporting local communities to boost their agricultural production and income.
	2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.	Agricultural productivity and income of food producers	The Goulburn-Murray economy is dominated by agriculture and food production so increasing the agricultural productivity and incomes of food producers is a high priority in this region.
	2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.	Sustainable agriculture	Sustainable agriculture to preserve the Goulburn-Murray assets and achieve productive farming is a vital issue for community wellbeing and financial viability of the region, whilst supporting ecosystem services.
	2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.	Genetic diversity	Agricultural activities in the Goulburn-Murray continue to be a major part of the economy, so utilisation of genetic resources would benefit agriculture and food production in this region.
	2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries	Rural infrastructure and agricultural research	New technologies, rural infrastructure development, and agricultural research expansion play an important role in the future sustainability and profitability of the Goulburn-Murray region.

SDGs Goals	Targets	Short Description	Reason for inclusion or exclusion of each target
	2.b Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round	Agricultural export subsidies and trade restrictions	Many farmers are currently being disadvantaged by trade distortions and high tariffs, thus improving and preventing trade restrictions and distortions in agricultural markets is important for the regional economy.
	2.c Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility	Control food markets and prices	Improving food commodity markets and limiting food price volatility would be beneficial for the agriculture of the Goulburn-Murray region.
06. CLEAN WATER AND SANITATION	6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	Drinking water	Drinking water and public health may be threatened by extreme water quality events like blue-green algae blooms in this region.
	6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	Sanitation and hygiene	Access to adequate and equitable sanitation and hygiene is not a major issue compared to e.g. water quality and water availability for agricultural consumptive use in this region.
	6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally	Water quality and wastewater	Over the last two decades, the Goulburn-Murray region has experienced extreme climate-related weather events like the Millennium drought, bushfires, and floods. These events and extensive agricultural practices have reduced water quality.
	6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	Water use efficiency and scarcity	There has been a major decline in water availability in the Goulburn-Murray region over the last twenty years, so it is important to increase water-use efficiency across all sectors especially agriculture.
	6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	Water resources management	This target was selected as water resources management has a key role in preparing for the uncertain future of the environment and agriculture in this region.
	6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	Water-related ecosystems protection	Protection of natural assets like water-related ecosystems will result in environmental, social,

SDGs Goals	Targets	Short Description	Reason for inclusion or exclusion of each target
			and economic benefits within the Goulburn-Murray region.
	6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	International cooperation	This target is mostly related to the international cooperation in water and sanitation-related activities to support developing countries rather than developed countries.
	6.b Support and strengthen the participation of local communities in improving water and sanitation management	Local participation in water management	In addition to the vital role of government in improving water management, local communities play an important role in achieving integrated water management outcomes in the region.
8.DECENT WORK AND ECONOMIC GROWTH	8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries	Economic growth	The long-term viability, wellbeing, and prosperity of the region are highly dependent on sustainable economic growth.
	8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors	Technology, innovation, and industry	Investment in technological innovation has benefits in different infrastructure areas like regional roads and rail, water security, logistics and export facilities, energy productivity, research and innovation, and other areas related to agriculture and food processing.
	8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services	Employment generation policies	This area is facing rural population ageing and a reduction in the number of farmers from younger generations, which could threaten the future of food production. Hence, creating job opportunities and promoting access to financial services to support local communities is important.
	8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead	Resource efficiency and decoupling economic growth from environmental degradation	Human development and intensive agricultural activities have brought several irreversible changes to the environment and ecosystem of this region, so it is important to tackle unsustainable development and decouple economic growth from environmental degradation.

SDGs Goals	Targets	Short Description	Reason for inclusion or exclusion of each target
	8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	Decent work for all women and men	Reason for selection of this target is similar to target 8.3.
	8.6 By 2020, substantially reduce the proportion of youth not in employment, education or training	Youth employment and education	Reason for selection is similar to target 8.3.
	8.7 Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms	End modern slavery	Such an issue has not been reported in interviews or seen in related documents of this region.
	8.8 Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment	Protect labour rights	There is an issue around seasonal labour availability as demand for labour is very high in the Goulburn-Murray region. There is a strong reliance on immigrant workers in agriculture. It is necessary to protect labour rights and enhance safe and secure work environments for these vulnerable workers.
	8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products	Sustainable tourism and promoting local culture	Tourism presents an opportunity in the Goulburn-Murray region for enhancing economic output and job creation.
	8.10 Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all	Strengthen the capacity of domestic financial institutions	This issue has not been reported in interviews or seen in related documents.
	8.a Increase Aid for Trade support for developing countries, in particular least developed countries, including through the Enhanced Integrated Framework for Trade-related Technical Assistance to Least Developed Countries	Increase Aid for Trade support for developing countries	This target is mostly related to the developing countries.
	8.b By 2020, develop and operationalize a global strategy for youth employment and implement the Global Jobs Pact of the International Labour Organization	Develop a global strategy for youth employment	This target is mostly related to the development of a global strategy for youth employment rather than local development.
13. CLIMATE	13-1: Strengthen resilience and adaptive capacity to climate related disasters	Strengthen climate change resilience and adaptive capacity	We selected these all three targets because the Goulburn Murray region is particularly vulnerable to the effects of climate change. It is

SDGs Goals	Targets	Short Description	Reason for inclusion or exclusion of each target
	13.2 Integrate climate change measures into national policies, strategies and planning	Climate change adaptation policies and strategies	essential to strengthen resilience and adaptive capacity to climate related disasters, adopt climate change adaptation policies, and improve education and awareness of local communities to cope with climate change effects.
	13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	Climate change education	
	13.a Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible	Implement the commitment undertaken by developed-country on Climate Change	This target is mostly related to the national level rather than the local level.
	13.b Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities	Effective climate change-related planning in the least developed countries	This target is mostly related to developing countries.
15. LIFE ON LAND	15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	Conservation and sustainable use of freshwater ecosystems	Rivers and wetlands of this region need to have efficient delivery of environmental water to improve ecosystem health and reverse the impacts of over extraction which has caused environmental degradation in the last few decades.
	15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	Forest sustainable management	There are several nationally recognised forests within the Goulburn-Murray region and it is important to promote the implementation of forest management and conservation in this region.
	15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	Restore degraded land and soil	Degradation of land by human activities and natural disasters like droughts, floods, and bushfires is a source of great concern for the community in the Goulburn-Murray region.
	15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development	Conservation of mountain ecosystems	This issue is a lower priority compared to the other targets like 15.2 and 15.3. However, this

SDGs Goals	Targets	Short Description	Reason for inclusion or exclusion of each target
			issue is mentioned in Target 15.1 and related issues are considered there.
	15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species	Biodiversity and natural habitats degradation	The loss of biodiversity and natural habitats in the Goulburn-Murray region generally has been caused by land clearance and unsustainable farming practices during the past 150 years.
	15.6 Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed	Utilisation of genetic resources	Genetic resources provide a key source of information for taxonomy. By developing our understanding of species, we can improve the conservation of threatened species in the Goulburn-Murray region.
	15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products	Poaching and trafficking of protected species	This target is a lower priority compared to other targets as this issue has not been reported in interviews or seen in related documents.
	15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species	Invasive alien species	Invasive species present a serious and ongoing threat to the rivers, estuaries, and wetlands in Victoria. Furthermore, invasive plants are an increasing threat to the region's biodiversity.
	15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts	Ecosystems/biodiversity into planning	These two targets have not been selected separately but have been included as part of Target 15.5 if we came across the related statements to target 15.9 and 15.a in the literature review process.
	15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems	Financial resources for biodiversity conservation	
	15.b Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation	Finance sustainable forest management	This target has not been selected separately but has been included as part of Target 15.2 if we came across the related statements to Target 15.b in the literature review process.
	15-c: Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities	Global support to combat trafficking of protected species	This target is mostly related to the global support to stop poaching and trafficking of protected species.

Table C.3. Overview of the evidence and literature on interactions among the 29 selected targets of priority Sustainable Development Goals (SDGs) for the Goulburn-Murray. The table summarises: (i) the amount of evidence for each interaction, (ii) robustness of the evidence for each interaction (summary terms: 'limited', 'medium' or 'robust'), (iii) scores assigned with the Nilsson scoring methodology, (iv) level of confidence in assigned scores derived from authors' judgement (summary terms: 'low', 'medium' or 'high'). As an example, target 2.3 pertains to doubling agricultural productivity and target 6.3 relates to improving water quality, hence pollution resulting from unsustainable agriculture can counteract (−2 scoring) reductions in water pollution and the protection of water and related ecosystems. Because multiple documents discussed this interaction, confidence in the score was high. Achieving target 6.3 (water quality) and target 6.6 (protecting and restoring water-related ecosystems) was expected to lead to co-benefits (+2, reinforcing). Due to the number of documents mentioning this interaction, our confidence in the score was high. Also, in this table for some targets that are conceptually overlapping and may have the same evidence, therefore the first two columns can refer to multiple targets. We uploaded Table C.3 to an online repository (i.e., http://dx.doi.org/10.17632/bv9cpw7tyn.1).

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
2.3 (Agricultural productivity and income of food producers)	**6.3** (Water quality and wastewater)	5	Robust	"The clearing of catchments for agricultural land, soil disturbance during forestry operations or urban development, and bare areas such as gravel roads and stock tracks, have led to substantial increases in the amounts of sediment (gravel, sand, silt and clay) entering ours streams and rivers. This sediment and its associated nutrients and chemicals can contaminate human and stock water supplies" (GBCMA 2018). "Agricultural production in rural landscapes provides a range of economic and social benefits. However, agriculture often has a cost in terms of the impact on land and water resources such as reduced environmental flows and water quality, biodiversity loss, soil erosion and degradation and other impacts" (Bryan et al. 2008). "Land use changes include increased dairy production and increased cropping. These have the potential to increase sediment and nutrient loads in waterways and toxicant impacts on groundwater" (DELWP 2019a). "Inappropriate effluent management – poor capture, containment and disposal of animal effluent resulting in effluent entering waterways" (NCCMA 2016a). "Nutrient budgeting – over application of	-2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				fertiliser relative to crop/pasture may result in high nutrient loads in runoff that can impact on waterways and wetlands" (NCCMA 2016a). "Land management issues for grazing: Grazing of native vegetation including grazing of understorey in forests and woodlands and native grasses. Grazing of riparian areas and accessing waterways and wetlands. Replacement of native grasslands with exotic species. Construction of dams in catchments of waterways. Application of fertilisers where runoff rates are high. Overgrazing – intensive grazing of pasture for extended periods or inadequate recovery time resulting in insufficient ground cover to prevent soil erosion. The above practices can result in: – Fragmentation of native vegetation and habitat – Decline in diversity and abundance of native species – Introduction and competition with native species by invasive plants – Introduction of exotic plants that compete with native species – Water quality decline – Reduced or altered water flows – Bed and bank instability – Soil erosion – Access to water"(NCCMA 2016a). "The land use history of the Goulburn region, including its agricultural and industrial history, may mean that there are substantial areas of contaminated land throughout the region. As of March 2018, there are currently 9 sites in the Goulburn region listed on the EPA's Priority Sites Register" (Aither 2019).		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
2.3 (Agricultural productivity and income of food producers)	**6.4** (Water use efficiency and scarcity)	1	Medium	"Yet water security and water-dependent ecosystems in many irrigated areas are threatened by the increase in demand for water to meet food requirements of growing populations" (Crossman et al. 2010).	-2	Medium
2.3 (Agricultural productivity and income of food producers)	**6.5** (Water resources management)	2	Medium	"Yet water security and water-dependent ecosystems in many irrigated areas are threatened by the increase in demand for water to meet food requirements of growing populations" (Crossman et al. 2010). "Irrigation in the Goulburn-Murray Irrigation District (GMID) was first developed in the late 1800s early 1900s with the completion of the Goulburn Weir in 1891. The Goulburn Weir was the first major diversion structure built for irrigation in Australia and was considered very advanced for the time. A network of channels was built over the period of 1900-1950 to deliver water to farm gates, it comprised 6,300 km of channels and 800 km of natural waterways. The biggest change to the system came in the 1950s and 1960s following completion of Eildon Dam and the expansion of Hume Dam. This supported more water entitlements for farms, the volume of entitlement farms received depended on their size, soil type and proximity to the channel system. Until the late 1960s and early 1970s water resources for farming were considered unlimited, however dry conditions showed that the resources were limited. As a result, Dartmouth Dam was built largely as a drought reserve for the system. This enabled Victoria to continue to support entitlements with a high degree of certainty. This was important because up until the late 1980s the only way for a farmer to increase their water entitlement was to purchase more land with existing entitlement. The creation of the water market in the early 1990s gave irrigators the ability to diversify or change their farming practices and to manage risks of low allocation years. The market is now widely used by irrigators and factored into farm planning and risk management "(DELWP 2019a).	-1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
2.3 (Agricultural productivity and income of food producers)	**6.6** (Water-related ecosystems protection)	3	Robust	"The basin has a large area of floodplain forests and wetlands, with 16 of the wetlands being Ramsar listed. It also supports a great diversity of nationally and internationally significant plants, animals and ecosystems, many of which are now threatened, vulnerable or degraded. The degradation of floodplain River Red Gum forests, native fish populations, water bird populations and the Coorong coastal lakes at the end of the system are now well documented. Much of this degradation has been caused by the increasing regulation of the Murray–Darling River system, and over-allocation of water for consumptive uses, over the past century" (Hart 2016). "Over-allocation of fresh water resources to consumptive uses (especially for agriculture in order to produce foods), coupled with recurring drought and the prospect of climate change, is compromising the stocks of natural capital in the world's basins and reducing their ability to provide water-dependent ecosystem services. Irrigation of agricultural crops in low-rainfall regions of the world is an important element of world food production" (Crossman et al. 2010). "Irrigated agriculture in the MDB faces a future of significant reductions in water availability as a result of a drier climate, as well as national efforts to reduce over allocation and return water to the environment. The first step should be to determine the water allocation for irrigation in a trade-off between meeting both environmental objectives and securing agricultural water supplies" (Wei et al. 2011). "Natural waterways across the region have been heavily impacted by post-European land use (clearing and agriculture). Despite this, the majority of waterways are in moderate condition"(Aither 2019).	-2	High
2.4 (Sustainable agriculture)	**6.3** (Water quality and wastewater)	2	Robust	"Salinity associated with high watertables has been the biggest natural resource challenge in the SIR over the last three decades. We live with and actively manage high watertables and associated salinity. Management of salt is essential to achieve a sustainable irrigation industry and protect the productive capacity of the region. Actions to manage salinity have significant	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				benefits for agriculture, water quality, water supply security and biodiversity"(GBCMA 2016c). "While water quality continues to be a priority in the SIRLWMP, significant investment over the last 20 years in water treatment plants, water reuse systems, dairy shed effluent design and management, improvements in fertiliser and water management and removal of stock grazing along streams have reduced phosphorus and nitrogen loads to below long-term targets. The five-year rolling average phosphorus load equates to a reduction of 80 per cent from the benchmark year of 1993-94 (GB CMA 2015a)"(GBCMA 2016c). "Implement current recommended practice to reduce water quality risks such as irrigation tail water reuse, fencing off stream sides, stream buffers, appropriate fertiliser applications and dairy effluent Ensure drains are managed for rainfall runoff only and not irrigation runoff discharge management" (NCCMA 2016a).		
2.4 (Sustainable agriculture)	**6.4** (Water use efficiency and scarcity)	2	Medium	"Agriculture is experiencing improved on-farm water use efficiency coupled with irrigation modernisation in the north of the region"(NCCMA 2016a). "The availability of water will pose a major challenge to northern Victoria over the next 10 - 20 years as the region adapts to an agricultural sector with less water rights. However, this also produces major opportunities in water trading and water use efficiency" (MSC 2018).	+2	Medium
2.4 (Sustainable agriculture)	**6.5** (Water resources management)	1	Medium	"Sustainable Agriculture Strategy to protect the regional assets of: land and soils; waterways; floodplains and wetlands; consumptive water available for irrigation; agricultural livestock and crop health; natural biodiversity; atmosphere and people in agriculture from the pressures that agricultural practices put on the condition of these assets" (NCCMA 2018).	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
2.4 (Sustainable agriculture)	**6.6** (Water-related ecosystems protection)	2	Robust	"Waterway management needs to consider how both natural and anthropogenic factors (i.e. human impact via farming practices, recreation, urban development etc.) impact on waterway condition and, therefore, on the values of the region's waterways. Helping farmers improve farm sustainability have impact on waterway condition" (NCCMA 2018). "Sustainable Agriculture Program: Working with communities and partner agencies to achieve productive farming while protecting the natural resource base. This is achieved by delivering on regional priority actions identified in the North Central Region Sustainable Agriculture Strategy to protect the regional assets of: land and soils; waterways; floodplains and wetlands; consumptive water available for irrigation; agricultural livestock and crop health; natural biodiversity; atmosphere and people in agriculture from the pressures that agricultural practices put on the condition of these assets."(NCCMA 2018). "'sustainable agriculture' is the efficient production of safe, high quality agricultural products, in a way that protects and improves the natural environment, the social and economic conditions of farmers, their employees and local communities, and safeguards the health and welfare of all farmed species. (http://www.saiplatform.org/) • Sustainable agriculture refers to an agricultural system that is ecologically sound, economically viable, and socially just—a system capable of maintaining productivity indefinitely."(NCCMA 2016a)	+2	High
2.4 (Sustainable agriculture)	**6.b** (Local participation in water management)	1	Medium	"The land and soils of the North Central CMA region contribute to regional economic viability, provide water purification, carbon cycling and storage, support for biodiversity, resistance to erosion and an abundance of clean air and water. Government, conservation and community groups in north central Victoria are working together to protect the region's significant natural capital while also maintaining long-term agricultural productivity, access and opportunities for recreation and protection of important cultural values" (NCCMA 2018).	+1	Medium

2.a (Rural infrastructure and agricultural research)	**6.3** (Water quality and wastewater)	3	Robust	Given these objectives: " To ensure a continues supply of high quality water for urban and rural use", related strategies include: "2.1 Promote the efficient use and re-use of water 2.2 Ensure compliance with the recommendations and requirements of the strategies such as the Stormwater Management Plan, the Floodplain Management Plan, the Regional Catchment Strategy and Council's local water initiatives. 2.3 Encourage best practice in engineering design work for new development in terms of water supply and use. 2.4 Protect the water supply catchment within the municipality.", and in relation to actions: "These strategies will be implemented by: **Using Policy and the exercise of discretion:** • Use Goulburn Valley Water and Goulburn Murray Water as referral authorities where appropriate. **Applying Zones and Overlays:** • Apply the Environmental Significant Overlay to catchment area as necessary. **Undertaking further strategic work:** Prepare educational and promotion packages on efficient use and re-use of water for developers, land owners and the generally community" (GSCC 2006a). "This intervention will provide local producers with grants to investigate and trial innovative processes that reduce or re-use waste and regenerate natural systems. This could include research and development in robotic effluent and solid waste separation, subsoil manuring, biosolid opportunities, or recycled water for cooling. Projects could become demonstrations to support learning and encourage others to implement across the region." (RPG 2020). "The Connections Project is the largest irrigation modernisation project in Australia. The Victorian and Australian governments are investing more than $2 billion to create a sustainable future for productive agriculture in northern Victoria. Above and beyond this, the Project will ensure the future prosperity of our region and our communities for generations to come. It's a key part of Victoria's contribution to the Murray Darling Basin Plan. The water savings are provided to Environmental Water Holders who protect and improve our waterway health to support fish, vegetation and water quality. When the Project is complete – and the channels that waste water through leakage, seepage and evaporation and meters are upgraded or rationalised – it's estimated an average annual water savings of 429GL will be achieved and	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				irrigation water use efficiency will be increased from about 70 per cent to at least 85 percent" (GMW 2018a).		
2.a (Rural infrastructure and agricultural research)	**6.4** (Water use efficiency and scarcity)	6	Robust	"Water purchases or new irrigation technologies or both that increase water use efficiencies provides multiple ecosystem service benefits in any location affected by water scarcity" (Crossman et al. 2010). "The GMW Connections Project is investing more than $2 billion to improve the delivery of water to irrigation businesses across the GMID. The Project is focused on modernising infrastructure and improving service standards while generating water savings, and is working to provide long term sustainability of irrigation in the region" (GMW 2018b). "Potential evapotranspiration demand will increase irrigation water requirements, and this combined with lower water availability means that there will be a continuing imperative to increase water use efficiency t/ML and adopt more efficient irrigation systems" (NCCMA 2016a). "Increasing competition for water resources, and increasing costs, put pressure on the viability of mixed farming operations even before the onset of reduced water availability. Mixed farming operations have been more opportunistic in their use of water and have been net sellers of water during low allocations years. There are always exceptions, with some mixed farmers actually growing, but the overall trend has been a decline in water use by the mixed farming operations" (NCCMA 2016a). "While it marked change in public and political attitudes following the heavy rains is remarkable, initiatives to reform water policy, modernize irrigation to improve water productivity, and improve environmental management should be continued to improve Australia's resilience in the face of a potentially dryer future" (Wei et al. 2011). "Despite the prevailing negative perception, there was a reported $300 to $400 m of investment in high-value milk products in the region. Individual farmers were considering a range of other crops, likely to yield a better return. Each year, $10s m are invested in agricultural research in Victoria. There was seen to be an opportunity to direct	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				some of that toward encouraging more profitable enterprises. Rubicon and Wine Industry Suppliers Australia were two cited examples of how modern technology could make a big contribution to change. Big water users in the region reported that they were able to lease water out when there was an oversupply, and rotate crops from high-value horticulture to other crops such as cotton, depending on the season. Having suitable land and reliable water at low cost were seen as key to future sustainability."(Downie et al. 2019). "Investing in rural water supply infrastructure will improve efficiency of water management. Irrigated agriculture in the MDB has to be equipped with infrastructure to face the challenges of reducing water availability in future. Firstly, basin-wide water accounting and seasonal water forecasting at catchment level can be improved to inform water trading about where, when and how much water is available, inform the upgrading of water supply infrastructure programs of where water is lost, to inform decision making for seasonal water carry over, and to assist farmers to minimize risks to cropping to optimize farm returns. Modernization of irrigation infrastructure can increase economic water productivity and the level of water supply. In addition, there is great potential for improving water delivery services (e.g. timeliness, high flow and flow stability) through automated control operating systems in water delivery systems." (Wei et al. 2011). "Infrastructure upgrades enable farmers to use irrigation water more efficiently" (Wittwer & Dixon 2013).		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
2.a (Rural infrastructure and agricultural research)	**6.5** (Water resources management)	2	Medium	"Increased construction of farm dams to supply water for domestic and stock consumption. 25 GL increase in the volume of small farm dams in rural-residential developments over a period of 10 years" (DELWP 2019b). "GOAL: More efficient, cost-effective water use STRATEGY: • Programs to improve capacity and capability to operate in competitive water market. • Programs to increase farmer understanding of the cost/ benefit of investing in new water use efficient (WUE) practices and farm systems. • Programs to improve farmer skills and capability to implement new practices/farm systems, including WUE and/or multi-use forage types. • Goulburn Murray Water tariff review to remove cross subsidies and other anomalies pushing up costs. • Commercially sustainable and affordable off-farm irrigation infrastructure footprint. • North East Sustainable Irrigation Plan completed to bolster pasture and cow productivity. • Market-based regional water retention strategy"(MD 2019).	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
2.a (Rural infrastructure and agricultural research)	**6.6** (Water-related ecosystems protection)	2	Medium	"Over-allocation of fresh water resources to consumptive uses, coupled with recurring drought and the prospect of climate change, is compromising the stocks of natural capital in the world's basins and reducing their ability to provide water-dependent ecosystem services. To combat this, governments worldwide are making significant investment in efforts to improve the sharing of water between consumptive uses and the environment. Many investments are centred on the modernisation of inefficient irrigation delivery systems and the purchase of consumptive water for environmental flows" (Crossman et al. 2010). "Goulburn Murray Water (GMW) is Australia's largest rural water corporation and manages Australia's largest irrigation delivery network known as the Goulburn Murray Irrigation District (GMID) with more than 21 000 individual customers. Both the Victorian and Commonwealth Governments have invested over $2 billion to modernise GMW's ageing and inefficient infrastructure with a view to reducing water losses to ensure that there is sufficient water availability to support irrigators in Northern Victoria and to meet environmental water savings targets" (SAP 2018).	+2	Medium
6.3 (Water quality and wastewater)	**2.3** (Agricultural productivity and income of food producers)	3	Robust	"Salinity refers to the movement and concentration of salt in landscapes. Both soil and natural waters can become saline. Hence salinity can be described as either soil salinity or water salinity. The effects of salinity are broad including: reduction in the productive capacity of affected land (e.g. crop yields)" (Aither 2019). "Environmental watering also has important social, cultural and economic benefits. It has been found to improve water quality for farmers" (DELWP 2019a). "Past clearing of native vegetation has caused saline water tables to rise, threatening crop production. Groundwater pumping is necessary but leads to discharging salt into the Murray River at levels that can be unacceptable to downstream users" (Walker et al. 2009).	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.4 (Water use efficiency and scarcity)	**2.3** (Agricultural productivity and income of food producers)	6	Robust	"Over the last twenty years, there has been an almost 50% net decline in water resources. This is due to a combination of climate change, water recovery as part of the Murray Darling Basin Plan, changes to water policy and competition for water from outside the region. Living with variability in water availability is already a feature of agriculture in the Goulburn Murray region. Supply and demand determine water price and competing industries buy or sell water at different price points" (RPG 2020). "Co-investing in efficient water infrastructure is an effective way to achieve positive social, economic and environmental outcomes while delivering value for money. The Australian Government's investments are simultaneously contributing to the long-term productivity of irrigated agriculture, strengthening regional communities and providing water for environmental benefit. These investments are delivering tangible benefits for irrigators and irrigation infrastructure operators. Benefits include increased ability for crop rotation and diversification and more reliable water supplies. These benefits are often reported by irrigators on top of a net increase in productive water use after infrastructure is upgraded, as most onfarm programs involve irrigators keeping a proportion of the water savings. On average, irrigators are retaining around 30 percent of water saving"(DAWR 2017). "In the Goulburn region, an added consideration is current adjustment occurring with respect to the dairy industry. The combination of a sharp fall in dairy prices, low water allocations, high water prices and water purchased for the environment led to over 45 per cent of dairy farms stopping production in 2009. Only a minority have returned to operation in subsequent years, meaning the overall milk output has fallen. Many farm businesses survived these difficult times by selling water entitlement to reduce debt" (Dairy Australia 2016). "They are now more exposed to the temporary water market and thus to also more exposed to future low allocations of water. The major local dairy processor, Goulburn Murray, experienced commercial difficulties because of this and other factors. It has recently been taken over by Canadian company Saputo. The implications of this	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				takeover are as yet unclear" (Aither 2019). "During drought periods, water trading allows scarce water resources to be allocated to regions and industries in greatest need. Carryover helps water users prepare or future droughts by accumulating storage reserves and drawing down on these reserves during dry years. Water trading and carryover also play a role in facilitating long-run adjustment. Water markets allow water allocations and entitlements to be traded into expanding industries and regions. Carryover rights give water users some control over the reliability of supply, allowing for adjustment in response to industry changes— such as increased reliability to support more horticultural activity" (Gupta & Hughes 2018). "Generally, water purchases will be driven by those irrigators which are able to produce agricultural outputs for which the benefits of using additional water outweigh the market costs of acquiring that water. Conversely, water will be made available for sale by those irrigators for which the benefits of using additional water are less than the water market price. These latter irrigators will find it more profitable to sell water and reduce irrigated production in times of water scarcity. The water market has grown considerably in the past decade as a consequence of institutional reforms to facilitate trade, and changes in relative marginal returns as a result of increasing scarcity of water and strong competing demands. The large majority of trades are for temporary water" (Ashton et al. 2009). "Low allocations in the 2019/20 water year that will send even more dairy farmers and pasture/ grain growers into negative cash flow" (Downie et al. 2019).		
6.4	**2.4** (Sustainable agriculture)	5	Robust	"Policy makers will increasingly have to turn to water demand management in the future to respond to greater water scarcity. Water markets have long been promoted as one of the most efficient ways to reallocate water by economists. If water markets are embedded within	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
(Water use efficiency and scarcity)				fair and effective meta-governance and property right structures, the potential exists for marketisation to increase efficiency" (Grafton et al. 2015). "Improved water trade enhances the productivity and growth of water dependent industries, and can help provide irrigators with confidence in their long-term future by enhancing their ability to manage business risks. Water markets continue to provide flexibility to water users, particularly in times of decreasing water availability. Water markets allow water users to buy or sell water to suit their individual business needs" (MDBA 2018). "Changes in agricultural practices within the local area, resulting from water reforms, involved the rationalisation of irrigation systems and a shift to dryland cropping. These trends have continued throughout the region resulting in reduced water usage and therefore increased flows in the Murray River. It is predicted that this will continue as water security becomes more uncertain and the effects of climate change are recognised. The constraint of water supply provides an opportunity for innovation and a culture shift towards more appropriate farming practices and products" (MSC 2018). "The efficient application of irrigation water is vital to a sustainable agricultural future"(NCCMA 2016a)." Irrigation drainage reuse and its contribution to sustainable irrigation in the region and water use efficiency. The reuse of irrigation drainage through drainage diversion allows development of land that does not have a water right. Counter-argument that stopping water from getting into drains also contributes to the sustainability of the region and to water use efficiency" (GMW 2000).		
6.4 (Water use efficiency and scarcity)	**2.a** (Rural infrastructure and agricultural research)	1	Medium	"The experience of drought was that much of the area reverted to dryland farming or remained idle. With the return of conditions closer to the long-term average and an increase in water allocation in the current years, land managers are making commercial decisions on their land use between intensively irrigated (nearly all years), opportunistic irrigation (occasionally irrigated) and dryland agriculture (not irrigated)" (NCCMA 2016a).	+2	Medium

6.4 (Water use efficiency and scarcity)	**2.c** (Control food markets and prices)	2	Medium	"In recent years, a series of reports have been commissioned by CMAs, government agencies, and the dairy industry to examine trends in water markets and water use, and their effect on local irrigation communities. They include the following reports: • Update on GMID water availability scenarios and irrigated production across the southern connected Basin – prepared by RMCG for Goulburn Broken Catchment Management Authority and published in June 2018. • The challenges and opportunities of changes to water availability on the food and fibre sector in the GMID - prepared by RMCG for Goulburn Broken CMA, North Central CMA, and Goulburn Murray Water and published in 2016. • Regional Irrigated Land and Water Use Mapping in the GMID - Goulburn Broken CMA (lead agency), Victorian Government, Dairy Australia, Murray Dairy, Goulburn Murray Water, North central CMA. Key findings from these reports include: • Increasing demand for GMID high-reliability water from outside the region; • Decreasing water use in GMID relative to network capacity, as a consequence of environmental water recovery and trade out of the region; • Increasing variability of climate, water availability and price; • Dairy sector using a farming system with low flexibility to adapt and subject to tight profit margins; and • Increasing supply cost and challenge of apportioning costs among remaining network users" (Downie et al. 2019). "The increasing cost of water and issues regarding the reliability of supply were frequently mentioned throughout the interviews. Water availability has declined in the GMID, due to a number of factors including water buy-backs under the Basin Plan, the effect of climate change on rainfall patterns and increased competition for water across the MDB. In dry times, Victoria was considered to provide the vast majority of water for agriculture in the MDB, as well as much of the water used for environmental flows. Figures quoted for the amount of water to be delivered to the region varied (e.g. a range of figures between 1,000 and 2,500 GL were quoted), and it was difficult to find documented evidence to ascertain what the correct figure was. This highlights a lack of certainty in the community about the amount of water actually being delivered into the system. Several interviewees indicated support for the previous actions and current position of the Victorian government in terms of scheduling challenges through the choke and also with regard to policy in the MDB	+1	Medium

				in general. Farming ventures to the west (e.g. Riverina) were seen to be more profitable than similar ventures in the GMID, due in part to the cheaper cost of land and larger parcel sizes. Water prices were considered likely to continue to rise on the open market, with farmers on the temporary water market particularly vulnerable. Approximately 900 GL was quoted as being tied to land within the GMID. The relative lack of NSW high security water was considered to increase reliance on Victorian water and to create competition. Opinion was divided regarding the current water market, and that may depend on the point of reference (e.g. whether one compares the Australian water market to other similar water markets overseas, or to other Australian commodity markets). The Australian water market was considered to be world-class for a water trading market. However, compared to other commodity markets, it lacks transparency, information, a central exchange and sophistication in how it is used. The need for a centralised water market platform was suggested a number of times. There was also a suggestion that carryover be restricted to actual water users, rather than investors, but this was disputed by others. There were differences in opinion as to the role of government, with some advocating greater regulation while others were strongly against intervention other than to improve the commercialisation of the system" (Downie et al. 2019). When water availability is not sufficient, it causes food price volatility. "There was significant reform of the Australian water sector through the 1990s, of which Victoria was arguably the leader nationally and world-wide. This reform was aimed at ensuring that, in a dry and highly-variable continent, water would be priced to give confidence that uses would be rational, fair and efficient, as far as practical. This included unbundling land and water rights in agricultural areas, including the GMID, water metering, free trade and splitting of water entitlements (perpetual) from allocations (determined by scientific analysis of sustainable reserves from month to month) (e.g. see SRW 2010). To date, the impact of water reform has been a central challenge to the GMID. Due to a range of factors, such as water for the environment, climate change, transferability of water inter-property and inter-Basin/region and increasing competition from other regions, the traditional arrangements for GMID agriculture have been placed under significant pressure" (Downie et al. 2019).		
6.5 (Water resources management)	**2.3** (Agricultural productivity and income of food producers)	1	Medium	"There was significant reform of the Australian water sector through the 1990s, of which Victoria was arguably the leader nationally and world-wide. This reform was aimed at ensuring that, in a dry and highly-variable continent, water would be priced to give confidence that uses would be rational, fair and efficient, as far as practical. This included unbundling land and	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				water rights in agricultural areas, including the GMID, water metering, free trade and splitting of water entitlements (perpetual) from allocations (determined by scientific analysis of sustainable reserves from month to month) (e.g. see SRW 2010). To date, the impact of water reform has been a central challenge to the GMID. Due to a range of factors, such as water for the environment, climate change, transferability of water inter-property and inter-Basin/region and increasing competition from other regions, the traditional arrangements for GMID agriculture have been placed under significant pressure" (Downie et al. 2019).		
6.6 (Water-related ecosystems protection)	**2.3** (Agricultural productivity and income of food producers)	2	Robust	"Increasing the water available to the environment cause irrigation communities impacted by a plan designed to map out strategies for reducing irrigation water use across the Basin and it causes reducing agricultural productivity and income" (Alston et al. 2018). "The dry conditions have created concern about river health and ongoing water supplies leading successive Australian governments to introduce measures to restructure water use and increase water available to the environment. This has included reducing the amount of water to be made available for irrigated agriculture in the Basin and it causes reducing agricultural productivity (food production)" (Alston et al. 2018). "In the Goulburn region, the combination of a sharp fall in dairy prices, low water allocations, high water prices and water purchased for the environment led to over 45 per cent of dairy farms stopping production in 2009" (Aither 2019).	-2	High
6.6 (Water-related ecosystems protection)	**2.4** (Sustainable agriculture)	1	Medium	"In response to perceived environmental costs during the Millennium Drought, the Australian government sought to acquire water by subsidising on and off-farm water use efficiency, and also by purchasing water entitlements from willing sellers. The most cost effective way to increase environmental flows by the Australian government is to purchase water entitlements" (Grafton et al. 2015).	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.b (Local participation in water management)	**2.3** (Agricultural productivity and income of food producers)	1	Medium	"Agricultural activities have the potential to cause salinity and water quality problems in neighbouring areas. Victoria has been working with local communities for almost 30 years to manage and reduce salinity in the rivers and catchments of the Murray–Darling Basin. Salinity, however, remains a management challenge and represents an ongoing environmental, social and economic risk" (DELWP 2019b).	+1	Medium
6.b (Local participation in water management)	**2.4** (Sustainable agriculture)	1	Medium	"Uncertainties in the environmental benefits arising from reduced water allocations to irrigation farmers contrast with their costs which are quickly and acutely felt in irrigation communities, and this hinders attempts to build ownership of plans to reduce water allocations to irrigation. Recent experience has clearly shown that lack of local community engagement with shared ownership and mutual responsibility results in opposition and rejection by rural communities dependent on irrigation of any proposals to reallocate irrigation water for environmental purposes. This happens because the communities along the Basin live first-hand with the realities of the prolonged drought and the challenge of reducing water extractions and know better than anyone the history, issues and previous interventions in their particular areas: what has been tried before, what has worked, and what has not" (DELWP 2019b).	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.b (Local participation in water management)	**2.a** (Rural infrastructure and agricultural research)	2	Medium	"Agricultural industries and rural communities worldwide are faced with improving outcomes for society and the environment from major change initiatives, such as irrigation modernization" (Ayre & Nettle 2017). "The roll-out of the Murray-Darling Basin Plan water saving projects will continue, with its success depending on a strong community government partnership to improve water-use efficiency within both the environmental and irrigation sectors for the benefit of the region's farms and floodplains. The Victorian Government is committed to supporting communities adapt and expand production with less water (2016). This will require a mix of existing and new ideas that encompass technological, management and engineering solutions. Further research and innovative delivery is key in improving water-use efficiency" (GBCMA 2016c).	+1	Medium
6.4 (Water use efficiency and scarcity)	**13.1** (Strengthen climate change resilience and adaptive capacity)	1	Medium	"Irrigated mixed farms produce crops for grains and fodder and pastures for livestock grazing (mostly beef cattle and sheep). Much of the irrigated mixed farming industry is associated with supplying feed to neighbouring dairy farms. Land managers in Mixed irrigation farms are moving to a more opportunistic use of irrigation water, using more water when it is affordable and expected irrigation commodity prices warrant its use and using less when it is scarce. The ability to move in and out of irrigation according to water availability and returns means the area is well suited to adaptation to a variable climate" (NCCMA 2016a).	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.5 (Water resources management)	**13.1** (Strengthen climate change resilience and adaptive capacity)	1	Medium	"The urban water corporations carry out a range of long-term, short-term and contingency planning to manage the impacts of extreme events. Urban water corporations have a vital role in water security and managing the supply of water to meet the needs of their urban customers. Under the statement of obligations issued by the Minister for Water to all water corporations in 2015, urban water corporations must prepare a strategy for managing water security to provide water services in the towns and cities in their area now and in the future" (DELWP 2019a). "Setting reserves aside earlier in the season offers insurance against drought and variations in climate. Early reserves were also introduced in the Goulburn and Murray systems. Under the policy, Goulburn-Murray Water builds reserves for the following season to ensure there is enough water to operate the distribution system (including storages, rivers and irrigation delivery systems). Once allocations reach 30 percent of High-Reliability Water Shares, inflows are assigned equally to the reserve and to increasing current season allocations until the maximum early reserve volume for that system is set aside. This means that setting aside water in the early reserve finishes before allocations reach 50 percent of High-Reliability Water Shares" (DELWP 2019a).	+2	Medium
13.1 (Strengthen climate change resilience and adaptive capacity)	**6.1** (Drinking water)	3	Robust	"During the Millennium Drought urban water corporations' ability to supply many towns were severely compromised. Urban water corporations had to adapt to changing conditions to make sure that towns did not run out of water. The course of action to maintain critical human water needs depended on the design of the supply system, entitlement rules and towns' needs. As well as demand management through water restrictions and water	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				efficiency programs, many short-term and long-term supply augmentation measures were completed" (DELWP 2019a). "As water resources become incrementally less available, staged water restrictions may be imposed by urban water corporations. Four stages are currently prescribed under water corporation bylaws. These staged restrictions progressively restrict more and more outdoor uses of water. For example, the ability to water a garden is limited progressively to the use of watering cans rather than a hose, on odd or even days and at specific times. Stage 4 restrictions represent Victoria's position on what constitutes critical human water needs and operate to make sure urban water supplies are used only for those purposes in times of severe shortage. These measures are designed to ensure the limited amount of drinking water available is secured for critical human needs for a longer period of time: 1. Water corporations may reduce or restrict the delivery of water to rural customers where there is insufficient capacity in the system. Water corporations may reduce, restrict or discontinue the supply of water to towns where there is insufficient capacity to meet critical human needs. 2. Permanent water saving rules have been in place since the Millennium Drought which provide permanent restrictions on how drinking water can be used outside the home. Water corporations may also apply staged water restrictions as water availability reduces to further restrict the use of drinking water to protect the availability of water for critical human need long term. 3. The Minister requires water corporations, under a Statement of Obligations, to undertake short term and long-term planning of future water needs to ensure available water is managed to meet critical human needs within those events that can be predicted. This planning includes a drought response plan for urban systems, and emergency management plans. 4. Where the measures employed by water corporations are not sufficient to address the		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				impacts of an extreme dry period, the Minister may declare a water shortage in an area or for a resource and temporarily qualify rights to temporarily change the water sharing arrangements in a system by reducing the water available to holders of a water access right in the area or resource" (DELWP 2019a). "Urban water security reflects the balance between demand for water and available supply, each of which is impacted by a number of factors over time. The resulting uncertainty when forecasting future urban water security is addressed through scenario planning. The scenarios – which consider the implications of population and climate change, among other factors – indicate the possible timeframe over which intervention may be required under a range of plausible conditions. Most water supply systems inherently have some level of vulnerability to infrequent and severe drought conditions that arise from time to time, for which Drought Preparedness Plans are prepared and implemented to ensure water supplies can be maintained over short periods of relative water scarcity. More substantial upgrades to system infrastructure are triggered when forecasts of demand and supply over time suggest that levels of service can no longer be maintained. The key challenges for water security in the Goulburn region are population growth (particularly in the southern peri-urban fringe) and climate change. The impacts of climate change, in particular, are generally forecast to contribute to increasing uncertainty and reduced availability of water resources" (Aither 2019). "GMW is committed to delivering long-term and short-term key strategic business objectives and drivers to deliver its part of this response as both a lead and a stakeholder. Integrate climate change adaptation into decision-making across the business (all sources of water, wastewater, and where relevant drainage and flood management) including: • source waters and demand • built assets		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				• natural environment • people and workplace • interdependencies • customer and product delivery" (GMW 2018b).		
13.1 (Strengthen climate change resilience and adaptive capacity)	**6.3** (Water quality and wastewater)	4	Robust	"Climate change is one of the risks for the degradation and decline in water quality. Degradation or decline in water quality, either from natural occurring events like drought and fire or human-induced impacts from land clearing and land use change, can significantly impact on beneficial uses. Sections of the catchments that retain a large amount of native vegetation like the mountains and highlands have been less affected by water quality degradation than flat lands that have been highly modified" (DELWP 2019b). "Victoria includes the impact of bush fire and the interception by regrowth after fire on water availability and condition as a threat which should be assessed" (DELWP 2019b). "Suspended sediments and nutrients were identified as a common threat to the water resources of the surface water resource plan areas. The threat arises from many causes including climate change, extreme wet periods, extreme drought, bushfire and change in land use" (DELWP 2019a). "Climate change could trigger pathogens (threat) and would be a risk for consumptive users including the use of water for human drinking, agriculture and irrigation, aquaculture, fish, and Aboriginal cultural uses, crustacean consumption, primary contact recreation (for example swimming) secondary contact recreation (for example fishing) and aesthetics. Also pests and weeds could trigger suspended solids and nutrients (threat) and would have a high risk for consumptive users including water for human drinking, agriculture and irrigation, aquaculture, and fish and crustacean consumption" (DELWP 2019a). "Some of the potential climate change impacts facing the Goulburn Broken Catchment include (DSE, 2008): • Water demand increases as a result of warmer temperatures and population growth	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				• Reduced water quality due to lower flows and higher temperatures, leading to algal blooms"(Lukasiewicz et al. 2012). "Key pressure on long-term water flows and shorter term water quality from wet eucalypt forests in key catchment areas (trend for excessive frequency in recent years). Severe fire weather projected to increase with climate change, potentially placing further pressure on water resources." (GBCMA 2016b).		
13.1 (Strengthen climate change resilience and adaptive capacity)	**6.4** (Water use efficiency and scarcity)	4	Robust	"Climate change led to reduced rainfall over south-eastern Australia, increased variability of rainfall and increased mean temperatures. An extended period of low rainfall resulting in severe low water availability. Also impacts on availability and condition of water resources arising from bushfires" (DELWP 2019b). "During the drought, inflows to the River Murray System were half the previous recorded minimum and created significant uncertainty as to whether even the most basic water needs could be met. In response to water scarcity, a broad range of mechanisms were made available for individuals through to the national scale to help adapt to low water availability, including: water trading, access to groundwater, altered farm management practices, off-farm sources of income and government assistance" (MSC 2018). "There is a well-understood expectation that climate change will exacerbate water scarcity across GMID's competitor markets (e.g. see Climate Change in Australia, 2019). It is of note that the competitor regions surrounding GMID have inferior access to water. In this way, water will become an increasingly costly and uncertain input to agriculture but, in this setting, GMID will almost certainly be relatively better placed than competitor regions." (Downie et al. 2019). "Climate has a strong and pervasive influence on the condition of water assets via precipitation patterns and their influence on stream flows and water-dependent ecosystem processes. Climate influence is also expressed in terms of water temperature. Direction of influence depends on climate phases, but overall assumed to be neither detrimental nor	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				beneficial under historical conditions. Climate change is likely to have an overall detrimental influence on the condition of water assets" (GBCMA 2016b).		
13.1 (Strengthen climate change resilience and adaptive capacity)	**6.5** (Water resources management)	3	Robust	"Climate change was found to be a common cause of risk across all water resource plan areas. The high level of risk was associated with its very high probability of occurring, and when climate change occurs, it typically impacts over wide spatial areas and for periods that extended over the life of the water resource plan and beyond. Climate change also posed Medium risks with regard to recreational and amenity uses, because of threats associated with declines in water availability and changes to seasonal patterns of inflows to or extraction from aquifers" (DELWP 2019a). "Local government authorities and water corporations own and manage water supply points to provide water supplies for water carting during drought" (DELWP 2019a). "Water for Victoria is the Victorian Government's adaptation response to the impacts of climate change on water resources and on the availability of water in the future. Victoria's temperature has steadily increased since the 1970s and overall stream flows have decreased by around 50 percent or more over the past 20 years. The Millennium Drought was characterised by a seasonal shift towards less rainfall during the cooler months of April to October when runoff was greatest and storages usually filled. Climate science predicts this is the new reality, with more extreme events such as floods, droughts and bushfires also likely to happen and affect water availability and condition. In Australia we accept that drought is part of life and many parts of Victoria have experienced drought conditions over the past decade. The Millennium Drought's severity has been linked to human-induced climate change. That drought was a wake-up call for many Victorians about taking water for granted, the importance of water security and the need to build resilience to drought" (DELWP 2019a). "The Millennium Drought triggered major reform in water management across the region and, more broadly, throughout Australia. It led to the Federal Government investing $12.9 billion into ten years of water reform funding through the Water for the Future Program. Outcomes included the introduction of the Commonwealth Water Act 2007, and the Murray Darling Basin Plan 2012" (MSC 2018). "Climate change is projected to exacerbate pressures on the condition of water. Most water condition indicators were assessed to be following a negative	+3	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				or neutral trend (the latter reflecting NRM program outcomes and water policy reforms). Terrestrial and freshwater ecosystems are considered most vulnerable to the effects of climate change. Climate change will particularly affect water supply, use and management. The interactions of environment, water policy and use, community desires and increased unpredictability of the amount, seasonality and distribution of water are complex. Climate change is anticipated to lead to new pressures through changes in rainfall and snow regime, reduced average runoff and increased air and water temperature, resulting in increased evaporation rates" (GBCMA 2016a).		
13.1 (Strengthen climate change resilience and adaptive capacity)	**6.6** (Water-related ecosystems protection)	2	Robust	"The risk assessment found that climate change could trigger a reduction in volume of water and a change to seasonal pattern (threats) which would have a very high risk for the environment's low reliability and uncontrolled (above cap) water. A reduction in volume (threat) would also be a high risk to the environment's high reliability water. The risk assessment found extreme drought could trigger a reduction in volume of water (threat) would be a high risk for the environment's low reliability and uncontrolled (above cap) water, and could trigger a change to interannual patterns (threat) and would have a high risk for the environment's uncontrolled (above cap) water" (DELWP 2019a). "Climate change was the only cause of risk that generated very high risks to water availability for environmental and consumptive uses. Extreme drought caused high risk to environmental and consumptive uses. As a result of climate change and extreme drought, adverse changes to the inflow of water to aquifers was identified as a common threat to the beneficial use of groundwater. Higher temperatures and extended periods of low rainfall can result in increased evapotranspiration and reduced infiltration, resulting in a decline in inflow to aquifers" (DELWP 2019a). "With the drought conditions in the Basin, environmental water holders, like all other water entitlement holders, have been allocated less water under state allocation policies. Water holders therefore need to manage a much smaller portfolio by carefully targeting the highest environmental priorities to achieve the best environmental outcomes. In a relatively dry year,	+3	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				it is especially important for environmental water managers and river operators to work together (especially in the southern Basin) and look for opportunities to effectively deliver environmental water in conjunction with the delivery of water to consumptive uses" (MDBA 2018).		
13.1 (Strengthen climate change resilience and adaptive capacity)	**6.b** (Local participation in water management)	1	Medium	"The urban water strategies, which include drought preparedness planning, recognise that they must actively prepare for drought, not just respond to it. In developing these plans, water corporations will work with their communities to find the best way of securing supply for each system during drought. By being involved, the community will better understand the likely water security risks over coming years" (DELWP 2019b).	+1	Medium
13.2 (Climate change adaptation policies and strategies)	**6.1** (Drinking water)	2	Robust	"Drought preparedness plans or drought response plans document the contingency measures the water corporation will implement to secure urban supply during times of water scarcity. This may include the implementation of water restrictions, including a decision-making framework for how and when restrictions are to be applied. As well as demand reduction measures (urban water restrictions, education programs), drought preparedness plans may outline contingency measures to further reduce demand or augment supplies" (DELWP 2019a). "Broadly speaking, the roles and responsibilities for climate change adaptation planning are: • DELWP sets the agenda for adaptation at state-wide level through preparation of climate change strategies and implementation of the Act. It also mainstreams climate change and adaptation planning into key plans, policies, and programs such as Water for Victoria, urban water strategies and catchment management strategies. • Water corporations develop their own adaptation programs and deliver specific activities set by DELWP, such as drought preparedness plans and urban water strategies, for urban and regional urban water corporations.	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				• The Department of Health and Human Services (DHHS) safeguards Victoria's drinking water supplies to both protect and enhance public health and wellbeing. To achieve this, the department ensures drinking water is delivered to Victorians by water businesses in accordance with the requirements of the Safe Drinking Water Act 2003 and the Safe Drinking Water Regulations 2015." (DELWP 2018) "Each urban water corporation produces an UWS, last prepared in 2017. These strategies provide a detailed 50-year forecast of water demands for communities, along with supply options, but do not focus on water quality. They set out actions that water corporations will implement for climate change adaptation to ensure safe, secure and affordable water services. The strategies make recommendations for supply augmentations and/or demand management based on hydrological modelling. This modelling uses climate change projections from the Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria"(DELWP 2018).		
13.2 (Climate change adaptation policies and strategies)	**6.3** (Water quality and wastewater)	2	Robust	"More intense rainfall and drier average conditions both affect sewer and wastewater infrastructure and operations. One way water corporations are addressing this is keeping abreast of new technology through programs such as Intelligent Water Networks (IWN) and Technology Approval Group and applying some of these technologies to their businesses. The IWN is a partnership between VicWater, 18 Victorian water corporations, and DELWP. The IWN is investigating new technologies, such as leak detection and energy optimisation equipment, to meet the range of potential future challenges associated with population growth and climate change. The Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria are used by water resource planners to ensure that towns and cities have secure water supplies under climate change, but there are currently no analogous guidelines for sewerage planners."(DELWP 2018)	+1	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				Some of the Strategies to address risk of climate change: "13. Leading climate change adaptation across Victoria's water system 14. Maintain compliance with Safe Drinking Water Act 2003, … 22. Managing water quality events 25. Planning for supply challenges by urban water corporations 28. Protecting our waterways and their catchments by strengthening integrated catchment management across Victoria 29. Protecting water quality implementing the State Environment Protection Policy (Waters) " (DELWP 2019b).		
13.2 (Climate change adaptation policies and strategies)	**6.4** (Water use efficiency and scarcity)	1	Medium	"During the Millennium Drought urban water corporations' ability to supply many towns were severely compromised. Urban water corporations had to adapt to changing conditions to make sure that towns did not run out of water. The course of action to maintain critical human water needs depended on the design of the supply system, entitlement rules and towns' needs. As well as demand management through water restrictions and water efficiency programs, many short-term and long-term supply augmentation measures were completed" (DELWP 2019a).	+2	Medium
13.2 (Climate change adaptation policies and strategies)	**6.5** (Water resources management)	3	Robust	"Victoria's water planning framework is designed to enable critical human water needs to be met throughout extremes of climate. It does this by integrating long-term planning, short-term planning and contingency planning" (DELWP 2019a). "Participate in development of the Victorian Water sector climate change adaptation plan (led by DELWP) in the Water working group. Readiness for climate impacts on water sources, floods and drainage are particularly relevant to GMW" (GMW 2018b). "The Victorian Climate Change Adaption Plan 2017-2020 (Department of Environment, Land, Water and Planning, 2017) states that ongoing flood studies will help flood-prone communities understand their risk, and new flood studies will	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				more explicitly consider the implications of climate change. Floodplain management in the areas of emergency management and land-use planning shall address climate change and increased exposure to vulnerabilities. Whilst the policy framework is in place to manage flood risk for the impact of climate change, there is substantial uncertainty about such risks posed" (GBCMA 2018).		
13.2 (Climate change adaptation policies and strategies)	**6.6** (Water-related ecosystems protection)	2	Robust	"Climate projections are that dry conditions in the MDB are likely to be more regular and severe than ever before, and recent policy initiatives are likely to reduce consumptive water use and redirect water to ecosystem management" (Wei et al. 2011). "Environmental water is used to improve the environmental health of rivers and wetlands in Victoria's North and Murray water resource plan area. This includes how environmental water can be used to mitigate against the impact of extreme dry conditions. The VEWH's seasonal watering plan is prepared for the different water availability scenarios of drought, dry, average and wet, and planned actions are constantly updated based on projected conditions. Environmental watering actions are developed for each scenario, for example, during dry conditions watering actions are focused on providing refuges for plants and animals to avoid critical losses, rather than on providing breeding opportunities. This plan informs the real-time operational decisions that are made to address needs with limited resources as the season progresses" (DELWP 2019a).	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
13.3 (Climate change education)	**6.5** (Water resources management)	1	Medium	"Water for Victoria recognises that government has a key role in applying research to water management policy, planning and practice. The Victorian Climate Initiative, in partnership with the Bureau of Meteorology and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has invested in developing an understanding of climate change and its impacts on water resources in Victoria" (DELWP 2019a). "Water for Victoria aims to improve Victoria's ability to apply this research to water management policy, planning and practice. Tools for modelling and scenario planning help inform decisions about options for action in a future with climate change and periods of reduced water availability. DELWP will continue to assess and report on changes in water resources, including changes in rainfall, streamflow and groundwater, to inform adaptation and evaluation of actions" (DELWP 2019a).	+2	Medium
13.3 (Climate change education)	**6.b** (Local participation in water management)	1	Medium	"Through Water for Victoria, the state has committed to build on this understanding by continuing to invest in research and working with partners including community groups, local government, Traditional Owners, research organisations and the water sector" (DELWP 2019a).	+1	Medium
6.3 (Water quality and wastewater)	**15.1** (Conservation and sustainable use of freshwater ecosystems) And **15.2** (Forest sustainable management)	4	Robust	"The Basin Water Quality and Salinity Management Plan will form part of the overall Basin plan, which must have regard for a range of related national and international initiatives. Based on advice from the MDBA, the anticipated Basin plan objectives for water quality is to: • protect and enhance water quality to ensure it is sufficient to meet the environmental, social, economic and cultural values of the Basin's water resources such that water quality is sufficient to meet all uses of the Basin's water resources"(MDBA 2010). "Ramsar wetlands in Murray Icon sites should have sufficient water quality to maintain the ecological character of those wetlands. Victoria holds all or part of four of the six Living Murray	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				icon sites, these are Barmah-Millewa Forest, Gunbower-Koondrook Perricoota Forest, Hattah Lakes, and Chowilla Floodplain and Lindsay-Wallpolla Islands and lies adjacent to the River Murray Channel" (DELWP 2019b). "Point source discharges are such as mining, irrigation and urban development near waterways pose hazards to surface and groundwater availability and condition. Stormwater discharges from existing and expanded urban developments (in major regional towns such as Wodonga, Echuca, Mildura)" (DELWP 2019b). "Extreme water quality events including blue-green algae and blackwater events can have negative impacts on the environmental health of rivers and wetlands. Catchment management authorities and environmental water holders may have a role to play in mitigating the impacts of water quality events through providing dilution flows. However this may not always be possible due to the volume of water needed particularly in the larger systems. Catchment management authorities work with the water corporations and the water holders to identify and implement feasible options to limit the impact of water quality events on the environment. This includes: reducing organic material load on the floodplain through regular wetland flooding; timing environmental flows to reduce risks such of poor water quality events; maintaining healthy refuges, or using small freshening flows to provide refuges during extreme events; restoring fish passage to allow movement away from poor water quality events; and if possible, containing poor water quality by closing regulators" (DELWP 2019a). "ater Sensitive Urban Design All new developments within the municipality currently must incorporate water sensitive urban design (WSUD) principles. When designing for drainage and water management, regard should be given to the Greater Shepparton City Council's Stormwater Management Plan. Developers must consider stormwater quality, include erosion and sediment control plans, and use appropriate treatments to minimise pollution, in accordance with the Best Practice Environmental Management Guidelines for Urban Stormwater. Appropriate treatments to minimise pollution may include:		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				− buffer strips; − vegetated swales; − bio-retention trenches and systems; − wetlands; − rain gardens; − open water bodies; − sedimentation basins; and − gross pollutant traps. In future years, research will obviously drive the introduction of further WSUD treatments, and stormwater reuse may become a legislative requirement for all developments." (GSCC 2006a).		
6.3 (Water quality and wastewater)	**15.3** (Restore degraded land and soil)	2	Robust	"Salinity refers to the movement and concentration of salt in landscapes. Both soil and natural waters can become saline. Hence salinity can be described as either soil salinity or water salinity. The effects of salinity are broad including: • reduction in the productive capacity of affected land (e.g. crop yields) • degradation of the environment and wildlife habitats • loss of water quality for stock and domestic water supplies …"(Aither 2019). "That the quality of surface water, when used in accordance with best irrigation and crop management practices and principles of ecologically sustainable development, does not result in crop yield loss or soil degradation" (DELWP 2019b). "Salinity is one of the most serious and widely-recognised forms of land degradation in Victoria. As a result, salinity management plans have been developed through consultation between the government and community. Any saline water discharges to land or waterways will come under the control of such plans. If a proponent is planning a mine wastewater disposal scheme in Northern Victoria, additional	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				consultation with the salinity management plan coordinators from DELWP or the local catchment" (DELWP 2019b). "Environmental assets, has been established to provide land and environmental protection from The Shepparton Irrigation Region groundwater management area plan, which has many priority high watertables, saline groundwater discharge and waterlogging. Users are encouraged to pump and use groundwater from the shallow Shepparton and Coonambidgal Formations to lower saline groundwater levels across the region" (DELWP 2019b).		
6.3 (Water quality and wastewater)	**15.5** (Biodiversity and natural habitats degradation)	2	Robust	"Salinity refers to the movement and concentration of salt in landscapes. Both soil and natural waters can become saline. Hence salinity can be described as either soil salinity or water salinity. The effects of salinity are broad including: • reduction in the productive capacity of affected land (e.g. crop yields) • degradation of the environment and wildlife habitats • loss of water quality for stock and domestic water supplies …"(Aither 2019). "The clearing of catchments for agricultural land, soil disturbance during forestry operations or urban development, and bare areas such as gravel roads and stock tracks, have led to substantial increases in the amounts of sediment (gravel, sand, silt and clay) entering ours streams and rivers. This sediment and its associated nutrients and chemicals can contaminate human and stock water supplies, smother breeding sites for fish and other in-stream animals and, by filling up stream pools, deprive these animals of the deeper waters that are a vital refuge in dry seasons and prolonged droughts" (GBCMA 2018).	+2	High
6.4	**15.1**	2	Robust	"Help develop and implement national guidelines and procedures for determining environmentally sustainable levels of extraction of water. A nationally agreed method will expedite the formulation of water plans that protect water-dependent ecosystems and include a pathway to recover over allocated systems. The methods will include guidelines for	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
(Water use efficiency and scarcity)	(Conservation and sustainable use of freshwater ecosystems)			establishing clear environmental outcomes" (Parsons et al. 2009). "Increase efficiency of water use through trading, especially the removal of barriers to inter-state trading (Qureshi et al. 2006, Young and McColl 2008), genetic modification of crops, and improved water, soil, and crop management. Khan and Abbas (2007) estimate that feasible on-farm efficiency increases in two irrigation areas on the Murrumbidgee River floodplain, a tributary of the Murray, could lead to a decreased water use that is between 16% and 33% of the current (small, but so far unrealized) allocation to environmental flows in the Murray River (500 GL/year). However, the tendency to expand the irrigated area to use the water savings would need to be countered" (Walker et al. 2009).		
6.4 (Water use efficiency and scarcity) and **6.5** (Water resources management)	**15.1** (Conservation and sustainable use of freshwater ecosystems) and **15.2** (Forest sustainable management) and **15.3** (Restore degraded land and soil) and **15.5** (Biodiversity and natural habitats degradation)	4	Robust	"Over-allocation of fresh water resources to consumptive uses, coupled with recurring drought and the prospect of climate change, is compromising the stocks of natural capital in the world's basins and reducing their ability to provide water-dependent ecosystem services. To combat this, governments worldwide are making significant investment in efforts to improve the sharing of water between consumptive uses and the environment" (Crossman et al. 2010). "Reallocation of large volumes of water from irrigation to the environment is emblematic of a new era in water resources policy" (Marshall & Alexandra 2016). "Policy makers will increasingly have to turn to water demand management in the future to respond to greater water scarcity" (Grafton et al. 2015). "Water security and water-dependent ecosystems in many irrigated areas are threatened by the increase in demand for water to meet food requirements of growing populations, coupled with intermittent droughts and the prospect of continued reduced runoff and water supply as a consequence of human induced climate change" (Crossman et al. 2010). "Moira Shire acknowledges: • Water is the lifeblood of the region and has economic, environmental and social value; • It is critical to use and manage potable and raw water appropriately yet differently; • Urban stormwater outfalls into	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				high value rivers and streams throughout the Shire and may then be re-used for a variety of purposes; and • Efficient use of water should occur despite climatic conditions. • The prosperity of irrigated land and environmental features should be protected through effective salinity management. Moira Shire Council will: • Endeavour to manage urban stormwater to meet the required standard; • Require all new developments to meet current standards; • Manage its own water use and waste water responsibly; • Play an important role in educating, advocating and responding to statutory requirements regarding sustainable water use and safe disposal of waste water; and • Support partners in their various roles in water management (see Appendix 2). • Continue to work in partnership with the Goulburn Broken Catchment Management Authority on programs that support the Council Plan" (MSC 2017).		
6.6 (Water-related ecosystems protection)	**15.1** (Conservation and sustainable use of freshwater ecosystems)	5	Robust	"Large-scale water for the environment deliveries to rivers and wetlands, natural inflows and additional protection and restoration works build on 20 years of activity that is addressing historical degradation. It could causes conservation and restoration of terrestrial and fresh water ecosystem" (NCCMA 2018). "Ramsar sites in Murray Icon sites are environmental asset that requires environmental watering" (DELWP 2019b). "The Living Murray program has also invested in works on the ground which help the efficient delivery of environmental water. Victoria holds all or part of four of the six Living Murray icon sites, these are Barmah-Millewa Forest, Gunbower-Koondrook Perricoota Forest, Hattah Lakes, and Chowilla Floodplain and Lindsay-Wallpolla Islands and lies adjacent to the River Murray Channel" (DELWP 2019b). "Under Basin Plan Victoria is required to recover 1,075.3GL from the consumptive pool for allocation to the environment. This water has been recovered through direct purchase of water entitlement by the Commonwealth Government, or the exchange of water entitlement for Government investment in efficient irrigation infrastructure. Recovered water is used to improve the environmental health of the Murray Basin's rivers, wetlands and floodplains, and	+3	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				the habitats of plants and animals that rely on the river system. The effects of past environmental watering have already produced beneficial outcomes for river, wetland and floodplain ecosystems – like waterbird breeding events at Barmah Forest" (DELWP 2019a). "Water for the environment is used to improve the health of our rivers, wetlands and floodplains. This water benefits the fish, animals and plants that depend on healthy rivers to feed, nest and grow. In turn, this provides social, recreational and economic benefits to the communities in the MDB" (MDBA 2018). "Barmah Forest is a large wetland remnant in a largely cleared landscape in which many wetlands have been inundated or drained. As such, it provides an external ecological service to the region. It is a refuge, breeding ground and staging post for the conservation of waterbirds" (Abel et al. 2006). Environmental Water Management: "Manage specific Victorian Environmental Water Holder entitlements for the Campaspe River (including the Coliban River), Loddon River System (including Tullaroop, Serpentine and Pyramid creeks) and 14 Central Murray and Mid Loddon wetlands, and seven Wimmera Mallee Pipeline wetlands. Collaborate with key partners, provide input to water policy, deliver technical investigations and respond to section 51 of the Water Act referrals. Ensure shared benefits for Traditional Owner Groups' cultural values, key recreational users and the regional economy... The project delivered 133 gigalitres of water to 23 wetlands and waterways across the region. These environmental and consumptive flows helped improve the environmental condition for target riverine species (e.g. fish, platypus and vegetation)."(NCCMA 2018). "The Living Murray 'Flooding for Life': Provide environmental flows to Gunbower Creek and restore regular flooding to Gunbower Forest through a combination of environmental watering, engineering works, monitoring, Indigenous partnership programs and community engagement… The project delivered 9,500 megalitres of environmental water to high priority wetlands with a focus on reducing carp populations and supporting aquatic vegetation growth."(NCCMA 2018)		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.6 (Water-related ecosystems protection)	**15.2** (Forest sustainable management)	1	Medium	"The Barmah Forest, along with the Millewa Forest across the river in New South Wales, is the largest river red gum forest in Australia and the most intact freshwater floodplain system along the River Murray. The forest is a major feeding and breeding site for waterbirds including egrets, spoonbills, ibis, bitterns and night herons, as well as for significant frog and turtle populations. A large diversity of significant fish species inhabit the forest wetlands and creeks including Murray-Darling rainbowfish, freshwater catfish, golden perch, flat-headed galaxias, Macquarie perch, Murray cod and silver perch. The forest also supports a broad range of floodplain vegetation including river red gum forest and woodland and the threatened Moira grass plains" (DELWP 2019b).	+3	Medium
6.6 (Water-related ecosystems protection)	**15.3** (Restore degraded land and soil)	1	Medium	"The degradation of waterways since European settlement is a source of great concern for GM people. Issues that we believe undermine the health of the waterways within the Goulburn Murray catchment and which need to be addressed include, amongst other things, change to the links between waterways with their floodplains" (GBCMA 2018).	+2	Medium
6.6 (Water-related ecosystems protection)	**15.5** (Biodiversity and natural habitats degradation)	6	Robust	"Ramsar sites are recognised for containing representative, rare or unique wetlands, or wetlands that are important for conserving biodiversity. A wetland must satisfy one or more of the criteria for identifying wetlands of international importance to be designated to this list. The Victorian Murray and Northern Victoria water resource plan areas support four of the Murray-Darling Basin's Ramsar sites. These are all priority environmental assets and are supported by priority ecosystem functions. Three of the four Ramsar sites are Living Murray Icon sites. National guidelines are being developed to provide clear guidance on how Ramsar sites must be managed, under both the Ramsar Convention and Commonwealth Environment Protection and Biodiversity Conservation Act 1999. A key component includes monitoring of a site's ecological character description, which is a baseline of wetland condition at the time of its listing as a wetland of international importance. Ramsar wetlands depend on Basin water	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				resources maintain their ecological character" (DELWP 2019b). "Floodplains and wetlands require periodic inundation to maintain the health of a whole range of water dependent ecosystems and communities. Nutrients and carbon that return with water from inundated floodplains are an important driver of food webs that underpin the health of the entire Murray system. Similarly variations in flow within the river channel and its anabranches are important, particularly in providing habitat and cues to trigger things like fish to spawn. Environmental watering aims to improve the ecological health of river systems by providing water to support these key ecological processes. At times this may include supporting and or mimicking natural river flow and wetland inundation patterns. At other times it might include delivering water to specific sites to support species or functions at much more localised scales, such as delivering water to allow water birds to complete their nesting. The benefits of environmental water delivery are being seen rights across the Murray-Darling Basin. Not only has environmental water delivery contributed to arresting the decline in ecological health of these systems but we are beginning to see some really positive improvements" (MDBA 2015). "In unregulated surface water systems there is no held environmental water that can be stored and released from storage to manage for specific and measurable environmental objectives. Environmental objectives in unregulated systems are to protect the existing conditions (habitat), rather than provide a specific flow to meet an environmental objective for example, fish, vegetation or connectivity. No priority environmental assets or priority ecosystem functions have been identified in unregulated surface water systems" (DELWP 2019a). "Currently a positive influence on the condition of biodiversity as has recently provided improved balance of environmental and consumptive water uses. With reduced rainfall under climate change, competition between environmental and consumptive water uses is likely to increase and water availability for environmental flows likely to reduce, leading to a detrimental influence on biodiversity condition" (GBCMA 2016b). "Kerang Priority Wetlands		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				Protection: Implement activities to address the critical threats impacting on the ability of six Ramsar wetlands to support and maintain their ecological character, particularly relating to native habitat and vegetation condition and pest animal control… The project was finalised this year with 1,929 hectares of revegetation in the Avoca Marshes to reinstate a canopy layer to these systems. Additional weed control, fencing and pest control helped improve Ramsar values" (NCCMA 2018). "More resilient habitats include free-flowing or undisturbed rivers as well as rivers with favourable physical characteristics such as a north-south orientation, topographic shading and a gradual habitat gradient. These habitats could potential conserve freshwater biodiversity under climate change because they may remain cooler, retain natural variability in ecosystem processes like flows, and enable migration of species and ecosystems. The protection and conservation of undisturbed and favourable freshwater systems is likely to provide more biodiversity benefits than heavily regulated or already degraded systems. Actions include fencing and restoring river banks, preventing the regulation and development of these river reaches, and reducing water extractions" (Lukasiewicz et al. 2012).		
6.6 (Water-related ecosystems protection)	**15.8** (Invasive alien species)	2	Robust	"The condition of land related to invasive plants and animals is considered to remain poor, with terrestrial and aquatic environments continuing to be vulnerable to new and emerging weeds and animal species, as well as long-established species, such as Paterson's Curse and foxes" (GBCMA 2013). "Recent studies and investigations suggest that wetland inundation will become much less frequent under moderate climate emissions scenarios. The effects of wetland drying combined with changes to the potential ranges of invasive species will make wetlands susceptible to invasion by non-wetland species, both exotic and native, and possibly see the emergence of 'sleeper' invasive species already present within the region"(NCCMA 2016b).	+1	low

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.b (Local participation in water management)	**15.1** (Conservation and sustainable use of freshwater ecosystems)	2	Robust	"Regional catchment strategies are the primary integrated planning framework for the management of land, water and biodiversity resources in each catchment and land protection regions in Victoria. Each catchment management authority prepares a regional catchment strategy in partnership with local communities and partners involved in integrated catchment management. some of regional catchment strategies are the region's land, water and biodiversity resources and how they are used" (DELWP 2019b). "In Victoria the Department of Environment, Land, Water and Planning, catchment management authorities, water corporations, the Victorian Environmental Water Holder and the Commonwealth Environmental Water Holder all play an important role in the delivery of environmental water and supporting environmental outcomes in Victoria's wetlands and rivers. Long-term planning is critical to achieving environmental outcomes and the Victorian environmental management framework ensures the relevant parties contribute to the long-term planning processes" (DELWP 2019a)	+1	Low
6.b (Local participation in water management)	**15.3** (Restore degraded land and soil)	2	Robust	"Another regional catchment strategies are the nature, causes, extent and severity of land degradation of catchments which can improve by catchment management authority in partnership with local communities and partners involved in integrated catchment management" (DELWP 2019b). "As the Traditional Owners of a large part of the Goulburn Broken and North Central catchment areas, we as Taungurung People have a crucial role in managing and caring for the waterways that nourish this catchment. Water is the lifeblood of our Country. It keeps Country alive by nurturing and sustaining plants, animals, soils and ecosystems. As Traditional Owners, we have responsibilities handed to us by our Ancestors to continue to look after Country. As water is the source of life for our Country, we have had and will continue to have significant responsibilities	+1	Low

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				relating to how water is managed now and into the future. Taungurung people have always and will always continue to look after Country" (GBCMA 2018).		
6.b (Local participation in water management)	**15.5** (Biodiversity and natural habitats degradation)	2	Medium	"Regional catchment strategies are the primary integrated planning framework for the management of land, water and biodiversity resources in each catchment and land protection regions in Victoria. Each catchment management authority prepares a regional catchment strategy in partnership with local communities and partners involved in integrated catchment management. some of regional catchment strategies are the region's land, water and biodiversity resources and how they are used" (DELWP 2019b). "Over 25,000 community members participated in activities to improve the environmental and productive resilience of the Catchment. While participation remains positive, members of the broader community have continuing concerns about the Catchment's health, relating especially to invasive weeds (88 per cent of respondents), declining numbers of native fish (79 per cent), and pest fish species (79 per cent): all considered a problem by respondents" (GBCMA 2016a).	+1	Low
15.2 (Forest sustainable management)	**6.3** (Water quality and wastewater)	1	Medium	"As a large and important floodplain wetland, Barmah Forest affects the water quality and overall ecological condition of the river and floodplain areas downstream of its borders. It produces, traps, filters and transforms organic matter such as leaf litter, which it then exports as repackaged carbon, nutrients and other material of all sizes These become food and habitat for downstream organisms, supporting primary and secondary production during and after flooding. Slow-flowing forest and wetland systems also act as traps for sediment, excess nutrients, and pollutants, reducing turbidity and improving water quality downstream" (Abel et al. 2006).	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
15.3 (Restore degraded land and soil)	**6.3** (Water quality and wastewater)	3	Robust	"The unprecedented fires in 2009 and 2013 caused areas in the upper regions of the Goulburn Broken Catchment to be particularly vulnerable to soil erosion, further increasing water quality risks through sedimentation. This sedimentation risk is also increased through stock grazing in and along waterways" (GBCMA 2016c). "Conversion from grazing to cropping is likely to have a significant impact on runoff water quality in streams areas of the Victoria. In the Northern Victorian water resource plan area two land use changes could have significant impact on the increased cropping and increased intensification of irrigated dairy production. Significant flooding can adversely impact on the condition of water resources" (DELWP 2019b). "Native vegetation is important for the health of the land and water assets of the region. Native vegetation provides low cost or free ecosystem services such as provision of clean air and water, pest control and protection from land degradation, particularly salinity"(NCCMA 2007).	+2	Medium
15.3 (Restore degraded land and soil)	**6.6** (Water-related ecosystems protection)	2	Medium	"There is a history of (predominantly) bushfire, storm and flood with recent data indicating the occurrence of some form of damage in every year since 200915 (Figure 62). The Goulburn region is also prone to protracted drought conditions such as the 'Millennium Drought' conditions between 2001 and 2010. The region is predisposed to both bushfires and floods, with the region experiencing major impacts from both bushfires and floods in the recent past – including the Black Saturday bushfires of 2009 and subsequent widespread flooding in 2010, both of which impacted large parts of Victoria. The risks presented to land use from flood hazards must continue to be considered in strategic and statutory planning decision making. These decisions should be based on the best quality information on flood hazards to minimise the risk to life, property, infrastructure and environmental assets. Many settlements are located on floodplains including Shepparton, Tatura, Euroa, Nagambie and Seymour."(Aither 2019). "When land is cleared for agriculture, the crops and pastures generally use water for	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				a shorter period, over a lesser depth, and overall at a lesser rate, than the native forest they replaced. This results in water accumulation in the soil, groundwater recharge and a rise in the water table causing widespread land degradation in Australia" (Silberstein et al. 1999). "When the water table rises into the root zone of the plants, waterlogging can be a problem, and salt tends to concentrate in the upper soil layers as transpiration and surface evaporation drive the capillary rise of water from the water table" (Silberstein et al. 1999).		
15.8 (Invasive alien species)	**6.3** (Water quality and wastewater)	2	Robust	"Environmental impacts of Invasive species may include predation on, or competition with, native species and loss of habitat Another environmental impacts may include changes to water quality or sediment, nutrient levels and the transmission of disease" (DELWP 2019b). "Invasive plants present a serious and ongoing threat to Victoria's biodiversity. Pests and weeds are one of the causes of generating the highest levels of risk for water quality in Goulburn-Murray" (DELWP 2019b). "Pest plants such as willow and pest animals such as carp have the potential to pose significant threats to the condition of water resources. Willows can lead to seasonal increases in biological oxygen demand and decreases in dissolved oxygen levels. Willows can also contribute to the abandonment of stream systems. Invasive species such as carp can increase turbidity in stream systems, and predate on native fish species" (DELWP 2019b). "Water quality is under threat in this SES from invasive species in waterways, including European Carp" (GBCMA 2013).	+2	High
15.8 (Invasive alien species)	**6.6** (Water-related ecosystems protection)	1	Medium	"Invasive species in waterways and along riparian land are an increasing threat to the health of rivers, estuaries and wetlands in Victoria. Invasive species affect waterway conditions and have the potential to threaten environmental, social, cultural and economic values" (DELWP 2019b).	+2	Medium

2.3 (Agricultural productivity and income of food producers)	**8.1** (Economic growth)	3	Robust	"The upper Murray region supports significant agricultural industries including dairy, beef, wool, cropping and horticulture, and forestry including managed pine and eucalypt forests. The region employs 29.1-46% of its workforce in agriculture, forestry and fishing sectors. Dairying is a major industry in the valley floodplains and the biggest contributor to the local economy, sheep grazing for wool and meat and beef cattle fattening are also important and dominate the foothills other agriculture includes wine grapes and niche crops. The High Plains in the central and south west are used by graziers to run cattle on some public and private land" (DELWP 2019a). "The Murray floodplain area has areas of national parks including Barmah and Gunbower National Parks, along with large areas of irrigated agriculture. The River Murray is a major source of water for some of the largest irrigation schemes in Australia which support dairying, broadacre cropping and horticulture" (DELWP 2019a). "In the north west, the Sunraysia irrigation region is a major producer of dried fruit, table grapes, wine grapes, almonds, pistachios, citrus and vegetables. The region has significant agricultural manufacturing industries and infrastructure and exports about $340 million of agricultural products each year" (DELWP 2019a). "This region (Gulburn Murray) is characterised by a relatively high concentration of agriculture and food product manufacturing industries as well as construction associated with rapid population growth in the peri-urban fringe. Agriculture and food manufacturing are key exports for the region. The strongest employment growth in the region, however, has been in the service sectors with the importance of agriculture and other manufacturing as employment industries projected to decline further in future" (Aither 2019). "This region (Gulburn Murray) has a lower GRP (Gross regional products) per capita than the Victorian average. GRP per capita has declined in the last 10 years while Victoria has seen growth in economic output. The lower GRP per capita can partly be attributed to lower labour productivity, lower participation rates and an ageing population. However, GRP per capita in this region is also substantially impacted by the high number of commuters living in the peri-urban fringe and commuting to Melbourne resulting in their economic output being attributed to other regions. This can be seen in the low level of GRP per capita in the LGAs (local government area) that make up the peri-urban fringe" (Aither 2019). "Capital investment in the Goulburn region is below the Victorian average" (Aither 2019). "Greater Shepparton LGA has the second highest GRP per capita of the LGAs within the Goulburn Region, although it is still below the average for Victoria. The largest industry in terms of GVA (Gross value added) in Shepparton is manufacturing, with important agriculture and health	+3	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				care industries. Greater Shepparton has a more diverse industrial structure than other LGAs in the region, due to the regional centre at Shepparton. The workforce participation rate in Shepparton is below the average for Victoria and appears to be diverging from the Victorian average" (Aither 2019). "The Goulburn region economy is highly concentrated within both agriculture and related food product manufacturing. Location quotient is a measure of the concentration of industries in a particular region compared to the State. Industries with a location quotient above 1 have a larger proportion of employment in that region compared to the Victoria overall" (Aither 2019). "The Goulburn region is highly modified from its pre-European settlement state and supports a range of land uses with the majority of land either agricultural or parkland. The Goulburn region is a strategically important agricultural region with good water resources; the area has been farmed extensively for both dryland and irrigated agriculture. Irrigation infrastructure development is concentrated in the northern part of the region on the Goulburn and Murray River water resources. Irrigated horticulture and dairy, and associated food processing are important industries centred around Shepparton" (Aither 2019). "The strength of the GBC (Goulburn Broken Catchment) is its natural resource-based farm, forestry and fisheries industries. These primary industries provide the raw materials to the processing/manufacturing sector mostly in the catchment, including food processing, feed milling, timber product manufacturing and fibre processing. In addition, the natural resource-based tourism industry attracts a high level of investment and contributes to regional wealth. The food processing industries, based principally on dairy and horticultural processing, are concentrated in the SIR Shepparton irrigation district). The timber industry and aquaculture are more significant in the dryland shires of the catchment" (GBCMA 2006).		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
2.3 (Agricultural productivity and income of food producers)	**8.2** (Technology, innovation, and industry)	2	Robust	"Production in agriculture builds the jobs in rural communities - this is at threat. $8bn of GDP comes out of the GMID and that is being put in jeopardy" (DELWP 2019a). "Many of the future profitable developments in the dryland are less reliant on traditional agriculture/horticulture commodity enterprises. Irrigation water will enhance opportunities for enterprises such as specialist horticulture, intensive livestock production (piggery and poultry), mushrooms, thoroughbred horses or herbs" (GBCMA 2006). "There is a strong competition between the existing irrigation areas and the dryland for the investment dollars for high value horticulture development, whether it be for fruit, wine grapes, olives, nuts or any other enterprise. In this regard, the irrigation area already is well served. It has the water, the irrigation infrastructure and many of the supporting services to enable new development to occur" (GBCMA 2006).	+3	High
2.3 (Agricultural productivity and income of food producers)	**8.3** (Employment generation policies) and **8.5** (Decent work for all women and men) and **8.6** (Youth employment and education)	3	Robust	"The region has irrigation-based industries including dairy, horticulture and viticulture, as well as dry land farming operations. These are supported by agriculture-related industries such as food processing, packaging, transport, and specialist engineering and electrical trades, and provides employment for many of the region's workforce." (DEDJTR 2018). "Employment in Greater Shepparton Part B East is concentrated in the agriculture, forestry and fishing industry which provides employment for 715 persons and accounts for 65% of all jobs in the district. There are also 120 jobs in the education sector, which are likely to be associated with the Dookie Agricultural College. − Greater Shepparton Part B West has a more diverse range of employment opportunities than in Greater Shepparton Part B East. The major source of local employment is the agricultural industry (34%) and the manufacturing industry (19%); however the electricity, gas and water supply, retail trade, and property and business services industries are also an important source of employment in the district."(GSCC 2006b). "The tendency to focus on enterprises or industries in isolation from the whole system has reduced resilience by missing critical linkages, feedbacks and unintended consequences. While	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				agricultural production and food processing are critical to economic and employment growth, the long-term resilience and wellbeing of the region is dependent on other factors such as ageing and declining populations, lifestyle land ownership, biodiversity, and ecosystem health" (RPG 2020). "The availability of skilled labour is emerging as a recurring issue across all components of the Greater Shepparton 2030 project. There is a local demand for skilled labour for emerging enterprises, many of which are based on high technology infrastructure." (GSCC 2006b).		
2.3 (Agricultural productivity and income of food producers)	**8.8** (Protect labour rights)	0	Limited	There is an issue around seasonal labour availability because demand for labour is very high in the Goulburn-Murray. Farmers need migrant workers and fruit pickers. Also, agricultural activities is one of the dangerous industries to work because of combination of hazards for workers.	-1	Medium
2.4 (Sustainable agriculture)	**8.1** (Economic growth)	2	Medium	" 'sustainable agriculture' is achieved when a farming system is able to proceed over the longer-term (a number of generations), without degrading the quality of the land or causing negative off-site impacts to the environment, whilst supporting ecosystem services, community wellbeing and financial viability" (NCCMA 2016a). "Sustainable agriculture refers to an agricultural system that is ecologically sound, economically viable, and socially just—a system capable of maintaining productivity indefinitely" (NCCMA 2016a). "The Strategy's four sustainable agriculture indicators are: 1. Profitable agricultural production 2. Environmental improvement 3. Enhanced social capacity 4. Climate change resilience" (NCCMA 2016a). "By-products as fertiliser:	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				While by-products are an acknowledged fertiliser resource, there are barriers to their use on agricultural land including consistency of supply, contamination concerns and knowledge about resources. This intervention would support a regional network to divert by-products from landfill and coordinate their use on farms across the region. Improved soil organic matter supports eco-system regeneration. This intervention will provide a valuable source of nutrients, cultivate microbes, improve water retention and increase yield" (RPG 2020).		
2.4 (Sustainable agriculture)	**8.2** (Technology, innovation, and industry)	2	Medium	"Agriculture in north central Victoria continues to undergo rapid change and to achieve greater agricultural sustainability, there will need to be the balance between achieving greater farming productivity whilst protecting the natural resource base and investing in the capacity of our agricultural community. The change drivers affecting agriculture currently include: • Increasing climate variability • Declining soil health • Water reform and irrigation modernisation • Technological advances • Consumer demand for quality food and organic products • High animal welfare standards and expectations" (NCCMA 2016a). "There is a policy framework that supports sustainable allocation of water to irrigators and is applied in all years including years of low water availability (e.g. during drought) as well as those of average or high water availability. • The Sustainable Irrigation Program reduces adverse impacts of irrigation on the environment and third parties, whilst improving water use efficiency. The program makes irrigation less vulnerable to climate change by reducing water leakage and evaporation, which means that there is more water available during normal years and during times of drought. The Victorian Government is investing $59.5 million in this over the next four years. • Victoria is investing $2.4 billion in irrigation modernisation and other water infrastructure projects. It includes contributions from the Victorian Government, Commonwealth Government and water corporations. The government is currently investing in the Sunraysia region, Werribee Irrigation District, Bacchus Marsh Irrigation District and	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				Macalister Irrigation District modernisation projects, and the Goulburn Murray Water Connections Project" (DELWP 2018).		
2.4 (Sustainable agriculture)	**8.4** (Resource efficiency and decoupling economic growth from environmental degradation)	1	Medium	"Enhancement of environmental and sustainability values is being achieved with new opportunities to value-add waste products by converting them to an input for another industry, whether it be milk by-products, horticultural processing waste, piggery waste, timber by-products or aquaculture waste" (GBCMA 2006).	+2	Medium
2.a (Rural infrastructure and agricultural research)	**8.1** (Economic growth)	2	Medium	"There is evidence that we may well become exporters of knowledge and technologies around building sustainable agriculture industries. For example, in 2015 Canberra Institute of Technology (CIT) signed a memorandum of understanding with India as part of a push by the ACT government to promote vocational education on the sub-continent. Hydroponic technologies become more important for production systems and some of these currently under-utilised approaches may offset deficits in traditional broad acre production" (NCCMA 2016a). "The large scale of holdings and relatively low cost of entry, compared to other areas with the same security of water, means that there is a relatively high return on investment for those land managers with the skills to manage these systems. At the same time there are opportunities available to diversify the agricultural base and develop more high value irrigation enterprises and intensive animal industries alongside the opportunistic irrigators and dryland enterprises" (NCCMA 2016a). "Over the decades and particularly in recent years, regions adjacent to the GMID (e.g. to the northwest) have shifted towards newer farming investments, notably nuts, while the infrastructure footprint of the GMID remains largely unchanged. That traditional infrastructure is characterised by smaller-scale dairy farms and orchards with intensive open-channel irrigation and housing."(Downie et al.	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				2019). “In addition to the issues raised about the liveability of the GMID, there was also seen to be a misalignment between regional education offerings and the skills required by local industry. Agriculture is not currently taught at a secondary level and universities only have a small research and teaching presence in the region, leading to a lack of transitional arrangements to support education in the region. There was also seen to be a mismatch between the skill sets of school- and university-leavers and industry, with much on-the-job training required. There was seen to be little interest from universities to redress this issue by a number of interviewees. Skills shortages in trade, agricultural technology and manufacturing were also highlighted. For example, Bendigo was cited as having only half the number of qualified welders as was needed, with similar situations in other centres and industries” (Downie et al. 2019).		
2.a (Rural infrastructure and agricultural research)	**8.2** (Technology, innovation, and industry)	2	Medium	“The GMID is an infrastructure-heavy zone, with many channels, relatively small land parcel sizes and much legacy infrastructure like houses and milking sheds, which make re-developing the land for other uses relatively complex and costly compared with competitor regions where the costs of larger scale modern farm development are much lower” (Downie et al. 2019). “The Goulburn region is also benefitting from billions of dollars of government investment in statewide and national infrastructure. This will improve: digital connectivity; regional roads and rail; logistics and export facilities; water security; energy productivity; research and innovation; workforce development; traceability and biosecurity, and many other areas relevant to agriculture and food processing” (DEDJTR 2018).	+2	High
2.a (Rural infrastructure and	**8.4** (Resource efficiency and decoupling economic growth from	1	Medium	“A regionally based centre for learning, in relation to agriculture and land management. This centre would provide a local resource to coordinate local research, data, extension, knowledge sharing and adoption. The intent is to work with leading partners to align with existing RD&E and create a culture of learning and success. Activities could include: •	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
agricultural research)	environmental degradation)			Communicating research and knowledge from other parts of region and outside the region. Need broad perspective to drive learning. • On ground experimentation pilots - farm trials. Supports farmer preference for practical demonstrations. • Coordination of regional agriculture and land data in a central place. • Developing water and financial literacy. • RD&E in relation to technology; soil health; crop varieties; regenerative agriculture; water use efficiency; indigenous crops" (RPG 2020). New technologies play an important role in the future sustainability and profitability of Goulburn-Murray agriculture.		
2.a (Rural infrastructure and agricultural research)	**8.5** (Decent work for all women and men) and **8.6** (Youth employment and education)	1	Limited	"In line with national trends, there are fewer and larger farms, with increasing production efficiency. Increasing scale, combined with mechanisation and automation, leads to reduced demand for labour and rural depopulation" (RPG 2020).	-1	Medium
2.b (Agricultural export subsidies and trade restrictions)	**8.1** (Economic growth)	1	Medium	"The heavy reliance on agriculture within the GMID, and particularly the reliance on low-value commodity agriculture, has meant that the region is extremely trade-exposed to shifts in export market prices and trade conditions over time. Some higher-value aspects of the GMID economy, like canned fruit, have also been affected by these shifts as well as by technological and other sector trends, such as packaging and food consumption trends. Notable shifts have included the removal of Australia from much of its traditional agricultural export market, as a result of the United Kingdom's entrance to the European Economic Union in 1973. Additional factors that have affected agricultural markets in the GMID include the floating of the Australian dollar and removal of tariff trade protections on the Australian agricultural sector from the 1970s through to the 1990s, along with the rise of global competitor food export economies enabled by these reforms. Finally, there have been corresponding rises in labour	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				cost inputs relative to the rise of export competitors in emerging markets that have lower labour input costs"(Downie et al. 2019).		
2.b (Agricultural export subsidies and trade restrictions)	**8.5** (Decent work for all women and men) and **8.6** (Youth employment and education)	2	Medium	"Investing in exporting links between Goulburn and Asia exploits growth in the Asian region for high demand product such as fresh fruit. Strong long-term demand prospects • There are low to no tariff barriers on fresh fruit and vegetables to most key Asian markets. • By value, Victorian fruit exports have more than doubled over the last four years. Goulburn produces half of Victoria's fruit. Goulburn's reputation is strong • Goulburn has a strong international reputation for food quality and safety that is highly valued by Asian consumers" (DEDJTR 2018). "Employment in the region relies heavily on irrigated agricultural enterprise; the major sectors being dairy, horticulture and mixed farming (MDBA 2010). There are approximately 1200 dairy farms in the region which employ more than 6600 people, either directly on dairy farms or in processing (GMIDWL 2018). Shepparton is the largest city in the region, and has the most diversified economy, but still relies heavily agriculture and agricultural services for employment (GMIDWL 2018). The western half of the GMID, which includes smaller towns such as Kerang, Cahuna and Pyramid Hill, have a less diversified economy and thus farm jobs are even more crucial to local employment (GBCMA 2016). Since 2006, the GMID has seen population growth in the municipalities of Shepparton (+8 %) and Moira (+5 %), while there were declines in Gannawarra (-12 %) and Loddon (-8 %) (GBCMA 2016)" (Downie et al. 2019).	+2	Medium
2.c (Control food markets and prices)	**8.1** (Economic growth)	3	Robust	"It is likely that China and India will be the focus of food production and consumption over the coming decades. In Asia the demand for protein will continue to be high. The difficulty, however, is that Australia is only capable of supplying about 2% of Asia's needs. This may be	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				an opportunity for Australia's land managers to achieve a premium price for Australian produce" (NCCMA 2016a). "The demand for fresh fruit from Asia could result in higher demand and further plantings such as stone fruit based on the skills and distribution networks around Swan Hill. Gaining new market access is an ongoing issue and accelerating productivity to stay competitive is also challenging given the high price of labour in Australia. With food processing in Australia becoming increasingly non-competitive, new fresh fruit markets will become even more important" (NCCMA 2016a). "Millions of farmers in Australia and around the world are currently being disadvantaged by trade distortions in global agriculture and food markets. Such distortions include high tariffs, which decrease or eliminate the competitiveness of foreign imports, government subsidies, which unfairly alter the costs of production, and guaranteed prices, which encourage overproduction. These distortions increase price volatility and can mean it is government policy, and not demand and competitive advantage, that drives production decisions. This increases price volatility, damages livelihoods and threatens the food security of millions" (DELWP 2019b). "On balance, these developments have tended to viewed as insoluble challenges to the GMID rather than as opportunities. Very large subsidies to the water sector have not, to date, enabled transition to a more profitable agricultural and food industry (e.g. see gross regional product figures for Greater Shepparton; id Community, 2019). Overall, with some notable isolated examples, the region has not undergone a significant shift away from lower-value agricultural commodities. This is notwithstanding extreme hard work and the embrace of technology and new markets where they have presented themselves at the individual farmer level. It could be argued that, in the face of the disruptions listed above, this has enhanced a cycle of low-return agriculture, which is further now challenged by water allocation risks and price. Likewise, the relative intransigence of the GMID infrastructure footprint has seen new investors generally overlook the region for lower establishment costs in surrounding farming regions with less legacy		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				channel infrastructure, larger lot sizes and lower purchase costs (e.g. see GBCMA, 2016). The net result of these responses now manifests itself in: • A lack of economic growth, in particular, low or no productivity growth per capita, which is an indicator of quality of life. • A shift in the regional economy to lower productivity and public sector industries (e.g. aged care and social services are now the largest industry in the Greater Shepparton Local Government Area, for example). • Generally lower than desired levels of investment in social infrastructure. • Loss of members of young generations to other destinations, with traditional GMID farming not seen as a profitable or desirable lifestyle." (Downie et al. 2019).		
2.c (Control food markets and prices)	**8.2** (Technology, innovation, and industry)	2	Medium	"Value adding opportunities emerge through innovative segregation of traditional bulk commodities and processing to meet specific needs of emerging and boutique markets – new processes, product differentiation, special packaging, target marketing. Hence, product development and marketing skills are in high demand" (GBCMA 2006). "The heavy reliance on agriculture within the GMID, and particularly the reliance on low-value commodity agriculture, has meant that the region is extremely trade-exposed to shifts in export market prices and trade conditions over time. Some higher-value aspects of the GMID economy, like canned fruit, have also been affected by these shifts as well as by technological and other sector trends, such as packaging and food consumption trends" (Downie et al. 2019).	+2	Low
8.1 (Economic growth)	**2.3** (Agricultural productivity and income of food producers)	0	Limited	In Goulburn-Murray, economic growth is seriously dependent on agricultural activities, but economic growth can also lead to the growth of the agricultural sector as well.	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
8.6 (Youth employment and education)	**2.3** (Agricultural productivity and income of food producers)	1	Medium	"The migration of the young from country to city is not a new phenomenon. The absence of young men in the country was noted many years ago by Bows field. 'One of the problems that is all the time tugging at the heart of the farmer is the absence from the farm of the young man. There are many neighbourhoods in which not one in ten male members of the community may truthfully be called a young man' (Bowsfield 1914). However, since Bowfield's day the rate of exit has accelerated. In the past 15 years the number of persons under 25 entering agriculture has rapidly declined" (Barr 2003).	+1	Medium
8.9 (Sustainable tourism and promoting local culture)	**2.3** (Agricultural productivity and income of food producers)	1	Medium	"The intent of this intervention is to diversify agricultural income streams through development of agri-tourism opportunities. This would link farms directly to consumers. Farm trails would be developed to promote the opportunities and guide tourists through the region. Repurposing of existing infrastructure (e.g. unused houses or farm sheds) would be encouraged. This intervention could incorporate a learning for change component. Increasing knowledge of the food supply system and connecting people to their food. It would also incorporate a focus on indigenous foods and multicultural foods. The phrase "many great flavours to taste" is an example from the Greater Shepparton Visitor Guide." (RPG 2020).	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.3 (Water quality and wastewater)	**6.1** (Drinking water)	1	Medium	"Extreme water quality events, including blackwater and blue-green algae blooms can be a risk to drinking water and public health. The Safe Drinking Water Act 2003 identifies that the Department of Health and Human Services must be immediately notified when a blue-green a bloom occurs, or if water contains other substances that may pose a health risk to the public. Urban water corporations may need to restrict demand as a result of a water quality event because water treatment plants can have reduced output, and clear water storages may be depleted if demand is not restricted. Demand is unlikely to be restricted during a blackwater event, however, water treatment plants may need to slow down operationally to closely monitor water quality. The powers relating to restricting, reducing and discontinuing water supply can also be used in response to a water quality event to protect the security of urban town supplies. Modifying supply allows water corporations to support longer-term availability of urban town supplies to meet critical human needs" (DELWP 2019a). "Water corporations may reduce or restrict the delivery of water to rural customers where there is insufficient capacity in the system (water shortage). Water corporations may reduce, restrict or discontinue the supply of water to towns where the quality of the water does not meet the standards for authorised use" (DELWP 2019a).	+2	High
6.3 (Water quality and wastewater)	**6.5** (Water resources management)	1	Medium	"Other initiatives such as on-farm storage, farm reuse systems, in-line storages, wetlands (whether en route or off line), strategic G-MW water harvesting storages for diversion of extreme high flow summer events, reduced point source discharges (industry, urban stormwater, sullage, sewage treatment plants, etc.), channel injection; drainage irrigated plantations at strategic locations, etc., can further reduce runoff discharges and associated nutrients into natural water courses; in addition to improving water resource management" (GMW 2000).	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.3 (Water quality and wastewater)	**6.6** (Water-related ecosystems protection)	3	Robust	"A key role of Environmental Protection Authority (EPA) Victoria, under the Environment Protection Act 1970, is to minimise the pollution of water environments. A particular focus for the EPA is the control of point sources of waste and wastewater, with a priority on avoiding the generation of wastewater. This is important because pollutants such as toxicants, nutrients and sediment can become concentrated in point-source discharges, leading to significant impacts on receiving waters. In Victoria, the discharge of wastes or wastewater from significant point sources (e.g. wastewater treatment plants and industries) to surface waters (including stormwater drains) is licensed by the EPA" (DELWP 2019b). "… aquatic Ecosystems — water salinity supplied from rivers and streams should be suitable to maintain the ecological character of ecosystem communities"(MDBA 2010). "A key role of Environmental Protection Authority (EPA) Victoria, under the Environment Protection Act 1970, is to minimise the pollution of water environments. A particular focus for the EPA is the control of point sources of waste and wastewater, with a priority on avoiding the generation of wastewater. This is important because pollutants such as toxicants, nutrients and sediment can become concentrated in point-source discharges, leading to significant impacts on receiving waters" (DELWP 2019b). "Surface water quality across the Victorian Murray and Northern Victoria water resource plan areas is highly variable spatially and temporally, but there is a general trend in decreasing water quality from east to west in the River Murray and from south to north in the tributary valleys, with major increases in concentration occurring between the Torrumbarry Weir and Swan Hill resulting from lower inflows and higher salt loads. Increasing gradients also occur from east to west for other water quality parameters such as dissolved organic carbon, filterable reactive phosphorus, total Kjeldahl nitrogen, total phosphorus and turbidity" (DELWP 2019b).	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.4 (Water use efficiency and scarcity)	**6.3** (Water quality and wastewater)	1	Medium	"Policy makers will increasingly have to turn to water demand management in the future to respond to greater water scarcity. Water markets have long been promoted as one of the most efficient ways to reallocate water by economists. It is possible that water trading between different water users can generate worse environmental outcomes. For instance, the direction of trade may result in lower return flows or reduced water quality" (Grafton et al. 2015).	-1	Medium
6.4 (Water use efficiency and scarcity)	**6.6** (Water-related ecosystems protection)	2	Robust	"In summary, water markets in the MDB have not resulted in the transfer of any substantial volumes of water from irrigators to non-farming 'high value' purposes, except to increase environmental flows" (Grafton et al. 2015). "Develop dynamic incentives. An example is to vary conservation payments to farmers so that when rainfall is plentiful incentive levels fall, but payments increase during droughts, when native ecosystems are under pressure from both moisture stress and grazing. Farmers would benefit from the alternative source of income in dry times" (Walker et al. 2009). "Develop dynamic rules that accommodate rainfall and other trends and fluctuations. The aim is to promote conservation, and land- and water-use decisions that are matched to prevailing circumstances. For example, Young and McColl (2008) advocate an entitlement and allocation system that matches inflows to use during floods and droughts, and under climatic change, giving environmental flows an entitlement to water that has precedence, along with urban water, over irrigation entitlements. Entitlements are secure rights, but the actual allocations vary with water availability" (Walker et al. 2009).	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.5 (Water resources management)	**6.3** (Water quality and wastewater)	2	Robust	"There is insufficient data relating to the impact of water quality events on a variety of users. Blue-green algae is the predominant water quality event and it is unclear what impact that has on domestic and stock use and irrigation. As identified in Victoria's North and Murray Risk Assessment there is insufficient information regarding Aboriginal values and uses of water to have an adequate strategy for management of the impacts of water quality events on their values and uses. As information about the impacts on these values improves, management strategies to respond to water quality events will be developed" (DELWP 2019a). "Water corporations develop management plans to manage risks to water resources. Throughout the region there are several reservoirs which offer access for recreational use. These are monitored for water quality by the respective managers who undertake monthly sampling for algal analysis over the summer period when these lakes are in high use. Where risks to the water quality are identified the public is immediately notified of the risks and restrictions on access may occur to prevent harm to individuals as a result of contact with contaminated water" (DELWP 2019a). "While water quality continues to be a priority in the SIRLWMP, significant investment over the last 20 years in water treatment plants, water reuse systems, dairy shed effluent design and management, improvements in fertiliser and water management and removal of stock grazing along streams have reduced phosphorus and nitrogen loads to below long-term targets. The five-year rolling average phosphorus load equates to a reduction of 80 per cent from the benchmark year of 1993-94 (GB CMA 2015a)"(GBCMA 2016c).	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.5 (Water resources management)	**6.6** (Water-related ecosystems protection)	2	Medium	"Trade and carryover are water management options available to water share holders, urban water corporations and environmental water managers in all the declared systems of northern Victoria" (DELWP 2019a). "Across all water resource plan areas, there are three key ways that Victorian water management meets environmental objectives: 1. Environmental water entitlements (bulk entitlements and environmental entitlements) and water shares that are held or managed by the Victorian Environmental Water Holder, Murray-Darling Basin Authority (MDBA) or Commonwealth Environmental Water Holder (CEWH). 2. Passing flow requirements specified for environmental purposes under bulk entitlements or water supply protection area water management plans. 3. Other water managed through water system management rules, including passing flows not specified as having an environmental purpose, and unregulated river diversion rules. This includes water which remains in the system after consumptive and environmental entitlements are taken out - referred to as 'above cap' water - and water used primarily for consumptive purposes, but which can also have a benefit for the environment" (DELWP 2019a). "Currently a positive influence on the condition of water assets as policy reform and water availability has recently provided for improved balance between environmental and consumptive water uses. With reduced rainfall under climate change, competition between environmental and consumptive water uses is likely to increase and water availability for environmental flows likely to reduce, leading to detrimental influence on the condition of water assets"(GBCMA 2016b).	+2	Medium
6.6	**6.3** (Water quality and wastewater)	2	Medium	"Environmental water is critical to protect the plants, animals and overall health of rivers, wetlands, floodplains and estuaries. It also has social, cultural and economic benefits. Environmental watering can increase recreational activities, sustain healthy Country for	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
(Water-related ecosystems protection)				Traditional Owners and improve water quality for farmers" (DELWP 2019b). "Riparian revegetation is a major investment for the CMA (CMA Respondent 1) that is carried out through the Waterway Grants Program that provides cash incentives for landholders for fencing, revegetation and the provision of off-stream watering points for stock in order to prevent or repair degradation along waterways (Goulburn Broken CMA, 2012b). The CMA uses the provision of fencing and revegetation incentives in order to counteract identified threats to freshwater conservation. These include: water quality (turbidity & nutrients), stock access; degraded riparian vegetation; degraded streamside zones; and poor riparian vegetation. Noticeable improvements to water quality can be observed provided that enough waterways are fenced off on both sides (CMA Respondent 4)" (Lukasiewicz et al. 2012).		
6.b (Local participation in water management)	**6.3** (Water quality and wastewater)	1	Medium	"Cyanobacteria (also known as blue-green algae) is the predominant water quality event that can occur in Victoria. Responses to cyanobacteria events relate to recreational use and public health and safety. Emergency response roles and responsibilities are set out in the Blue-Green Algae Circular: Management Plan 2016-17 (2015) and relate to establishing a process to ensure appropriate communications and planning for cyanobacteria events. Water corporations coordinate the management of major outbreaks while local water managers (water corporations, catchment management authorities, local councils, Parks Victoria, Alpine Resort Management Boards and private companies) monitor and manage local blooms under their own emergency plans" (DELWP 2019a).	+2	Medium
6.b (Local participation in water management)	**6.5** (Water resources management)	4	Robust	"We're continuing to partner with Coliban Water to review planning schemes and community-driven property planning for on-ground works to protect the key water supply catchment and rivers in the Upper Coliban. These projects are outstanding examples of working with communities and our partners to achieve integrated catchment management outcomes" (DELWP 2019b). "Decisions on water management, planning and policy should be informed	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				and influenced by Barapa Barapa as an equal partner" (DELWP 2019a). "The Aboriginal Waterways Assessment (AWA) is a tool for Aboriginal communities to consistently measure and prioritise river/wetland health so that they are better placed to negotiate for their Country's water needs. The tool is used to capture and record information about the cultural values, uses, and health of waterways and wetlands to assist Aboriginal people to be more meaningfully involved in water planning processes on their Country" (DELWP 2019a). "The Local Management Plan (LMP) recognises and acknowledges that the Traditional Owners have a deep connection to their lands and water. The LMP identifies the need to develop a greater understanding of the cultural objectives and values relating to the water and environment planning" (DELWP 2019a). "The urban water corporations engage in extensive community consultation when preparing their urban water strategies. Water corporations must consult their customers on the agreed levels of service, taking into account customers' ability and preparedness to pay for increased water security" (DELWP 2019a). "Traditional Owner values and uses of water and cultural knowledge are increasingly being recognised in Victoria's water planning and management frameworks, including regional waterway strategies and sustainable water strategies" (DELWP 2019a). "Traditional Owner representation on our Strategic Advisory Committee, which is a partnership between GMW and our stakeholders to shape the future of water delivery in northern Victoria. • Traditional Owner representation in Land and On-Water Management Implementation Committees such as at Kow Swamp. • GMW forming Working Groups to assist in the delivery of Corporate Plan projects. There is opportunity for engagement with Traditional Owners regarding participation in this process" (GMW 2018b). "The community continue to actively participate in natural resource management activities, building its capacity, resilience and support of the region's assets.		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				Increased funding availability and a positive Landcare health score support this" (NCCMA 2018).		
6.b (Local participation in water management)	**6.6** (Water-related ecosystems protection)	3	Robust	"Traditional Owners are increasingly involved in the setting of environmental water objectives through the Victorian environmental water planning process, and through engagement with Victoria's water resource plans, and are expressing a clear desire for stronger involvement in the future" (DELWP 2019a). "Waterwatch is a successful citizen science program bringing water quality messaging and hands-on education to the broader community and school-aged children. In a funding-limited environment, the challenge is how to continue the resource-heavy program to ensure future generations know the importance of river health. Approach: River Detectives is an online-based resource that teaches the teachers how do deliver the core components of Waterwatch, as well as expanding the program to fit in with the school curriculum. For the past two years, the River Detectives pilot program has been run out in four CMA regions, and Melbourne Water. The aim is to make it state wide. Results: Increased student participation with more than 150 schools and groups taking part, including primary and secondary school and community organisations. 273 educators attended 44 professional learning workshops to both develop their skills in sampling, monitoring for water quality, waterbugs, habitat and catchment health, which they went on to share with their students. Key partners: North Central CMA, Corangamite CMA, North East CMA, Wimmera CMA, and Melbourne Water, Waterwatch Victoria, National Waterbug Blitz, The Waterbug Company and Federation University's Centre for eResearch and Digital Innovation."(NCCMA 2018) "Restore native fish populations through the Native Fish Recovery project. Continue sharing ideas, transferring knowledge, and collaborating on initiatives with Dja Dja Wurrung. Improve riparian conditions and management of Birch's Creek and the Upper Coliban waterways using traditional waterway management approaches and strategic partnerships and initiatives through the North Central CMA Priority Waterways project" (NCCMA 2018).	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				"The Goulburn Broken CMA, in partnership with land managers, continues to undertake activities to protect and improve the condition of rivers and wetlands across the catchment. Since 1997, over 1,000 kilometres of fencing has been erected, approximately 24,000 hectares has been treated for weeds along waterways. More recently, the Goulburn Broken CMA has focused on re-snagging waterways to improve instream habitat. Approximately 2,779 instream woody habitat pieces have been added to priority waterways, including the Goulburn River, Broken Creek, Hughes Creek, Holland Creek and Tahbilk Lagoon" (GBCMA 2016a).		
8.9 (Sustainable tourism and promoting local culture)	**8.1** (Economic growth)	3	Robust	"Downstream on the River Murray, recreation and tourism bring in substantial income for the region. The area and its wetlands and national parks attract visitors for water sports, fishing, camping, bushwalking, house boating, historic paddle-steamers, and locally produced wine and food. Recreation and tourism create substantial income for centres like Echuca and Yarrawonga and economic opportunities for smaller communities. Overall, the Murray region attracts more than five million tourists each year. In the Mallee region, significant wetlands like the Hattah-Kulkyne National Park and Lindsay, Mulcra and Walpolla islands in the Murray-Sunset National Park provide recreational and community benefits" (DELWP 2019a). "In the past 10 years tourist visitation to areas within Moira Shire have increased considerably. Tourism is considered to be an important sector to Moira Shire in terms of economic output and job creation" (MSC 2018). "The main town to attract tourists is Yarrawonga and the Sun Country area showed further growth in domestic overnight and day trip visitors, generating more than $322 million into the region in the 2017. The report also stated domestic daytrip visitors spent $81 million in the region with an average of $140 per visitor. Yarrawonga is a well-established tourism location that leverages proximity to the Murray River and Lake Mulwala. Additionally, tourism in Yarrawonga is benefited by its location on the border of Victoria and New South Wales. The recent GMS states that Yarrawonga – with growth in visitation over time having implications for the quality and stock	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				of short-stay accommodation as well as infrastructure supporting access to the water economy in the area. One of the key findings in the GMS was to provide some direction in relation improving community infrastructure and assets to help support future growth of the tourism industry" (MSC 2018). "Lake Mulwala in Yarrawonga proved to be a reliable water body because of its role in the irrigation system. Throughout the drought it provided a positive reminder and economic support to the community through tourism. The lake is 4,450 hectares in size and has a storage capacity of 117,500 mega litres. Lake Mulwala has an attractive foreshore and attracts visitors interested in water sports, walking, outdoor gatherings (such as picnics or barbeques), and fishing. In the future it is considered that there is the opportunity for Yarrawonga and to a lesser extent the other main towns to increase opportunities for tourism to diversify the economy and counter the decline of more traditional industries, in particular agriculture. There are a range of recommendations for assisting Yarrawonga in this transition within the GMS which should be implemented" (MSC 2018). "The natural environment is also integral to tourism, which is the Shire's seventh largest contributor to economic output (Moira Shire Annual Report 2015/16). Many residents and visitors enjoy canoeing, swimming, fishing, camping and bush walking" (MSC 2017).		
8.9 (Sustainable tourism and promoting local culture)	**8.2** (Technology, innovation, and industry)	1	Medium	"Tourism is also an important employer in the region, Major Towns' Strategy Plan Review 2018 representing 569 jobs and 6.2 per cent of the overall employment in Moira Shire" (MSC 2018).	+2	Medium
2.a	**2.4** (Sustainable agriculture)	4	Robust	"Land managers in Northern Victoria's gravity irrigation districts are gaining access to a $2 billion modernised irrigation supply system that will deliver higher service levels for increasing	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
(Rural infrastructure and agricultural research)				the productivity from irrigation. It is important that the maximum benefit is achieved from this investment. The modernisation of the GMW system is well underway and due to be completed in 2018" (NCCMA 2016a) "Land managers will keep increasing their productivity by increasing their enterprise scale and adopting new technologies. This is a challenge given the area of cropped arable land has remained relatively static over past decade indicating that land inputs are finite" (NCCMA 2016a). "This project began in 2016 with limited funding and the group hopes to continue and expand the project with additional funding. The focus is on combining new technologies, and integrated pest and disease management with data the group has already collected to optimise management in different zones within a paddock and on-farm in a practical, more sustainable and profitable way. The project also aims to increase the knowledge of farmers in the Normanville about combining new technologies and using this knowledge to decide if it is practical, profitable and sustainable to change management in different paddocks and zones. For example, optimising inputs and plant growth within paddock zones so fertiliser is not over or under supplied, and management options (e.g. gypsum) for particular paddock zones to reduce and target pesticide use and encourage beneficial insects" (NCCMA 2018). "Each year, $10s m are invested in agricultural research in Victoria. There was seen to be an opportunity to direct some of that toward encouraging more profitable enterprises. Rubicon and Wine Industry Suppliers Australia were two cited examples of how modern technology could make a big contribution to change. Big water users in the region reported that they were able to lease water out when there was an oversupply, and rotate crops from high-value horticulture to other crops such as cotton, depending on the season. Having suitable land and reliable water at low cost were seen as key to future sustainability." (Downie et al. 2019). "A regionally based centre for learning, in relation to agriculture and land management. This centre would provide a local resource to coordinate local research, data, extension, knowledge sharing and adoption. The intent is to work with		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				leading partners to align with existing RD&E and create a culture of learning and success. Activities could include: • Communicating research and knowledge from other parts of region and outside the region. Need broad perspective to drive learning. • On ground experimentation pilots - farm trials. Supports farmer preference for practical demonstrations. • Coordination of regional agriculture and land data in a central place. • Developing water and financial literacy. • RD&E in relation to technology; soil health; crop varieties; regenerative agriculture; water use efficiency; indigenous crops" (RPG 2020). "Smart Farming: In a changing and complex environment, embracing change and complexity is vital. This includes embracing technology change. It increases the resilience of farming enterprises and food manufacturing by enabling them to move up the value chain to higher profitability production. In this intervention, we propose building local capability through connection with leading research and innovation partners. This will include: • Building on findings from the current AgVic On-Farm Internet of Things Trial. • Increasing digital literacy through courses, digital festivals and other initiatives • Trialling low-power wide area networks • Investigation of opportunities to capitalise on existing digital infrastructure in the region. • Investigation of opportunities to utilise robotics and artificial intelligence to enhance agricultural production" (RPG 2020).		
2.b (Agricultural export subsidies and trade restrictions)	**2.3** (Agricultural productivity and income of food producers)	2	Medium	"Additional factors that have affected agricultural markets in the GMID include the floating of the Australian dollar and removal of tariff trade protections on the Australian agricultural sector from the 1970s through to the 1990s, along with the rise of global competitor food export economies enabled by these reforms" (Downie et al. 2019). "Investing in exporting	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				links between Goulburn and Asia exploits growth in the Asian region for high demand product such as fresh fruit. Strong long-term demand prospects • There are low to no tariff barriers on fresh fruit and vegetables to most key Asian markets. • By value, Victorian fruit exports have more than doubled over the last four years. Goulburn produces half of Victoria's fruit" (DEDJTR 2018).		
15.1 (Conservation and sustainable use of freshwater ecosystems)	**15.5** (Biodiversity and natural habitats degradation)	4	Medium	"The Central Murray wetlands are located in the vicinity of Barmah and Gunbower Forests. There are several internationally-recognised Ramsar-listed wetlands within the system including Lake Cullen, Hird Swamp and Johnson Swamp, while many of the others are of regional significance. These are part of the Kerang wetlands Ramsar site. Species including the Murray hardyhead, the Australian painted snipe and the growling grass frog. The wetlands provide habitat for many threatened bird species listed under legislation and international agreements, including the great egret and white-bellied sea eagle" (DELWP 2019a). "Gaining reaches are places along the river where groundwater flows into the stream channel. Conserving freshwater gaining reaches may provide many benefits for biodiversity because groundwater can be a more reliable source of high quality water independent of yearly variability. Actions include establishing conservation zones, riparian restoration and the prevention of excessive groundwater abstraction. Conservation of gaining reaches The protection of gaining river reaches may be important in the GB CMA where a number of drought refuges for native fish were identified in the catchment (Thomson & Bond, 2011). The CMA is currently engaged in identifying refugia under climate scenarios, doing demonstration and rehabilitation reach projects, as well as monitoring species condition and health. The River Strategy aims to enhance aquatic refugia by establishing protection zones in the Eurora Strathbogie, mid Goulburn, Acheron, Rubicon and Taggerty rivers (Goulburn Broken CMA,	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				2005). During the drought, actions to protect fish refugia included increased monitoring (of salinity and dissolved oxygen levels) and prioritising refugias for riparian fencing incentives. If monitoring indicated that key environmental thresholds were crossed, environmental water was released. This situation did arise in 2009; however no environmental water was available at the time (DSE Respondent)" (Lukasiewicz et al. 2012). "Riparian vegetation increases freshwater habitat quality (providing food, shelter and nutrients to native fauna) and can decrease water temperatures raised through climate change. It may also increase the health of riparian ecosystems and their resilience to extreme events like floods and droughts. Actions to restore riparian vegetation include: planting riparian flora, fencing off riparian zones, ongoing weed control in riparian zones and the provision of off-river watering points for domestic stock" (Lukasiewicz et al. 2012). "**Freshwater habitat connectivity:** This option focuses specifically on the provision of in-stream connectivity. It involves the provision of fishways and fish ladders, the removal of redundant in-stream barriers (such as weirs and road crossings) and the re-connection of wetlands to rivers. These changes enable fish to migrate to more favourable habitats when extant conditions become unfavourable. Freshwater habitat connectivity The Goulburn Broken CMA aims to enhance floodplain-to-river linkages over 30 km of stream in the Lower Goulburn River and the Lower Goulburn Floodplain. This is to be achieved through the implementation of the Lower Goulburn Floodplain Management Plan. The CMA is also working on removing barriers to fish movements; however the Goulburn Broken has already benefitted from extensive fish programs in the past that focused on removing barriers and providing fish ladders (DSE Respondent). The Winton Wetlands project, through restoring a wetland of significant size, provides 'biolinks' to the rest of the catchment (Winton Wetlands Respondent), establishing important biodiversity connections for terrestrial and aquatic habitats (DSE Respondent)" (Lukasiewicz et al. 2012). "Many threatened plant and animal species have been recorded in		

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				the region, including species protected under State and Commonwealth legislation. Significant species include: • Superb Parrot – Nationally listed and Moira has the only breeding population in Victoria; • Grey-crowned Babbler – State listed and Moira has the third most significant habitat in Victoria; • Bush Stone Curlew, Tree Goanna and Yarran Wattle – State listed; • Water Milfoil – Largest Victorian population, recorded at Kinnairds Wetland in Moira Shire; • Trout Cod – critically endangered, Murray River provides habitat for a significant population; and • Murray Cod and Golden Perch" (MSC 2017). "Contribute towards Goulburn Broken Catchment Biodiversity Strategy targets: 1. Increase the extent of native vegetation in fragmented landscapes by 70,000ha by 2030. 2. Improve the quality of 90% of existing habitat by 10% by 2030. 3. Increase the population viability of 20 flagship species by 2030." (MSC 2017). "• Strategic revegetation and native vegetation protection programs to identify and build the size and connectivity of key native vegetation remnants, for example, along roads and waterways to nearby public land forest areas and strengthen water quality protection • Strengthen native vegetation retention controls and planning to protect resilience features of high value remnant native vegetation patches and drought refugia • Modify land use planning in flood zones to reflect projected changes in flood depth and extent with climate change" (GBCMA 2016b).		
15.2 (Forest sustainable management)	**15.3** (Restore degraded land and soil)	3	Robust	"Reduction in area of plantations is likely to increase recharge and runoff. Establishment of new commercial plantations could decrease runoff or recharge" (DELWP 2019a). "When the water table rises into the root zone of the plants because of agriculture, waterlogging can be a problem, and salt tends to concentrate in the upper soil layers as transpiration and surface evaporation drive the capillary rise of water from the water table. Planting large numbers of trees in areas with waterlogging and salinity problems has been proposed as a means of achieving a similar level of `drainage' (Schofield et al., 1989; Heislers and Parsons, 1994). The	+2	High

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				trees are thought of as acting like pumps, lowering the water table by virtue of their deep rooting capability, and creating small underground `sinks' into which water from surroundings areas can drain. An essential aim of the integration of plantations and farming is to optimise management of the farming activities and any commercial return from the plantation, while maximising environmental benefits: maintaining a lower water table and creating a deeper zone of salt accumulation" (Silberstein et al. 1999). Guttrum-Benwell Forest Sustainable Diversion Limit Offset: “Mimic a natural flooding regime to the forest, particularly to address the reduced frequency and duration of floods by delivering water to the forest and semi-permanent wetlands via inlets and levees to contain water on the floodplain…The project successfully delivered preliminary investigations on flora and fauna values and cultural heritage in the proposed construction footprints; undertaken a variety of feature and topographical survey to inform concept designs and hydraulic modelling; and geotechnical investigations for borrow pits are awaiting planning permit approval. Actively engaged with adjacent landholders, a wide variety of local community, key stakeholders and Traditional Owners to increase their input and involvement” (NCCMA 2018).		
15.2 (Forest sustainable management)	**15.5** (Biodiversity and natural habitats degradation)	2	Robust	"The Barmah Forest, along with the Millewa Forest across the river in New South Wales, is the largest river red gum forest in Australia and the most intact freshwater floodplain system along the River Murray. The forest is a major feeding and breeding site for waterbirds including egrets, spoonbills, ibis, bitterns and night herons, as well as for significant frog and turtle populations. A large diversity of significant fish species inhabit the forest wetlands and creeks including Murray-Darling rainbowfish, freshwater catfish, golden perch, flat-headed galaxias, Macquarie perch, Murray cod and silver perch. The forest also supports a broad range of floodplain vegetation including river red gum forest and woodland and the threatened Moira grass plains" (DELWP 2019a). The Gunbower Forest Key Asset Protection	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				project: “Address the critical threats impacting on the forest’s ability to support and maintain its ecological character, particularly relating to native habitat and vegetation condition and pest animal control within the forested environment and areas that adjoin the forest ...The project was finalised with over 4,000 hectares of targeted fox control. This led to a 65-70 per cent reduction in raided turtle nests (in areas baited). Additional weed control, fencing and revegetation helped improve Ramsar values.” (NCCMA 2018). “Gunbower National Park Sustainable Diversion Limit Offset: Enable the delivery of environmental water to the wetlands and forest of the Gunbower National Park to mimic a natural flood event, including the delivery of water to almost half of the permanent and temporary wetlands and river red gums with flood dependent understorey. Enhance infrastructure and channels to enable the provision of water to land that can currently not be watered by any other infrastructure…The project successfully delivered supporting investigations critical to inform decisions around the new concept designs including: cultural heritage site locations, threatened flora and fauna, and large old trees; topographical survey has been completed to inform decisions around optimal siting of infrastructure. Actively engaged with adjacent landholders, a wide variety of local community, key stakeholders and Traditional Owners to increase their input and involvement.”(NCCMA 2018).		
15.3 (Restore degraded land and soil)	**15.1** (Conservation and sustainable use of freshwater ecosystems) and **15.5**	3	Robust	"Earth resource development was found to be a cause of risk in the Northern Victoria surface water resource plan area. This risk was associated with sand and gravel extractions from the floodplain of the mid Goulburn River (groundwater)" (DELWP 2019a). "Urbanisation increases impermeable areas and increases runoff. Conversion from deep-rooted native perennial pasture to shallow-rooted annual crops is likely to increase recharge and runoff (Shift from grazing enterprises to cropping enterprises). Continuing higher density urbanisation around regional centres such as Bendigo and Shepparton will increase runoff and decrease	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
	(Biodiversity and natural habitats degradation)			groundwater recharge, although the impact is unlikely to be significant because the areas involved are expected to be relatively small" (DELWP 2019a). "Growth in number of runoff dams could decrease runoff or recharge. The runoff dams are the primary source of domestic and stock water in the unregulated parts of Victoria's North and Murray water resource plan area" (DELWP 2019a). "Geomorphic restoration involves improving the stream substrate to retain and enhance the various niches that particular aquatic biota requires to thrive. For instance, deep pools in the stream bed may provide drought refuge for fish under climate variability and change but are at risk of sedimentation. Actions include conserving deep pools, controlling bank instability and erosion, stabilising or removing sand slugs and re-snagging. Geomorphic restoration will improve in-stream habitat for freshwater biodiversity and therefore increase species resilience. Geomorphic restoration The Goulburn Broken CMA engages in habitat enhancement to counteract the threats of losing in-stream habitat, bank erosion, bed instability, channel modification, and turbidity. While it is a common activity for the CMA, it attracts less investment because activities are region-specific. For example, sandslug removal is common in the south-west but Gippsland sees more wood re-instatement (DSE Respondent). Actions undertaken by the CMA include stabilising in-stream and near-stream erosion in the Goulburn system, enhancing aquatic refugia and protecting in-stream habitats and assessing channel modification in the Broken system. A state-wide annual stream monitoring program indicates that fish utilise snags almost immediately after they are put back in the water but whether this increases the overall fish population in the area is as yet unclear. For example the 2010 flooding caused many trees to fall in the Broken River and within weeks, fish were using them as habitat 'while this is positive, these fish moved from other areas into new snags so the question is whether population is increasing or being moved around' (CMA Respondent 4)" (Lukasiewicz et al. 2012). "The Wunghnu-Numurkah complex fires in 2014 burnt approximately 10,000 hectares, causing significant native vegetation loss,		

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				due to the fires themselves and afterwards when trees considered to be dangerous were removed. It was estimated that over 2,000 mature native trees were destroyed and many remnant patches were substantially damaged. This is significant in a landscape where remnant vegetation is already scarce. Fires are a natural occurrence, however management to minimise the impact on the natural environment, especially during clean-up operations, is critical." (MSC 2017).		
15.8 (Invasive alien species)	**15.5** (Biodiversity and natural habitats degradation)	3	Robust	"Invasive species compete with, displace, damage or prey on native flora and fauna, reducing population and affecting recruitment. Climate change may enable the introduction of new invasive species" (GBCMA 2016b). "One example of a species with a major influential ecological role on the Barmah floodplain is River Red Gum, Eucalyptus camaldulensis. It is widespread and influences other species through space occupancy, shading and litter fall. Giant Rush Juncus ingens, is another example as it is an invasive, species and also a nesting habitat for birds" (Abel et al. 2006). "Preventing the introduction of exotic species, identifying and eradicating incursions and sleeper species (species that may become a greater threat in the future), preventing the spread and containing species that are beyond eradication are all interventions for controlling invasive plants and animals. Control of exotic species will decrease the vulnerability of native flora and fauna to the climate induced spread of invasive species. Actions include identification and eradication of newly observed invasive species, controlling vectors like the aquarium and nursery trades, weeding, the removal of exotic trees from river banks, fencing and installing carp cages in streams. Management of exotic species The Goulburn Broken CMA is engaged in programs to manage exotic vegetation and revegetate with native species around streams in the Goulburn system. Willow removal and replacement with native vegetation is a significant and ongoing management activity (CMA Respondent 3). Willows were originally introduced into the catchment to manage erosion but	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				actually ended up contributing to it because they have a big root ball which grows up into the river bed, protrudes from the bank and then pushes water to the other side of the river; 'next thing you've got erosion problems on the other side of the river' (CMA Respondent 4). In some places, willow removal is followed by the introduction of native poa grass that stabilises the bank and, in time provides fodder for stock (CMA Respondent 3)" (Lukasiewicz et al. 2012).		
15.8 (Invasive alien species)	**15.2** (Forest sustainable management)	1	Medium	"Foxes and feral cats kill native species that keep the forest system healthy, such as Bandicoots that spread fungus, vital for maintaining soil structure" (GBCMA 2013).	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
15.8 (Invasive alien species)	**15.1** (Conservation and sustainable use of freshwater ecosystems)	2	Medium	"Invasive species in waterways and along riparian land are an increasing threat to the health of rivers, estuaries and wetlands in Victoria. Invasive species affect waterway conditions and have the potential to threaten environmental, social, cultural and economic values. Environmental impacts may include predation on, or competition with, native species and loss of habitat" (DELWP 2019b). “Interviews and workshop discussions revealed that carp management is not prioritised in the catchment because of a belief that, due to the interconnectedness of the freshwater 18 systems, carp management is a futile activity; ‘no one knows how to deal with the problem . . . Get rid of them on one area, flood comes in and then carp everywhere’ (CMA Respondent 3). The CMA has considered the installation of carp cages but this has not been pursued because the Goulburn Broken as an aquatic system is so inter-connected (CMA Respondent 4). The drought acted as a natural control for the carp population but the floods have caused an explosion in carp numbers. The decline in water quality and native species associated with carp activity has been observed by some landholders in the Broken Creek (CMA Respondent 3). Other pests in riparian environments include rabbits and, surprisingly, wombats. Both species have been reported to cause bank erosion through burrowing. Rabbits can be shot as standard pest management but wombats are a native species and as such require permission to be sought from the relevant government department (CMA Respondent 3)”(Lukasiewicz et al. 2012).	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
15.2 (Forest sustainable management)	**8.9** (Sustainable tourism and promoting local culture)	1	Medium	"Approximately 100,000 visitor days per year are reported for Barmah Forest and a high proportion are involved in non-market tourism and recreation. Rivers, lakes & billabongs swamps and marshes are important for boating & fishing, bait collection, picnicking, canoeing and duck hunting. Rush beds, open grassland plains, Red Gum forest, Blackbox woodland, Grey and Yellow Box woodland are important for scenic driving, 4WD driving, trail bike riding, cycling, horse riding, bushwalking, orienteering, picnicking, camping, hunting feral animals, bird-watching and nature study" (Abel et al. 2006).	+1	Medium
8.1 (Economic growth)	**15.1** (Conservation and sustainable use of freshwater ecosystems)	1	Medium	"The development, operation, closure and legacy of earth resource activities such as mining, quarrying, oil and capture and storage, geothermal and pipelines that intersect aquifers/ aquitards and/or are near waterways pose hazards to surface and groundwater availability and condition, including structural damage to aquifers. Mining (and aquifer dewatering) in the Bendigo region, and legacy issues (such as mercury and arsenic contamination) in the Upper Goulburn, Bendigo, and other historic mining areas. Ongoing gold mining with tailing storage facilitates. Quarrying – 20 percent expansion of existing floodplain based sand and gravel extractions (particularly in the upper Goulburn River floodplain) with onsite disposal dams" (DELWP 2019b).	-2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
8.1 (Economic growth)	**15.2** (Forest sustainable management)	1	Medium	"The Mid Murray Forest Management Area, within which Barmah Forest lies, produces about 80% of Victoria's red gum timber in 2000/01 (DNRE 2002). This was harvested from Barmah Forest from within the area designated as State Forest, plus some from Barmah State Park (The licence for harvesting in Barmah State park expired in 2003 (Murray Thorson, Forester in charge Cohuna DSE). The volume of red gum from Barmah Forest was 44% of the volume from the Mid Murray Forest Management Area in 2000/2001, and 0.4% of the volume of Victoria's hardwood production in 2000/01 (DNRE Annual Report 2000/01). The revenue from forest products from Barmah Forest in 2000/2001 was about $232,000, or about 0.3% of the Victorian revenue from forest products ($78,335,000 in 1999/2000, DNRE 2001)" (Abel et al. 2006)	-2	Medium
2.3 (Agricultural productivity and income of food producers)	**15.1** (Conservation and sustainable use of freshwater ecosystems) and **15.2** (Forest sustainable management) and **8.4** (Resource efficiency and decoupling economic growth from environmental degradation)	4	Robust	"The environmental issues associated with this industry (horticulture) include potential spray drift, noise (scare guns), and subsurface drainage disposal, which may impact on the aquatic ecology of drainage basins" (NCCMA 2016a)· "The effect of grazing is best understood and has been most intensively studied, where pastoralism is the dominant or significant land use, such as the rangelands of the semi-arid and arid zones, followed by grassy woodlands in the temperate zone and tropics. The number of studies of grazing in wetlands and floodplains is much fewer and cover three areas: impact studies done in the field, manipulative experiments to determine specific effects, and gradient studies linking grazing with impact. Three examples are presented here, all relevant to the Barmah Forest…• Riparian River Red Gum woodland: In the riparian zone of the Murrumbidgee River, the differences between grazed and currently ungrazed (i.e. grazing has ceased) sites in River Red Gum woodland included a range of effects which when combined, pointed to reduced riparian functioning (Robertson and Rowling 2000). Ungrazed sites were characterised by higher biomass of ground cover, much greater densities of saplings and seedlings of the dominant tree species and much greater abundance	-2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				of litter and organic material on the ground. Arising from this, RARC (rapid appraisal of riparian condition) was developed and successfully calibrated with stocking density (Jansen et al., 2005). The negative effect of stock and stocking history on native fauna such as woodland birds and frogs was determined using RARC and a measure of wetland condition (Jansen and Healey 2003). Effects of grazing may not be easily reversed (Jansen and Robertson, in press). What emerges indirectly from the first two examples is the importance of surface water and hence water regime, i.e. whether surface water is present or not and for how long etc, in determining patterns of stock impact on floodplains. The third example emphasises that although the primary effect of grazing is on vegetation structure, the consequences of this are reduced habitat quality for some species, and reduced functioning, and that these effects are carried forward in time" (Abel et al. 2006). "Vegetation clearing during the past 150 years has contributed to a substantial dryland salinity problem as well as leaving a number of ecological vegetation classes at well below sustainable levels for maintaining ecosystem heath and biodiversity (NCCMA 2003). Loss of biodiversity is seen as the cause of many of regions natural resource management problems, reducing landscape resilience and capacity for regeneration" (Jones et al. 2007).		
2.3 (Agricultural productivity and income of food producers)	**15.3** (Restore degraded land and soil)	6	Robust	"… soil fertility is decreasing due to a number of factors including acidification, leaching, overuse of fertilisers, salinity, loss of biodiversity, overstocking and grazing pressure and generally unsustainable farming practices (Colloff, M in Binning et al 2001)"(GBCMA 2017). "After 150 years of traditional agriculture, the soils of north central and northern Victoria are depleted in soil structure and this is impacting on the health of the resource. Salinity, wind and water erosion, compaction, and a host of other issues contribute to poor soil health and, in turn, reduces the productive capacity of the land and alters its hydrology. The situation is typically exacerbated by the inherent properties of soil landscapes including dispersion driven	-2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				by a sodic predisposition”(NCCMA 2018). “Goulburn region has a higher risk of erosion from bare soils in dryland areas than other parts of Victoria. Sheet, gulley and tunnel erosion on farmland is a threat to soil health. While soil health is satisfactory and on a stable trend, salinity is an issue in dryland and irrigation areas" (Aither 2019). "The region has a higher risk of erosion from bare soils in dryland areas than other parts of Victoria. Sheet, gulley and tunnel erosion on farmland is a threat to soil health. While soil health is satisfactory and on a stable trend, salinity is an issue in dryland and irrigation areas" (Aither 2019). "The Goulburn region has agriculturally productive soils that support both dryland and irrigated agriculture. The Goulburn Broken region has had a slightly elevated risk of erosion from bare soils in dryland production areas since 2011" (Aither 2019). "The knowledge of the extent and severity of salinity are poor in Victoria (CES 2013). However generally speaking, salinity is an issue in the Goulburn region due to the widespread conversion of native vegetation land to agricultural land and a shallow water table (Goulburn Broken CMA 2017a). Salinity can be an issue in both dryland and irrigated areas due to changes in hydrology as a result of land use change. The spread of dryland salinity in Victoria slowed or receded in many areas during the dry period (known as the Millennium Drought) due to lower groundwater tables however, the area impacted by salinity is likely to increase with a return of wetter conditions" (Aither 2019). "Overgrazing – intensive grazing of pasture for extended periods or insufficient recovery time resulting in insufficient ground cover (dairy)" (NCCMA 2016a). “Legacy and ongoing effect of cropping and grazing on various measures of soil and land health. Improved practice in recent years is likely to reduce negative influence on condition rather than improve it (overall). Intensification of drought and extreme rainfall with climate change is likely to exacerbate influence on land condition” (GBCMA 2016b).		
2.3	**15.5**	6	Robust		-2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
(Agricultural productivity and income of food producers)	(Biodiversity and natural habitats degradation)			“North central Victoria is home to scattered areas of high biodiversity value (source: NaturePrint V3). While most of the high value areas are captured in existing parks and reserves, narrow bands along major streams illustrate the importance of riparian zones for the protection of biodiversity across the region. There is a relatively steady long-term incremental decline in areas affected by land clearing, livestock grazing, inappropriate land uses, invasive pest species and predicted increases in climate variability (North Central Regional Catchment Strategy 2013-2019.”(NCCMA 2018). "Areas of high biodiversity conservation value were concentrated in less modified land-cover types. Substantially modified land-cover types (generally associated with agriculture and irrigated pastures) had lower habitat quality and biodiversity value" (Baral et al. 2014). "The Shepparton regional hub is the largest population centre in the Goulburn Region. A network of smaller towns surrounds the conglomeration of Shepparton-Mooroopna. More highly populated areas are clustered around the Hume Freeway south towards Melbourne. The landscape surrounding the Shepparton regional hub is highly altered as a result of clearing of native vegetation on private land for urban and agricultural use. Land use is heavily focused towards agriculture with 94 per cent of land designated for this use. Irrigated infrastructure supports important dairy and horticulture industries and associated food processing. Dryland agriculture is also important" (Aither 2019). "Much of the influence on condition is from historical activity, although, extension of cultivation to new areas (with changing technology and economics) and ongoing grazing is affecting native vegetation remnants in rural areas. No direct modification of influence on condition with climate change" (GBCMA 2016b). “The North Central CMA region is one of Australia’s most highly cleared and fragmented landscapes and while development has resulted in a productive and vibrant regional economy it is now crucial to protect and rebuild biodiversity assets for the future (North Central Regional Catchment Strategy 2013-19). The region’s eight bioregions are affected with three bioregions at less than 10 per cent		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				of cover pre-European extent (Murray Mallee, Wimmera and Victorian Riverina). The Murray Fans bioregion has 20 per cent cover compared to pre-European vegetation, while the remaining three bioregions (Central Victorian Uplands, Goldfields and Northern Inland Slopes) have between 20—30 per cent of pre-European cover."(NCCMA 2018). "Historical clearing and current farming practices have impacted the vegetation cover with approximately 15 per cent of cover remaining across the North Central CMA region, making it one of the most cleared regions in the country."(NCCMA 2018). "Most species of Australian waterbirds seem to have been adversely impacted by land use changes, water abstraction and river regulation in south-eastern Australia including the MDB (e.g. Kingsford 1999, 2000, 2004)" (Abel et al. 2006). "The area has been subject to extensive vegetation clearing for agriculture and pastoral production, with native vegetation now highly fragmented and often degraded (NCCMA, 2005). Since European settlement in the mid 1800s, an estimated 70% of native vegetation (18,300 ha) has been cleared. Associated effects of this clearing include widespread declines in biodiversity, increased soil and stream salinity and soil erosion (NCCMA, 2011). Each of these land management problems is of national importance (Steffen et al., 2009) and for this reason this study area is reflective of the challenges affecting many parts ofthe region. Major land use-land cover types and the proportion of the area occupied by each land use in Reedy Lakes and Winlaton include: (i) irrigated farming, 28%; (ii) dryland cropping, 26%; (iii) native vegetation, 23%; (iv) degraded land undergoing rehabilitation, 10%; (v) water, 10%; and (vi) other, 3%" (Baral et al. 2014).		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
2.4 (Sustainable agriculture)	**15.1** (Conservation and sustainable use of freshwater ecosystems) and **15.2** (Forest sustainable management)	2	Robust	"Protecting Remnant Grassy Ecosystems on the Riverine plains: Improve the condition of grasslands, grassy woodlands and seasonally herbaceous wetlands in the lower Loddon and Avoca catchments. Directly engage with Traditional Owners and improve community awareness and increase the knowledge and attitudes of key private land managers…The project was finalised with over 450 hectares of high quality plains-wanderer habitat covenanted (permanently included in the National Reserve estate). Managed grazing ensures habitat is suitable for plains-wanderers. Supporting weeds control, fox control and revegetation activities were also undertaken across this area" (NCCMA 2018). "A catchment recognised locally, nationally and internationally for quality agricultural produce and where community values contribute to the benefits of abundant and well maintained environmental assets used for tourism and recreational activities. The environmental footprint of irrigation and dryland farming will be significantly reduced, with farmers occupying less land and using less water whilst managing their resources more sustainably. New opportunities will arise for increasing the ecosystem services provided by the land retired from agriculture and by improved environmental flows. The region's economy will be robust, with much of the agricultural produce processed within the region, generating employment and wealth creation opportunities for a regional community actively engaging in natural resource management programs" (Walker et al. 2009).	+2	High

2.4 (Sustainable agriculture)	**15.3** (Restore degraded land and soil)	1	Medium	"Farming for Sustainable Soils - Phase 2: A community-based approach to land protection and soil conservation to improve the soil health of the region by establishing soil health groups and, in partnership, develop a plan to address the primary soil health issues…The project delivered nearly 2,000 hectares of practice change and involved 643 participants from over 150 enterprises in improving skills and knowledge in soil management and sustainable agricultural practices." (NCCMA 2018). "Case study Farming for Sustainable Soils Challenge: After 150 years of traditional agriculture, the soils of north central and northern Victoria are depleted in soil structure and this is impacting on the health of the resource. Salinity, wind and water erosion, compaction, and a host of other issues contribute to poor soil health and, in turn, reduces the productive capacity of the land and alters its hydrology. The situation is typically exacerbated by the inherent properties of soil landscapes including dispersion driven by a sodic predisposition. Approach: From the outset the approach of Farming for Sustainable Soils recognised that the best opportunity to improve the soils of the region was to work with farming communities to have them assume the responsibility for the condition of the soils in their area. Accordingly, the approach adopted was community based. Farming communities in priority areas came together to build soil health programs suited to local conditions and local circumstances. In a partnership with the CMA, each group employed a part-time community facilitator to identify and implement an action plan targeted at addressing the local community's soil health issues. Results: Over nine years, 14 FSS groups formed comprising more than 400 farmers. Through extensive soil sampling, laboratory analyses and field assessments each community came to understand the condition of the soils of their area (around 400 square kilometres). Each group understood the issues that they confronted, and each of them engaged in building their knowledge base through workshops with expert scientists brought in from around the nation. They used the information and knowledge to establish trials of promising practices in their quest for more sustainable land management. Each of these groups now forms a nucleus for land management change. Between January 2015 and June 2018, the project delivered 722 hectares of soil treatment, 3,202 hectares of agricultural practice change, nine soil health plans and engaged 1,268 participants in engagement events. Key partners: The partnership between the North Central CMA and the groups is substantive, as is the intra-group partnerships that have formed within the participating farming communities. In most areas Landcare has also been a significant partner, commonly acting as	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				the legal entity and banker for FSS groups. Numerous industry partnerships have included Agriculture Victoria, farm advisory providers and suppliers such as Elders and Landmark and many others" (NCCMA 2018).		
2.c (Control food markets and prices)	**15.2** (Forest sustainable management)	0	Limited	Easy access to markets can lead to the development of agricultural areas and agricultural productivity, but this may lead to deforestation too.	-1	Medium
15.8 (Invasive alien species)	**2.3** (Agricultural productivity and income of food producers)	2	Medium	"Invasive species occur as a result of human activities and beyond their natural range, threatening valued environmental, agricultural or other social resources by the damage they cause. Such species can include organisms endemic to a country other than Australia, or translocated native species" (DELWP 2019b). "Pest plants and animals are a serious problem in the Shire as they can impact on biodiversity and **agricultural production**. Landowners are responsible for the management of pest plants and animals on their properties. They have a legal responsibility under Section 20 of the Catchment and Land Protection Act 1994 (CaLP Act) to take all reasonable steps to eradicate regionally prohibited weeds, prevent the growth and spread of regionally controlled weeds, and prevent the spread of, and, as far as possible, eradicate, established pest animals." (MSC 2017).	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
15.3 (Restore degraded land and soil) and **15.5** (Biodiversity and natural habitats degradation) and **15.8** (Invasive alien species)	**2.3** (Agricultural productivity and income of food producers)	2	Robust	"Invasive species reduce agricultural productivity and, in some cases, expose soils to erosion (e.g. cape weed on ridges)" (GBCMA 2016b). "Past clearing of native vegetation has caused saline water tables to rise, threatening crop production. Groundwater pumping is necessary but leads to discharging salt into the Murray River at levels that can be unacceptable to downstream users. The recent drought has reduced the immediate threat of rising water tables, but resulted in insufficient water for irrigation. Climate change threatens the future viability of irrigation. ● Water storage, together with unseasonal releases of water for irrigation, is degrading the ecological functions of river channels, floodplains, and wetlands, and reducing their values to humans. ● Application of nitrogenous fertilizer and leguminous plants are lowering soil pH to the extent that soil health is declining in some areas. ● Native dryland vegetation is sparse, fragmented, and in poor condition, and many native species are threatened. ● Energy costs are an important driver in the system. If carbon emissions are capped or taxed, the intensive agricultural sectors may become economically unviable. Similarly, salinity outputs from the region to the Murray River are already capped, but salinity control through pumping into evaporation basins is also energy intensive" (Walker et al. 2009).	+1	Medium
15.3 (Restore degraded land and soil)	**2.4** (Sustainable agriculture)	1	Medium	"Government, conservation and community groups in north central Victoria are working together to protect the region's significant natural capital while also maintaining long-term agricultural productivity, access and opportunities for recreation and protection of important cultural values. Managing and improving soil health on private land is a key focus for enabling sustainable agriculture."(NCCMA 2018)	+1	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
13.1 (Strengthen climate change resilience and adaptive capacity)	**15.3** (Restore degraded land and soil)	4	Robust	"It is expected that the impact from climate change will see an increase in the number of bush fires across the region. Bushfire-impacted areas will lead to increases in rainfall runoff because of the effect of heat on the soil and removal of vegetation. Such impact will be dramatic in terms of increased magnitudes of runoff" (GBCMA 2018). "Climate change can have a significant impact on soils and the functions that soil performs… Increasing damage to the land (land degradation) may occur in the form of soil erosion, desertification, salinisation, or loss of peat soils, further impacting on the capability of soils to support the needs of agriculture"(NCCMA 2016b). "Although our weather has always been highly variable, our climate is changing due to human induced impacts and our weather is predicted to include more extreme events. In the last decade, the challenges of climate extremes have been evident in Moira through drought (including times of reduced availability of irrigation water), floods, fires and storms. Predictions are that extreme events will become more frequent, temperatures will continue to increase and rainfall decrease. This will present a number of challenges for Council, businesses and the general community, so it is critical we take action now. We have already made significant progress in reducing Council's greenhouse gas emissions, with the implementation of the Watts Working Better street lighting project and Kerbside Organics Service, which together have reduced annual emissions by approximately 1,575 tonnes CO2 E (see Appendix 4 for further details of these projects). However, there is a lot more we can do to reduce our emissions and build resilience to assist Council and the community in dealing with a changed climate." (MSC 2017). "Decreasing greenhouse gas emissions benefits our natural environment as well as having financial benefits; • Australian Government signed the Paris Agreement at United Nations Framework Convention on Climate Change, which aims to limit an increase in global temperatures to "well below" 2o C (aspirational goal of 1.5o C); and • Victorian Government targets: – Net Zero Greenhouse Gas Emissions by 2050 – 25% of electricity from renewables by 2020 and 40% by 2025."(MSC 2017)	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
13.1 (Strengthen climate change resilience and adaptive capacity)	**15.5** (Biodiversity and natural habitats degradation)	3	Robust	"Key pressure on terrestrial ecosystems in forest and alpine areas (trend for excessive frequency) and rural land (trend for insufficient fire). Severe fire weather to increase with climate change, placing (especially) biodiversity in fire-sensitive systems in public land areas at risk" (GBCMA 2016b). "Increasing resilience to climatic shocks/changes • Conserves or enables access to future habitat • Extends habitat connectivity and migration paths for biota"(Lukasiewicz et al. 2012). "Reduced water availability and increased temperature will drive how biodiversity responds to climate change. Climate change is anticipated to exacerbate existing pressures on biodiversity, primarily relating to habitat loss, resulting in flora and fauna being unable to move through fragmented landscapes, increasing the risk of extinction through elevated inbreeding and subsequent loss of subpopulations. Predicting how populations, species and communities will respond is challenging because each is likely to be different. Almost all biodiversity will be affected by climate change, with alpine, terrestrial and freshwater ecosystems likely to be the most vulnerable" (GBCMA 2016a).	+2	Medium
13.2 (Climate change adaptation policies and strategies)	**15.1** (Conservation and sustainable use of freshwater ecosystems)	1	Medium	"The dry conditions have created concern about river health and ongoing water supplies leading successive Australian governments to introduce measures to restructure water use and increase water available to the environment" (Alston et al. 2018).	+2	Medium
13.2 (Climate change adaptation policies and strategies)	**15.2** (Forest sustainable management)	1	Medium	"Future changes in State and Commonwealth policy and legislation about carbon sequestration may see an increase in plantation area" (DELWP 2019a).	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
2.4 (Sustainable agriculture)	**13.1** (Strengthen climate change resilience and adaptive capacity)	1	Medium	"Goulburn Murray regional hub in the One Basin CRC The ONE Basin CRC is a University of Melbourne and University Southern Queensland proposal. The purpose of this new CRC is to deliver valued and trusted advice for the agri-sector, leaders, communities and environmental managers in the Murray Darling Basin. The CRC proposes to develop policy, technical and financial solutions that support Basin communities, businesses and governments to understand and reduce their exposure to climate, water and environmental threats. A Goulburn Murray regional hub would support two-way learning between researchers and our region about water challenges and opportunities of relevance to us and the wider basin" (RPG 2020). Sustainable agricultural activities are very effective in climate adaptation and mitigation.	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
2.a (Rural infrastructure and agricultural research)	**13.1** (Strengthen climate change resilience and adaptive capacity) and **13.2** (Climate change adaptation policies and strategies) and **13.3** (Climate change education)	1	Medium	"A pilot biogas system will be constructed within the Goulburn Murray region to demonstrate their potential to local farmers. Methane from effluent/manure can be captured from lagoons/ponds through biological or thermochemical processes to produce energy. Other benefits include reduced odour and Greenhouse gas emissions, and improved fertiliser value of solids by-products. To make systems viable, farms need to be of sufficient scale or potentially work together in clusters. They also need to incorporate use of feedpads or barn style housing to ensure sufficient solids production and capture" (RPG 2020). "Coordinated research into key areas of change in the Goulburn Murray region can support local adoption of innovations that strengthen resilience. This intervention could be realised through a formal body, such as the One Basin CRC (B2), or the Goulburn Murray learning hub (B1), or individuals or organisations could band together to do research and share results. Research topics could include: • Circular economy opportunities and barriers in the region. • Climate risk analysis of major food value chains and identification of business opportunities • The practical applicability of climate smart agriculture technologies in the Goulburn Murray region • Social research into regional and local barriers to adoption of innovation. • The effects of various technologies on water use efficiency" (RPG 2020).	+2	Medium
2.3 (Agricultural productivity and income of food producers)	**13.1** (Strengthen climate change resilience and adaptive capacity)	3	Robust	"Agriculture is one of the largest sources of greenhouse gases within the region and is also expected to be affected by climate change, largely through increased temperatures, increased atmospheric CO2 and reduced rainfall. The mitigative capacity of the regional agriculture and agricultural soils is unexplored but may be substantial when compared to emissions" (Jones et al. 2007). "regulation of climate" — Specific issues concern greenhouse gas emissions. Animals within the Goulburn Broken Catchment produce methane emissions equivalent to	-2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				about 1480kt CO2 year, an additional 340kt CO2 per year is generated from the pasture and is exacerbated by nitrogen fertilisation, water logging and legume pastures. Animal waste contributes to nitrous oxide emissions equivalent to approximately 160kt CO2 per year" (CSIRO 2003). "Human activity is causing climate change, through our release of greenhouse gases from the burning of fossil fuels, land use change and agriculture. Atmospheric concentrations of carbon dioxide are now more than 40% higher than they were before industrialisation. The Goulburn Murray region has been getting warmer and drier. The region can expect temperatures to continue to increase year round; more hot days and warm spells; fewer frosts; less rainfall in autumn, winter and spring; and more frequent and more intense downpours. By the 2050s the climate of Shepparton could be more like Griffith, NSW, while Swan Hill will be more like Balranald, NSW" (RPG 2020).		
13.1 (Strengthen climate change resilience and adaptive capacity)	**2.3** (Agricultural productivity and income of food producers)	4	Robust	"The impact of climate change on agricultural productivity is anticipated to be reduced yields, and as a major economic driver this may have major impacts on the Goulburn region as a whole" (Aither 2019). "Research suggests that farmers have adapted to the longer-term changes in climate by focusing on technologies and management practices that improve productivity during dry years. Anecdotal information suggests that farmers have made a variety of management practice changes—including adoption of conservation tillage—to better exploit summer soil moisture, as an adaptation to reduced winter rainfall. There is also evidence of shifts in the location of cropping activity over time. Both the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) and ABS data shows that the amount of cropping activity in higher-rainfall zones—such as south-western Victoria—has increased in recent decades. At the same time, there is evidence that cropping activity has decreased in some inland areas that have been heavily affected by the deteriorating climate" (Aither 2019). "While the full impact of climate changes on the	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				agricultural industries across the Goulburn region is difficult to predict, particularly in the short-term, an increase in the risks to agricultural productivity from the expected impacts of climate change is likely. Shorter growing seasons, more extreme rainfall events, increasing bushfire risks and water scarcity are all potential risks that could substantially reduce the economic output of these regions" (Aither 2019). "The potential impacts of climate change on the horticulture industry include: – Government water policy decreasing the pool of available water for productive agriculture – Decreased water availability due to reduced rainfall – Increased water demand arising from greater evapotranspiration (ET) – Increased incidence of damage from sunburn and other breakdown disorders due to increase in the number of hot summer days (over 35ºC) – A reduction in the number of frost days reducing winter chilling (which is important for some fruit trees for setting fruit, meaning that it may become necessary to consider low chill varieties and alternative management options) – Increased intensity of frosts during spring may damage developing fruit and production – Increase in intense weather events (extremely heavy rainfall events) impacting on fruit quality – The risk of crop failures due to more variable/volatile growing conditions is also predicted to increase, affecting the industry's ability to meet increasingly specific and targeted quality assurance/market requirements – The horticulture industry may also be affected by policies to mitigate climate change, which are likely to result in higher energy, input and transport costs. For example cooling – Pests and disease" (NCCMA 2016a). "Some of the potential climate change impacts facing the Goulburn Broken Catchment include (DSE, 2008): • Water demand increases as a result of warmer temperatures and population growth		

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
				• Reduced water quality due to lower flows and higher temperatures, leading to algal blooms • Greater bushfire activity • Increased heat stress on dairy cattle, leading to reduced milk production • Inadequate winter chilling for some fruit trees, leading to reduced fruit yield and quality • Reduced risk of damaging winter frosts for other crops due to higher temperatures • Reduced grape quality due to higher temperatures" (Lukasiewicz et al. 2012). "Climate change is anticipated to generally have a negative effect on soils and production. Climate change is likely to affect the distribution and viability of agricultural enterprises, such as cropping and grazing, because of extreme weather and climate events and changes in the distribution of pests and diseases. Agricultural industries will need to adapt to a changing climate if they are to be viable in the long term" (GBCMA 2016a).		
13.2 (Climate change adaptation policies and strategies)	**2.3** (Agricultural productivity and income of food producers)	2	Robust	"Over the last two decades Australia has experienced a series of catastrophic climate-related weather events, including the lengthy Millennium drought (a period of significant dry weather from 1997 to 2009 (DELWP, 2016)), as well as major bushfires, cyclones and widespread flooding across several states. These events have had significant impacts on agriculture, on the rural communities that provide the essential infrastructure support to these industries and on farm families making decisions concerning food production during periods of uncertain and extremely volatile weather conditions" (Alston et al. 2018). "The ''Big Dry'', a prolonged dry period in Australia from 1997 to 2009, dried out much of the Murray Darling Basin (MDB) and resulted in large agricultural losses and degraded river ecosystems" (Wei et al. 2011).	+2	High

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
13.2 (Climate change adaptation policies and strategies)	**2.4** (Sustainable agriculture)	1	Medium	"The Goulburn region, similar to other regions, is characterised by threats of both bushfire and flooding including vulnerable areas that intersect with towns and cities and areas that are experiencing rural residential and tourism expansion. The impact of climate change on agricultural productivity is anticipated to be reduced yields, and as a major economic driver this may have major impacts on the Goulburn region as a whole. Research suggests that farmers have adapted to the longer-term changes in climate by focusing on technologies and management practices that improve productivity during dry years" (Aither 2019).	+2	High
13.3 (Climate change education)	**2.3** (Agricultural productivity and income of food producers)	1	Medium	"Over the last two decades Australia has experienced a series of catastrophic climate-related weather events, including the lengthy Millennium drought (a period of significant dry weather from 1997 to 2009 (DELWP, 2016)), as well as major bushfires, cyclones and widespread flooding across several states. These events have had significant impacts on agriculture, on the rural communities that provide the essential infrastructure support to these industries and on farm families making decisions concerning food production during periods of uncertain and extremely volatile weather conditions" (Alston et al. 2018).	+2	Medium
6.4 (Water use efficiency and scarcity)	**8.1** (Economic growth)	2	Medium	"Water availability and security are key strengths for the Victorian economy. This plan provides water security for Victoria's growing population and economy in the face of drought and the challenge of climate change" (DSE 2007). "Water security: A major benefit would be for the development of water rights (either government issued or privately provided) that would assure 100% reliability. Only through this means will large investors aiming at high-value food have sufficient security to make their investments. Water market derivatives for future supplies, leasing of water shares and enhanced commercial opportunity will also lead to greater investment opportunities" (Downie et al. 2019).	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
6.6 (Water-related ecosystems protection)	**8.9** (Sustainable tourism and promoting local culture)	2	Medium	"Most land in the Mitta Mitta catchment is in the Alpine National Park which is used for recreational and nature-based tourism like fishing, camping and four-wheel driving, and conservation" (DELWP 2019a). "Regional Resilience Fund – Natural Assets: The purpose of this intervention is to incentivise investment that increases the resilience of the natural assets within our region. This will result in environmental, social and economic benefits, including improved liveability and wellbeing, carbon sequestration, and increased recreation and tourism opportunities. Eligible projects are those that can create adaptive or transformative change to practices, systems and risk mitigation strategies. It could include the Resilient Rivers program, revegetation, floodplain restoration, and other projects to improve natural assets. Incentives could be in the form of tax incentives, low interest loans or grants to support innovative projects. They could be sourced from public or private investment. This intervention is closely related to the Regional Resilience Fund – Agriculture (A5)" (RPG 2020).	+2	Medium
8.4 (Resource efficiency and decoupling economic growth from environmental degradation)	**6.3** (Water quality and wastewater)	3	Robust	"By-products as fertiliser: While by-products are an acknowledged fertiliser resource, there are barriers to their use on agricultural land including consistency of supply, contamination concerns and knowledge about resources. This intervention would support a regional network to divert by-products from landfill and coordinate their use on farms across the region. Improved soil organic matter supports eco-system regeneration. This intervention will provide a valuable source of nutrients, cultivate microbes, improve water retention and increase yield" (RPG 2020). "The clearing of catchments for agricultural land, soil disturbance during forestry operations or urban development, and bare areas such as gravel roads and stock tracks, have led to substantial increases in the amounts of sediment (gravel, sand, silt and clay) entering ours streams and rivers" (GBCMA 2018). "Increasing toxicant levels have been identified as a potential risk to the groundwater resources. The risks could arise from earth resource development, point source discharges and changes to land use" (DELWP 2019a).	+2	Medium

Affecting Target(s)	Affected Target(s)	Evidence Amount	Evidence Robustness	Interaction Description	Score	Confidence
8.1 (Economic growth) and **8.2** (Technology, innovation, and industry)	**6.3** (Water quality and wastewater)	1	Medium	"There is a range of mining activities in Victoria's Northern and Murray water resource plan area. The risk assessment done for the water resource plan indicates that some of these activities have a significant risk of affecting water quality but none has a major risk of affecting water quantity. There is no coal seam gas mining in Victoria's North and Murray water resource plan area" (DELWP 2019b).	-2	Medium

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