Mid Goulburn Broken & Upper Goulburn Sustainable Irrigation Action Plan (SIAP)

Land and Water Management Plan for Irrigation in the Goulburn Broken Dryland Catchment
Year 2008 - 2013

Document Review and Authorisation

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Abbreviations and Glossary of Terms

Abbreviations

ABS	Australian Bureau of Statistics
CMA	Catchment Management Authority
CRG	Community Reference Group
Dozer Licence	An irrigator who only irrigates some years, such as times of dry conditions
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
Eutrophication	Nutrient loading of water ways
EVC	Ecological Vegetation Class
EWR	Environmental Water Reserve
GIS	Geographical Information System
GMA	Groundwater Management Area
G-MW	Goulburn-Murray Water
GSPA	Groundwater Supply Protection Area
Guidelines	Guidelines for the preparation of LWMPs that apply to designated irrigation areas in Victoria
GWMP	Groundwater Management Plan
IDG	Irrigation Development Guidelines are a guide to irrigation developers on the process that needs to be followed to obtain a WUL, and are needed to ensure Water Authorities and irrigators are meeting the requirements for issuing a WUL.
MAT	Management Action Target a measure of the targeted quantity or quality of works or measures that will directly or indirectly impact on the quality of the resource or asset and usually aimed at achieving a particular Resource/asset Condition outcome
PCV	Permissible Consumptive Volume
RCS	Regional Catchment Strategy
RCT	Resource Condition Target is the targeted quality of a resource or asset and usually expressed in terms of the quality in the resource /asset in question
Resource Condition Outcome	Quality of a resource/asset resulting from management action(s) or natural change(s) in the catchment that impact on the resource/asset quality.
SIAP	Sustainable Irrigation Action Plan that applies to a designated irrigation area in Victoria
SIAP preparation	Development of new SIAP Review of an existing SIAP Renewal of an existing SIAP
SIAP review	Undertaken every five years to ensure that any new initiatives are included and implementation rates are appropriate, but not resetting the original Plan outcome targets and underlying principles. Involves documenting what has been achieved, what is expected to be delivered and a program for delivering the desired outcomes together with the timeframe for delivery (i.e. effectively resets the target management action implementation rates) Applies to Land & Water Management Plans that have been endorsed post 2000.
SIAP renewal	Undertaken every 15 years, or the half life of the Plan, which ever is the shorter Revisits the vision and examines the relevance and applicability of principles and assumptions underlying the SIAP and SIAP outcome goals, and adjusts the Plan target outputs to match any changes/adjustments to the Plan principles, assumptions and goals.
Sleeper Licence	An irrigator who hold an irrigation licence but does not irrigate
TBL	Triple Bottom Line Assessment which comprises a Social,

	Environmental and Financial assessment of a particular action or program of actions
Unbundling	Unbundling separates an existing water entitlement into: water shares (high and low reliability), a delivery share (for regulated diversion licences this is called an extraction share), and a water-use licence.
Water savings	The water savings referred to in this plan are on farm water savings
WUL	Water Use Licences are granted by the Water Authority, on behalf of the Minister, to authorise the licensee to use water for irrigation on a property in accordance with the Water-Use Objectives and Standard Conditions.

Irrigation Terminology

centre pivots	Irrigates a circular area of pasture as a boom is moved in a clockwise or anti-clock wise direction from a fixed central location. Often a gun is attached at the end of the boom to irrigate corners of the paddock
Drip	Above ground low volume emitters.
fixed/permanent spray	Sub-surface pipes with risers, which are in a fixed location and not moved.
Flood (delivered through channels or pipped and risers)	Flat or lasered ground where water is released from a channel or pipe and flows over the paddock**.**
K-line (pods)	Sub-surface pipes with risers. Attached to each riser is a poly pipe with a series of seven to eleven sprinklers attached, these are moved around the riser typically in a six day rotation.
Key line (wild flood)	Allowing water to flow down the side of a hill from a channel, also called wild flood.
long lateral hand move (bike shift)	Sub-surface pipes with risers. Attached to each riser is a poly pipe with a sprinkler attached, these are hand moved around the riser typically in a six day rotation.
micro sprinklers	Small sprinklers used at the base of horticultural crops.
moveable pipes	Aluminium pipes connected together with risers attached and laid on the ground surface.
rotor rainor	A boom, which rotates covering approximately a 100 m diameter dropping water and is manually moved across the paddock.
subsurface drip	Underground tape with spaced emitters.
travelling guns	A gun or canon, which throws out water as the gun, rotates and is winched by cable across the paddock.
travelling boom	A boom, which throws out water as the gun, rotates and is winched by cable across the paddock.
Water babies	A device placed in a flood irrigation bay to indicate how far water has travelled down the bay.
Weather stations	Can be used to calculate appropriate water application rates.

Summary of SIAP Sections, Content and Purpose

Section 1	**Executive Summary** Summary of plan and actions	
Section 2	**Plan Status**	
Section 3	**Future Direction** Vision Mission Objectives	Where do we want to be?
Section 4	**Context** History, planning framework, implementation, linkages	Where are we now? How have we got here?
Section 5	**Plan Development** Methodology, consultation and engagement	
Section 6	**Setting Priorities for Resource Allocation** Assets based approach, asset values, threats Risk assessment, significant issues	How have we prioritised issues and determined important assets?
Section 7	**Recommended Actions and Targets** Resource condition targets, management action targets, programs, contribution to RCTs	What management actions will we use to protect these assets?
Section 8	**Implementation of the Plan** Responsibilities Timeframes	How will we implement these management actions?
Section 9	**Triple Bottom Line Assessment**	
Section 10	**Assumptions and Knowledge Gaps**	What other information will assist our decision making now and in the future?
Section 11	**Future Challenges and Opportunities**	
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1 Executive Summary

This Sustainable Irrigation Action plan has been developed to give a more rigorous basis for investment in the region to improve the sustainability of irrigation. This is the first time such a plan has been developed for the Goulburn-Broken Upper and Mid CMA region. Irrigation investment and planning for the region in the past has relied on other strategies and sub-strategies for guidance. One of the key objectives of the plan is to improve on farm water use efficiency and minimise irrigation related impacts to other assets.

The GBCMA region represents approximately 10% of the States catchment by area but provides 15% of the states combined average stream flow. The total gross value of agriculture in the region is approximately $1.5 billion including the SIR which is Victoria's highest gross value earner. It is difficult to determine the contribution of irrigation alone. The level of allocated irrigation in the entire GB area is approximately 340,000 hectares within a total of 2.4 million hectares. The SIR has an irrigation area of 320,000 hectares. The volume of irrigation water allocated to the Goulburn-Broken Upper and Mid area is around 85 Gigalitres. The source and use of this allocation is very diverse. Agricultural industry types using this irrigation water is dominated by pasture/fodder enterprises. Horticulture and cropping industries exist but to a lesser extent within the region. Most of the irrigation can be found along the main river valleys, the Goulburn River and Broken River valleys. Irrigation water is diverted directly from regulated and unregulated rivers and streams, pumped from ground water and taken farm dams. There is also a large diversity of irrigation management.

The Sustainable Irrigation Action Plan (SIAP) has been developed by using an Assets Based Approach; however, this plan has used a different approach to the new Land and Water Asset Based Framework prepared by Department of Sustainability and Environment (DSE). The new Framework had not been completed at the time this SIAP was being developed. The approach taken by this plan was to identify assets in a broader sense ie all remnant native vegetation and all wetlands, rather than focus on a particular patch of remnant vegetation or a particular wetland. A panel of experts as well as the Community Reference Group (CRG) identified these "broader assets" where irrigation potentially poses some form of threat, and identifies what that threat is. Irrigation itself has been identified as an asset to the region and as such threats to irrigation were also identified. One-hundred and six threats were identified. The plan has focussed on broader assets due to the wide dispersion of both irrigation across the catchment and of remnant vegetation and irrigation having cumulative affect on assets such as water quality, rather than just targeting the irrigation at the site of the problem. A risk assessment of the potential threats was undertaken by the panel of experts to determine what the high and extreme risks irrigation poses to assets, and those that threaten irrigation. There were 66 threats deemed to be significant (high or extreme risk).

In addition to the broader assets some known specific assets with a defined location in the region were also examined. There are a number of key assets and high value stream reaches identified in the region however a large proportion of these are unaffected by irrigation. For example the Howqua Sub-catchment has one sole irrigator allocated 2ML. Within this sub-catchment the Howqua River has been identified as a High Priority Stream and the Eildon BAP zone a Very High Priority, both reflective of their valued assets.

The plan has made calculated estimates on the potential water savings and nutrient load reduction for the region. This is for the case of every irrigator adopting best irrigation management principles tomorrow (ie moving from current status to a perfect world scenario). The calculated annual estimated saving (non cumulative) is 16,000 ML of water, 170 tonnes, of Nitrogen, 130 tonnes of phosphorus, 1,600 tonnes salt and 400 tonnes of soil. The plan has identified the sub-catchments where the greatest water savings and nutrient loading reductions can be made by improving irrigation management. These sub-catchments have been identified mainly due to the high concentration of irrigation within them and consequently would be priorities for running field days and group events. Sub-catchments identified as having great savings should not be used for setting priority for individual farm actions. Farms with the greatest potential for change should be targeted. Targeting a farmer with 100ML

outside one of the identified sub-catchment would provide greater benefits than targeting three irrigators with who only have 15 ML each. There is more scope for saving water and reducing nutrient loading on the one farm, than the three combined.

A list of eight management actions were examined (some with sub-categories) to determine the effectiveness they could have in terms of making on farm water use improvements and improving river water quality. Although these management actions will have other benefits, the water savings, and nutrients salt and soil reductions in rivers was used to undertake a benefit cost analysis and to examine which management actions warrant government investment. Of the management actions examined, this plan recommends the best four for investment of government money in:

- Soil Moisture Monitoring – encouragement, incentives and know how (2,061 ML saved over 5 years)
- Intensive extension for irrigators with >15ha – farm planning (1280 ML saved over 5 years)
- Education –field days and farmer group meetings (171 ML saved over 5 years)
- Irrigation system checks – examining the operation of irrigation systems (825 ML saved over 5 years)
- Benchmarking – measuring the performance of the irrigation enterprise (412 ML saved over 5 years)
- Intensive extension for all irrigators – farm planning (618 ML saved over 5 years)
- System change incentives for flood irrigation (private investment of 75%) (892 ML saved over 5 years)

There were other management action which still returned a positive investment of government money. These were

- System change incentives (private investment of 50%) (819 ML saved over 5 years)
- Re-use dam incentives (292 ML saved over 5 years)

To determine the benefit cost ratio for these management activities many assumptions had to be used, particularly in the determination of water savings and load reductions. Other potential project ideas and future challenges are put forward as suggestions (without a benefit:cost analysis). Some of these are related to gathering information around the assumptions used such as

Timing of water extraction
New irrigation developments
Investment in 3-phase power infrastructure
Saving trees from irrigation conversion
Assessing irrigation rostering duration due to low stream flow
Monitoring of ground water
Stream flow management plans
Monitoring Timing of Water Extraction
Incentive to save water where trading is restricted
Managing Domestic and Stock water use on specific rivers
Using Irrigation water to establish pastures
Sharing of data between organisations
Location and area of Irrigation

Some areas for future research are also suggested such as

- Examination of alternative pasture and fodder crop irrigation options
- Using more water use efficient crops
- Examining the prospect of autumn start or extended spring irrigation
- Irrigation scheduling for a range of crops
- Irrigation management of fodder crops
- Examining appropriateness of sub-surface irrigation on a range of the regions soil types
- Crop nutrient requirements
- Understanding nutrient losses from irrigated areas
- Examining climate change and water uncertainty with a risk management approach to irrigation

2 Plan Status

To date activities related to irrigation have relied on other strategies and sub-strategies for guidance. This Sustainable Irrigation Action Plan (SIAP) provides a more specific look at irrigation and irrigation activities in the region. The SIAP is a "Land and Water Management Plan" focussing on Irrigation.

The Mid Goulburn Broken and Upper Goulburn SIAP will ensure that there is:

- Alignment to Federal, State and regional policies and strategies
- Consistent approach and criteria for priority setting for land and water management planning activities and
- Defined and consistent approvals process.

This plan is the first attempt to bring together irrigation related information and data to describe the overall irrigation industry in the region. This information has then been used to identify on farm management actions to bring about on farm water savings and minimise environmental impacts that irrigation may cause. One of the purposes of the SIAP is to provide a regionally developed implementation planning document that guides Government investment in natural resource management (NRM) implementation works and measures in the MGB & UG catchment. The SIAP aligns with the overarching Goulburn Broken Regional Catchment Strategy and provide a coordinated approach to NRM. The SIAP has been developed in consultation with the community and comprises stakeholder and professionally (technically and economically) justified activities. The SIAP will also assist the Minister in making decisions on the distribution of funding for projects related to NRM, with a greater degree of confidence.

The SIAP describes the implementation of the works and measures to achieve the broad strategic targets included in the Goulburn Broken Catchment Strategies. The MGB & UG SIAP provides detailed implementation targets of a 5 year timeframe from 2008 – 2013. Figures have been based on 30 year costs and benefits and provide an integrated 5 year detailed works program and annual works plan to achieve targets. The SIAP provides input to the Regional Catchment Investment Planning process but is not replaced by Regional Catchment Investment Plans as described in Figure 1.

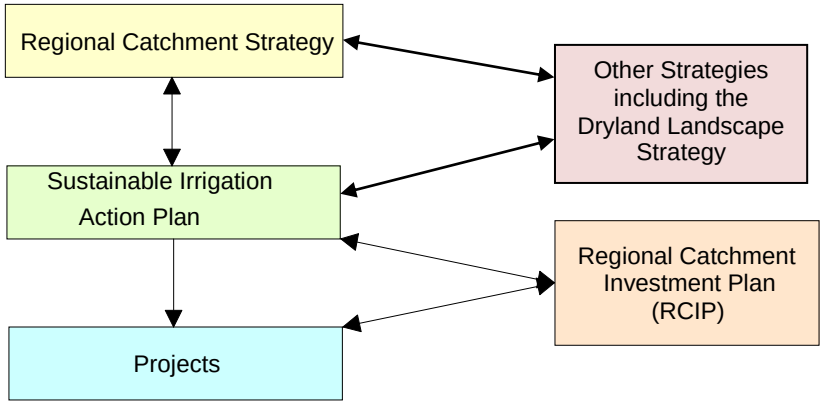


Figure 1: Role of the GB SIAP in the Regional Catchment Investment Planning Process

3 Plan Objective

The Goulburn Broken Catchment Management Authority (GBCMA) region has a wealth of environmental, social and economic assets. These assets affect each other positively and negatively. It is important these assets are allowed to flourish in a way that minimises any negative impacts on other assets. Irrigation is an important economic and social asset to the region. Even though it does not cover a large proportion of the land, it is still an important part of the landscape and economy within the region. This Sustainable Irrigation Action Plan **(referred to as the Mid Goulburn Broken and Upper Goulburn Sustainable Irrigation Action Plan)** describes irrigation across the region and how it interacts with other assets in the Goulburn Broken (GB) CMA region. Irrigation can be a threat to other assets (particularly environmental assets) across the region. This SIAP highlights the threats irrigation poses to other assets, defines the seriousness of these threats, and suggests some management actions to address threats. The SIAP also suggests what impact these management actions will have in protecting assets. A benefit: cost analysis has been undertaken for the management actions recommended.

Irrigated agriculture is an important part of our landscape. The Goulburn Broken Catchment Management Authority region is approximately 2.4 million hectares in size. There is approximately 340,000 hectares of irrigation; this however includes the Shepparton Irrigation Region (320,000ha) which leaves 20,000 hectares of irrigation in the dryland. 37% of the State water entitlement is allocated within the Goulburn and Broken Basins. The GBCMA region represents approximately 10% of the States catchment by area but provides 15% of the states combined average stream flow. It provides employment and adds to the region's economic wealth and stability. Irrigation is an asset to our region. Irrigation can impact on other assets (both positively and negatively) particularly environmental assets. It is critical to aim to minimise negative effects while still retaining and enhancing irrigation as an asset. In a large number of cases actions to improve the economics of irrigation reduces the negative impact on the environment.

The current and future impact of climate change/variability will continue to add further stain on irrigation in the region. Climate change/variability will decrease the availability of water for irrigation, towns, and stream flow. The demand for water will increase while the availability decreases. This will increase the need for irrigators to manage their water better and improve management practices. As well as resulting in reduced water available to irrigators the impacts of climate change can affect the type of plants irrigated. Increase in temperatures may improve the growth of C4 crops like millet, sorghum and maize or decrease growth of C3 plants such as perennial ryegrass. Climate change may reduce the level of frosts which can reduce the flowering of some horticulture plantations and damage plants.

Investing in sustainable irrigation in the upper catchments (MGB & UG) will reduce the impact of irrigation to land and water quality in the lower catchments. Considering the Shepparton Irrigation Region (SIR) generates approximately $5.9 billion annually (Michael Young and Associates, 2001) it is important to protect the economic asset of the region.

3.1 Vision

A vision for the future of irrigated agriculture in the Mid Goulburn Broken and Upper Goulburn region has been proposed:

> *"To make irrigated agriculture sustainable and economic for diverse communities by efficiently utilising water resources allocated."*

This vision will contribute to the overall objective of the GB Regional Catchment Strategy which is:

> *"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 creating opportunities for a regional community actively engaging in natural resource management programs."

(RCS, 2003).

3.2 Objective of the Plan

The vision will be achieved by implementing management actions that improve the water use efficiency, and minimise the environmental impacts of irrigated agriculture throughout the Catchment.

3.3 Objectives for Plan Development

The key objectives of the Mid Goulburn Broken & Upper Goulburn Sustainable Irrigation Action Plan are:

- To improve knowledge of existing and potential future irrigation industries across the GBCMA Dryland region.
- To assess the current and potential impacts from irrigation on key environmental, social and economic assets.
- To identify priority locations and management actions to address irrigation-related threats to assets, and contribute to the attainment of key targets in the Goulburn Broken Regional Catchment Strategy and relevant Action Plans.
- To provide a framework and justification for Government investment in Sustainable Irrigation across the GBCMA Dryland region.

The SIAP will help ensure that the region's water resources are used sustainably and efficiently. Direction for this is provided by the Victorian Government White Paper *"Securing Our Water Future Together".* The Sustainable Irrigation Action Plan is also developed within the framework provided by the Goulburn Broken Regional Catchment Strategy and its component Action Plans.

4 Context

4.1 Plan Context

This is the first SIAP for the Mid Goulburn Broken and Upper Goulburn region of the Goulburn Broken Catchment Management Authority (GB CMA). The Sustainable Irrigation Program has driven government investment in activities and the responsible management of irrigation management in the absence of a formal Land & Water Management Plan.

One of the primary objectives of the Sustainable Irrigation Program in the MGB & UG region has been to improve the water use efficiency, and minimise the environmental impacts of irrigated agriculture throughout the Catchment. This objective is expected to help facilitate the provision of ecologically sustainable flows in rivers, and assist in the reduction of the salinity, water quality, and biodiversity impacts of irrigation. The program has aimed to achieve the long-term sustainability of irrigated agriculture in the region, by addressing all significant threats (arising from irrigation) to environmental, social and economic assets.

The development of this new SIAP highlights the importance of irrigation in the region and the need to incorporate a community endorsed strategy for management of irrigation.

The area covered by the Plan is the Mid Goulburn Broken and Upper Goulburn areas within the Goulburn Broken CMA region. A very high proportion of this area is unirrigated. This plan will only focus on the small but important areas where irrigation exists.

The MGB & UG region provides a wealth of natural assets that have been analysed in the Regional Catchment Strategy and component Action Plans. It is important that these assets (environmental, economic and social) are not degraded in quality from threats arising from irrigation.

The GB Regional Catchment Strategy and its component Action Plans do not currently cover threats related to irrigation in the MGB & UG region in great detail. The SIAP addresses these irrigation-specific threats and investigates the interactions between irrigation and the environmental, social and economical assets of the Mid Goulburn Broken and Upper Goulburn.

The SIAP recommends a program of actions and investment to address identified threats to assets, and ensures the sustainability of irrigated agriculture in the MGB & UG of the GB CMA region.

4.2 History of Planning Process

A new “asset-based framework” has recently been developed for the consistent development of Land and Water Management Plans. This framework has not been used for the SIAP because as it had not been developed when the SIAP was initiated. Future SIAP’s should be developed with consideration of the new asset-based framework.

The SIAP has been developed using the fundamentals of the asset-based approach however it differs from the new framework.

The asset approach ensures investment is directed to protecting high value assets that are threatened. This SIAP highlights Environmental, Social and Economic assets, and how issues associated with irrigation are threatening these assets.

A Community Reference Group (CRG) was established in December 2005 for the purpose of overseeing the development of the SIAP. The Groups primary objective was to ensure a draft plan was prepared for submission to the GBCMA Board and DSE for endorsement. Representation within the group consisted of key community and agency stakeholders with an interest in Sustainable Irrigation in the Mid Goulburn Broken and Upper Goulburn region.

Funding for Sustainable Irrigation in the Mid Goulburn Broken and Upper Goulburn areas is currently through the Regional Catchment Investment Plan (RCIP) within the Salinity Infrastructure program. State and National Action Plan (NAP) money are the sources from which funds originate.

4.3 Overview of plan area

The Goulburn Broken Catchment is divided into three geographical areas as seen in Figure 2.

The Upper Goulburn area includes the unregulated section of the Goulburn River upstream of Lake Eildon where many streams flow down from the alpine area of north east Victoria. From the weir at Eildon, the Goulburn River runs westward to Seymour then heads north towards the River Floodplains of the Goulburn Broken Region.

The Mid Goulburn Broken area incorporates all of the Broken River and the mid section of the Goulburn River. From upstream of Lake Nillahcootie where it is regulated and again at Casey's Weir, to the East Goulburn Main Channel located at Shepparton East. The Broken Creek diverts away from the Broken River at Casey's Weir, flowing northward to Katamatite and eventually meets the Murray River near Picola. The Goulburn River included in the Mid Goulburn Broken region includes the segment from Seymour to Goulburn Weir at Nagambie. Tributaries of the Goulburn River around this area generally originate from the Strathbogie Range.

This SIAP relates to the above two geographical areas (Upper Goulburn and Mid Goulburn Broken).

The Shepparton Irrigation Region (SIR) is the floodplain area of the Goulburn Broken Catchment and is where the most intensive irrigation occurs. The Goulburn Weir at Nagambie regulates and distributes the large volumes of water to the irrigation region. The SIR has been intensively managed since the implementation of the Shepparton Irrigation Region Land and Water Management Plan in June 1990. This plan aims to achieve sustainable land management through various programs with annual investments of approximately $16 million. The major issues facing this area are salinity in shallow aquifer systems, surface-drainage, blue-green algae outbreaks and river and wetland health management.

Legend

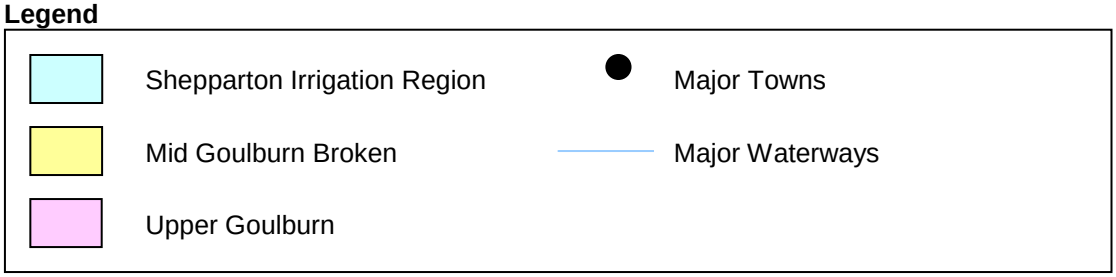


Figure 2: The Goulburn Broken Catchment

4.3.1 Catchment Management Structure

The Goulburn Broken Catchment Management Authority (GBCMA) is responsible for preparation of the Regional Catchment Strategy (RCS) and reporting of outcomes and targets. Eleven members comprise each Implementation Committee from various stakeholder groups, which provides support and input to the Regional Catchment Strategy and Sub-strategies.

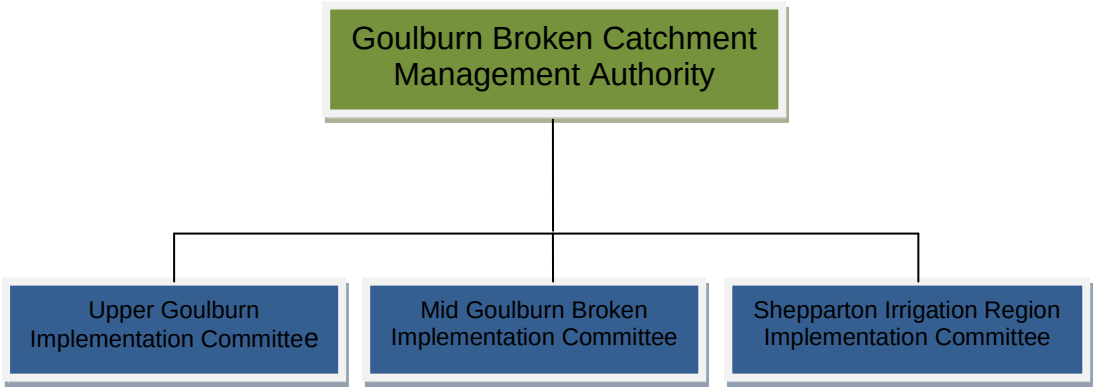


Figure 3: GBCMA structure

4.3.2 The Goulburn and Broken Basins

The region is made up of two river basins each flowing generally in a north-west direction towards the Murray River. The Goulburn and Broken Basins each have different characteristics in topography, rainfall, soil types, industries and power type.

The Goulburn Basin

The Goulburn Broken Regional River Health Strategy 2005-2015, describes the Goulburn River Basin as Victoria's largest, covering over 1.6 million hectares or 7.1% of the state's total area.

The terrain varies significantly across the catchment from the high ranges and mountains of the Great Dividing Range in the south, to the flat country of the Murray Plain in the north. The high country in the southeast experiences cold winters with persistent snow and an average annual rainfall greater than 1,600mm. Rainfall decreases northward, and in the far north of the catchment is less than 450mm per year, only one third of the annual evaporation in that area. With the higher rainfall, a number of the Goulburn River's major tributaries rise on the northern slopes of the Great Dividing Range. These include the Big, Delatite, Howqua and Jamieson rivers.

The upper Goulburn catchment generates around 8% of the water resources in the Murray Darling Basin from an area less than 2% of its catchment. Lake Eildon, with a 3,334 GL capacity, is the major water storage that captures and distributes water for agricultural, industrial and urban use through the highly productive irrigation areas of the Goulburn and Murray Valleys.

Approximately 60% of the catchment is publicly owned and is managed as hardwood forests. Rainfall distribution, vegetation and topography vary greatly from the ski fields at Mount Buller in the Victorian Alps to the foothills and flood plains of the Goulburn River near Nagambie.

Its natural attractions appeal to tourists and recreational users from many centres including heavily populated Melbourne, less than two hours drive away. Boutique industries, viticulture, orchards, recreation and environmental tourism increasingly support the more traditional land uses of beef and sheep grazing and dryland crops.

The defining features of the upper Goulburn catchment include the colours of the bush, infinite space, landscape diversity and indigenous heritage. The catchment is home to the Taungurung people, part of the aboriginal Kulin Nations, whose heritage is evident throughout the region.

There are 1075km of streams in the Goulburn Basin, 45% of these are of Moderate ISC (Index of stream condition) rating and 10% of Excellent rating. The Goulburn River stream flow has been modified by the dam at Lake Eildon and downstream at Goulburn Weir.

The Broken Basin

The Goulburn Broken Regional River Health Strategy 2005-2015, notes the Broken River basin as 772,386 hectares representing 3.4% of Victoria's total area. The Broken River is a tributary of the Goulburn River and joins the Goulburn River at Shepparton. The basin also includes the catchment of the Broken Creek that diverges from the Broken River west of Lake Mokoan and flows north-west to the Murray River.

Climate varies considerably across the Broken River catchment. In the south, average annual rainfall is about 1,270 mm. This decreases to about 700 mm near Benalla, 550 mm at Dookie and 470 mm at Cobram. Across the northern section rainfall generally decreases to the west.

Most of the Broken River catchment has been cleared of native vegetation for agriculture comprising mainly grazing in the south and mixed cereal and dryland grazing in the central region. A large part of the northern section is within the Murray Valley irrigation district where intensive horticultural, dairy and livestock production occurs.

In the north of the basin a unique linear corridor exists, bordering the Broken, Nine Mile and Boosey Creeks. The area spanning 1030 hectares was proclaimed as the Broken-Boosey State Park with the passing of the Box-Ironbark Bill in 2002. The park includes streamside reserves and public land water frontages along creek systems and is the only substantial occurrence of high quality native vegetation on the northern plains.

Streamflow is extremely variable between seasons and between years. The three months July to September generally account for over half the annual stream flow.

The catchment has a mean annual flow of 325,000 ML (0.42 ML/hectares); however annual flow has varied from a minimum of 5,000 ML in the drought year of 1943, to a maximum of more than 1,000,000 ML in the flood years of 1917 and 1956.

Two major and two smaller storages have been constructed within the catchment. Lake Nillahcootie was built in 1967 with a capacity of 40,000 ML and Lake Mokoan, constructed in 1971, has a capacity of 365,000 ML. These reservoirs provide water for stock, domestic and irrigation supplies. Two small reservoirs constructed on Ryans Creek, provide water to the town of Benalla.

The city of Benalla is the largest urban community. There are also a number of major towns including Cobram, Nathalia, Yarrawonga and Numurkah.

The Broken Basin includes 788.5km of streams. Of this, 46% is classified of moderate rating as per ISC, 37% defined as poor, 12% very poor, 3% excellent and 2% has insufficient data to be classified. Flow has been modified by a reservoir at Lake Nillahcootie and Lake Mokoan however there are decisions over Mokoans management that are currently concerning its future use as an irrigation collection reservoir.

4.3.3 Natural Resource Units

The MGB & UG region is very diverse in terms of landforms, topography, climate, soils and water availability. The region has been divided up into a total of 61 smaller sub-catchment units (Figure 4).

G-MW data incorporates a field known as Sub-Customer Group (SCG). Each Service Point that diverts water for irrigation is given a SCG classification (Appendix 1 provides the description of the SCGs and a list of sub-catchments). Figure 4 shows the distribution of Sub Catchments.

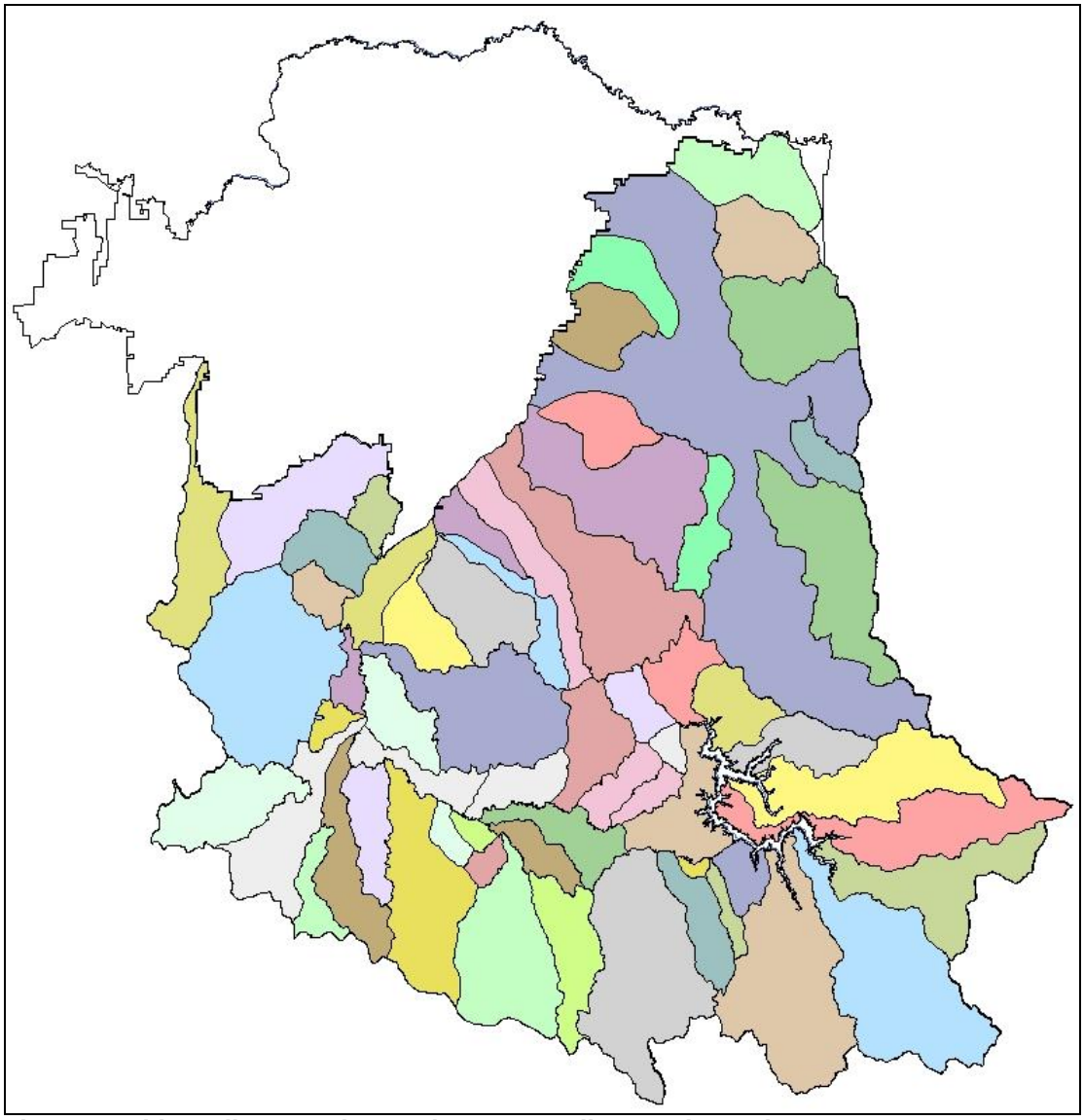


Figure 4: Mid Goulburn Broken and Upper Goulburn Sub Catchments

4.3.4 Irrigation in the Mid Goulburn Broken and Upper Goulburn catchment region

Irrigation within each of the sub-catchments varies in terms of intensity, industry type, irrigation system used, sources of water, and soil types.

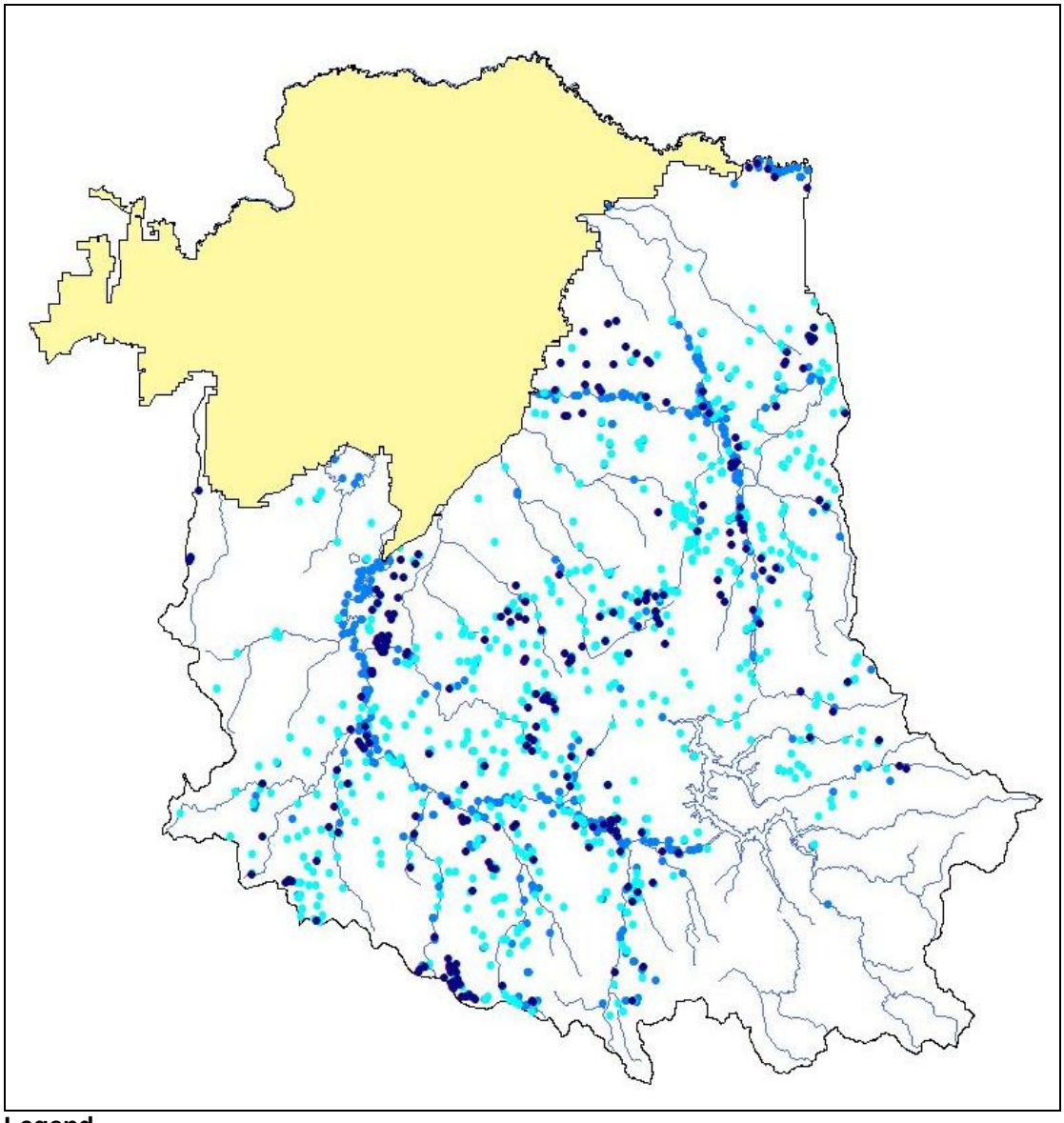
Location and Volume

Sources of water for irrigation provide dryland farmers the opportunity to access water and expand an enterprise on a property. Surface water river diverters are limited by their proximity to extract water from a river. Surface water diverters follow the paths of the river flow in regulated and unregulated streams, with many between Lake Eildon and Goulburn Weir on the Goulburn River (Figure 5).

The location of groundwater bores in the region follows river paths to an extent but is obviously not limited by its proximity to a river or stream for extraction. The nature of groundwater flow however, suggests that prior streams have large water bearing ability in river plain areas. Voids in fractured rock also provide the ability to store groundwater and gain access to. Much of the groundwater allocation in the region occurs between Lake Eildon and Goulburn Weir on the Goulburn River.

Groundwater users are limited by, a) finding a suitable aquifer within property boundaries, b) the yield of the aquifer for its viability to invest in infrastructure, and c) the quality of the water that is extracted from the aquifer.

Dams on farms are evenly distributed around the region for irrigation however their purpose is normally to store water from another source. Pressurised systems require certain volumes for one irrigation session therefore sourcing the water from storage ensures its availability. The Farm Dams legislation and also soil type on the property limit dam location, as lighter soils tend to leak into the groundwater therefore making the source not viable. Again the most Farm Dams allocation is between Lake Eildon and Goulburn Weir on the Goulburn River.



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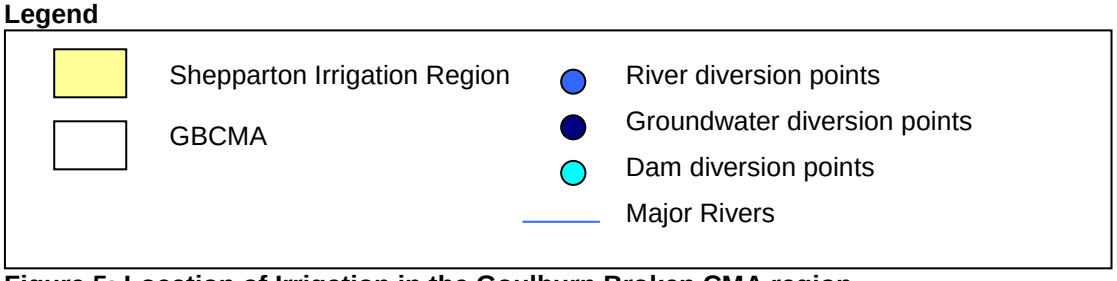

Figure 5: Location of Irrigation in the Goulburn Broken CMA region

Table 1 shows the number of irrigation licenses and the volume and area allocated within each sub-catchment. These figures are based on the 2006 licence allocation figures.

Table 1: Number of irrigators, volume allocated and area licensed to irrigate for each sub-catchment.

Sub-catchment	No.	Volume (ML)	Area (ha)	Sub-catchment	No.	Volume (ML)	Area (ha)
Acheron	70	1424.2	555.6	King-Parrot	53	1495.8	380.1
Back	17	1958.5	346.2	Kurkurac	30	744	294
Boosey	34	846	301.5	Limestone	17	1192	318
Boundary	7	378	99.6	Lower Goulburn	48	5684.7	1133.9
Branjee	1	297	51	Majors	9	322	81
Brankeet	5	73	20	Merton	8	221	67.9
Broken	296	26636.8	6049.2	Mollisons	13	247	86.9
Buffalo	2	105	19.3	Muckatah	50	7291.9	2592.8
Castle	13	448.5	148.5	Murrindindi	13	235.2	97.8
Christie Hill	4	234.5	39	Pranjip	30	658.5	391.2
Congupna	7	439.5	133.6	Rubicon	4	220	39.4
Cornella	4	166	42	Sandy	7	368	71.1
Creightons	11	259.5	56	Scrubby	62	4644.4	1108.1
Dabyminga	12	197	69.1	Seven	64	1529.9	495.7
Dairy	5	809	90.3	Sheep-pen	18	1830	512
Delatite	20	434.9	191	Sheepwash	13	3274.8	545.6
Dry	16	338	98.2	Snobbs/Rubicon	2	15	10.9
Eastern Dairy	9	652	122.5	Spring	7	556	97.1
Five	25	640	173.7	Stony	3	32	15
Ford	11	84	19	Strath.North Tribs	55	4962.9	1224.9
Hjuts	43	2551.5	540.4	Sunday	16	388.4	142.3
Holland	29	743.2	204.2	Tallangalook	6	53	24
Home	22	790.8	236.1	Upper Goulburn	1	5	1.7
Honeysuckle	18	489	138	Wanalta	9	53	36.2
Howqua	1	2	1	Whiteheads	32	1867	418
Hughes	75	2664.5	1115.5	Wormangal	13	1538	309.1
Jamieson	4	49	9.2	Yea	87	2280.7	576.7
Johnson	2	19	6	Unknown	11	92	97

Source GMW 2006

Sources of Irrigation Water

There are four main sources of irrigation water:

- Diversions from regulated rivers;
- Diversions from unregulated rivers and streams;
- Irrigation dams (registered or licensed); and
- Ground water (bore or drag line hole).

The regulated rivers are the Goulburn River below Eildon, the Broken River below Nillahcootie and Broken Creek below Casey's Weir.

Table 2 shows licence allocations and how the water is sourced. The greatest volume of water is allocated out of rivers within the plan area.

Table 2: Volume and area of irrigation by source (Based on 2006 allocation figures)

Source	No.	Volume (ML)	Area (ha)
Dam	597	11,076	4,589
Groundwater	251	15,848	3,306
River	596	58,612	14,072

Domestic and stock users also divert water from rivers and streams where irrigation occurs. Generally the amount of irrigation diverted from an individual steam far exceeds that diverted for domestic and stock, however there are some exceptions. There are 13 rivers where D&S is equal to or higher than the irrigation volume allocated. There is an additional ten rivers

where D&S is greater than the irrigation volume allocated. Appendix 2 shows the number and volume of, allocated irrigation and domestic and stock diversions from rivers and stream in the catchment which are irrigated from.

Ground water can be extracted from shallow aquifers or from deep leads. Extraction from the shallow aquifers can be from bores or drag line holes. Dragline holes are an excavated hole where groundwater flows in laterally. The recent dry weather conditions have resulted in reduced flow rates from shallow aquifers or even zero. Irrigators accessing water from the deep leads may have a more secure source of water, but there is a need to pump water from a greater depth meaning the cost of pumping the water will be significant. Note some of these deep bores may be over 100 meters deep but if there is a positive pressure, this can bring the static level up closer to the surface. The ground water can be sourced from storages in fractured rocks, granitic rocks, riverine plains, and upland alluvium.

4.3.5 Industries

The irrigation industry in the region is very diverse including pastures, a range of horticultural crops, viticulture, wool, forestry and grazing (sheep and beef).

DPI (January 2005) states that the Goulburn Statistical Division had the highest total gross value of agriculture in Victoria of $1.5 billion. This includes 48% of the states fruit production, 23% of milk production and 22% of the value from pastures and grasses. Of course these figures include the SIR which is Victoria's greatest gross value earner. There is very little data separating the irrigation region and the dryland areas of the Goulburn Broken Catchment however the proximity of irrigation business infrastructure is an advantage compared to other dryland areas in northern Victoria.

Figure 6 shows the dominance of pasture industries in the Goulburn Broken Dryland over other industry types that are allocated irrigation water. Pasture for grazing was the greatest user of irrigation water in 2003/04 with other crops and grapevines making up approximately 6,000ha.

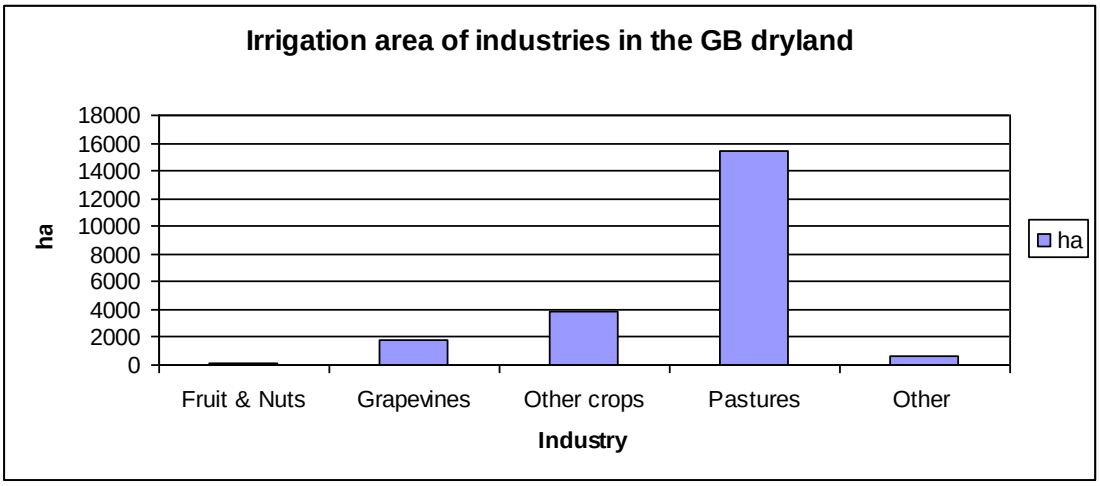

Figure 6: Industry type irrigated in the Mid Goulburn Broken and Upper Goulburn areas. From ABS 2000/01 Agriculture Census (Morris 2006).

Table 3 refers to the area of general land use types and includes the SIR (approximately 900,000ha). The total dryland area is approximately 1.4 million hectares however the total area of irrigation for 2003/04 in the dryland is approximately 22,000ha where nearly 16,000ha is under irrigated pasture as can be seen in Figure 6.

Table 3: Goulburn Broken Land Use– Goulburn Broken Regional River Health Strategy 2005

Land Use Type (ha)	Goulburn	Broken	Total
Native Vegetation (forested)	544,000	111,650	655,650
General agriculture (Dryland)	916,800	532,070	1,448,870
Intensive agriculture (irrigation)	110,400	99,330	209,730
Plantation (pines)	6,400	16,940	23,340
Urban	1,600	770	2,370
Total (ha)	1,579,200	760,760	2,339,960

4.3.6 Types of irrigation systems used

There is a large diversity of irrigation systems used in the region. This diversity exists due to the varying topography, plants irrigated, era of installation, area irrigated, soil types, sources of water, access to 3-phase power, and attitudes of farmers. The types of irrigation systems found are summarised with additional details in the glossary:

- flood (delivered through channels or pipe and risers)
- key line (wild flood)
- centre pivots
- fixed/permanent spray
- long lateral hand move (bike shift)
- K-line (pods)
- travelling guns
- travelling boom
- rotor rainor
- moveable pipes
- drip
- micro sprinklers
- subsurface drip

Many irrigation properties have more than one irrigation system and some have more than four different types.

4.3.7 Characteristics of irrigation in the GBCMA region

There are significant differences between irrigation in the GBCMA region compared with defined irrigation regions such as the Shepparton Irrigation Region (SIR). These include:

- a small proportion of the landscape is irrigated
- lack of channel infrastructure meaning the vast majority of irrigation water has to be pumped from rivers/streams, ground water and dams
- large proportion of the diverted irrigation water used is unregulated with these rivers/streams subject to Stream Flow Management Plans in the future which may affect availability of water
- majority of irrigation used where irrigated pasture makes up only a small proportion of the grazing farm
- irrigation season is shorter and hence the time period to profit from irrigation infrastructure is lower
- higher rainfall with lower evaporation rates requires less water to grow crops
- issues of rising water tables and salinity are less significant than down stream
- lack of channel infrastructure can mean low evaporation and seepage losses
- Irrigation scheduling can be more precise because access to water is less complicated.

4.3.8 Irrigation volumes and area

The total volume of water licensed for irrigation in the region is over 85 Gigalitres (GL) and over half of this is regulated (62%). The volume of licensed irrigation water is described in Table 4.

The greatest volume of licensed irrigation water and the majority of licensed irrigators are below Lake Eildon to Goulburn Weir on the Goulburn River and Lake Nillahcootie to Casey's

Weir on the Broken River. The highest volume per licence tends to be found downstream of Bundalong on the Murray River.

Not all of the licensed irrigation water is utilised because of “sleeper” and “dozer” licences. A “sleeper” is an irrigator who does not irrigate and a “dozer” only irrigates some years, such as times of dry conditions. The G-MW diversion inspectors have estimated sleeper licence values of; 20% in the Broken River and Broken Creek, 60% in the Upper Goulburn zone, and 50-60% in the Mid-Goulburn area. If all these licences became active it may place more of a strain on the system. However, it is expected a large number of the “sleepers” are lifestyle/hobby farmers, and hence the licence volumes may be lower than the average and some of the water may have been traded to other irrigators. The level of irrigation development of these sleepers in the future is difficult to predict. It depends on a number of different factors such as: the cash flow of the potential developer, the cost of pumping water, ie diesel or electricity, future increases in water allocations, changes to trading laws, and gross margins between dryland and irrigated crops.

Table 4: Volume, Number and Average Volume of licensed irrigation allocation and how it is sourced

	Regulated			Unregulated			Farm Dam			Groundwater			Total		
	No	**Vol (ML)**	**Ave Vol (ML/Lic)**	**No**	**Vol (ML)**	**Ave Vol (ML/Lic)**	**No**	**Vol (ML)**	**Ave Vol (ML/Lic)**	**No**	**Vol (ML)**	**Ave Vol (ML/Lic)**	**No**	**Vol (ML)**	**Ave Vol (ML/Lic)**
Tribs of Eildon				10	238.9	24	27	368	14	4	142.5	36	**41**	**749.4**	18
Eildon - Goulburn Weir	204	21920	107	120	5124	43	313	4617	15	144	10539	73	**781**	**42200**	54
Goulburn Weir - Broken R	4	119	30	14	534	38	96	2392	25	28	714	26	**142**	**3759**	26
Goulburn R off stream systems	5	96	19							4	166	42	**9**	**262**	29
us Nillahcootie				1	40	40	5	38	8	1	40	40	**7**	**118**	17
Nillahcootie - Casey's	62	4056	65	12	308	26	80	1767	22	31	755	24	**185**	**6886**	37
Lake Mokoan	14	1498	107				19	274	14				**33**	**1772**	54
Casey's - Goulburn R	64	12705	199				22	449	20	21	2243	107	**107**	**15397**	144
Broken Creek	42	6020	143	2	74	37	32	497	16	13	507	39	**89**	**7098**	80
Murray R ds of Bundalong	45	6550	146							5	741	148	**50**	**7291**	146
Total	**440**	**52964**	**120**	**159**	**6319**	**40**	**594**	**10402**	**18**	**251**	**15848**	**63**	**1444**	**85533**	**59**

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4.3.9 Recycled Water Use

A small proportion of irrigation occurs in the Mid Goulburn Broken and Upper Goulburn with recycled water, sourced from Goulburn Valley Water, the urban Water Authority. The quality is determined by the treatment of the urban wastewater. The Environmental Protection Authority (EPA) implement guidelines that govern the use of recycled water with issues including spray drift in pressurised systems, nutrient leeching and run off.

In 2001/02 Goulburn Valley Water had access to 6395 ML across its jurisdiction. In comparison to 2003/04, 6988 ML was used which accounted for 10% of the states reclaimed water supply (DPI, 2006). The sites within the dryland area include, Alexandra, Bonnie Doon, Broadford, Eildon, Mansfield, Nagambie, Seymour, Upper Delatite, Wallan and Yea. The industries irrigated are grazing, golf courses and forestry

4.4 Planning framework

The GB Regional Catchment Strategy identifies broad catchment assets and threats, and provides direction on how to protect the assets of highest value and risk. The various component Action Plans of the Regional Catchment Strategy (RCS) provide more detailed direction on the protection of specific land, water or biodiversity assets, or on the management of specific threats to assets. For example, the GB Regional River Health Strategy aims to achieve improvements in the riverine assets of the region. The Water Quality Strategies provide a framework for managing threats to water quality. Protection of the land assets is managed through the GB Soil Health Action Plan and the GB Dryland Salinity Action Plan. Biodiversity assets are managed through the GB Native Vegetation Plan.

The Regional Catchment Strategy is of critical importance for the region as it provides the opportunity to deliver a coordinated approach to catchment management. It establishes the framework for integrated catchment management and set priorities and actions.

A Dryland Landscape Strategy (DLS) for the Goulburn Broken region is currently in development which will provide a vehicle to holistically integrate programs across the Dryland region. At a strategic level, there are six programs including, Natural asset protection, Investment diversification, Land use sustainability, resilient communities and Climate change adaptation. As articulated in Figure 7, outcomes from the DLS will feed into the RCS targets, and once it has been completed, Sub-strategy outcomes will feed into the DLS targets.

Key Regional Strategies and Plans that need to be linked to the proposed SIAP include:

- Goulburn Broken Regional Catchment Strategy
- Goulburn Broken Water Quality Strategy
- Goulburn Broken Dryland Salinity Management Plan
- Goulburn Broken Native Vegetation Management Strategy
- Goulburn Broken River Health Strategy
- Goulburn Broken Soil Health Strategy
- Goulburn Valley Water wastewater reuse program
- Victoria's Greenhouse Strategy
- Irrigation water metering program

The SIAP will also help to position the region to support implementation of the irrigation management components of the following strategies and plans that are currently under development, or planned to be developed in the near future:

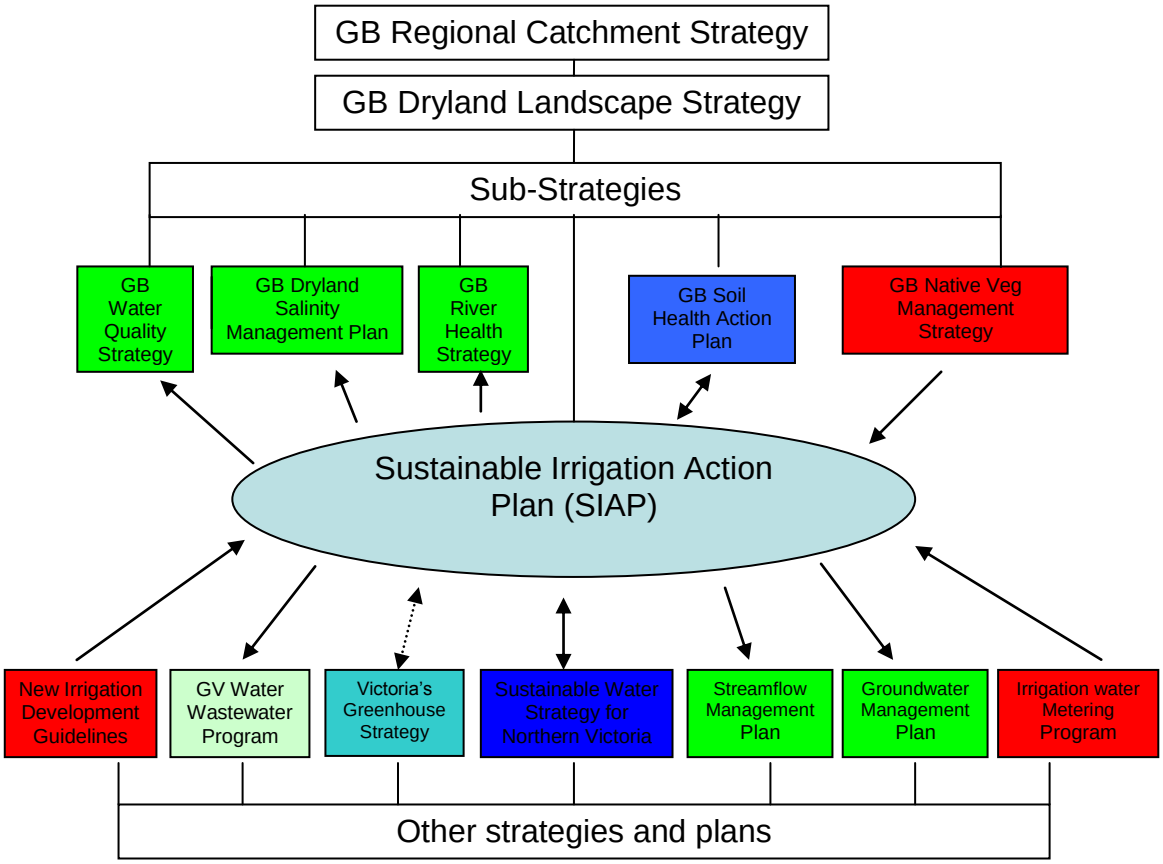
- Streamflow Management Plans for the Yea and King-Parrot Rivers, with others likely to follow
- Groundwater Management Plan for the Mid Goulburn Groundwater Management Area, with others likely to follow
- Sustainable Water Strategy for Northern Victoria

- Dryland Landscape Strategy
- Land and Biodiversity White Paper

A summary of these strategies and their inter relationships is provided in Figure 7.

Key Statewide strategies that have influenced the development of the MGB & UG SIAP include:
- State Environment Protection Policy – Waters of Victoria
- The MDBC Living Murray Environmental Flow Initiative
- Victorian Water Irrigation Farm Dams Act 2002
- The Environment Sustainability Action Statement (July 2006)
- Water Use Licences – Standard Conditions and Water Use Objectives
- Salinity Management Framework
- Victoria's Greenhouse Strategy

The influences of these broader strategies are outlined in Section 4.6.



Strategies coloured green indicate the SIAP will enhance the objectives. Those coloured red will help meet the objective of the SIAP. Those coloured blue will be enhanced by the SIAP and help the SIAP meet the objectives. The light blue and green indicate a weaker influence. The direction of arrows also indicates the direction of influence with the double arrow indicating an influence both ways.

Figure 7: Summary of strategies and sub-strategies and their interactions

4.5 Plan development process

The Goulburn Broken CMA is responsible for development and implementation of the SIAP.

The GB CMA has ensured the establishment of a **community reference group** (CRG) to oversee project direction and delivery to the CMA and facilitate the timely delivery of the project to the desired standard. The CRG has representatives from major stakeholders (as outlined in acknowledgements).

The GB CMA has contracted DPI to undertake the technical development of the SIAP. DPI has established a **Technical Experts Panel** to assist in the development of the SIAP.

DSE (Melbourne) is responsible for policy level appraisal and final endorsement of the SIAP.

The GB CMA will be responsible for implementation of the SIAP in conjunction with DSE (regional) and DPI. The GB CMA will be dependent upon the existing structures to ensure timely and efficient delivery of the proposed action plan.

4.6 Linkages with broader strategic programs

In recent years there have been vast changes in water reform under the Water Act. The White Paper changed the overall management of water in the State in 2004. The documents described below have been endorsed by the State Minister. The major objectives of the documents are to minimise the impact of extraction and utilisation of the water.

4.6.1 Streamflow Management Plans (SFMP)

SFMPs are plans that manage unregulated water that is in high demand in specific catchments. The plans cover issues including, the environmental flow requirements, rules for sharing water when the resource is scarce, monitoring and metering programs, rules for the allocation of extra water, and the conditions of trading water. They are developed with the local community and ensure that all surface water in the sub catchment is managed sustainably and fairly. SFMPs in the Goulburn Broken Region are not yet established however once the extraction rates are determined, appropriate management can be proposed. Currently the King Parrot Creek and Yea River have draft SFMP's that are being reassessed under new criteria.

4.6.2 Environmental Flow

DSE defines Environmental Flow as “the flow regime of a river needed to satisfy specified ecological requirements.” It also takes into account the prosperity and conservation of the local community economically, socially and environmentally. Water that is set aside for the long term health of the river system is known as the Environmental Water Reserve (EWR) and is legally protected through legislation.

4.6.3 Farm Dams

Different types of farm dams are used for different purposes. The impact of farm dams depends on their location within a catchment, their size, evaporation rates, use, and level of development in the catchment. Dams can be located either on waterways or off waterways. A construction licence is required for all dams on waterways. Licensing authorities can advise whether the proposed site of a dam is on a waterway.

4.6.4 Groundwater

All ground water use other than domestic and stock must be licensed. Prior to a licence being granted, consideration is made as to the impact of the extraction i.e. the impact to other ground water users or the environment. The Government declares Permissible Consumptive Volumes (PCV) in order to manage aquifers sustainably. In areas where water levels are declining, a

Water Supply Protection Area is declared and a management plan prepared. This is to place appropriate management restriction on groundwater licences in the relative area (DPI, 2006).

The established Groundwater Management Area's (GMA's) in the Mid Goulburn Broken and Upper Goulburn area include Alexandra (PCV 1937ML/yr), Goorambat (No allocation limit established) and Kinglake (PCV 2,015ML/yr) (DPI, January 2005).

The establishment of sustainable yield figures becomes extremely complex due to interactions between groundwater aquifers and surface water bodies.

Existing ground water licences greater than 20 ML will be required to be metered, and all new licences independent of volume, will require a meter. The development of any bores must first obtain a bore construction licence and a licence to take water before any water can be extracted.

4.6.5 Water Trade

The ability to trade water on the water market provides licence owners with a greater flexibility of managing the productivity of their farm. Buying and selling water can be done permanently or temporarily and prices are based on tender processes managed by Watermove, which is a non-profit company. Trading zones define the areas an irrigation licence holder can buy and sell. There are implications of trading permanent water out of a trading zone.

4.6.6 Water Use Licences

From 1 July 2007 a Water Use Licence (WUL) is required by anybody wishing to irrigate land using surface water supplied by a regulated water supply system in Northern Victoria. A WUL recognises and defines an irrigator's authority to use water for irrigation on a property, and has legislative backing. WUL's will occur for unregulated water users some time in the future.

The Authority, where requested by the Minister for Water, shall advise the Minister on Standard Conditions and Water Use Objectives for WULs (including suggested changes to wording on Standard Conditions and Water Use Objectives) in accordance with relevant legislation. The Minister will then make a decision on the recommended changes to Standard Conditions and Water Use Objectives.

The Mid Goulburn Broken and Upper Goulburn SIAP is consistent with the intent of the Water Use Objectives and Standard Conditions in the WULs (Appendix 3)

4.6.7 Irrigation Development Guidelines

Irrigation development guidelines consistent with the Water Use Objectives and Standard Conditions approved by the Minister for Water have been prepared for the Goulburn Broken region. These guidelines ensure that the WUL Objectives and Standard Conditions are met by new development. The Mid Goulburn Broken and Upper Goulburn SIAP support and are consistent with the Goulburn Broken Irrigation Development Guidelines.

5 Plan Development

The Mid Goulburn Broken and Upper Goulburn SIAP was initiated by the GBCMA in 2005 with the publication of a project brief endorsed by DSE.

5.1 Methodology

5.1.1 The general planning process

Development of the SIAP commenced with the establishment of a Community Reference Group in December 2005 with defined terms of reference and representation from key stakeholders. Members included DSE region, DSE investors, GMW, Community, Upper Goulburn Implementation Committee, Mid Goulburn Broken Implementation Committee and DPI staff.

The development of the SIAP for the Mid Goulburn Broken and Upper Goulburn of the Goulburn Broken CMA was undertaken concurrently with the SIAP for the North East region. This allowed joint CRG and common resources to be utilised ensuring greater efficiencies.

The CMA contracted DPI staff to undertake the technical development and preparation of the SIAP under the guidance of the CRG. The CRG have convened on nine occasions to review the approach adopted, methodology used for risk assessment and the establishment of management targets.

A Technical Experts Panel was established to review technical information and ensure a rigorous analysis of risks and proposed management actions. This Panel included representatives from Department of Primary Industries, Murray Darling Freshwater Research Centre, Goulburn Murray Water, consultants and farmers.

This plan is currently available for DSE policy appraisal and broader stakeholder consultation.

5.1.2 Identification of threats and associated risks

The Technical Experts Panel identified irrigation assets in the region and assets which irrigation may affect positively and negatively. Threats against these assets where then determined by the panel and a risk analysis undertaken on the threats to determine a high or extreme risk level.

5.1.3 Data sources and interpretation

The location of allocated irrigation was supplied by G-MW. The data provided the volume and area allocated to the irrigation licence, the source of water, and the stream name where applicable. A break down of the proportion per area of different irrigation industries was obtained from the ABS. Different soil properties, location of wet lands, significant rivers and significant biodiversity location were obtained from GIS layers. This data/information was combined to gain an understanding of the likely soil types and their characteristics that are irrigated across the region. By imposing a number of assumptions, potential on farm water savings and possible nutrient load reductions were calculated for the whole catchment and for each sub-catchment. This information also allowed the proximity and intensity of irrigation to biodiversity assets, wetland and significant rivers to be determined.

5.1.4 Analysis of the effectiveness of management options

A number of management options or programs are suggested to address the high risk threats that were identified. These programs were designed to bring about on farm water savings and reduce nutrient and salt loads leaving the farm. The programs were scrutinised for the level of savings and cost effectiveness. The benefits were determined by estimating the level of community engagement and effectiveness of each program. This resulted in an overall impact and an estimate of savings. An economic benefit was determined by placing a dollar figure on the

water, nutrient and salt load reductions estimated to occur. The cost of implementing each program over five years allowed a ranking of a benefit:cost analysis of the suggested programs; the benefits were measured over 30 years.

5.2 Consultation and engagement

Consultation has occurred via the Community Reference Group and the Technical Experts Panel. Additional consultation will be undertaken with regional stakeholders following DSE endorsement.

6 Setting priorities for resource allocation

6.1 Assets based approach

A new “asset-based framework” has been developed by DSE for the consistent development of Land and Water Management Plans. This new framework has not been used with this SIAP because the framework had not been finalised in time. Future SIAP’s should be developed with the consideration of the new asset-based framework.

The Assets Based Approach used in this plan is predicated on identifying natural/built elements, valuing these resources and identifying risks that impact on these identified assets. The rationale of this is that it will provide a way of:

- identifying and locating assets within the landscape
- providing a nominal value for these assets, and
- Identifying risks associated with land use and other activities that affect these assets, services provided by these assets and consequences of these risks.

By undertaking this approach, actions to manage natural resources in the environment can be developed in a relatively transparent manner. These actions can be prioritised to deal with threats/impacts that have a high level of consequence to assets/asset services that have been identified by the community and government to be of high value. This is reflected by examining impacts on services provided by assets. The assets based approach is summarised in Figure 8.

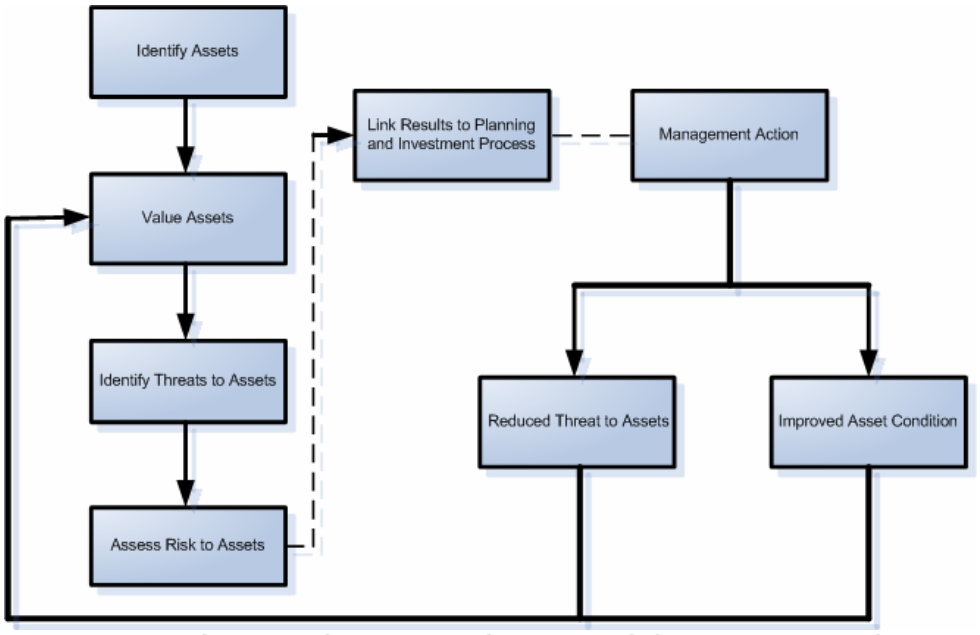


Figure 8: Assets Based Approach Conceptual Framework (source DSE 2005)

6.1.1 Definition of an asset

An asset is defined as – a natural or human-made physical entity. Three classes of assets are typically recognised; water, land fertility (which accounts for agricultural productivity & irrigation), built infrastructure (such as roads and buildings), and biodiversity (the natural environment) (AS 4360 Risk Management Standard).

The approach taken in the SIAP is not to define assets as individual locations, structures, plants or animals, but rather take an encompassing approach with an aim to reduce the threats to all

assets not just one. Particularly when considering river health, works can not just be focussed on one river reach because the whole catchment up stream is contributing. The plan however has looked at irrigation proximity to identified priority assets, priority streams, and salinity priority zones in the region.

The SIAP incorporates all Natural assets listed under the Goulburn Broken Regional Catchment Strategy and most Economic and Social Assets.

The assets associated with irrigation in the GBCMA region have been divided into three categories Environmental, Social and Economic. These have then been broken up further into Primary Assets, Secondary Assets and finally Asset Items.

6.1.2 Assets framework

The Environmental, Social and Economic Asset Values have been broken up into four Primary Assets, Secondary Assets and finally Asset Items (Table 5). The Primary Environmental Assets are water, land, biodiversity and atmosphere. The Primary Social Assets are regional development and tourism while the Primary Economic Assets are irrigated agriculture and land use.

Table 5: Environmental, Social and Economic Asset values identified in the plan

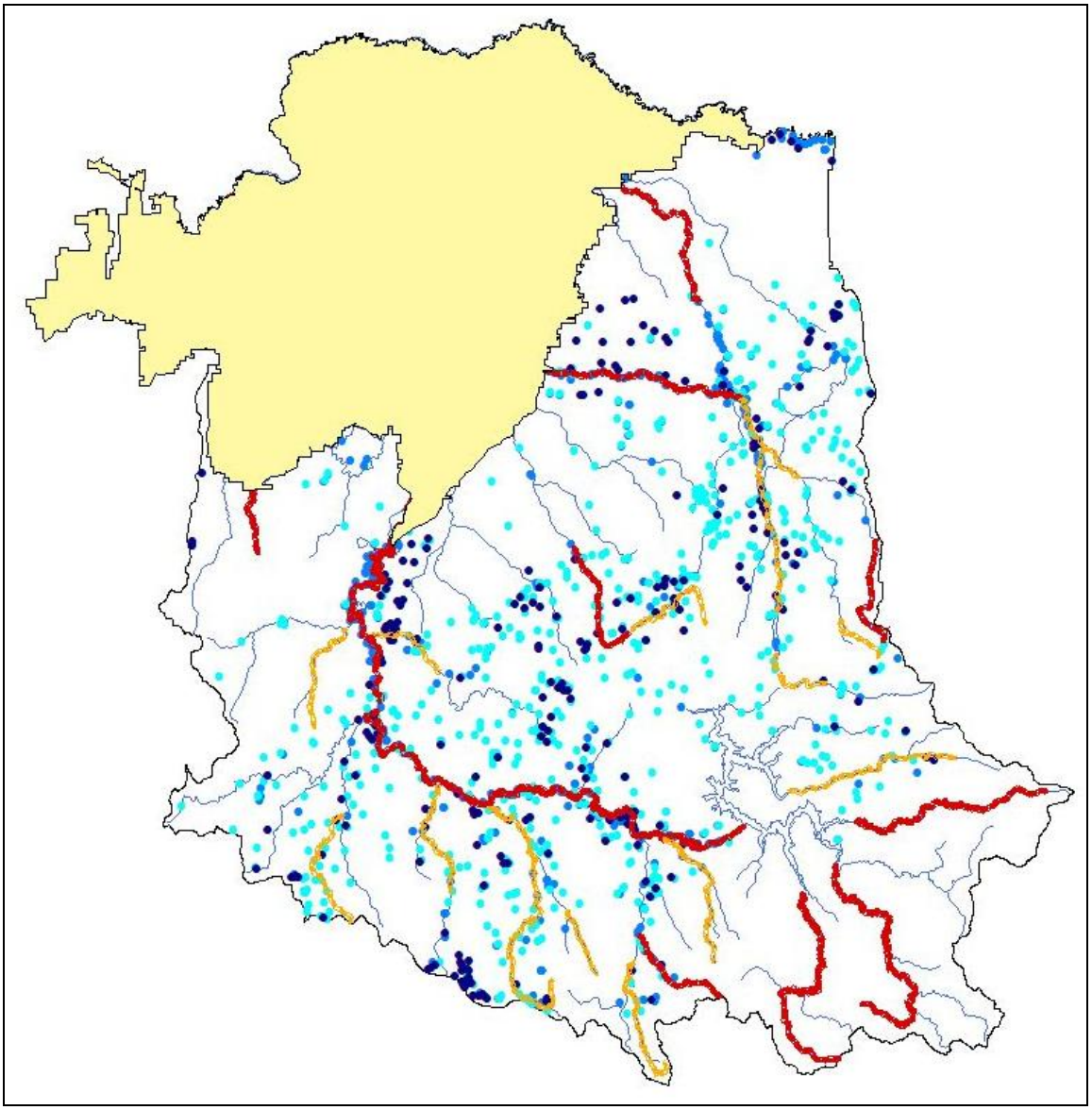
Asset Value	Primary Asset	Secondary Asset	Asset Item
Environment	Water *(Priority Streams against irrigation points in Figure 9)*	Regulated rivers & streams	Flows Water quality
		Unregulated rivers & streams	Flows Water quality
		Wetland	Water quantity & quality
		Aquifers	Water quantity Water quality
	Land	Soil health	Physical Chemical Biological
	Biodiversity *(EVC's & BAP's against irrigation points in Figure 10 & 11)*	Remnant Native Vegetation	Biodiversity Action Plan sites Terrestrial / Riparian adjacent to irrigation Terrestrial / Riparian within irrigated area
		Native Fauna	Aquatic species Terrestrial species
		Native Flora	Aquatic species Terrestrial species
	Atmosphere	Climate	Stability Air quality
Social	Regional Development	Population	Population growth
		Infrastructure	Infrastructure
	Tourism	Recreation	Recreational use of water

		Cultural Heritage	Indigenous heritage European heritage
Economic	Irrigated Agriculture	Access to Water	Availability of water (within regulated system) Availability of water (within unregulated system)
		Access to Land	Availability of land
	Land use	Productivity of irrigated agriculture	Productivity

6.1.3 Assets of the GB Dryland

Priority Streams

Rivers and streams in the GB Dryland have been prioritised according to criteria established by the Regional River Health Strategy. In this plan they are viewed as a significant asset and need to be protected from risks associated with irrigation.



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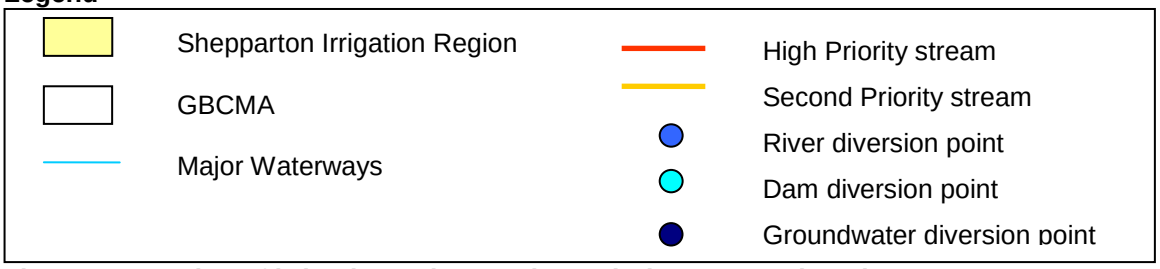
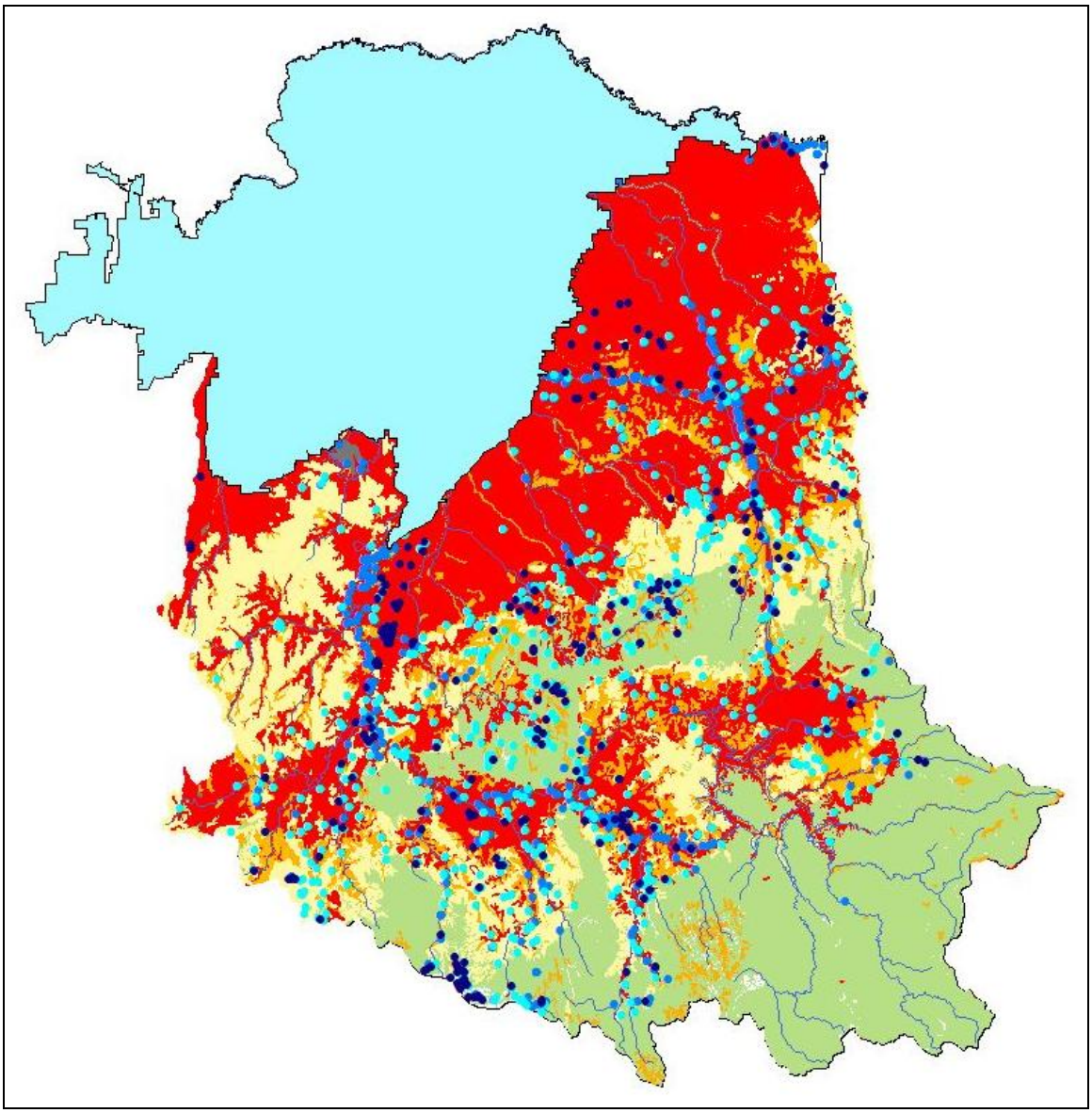


Figure 9: Location of irrigation points against priority streams (2005)

Ecological Vegetation Classes

Present day EVC's within the GB dryland are shown in Figure 10. It is documented that the landscape has been cleared selectively to make way for agricultural development since 1750, mainly on grassy woodland types. Parts of the landscape are also degraded from their original status from many threatening processes.



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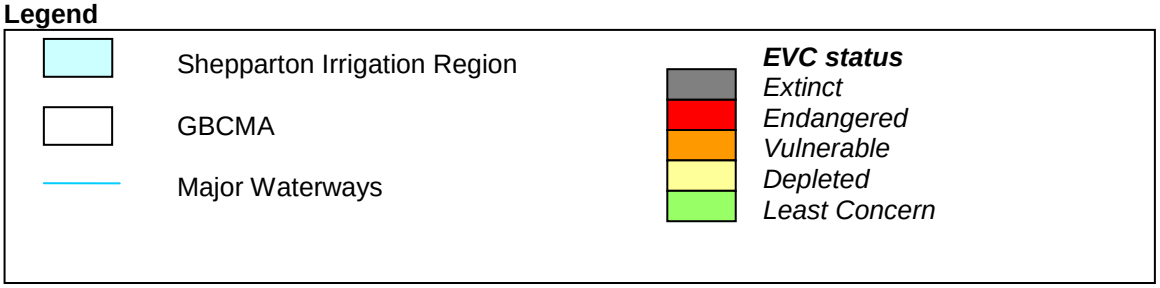
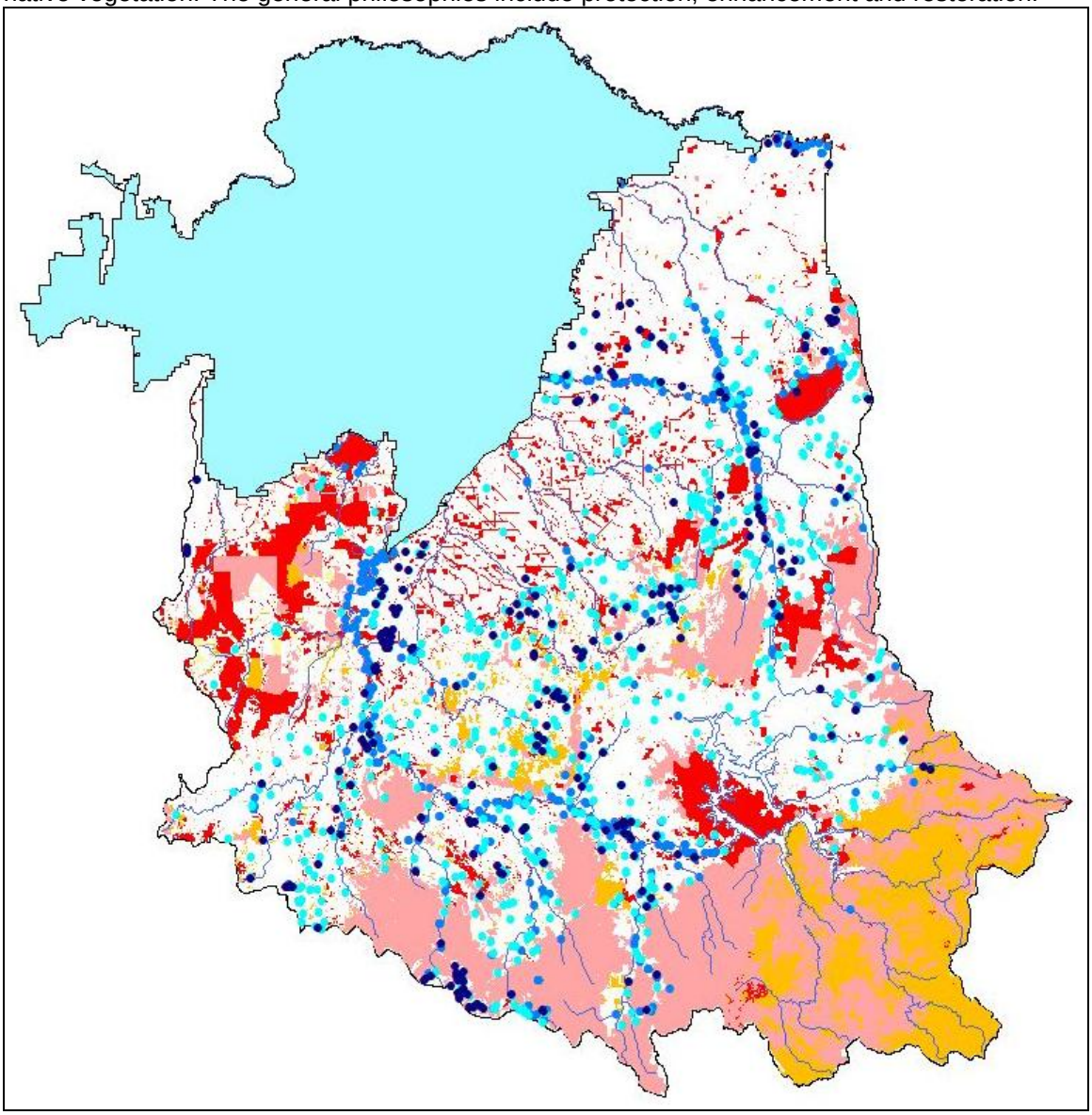


Figure 10: Location of irrigation points against ecological vegetation class status (2005)

Biodiversity Action Plan sites

BAP sites in the GB dryland are the response to the Victorian Governments *Victoria's Biodiversity Strategy (1997)* and are designed to target planning at a landscape level. Each BAP zone has a plan completed that identifies assets, priorities for action and the best option for restoration of native vegetation. The general philosophies include protection, enhancement and restoration.



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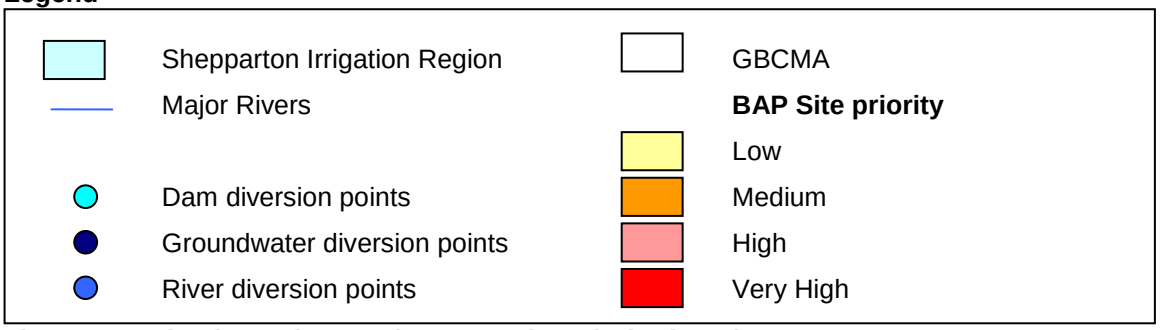

Figure 11: Irrigation points against BAP site priority (2005)

6.2 Threats to assets

6.2.1 Definition of a threat

A Threat is defined as a potential or existing adverse impact on an asset (AS 4360 Risk Management Standard).

6.2.2 Identified threats

An assessment of threats was undertaken with over one hundred and six irrigation-related threats being identified. Technical experts were utilised to identify these threats and the potential impact of the threat on the asset item.

6.3 Risk assessment

6.3.1 Definition of a risk

A risk has been defined as the chance of something occurring that will impact on the achievement of objectives (AS 4360 Risk Management Standard).

6.3.2 Risk assessment

An analysis of assets and threats was undertaken using a standard risk assessment approach. This involved the allocation of the likelihood and consequence of a particular threat occurring.

Likelihood is the probability that a defined impact will occur within a specific time period.
Consequence is the degree of severity of an occurrence of the hazard.
(Australian Risk Management Standard AS 4360).

Likelihood ranged from Improbable to Certain based on how often a threat may occur (Appendix 4). Consequence ranged from Low to Catastrophic depending on the impact of the threat (Appendix 4).

The CRG were involved in the assessment of the likelihood and consequence for each of the threats drawing on their own experience and knowledge. All assessments were collated with an average likelihood and consequence score determined for each asset/threat combination.

A standard risk assessment matrix (Appendix 4) was then used to determine a final risk score ranging from low to extreme (Low, Medium, High, Extreme).

The risk assessment was conducted on the asset/threat combinations. The threats have been colour coded based on the risk rating. The entire risk assessment is included in Appendix 5.

E = Extreme	H = High	M = Medium	L = Low

6.3.3 Environment

The threats identified related to irrigation and the processes surrounding irrigation. The SIAP intends to direct management to irrigation-related threats currently or potentially impacting on high value assets.

6.3.4 Social

The CRG identified the deterioration of water quality and reduced water availability as a threat to social assets, affecting population growth and recreational activities. Also increased agricultural activities, such as grazing, as a result of irrigation can increase pressure on cultural heritage sites.

6.3.5 Economic

As with all environmental threats, there is in most cases an economic loss that is more often than not imposed on the private landowner. For example salinity and below average rainfalls can decrease productivity.

The Goulburn Broken Water Quality Strategy estimated the cost of potentially toxic algal blooms in the catchment is estimated at $17.2 million per year. A major cost is to farm stock and domestic supplies and irrigation water supplies.

6.4 Significant Issues

6.4.1 Definition of a Significant Issue

A significant issue was determined from the risk assessment. Any asset/threat combination that resulted in an extreme or high risk assessment was nominated as a significant issue. Of the 106 threats assessed 31 where considered Extreme and 34 were considered High risk.

The major asset/threat combinations (high and extreme risks) have been summarised in Table 6.

Table 6: Significant issues as identified through risk assessment (extreme and high risks)

	Primary Asset	Secondary Asset	Asset Item	No.	Threat	Risk	Impact
Environment	Water	Regulated rivers & streams	Flows	1	Diversion of surface flows for irrigation	E	Altered natural flow patterns of stream (includes floods, normal flows, low flows, slack water)
			Water quality	3	Salinisation	H	Increased stream salinity levels (decline in health of aquatic life and biodiversity); increased salt loads (downstream impacts)
				4	Eutrophication	E	Altered stream ecology; increased algal blooms; reduced biodiversity
				5	Erosion	E	Increased turbidity, sedimentation (sand slug), light blocking
				7	Decline riparian vegetation (inc. grazing)	H	Change in carbon levels in water, loss fish habitat, decline food source
				9	Pollution (including thermal pollution cold)	H	Impacts on species (e.g. native fish breeding); decline in productivity of aquatic life
				10	Lack of knowledge/monitoring	E	Poor management decisions
		Unregulated rivers & streams	Flows	11	Diversion of surface flows for irrigation	E	Altered natural flow patterns of stream (includes floods, normal flows, low flows, slack water)
				12	Capturing surface run off (irrigation farm dams)	H	Less surface run off into streams and infiltration into aquifers
			Water quality	13	Salinisation	E	Increased stream salinity levels (decline in health of aquatic life and biodiversity); increased salt loads (downstream impacts)
				14	Eutrophication	E	Altered stream ecology; increased algal blooms & acid sulphate; reduced biodiversity
				15	Erosion	E	Increased turbidity, sedimentation (sand slug), light blocking
				17	Decline riparian vegetation (inc. grazing)	H	Change in carbon levels in water, loss fish habitat, decline food source
				18	Pollution (including fuel spills & pesticide)	H	Death/decline in health of aquatic life; decline in aquatic

						biodiversity
			20	Lack of knowledge/monitoring	E	Poor management decisions
	Wetland	Water quantity & quality	21	Irrigation water use (reduced wetland inflows from stream, local catchment or groundwater)	H	Altered flooding/drying regime (reduced inflows); altered wetland ecology
			22	Salinisation	H	Increased salinity levels (decline in health of aquatic life and biodiversity)
			23	Sedimentation	H	Increased turbidity; altered wetland ecology; in-filling of wetland depression
			24	Eutrophication	H	Altered wetland ecology; increased algal blooms & acid sulphate; reduced biodiversity
			25	Soil acidification	H	Decreased water pH; altered wetland ecology
			26	Irrigation water use (reduced wetland flushing)	H	Creates nutrient sinks (P & S build up); altered wetland ecology
			27	Water logging	H	Change of fringe
			28	Pollution (including fuel spills, pesticide, fertiliser spills & antibiotics)	H	Death/decline in health of aquatic life; decline in aquatic biodiversity
			30	Lack of knowledge/monitoring	E	Poor management decisions
	Aquifers	Water yield	31	Groundwater use for irrigation	H	Decline in contribution to streamflows
		Water quality	32	Salinisation	E	Increase salt stores in aquifers
			36	Lack of knowledge	E	Poor management decisions
Land	Soil health	Physical	37	Loss of vegetation cover	H	Increased risk of erosion; deterioration of soil structure; loss of organic matter
			38	Compaction (stock, machinery & cultivation)	H	Deterioration of soil structure
		Chemical	42	Poor irrigation practices (e.g. systems, rates, fertiliser use)	H	Acidification and nutrient loss (run off & leaching)
		Biological	43	Erosion	H	System shift
			44	Water logging	H	Creates an anaerobic environment
			45	Cultivation	H	Change of habitat
			46	Deterioration of soil structure (Compaction &	H	Change of habitat

					sodicity)		
				47	Chemical imbalance	H	System shift
		Remnant Native Vegetation	Biodiversity Action Plan sites	48	Eutrophication	E	Change to natural condition
				49	Water logging	E	Change to natural condition
				50	Increasing edge effects (vegetation decline, pests, weeds)	E	Shrinkage/loss of BAP area
			Terrestrial / Riparian adjacent to irrigation	51	Grazing	E	Change to natural condition (decline/loss of species, weed invasion)
				52	Eutrophication	H	Change to natural condition (decline/loss of species, weed invasion)
				53	Water logging	E	Change to natural condition (decline/loss of species, weed invasion)
			Terrestrial / Riparian within irrigated area	54	Irrigation Development (on previously unirrigated land)	H	Removal of any remnant native vegetation, and eventual decline/loss of remnant trees
				55	Tree clearing within irrigated area (e.g. for reconfiguration, system change)	E	Removal of remnant trees
				56	Grazing (including stock camp and ring barking trees)	E	Decline/loss of remnant trees
				57	Eutrophication	E	Decline/loss of remnant trees
				58	Water logging	E	Decline/loss of remnant trees
		Native Fauna	Aquatic species	59	Altered flow regimes; deterioration of water quality	E	Decline/loss of species
			Terrestrial species	60	Loss of habitat	E	Decline/loss of species
		Native Flora	Aquatic species	61	Altered flow regimes; deterioration of water quality	E	Decline/loss of species
			Terrestrial species	62	Clearing	E	Decline/loss of flora
				63	Irrigation development (on previously unirrigated land)	E	Decline/loss of flora
Social		Cultural Heritage	Indigenous heritage	73	Grazing/cultivation/clearing	H	Damage to heritage sites
Economic	Tourism	Cultural Heritage	Indigenous heritage	83	Grazing/cultivation/clearing	H	Damage to heritage sites

	Water Use	Access to Water	Availability of water (within regulated system)	86	Increased environmental flows	H	Reduced water availability for irrigation
				87	Below average rainfalls/over allocation	H	Reduced water availability to irrigation
				88	Transfer of water right out of region	H	Loss of water for irrigation from whole region
				92	Increased demand for water (irrigation and domestic)	E	Increased cost of water for irrigation
			Availability of water (within unregulated system)	93	Increased environmental flows	E	Reduced water availability
				94	Below average rainfalls/over allocation	E	Reduced water availability to irrigation
				95	Transfer of water right out of region	E	Loss of water for irrigation from whole region
				97	Government Regulations (SFMP's, GWMP's, Farm Dams, IDG's, WUL's)	H	Barrier to development
				98	Deterioration of water quality	H	Water unsuitable for irrigation
				99	Increased demand for water (irrigation and domestic)	E	Increase cost of water
	Land Use	Access to Land	Availability of Land	101	Increased dominance of lifestyle landholders across region	H	Limiting availability of land for irrigation and increasing land values
		Productivity of irrigated agriculture	Productivity	103	Weeds	H	Decrease in productivity and WUE
				104	Water logging	H	Decrease in productivity, WUE & crop choice

6.4.2 Significant Issues related to environmental assets

In summary the significant issues that were identified in the risk assessment include:

- Additional diversion from high demand systems will alter the natural flow of rivers and streams.
- Irrigation adjacent to regulated and unregulated rivers and streams can increase, water turbidity from erosion and eutrophication from fertiliser application if not managed correctly.
- Irrigation adjacent to unregulated rivers and streams can increase the salinity level in areas of high salinity priority if not managed correctly.
- Irrigation in the areas with lighter soils is at risk of water infiltrating into the groundwater raising the watertable if not managed correctly.
- Terrestrial and riparian vegetation adjacent to irrigation is at risk from grazing animals and waterlogging if not managed correctly.
- Terrestrial vegetation within an irrigated area is at risk from grazing, eutrophication, waterlogging and tree removal to make way for irrigation systems.
- Aquatic fauna and flora is at risk from altered flows in rivers and streams.
- Terrestrial fauna is at risk from loss of habitat resulting in decline of numbers.
- Terrestrial flora is at risk from clearing and irrigation development (on previously unirrigated land).
- Availability of water in a regulated and unregulated system is at risk from higher demand, which would increase the cost of water for irrigators.
- Availability of water in an unregulated system is at risk of increased environmental flows, reducing the amount available to irrigators.
- Availability of water in an unregulated system is at risk from the transfer of water out of the region reducing the amount within an area.
- Availability of water in an unregulated system is at risk from below average rainfalls, reducing the amount within an area.
- Management of water quality issues, wetlands, biodiversity and aquifers are at risk as a result of knowledge gaps.

6.4.3 Spatial analysis of significant issues

The risk assessment provided a means to identify issues across the Goulburn Broken Dryland region however it did not highlight where threats actually exist within the large and diverse region. Use of GIS data allowed spatial analysis of several issues. The main threatening process highlighted in this analysis is associated with soil type and how it allows water to pass through it.

The risk of irrigation water getting past the root zone is a volume of water removed from a source only to be wasted. In addition to this water being wasted the water escaping past the root zone is likely to contain nutrients adding to the problem of eutrophication of rivers and streams (identified as an extreme threat in Table 6). When this water escaping past the root zone is linked to shallow water tables there is potential of increasing salinisation. Irrigation points were intersected with Water Erosion risk where soils were classified as Very High to Low risk based on light or heavy soil characteristics and hence the potential for water to move past the root zone. The results have been tabulated for more detailed understanding of where the biggest proportion of threat is occurring.

Waterway Issues

Irrigation close to waterways can increase nutrient loads, sedimentation or pollution to that waterway. Poorly managed irrigation close to waterways on light soil types can cause nutrients, in particular nitrogen, to leach and enter the river or stream. Poorly managed irrigation on dispersive soils, can allow soil particles to enter the river or stream. Irrigation data points were intersected with a Water Erosion Risk layer where Very High Water Erosion Risk corresponds to lighter soils and Low Water Erosion Risk corresponds to heavier soils.

Table 7. Number and volume of licensed irrigators within 500m of a waterway and the associated water erosion risk and the percentage of the total irrigation in the region.

Water erosion risk	Number of licenses	Volume (ML)
Very High	18 (1.2%)	442.3 (0%)
High	85 (6%)	2,407.8 (2.8%)
Medium	21 (1.4%)	584.4 (0.7%)
Low	210 (15%)	25,564.5 (30%)
Unknown	29 (2%)	1,929.7 (2.3%)
Total	363 (26%)	30,928.7 (37%)

There are a total of 363 licenses for irrigation within 500m of a waterway allocated nearly 31,000ML. The majority of these licenses are located on Low Water erosion risk soils (15%). Just over 1% of irrigators are licensed to irrigate within 500m of a waterway on Very High water erosion risk soils (Table 7).

Table 8. Number and volume of licensed irrigators within 500m of a waterway on Very High Water Erosion Risk soils by Subcatchment.

	Very High Water Erosion Risk		Total	
Subcatchment	**Number**	**Volume (ML)**	**Number**	**Volume (ML)**
Acheron	0	0	19	664
Back	0	0	8	965.5
Boosey	0	0	2	25
Broken	1	10	132	16,921.4
Christie Hill	0	0	1	6
Creightons	0	0	3	168
Delatite	0	0	4	202.4
Five	0	0	11	340
Ford	0	0	4	54.5
Hjuts	0	0	7	1,278.5
Holland	0	0	9	302.9
Home	1	4	8	312
Honeysuckle	0	0	5	239
Hughes	1	127	12	819
Johnson	0	0	1	74
King Parrot	11	248.9	21	387.5
Kurkurac	2	33	4	47
Limestone	0	0	1	30
Lower Goulburn	0	0	15	1,279.7
Majors	0	0	4	30
Mollisons	0	0	1	2
Muckatah	0	0	1	617
Murrindindi	1	14.4	8	171.2
Pranjip	0	0	3	14
Rubicon	0	0	2	213
Sandy	0	0	2	359
Scrubby	0	0	8	1,035
Seven	0	0	7	76.3
Snobs/Rubicon	0	0	1	34
Strath. N. Tribs	0	0	18	2,597.9
Sunday	0	0	7	216.4
Tallangalook	0	0	2	7
Upper Goulburn	1	5	1	5
Wanalta	0	0	3	19
Whiteheads	0	0	12	1,034
Yea	0	0	16	381.5
Total	18	442.3	363	30,928.7

The majority of the 18 licenses on Very High Water Erosion Risk soils are in the King Parrot Creek subcatchment (11). Of the total 363 licenses within 500m from a waterway, 132 are located in the Broken subcatchment (Table 8).

Priority Streams

A number of rivers and streams have been classified as "High Priority" or "Second Priority" within the catchment. The two priorities are divided based on their environmental, economic or social value, or whether it supports national or international significant flora or fauna.

Table 9. Number and volume of licensed irrigators within 500m of a Priority Stream and the associated Water Erosion Risk and the percentage of the total irrigation in the region.

	Very High Water Erosion Risk		Total	
River Priority	**Number**	**Volume (ML)**	**Number**	**Volume (ML)**
High	1 (0%)	5 (0%)	243 (17%)	26,703 (32%)
Second	1 (0%)	1 (0%)	108 (7.6%)	6,525.7 (7.7%)
Total	2 (0.1%)	6 (0%)	351 (25%)	33,228.7 (39%

There are many priority streams in the Goulburn Broken Dryland as seen in Figure 9. Two irrigation licenses are within 500m of a priority stream on Very High Water Erosion Risk soils. The High Priority stream locality is in the Upper Goulburn subcatchment and the Second priority stream is in the Yea subcatchment. There are 351 licenses to irrigate within 500m of a priority stream, 243 of these are close to a High Priority stream, 17% of the total irrigation in the region (Table 9).

Table 10. Number and volume of licensed irrigators within 500m of a Priority Stream on Very High and High Water Erosion Risk soils by Subcatchment.

	Very High and High Water Erosion Risk		Total	
Subcatchment	**Number**	**Volume (ML)**	**Number**	**Volume (ML)**
Acheron	11	295.2	17	883.2
Back	7	411	25	1,674
Broken	5	652	107	14,463.9
Christie Hill	0	0	23	1,037.5
Delatite	5	209.4	5	209.4
Dry	3	7	4	9
Eastern Dairy	0	0	1	25
Hjuts	0	0	6	1,462.5
Holland	0	0	1	6
Hughes	0	0	7	679
Johnson	0	0	1	74
King Parrot	9	204.6	15	441.6
Limestone	3	44	5	104
Lower Goulburn	6	327	29	2,254
Majors	0	0	2	64
Rubicon	2	213	4	457
Sandy	0	0	2	524
Scrubby	0	0	15	2,187.5
Seven	0	0	5	73
Sheepwash	0	0	1	848
Snobs/Rubicon	0	0	1	34
Snobs	0	0	2	155.5
Strath. N. Tribs	4	123.9	30	3,492.8
Sunday	0	0	1	74
Upper Goulburn	1	5	1	5
Whiteheads	0	0	12	1,251
Yea	23	634.4	25	689.8
Total	79	3,126.5	351	33,228.7

The main location of irrigators within 500m of a Priority Stream is in the Broken Sub-catchment area with 107 of the total 351 irrigators. Only five of these are irrigating on soil types with a Very High or High Water Erosion Risk. The Yea River Sub-catchment however has a total of 25 irrigators within 500m of a Priority Stream and 23 of these are irrigating on Very High or High Water Erosion Risk soils (Table 10).

Biodiversity Issues

Irrigation adjacent to ecologically significant biodiversity can have negative impacts on them. For example irrigation of orchards can encourage exotic insects, birds and animals. Water applied via irrigation and not used can cause water logging and irrigation grazing systems generally have higher stocking rates and hence grazing damage on these areas can be increased.

Biodiversity Action Plan sites in the Goulburn Broken Catchment have been identified and relevant management plans have been completed on each zone. The plans contain specific information on assets and priorities for action and identify the best option for restoring native vegetation for that zone. The philosophy of BAP is that management of sites are directed towards, protection, enhancement and restoration.

Table 11. Number and Volume of irrigation within 500m of BAP priority sites and the associated Water Erosion Risk

BAP priority *Water Erosion risk*	Very High		High		Medium		Low		Total	
	No.	Vol (ML)	No.	Vol (ML)	No.	Vol (ML)	No.	Vol (ML)	No.	Vol (ML)
Very High	23	771	60	1,574	38	1,092	16	516	137	3,952
High	131	4,983	145	4,358	69	1,345	57	1,080	402	11,767
Medium	41	2,023	53	1,247	45	999	15	373	154	4,643
Low	269	30,038	69	7,631	9	241	5	51	352	37,960
Unknown	25	3,148	1	74	0	0	0	0	26	3,222
Total	489	40,962	328	14,884	161	3,677	93	2,021	1,072	61,575

In total there are 1,072 irrigation licenses within 500m of a priority BAP site in the dryland region (Table 11). The majority of these are close to a Very High priority BAP site (489 licenses) however the dominant water erosion risk soil type is Low (269). Possibly the greatest threat are the 23 licenses on Very High water erosion risk soil types as well as the 131 licenses on High water erosion risk soil types close to Very High BAP priority sites. This however is 11% of the total number of irrigators in the region. There are 137 irrigators on Very High water erosion risk soil types and are within 500m of all priority BAP sites, the breakdown of where they appear in the landscape can be seen in Table 12.

Table 12. Number and Volume of irrigators within 500m of all BAP priority sites and their associated water erosion risk by sub-catchment.

	Very High Water Erosion Risk		Total	
Subcatchment	**Number**	**Volume (ML)**	**Number**	**Volume (ML)**
Acheron	10	100	64	1,449.2
Back	0	0	15	1,573
Boosey	8	429.5	31	1,043.5
Boundary	0	0	4	111
Branjee	0	0	1	297
Brankeet	0	0	2	20
Broken	2	14	185	21,091.8
Buffalo	0	0	1	31
Castle	1	80	12	445.5
Christie Hill	0	0	11	512.5
Congupna	0	0	4	101.5
Cornella	0	0	3	126

Creightons	0	0	9	217
Dabyminga	3	17	14	253
Dairy	0	0	1	397
Delatite	1	4	19	397.9
Dry	5	287	19	447
Eastern Dairy	2	146	6	542
Five	0	0	28	726
Ford	0	0	6	37
Four & Seven	0	0	5	22
Hjuts	4	23	20	1,122
Holland	0	0	20	637.9
Home	2	35	21	620.8
Honeysuckle	0	0	10	365
Howqua	1	2	1	2
Hughes	12	1003	66	2,322.5
Jamieson	4	49	4	49
Johnson	1	15	3	93
King Parrot	20	334.9	48	1,599.4
Kurkurac	9	225	21	517
Limestone	2	12	14	1,161
Lower Goulburn	0	0	16	1,901.7
Majors	0	0	9	84
Merton	1	23	6	147
Mollisons	1	5	10	176
Muckatah	0	0	3	651
Murrindindi	2	33	11	207.2
Nine Mile	0	0	1	5
Pranjip	3	168	22	299
Rubicon	1	1	4	261
Sandy	0	0	6	403
Scrubby	12	521.5	50	4,040.9
Seven	0	0	50	1,172.1
Sheepen	0	0	16	1,651
Sheepwash	0	0	11	2,882
Snobs/Rubicon	0	0	2	44
Snobs	0	0	3	160.5
Spring	0	0	2	23
Stony	0	0	2	26
Strath. N. Tribs	0	0	36	2,969.9
Sunday	2	31	13	304.4
Tallangalook	2	10	4	17
Upper Goulburn	1	5	1	5
Wanalta	0	0	9	53
Whiteheads	3	6	26	2,836.3
Wormangal	1	78	6	635
Yea	21	294.3	85	2,289
Total	137	3,952.2	1,072	61,574.5

Twenty-one of the 137 irrigators within 500m of a BAP site on Very High water erosion risk soils are in the Yea River subcatchment and a further 20 are located in the King Parrot Creek subcatchment. The Broken sub-catchment has the most irrigators within 500m of a priority BAP site (185) however only two of these are on the highest risk soil type. Of the total irrigators close to a priority BAP site within the Jamieson and Upper Goulburn sub-catchments, they all irrigate on Very High or High water erosion risk soil types (Table 12).

Ecological Vegetation Classes have been mapped around the state and classified with a status depending on the amount of EVC that is remaining and the condition that it is in since 1750. Much of the original EVC's have been cleared with little remaining, therefore targeting management to enhance and protect what is remaining is a priority for the catchment. Table 13 shows the criteria for each status category.

Table 13. Conservation status of Ecological Vegetation Classes

Status	Criteria
Endangered	<10% pre-European extent remains OR <30% remains but severely degraded OR rare and severely degraded.
Vulnerable	10-30% pre-European extent remains OR 30-50% remains but severely degraded OR rare and partly degraded.
Depleted	30-50% pre-European extent remains OR >50% remains but moderately degraded.
Rare	Naturally rare EVC (limited occurrence) but not depleted or degraded.
Least Concern	>50% pre-European extent remains with little or no degradation.

Table 14. Number and Volume of irrigators within 500m of a present day EVC and the associated water erosion risk.

EVC status	Extinct		Endangered		Vulnerable		Depleted		Rare		Least concern	
Water Erosion risk	No.	Vol (ML)	No.	Vol (ML)	No.	Vol (ML)	No.	Vol (ML)	No.	Vol (ML)	No.	Vol (ML)
Very High			51	1643	36	1628	59	1253			16	313
High			237	12389	101	2599	84	2136	3	45	90	1568
Medium			44	3028	31	588	15	187			81	1977
Low			411	40570	88	11693	18	350			1	23
Unknown	2	204	20	645	2	371						
Total	2	204	763	58275	258	16879	176	3926	3	45	188	3881

In total there are 1390 licensed irrigators within 500m of an EVC allocated 83210 ML (Table 14). This is 96% of all dryland irrigators in the region. Of these 162 are associated with Very High water erosion risk soils, the majority of which are within a Depleted EVC. Of significance however, are the 51 irrigators on Very High water erosion risk soils within 500m of an Endangered EVC. The location of these can be seen in Table 15. The plan did not examine the tolerance of each EVC to nutrient, salinity or waterlogging increases. This was considered out of the scope of the plan and the accuracy of the data would be insufficient for this level of detail.

Table 15. Number and Volume of irrigators within 500m of a present day Endangered EVC associated with Very High Water Erosion Risk soils by sub-catchment.

Sub-catchment	Number	Volume (ML)
Acheron	2	11
Boosey	8	340
Boundary	1	30
Castle	2	92
Dabyminga	2	66.5
Dry	1	62
Eastern Dairy	2	146
Hjuts	1	1
Home	2	128
Jamieson	2	12
King-Parrot	1	6
Kurkurac	1	14
Limestone	5	86
Scrubby	11	476
Strath North Tribs	3	143

Tallangalook	1	6
Whiteheads	3	14
Wormangal	1	3
Yea	2	6
Total	51	1642.5

The Scrubby and Boosey sub-catchments have more irrigators that are irrigating within 500m of a present day Endangered EVC on Very High water erosion risk soils.

Table 16. Number and Volume of irrigators within 500m of a present day EVC by sub-catchment.

	Very High Water Erosion Risk		Total	
Subcatchment	**Number**	**Volume (ML)**	**Number**	**Volume (ML)**
Acheron	6	58	68	1621.9
Back	0	0	17	1631.5
Boosey	11	461.5	38	1312.5
Boundary	2	65	7	410
Branjee	0	0	1	297
Brankeet	2	52	4	72
Broken	1	52	270	25600.3
Buffalo	0	0	1	31
Castle	2	92	14	455.5
Christie Hill	0	0	11	444.5
Congupna	0	0	7	439.5
Cornella	0	0	4	166
Creightons	0	0	10	220
Dabyminga	5	83.5	14	253
Dairy	0	0	4	682
Delatite	2	31	22	445.9
Dry	4	275	19	454
Eastern Dairy	2	146	10	1141
Five	0	0	31	805
Ford	0	0	9	86.5
Four & Seven	0	0	12	85
Hjuts	2	2	27	1277
Holland	0	0	39	1152.2
Home	5	227.8	22	724.8
Honeysuckle	0	0	16	479
Howqua	1	2	1	2
Hughes	10	943	74	2638.5
Jamieson	3	43	3	43
Johnson	1	15	3	20
King Parrot	19	353.9	49	1603.4
Kurkurac	10	185	25	601
Limestone	7	98	15	1163
Lower Goulburn	0	0	44	4510.7
Majors	0	0	9	84
Merton	0	0	8	221
Mollisons	0	0	14	254
Muckatah	0	0	29	5670.5
Murrindindi	2	34.4	13	235.2
Nine Mile	0	0	1	5
Pranjip	3	168	30	601
Rubicon	0	0	5	383
Sandy	0	0	6	403
Scrubby	16	613	67	5627.9
Seven	0	0	60	1388.9

Sheepen	0	0	18	1825
Sheepwash	0	0	12	3129
Snobs/Rubicon	0	0	2	44
Snobs	0	0	3	160.5
Spring	0	0	4	30
Stony	0	0	2	26
Strath. N. Tribs	5	258.5	49	4013.9
Sunday	2	31	14	366.4
Tallangalook	3	16	7	54
Upper Goulburn	1	5	1	5
Wanalta	0	0	8	49
Whiteheads	6	24	38	3712.3
Wormangal	3	132	14	1778
Yea	26	369.3	85	2269.6
Total	162	4836.9	1390	83208.9

The Yea sub-catchment has the greatest number of irrigators irrigating within 500m of a present day EVC on Very High water erosion risk soils however Table 15 shows that only 2 of these are within an Endangered EVC.

7 Recommended actions and targets

The recommended actions and targets of the SIAP were developed based on the information established in the risk assessment. The SIAP aims to address the aspirational targets of the GBRCS by meeting the resource condition targets set by other Sub-strategies. There were no further RCT's required to be set by the outcomes of the SIAP in addition to what is currently set by other Sub-strategies. The objective of the SIAP is to link the short term (5 year) management action targets (green box) with the longer-term targets of the RCS and related Sub-strategies (blue box) seen in Figure 12. The link between SIAP outputs and the region RCT's is shown in section 7.4.

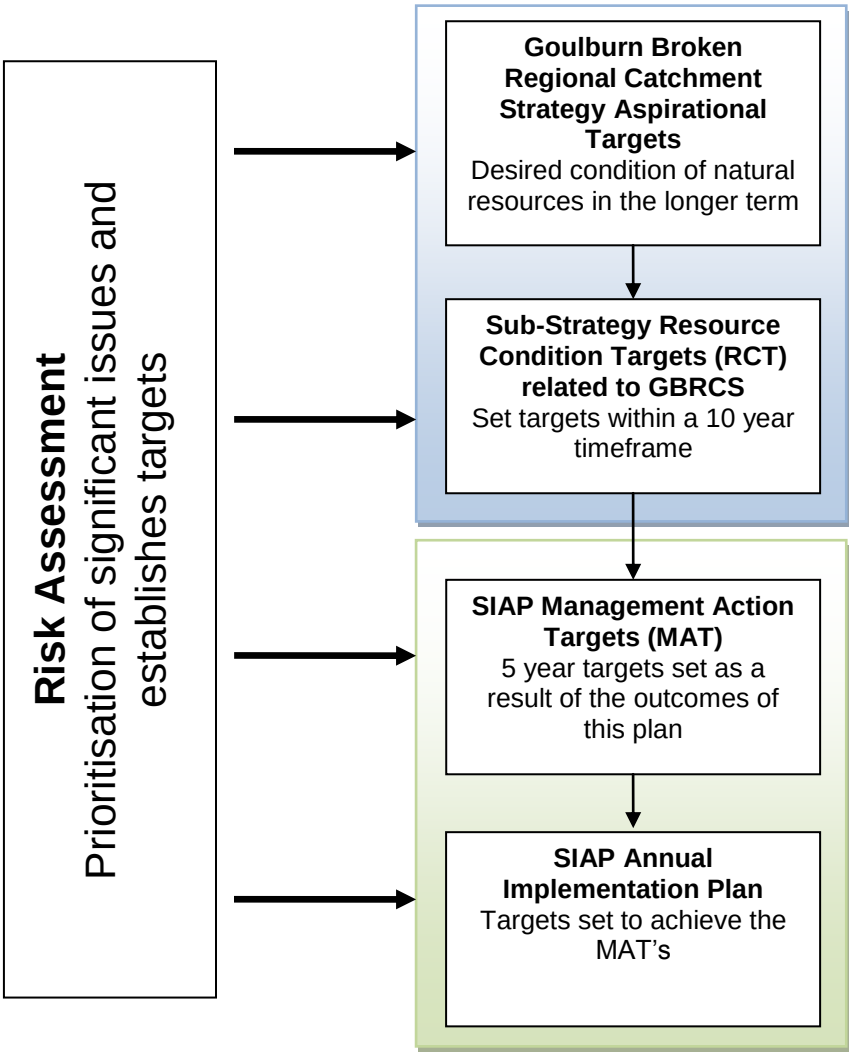

Figure 12. Relationship between aspirational targets (Vision), resource condition targets, management action targets, implementation plan and risk assessment.

7.1 Existing Goulburn Broken Resource condition targets

The Goulburn Broken Regional Catchment Strategy defines a number of high-level targets for the region (see Appendix 6). Of these, a number are relevant to the SIAP. There are no RCT's related to water savings and environmental flows. This plan has not put forward any new RCT's. There are no RCT's for environmental flows as these will be dealt with by the development of

stream flow management plans. Other plans have provided RCT's which irrigation can relate to, these are listed below.

Water Quality (Nutrients) in Rivers and Streams (Investment Area 5)

- Maintain and improve In-stream and riparian, Ecologically Healthy Rivers, Representative Rivers, Heritage Rivers, Rivers of Regional Significance and Public Frontages.
- Reduce potential phosphorus loads by 65% by 2016.

Dryland Salinity: Watertables and River Murray Salinity (Investment Area 2)

- Maintain increase to salinity levels of the River Murray at Morgan from the GB Dryland at or below 1.3 EC's by 2050. This means reducing saltloads by 34,000 tonnes per year by 2050.
- Reduces increase in salinisation of dryland areas where possible. This means reducing area of dryland that would otherwise be salinised (in foothills and river valleys of highland areas): 1,500 ha by 2050.

A Resource Condition Target for water use and environmental flows has not been defined in the RCS in Investment Area 3.

7.2 Potential water savings and load reductions

The resource condition targets of the RCS focus on managing salinity, nitrogen (N), phosphorus (P) and sediments in waterways. There is also recognition of watertables, soil acidity and biodiversity as major potential issues. The SIAP MAT's feed into the RCT's of the RCS as defined by the purpose of the management action. The GBCMA reports on improved irrigation systems in Investment Area 5 (Water quality (nutrients) in rivers and streams) where investment is specifically targeting surface water issues by improving irrigation systems. Therefore if improving irrigation systems was an outcome of the SIAP, this would contribute to Investment Area 5 of the RCS.

To contribute to the RCTs the following management approaches have been proposed. These management actions have been determined on the need to reduce the movement of water, N, P, salt and soil from the farm and are irrespective of whether the savings are on farm or downstream. A farming system that ensures resources are managed internally (closing the loop) is the preferred outcome which will enhance productivity and profitability. Changes in irrigation management practices and technology can assist this outcome.

7.2.1 Water Savings and Load Reductions

The potential level of water savings and the reduction of nitrogen, phosphorus, and salt loads and soil sedimentation as a result of change in irrigation management can be estimated for the whole MGB & UG region of the GB CMA. The potential level of savings is the difference between current irrigation management and all irrigators adopting best management practice.

The assessment of management options has been based on the potential of that option to save water, salt, soil, nitrogen and phosphorus. A framework was developed to assess the potential benefits of management options within different sub-catchments, and for different irrigation systems, crops and locations (Figure 14). This framework integrated irrigation data from G-MW with GIS data within different sub-catchments considering crop being irrigated, irrigation type, soil type and current status of on-farm practice. These figures are making the assumption that water allocations are fully used and there are no "sleeper" or "dozer" licences. This approach has been taken because it is difficult to determine the extent of "sleepers" and "dozers", and they may choose to start irrigation at any time and given the dry conditions recently these sleepers are likely to choose to begin irrigation.

Likely water savings per hectare were then allocated to the different scenarios and for each of the 61 sub-catchments in the region. These savings were then combined to determine potential

savings over the whole region. A similar approach was taken for salt, soil, nitrogen and phosphorus savings.

The potential savings for each sub-catchment are provided in Appendix 7 a. It has been determined from this approach for the whole MGB & GB region of the GB CMA there is a potential to save over 16,000 Megalitres annually through on farm water use efficiency improvements. It is expected this will lead to further benefits such as reducing nitrogen in waterways by 170 tonnes, phosphorus by 137 tonnes, salt by 1594 tonnes, and soil by 360 tonnes annually (Figure 13). The water savings achieved may go towards environmental flows or irrigators may increase the irrigated area or sell the water to other irrigators. In unregulated rivers the savings will help irrigators adapt to stream flow management plans and rostering. The savings will also reduce the energy used to pump the wasted water.

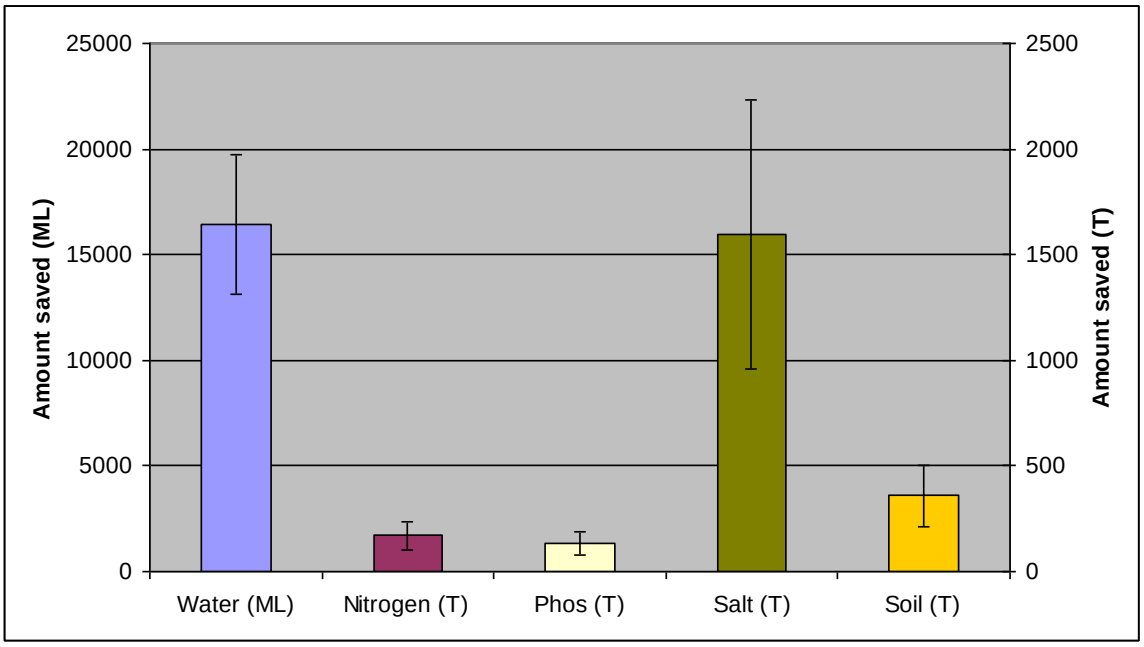

Figure 13: Potential annual savings in water (ML), nitrogen, phosphorus, salt and soil (tonnes)

The potential water savings and load reductions for the whole catchment, exclusively from flood irrigation or flood irrigation on heavy soils (potential for re-use dams) or focussing on irrigation greater than 15 ha are provided in Table 17. These savings are if all irrigators participated in all the management actions with 100% effectiveness for one year.

Table 17: Annual potential savings

Program	Water saving	Nitrogen	Salt	Soil	Phos (Sol)
Whole catchment	16,423 ML	170 T	1594 T	360 T	137 T
Target flood	11,686 ML	118 T	1259 T	260 T	93 T
Greater than 15ha	12,646 ML	131 T	1227 T	277T	105 T
Heavy soils	6,661 ML	3 T	64 T	231 T	2.4 T

The sub-catchments have been ranked as high, medium or low priority in terms of their ability to save water, nitrogen, phosphorus, salt or soil (Appendix 7 b).

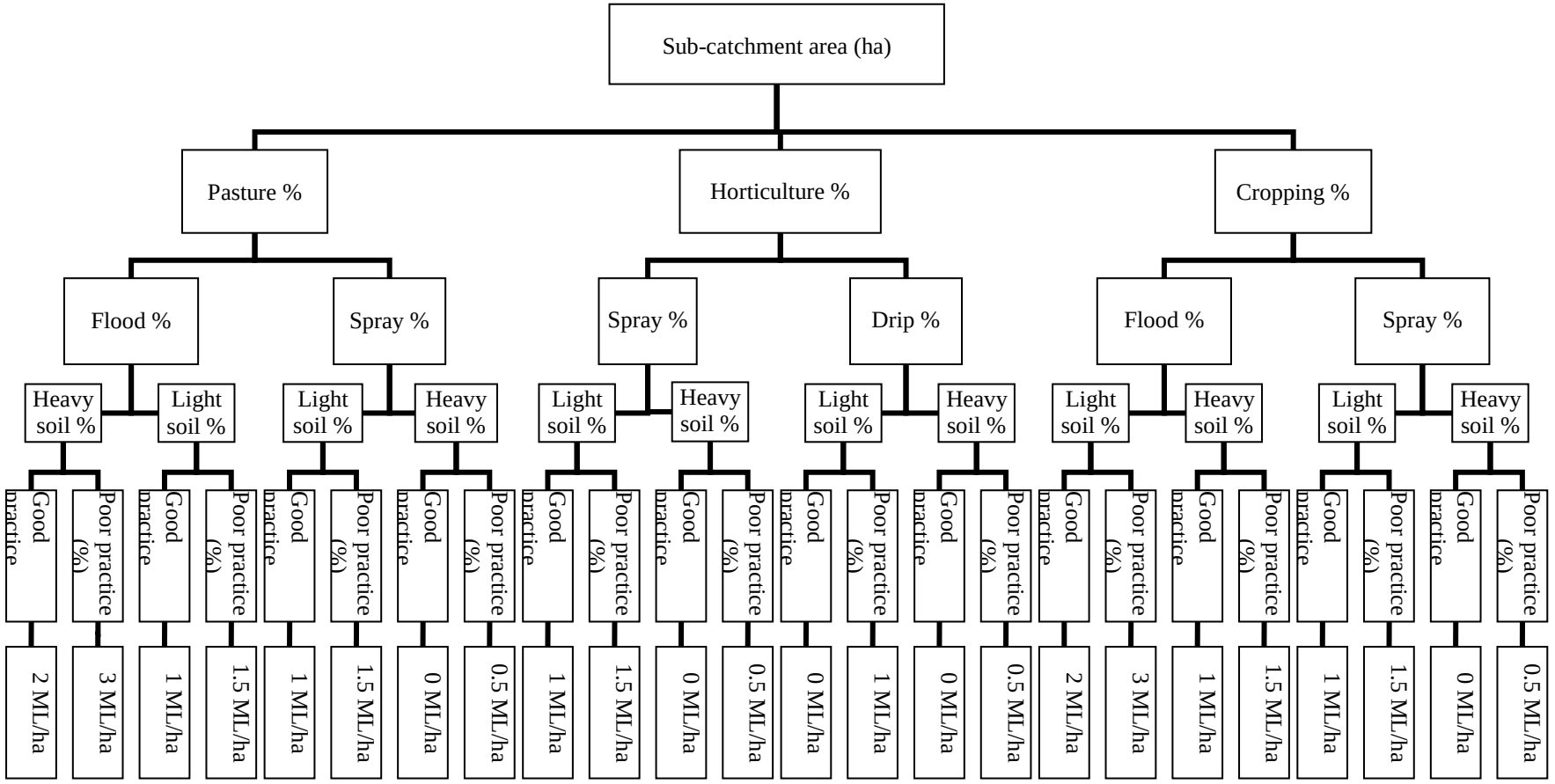

Figure 14: Framework to assess the potential benefits of management options. Irrigation in each sub-catchment was broken up by percentage of industry, irrigation type, soil characteristics, and good or poor irrigation practice.

7.3 Management Action

New irrigation developments undergo a risk assessment to ensure the standard of irrigation is high and hence off site impacts are minimised, however existing irrigation may be different. The management actions proposed in the SIAP relate to existing irrigation where there is a “legacy of history”, and hence best management practices may not occur. There is still a duty of care to minimise overuse of water and minimise nutrient run-off, however, there is a role of government to invest in improvements beyond minimal legislative duty of care and encourage best practice irrigation.

Achievement of the potential savings suggested in the previous section can be facilitated by a number of management actions. While the full savings are not practical to meet, a proportion of the potential savings is possible.

Different management actions are required to address the different priority issues. Some priority issues can be addressed to varying degrees by a number of management actions. Some management actions can address more than one priority issue.

The potential management actions considered are:

- **Improved water use efficiency:** including encouraging soil moisture monitoring equipment and irrigation system change
- **Intensive irrigation extension:** including Whole Farm Planning, benchmarking irrigation performance and checking irrigation systems performance
- **Education:** including field days workshops and printed material
- **Installing buffer zones:** planting vegetation zones between irrigated areas and asset to be protected
- **Saving trees from irrigation conversion:** protecting established trees while allowing improving irrigation systems to be installed.

There are other ways to help bring about the savings, some of these recommended are:

- **Monitoring**: designed to keep tabs on potential problems and trends over time.
- **Research**: designed to answer important key knowledge gaps.
- **Policy**: designed to have more control of water use when the need arises.

7.3.1 Management Options

Eight major management options are suggested as having potential to address a range of the threats identified, particularly the threats identified as having a high or extreme risk, shown in Table 6. How these eight management options can address these threats specifically is detailed in Appendix 9.

A major aspect of the management options is to improve water use efficiency and reduce the loading of nitrogen, phosphorus, salt and soil. These eight management options have been assessed for there ability to make “on farm” water savings and reduce nutrient loading. It is not expected all management option be implemented. Each management option will be examined separately to see if public investment is warranted and which ones deliver the greatest gain.

1. Irrigator Education

This option will deliver an ongoing series of field days and workshops aimed at improving water use efficiency and minimising any negative impacts of irrigation. It is proposed that five topics will be conducted in three different locations across the region each year. These days may include advice on more water efficient crop types, better fertiliser management, advice on soil moisture monitoring equipment and the interpretation of data or the promotion of benefits of irrigation farm plans. This management option is clear on the benefits that could be conveyed to irrigators

however it is fair to acknowledge that the costs associated with how irrigators interpret the messages is hard to predict as irrigators would behave differently. The focus of these would be in sub-catchments rated high in Appendix 7 b). The education management option will address some of the threats identified as high or extreme risks identified in Table 6. The relevant threats from Table 6 include, 3-5, 7, 11-15, 17, 18, 21-24, 26-28, 31, 32, 37, 38, 42-63, 86-88, 92-95, 97-99, 101, 103, and 104.

2. Increased use of Soil Moisture Monitoring Equipment (SMME)
This option would encourage the use of soil moisture monitoring equipment by providing a grant to subsidise the cost. The grant proposed would fund half the cost of the equipment and provide half a day with each purchase to provide advice to farmers on placement, installation and data interpretation. Analysis is based on adoption of soil moisture monitoring by 50 participants per year. The relevant threats from Table 6 include, 3-5, 11, 13-15, 18, 21-24, 27, 28, 31, 32, 37, 38, 42-44, 46, 48, 49, 52-54, 58-61, 86-88, 92-95, 97-99, 101, 103 and 104.

3. System Change Program
A) All irrigators in the region 50/50 This option involves providing advice and funds to change/improve any type of irrigation system to increase the efficiency of water use. This option will provide half the cost of the change or improvement. The approving officer will have to be satisfied the change/improvement will provide an increase in water use efficiency.
B) Only available to flood irrigators 50/50. This option is a more specific option to 3A, as it is targeting flood irrigators. It is believed the biggest increase in efficiency can be gained by targeting inefficient flood irrigation systems on permeable soils. Again the approving officer will have to be satisfied the change/improvement will provide an increase in water use efficiency.
C) Only available to flood irrigators 25/75. This sub-option is the same as 3B however only providing 25% of the cost of the change/improvement.

If there was a higher demand for this management option than could be supplied then priority would be given to sub-catchments identified in Appendix 7 b). The threats identified as high or extreme risk in Table 6 addressed by this management option are numbers, 3-5, 11-15, 18, 21-24, 27, 28, 31, 32, 37, 38, 42-44, 46, 48, 49, 52-54, 58-61, 86-88, 92-95, 97-99, 101, 103 and 104.

4. Benchmarking Program
This option will provide irrigators with a chance to measure how much water is being applied for the level of production received.

5. System Checks
This option will allow the irrigators to measure the performance of their irrigation system and compare the application relates to the crop demands calculated from evapotranspiration figures and using soil moisture monitoring equipment. It can also measure the distribution of uniformity of spray irrigation and examine the pump efficiency and impeller effectiveness.

6. Intensive Irrigation Extension (including Whole Farm Planning)
A) All irrigators in the region. This option proposes intensive one-on-one extension support to help irrigators identify and implement more efficient irrigation practices. The option to do an EM 38 survey to analyse soil type variation could also be explored.
B) Target >15ha. As above with the exception of targeting properties with more than 15ha of irrigation. If demand for this management option was high priority would be given to sub-catchments identified in Appendix 7b. The threats identified as high or extreme risk in Table 6 to be addressed by this management option are numbers, 3-5, 7, 11-15, 17, 18, 21-24, 27, 28, 31, 32, 37, 38, 42-44, 46, 48-56, 58-63, 73, 86-88, 92-95, 97-99, 101, 103 and 104.

7. Buffer Zones

This option proposes providing an incentive to plant buffer zones where there is likely to be nutrient escape from the irrigated areas to reduce nutrients entering waterways, wetlands and remnant vegetation patches. The buffer zones can also be useful to and reduce "edge affects" of irrigation to natural vegetation. For example vineyards can increase the population of introduced birds which can disturb adjacent natural vegetation.

8. Reuse
A Reuse incentive will fund half of the installation of a reuse dam and would be limited to areas with appropriate soil types to reduce leakage potential. It is designed to capture irrigation drainage and limit offsite impacts.

Some of these management options are not new to the region, however they have not previously been scrutinised to examine if investment is worthwhile. Some of the management options have been modified to improve effectiveness. The new management options suggested for consideration are; re-use dams, benchmarking, system check, and buffer zones.

7.3.2 Participation and Effectiveness

Targets for participation rates and effectiveness were defined for each of the management options. The participation rates used have been determined from past experience. The effectiveness is a reflection of the level of engagement from participants and the ability of the program to bring about real change on the ground. A summary of effectiveness and impact of ten of the management options (saving trees from irrigation conversions were too difficult to quantify) is provided in Table 18.

Table 18. Target participants for programs, expected effectiveness and consequential impact.

Program	No. Irrigators	Participants	Audience	Effectiveness	Impact
Education	1444	150	10 %	5%	0.5%
SMME	1444	50	3.5%	50%	1.7%
Sys. Change	1444	10	1%	90%	0.6%
Sys. Change flood target	855	10	1%	90%	1%
System Check	1444	20	1%	50%	0.7%
Benchmarking	1444	20	1%	25%	0.3%
Intensive Extension	1444	10	1%	50%	0.5%
Intensive Extension >15ha	358	10	3%	50%	1.3%
Reuse	827	10	1%	50%	0.6%
Buffer zone	1444	10	1%	30%	0.2%

7.3.3 No Plan Scenario

Pressure on irrigators to use water more efficiently and improve irrigation practices has never been greater and hence without this plan its expected change would still occur. Programs such as the metering program will also bring about change. Implementation of this plan however, will bring about greater change and at a faster rate than if nothing is done (Table 19).

It is difficult to estimate what extent things will change without the plan. It is expected the difference in change between with or a without plan scenario will vary for each of the different program aims. For example it is not expected that soil moisture monitoring equipment will be taken up to any large extent without the program to provide support and advice, where as it might still be expected some irrigators will update irrigation systems to improve their water use efficiency without the plan.

The education program has a target of 150 participants per year with effectiveness estimated at 5%. Without the program it is estimated 15 irrigators (10% less) a year may still adopt the type of information provided through the program. In a no plan scenario a higher effectiveness could be expected since irrigators sought the information out themselves and may be more willing to change.

The soil moisture monitoring program has set a target of engaging 50 land holders per year over a five year period with an estimated 50% effectiveness. Without the program it is estimated five may install this type of equipment per year. It could be assumed that effectiveness would be less than 50% without the program as it would be hard for irrigators to obtain unbiased information to select the most appropriate system and receive follow up advice and interpretation of results.

The system change program is probably where most change will still occur without the program being implemented. The target set for the plan is 10 systems per year over five years, and an estimated effectiveness of 90%. It is assumed that an estimate of three system changes may still occur without the plan but without the support of the program, not all of these system changes are likely to be the best system to install as irrigators opt for the cheapest installation cost not the best over all economic choice.

The benchmarking and systems check programs have set a target of engaging 20 land holders per year over a five year period for each program with approximately 25% effectiveness for the benchmarking and 50% for the systems check. Without these programs it is difficult to imagine any irrigators benchmarking and checking their systems.

The intensive extension program has a set target of engaging 15 land holders per year over a five year period for each program with an estimated 50% effectiveness. Without this program it is envisaged few irrigators will identify where and what major improvements can be made to their irrigation system, apart from the 3 per year predicted to change systems.

The aims of the program to install buffer zones are not likely to be met without the plan. The programs target was 10 buffer zones per year over five years to be planted, without the incentive it is estimated only one irrigator would plant a buffer zone.

Table 19: Target participants for programs, expected effectiveness and consequential impact.

Program	Participants		Effectiveness	
	With plan	No plan	With plan	No plan
Education	150	20	5%	10%
SMME	50	5	50%	<50%
System Change	10	3	90%	70%
Benchmarking	20	0	25%	N/A
System Check	20	0	50%	N/A
Intensive Extension	10	3	50%	70%
Buffer zone	10	1	30%	30%

7.3.4 Issues affecting adoption of management options

There is a large diversity of farming enterprises in the region, and the extent to which farms rely on irrigation varies enormously. Issues influencing adoption of management options include:

- relative dependency on irrigation (low dependence means a low priority)
- attitudes to investment in infrastructure and management practices during a time of uncertainty and significant water reform.
- physical constraints to the implementation of irrigation infrastructure (ie trees, powerlines, roads etc.
- price of diesel and electricity, this may force a move to low pressure irrigation systems, or reduced water use or even a cessation of irrigation in some cases.

7.4 Contribution to Resource Condition Targets

The GB RCS has an annual achievement reporting structure including nine Investment Areas that encompass activities directly related to RCT's. The longer term outcomes of the SIAP feed into RCT's already established by other sub-strategies therefore it is important to highlight the relationship between SIAP annual works outcomes, the sub-strategy to which outcomes relate to and the Investment Area it has input to. The SIAP programs will ensure that there are minimal off-site impacts due to irrigation. This includes reduction in the volume of water used and minimal movement of nitrogen, phosphorous, salt and soil.

These outcomes will ensure the protection of natural assets while providing for social and economic development.

SIAP outcomes will contribute to the following applicable RCT's of relevant Sub-strategies:

- *RCT for Investment Area 2 – Dryland Salinity: Watertables and River Murray Salinity*
    - *Save 1500ha of foothills and river valleys of highland areas from salinisation by 2050*
    - *Maintain increases to salinity levels of the River Murray at Morgan from the GB dryland at or below 1.3 EC's by 2050.*

  SIAP contribution
    - **Use of IDEP's to plan for works**
    - **Installation of Buffer zones for the interception of surface water action.**
- *RCT for Investment Area 5 – Water Quality (Nutrients) in rivers and streams:*
    - *Reduce potential phosphorus loads by 65% by 2016 by reducing phosphorus loads from:*
        - *Irrigation drains by 50%*
        - *Dryland and diffuse sources by 20%*
        - *Wastewater management facilities by 80%*
        - *Urban stormwater*
        - *Intensive agricultural industries and local water quality issues*

  SIAP contribution
    - **Improve irrigation systems by**
        - **Irrigator education**
        - **SMME**
        - **System change**
        - **Benchmarking**
        - **System checks**

Table 20. Description of how the SIAP links with Sub-strategies and plans

Sub-strategy	Link direction	SIAP input	RCS Investment Area
Goulburn Broken Water Quality Strategy	SIAP → GBWQS	Improved irrigation by MAT's: • Irrigator education • SMME • System change • Benchmarking • System checks • Reuse	5
Goulburn Broken Regional River Health Strategy	SIAP → GBRRHS	Improved irrigation by MAT's: • Irrigator education • SMME • System change • Benchmarking • System checks • Reuse	5 There is no RCT's identified in Investment Area 3 for river flows

Goulburn Broken Dryland Salinity Management Plan	SIAP → GBDSMP	Improved irrigation by MAT's: • Buffer zones • IDEPS	2
Goulburn Broken Soil Health Action Plan	SIAP ↔ GBSHS	GBSHS aims to enhance soil structure for improved production. SIAP assists with water logging and salinity goals.	- (The GBSHS is not referenced in RCS RCT's)
Goulburn Broken Native Vegetation Management Strategy	SIAP ← GBNVMS	GBNVMS provides best management principles for the installation of buffer zones.	- (The GBNVMS has input to Investment Area 6 in RCS however SIAP has no input to IA 6)
Other strategies and plans			
Dryland Landscape Strategy	SIAP → DLS	SIAP will enhance DLS vision of "Healthy environment, strong communities".	NA
New Irrigation Development Guidelines	SIAP ↔ NIDG's	Both SIAP and NIDG's enhance each other by providing WUE measures into IDG's and best practice benchmarks into SIAP	NA
Goulburn Valley Wastewater	SIAP → GVWW	SIAP WUE measures	NA
Streamflow Management Plans	SIAP → SFMP	SIAP WUE measures in high demand areas	NA
Groundwater Management Plans	SIAP → GWMP	SIAP WUE measures in high demand areas	NA
Metering program	SIAP ← MP	Provides data on numbers of diversions metered	NA
Victorian Greenhouse Strategy	SIAP VGS		NA
Sustainable Water Strategy for Northern Victoria	SIAP ↔ SWSNV	SWSNV assists with reliability of water supply and SIAP assists with WUE measures	NA

Table 21. Savings expected over a five year and 10 year period

Program	Water (ML)		Nitrogen (T)		Salt (T)		Soil (T)		Phosphorus (T)	
	5yr	10yr	5yr	10yr	5yr	10yr	5yr	10yr	5yr	10yr
Education	171	1237	1.7	12.7	16.5	120.0	3.7	27.1	1.4	10.2
SMME	2061	8885	21.3	91.8	200.0	862.4	45.2	194.6	4.7	34.3
System Change	819	3327	8.4	34.4	79.4	322.8	17.9	72.9	1.7	12.0
System Change – target flood	892	3844	9.0	38.8	96.1	414.2	19.8	85.5	1.9	14.1
Benchmarking	412	1777	4.3	18.4	40.0	172.4	9	38.9	3.4	14.8
System check	825	3554	8.5	36.7	80.0	344.9	18.1	77.9	1.9	13.7
Intensive Extension	618	2666	6.4	27.6	60.0	258.7	13.5	58.4	1.4	10.3
Intensive Extension >15ha	1280	5519	13.2	57.0	124.2	535.7	28	120.9	2.9	21.3
Reuse	292	1258	0.1	0.6	2.8	12.0	10.1	43.6	0	0.2
Buffer Zone	0	0	2.5	11.0	24.0	103.4	18.1	77.9	0.6	4.1

7.5 Programs and Management Actions

The Goulburn Broken SIAP has examined eight programs plus a coordination program to be implemented to assist the further development of sustainable irrigation industries in the region. A mix of the most appropriate programs, depending on funds, will make significant savings of water, and reduce the potential impacts of off-site movement of nitrogen, salt, soil, and phosphorus.

These programs to be examined have been established to address the major risks (significant issues) considering regional targets and also the benefit cost analysis (Section 9).

An overall management program could incorporate a suite of management actions including:

Coordination

1. **Irrigator Education**
2. **Soil Moisture Monitoring (SMM)**
3. **System Change (target flood)**
4. **Re-use dam**
5. **Benchmarking**
6. **System Check**
7. **Intensive Irrigation Extension (target >50ML)**
8. **Buffer Zones**

The final program (made up of some or all of the management actions) will benefit the irrigators, the regional economy and the environment.

A summary of the programs is provided in Table 22.

Table 22. Summary of management actions and their targets, and public cost and benefits

	Summary	Target	Cost	Benefit
Coordination Program	Will ensure coordination with major water and natural resource management initiatives, and linkages with other programs operating in the region. The program will also coordinate monitoring, evaluation and reporting on implementation of this Plan.		$50,000 per year for 5 years	Necessary for implementation of other programs
1. Irrigator Education Program	Will deliver an ongoing series of field days and workshops aimed at improving water use efficiency and minimising the negative impacts of irrigation. It is proposed that five topics will be conducted in four different locations across the region each year. As examples, these days may include advice on more water-efficient crop types or advice on soil moisture monitoring equipment and the interpretation of data.	15 field days/education sessions per annum, attracting an average of 10 participants per session	$14,000 per year for 5 years using a NPV of 4%	$164,000 per year using a NPV of 4% over 5 years
2. Soil Moisture Monitoring (SMM) Program	Will provide incentives and extension to encourage the adoption and use of soil moisture monitoring equipment. The proposed incentive would fund half the cost of the equipment. Extension support of half a day for each participant will be provided to assist landholders with placement, installation and data interpretation.	50 participants per annum installing and utilising soil moisture monitoring equipment	$45,000 per year for 5 years using a NPV of 4%	$550,000 per year using a NPV of 4% over 5 years
3. System Change Program a) All irrigators in the region 50/50	Will provide advice and incentives to assist landholders to change irrigation systems to more efficient ones. It is proposed that incentives will cover one half of the planning costs (development of an IDEP) up to a maximum of $4,000 per landholder, and one quarter or half of the implementation costs.	10 participants per annum, leading to improved irrigation practices over 200 ha	$212,000 per year for 5 years using a NPV of 4%	$213,000 per year for 5 years using a NPV of 4%
3. System Change Program b) Only available to flood irrigators 50/50	As above except targeting inefficient flood irrigation systems on permeable soils.	10 participants per annum, leading to improved irrigation practices over 200 ha	$212,000 per year for 5 years using a NPV of 4%	$248,000 per year for 5 years using a NPV of 4%
3. System Change Program c) Only available to flood irrigators 25/75	As above except incentives will cover one quarter of the implementation costs up to a maximum of	10 participants per annum, leading to improved irrigation practices over 200 ha	$112,000 per year for 5 years using a NPV of 4%	$248,000 per year for 5 years using a NPV of 4%
4. Benchmarking program	Will allow irrigators to gauge how they are performing in relation to industry benchmarks, against their local peers, and against themselves over different years. This will highlight if there is scope and where to improve irrigation practices and/or crop management.	20 participants per annum, leading to improved irrigation practices over 400 ha	$23,000 per year for 5 years using a NPV of 4%	$112,000 per year using a NPV of 4% over 30years
5. System Check	Will Allow irrigators to determine the efficiency of their system and become skilled at performing the test on an ongoing basis to maintain efficiency. This may be a precursor to obtaining an IDEP on the property as it will indicate if investment in an upgrade is required for the systems	10 participants per annum, leading to improved irrigation practices over 150 ha	$23,000 per year for 5 years using a NPV of 4%	$220,000 per year using a NPV of 4% over 5years

6 a). Intensive Irrigation Extension (including Whole Farm Planning)	Will provide intensive one-on-one extension support with priority landholders to help irrigators identify and implement more efficient irrigation practices. A basic Whole Farm Plan will be developed with the landholder. An EM 30 survey may be a part of this to analyse soil type variation and implications. This may be a precursor to development of new irrigation systems and/or development of an Irrigation Drainage and Environmental Plan (IDEP).	10 participants per annum, leading to improved irrigation practices over 457 ha	One-on-one $43,000 per year for 5 years using a NPV of 4%	One-one-one $165,000 per year using a NPV of 4% over 5 years
6 b). Intensive Irrigation Extension (including Whole Farm Planning)>15ha	Will provide intensive one-on-one extension support with priority landholders to help irrigators identify and implement more efficient irrigation practices. A basic Whole Farm Plan will be developed with the landholder. An EM 30 survey may be a part of this to analyse soil type variation and implications. This may be a precursor to development of new irrigation systems and/or development of an Irrigation Drainage and Environmental Plan (IDEP). To ensure a greater return of funds invested, irrigators with at least 15ha of irrigation will be targeted. Irrigators with less-efficient systems will also be targeted.	10 participants per annum, leading to improved irrigation practices over 457 ha	One-on-one >15ha $29,000 per year for 5 years using a NPV of 4%	One-on-one >15ha $342,000 per year using a NPV of 4% over 5 years
7. Buffer Zones	Will link to revegetation and biodiversity programs operating in the region to assist the protection and enhancement of biodiversity assets as well as limiting the impacts of the irrigation drainage. Specialist extension services and incentives for on-farm works will be provided through other programs.	10 participants per annum, reducing nutrient escape from 150 ha	$32,000 per year for 5 years using a NPV of 4%	$52,000 per year using a NPV of 4% over 5 years
8. Reuse	Will provide an incentive for on ground works to collect excess drainage water from leaving the property and having an impact on the surrounding area. The target area is limited to soil types where leakage is not an issue, notably heavier soil types.	10 participants per annum, leading to improved irrigation practices over 150 ha	$101,000 per year for 5 years using a NPV of 4%	$32,000 per year using a NPV of 4% for 5 years.

8 Future challenges and opportunities

For irrigation to be sustainable in the Goulburn Broken area there will be many challenges and changes to deal with. To assist with the approach some projects and research ideas have been suggested.

8.1 Future projects

As well as the eight management actions proposed, there are other projects which should be considered for the future, to help achieve the aims of the SIAP.

8.1.1 Timing of water extraction

When the irrigation metering program is completed it will be possible to monitor timing and volume of irrigation water diverted over the irrigation season compared to stream flow on unregulated rivers/streams. If the main extractions are occurring at times when rivers are stressed, on farm management options can be researched or examined to encourage water use over less critical times for stream flow.

8.1.2 New irrigation developments

This report has focused on current irrigation within the MGB & UG region of the GB CMA, and what can be done to improve irrigation practice to minimise effects on the environment and enhance the irrigation industry. A report examining where irrigation is best encouraged would help industry investors and local industry development officers. It would also highlight areas where new irrigation is likely to contribute negatively to environmental issues.

8.1.3 Investment in 3-phase power infrastructure

Access to three-phase electricity is limited in the region, which means a large number of irrigators pump water using diesel. Using three-phase electricity has advantages over diesel. Diesel is more expensive to pump water, has higher labour demands and posses the treatment of diesel/oil spills into water ways. An investigation could be undertaken to determine where public and private investment is worth while to provide three-phase electricity.

8.1.4 Saving trees from irrigation conversion

Replacing a water inefficient flood irrigation system with a centre pivot irrigation system which is likely to use less water per hectare often means the removal of established trees (identified as an extreme risk Table 6). Hence, there is a conflict between water savings and retaining biodiversity assets. There is provision available for vegetation removal and off set plantings however this is often not a desired out come for both parties. There are other irrigation systems which could be installed which would allow the trees to be retained however the set up cost of these could be an extra $3,000 per hectare or more. A programme to help the irrigator with the extra cost of a system to retain the trees could be worth investigating. This may involve irrigators placing a covenant fencing off and replanting areas around the remanent trees while the extra cost of the alternative system is subsidised.

8.1.5 Assessing irrigation rostering duration due to low stream flow

Currently when rivers such as the Yea River are deemed to have low enough flows, a ten day roster is imposed. The typical ideal irrigation interval for pasture is around 5 to 7 days in the middle of the irrigation season. The ten day roster forces poor irrigation practice. The current rostering program should be re-examined to better suit the irrigators needs while still meeting the objectives of the roster program.

8.1.6 Monitoring of ground water

The interaction of ground water and river systems in the region is complex and not well understood. The occurrence of below average rainfall in recent years has lead to possibly less inflow to ground water aquifers while also creating an increased interest in bore

installations. The affect both of these may have on stream flows further down the catchments is not well understood and warrants further investigation.

8.1.7 Streamflow Management Plans

Currently a Streamflow Management Plan is being undertaken for the Yea River and King Parrot Creek, for supply of environmental flow. It is anticipated more Streamflow Management Plans will be developed for unregulated river systems. These are designed to manage the flow of the stream in such a way as to provide the best the outcome in times of low flow for, irrigators, domestic and stock users, towns, and the environment. The Streamflow Management Plans should help to address the extreme threat to the Asset Item "Flows" identified in Table 7 for the unregulated rivers and streams.

8.1.8 Monitoring Timing of Water Extraction

Goulburn Murray Water is implementing an irrigation metering program. When in place this will enable data to be collected showing the timing and volume of water diverted over the irrigation season. This can be compared to stream flow patterns on unregulated rivers/streams and then water extraction can be encouraged over less critical times for stream flow.

8.1.9 Incentive to save water where trading is restricted

With the implementation of the metering program, water use verses allocation can be recorded. Currently irrigators who have trade restrictions (those on small unregulated rivers, or at the end of the river, or ground water licences) have little incentive to save water, as they will still have to pay for a full allocation if they use it or not without the option of trading water savings. An ability for these irrigators to pay for usage only may encourage irrigators to not use their full allocation.

8.1.10 Managing Domestic and Stock water use on specific rivers

Monitoring of all domestic and stock water use is likely to be too expensive compared to the gain. However in river systems where the total domestic and stock allocated is equivalent to or greater than the allocated irrigation, a monitoring program may be of some importance to maintain stream flow. The increase of lifestyle farmers in the region will continue to add more pressure on rivers. A scheme to have new domestic and stock licences metered may help keep this potential problem under check.

8.1.11 Using Irrigation water to establish pastures

The vast majority of pasture /fodder irrigators only irrigate a small proportion of the whole farm, therefore rely heavily on pasture growth from the dryland proportion. Recent climatic conditions have left farmers with a late autumn break making it very difficult to gain weed control and establish perennial pastures. This has lead to some farmers saving reduced irrigation allocations for autumn to allow for better weed control and establishment of perennial pastures.

8.2 Future challenges

8.2.1 Sharing of data between organisations

During the process of developing this plan gaining access to data from other organisations was difficult, time consuming and sometime non existent. Greater collaboration between organisations would have been of great value to this plan and for plans in the future.

8.1.2 Location and area of Irrigation

The location of irrigation data points represented in this report comes from data supplied by GMW. The data provided the location of the service delivery point, ie where water is extracted, not where the water is applied. Where water is transported a distance form the service point the irrigated area is not accurately represented as that location. Some irrigation extractions did not have a location at all. The data supplied by GMW also provided an area

allowed to irrigated, however it is expected a large number of irrigators irrigate less than that area. A more exact location of where irrigation and the areas would greatly add value to future plans of irrigation in the region.

8.1.3 Research & Development Program

This program will encourage and assist the establishment of research programs to address major knowledge gaps related to irrigation in the Goulburn Broken dryland region. A key focus would be verification of assumptions used in development of this Plan. Major knowledge gaps include: More precise information on irrigation water use across the catchment (annual data on volumes used, crops, systems, etc), impact of irrigation on salinisation processes, further refinement of knowledge about potential of irrigation systems and improved management to achieve productivity and environmental benefits.

8.2 Future Research

Research and development will contribute to the improvement of irrigation practice across the state. The majority of the research will be conducted outside the MGB & UG region of the GB CMA and conducted in regions where irrigation is a higher priority. The MGB & UG region of the GB CMA does have some unique issues where research could be advantageous. These include;

- Examination of alternative pasture and fodder crop irrigation options
- Using more water use efficient crops
- Examining the prospect of autumn start or extended spring irrigation
- Irrigation scheduling for a range of crops
- Irrigation management of fodder crops
- Examining appropriateness of sub-surface irrigation on a range of the regions soil types
- Crop nutrient requirements
- Understanding nutrient losses from irrigated areas
- Examining climate change and water uncertainty with a risk management approach to irrigation

9 Implementation of the Plan

9.1 Plan Coordination

DPI is responsible for overseeing implementation, coordination and reporting of the Plan. Outcomes will be reported to the GBCMA.

There are significant links between the CMA, G-MW and DPI due to implementation of Water Use Objectives and extension services provided. These links have an impact on current and future land and water management planning by determining roles and responsibilities to meet the objectives.

9.2 Implementation Program

Implementation of programs within the Sustainable Irrigation Program is dependant on the level of funding available annually. The cost effectiveness of each program will determine its implementation timing.

Table 23 describes timing, locality, implementation responsibility, costs and cost shares of each program.

Table 23: Short term (1-5 year) Implementation Program

Program	Target Area*	Implementation Timeframe	Implementation responsibility	Cost (undiscounted)	Public & Private cost share
Coordination Program	MGB & UG	5 years	DPI	$50,000	$50,000 : $0
1. Irrigator Education Program	MGB & UG	5 years	DPI	$34,875	$16,125 : $18,750
2. Soil Moisture Monitoring (SMM) Program	MGB & UG	5 years	DPI	$147,575	$50,075 : $97,500
3. System Change Program a) All irrigators 50/50	MGB & UG	5 years	DPI	$462,900	$237,900 : $225,000
3. System Change Program b) All irrigators 50/50	Farms flood irrigating on light soil in the GB dryland	5 years	DPI	$462,900	$237,900 : $225,000
3. System Change Program c) All irrigators 25/75	Farms flood irrigating on light soil in the GB dryland	5 years	DPI	$462,900	$125,400 : $337,500
4. Benchmarking program	MGB & UG	5 years	DPI	$43,800	$25,800 : $18,000
5. System Check	MGB & UG	5 years	DPI	$43,800	$25,800 : $18,000
6 a). Intensive Irrigation Extension (including Whole Farm Planning)	MGB & UG	5 years	DPI	$54,000	$48,375 : $5,625
6 b). Intensive Irrigation Extension (including Whole Farm Planning) >15ha	MGB & UG	5 years	DPI	$36,000	$32,250 : $3,750
7. Buffer Zones	MGB & UG	5 years	DPI	$143,810	$36,140 : $2,500
8. Reuse	MGB	5 years	DPI	$185,450	$113,450 : $72,000
9. Feasibility of future projects examined (listed in 8.1)	MGB & UG	5 years	unknown	unknown	unknown
10. Feasibility of future research examined (listed in 8.2)	MGB & UG	5 years	unknown	unknown	unknown

10 Benefit, Cost Analysis

It is not expected each management action option be undertaken. An economic analysis was carried out to determine the cost and benefit of each management action option, this enables the management actions to be checked if there is a positive return on investment and to be ranked in order of greatest return for investment.

10.1 Economic Analysis

A benefit: cost analysis was undertaken for each of the major management options, implemented over a five year period. Total costs and benefits were quantified over a 30 year period (Appendix 8 includes assumptions used). The benefit: costs ratio for the programs are shown in Table 24 demonstrating where investment is best justified, i.e. higher than 1:1 ratio.

Table 24. Total cost: benefit ratio of programs at 4% and 8% NPV, and the public and private investment proportions at 4% and 8% respectively.

	Total Project		Public	Private
	4%	**8%**	**4%**	**8%**
Education	***7.5***	***4.6***	***11.4***	***2.5***
SMME*	***6.0***	***3.9***	***12.3***	***1.8***
System Change	0.5	0.3	**1.0**	0.3
System Change target flood (50:50)	0.9	0.6	**1.2**	0.4
System Change target flood (25:75)	0.9	0.6	***2.2***	0.3
Benchmarking	***4.1***	***2.9***	***5.0***	***2.1***
System Check	***8.1***	***5.2***	***9.6***	***4.0***
IDEP	***4.9***	***3.2***	***3.8***	***9.5***
IDEP >15ha	***15.3***	***9.8***	***11.9***	***29.6***
Reuse	0.3	0.2	0.3	0.2
Buffer Zone	1.5	0.9	***1.6***	0

Bold Italics indicate ratio >1:1

*SMME includes weather stations and water babies

Management options have been ranked in order of cost-effectiveness from highest return of public money to lowest. The ranking is:

1:12.3 Soil Moisture Monitoring incentives
1:11.9 IDEP >15ha
1:11.4 Education
1:9.6 System Check
1:5.0 Benchmarking
1:3.8 IDEP
1:2.2 System change incentives targeting flood with a 25:75 (public: private cost share ratio)
1:1.6 Buffer Zones
1:1.2 System change incentives targeting flood with a 50:50 (public: private cost share ratio)
1:1.0 System change incentives 50:50 (public: private cost share ratio)
1:0.3 Reuse

This suggests with the exception of one option, all are worthy of public investment, the exception being Reuse incentive.

The management action, “installing buffer zones”, resulted in a low cost benefit ratio because the ratio was based on water and nutrient savings, however the installation of buffer zones can provide added benefits that are difficult to include in this analysis. Buffer zones can protect areas with a biodiversity value and wetlands from negative impacts from irrigation.

Management actions to do with systems change resulted in a positive cost benefit ratio, however greater benefit is gained where government investment is 25% of the cost share targeting flood irrigation. It is recommended that incentives based on system change should occur on some form of sliding scale. This would allow more money to be spent where the biggest benefits can be gained.

11 Assumptions and knowledge gaps

11.1 Assumptions used in savings

The assumptions that need to be tested or updated for future plans are seen in Table 25. A ranking of importance and a confidence level is also provided.

Table 25. Assumptions used in the calculations of potential savings.

Assumption	Importance	Confidence
Area of irrigation based on the mega litres allocated and a average application of 5ML/ha	High	Moderate
Industry figures are based on Australian Bureau of Statistics figures 2000-01 and should be updated for any future planning	High	High
The method of irrigation percentages used were based on a survey of the G-MW Diversion Inspectors. This could be captured more accurately	High	Moderate
Percentage allocations of light and heavy soils were based on a leaching GIS layer	Moderate	Moderate
Good and Poor practice farmers were allocated 50/50	Moderate	Moderate
2-3ML/ha can be saved on flood irrigated light soils	High	Moderate
1-1.5 ML/ha can be saved on flood irrigated heavy soils	Moderate	Moderate
1-1.5 ML/ha can be saved on spray irrigated light soils	Moderate	
0-0.5 ML/ha can be saved on flood irrigated heavy soils	Low	Moderate
0-1 ML/ha can be saved on drip irrigated light soils	Low	Moderate
0-0.5 ML/ha can be saved on drip irrigated heavy soils	Low	Moderate
5-10kg of Nitrogen saved per ML of water saved	High	Moderate
2-8kg of Phosphorus saved per ML of water saved	High	Moderate
Differing amounts of Salt saved per ML of water saved in high salinity risk areas	Moderate	Moderate
Percentage allocations of soils prone to water erosion where based on a GIS layer	Moderate	Moderate
30-50 kg soil/ha can be saved on flood irrigated highly prone soils	Moderate	Moderate
20-30 kg soil/ha can be saved on flood irrigated lowly prone soils	Moderate	Moderate
10-30 kg soil/ha can be saved on spray irrigated highly prone soils	Moderate	Moderate
10-20 kg soil/ha can be saved on spray irrigated lowly prone soils	Moderate	Moderate
10 kg soil/ha can be saved where drip irrigated is used	Low	Moderate
15mg of Phosphorus saved for every kg of soil saved	Low	Moderate

11.2 Assumptions used in benefit: cost analysis

The assumptions made with the costs associated with the different programs are:

- average cost for soil moisture monitoring equipment per farm is $2000
- average cost for a new irrigation system is $3000/ha
- average cost for a re-use dam is $14,000 per dam
- three days are required per farm for the Intensive Extension program @ $645/day

The assumptions made with the benefits associated with the different programs are:

- Water has a value of $70/ML and split 50:50 between the irrigator and the public (It is difficult to determine if this is likely to increase)
- Nitrogen is worth $1000/t of N to the farmer (this is likely to increase)
- Nitrogen kept out of waterways is worth $200/t of N to the public
- Phosphorous is worth $3000/t of P to the farmer (this is likely to increase)
- Phosphorous kept out of waterways is worth $14667/t of P to the public
- Salt kept out of waterways is worth $37/t to the public
- Soil kept on farm is worth $200/t to the farmer
- Soil kept on farm is worth $500/t to the public
- Discount rate for the public benefit was set at 4% and analysed over a 30 year period
- Discount rate for the private benefit was set at 8% and analysed over a 30 year period

11.3 Data Limitations

The MGB & UG region of the GB CMA is not viewed as a major irrigation district, and hence data on irrigation in the region has not been compiled. Statistics about irrigation in the region are generally scarce. Although this report has used data on numbers of irrigators, area and volume, these are based on licences to irrigate not on actual water use. It is not accurately known how many of these irrigation licences are not being used i.e. “sleeper” or “dozer licences”. This report has utilised the irrigation license data as provided by Goulburn Murray Water, and it has been assumed all of these licences are being utilised even though we know that not to be true. Goulburn Murray Water currently have a metering program, to ensure all irrigators will be metered in the future; this information should be available for future reviews of this plan.

The scarcity of data has meant a number of assumptions have been made in order to determine potential savings.

12. Recommendations

While not as large as other regions the irrigation industry is an important component to the Mid Goulburn Broken & Upper Goulburn CMA region. Important in terms of an economic asset and its dominance in key areas of the landscape. The Mid GB & Upper Goulburn region is also important in its role of supply a large proportion of the Murray Darling Basins flows. Improvements and efficiency gains can be made in all agricultural industries, and the irrigation industry in the region is no different. This plan has undertaken a benefit: cost analysis of some management actions and prioritises government investment. The plan has also suggested other activities and actions to improve irrigation across the region.

12.1 Recommended proposed management actions

The SIAP examined a number of different management option which are described in more detail in Table 22. Of the management actions examined the plan recommends priority investment in the following five activities that returned a greater than 5:1 benefit cost ratio:

1. Providing soil moisture monitoring and irrigation scheduling equipment
2. Implement intensive one to one extension for irrigators with greater than 15ha irrigation
3. Irrigator education activities
4. Implement a program to check the efficiency of irrigation systems
5. Implement a program to benchmark irrigation practices

There are five management actions that return a positive investment of public money but are of less benefit than the 5:1 benefit cost ratio that the above mentioned actions provide. While not in the top five recommended management actions, the plan recommends they be conducted. These lower priority five include:

1. Implement intensive one to one extension
2. Providing an incentive covering a quarter of the cost of irrigation systems upgrade targeting flood irrigators
3. Providing an incentive to install vegetation buffer zones to intercept water and nutrients
4. Providing an incentive covering half of the cost of irrigation systems upgrade targeting flood irrigators
5. Providing an incentive covering half of the cost of irrigation systems upgrade

If an incentive is to be provided for irrigation systems change it is recommended that a form of sliding scale of the public benefits to incentives granted, be examined.

The management action to provide an incentive for reuse dams resulted in a low benefit: cost ratio however it should not be totally disregarded, as there are benefits for reuse dams in certain areas around the region depending on the soil type to ensure public benefit.

The plan has not suggested priority locations or sub-catchments where these management options should focus. The figures in Appendix 7 could be used as a guide; however, those sub-catchments shown as high priority are driven mainly by high irrigation density. Hence there may be one large irrigator in a non priority sub-catchment who as an individual is more important than two or more smaller irrigators in a priority sub-catchment.

As seen in Figure 9, much of the Goulburn River below Eildon and some tributaries above Eildon is classified as High Priority Stream. This is similar for the lower reaches of the Broken River and Broken Creek. Irrigators interested in a management option should be given priority if funding is short where impact on a High Priority Stream may be established.

12.2 Other recommendations

Sound knowledge of irrigation within the region is lacking. The plan recommends where possible the collection of the following information/data.

- A better understanding of water use and its timing over the irrigation season. This plan has used data including irrigation water allocated which is different to that being used.
- A better data base of where irrigation is occurring and the area irrigated.
- A data base containing the above two dot points and linked to the irrigation industry.

There are specific catchments in the Mid Goulburn Broken and Upper Goulburn region where the amount of domestic and stock water obtained from water ways is significant volumes that places pressure on irrigators and flows in the waterway during dry periods. It is recommended where the domestic and stock water is likely to be diverted in significant volumes that these pumps are also metered.

The plan also recommends investment into applicable research and trials to meet the needs of the unique situation of the irrigators in the Mid Goulburn Broken and Upper Goulburn region.

13. Monitoring, evaluation and reviewing

It is important that Plan implementation is monitored to measure the rate of implementation and performance of the effectiveness of Plan works and measures. This will also assist in refining the relationships between management actions and resource condition outcomes.

The Monitoring, Evaluation and Reporting aspects of the SIAP are aligned to the Goulburn Broken MER Strategy (March 2004). The Strategy aims to monitor, evaluate and communicate key outcomes of the programs funded through the RCS. Table 26 explains how SIAP outputs will be monitored and evaluated as per MER Framework. This however is reliant upon the level of funding that the program attracts for implementation.

13.1 Monitoring

The success of the SIAP programs will be measured by using the outcome-based indicators listed in Table 26.

Table 26: Monitoring of outcome-based indicators

	Indicator	**Report method**	**Responsibility**	**Report frequency and recipient**		
				IC	**Board**	**Investor**
Works on ground		Text report	Project Leader	Quart	Quart	Annual
-Irrigation education	No. & count of participants					
-SMME	No. & area serviced					
-System change	No. & area serviced					
-Benchmarking	No.					
-System check	No. & area serviced					
-Buffer zones	No. & area					
-Reuse	No. & area serviced					
Planning for works				Quart	Quart	Annual
-IDEP's	No. & area serviced					
Investment				Quart	Quart	Annual
	Proposed					
	Spent					
Resource condition	Baseline conditions	Databases	CMA	5 yrs	5yrs	5yrs

13.2 Evaluation

Success of plan implementation will be measured by efficiency and effectiveness of works and works support (IDEP's) listed in Table 27.

Table 27: Evaluation of outcome-based indicators

	Indicator	Report method	Responsibility	Report frequency and recipient		
				IC	**Board**	**Investor**
Efficiency of works & works support		Text report	Project Leader	Quart	Annual	Annual
-IDEP's -Buffer zones -Irrigation systems improved -Reuse	No./$ Area/$ Area/$ No./$			*Input at Resource Condition level into GBDSMP* *Input at Resource Condition level into GBWQS*		
Effectiveness of works & works support				5yrs	5yrs	5yrs
-IDEP's -Buffer zones -Irrigation systems improved -Reuse	*ML on-farm water savings *ML intercepted *ML on-farm water savings *T nutrients intercepted			*Input at Resource Condition level into GBDSMP* *Input at Resource Condition level into GBWQS*		

*Indicators are based on assumptions listed in Table 25

13.3 Reviewing

The review of the SIAP will occur after five years of implementation. It will incorporate activities including achievements, program viability, continuous improvement and further investment justification (Table 28).

Table 28: Activities carried out for reporting of plan implementation

Reporting activity	**Reporting**	**Method of Communication**
Achievements	Evaluation information	Report
Program viability	Investment v's Actual benefits	Report
Continuous improvement	Review of indicator appropriateness	Report (incorporate changes if required)
Further investment justification	Investment v's Actual benefits	Report
Communication to stakeholders	Plan implementation activities & benefits	Presentations, flyers, media articles.

14 Next Plan Review/Renewal

The Plan will be reviewed after five years of implementation. Therefore it is envisaged that a formal review of the document be performed 2013/2014 assuming implementation of programs will start in the 2008/09 financial year.

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16 Appendices

Appendix 1. Natural Resource Units

SCG's describe the major river that the diversion occurs on, if it is a regulated or unregulated diversion and also places the diversion in a more specific location along the river. Groundwater bores and Farm Dams are also attributed a SCG that reflects the area of the Diversion

Table 1. SCG descriptions

SCG	Description
GORB	Goulburn River (regulated)– Lake Eildon and downstream to Goulburn Weir
GORC	Goulburn River (regulated) – Goulburn Weir to Broken River
GORF	Goulburn River (regulated) – Off stream systems (Cattanach and Stuart Murray Canals, Waranga Basin)
GOUA	Tributaries of Lake Eildon and Goulburn River upstream of Eildon
GOUB	Tributaries of Goulburn River – downstream Lake Eildon to Goulburn Weir
GOUC	Tributaries of Goulburn River – Goulburn Weir to Broken River
BRRB	Broken River (regulated) – Lake Nillahcootie and downstream to full supply level of Casey's Weir
BRRC	Broken River (regulated) – Casey's Weir and downstream to Goulburn River
BRRD	Lake Mokoan (Broken River system)
BRRE	Broken Creek (regulated) – Casey's Weir to Waggarandall Weir
BRUA	Tributaries of Lake Nillahcootie and Broken River upstream of Lake Nillahcootie
BRUB	Tributaries of Broken River – downstream Lake Nillahcootie to full supply level of Casey's Weir
BRUC	Tributaries of Broken River – Casey's Weir and downstream to Goulburn River
BRUD	Tributaries of Lake Mokoan (Broken River system)
BRUE	Tributaries of Broken Creek – Casey's Weir to Waggarandall Weir
BRUF	Broken Creek and Tributaries – Waggarandall Weir to Murray

Table 2. List of Sub-Catchments

Acheron	Dairy	Johnson	Seven
Back	Delatite	King-Parrot	Sheep_pen
Boosey	Dry	Kukurac	Sheepwash
Boundary	Eastern Dairy	Limestone	Snobs/Rubicon
Branjee	Five	Lower Goulburn	Spring
Brankeet	Ford	Majors	Stony
Broken	Four & Seven	Merton	Strath N.T
Buffalo	Hjuts	Mollisons	Sunday
Castle	Holland	Muckatah	Tallangalook
Christie Hill	Home	Murrindindi	Upper-Goulburn
Congupna	Honeysuckle	Pranjip	Wanalta
Cornella	Howqua	Rubicon	Whiteheads
Creightons	Hughes	Sandy	Wormangal
Dabyminga	Jamieson	Scrubby	Yea

Appendix 2. Irrigation volumes vs Domestic and Stock

River	Irrigation No.	Irrigation Volume (ML)	D&S No.	D&S Volume (ML)	D&S/Irrigation %
ACHERON RIVER	40	1681.9	79	164	10%
ALLISONS CREEK	4	68.8	2	4	6%
ANCONA CREEK	1	50	1	2	4%
AULT BEAG CREEK	2	18.2	2	4	22%
BADDAGINNIE CREEK	4	232.8	7	14	6%
BOGGY CK (YEA R)	1	70	0	0	0%
BOOSEY CREEK	6	306.8	22	44	14%
BOUNDARY CK (HUGHES)	1	50	3	6	12%
*^BRANKEET CREEK	1	37	22	48	130%
BREAK O'DAY CK (K P)	2	57	0	0	0%
BROKEN (CASEYS – G'RV)	79	13772.3	34	274	2%
BROKEN (NILL - CASEYS)	69	4684.9	38	230	5%
BROKEN CREEK CENTRE	1	12	2	4	33%
*^BROKEN CREEK LOWER	2	10.4	48	96	923%
BROKEN CREEK UPPER	40	5139	15	32	1%
BROKEN RIVER (UPPER)	1	40	8	16	40%
BROKEN RIVER TRIB	4	151.4	2	4	3%
BULLOCK YARD CREEK	1	107	0	0	0%
BURNT CREEK	8	629	3	6	1%
CAMPBELLS CREEK	6	136.9	0	0	0%
CAPTAINS CREEK	2	30	3	6	20%
CASTLE CREEK	4	219	4	8	4%
CHINAMANS CREEK	1	2.5	0	0	0%
CHRYSTAL CREEK	1	23	0	0	0%
CHYSER CREEK	7	334	3	6	2%
COCKPIT CREEK	2	55.4	2	6	11%
COLES CREEK	1	3	0	0	0%
COLONIAL (SPRING) CK	1	65	5	10	15%
CONNELLEYS CREEK	1	24	3	6	25%
*CREIGHTONS CREEK	3	37.3	13	26	70%
CRYSTAL CREEK	3	125	13	30	24%
CUMMINS CREEK	2	43	0	0	0%
DELATITE RIVER	13	351.3	61	128	36%
DIP CREEK	1	25	0	0	0%
ELLIOTTS CREEK	1	205	0	0	0%
FAITHFULLS CREEK	3	116.1	2	4	3%
FISHERS CREEK	2	82	8	16	20%
FORDS CREEK	2	76.5	1	2	3%
GLEN CREEK	1	25	6	12	48%
GODFREYS CREEK	2	53	9	22	42%
GOULBN TRIB(EIL-G'W)	4	170.5	8	16	9%
GOULBURN (EILDON - GW)	158	16073	194	452	3%
GOULBURN (GW - BROKEN)	69	4275.3	111	246	6%
*^GOULBURN R ABOVE EIL	2	11	51	102	927%

HEALTH CREEK	4	122	9	24	20%
HIRTS CREEK	2	122	0	0	0%
HOLLANDS CREEK	13	340.1	37	76	22%
HOME CREEK	3	144	12	32	22%
HOME STATION CREEK	1	11	2	4	36%
HORSEYARD CREEK	1	14.4	3	6	42%
HOWQUA RIVER	3	111	15	32	29%
HUGHES CREEK	11	1260.6	8	18	1%
ISLAND CREEK	6	438	6	12	3%
*^JAMIESON RIVER	3	31.7	56	116	366%
JOHNSONS CREEK	1	49.8	1	2	4%
JOHNSTON^S CREEK	3	162.8	3	6	4%
KATYS CREEK	2	74.8	9	20	27%
KEPPELS CREEK	1	338	4	8	2%
KILMORE CREEK	2	120	0	0	0%
*KING PARROT CREEK	17	492.3	212	436	89%
KURKURUC CREEK	2	129	3	6	5%
*^LAKE EILDON	6	150	122	274	183%
LAKE MOKOAN	15	1515	39	315	21%
LAKE NAGAMBIE	54	6784.7	148	408	6%
LAKE NILLAHCOOTIE	4	29	4	10	34%
LIMA CREEK	14	336.6	4	8	2%
LIMA EAST CREEK	7	137.2	4	8	6%
LIMESTONE CREEK	1	920	6	16	2%
LITTLE RIVER	13	257.1	34	70	27%
LITTLE STEAVENSON R	1	41.3	0	0	0%
MAJOR CREEK	3	884	4	10	1%
*^MAJORS CREEK	1	8.6	8	16	186%
MAN-O-WAR CREEK	1	11	1	2	18%
MCKAY CREEK	2	130	0	0	0%
*^MERTON CREEK	1	10	8	18	180%
MILL CREEK	1	145	1	2	1%
MOLLISONS CREEK	4	110	1	2	2%
MOUNTAIN CREEK	4	85.2	3	8	9%
MOUNTAIN HUT CREEK	1	2.5	0	0	0%
MUDDY CK (PRANJIP)	1	47	6	12	26%
MURRINDINDI CREEK	14	319.9	20	42	13%
NIAGAROON CREEK	1	81	1	2	2%
NINE MILE CK (Creightons Ck Trib.)	1	23	1	2	9%
NUMBER ONE CREEK	4	91.8	0	0	0%
NUMBER THREE CREEK	3	112	2	4	4%
PHEASANT CREEK	8	268.8	7	14	5%
REEDY CREEK TRIB	1	126	0	0	0%
RUBICON RIVER	12	558.7	15	32	6%
*^RUNNING CREEK	1	2.5	2	12	480%
*^RYANS CREEK	4	37.4	30	66	176%
SAM^S CREEK	1	27	2	4	15%
SAMARIA CREEK	2	12	2	4	33%
SEVEN CREEKS	33	1034.5	35	72	7%
STEAVENSON RIVER	20	1073.5	16	34	3%
STIRLING CREEK	4	176	4	12	7%
STONY CK(FLOWERDALE)	4	92.3	3	6	7%
STONY CREEK	1	162	3	10	6%

(Honeysuckle Ck Trib.)					
*^STRATH CREEK	1	3	2	4	133%
SUNDAY CREEK	6	204	4	36	18%
*SWAMP CREEK	1	10	4	8	80%
TAGGERTY RIVER	2	179	2	4	2%
TIMBERTOP CREEK	1	18	2	4	22%
VARIOUS STREAMS	1	9	0	0	0%
WALLABY CREEK	1	14.8	1	2	14%
WILD DOG CREEK	2	52	0	0	0%
WILKES CREEK	3	329	2	4	1%
YEA RIVER	43	1514.1	99	214	14%

* Streams where the volume of domestic and stock comprises at least half of the irrigation volume
^ Streams where domestic and stock volumes exceed irrigation

Appendix 3. Water Use Objectives and Standard Conditions

Water-Use Objectives

There are five specific matters listed in the legislation for which the Minister for Water can set water-use objectives. They are:

- Managing groundwater infiltration
- Managing disposal of drainage
- Minimising salinity Protecting biodiversity
- Minimising cumulative effects of water use

Managing groundwater infiltration In placing conditions on water-use licences in order to manage groundwater infiltration, the delegated Authority must aim to: Limit infiltration to groundwater systems arising from irrigation so as to minimise or avoid waterlogging, land salinisation, water salinisation and groundwater pollution.

Groundwater infiltration is the dominant driver of land and water salinisation within irrigation districts. To address this, water-use licenses will establish annual use limits per hectare of irrigated land. In setting the annual use limits consideration must be given to crop requirements, drainage systems and drainage re-use, and the need for vertical drainage to flush salt accumulation.

Managing disposal of drainage In placing conditions on water-use licences in order to manage the disposal of drainage, the delegated Authority must aim to: *Control the disposal of drainage from irrigation so as to minimise or avoid waterlogging, salinising or eutrophying waterways, wetlands, native vegetation, groundwater and other persons' property.*

Where a development is not part of a coordinated drainage scheme, the Victorian Government require the proponent to take individual responsibility for ensuring that any drainage water produced does not damage the environment. In such cases the water-use licence will specify conditions relating to drainage disposal and measures to mitigate environmental impacts. The Victorian Government will support an audit and compliance initiative to ensure those licence conditions in regards to drainage and environmental protection are met. Proponents will be fully responsible for the cost of remedial works if conditions have not been met, and in the case that environmental impacts are found, remedial actions taken.

Where there is approval for the development to be incorporated into a coordinated drainage scheme, it is the proponent's responsibility to ensure that drainage water is disposed via the coordinated drainage scheme.

The water-use licence may specify drainage contingencies, monitoring and reporting requirements and remedial actions.

Minimising salinity In placing conditions on water-use licences in order to minimise salinity, the delegated Authority must aim to*: Ensure that licence-holders are responsible for the full costs of any necessary offsetting works where limits on groundwater infiltration and controls on drainage disposal are not sufficient to manage identified risks to land or water salinisation.*

The Victorian Government aims to ensure that where salinisation of waterways cannot be avoided, the proponent will be responsible for meeting the cost of offsetting works. Where there is a reasonable probability that an irrigation development will result in material salinisation of a waterway, the development will either not be able to proceed or the proponent will be required to meet the costs of any offsetting works.

Protecting biodiversity In placing conditions on water-use licences in order to protect biodiversity, the delegated Authority must aim to: *Set corrective action thresholds and corrective action procedures where limits on groundwater infiltration and controls on drainage disposal are*

not sufficient to manage identified risks, associated with water use, to specific wetlands, native vegetation stands, or native animal habitats.

The Victorian Government aims to bring about protection and enhancement in biodiversity including a net gain in the extent and quality of native vegetation. Irrigation development is required to comply with the Victoria's Biodiversity Strategy and the Native Vegetation Management Framework. The Regional Irrigation Development Guidelines will provide a link to procedures and policies relevant to the protection and enhancement of native vegetation and to the broader protection of fauna, threatened species and wetlands. The Regional Irrigation Development Guidelines should provide a process to facilitate and ensure compliance with these requirements.

Irrigation developments can pose a direct and on going risk to wetlands, remnant vegetation, fauna, and threatened species through clearance, salinisation, waterlogging and water quality issues. In these instances, the Rural Water Authority in consultation with the Catchment Management Authority, Department of Sustainability and Environment and Local Government may write specific conditions into a water-use licence in due course.

Minimising cumulative effects of water use In placing conditions on water-use licences in order to minimise the cumulative effects of water use, the delegated Authority must aim to: Ensure the combined impact of a series of individually acceptable increases in water use within defined boundaries is not greater than the sum of the individual impacts on other persons and the environment.

The Victorian Government aims to ensure that the effect of small incremental decisions do not undermine its biodiversity, infiltration of groundwater, and drainage disposal water-use objectives.

The history of irrigation demonstrates that well managed, isolated, small-scale irrigation enterprises may cause little environmental damage. It also demonstrates that the larger-scale, more intensive irrigation, resulting from a cluster of such properties can pose significant threats to biodiversity protection, infiltration to groundwater and responsible drainage disposal.

The Victorian Government seeks to build review mechanisms into water-use licences to take account of these changing pressures. Therefore, the cumulative effect conditions of water-use licences will specify the trigger for conducting these reviews. The trigger may nominate the sum total of annual use limits that can be approved within a designated area without a review.

The review may also identify that because of the clustering of irrigation development, it is appropriate for a coordinated drainage scheme to be implemented.

Standard Conditions for Existing and New Water-Use Licence

All water-use licences that are current on 1st July 2007 and all new water-use licenses created after 1st July 2007 are subject to the following standard conditions to meet the set water use objectives:

Managing groundwater infiltration

- Water used for the purposes of irrigation on the land specified in the licence must be measured through a meter approved by a water authority unless the water authority has granted an exemption in writing.
- Ponded irrigation (ie. rice) must not be carried out on the land specified in the licence without the addition of particular conditions governing the use of such an irrigation system.

Managing disposal of drainage

- Where irrigation results in drainage from the land specified in the licence, that drainage water must be disposed in ways that meet with the standards, terms and conditions adopted from time to time by the water authority.

Additional conditions for Water-Use Licences subject to the Regional Irrigation Development Guidelines Additional conditions apply for water-use licences subject to the irrigation development guidelines.

Managing groundwater infiltration Conditions specific to each Catchment Management Authority are prescribed in Appendix 2-3,

Managing disposal of drainage

- Where irrigation results in drainage from the land specified in the licence, water may only be used for irrigation while that drainage water is disposed of in accordance with the arrangements specified in the endorsed irrigation and drainage plan and with any terms and conditions that apply to a drainage service that is employed.

Minimising salinity

- Where the endorsed irrigation and drainage plan identifies that the quality of the water being used for irrigation poses significant risk of salt accumulating in the irrigated soil, water may only be used for irrigation if its electrical conductivity lies within the range specified in the endorsed irrigation and drainage plan.
- Where the endorsed irrigation and drainage plan shows that all or part of the land being irrigated is within a 'salinity impact zone,' and where the Minister for Water, or a water authority acting for the Minister for Water, under Section 287A of the Water Act has given notice in writing requiring the owner to make a payment or payments towards the cost of works or measures to off-set any impact on river salinity, water may only be used for irrigation while the payments are being made as required.

Protecting biodiversity Where the endorsed irrigation and drainage plan identifies that the use of water for irrigation poses direct and ongoing risks to wetlands, native vegetation, or the habitat of native animals, water may only be used for irrigation while the licence holder meets the relevant monitoring and correctional requirements specified in the plan with regard to:

- installing and maintaining the specified monitoring equipment;
- following the specified data reading, recording and auditing requirements; and
- carrying out the specified corrective action procedures, within the specified time, where a specified threshold for these is breached.

Appendix 4. Risk Terminology

Determining Likelihood Levels

Likelihood	Description	
Certain	Occurs one or more times a year	Expected to occur in most circumstances
Likely	Occurs once every 5 years	Probably occur in most circumstances
Possible	Occurs once every 20 years	Might occur at some time
Unlikely	Occurs once every 100 years	Could occur at some time
Improbable	Occurs once every 1000 years	Occurs only in exceptional circumstances

Determining Consequence Levels

Consequence Severity	Low	Minor	Moderate	Major	Catastrophic
Impact	Impacts to the biological or physical environment that: • No indigenous species damage; and/or • Cause damage to species, habitat and/or cultural or heritage items of no formal significance; and/or • Are within the immediate area of the source of impact; and/or • Impair natural ecosystem function or commercial productivity of land across 1ha; and/or • Are short term (<3 months); and/or • Cause human illness /	Impacts to the biological or physical environment that: • Cause single indigenous species damage • Result in damage or loss of species, habitat and/or cultural or heritage items of local significance; and/or • Are within the immediate area of the source of impact; and/or • Impair natural ecosystem function or commercial productivity of land across >1 to 1,000ha; and/or • Are short to medium term (<1 year); and/or	Impacts to the biological or physical environment that: • Cause multiple indigenous species damage within a local area (eg. Single Sub Catchment) • Cause damage or loss of species, habitat and/or cultural or heritage items of Sate significance; and/or • Extends beyond the immediate area of the source of impact however still within the local area (eg. Single Sub Catchment) • Impair natural ecosystem function or commercial productivity	Impacts to the biological or physical environment that: • Cause multiple indigenous species damage across a regional area (eg. CMA area); and/or • Cause damage or loss of species, habitat and/or cultural or heritage items of National significance; and/or • Extend regionally (eg. Across CMA area); and/or • Impair natural ecosystem function or commercial productivity or land across >10,000 to 50,000ha; and/or	Impacts to the biological or physical environment that: • Cause indigenous species extinction; and/or • Cause irretrievable loss of habitat and/or cultural or heritage items of State / National / International significance; and/or • Extend nationally; and/or • Impair natural ecosystem function or commercial productivity of land across > 50,000ha; and/or • Cause multiple human fatalities, or regional human health effects

	effects not requiring medical treatment. • Resource not impaired. • Social activities not affected	• Cause human illness / effects that require one person to require medical treatment. • Resource temporarily affected • Social activities temporarily affected	of land across > 1,000 to 10,000ha; and/or • Are medium term (1-10 years) • Cause a single hospitalisation or local area human health effects requiring medical treatment or resulting in reversible impairment. • Loss of resource but sustainability unaffected • Inability to carry out social activities	• Are longer term (>10 years); and/or • Cause human fatality or local area human health effects requiring multiple hospitalisation and/or permanent disabling effects on human health in one person. • Loss of sustainability of selected resources • Loss of a social asset	requiring multiple hospitalisation, and/or permanent disabling effects on human health in more than one person. • Loss of sustainability of most resources. • Loss of most social assets

Determining Risk Levels

Consequence Likelihood	**Low**	**Minor**	**Moderate**	**Major**	**Catastrophic**
Certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	Extreme	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Low	Medium	High	High
Improbable	Low	Low	Medium	High	High

Appendix 5. The Entire Risk Assessment for all Asset Items/Threat Combinations

	Primary Asset	Secondary Asset	Asset Item	No.	Threat	Risk	Impact
Environment	Water	Regulated rivers & streams	Flows	1	Diversion of surface flows for irrigation	E	Altered natural flow patterns of stream (includes floods, normal flows, low flows, slack water)
				2	Capturing surface run off (irrigation farm dams)	M	Less surface run off into streams and infiltration into aquifers
			Water quality	3	Salinisation	H	Increased stream salinity levels (decline in health of aquatic life and biodiversity); increased salt loads (downstream impacts)
				4	Eutrophication	E	Altered stream ecology; increased algal blooms; reduced biodiversity
				5	Erosion	E	Increased turbidity, sedimentation (sand slug), light blocking
				6	Soil acidification	M	Decreased water pH; altered stream ecology
				7	Decline riparian vegetation (inc. grazing)	H	Change in carbon levels in water, loss fish habitat, decline food source
				8	Pollution (including fuel spills, pesticide, fertiliser spills & antibiotics)	M	Death/decline in health of aquatic life; decline in aquatic biodiversity
				9	Pollution (including thermal pollution cold)	H	Impacts on species (eg. native fish breeding); decline in productivity of aquatic life
				10	Lack of knowledge/monitoring	E	Poor management decisions
		Unregulated rivers & streams	Flows	11	Diversion of surface flows for irrigation	E	Altered natural flow patterns of stream (includes floods, normal flows, low flows, slack water)
				12	Capturing surface run off (irrigation farm dams)	H	Less surface run off into streams and infiltration into aquifers
			Water quality	13	Salinisation	E	Increased stream salinity levels (decline in health of aquatic life and biodiversity); increased salt loads (downstream impacts)
				14	Eutrophication	E	Altered stream ecology; increased algal blooms & acid sulphate; reduced biodiversity
				15	Erosion	E	Increased turbidity, sedimentation (sand slug), light blocking

			16	Soil acidification	M	Decreased water pH; altered stream ecology
			17	Decline riparian vegetation (inc. grazing)	H	Change in carbon levels in water, loss fish habitat, decline food source
			18	Pollution (including fuel spills & pesticide)	H	Death/decline in health of aquatic life; decline in aquatic biodiversity
			19	Pollution (including thermal pollution hot)	M	Impacts on species (eg. native fish breeding); decline in productivity of aquatic life
			20	Lack of knowledge/monitoring	E	Poor management decisions
		Wetland	Water quantity & quality	21	Irrigation water use (reduced wetland inflows from stream, local catchment or groundwater)	H	Altered flooding/drying regime (reduced inflows); altered wetland ecology
				22	Salinisation	H	Increased salinity levels (decline in health of aquatic life and biodiversity)
				23	Sedimentation	H	Increased turbidity; altered wetland ecology; in-filling of wetland depression
				24	Eutrophication	H	Altered wetland ecology; increased algal blooms & acid sulphate; reduced biodiversity
				25	Soil acidification	H	Decreased water pH; altered wetland ecology
				26	Irrigation water use (reduced wetland flushing)	H	Creates nutrient sinks (P & S build up); altered wetland ecology
				27	Water logging	H	Change of fringe
				28	Pollution (including fuel spills, pesticide, fertiliser spills & antibiotics)	H	Death/decline in health of aquatic life; decline in aquatic biodiversity
				29	Pollution (including thermal pollution)	M	Changing dynamics
				30	Lack of knowledge/monitoring	E	Poor management decisions
		Aquifers	Water quantity	31	Groundwater use for irrigation	H	Decline in contribution to streamflows
			Water quality	32	Salinisation	E	Increase salt stores in aquifers
				33	Eutrophication	M	Increase nutrient levels in aquifers
				34	Pollution (including fuel spills & pesticide)	M	Death/decline in health of aquatic life; decline in aquatic biodiversity

			35	Pollution (including Thermal Pollution)	M	Decline in health of aquatic life
			36	Lack of knowledge	E	Poor management decisions
Land	Soil health	Physical	37	Loss of vegetation cover	H	Increased risk of erosion; deterioration of soil structure; loss of organic matter
			38	Compaction (stock, machinery & cultivation)	H	Deterioration of soil structure
			39	Chemical imbalance (inc. sodicity)	M	Deterioration of soil structure
		Chemical	40	Product removal	M	Acidification and nutrient loss/imbalance
			41	Irrigation with poor quality water	M	Increased soil salinity, sodicity, chemical imbalance
			42	Poor irrigation practices (eg. systems, rates, fertiliser use)	H	Acidification and nutrient loss (run off & leaching)
		Biological	43	Erosion	H	System shift
			44	Water logging	H	Creates an anaerobic environment
			45	Cultivation	H	Change of habitat
			46	Deterioration of soil structure (Compaction & sodicity)	H	Change of habitat
			47	Chemical imbalance	H	System shift
	Remnant Native Vegetation	Biodiversity Action Plan sites	48	Eutrophication	E	Change to natural condition
			49	Water logging	E	Change to natural condition
			50	Increasing edge effects (vegetation decline, pests, weeds)	E	Shrinkage/loss of BAP area
		Terrestrial / Riparian adjacent to irrigation	51	Grazing	E	Change to natural condition (decline/loss of species, weed invasion)
			52	Eutrophication	H	Change to natural condition (decline/loss of species, weed invasion)
			53	Water logging	E	Change to natural condition (decline/loss of species, weed invasion)
		Terrestrial / Riparian within irrigated area	54	Irrigation Development (on previously unirrigated land)	H	Removal of any remnant native vegetation, and eventual decline/loss of remnant trees

				55	Tree clearing within irrigated area (eg. for reconfiguration, system change)	E	Removal of remnant trees
				56	Grazing (including stock camp and ring barking trees)	E	Decline/loss of remnant trees
				57	Eutrophication	E	Decline/loss of remnant trees
				58	Water logging	E	Decline/loss of remnant trees
		Native Fauna	Aquatic species	59	Altered flow regimes; deterioration of water quality	E	Decline/loss of species
			Terrestrial species	60	Loss of habitat	E	Decline/loss of species
		Native Flora	Aquatic species	61	Altered flow regimes; deterioration of water quality	E	Decline/loss of species
			Terrestrial species	62	Clearing	E	Decline/loss of flora
				63	Irrigation development (on previously unirrigated land)	E	Decline/loss of flora
	Atmosphere	Climate	Stability	64	Greenhouse gas emissions	M	Global warming
			Air quality	65	Exhaust from machinery	M	Increase in fumes/air particles
Social		Population	Population growth	66	Deterioration of water quality	M	Reduced population growth due to poor water quality
				67	Diversion of surface flows	M	Reduced population growth due to reduced water availability
		Infrastructure	Infrastructure	68	Salinisation; water-logging	M	Impacts on roads, buildings, underground service lines, etc.
				69	Erosion	M	Impacts on roads, buildings, underground service lines, etc.
		Recreation	Recreational use of water	70	Deterioration of water quality	M	Decline of people using asset
				71	Diversion of surface flows	M	Stream becomes unusable for recreational use
				72	Low water storage levels	M	Storage becomes unusable or unsafe for recreational use
		Cultural Heritage	Indigenous heritage	73	Grazing/cultivation/clearing	H	Damage to heritage sites
			European heritage	74	Grazing/cultivation/clearing	M	Damage to heritage sites
				75	Salinisation	M	Damage to heritage sites
Economic	Tourism	Population	Population growth	76	Deterioration of water quality	M	Reduced population growth due to poor water quality

				77	Diversion of surface flows	M	Reduced population growth due to reduced water availability
		Infrastructure	Infrastructure	78	Salinisation; water-logging	M	Impacts on roads, buildings, underground service lines, etc.
				79	Erosion	M	Impacts on roads, buildings, underground service lines, etc.
		Recreation	Recreational use of water	80	Deterioration of water quality	M	Decline of people using asset
				81	Diversion of surface flows	M	Stream becomes unusable for recreational use
				82	Low water storage levels	M	Storage becomes unusable or unsafe for recreational use
		Cultural Heritage	Indigenous heritage	83	Grazing/cultivation/clearing	H	Damage to heritage sites
			European heritage	84	Grazing/cultivation/clearing	M	Damage to heritage sites
				85	Salinisation	M	Damage to heritage sites
	Water Use	Access to Water	Availability of water (within regulated system)	86	Increased environmental flows	H	Reduced water availability for irrigation
				87	Below average rainfalls/over allocation	H	Reduced water availability to irrigation
				88	Transfer of water right out of region	H	Loss of water for irrigation from whole region
				89	Transfer of water right within region	M	Loss of water for irrigation from specific communities
				90	Government Regulations (IDG's, WUL's)	M	Barriers to development
				91	Deterioration of water quality	L	Water unsuitable for irrigation
				92	Increased demand for water (irrigation and domestic)	E	Increased cost of water for irrigation
			Availability of water (within unregulated system)	93	Increased environmental flows	E	Reduced water availability
				94	Below average rainfalls/over allocation	E	Reduced water availability to irrigation
				95	Transfer of water right out of region	E	Loss of water for irrigation from whole region
				96	Transfer of water right within region	M	Loss of water for irrigation from specific communities
				97	Government Regulations (SFMP's, GWMP's, Farm Dams, IDG's, WUL's)	H	Barrier to development

				98	Deterioration of water quality	H	Water unsuitable for irrigation
				99	Increased demand for water (irrigation and domestic)	E	Increase cost of water
	Land Use	Access to Land	Availability of land	100	Unavailability of land suitable for irrigation	M	Decline/deterioration of irrigation growth
				101	Increased dominance of lifestyle landholders across region	H	Limiting availability of land for irrigation and increasing land values
				102	Government Regulations (Shire planning, Native veg clearance controls, IDG's)	M	Barriers to development
		Productivity of irrigated agriculture	Productivity	103	Weeds	H	Decrease in productivity and WUE
				104	Water logging	H	Decrease in productivity, WUE & crop choice
				105	Acidification	M	Decrease in productivity, WUE & crop choice
				106	Nutrient imbalance	M	Decrease in productivity and WUE

Appendix 6. Targets relating to the Goulburn Broken Regional Catchment Strategy

Asset	***Aspirational Target***	***Resource Condition***	***SIAP input to RCT's***
Water	Maintain the condition of all reaches (benchmark 2003) of rivers and streams rated as 'good' or 'excellent'. Improve the overall condition (benchmark 2003) of rivers and streams rated as 'marginal', 'poor' and 'very poor' by 2050.	Maintain and improve In-stream and riparian, Ecologically Healthy Rivers, Representative Rivers, Heritage Rivers, Rivers of Regional Significance and Public Frontages	NA

	Improve and maintain water quality at optimum levels within and downstream of the Catchment for native ecosystems, recreation, human and animal consumption, agriculture and industry.	Reduce potential phosphorus loads by 65% by 2016.	• Improve irrigation systems by:
			  • Providing 15 education days
			  • 50 SMME incentives
			  • 10 System change incentives
			  • Provide benchmarking for 20 participants
			  • 10 system check incentives
			• Providing 10 reuse incentives

Land	The long term targets of the Dryland Salinity Management Plan are to: • Deliver an integrated program to protect and enhance natural resources within the catchment • Develop a high level of community responsibility and accountability • Control land degradation and protect important terrestrial and aquatic assets • Maintain water quality for all beneficial uses, including agricultural, environmental, urban, industrial and recreational.	Maintain increase to salinity levels of the River Murray at Morgan from the GB Dryland at or below 1.3 EC's by 2050. This means reducing saltloads by 34,000 tonnes per year by 2050. Reduces increase in salinisation of dryland areas where possible. This means reducing area of dryland that would otherwise be salinised (in foothills and river valleys of highland areas): 1,500 ha by 2050. Manage salinised land and land with high watertables in the riverine plain ("Live with Salt"). This means managing salinised land in the riverine plain: 30,000ha by 2100 and managing land with high watertables in the riverine plain 120,000 ha by 2100.	• Provide 10 IDEP incentives per year to plan for works • Provide 10 participants with an incentive to install buffer zones for the interception of surface water action.
	We will seek to maintain the capacity of region's soils to support human health and habitation and to contribute to enhanced water and air quality.	The focus on soil health over the next five years will be to manage Soil salinity (EC) and sodicity in irrigated regions, and Acidity (pH) soil structure and erosion in dryland regions.	NA
Biodiversity	The community will work in partnership with Federal and State Governments and other	**Native Vegetation** Maintain extent of all native vegetation types at 1999	NA

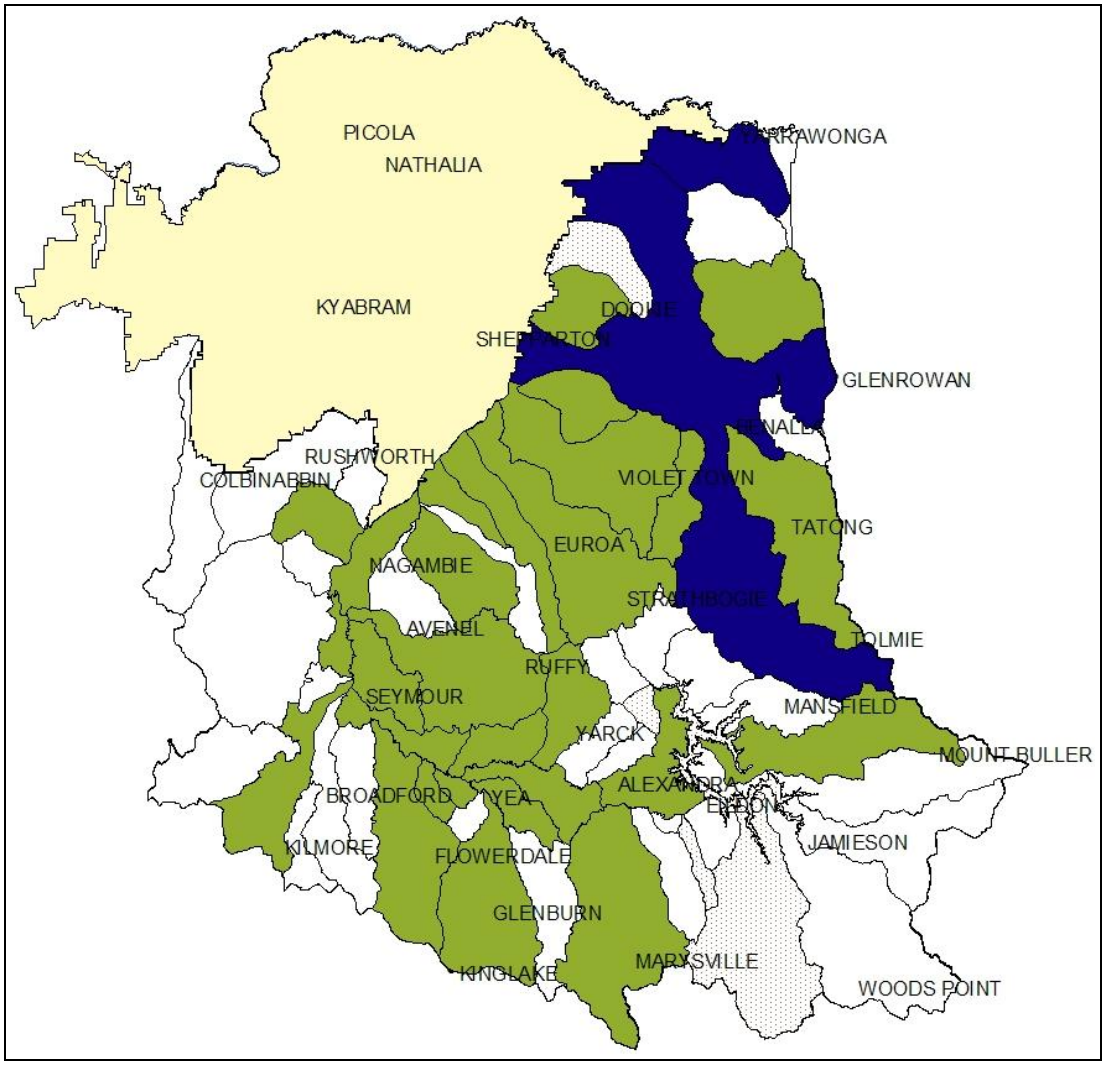
	agencies to protect and enhance ecological processes and genetic diversity to secure the future of native species of plants, animals and other organisms in the Catchment.	levels in keeping with the goal of 'net gain' listed in Victoria's Biodiversity Strategy 1997. Improve the quality of 90% of existing (2003) native vegetation by 10% by 2030. Increase the cover of all endangered and applicable vulnerable EVC's to at least 15% of their pre-European vegetation cover by 2030. **Threatened Species** Increase 2002 conservation status of 80% threatened flora and 60% threatened fauna by 2030.	
Atmosphere	Greenhouse emissions from the Catchment will be limited to nationally agreed levels.	Regional and Sub-regional goals and targets will be determined.	NA

Appendix 7 a) Potential, water, nitrogen, phosphorus, salt and soil saving with each sub-catchment

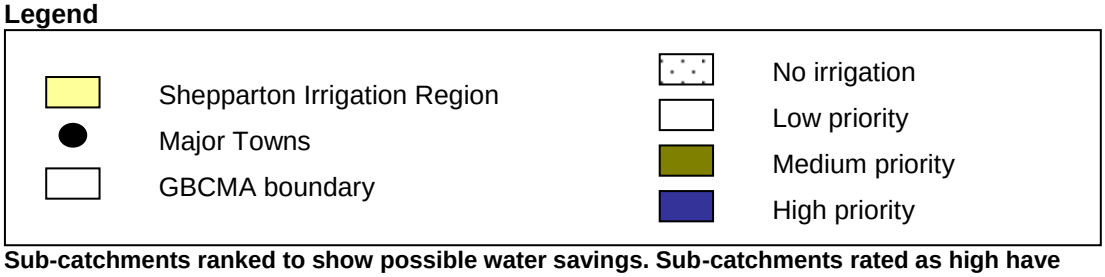
	Water (ML)	Nitrogen (kg)	Soluble P (kg)	Salt (kg)	Soil (kg)
Acheron	334	3244	2846	7523	4933
Back	444	4088	2785	186,732	10262
Boosey	239	2798	2389	47,787	7600
Boundary	77	655	541	1413	1329
Branjee	131	1200	1064	0	1568
Brankeet	17	141	117	0	249
Broken	6328	68968	56353	880,431	157469
Buffalo	42	382	319	7494	771
Castle	122	1260	1025	8164	2823
Christie Hill	66	599	530	0	842
Congupna	105	1183	917	9732	4401
Cornella	25	221	122	611	619
Creightons	97	806	623	324	1321
Dabyminga	30	280	245	2748	436
Dairy	136	1243	1090	1910	1917
Delatite	104	991	876	0	1312
Dry	72	637	543	675	1134
Eastern Dairy	156	1438	1267	7511	2071
Five	214	1855	1357	3117	3627
Ford	10	96	76	0	191
Four & Seven	39	328	282	0	627
Hjuts	500	5954	5637	7692	7888
Holland	187	1538	1299	24796	4314
Home	232	1950	1685	4498	2353
Honeysuckle	232	1950	1685	4538	2559
Howqua	0	1	1	0	6
Hughes	314	3018	2345	3255	9416
Jamieson	1	8	5	0	37
Johnson	1	12	7	290	38
King-Parrot	316	2893	2535	0	4540
Kukurac	176	1611	1413	0	2695
Limestone	287	2597	2275	11062	3952
Lower Goulburn	815	7281	4220	0	18812
Majors	24	236	149	11159	1032
Merton	49	405	340	0	635
Mollisons	64	554	481	2150	799
Muckatah	1080	9781	6688	15118	21978
Murrindindi	25	239	192	1210	469
Pranjip	146	1216	886	18899	2830
Rubicon	55	507	448	1839	715
Sandy	94	854	540	0	2199
Scrubby	955	8738	7684	61995	13172
Seven	617	5138	4129	8884	8488
Sheep_pen	168	2059	1676	191131	5247
Sheepwash	133	1731	1169	32165	6287
Snobs/Rubicon	3	27	23	0	51
Spring	57	1128	957	1480	1808
Stony	3	65	55	79	139
Strath N.T	410	8062	6840	0	13739

Sunday	42	646	528	1244	1466
Tallangalook	4	97	81	0	177
Upper-Goulburn	0	3	1	0	10
Wanalta	13	172	136	1807	391
Whiteheads	150	1982	1379	16544	6276
Wormangal	96	1097	648	3439	4880
Yea	331	3232	2693	2577	4840

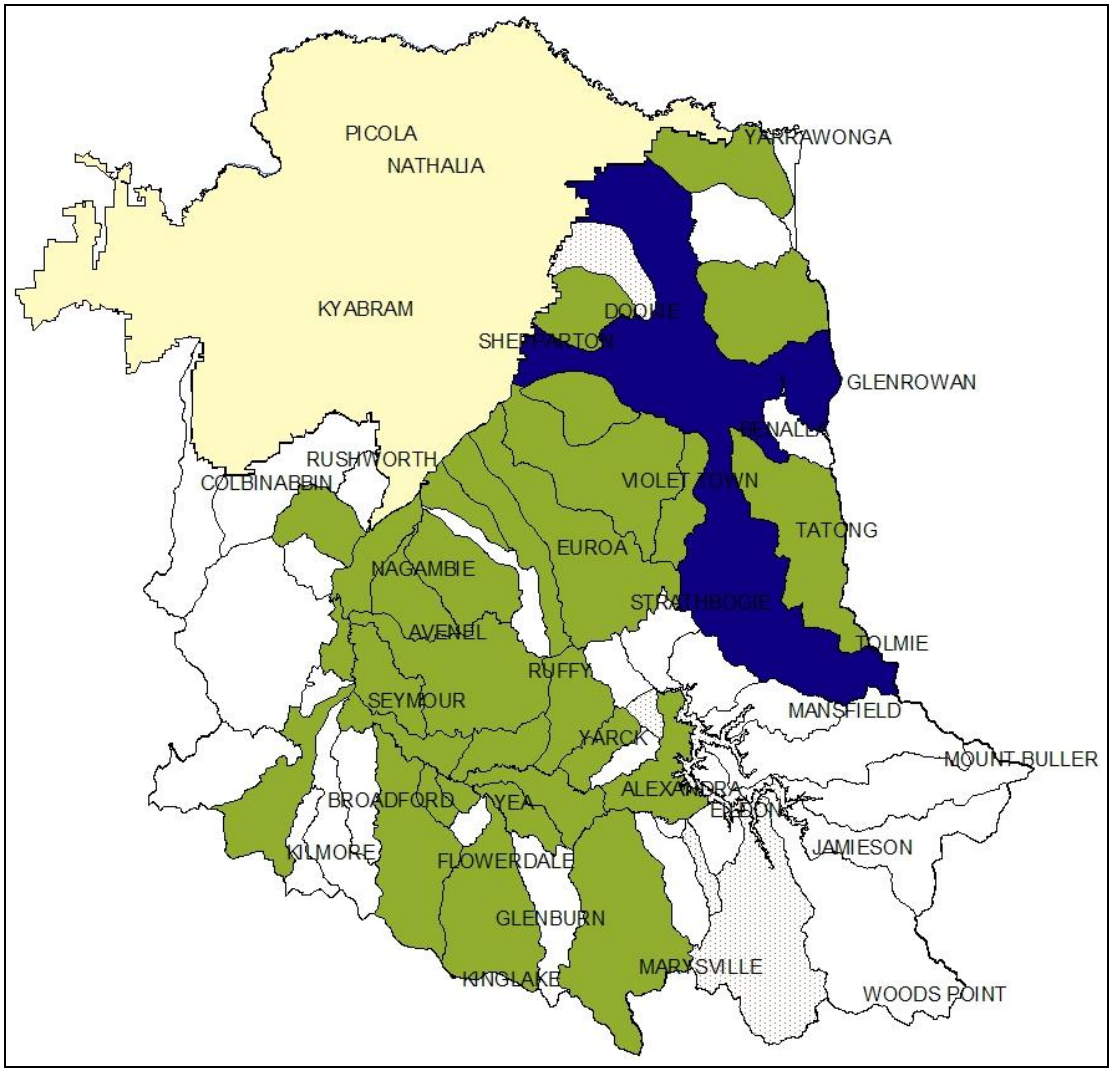
Appendix 7 b) Priority Sub-catchments



Legend



Sub-catchments ranked to show possible water savings. Sub-catchments rated as high have potential to save over 1,000 ML, those rated medium have the potential to save between 100 and 1,000 ML, those rated low have the potential to save under 100 ML. Four sub-catchments have no irrigation.



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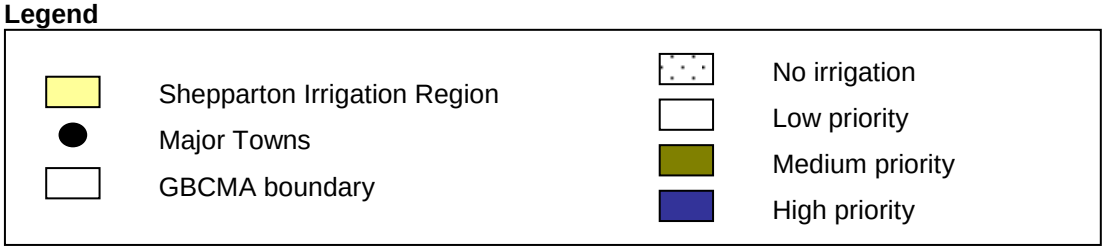
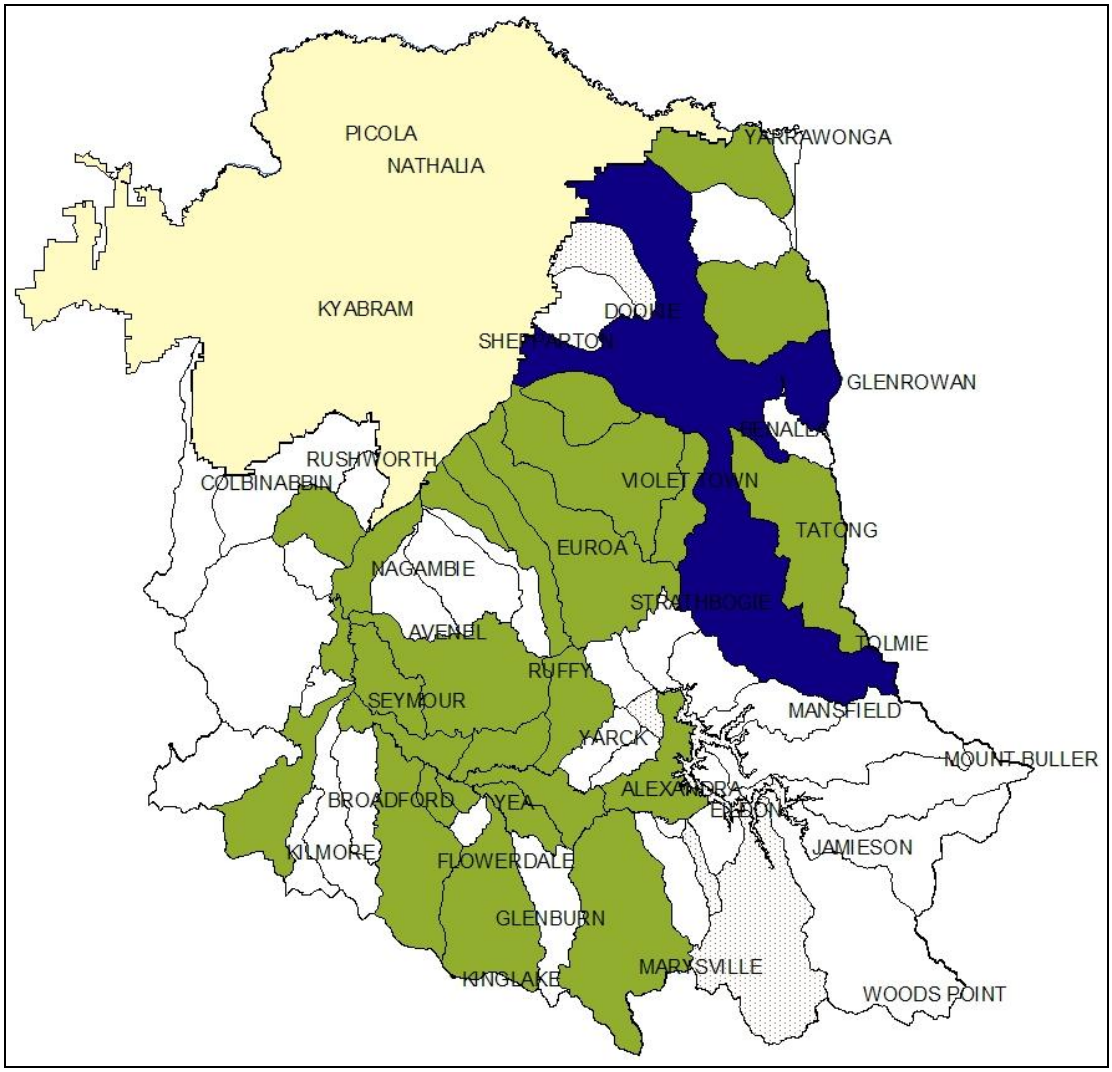


Sub-catchments ranked to show possible Nitrogen savings. Sub-catchments rated as high have potential to save over 10,000 kg, those rated medium have the potential to save between 1,000 and 10,000 kg, those rated low have the potential to save under 1,000 kg. Four sub-catchments have no irrigation.



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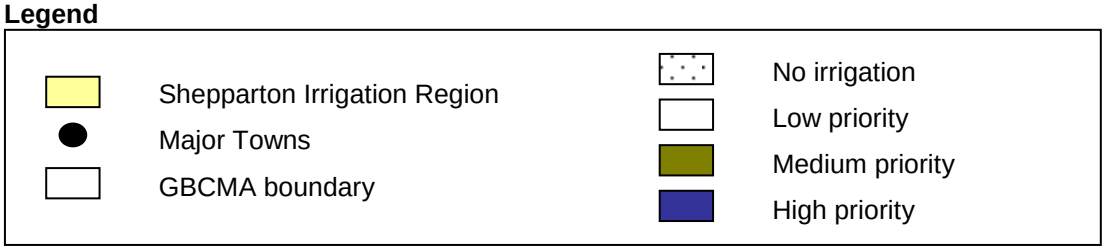
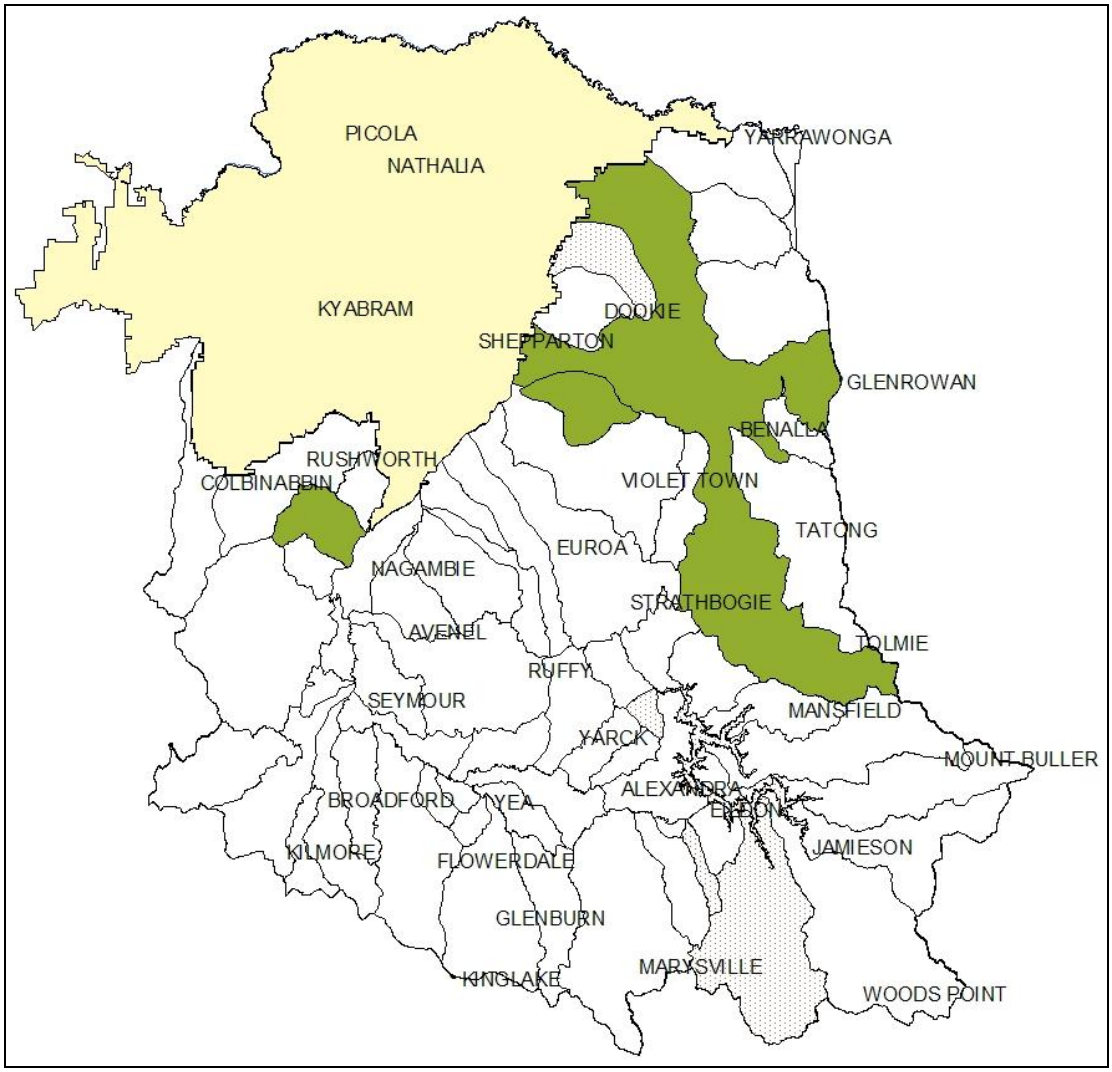


Sub-catchments ranked to show possible Phosphorus savings. Sub-catchments rated as high have potential to save over 10,000 kg, those rated medium have the potential to save between 1,000 and 10,000 kg, those rated low have the potential to save under 1,000 kg. Four sub-catchments have no irrigation.



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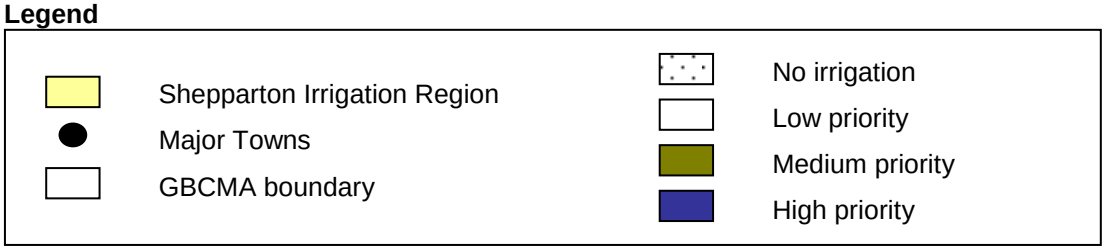
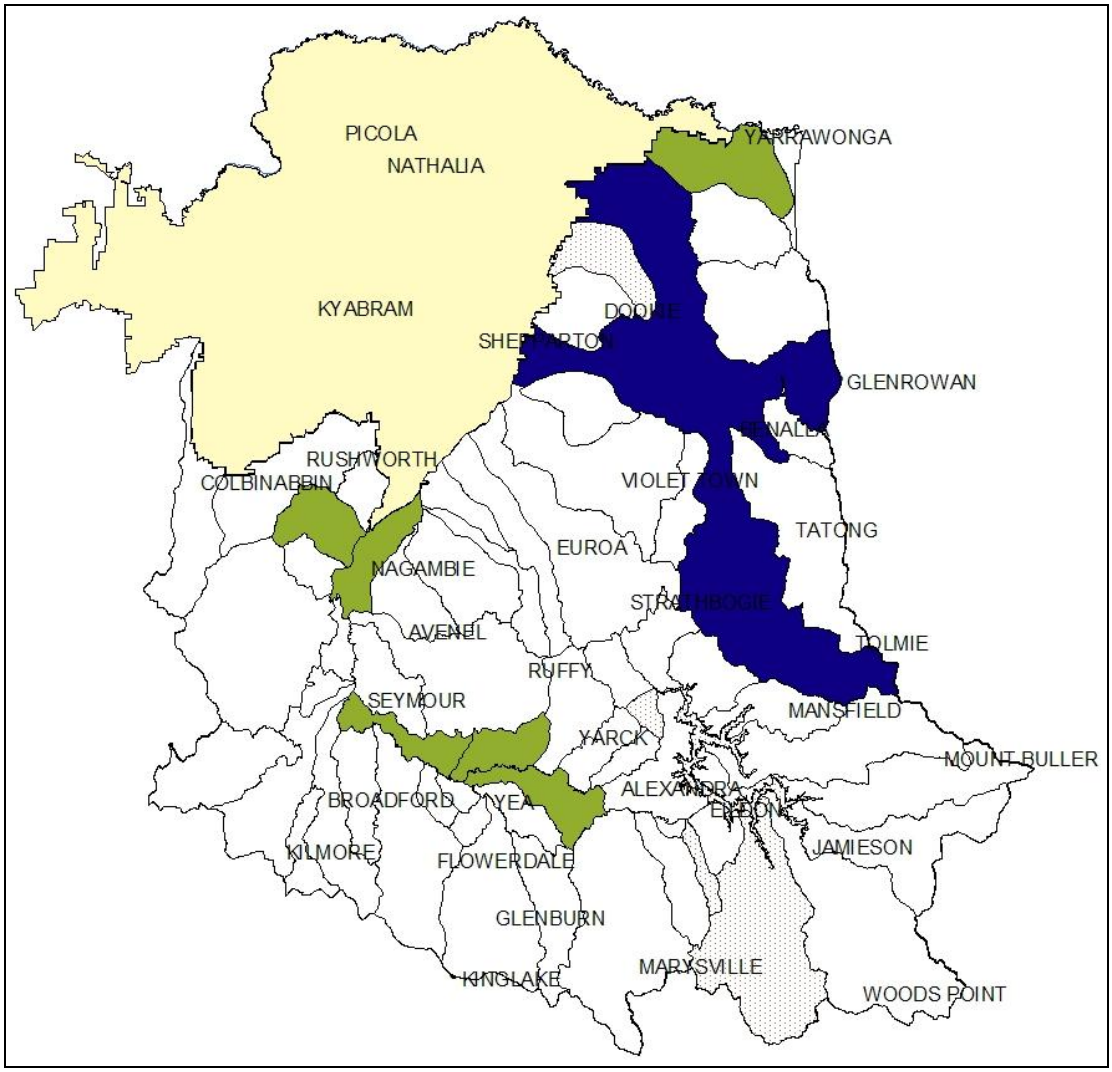


Sub-catchments ranked to show possible Salt savings. Sub-catchments rated as high have potential to save over 1,000 kg, those rated medium have the potential to save between 100 and 1,000 kg, those rated low have the potential to save under 100 kg. Four sub-catchments have no irrigation.



Legend

- Shepparton Irrigation Region
- Major Towns
- GBCMA boundary
- No irrigation
- Low priority
- Medium priority
- High priority

Sub-catchments ranked to show possible Soil savings. Sub-catchments rated as high have potential to save over 100,000 kg, those rated medium have the potential to save between 10,000 and 100,000 kg, those rated low have the potential to save under 10,000 kg. Four sub-catchments have no irrigation.

Appendix 8. Benefit-Cost Analysis

Table 1: Total cost (for five years) and benefit (over 30 years) of the total programs at a 4% and 8% NPV, and for the public and private investment at a 4% and 8% NPV respectively.

	Total Project				Public		Private	
	4%		8%		4%		8%	
	Cost (,000)	benefit (,000)	Cost (,000)	benefit (,000)	Cost (,000)	benefit (,000)	Cost (,000)	benefit (,000)
Education	$155	$1,172	$139	$634	$72	$819	$75	$191
SMME	$656	$3,946	$589	$2,270	$223	$2,752	$389	$712
System Change	$2,061	$1,064	$1,848	$595	$1,059	$1,064	$898	$289
System Change target flood (50:50)	$2,061	$1,824	$1,848	$1,029	$1,059	$1,238	$898	$338
System Change target flood (25:75)	$2,061	$1,824	$1,848	$1,029	$558	$1,238	$1,348	$338
Benchmarking	$195	$801	$175	$499	$115	$560	$72	$150
System Check	$195	$1,579	$175	$908	$115	$1,101	$72	$285
IDEP	$240	$1,184	$216	$681	$215	$826	$22	$214
IDEP >15ha	$160	$2,451	$144	$1,410	$144	$1,709	$15	$442
Reuse	$826	$281	$740	$165	$505	$159	$287	$71
Buffer Zone	$172	$262	$154	$145	$161	$262	$10	$0

Assumptions used in benefit: cost analysis

The assumptions made with the costs associated with the different programs are:

- The average cost for soil moisture monitoring equipment per farm is $2000
- The average cost for a new irrigation system is $3000/ha
- Three days are required per farm for the Intensive Extension program

The assumptions made with the benefits associated with the different programs are:

- Water has been valued at $70/ML (value traded on the temporary market) and split 50:50 between the irrigator and the public
- Nitrogen is worth $1000/t of N to the farmer
- Nitrogen kept out of water ways is worth $200/t of N to the public
- Salt kept out of water ways is worth $37/t to the public
- Soil kept on farm is worth $200/t to the farmer
- Soil kept on farm is worth $500/t to the public
- The discount rate used for the public benefit was set at 4% and analysed over a 30 year period
- The discount rate used for the private benefit was set at 6% and analysed over a 30 year period

Appendix 9. Electronic version of Risk Assessment

"Management Actions in plan.doc"