



PART B

Our Approach to the Strategy

Photo: Goulburn River, Wally Cubbin

Chapter Five:

Overview of Approach

This Chapter:

Sets out the approach taken in the development of the Strategy; and

Sets out the approach to the identification of priority waterways

5.1. OVERVIEW OF APPROACH

This Strategy was prepared in accordance with the requirements of the *Victorian Waterway Management Strategy* (DEPI 2013b, d). The development of the Strategy has involved a range of processes and has included information and input from the *Regional Catchment Strategy (2013)* planning process, regional planning group processes and the community. The Strategy has been developed to provide implementation detail to the high-level outcomes within the *Regional Catchment Strategy*.

This Strategy incorporates the following key elements:



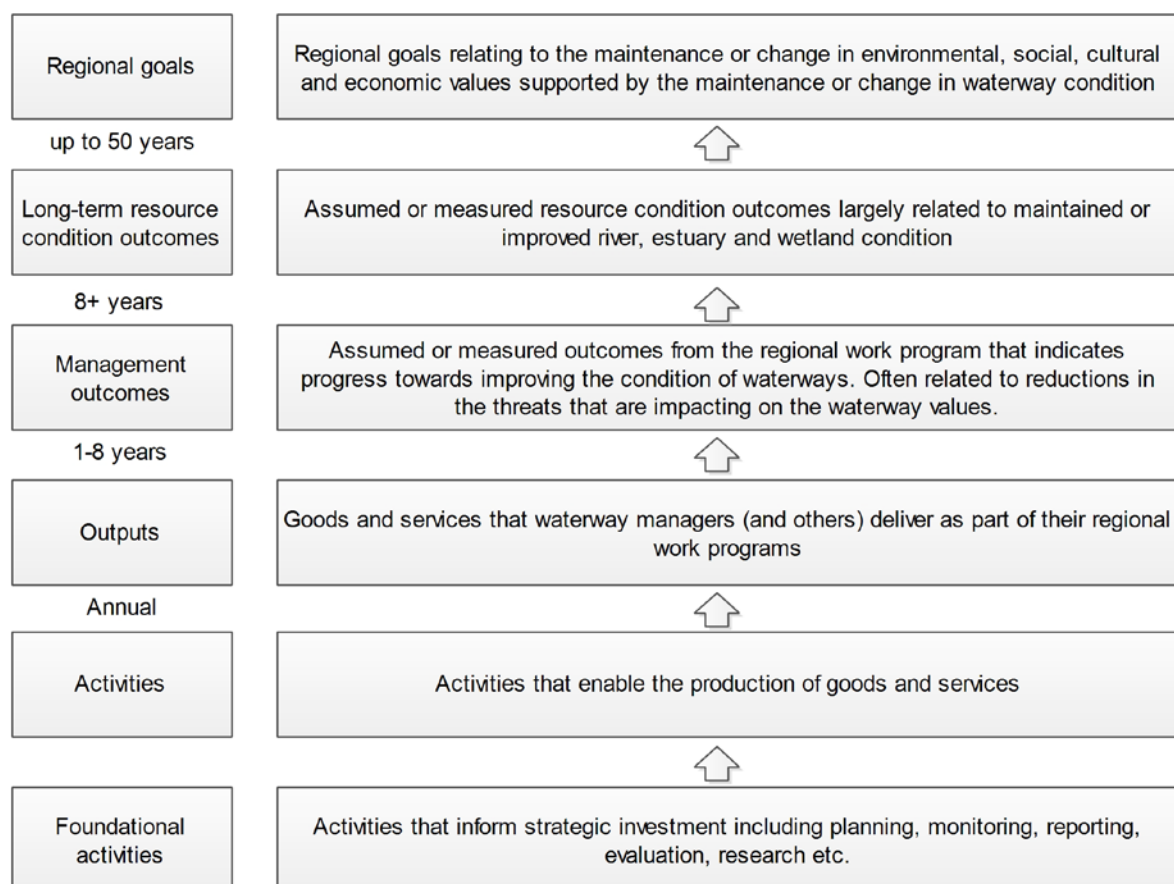
5.2 PROGRAM LOGIC

Program logic is a commonly used planning approach in NRM that uses a diagram to demonstrate the rationale for a program and express how change is expected to occur.

Program logic provides the rationale for how the Strategy will contribute to the vision for Victoria's waterways, as identified in the *Victorian Waterway Management Strategy* (DEPI 2013b) and the Goulburn Broken region's vision, as identified in the *Goulburn Broken Regional Catchment Strategy* (GB CMA 2013). (See Section 5.3)

The simplified program logic for the Strategy is illustrated in Figure 5-1. It describes how each year, specific management activities and outputs are delivered by regional agencies to achieve particular management outcomes. Over the eight-year planning period, these outputs and outcomes collectively contribute to either maintaining or improving the environmental condition of waterways. In the long-term, this will ensure that Victoria's waterways can continue to support environmental, social, cultural and economic values.

Figure 5-1: Program logic for Strategy



5.3 VISION AND REGIONAL GOALS

This Strategy requires a vision to guide its development and set its direction.

To ensure that the Strategy links to both the *Victorian Waterway Management Strategy* (DEPI 2013b) and the *Goulburn Broken Regional Catchment Strategy* (2013), their visions were used as a starting point (section 5.2).

The Vision for Victoria's waterways is:

Victoria's rivers, estuaries and wetlands are healthy and well-managed; supporting environmental, social, cultural and economic values that are able to be enjoyed by all communities.

The Vision for the Goulburn Broken catchment is:

Healthy, resilient and increasingly productive landscapes supporting vibrant communities.

Based on the above, the Vision for the region's waterways is:

Resilient Waterways, Vibrant Communities.

The waterway systems of the Goulburn Broken region are vibrant and resilient so that communities can enjoy the values and benefits they provide and contribute to their maintenance and improvement.

The 20 to 30 year objectives for waterways (from the Regional Catchment Strategy, 2013):

Waterways

Long-term objectives include:

- 350 km of river maintained in excellent or good condition;
- Ecological flow objectives met in high value reaches;
- Nutrient loads reduced or improved;
- Riparian condition maintained or improved along 550 km of river;
- Instream habitat maintained or improved along 140 km of river; and
- The maintenance and improvement of significant wetlands feature in Shepparton Irrigation Region groundwater and salt management planning (Oppy 2010).

Water quality

The resource condition target is to reduce potential phosphorus loads by 65% by 2016 (GB CMA 1996). This will be achieved by reducing phosphorus loads from:

- Irrigation drains by 50%;
- Dryland and diffuse sources by 20%;
- Wastewater management facilities by 80%;
- Urban storm water; and
- Intensive agricultural industries and local water quality issues.

Floodplains

- Reduce the impact of flooding on the built environment; and
- Provide ecosystems with natural flooding patterns where appropriate.

Salinity

- Manage shallow groundwater for salinity control within the SIR by improved irrigation management on farms, improved surface water management within drainage catchments and consistently pumping groundwater with appropriate reuse over 216,000 ha;
- Keep increases to salinity levels of the River Murray at Morgan at or below 8.9EC (electrical conductivity units); and
- Ensure no net increase instream salinity in the Goulburn River upstream of Goulburn Weir.

5.3.1 REGIONAL GOALS

A set of high-level goals were developed to assist in setting broad directions for management and identifying priority waterways in the Goulburn Broken region. The goals are:

- Maintain or improve the resilience of the region's waterways;

Social

- Maintain or improve waterways of high community value;

Economic

- Maintain or improve water quality in priority water supply catchments;

Environment

- Populations of threatened aquatic dependent species will be maintained or improved including Trout cod, Macquarie perch, Murray cod, Eel tailed catfish, Barred galaxias, Golden perch, wetland-dependent threatened species and nationally threatened ecological communities (seasonal herbaceous wetlands and alpine bogs and fens);
- Barmah Forest (Ramsar site) will be managed to maintain its ecological character;
- The values associated with Heritage Rivers will be maintained or improved;
- Wetlands with formally recognised significance are maintained or improved;
- Waterways in a near natural or ecologically healthy state are retained;

Urban Waterways

Urban waterways are managed to improve environmental condition, amenity and water security.

In general, the regional goals were developed to:

- Apply to a timeframe generally longer than 20 years;
- Have a conceptual or qualitative link to management outcomes; and
- Be region wide and guide priority setting.

5.4 AQUATIC VALUE IDENTIFICATION AND RISK ASSESSMENT (AVIRA) – THE ASSET-BASED APPROACH

Threat-based approaches to natural resource management have lessened across Australia over the past decade, and have been largely replaced with asset-based approaches that focus on important natural 'assets', rather than on threat-based issues.

AVIRA (Aquatic Value Identification and Risk Assessment) is the framework that contains information on waterway assets and threats and applies a risk assessment process to assist in the planning for waterway management activities.

AVIRA is an update of the RiVERS⁷ decision support tool that was used in the development of the first RRHSs and will inform the development of the RWSs across Victoria.

The AVIRA decision-support tool has been developed to replace the RiVERS decision-support tool. RiVERS was an asset inventory that documented the social, economic and environmental assets (what we now call ‘values’), and the threats to these assets (values), for rivers across the state.

AVIRA stores information on the environmental, social and economic values of rivers (see Appendix B), but will also include information on the values of selected estuary and wetland assets. For each asset, AVIRA stores information on the threats to these values and conducts an automated risk assessment for every value/threat combination. AVIRA undertakes the first four of the steps of the asset-based approach.

AVIRA was used to inform priority setting for the development of this Strategy. AVIRA also incorporated a risk-based assessment for all waterways.

The data contained in the AVIRA database is considered the best available at the time this Strategy was prepared. The list of values and threats contained in AVIRA is shown in Appendix B.

5.5 MANAGING FOR WATERWAY RESILIENCE

The Stockholm Resilience Centre defines resilience as “the capacity of a system, be it an individual, a forest, a city or an economy, to deal with change and continue to develop. It is about the capacity to use shocks and disturbances like a financial crisis or climate change to spur renewal and innovative thinking. Resilience thinking embraces learning, diversity and above all the belief that humans and nature are strongly coupled to the point that they should be conceived as one social-ecological system.”

By applying a resilience approach, the Strategy aims to maintain, and where possible improve, the values contained within a river or wetland system. By applying this approach the whole system will be managed, rather than an individual aspect or value, for the benefit of current and future generations.

The resilience of our waterways is dependent on achievement of the high-level outputs and outcomes identified within the *Regional Catchment Strategy*. These will be achieved through the delivery of the actions contained within this Strategy.

The Strategy has considered the resilience of our waterways to:

- determine if waterways are in the state in which we desire;
- determine measures required to maintain resilience; and
- determine if/which waterways are close to a tipping point.

It is clear that waterway values exist across the range of waterway states. For example, threatened species and waterway recreation exist in near natural and working rivers. The values that exist within the stream all need to be taken into account when deciding on the appropriate management strategies prior to the implementation of works. Often, not all threats need to be addressed to reach the desired condition or state.

It is clear that we need to understand the current state of the waterway and determine a desired future state to determine what management measures need to be employed.

⁷ RiVERS is a database application developed for the Victorian Catchment Management Authorities which was utilised to assist in developing Regional River Health Strategies and prioritising waterway management activities using a risk-based management approach.

5.5.1 WATERWAY STATES, DIFFERING ENVIRONMENTAL CONDITION, SUPPORTING VALUES AND TYPICAL USES





Notionally, there are a number of possible states for waterways depending on their condition, intrinsic values and typical use.

Four states have been identified in Victoria (DSE 2002; DEPI 2013b): near natural, ecologically healthy, sustainable working and highly modified. While the majority of our waterways are in a sustainable working or highly modified state and have suffered a loss of biodiversity or a loss of ecological functions, some maintain near natural or ecological characteristics (refer to Table 5-1). All systems support important social and economic values. The environmental, social and economic values are not static: they could change through natural environmental cycles (such as droughts, bushfires and floods) and with changes to community expectations, needs and values.

In the development of this Strategy, waterways have been categorised into one of the four states (described by DEPI 2013b). These are presented in Table 5-1.

The resilience of our waterways is dependent on the delivery of the actions contained within this Strategy and delivery of the high-level outputs and outcomes identified within the *Regional Catchment Strategy*.

Table 5-1: River and wetland ecosystem states

State	Near Natural	Ecologically Healthy	Sustainable Working	Highly Modified/Degraded
Values	High degree of naturalness, moderate-low recreational, wilderness, tourism. Significant species <i>Barred galaxias</i> .	High degree of naturalness, high recreational and tourism, water supply.	Moderate naturalness, some significant species, high recreational and tourism, water supply and delivery, low to medium agriculture and/or urban pressure. Significant species Murray cod, Trout cod.	Low level of naturalness, moderate recreational and tourism, intensive production, high flow modification/water supply, agriculture or urban pressure high.
Modification	Very Low	Low	Moderate	Moderate to high
Basis - ISC (2010)	50-45	44-35	34-21	20-0
				
Examples	Big River R68 / Ryans Creek R 17	Howqua River R70 (Waterway) / Yea River 55-57	Seven Creeks / Holland Creek R14 Barmah Forest Ramsar Site	Goulburn River R 1-9 / Mollisons Creek R42,43
Naturalness	Very High	High	Med	Low-Very Low
Socio Economic	Low	Low	High	High

ISC Rating	Excellent	Good	Moderate	Poor	Very Poor
ISC 1999	42-50	35-41	26-34	20-25	0-19
ISC 2004	37-50	29-36	19-28	14-18	0-13
ISC 2010	40-50	35-39	25-34	20-24	0-19

Using the data contained within the Index of Stream Condition (ISC)⁸ (Appendix D) and by applying the rules from the Table above, the waterways close to “tipping point” are identified in Table 5-2. The ISC has been applied to the process of identifying and defining tipping points and states for rivers only; further work is required to evaluate tipping points and states for wetlands. Those approaching a tipping point in near natural or ecologically healthy are considered priority waterways for the development of work programs.

Table 5-2: Streams approaching a tipping point (identified by applying the ISC and condition states)

State (Current)	Rules Applied	Waterways ⁹	Approaching “State”
Near Natural	ISC (at 45-46)	(none)	Ecological Healthy
Ecologically Healthy	ISC (at 35-36)	Goulburn River (5-15); Acheron River (5-62); Rubicon River (5-65); Howqua River (5-69) and Delatite River (5-72)	Sustainable Working
Sustainable Working	ISC (at 21-22)	Creightons Creek (5-27); Deep Creek (5-34); Dairy Creek (5-53); Delatite River (5-71) and Kurkurac Creek (5-78)	Highly Modified

Waterways within the region have been subjected to many shocks over the past decade including drought, bushfire and flood. Overall, they have been remarkably resilient to these pressures. Key drivers likely to impact on the region’s waterways over the life of this Strategy include floods and bushfire (Table 5-3). These key shocks are unlikely to see our waterways approach a tipping point and move to an alternative state, in the life of this Strategy.

For each waterway within AVIRA a state has been assigned based on the Index of Stream Condition. These states are shown in Appendix D.

5.5.2 PRIORITY ACTION FOR TIPPING POINTS

Table 5-3 summarises the key characteristics of each stream condition state and describes the key shocks, drivers and thresholds or tipping points for each system.

There remains many knowledge gaps in waterway resilience, specifically relating condition, trends and their associated tipping points. Improvement of these knowledge gaps is a priority and will be undertaken as resources are identified during the life of this Strategy.

The following table details priority actions; the timeframe for implementation and the responsible agency, authority or group:

Action	Timeframe	Responsibility
Further refine States and Tipping points at SES, reach and asset scales for waterways.	2015	GB CMA, Educational Institutions, Researchers
Improve resilience of those waterways and approaching a “tipping point” based on the ISC through delivery of priority actions in Chapter 7.	2014-2022	GB CMA, GMW, Parks Victoria, Municipal Government, DEPI (regional), Community

⁸ The 2004 and 2010 ISC results cannot be directly compared due to the different methodology that has been employed.

⁹ An assessment of wetlands was incomplete and will be developed over time.

Table 5-3: States, Shocks, Drivers and Tipping Points

State	Key Characteristics	Main values delivered
Near Natural/ Pristine	<ul style="list-style-type: none"> all plant and animal species in the waterway or wetland are native (no exotic species exists within the system); natural ecosystem processes are maintained; major natural habitat features are represented and are maintained over time; and native riparian vegetation communities exist sustainably for the majority of its length. 	Good water quality, aesthetics, native flora and fauna, cultural, natural Flow (quantity), refugia.
Shocks	Drivers	Thresholds
Fire/Drought	<ul style="list-style-type: none"> Climate 	Encroachment of pest plants, pest animals.

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State	Key Characteristics	Main values delivered
Near Ecologically Healthy	<ul style="list-style-type: none"> the majority of plant and animal species in the waterway or wetland are native (minimal exotic species exists in the system); natural ecosystem processes are maintained; major natural habitat features are represented and are maintained over time; and native riparian vegetation communities exist sustainably for the majority of its length. 	Good water quality, aesthetics, native flora and fauna, exotic flora and fauna, cultural.
Shocks	Drivers	Thresholds
Fire, Floods, Drought	<ul style="list-style-type: none"> Climate, land development, population, land use intensification 	Changed channel hydrology, channel modification, changed riparian/adjacent land use.

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State	Key Characteristics	Main values delivered
Sustainable/ Working	<ul style="list-style-type: none"> native and exotic plant and animal species are present in the waterway or wetland; major natural habitat features are modified; linkages between river and floodplain and associated wetlands; are often modified; native riparian vegetation communities modified for majority of its length; adjacent land use modified; and flow regimes slightly to highly modified. 	Tourism/recreation, provision of water supply, native and exotic flora and fauna, cultural.
Shocks	Drivers	Thresholds
Fire. Floods, Drought, Salinisation, Inappropriate water regimes, Water Quality Shocks (DO, Algae, etc.)	<ul style="list-style-type: none"> Climate, land development, population, land use intensification. 	Land use change, channel modification, changes to flow regimes, changes to riparian land.

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State	Key Characteristics	Main values delivered
Highly Modified/ Degraded	<ul style="list-style-type: none"> native plants have been highly modified/removed or dominated by exotic species in the waterway or wetland; natural ecosystem processes are highly modified; major natural habitat features are highly modified; linkages between river and floodplain and associated wetlands are highly modified; adjacent land use highly modified; and flow regimes are highly modified. 	Tourism/recreation, provision of water supply, cultural, heritage, urban recreation.

Chapter Six:

Priority Setting

This Chapter:

Sets out the approach taken to establish priority waterways within the Strategy

6.1 IDENTIFYING PRIORITY WATERWAYS

Waterways within the Goulburn Broken region provide our community with an immense array of values. These include environmental (e.g. native fish, vegetation), economic (e.g. water supply, supporting agriculture and production), cultural and social (e.g. recreation, aesthetics). A number of existing threats could potentially impact on these values.

While we would like to rehabilitate all waterways in the region, we don't have the necessary resources (people, dollars, time) to complete such a task. Therefore, we have to find some way of allocating the available resources to the region's highest priority waterways.

The key objective of the Strategy is to identify priority waterways for investment over the next eight years to ensure we maintain the resilience of these systems to support or improve the values they provide.

6.2 DEFINING WATERWAYS

6.2.1 ASSETS

Identification and ranking of priority waterways was informed by the Aquatic Value Identification and Risk Assessment (AVIRA) decision support tool (refer to Appendix B). AVIRA is an asset inventory, which:

- documents the environmental, social and economic values and threats associated with waterway assets (river reaches, wetlands and estuaries); and
- assesses risks to values to assist in planning for waterway management activities.

For the Goulburn Broken region, 117 river reaches and 158 wetlands were assessed using data from the third ISC (Index of Stream Condition) and IWC (Index of Wetland Condition). This data was considered the best and most comprehensive information available at the time the Strategy was prepared.

6.3 IDENTIFYING HIGH VALUE WATERWAYS

The *Victorian Waterway Management Strategy* (DEPI 2013b) states that waterways will be considered high value if they have one, or more, of the following characteristics:

- formally recognised significance;
- presence of highly threatened or rare species and communities;
- high naturalness values (for example, aquatic invertebrate communities and riparian vegetation) or special waterway features (for example, drought refuges and important bird habitat); and
- high social, cultural and economic values (for example, recreational fishing, Aboriginal cultural heritage, urban/rural water sources).

For waterway assets in AVIRA, the above characteristics can be assessed using specific scoring rules as detailed in Appendix C. If a waterway meets one or more of these scoring rules, it is considered to be a high value waterway. Thus:

- all 117 river reaches in the Goulburn Broken region were identified as high value waterways; and
- 114 of 158 wetlands in the Goulburn Broken region were identified as high value wetlands.

These results are summarised by SES (Landscape) in Appendix E and summarised by SES (Landscape) in Table 6-1.

Table 6-1: High value waterways and wetlands by SES in the Goulburn Broken region

Socio-Ecological System	Number of High Value Waterways	Number of High Value Wetlands
Agricultural Floodplains	18	90
Productive Plains	43	16
Upland Slopes	21	4
Commuting Hills	23	
Southern Forests	12	3
TOTAL	117	113

6.4 PRIORITY WATERWAYS

As shown in Table 6-1, a high number of waterways within the region were identified as high value waterways. However, to develop a realistic eight-year regional work program, the number of waterways must be reduced and prioritised.

The approach adopted was to identify which high value waterways aligned to the regional goals. This involved the identification of relevant and/or attributable AVIRA values and the determination of scoring cut-offs (or rules).

AVIRA rules for linking high value waterways to regional goals are detailed in Table 6-2. AVIRA rules could not be developed for the urban waterways goal.

A short list of 64 waterways from 117 high value waterways, and 15 wetlands from the list of 113 high value wetlands was developed by applying rules from regional goals (Appendix E and Appendix F).

A number of additional wetlands were included to make 23 in total, as they form part of current priority wetlands for the delivery of environmental water or the protection of threatened biota (Moodie Swamp, Tahbilk Lagoon, One Tree Swamp, Two Tree Swamp, Wallenjoe Swamp, Alpine Bogs and Stockyard Plain).

Table 6-2: Regional Goal, Approach and AVIRA Rules

Regional Goal	Approach	AVIRA Rule
Maintain or improve waterways of high community value	Maintain or improve waterways with multiple social benefits, indicative of use by a broad cross section of the community.	Rank waterways based on the number of values met under the AVIRA social category: activity. A waterway will be considered to have met the goal if: <ul style="list-style-type: none"> it has four or more high value attributes under the AVIRA social category: activity.
Maintain and improve water quality in priority water supply catchments	Maintain or improve waterways within Special Water Supply catchments.	Include waterways within Special Water Supply catchments, under the <i>Catchment and Land Protection Act 1994</i> . AVIRA identifies waterways within Special Water Supply catchments with a score of 4 (open SWSC) or 5 (closed SWSC) for the 'urban/rural township water sources' value.
Populations of threatened aquatic dependent species will be maintained or improved including Trout cod, Macquarie perch, Murray cod, Eel tailed catfish, Barred galaxias, Golden perch	Maintain or improve the resilience of known populations of Trout cod, Macquarie perch, Murray cod, Eel tailed catfish, Barred galaxias, Golden perch.	Include waterways with: <ul style="list-style-type: none"> One or more critically endangered or endangered fish species present OR <ul style="list-style-type: none"> Three or more threatened fish species present (vulnerable or greater).
	Maintain or improve the resilience of known populations of other significant waterway dependent species.	Include waterways with: <ul style="list-style-type: none"> One or more critically endangered species present OR <ul style="list-style-type: none"> Two or more endangered species present OR <ul style="list-style-type: none"> Four or more threatened species present (vulnerable or greater).
Wetland-dependent threatened species and nationally threatened ecological communities seasonal herbaceous wetlands and alpine bogs and fens	Wetland-dependent threatened species and nationally threatened ecological communities – seasonal herbaceous wetlands and alpine bogs and fens.	Include waterways with Wetland-dependent threatened species and nationally threatened ecological communities.
Barmah Forest will be managed to maintain its ecological character	Maintain or improve the listed values of Barmah Forest.	Include waterways listed as a key feature of the Ramsar site.
The values associated with Heritage Rivers will be maintained or improved	Maintain or improve the listed values of heritage rivers.	Include river reaches that form part of a Heritage River.
Wetlands with formally recognised significance are maintained or improved	Maintain or improve the condition of values of Living Murray Icon Sites.	Include waterways listed as a key feature of a Living Murray Icon Site.
	Maintain or improve the condition of values of DIWA wetlands.	Include waterways listed as regionally important wetlands within the RCS.
Waterways in a near natural or ecologically healthy state are retained	Protect all environmental values of near natural or near ecologically healthy rivers.	Near natural river reaches: <ul style="list-style-type: none"> 3ISC Environmental Condition – Excellent AND <ul style="list-style-type: none"> no motor boating, wastewater discharge, water carrier, commercial fishing or extractive industries Near ecologically healthy river reaches: <ul style="list-style-type: none"> 3ISC Environmental Condition – Good AND <ul style="list-style-type: none"> no motor boating, wastewater discharge, water carrier, commercial fishing or extractive industries.

6.4.1 ASSESSING RISK AND FEASIBILITY

Assessing Risks

A risk assessment is undertaken in AVIRA for each waterway. For example, for each river reach, 38 values are assessed against 22 threats, resulting in 836 risk level assessments.

For each high value waterway with links to one or more regional goals, the following approach was taken:

1. Identify all threats to high value attributes (linked to regional goals) where the recommended treatment is “Reduce Threat” (see Figure 6-1).
2. Determine a “first cut” of the feasibility (high, medium, low) of reducing each threat.

Priority for the development of the regional works program should then be given to:

- waterways with higher scores (in general these have significant value and management of the threats is feasible); and
- waterways with very low scores (in general these are waterways with minimal threats that just require maintenance).

A summary of recommended actions from the regional priority setting processes is as follows:

Figure 6-1: Summary Outcomes of the regional priority setting process

	Low risk to values	High risk to values
Priority waterways	Management activities to maintain waterway condition	Management activities to reduce threats to waterway condition
Other waterways	Not a priority within the eight-year planning period	Management activities only if they: <ul style="list-style-type: none">• reduce threat to high value waterways• provide connectivity• protect public infrastructure or reduce risks from extreme events• maintain or strengthen community commitment to improving the condition of local waterways• are required to meet statutory or regulatory obligations.

Considering Technical Feasibility

A “first cut” of the technical feasibility (high, medium, low) of reducing each threat (i.e. implementing onground actions) was determined for each identified risk. Social and/or economic factors were assessed later when developing the works program.

Calculating a Priority Waterway Score

Raw scores were calculated for each risk/feasibility combination to calculate the score for a priority waterway as follows: raw score = risk level x feasibility

where: risk level = 5–very high; 4-high; 3-moderate; 2-low; 1-very low

feasibility score = 3–high; 2–medium; 1–low.

All raw scores for a waterway were then added and the total divided by the number of raw scores calculated. This produced a Priority Waterway Score (ranging from 0-Low and 15-High) from which a priority list of waterways can be established. Once Priority Waterway Scores were calculated for each priority waterway, the waterways could be ranked from highest score to lowest score. See Appendix K for high-level results (risk and feasibility).

Using the AVIRA rules described in Table 6-2 and by applying the risk and feasibility assessment the following refinement of high value waterways was achieved (Figure 6-2):

- **River reaches:** From 117 high value waterways to 64 priority rivers.
- **Wetlands:** From 113 high value wetlands to 23 priority wetlands.

These results are shown by SES (Landscape) in Table 6-3 and Figure 6-3 and detailed in Appendix F. Figure 6-3 illustrates the results by SES.

The results contributed towards the development of a works program for the next eight years (2014 – 2022).

Figure 6-2: Filtering waterway assets to identify priority waterways

Total number of waterway assets	River Reaches (117)	Wetlands (158)	Appendix E
Total number of high value waterways	River Reaches (117) 100%	Wetlands (113) 71%	Appendix E
Total number of priority waterways	River Reaches (64) 54%	Wetlands (15) 9%	Appendix F Appendix E
		Including current priority Wetlands (23) 14%	(see Section 6.4)

6.4.2 MANAGEMENT UNITS

Management units (titled Social Ecological Systems – SESs or Landscapes) were established for the Goulburn Broken region during consultation with the community as part of the *Regional Catchment Strategy* process.

SESs describe the linked social and ecological systems in which we all live within the Goulburn Broken catchment. SESs can be described at a number of scales and encompass the social, ecological, economic, political, cultural and biophysical system components and acknowledge their inter-linkages and inter-dependencies. Understanding SESs and identifying their drivers, threats and thresholds helps managers to develop strategies to keep the system within limits, where appropriate.

The six SESs or Landscapes shown in Figure 6-3 have been adopted as the key management units for the Strategy.

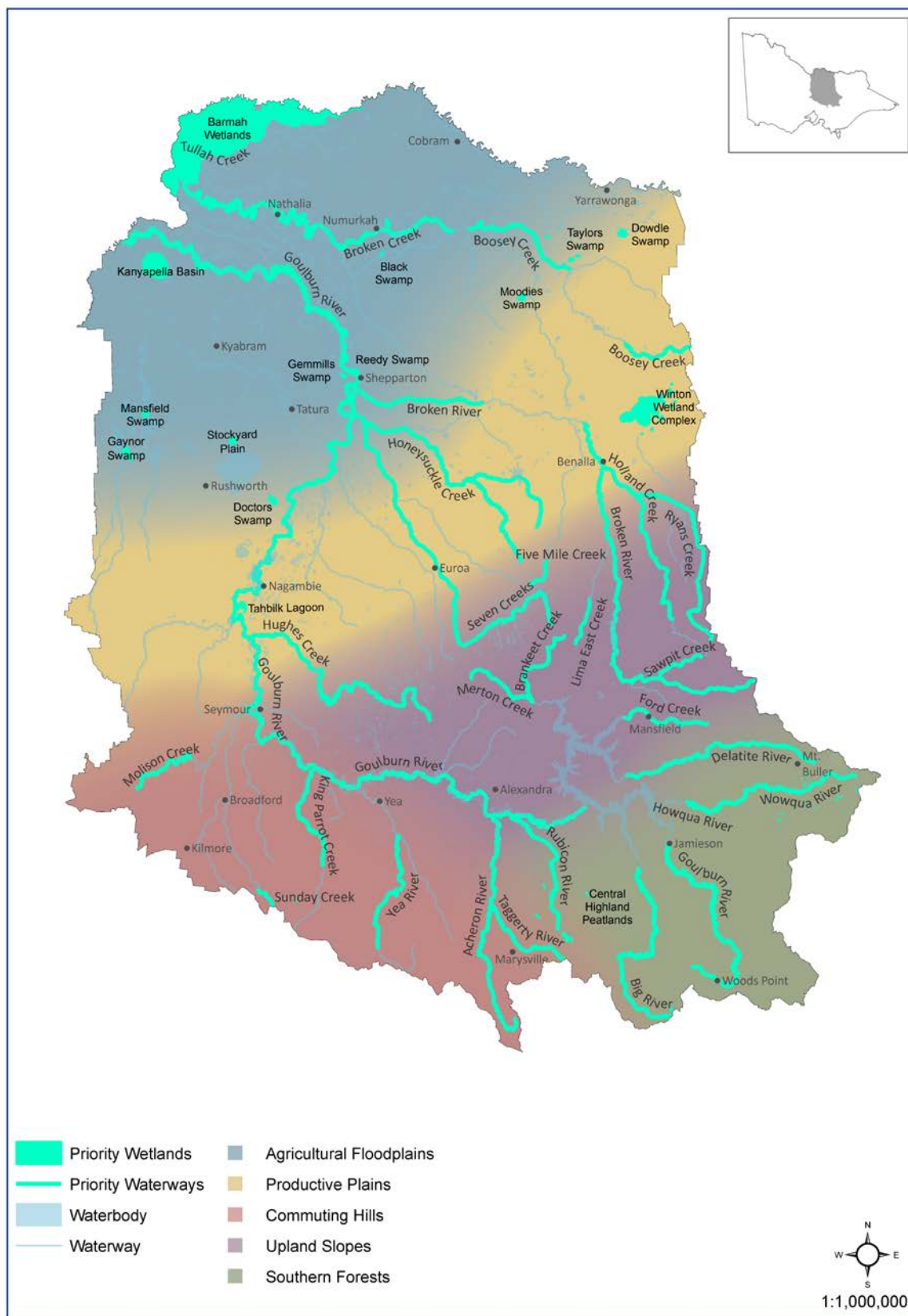
Figure 6-3: Priority Waterways – Example of risks and feasibilities spreadsheet

5-05	Goulburn River											Priority Waterway Score		
High Value Waterway Status					Links to Regional Goals									
Type	Category	Status			Goal								Link	
Environmental	Formally Recognised Significance	x			Protect all populations of threatened aquatic dependent fauna species within known locations								x	
	Representativeness				Retain the ecological character of Barmah Forest/Wetland									
	Rare or Threatened Species/Communities	x			Protect and improve the values associated with Heritage Rivers								x	
	Naturalness				Enhance urban waterways in partnership with local government (aligned with community expectations and values)									
	Landscape Features	x			Protect and enhance wetlands with recognised conservation significance									
Social	Activity	x			Protect rivers in pristine and near ecologically healthy status									
	Place				Maintain and improve water quality in high priority water supply catchments									
	People	x			Maintain high value recreation areas								x	
Economic	Water	x												
	Power Generation													
	Other Resources													
Risk Assessment														
												Feasibility		
Type	Value Name	Value Scd	Goal Lin		Threat Name	Threat Scd	Associati	Confiden	Risk Leve	Treatment	High	Moderz	Low	
Environmental	Significant Amphibians	5	x		Invasive Fauna (Aquatic)	5	High	High	Very High	Reduce Threat Level				
Environmental	Significant EVCs	5	x		Invasive Fauna (Terrestrial)	5	High	High	Very High	Reduce Threat Level				
Environmental	Significant Fish Migratory	5	x		Inc in Low Flow Magnitude	5	High	High	Very High	Reduce Threat Level				
Environmental	Significant Fish Migratory	5	x		Inc in Prop of Zero Flow	5	High	High	Very High	Reduce Threat Level				
Environmental	Significant Fish Migratory	5	x		Invasive Fauna (Aquatic)	5	High	High	Very High	Reduce Threat Level				
Social	Motor Boating	5	x		Inc in Prop of Zero Flow	5	High	Low	Very High	Reduce Threat Level				
Social	Recreational Fishing	5	x		Inc in Prop of Zero Flow	5	High	Low	Very High	Reduce Threat Level				
Social	Recreational Fishing	5	x		Invasive Fauna (Aquatic)	5	High	Low	Very High	Reduce Threat Level				

Table 6-3: Priority Waterways in the Goulburn Broken Catchment, by Landscape

AGRICULTURAL FLOODPLAINS		PRODUCTIVE PLAINS		UPLAND SLOPES	
4-01	Broken River	4-03	Broken River	4-04	Broken River
4-21	Broken Creek	4-13	Holland Creek	4-05	Broken River
4-22	Broken Creek	4-34	Boosey Creek	4-06	Broken River
4-23	Broken Creek	5-06	Goulburn River	4-08	Five Mile Creek
4-24	Broken Creek	5-07	Goulburn River	4-10	Lima East Creek
4-32	Boosey Creek	5-08	Goulburn River	4-11	Sawpit Gully Creek
4-36	Tullah Creek	5-09	Goulburn River	4-14	Holland Creek
5-01	Goulburn River	5-10	Goulburn River	4-16	Ryans Creek
5-02	Goulburn River	5-17	Seven Creeks	4-17	Ryans Creek
5-03	Goulburn River	5-18	Seven Creeks	5-13	Goulburn River
5-04	Goulburn River	5-19	Seven Creeks	5-14	Goulburn River
5-05	Goulburn River	5-20	Seven Creeks	5-38	Hughes Creek
60101	One Tree Swamp	5-22	Honeysuckle Creek	5-39	Hughes Creek
60102	Two Tree Swamp	5-23	Honeysuckle Creek	5-62	Acheron River
60118	Gaynors Swamp	5-37	Hughes Creek	5-73	Ford Creek
60205	Kanyapella Basin	5-76	Honeysuckle Creek	5-74	Brankeet Creek
60240	Yambuna Bridge Road Wetland	61918	Tahbilk Lagoon	5-75	Merton Creek
60265	Mansfields Swamp	62900	Stockyard Plain		
60269	Wallenjoe Swamp	67053	Moodie Swamp		
60706	Barmah Forest	67905	Dowdle Swamp		
62010	Doctors Swamp	67909	Winton Wetland Complex		
63156	Gemmills Swamp				
63173	Reedy Swamp				
63203	Black Swamp				
63206	Kinnairds Wetland				
66906	Sampys Swamp				
66911	Taylors Swamp				
67091	Mulquiney Road Wetland				
		COMMUTING HILLS		SOUTHERN FORESTS	
		5-11	Goulburn River	5-15	Goulburn River
		5-12	Goulburn River	5-16	Goulburn River
		5-42	Mollison Creek	5-63	Acheron River
		5-43	Mollison Creek	5-64	Taggerty River
		5-47	Sunday Creek	5-65	Rubicon River
		5-51	King Parrot Creek	5-66	Rubicon River
		5-55	Yea River	5-67	Big River
		5-56	Yea River	5-68	Big River
				5-69	Howqua River
				5-70	Howqua River
				5-71	Delatite River
				5-72	Delatite River
				CHP/AB	Central Highland Peatlands / Alpine Bogs

Figure 6-4: Priority Waterways within each Social Ecological System/Landscape



6.5 DEVELOPING THE REGIONAL WORK PROGRAM

This section establishes the strategic understanding of the management activities and strategies required to reduce the threats to values.

The Conceptual Model Project (GHD 2012b) is the basis of this work and has produced a set of conceptual models that provide consistent assumptions about the relationships between values and threats and the management activities required to reduce threats to values.

The conceptual models provide consistent, and as far as possible evidence-based, assumptions on the relationships between values and threats; management objectives to reduce the threats to values and the management activities required to achieve particular specified outcomes.

A matrix (Table 6-4) identifying management strategy options to maintain waterways and/or reduce high risk threats was prepared from the models (GHD 2012).

Management strategies to mitigate threats are rated on the confidence in the approach and temporal response of the management activity to mitigate the threat.

Temporal responses have been developed to align with the timeframe of the RWSSs. Temporal responses have been scored as a 1, 2 or 3 where the scores are defined as:

Temporal Rating	Clarifier
1	Expected response to management activity less than one year
2	Expected response to management activity in 1-8 years
3	Expected response to management activity greater than 8 years

Confidence in the effectiveness of the management activity to treat the threat has been defined as High or Medium which are defined as follows:

Confidence Ratings	Clarifier
High	Repeated scientific evidence supports association rating
Medium	Expert/professional opinion based on logical/plausible connection rather than direct evidence

Table 6-4: (GHD, 2012) identifies management strategy options to maintain waterways and/or reduce high risk threat

Most Used Onground Works																		Other Works		
Threats to River Reaches	Aquatic Weed Control	Buffer Strip Establishment	Environmental Water	Fencing Remnants	Grazing Regime Change	Natural Regeneration	Off Stream Watering	Pest Animal Management	Pest Plant Control	Revegetation	Soil Erosion Control	Stream Bank Stabilisation	Stream Bed Stabilisation	Fish Passage	Urban Stormwater Management	Wetland Watering Regime Changed	Resnagging streams	Fire Regime Change	Soil Conservation	Stock Containment
ALTERED WATER REGIMES																				
Altered Flow Regimes																				
Increase in Low Flow Magnitude			H1																	
Reduction in High Flow Magnitude			H1																	
Increase in Proportion of Zero Flow			H1																	
Change in Monthly Stream flow Variability			H1																M2	
Altered Stream flow Seasonality			H1																H1	
ALTERED PHYSICAL FORM																				
Bank Instability		H2		H2	H2	H2	M2			H2	H2	H1	M2							H2
Bed Instability (Degradation)					H2					M2	H2	H2	H1							H2
POOR WATER QUALITY																				
Degraded Water Quality		H2			H2		M2			H2	H2	H1	H1		H1				H2	H2
Thermal Water Pollution																				
Disturbance of Acid Sulphate Soils																				

Most Used Onground Works																Other Works				
Threats to River Reaches	Aquatic Weed Control	Buffer Strip Establishment	Environmental Water	Fencing Remnants	Grazing Regime Change	Natural Regeneration	Off Stream Watering	Pest Animal Management	Pest Plant Control	Revegetation	Soil Erosion Control	Stream Bank Stabilisation	Stream Bed Stabilisation	Fish Passage	Urban Stormwater Management	Wetland Watering Regime Changed	Resnagging streams	Fire Regime Change	Soil Conservation	Stock Containment
DEGRADED HABITATS																				
Degraded Riparian Vegetation		H2		H2	H1	H2	H2			H2		H1						H2		H1
Large Trees					H3		M3		M3	H3		M1						M1		M3
Loss of Instream Habitat										H3										
Large Wood		H2								H3							H1			
Sedimentation		H2			H2		M2				H2	H2	H1						H2	
Livestock Access				M3	M2	H2	H1			H1										H2
INVASIVE FLORA AND FAUNA																				
Invasive Flora (Riparian)				H	H	H2	M2		H1	M2		H1						H2		M2
Trees		M2		H1	H3	H3	M3		H1	M2		H1						H2		M3
Shrub Layer		M2		H2	H2	H2	M2		H1	M2		H1						H1		M2
Ground Layer		M1		H3	H2	H1	M1		H1	M2		H1						H1		M1
Invasive Flora (Aquatic)	H1				H2				H1											M1
Invasive Fauna (Terrestrial)								H2												
Invasive Fauna (Aquatic)			M2					H1												
REDUCED CONNECTIVITY																				
Barriers to Fish Migration														H1						
Reduced Riparian Connectivity				M3		H2														
Longitudinal Continuity		H2		M2	H	H2	M2	2	M2			M2						H2		H2
Vegetation width		H2		H	H	H2	H2	M2	M2			H1						H1		H2
Reduced Floodplain Connectivity			H1														H1			