System Harmonisation: Concept, Issues and Progress

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CRC for Irrigation Futures
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Executive Summary

Irrigation and environmental sustainability in irrigated catchments have, to date, been managed as two competing enterprises under separate and divergent control. In Australia there is an increasing quest and support for a “harmonised” business approach to sustainable use of land and water resources to achieve enduring business partnerships in water management. The “System Harmonisation” approach seeks to identify business opportunities for irrigators to become an integral part of an expanding environmental services industry and in so doing support a truly sustainable and diversified irrigation business environment. A good understanding of system wide harmonisation can be gained from how irrigation systems are linked with the catchment water cycle and how life support systems and regional economies depend on them. The system harmonisation framework involves an all encompassing approach that combines research and business principles to achieve productive and environmental improvements at the catchment level. The framework involves five feasibility steps including three research components and a business analysis component: The research components comprise analysis and characterisation of hydrologic systems, water productivity, markets and ecosystem services, and mechanisms and processes for change. While the business component is based on the formation of Regional Irrigation Business Partnerships (RIBP) to explore and implement opportunities for improved productive and/or environmental outcomes through changes in water management. The system harmonisation process establishes the base physical, economic and social position of the region, identifies the key pressure points in the system and the system constraint. The key pressure points in a water system can be of a biophysical, economic, social, environmental or institutional nature. It is the changes in these key pressure points that need to be assessed, in a comprehensive and systematic way, to enhance the multifunctional productivity of irrigation systems.

Internationally there is a major lag between research and management policy since most water management policy is based on outdated knowledge and technology and there is a paradigm lock between water scientists and policy makers and users. In many catchments stakeholders are unaware of what technical facilities are available
and scientists do not appreciate how to become part of real solutions. System Harmonisation project is aimed to bridge the gap between the water policy, water resource management and scientific communities right from the setting of research agenda to the free flow of information for use in management and policy making for enhancing the multifunctional productivity of water resources.

This document explains that vision and reports the progress to date in implementing the System Harmonisation Framework in selected catchments across Australia:

- Coleambally Irrigation Area
- South Creek Catchment in Western Sydney
- Limestone Coast
- Macintyre Brook

The core elements of System Harmonisation framework link research to local needs:

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Expected outcome include improved business productivity and viability through better cropping decisions (timeliness, choices, markets, etc.) and improved communication, with environmental service benefits. Early findings show mixed achievements, with some RIBPs already established while others making rapid advance toward achieving this milestone. The System Harmonisation initiative brings together the biggest groups of researchers and water managers to deliver benefits to regional Australian communities through better water management and environmental stewardship.
1. Introduction

Irrigation and environmental sustainability have to date been managed as two competing enterprises under separate and divergent control. This approach has often translated into polarised approaches to resource management to the detriment of both production and environmental sustainability. There is an increasing need and support for a “Harmonised” business approach to sustainable use of land and water resources in Australia and elsewhere. This approach seeks to identify business opportunities for irrigators to become part of an expanding environmental services industry and in so doing support the expansion of a truly sustainable and diversified irrigation business environment. This concept is based on improving irrigation businesses by seeking to establish enduring business arrangements that connect irrigators with environmental services, as well as increasing the productivity of water.

The System Harmonisation™ is defined as “a strategy to improve cross-organisational communication and system-wide management and improve production and environmental outcomes.” The key objective of this research program is to establish Regional Irrigation Business Partnerships (RIBPs) to capture the production and environmental gains from research improving regional irrigation systems management and to market these benefits through a regional business plan or investment prospectus. Key characteristics of perfectly harmonised system include:

- At farm level, integration across all elements of the farm production resource bases (social, economic, technical and environmental) to achieve an optimum returns on all resources. More specifically, it implies the irrigation requirements of the crop can be met by all elements on the on farm delivery system and that there is a balance of the flow across all elements.

- At system level, optimisation of flow management to meet the productivity and environmental outcomes. More specifically, maximizing the productivity entails a system that can supply water at the highest level of service in the most cost-effective way while meeting agreed environmental objectives.
At catchment level, adjustments for difference or inconsistency between water supply and demand; making resources more productive; have the ability to attract invest funds; meeting the environmental standards for water, soil and species protection; meet food safety; have appropriate data and information management system that can be readily accessed and complied in compatible way; achieve competitiveness not only on natural comparative advantage, but also on environmental polices within Australia and abroad; and have operating rules for dams groundwater storages to meet the environmental and consumptive demand.

At value chain level, provides effective set of activities for an organisation and links them to organisation’s competitive position. The value chain can be defined as a “service of linked business processes that create a value in both products and services, which are delivered to costumers”.

Water resource systems involve many subsystems, which are intrinsically linked to one another through physical, environmental, economics and social level. In addition to the physical or biophysical restraints, economic, environmental and social elements present key recourse pressure points in the system. In particular, these relate to the capacity to optimise on-farm and near-farm irrigation system performance and water demand patterns to deliver productive and environmental dividends. The focus of the System Harmonisation™ program is to gain insights in relation to these pressure points in a systematic and comprehensive way and proposed changes to effectively manage these pressure points. The main aim of this project is to identify opportunities for improving the management of surface and groundwater resources to satisfy environmental and consumptive demand in irrigated catchments. To achieve this aim, it will focus on the following specific objectives:

- To identify opportunities to modify irrigation system demand and supply parameters through improved on farm/off farm infrastructure management, changed cropping mixes, potential ground water substitution and trading options;
- To assess the economic, environmental and social impact of these changed management practices;
• To obtain community feedback on the value of these options in meeting the economic and environmental issues arising from the implementation of water reform in irrigated catchments

• To achieve consensus between catchment stakeholders and scientists on future catchment scenarios and knowledge gaps; and

• To realise current and future business opportunities for joint CRC-industry research investments in future.

System harmonisation analysis is an all encompassing approach that combines research and business principles to achieve productive and environmental improvements at the catchment level. In Figure 1 this combined conceptual analytical and business framework is shown. The analysis involved a comprehensive assessment of the hydrologic system that allows the identification of hydrologic interventions aimed to capture productive and environmental opportunities, along with an economic and social analysis of these opportunities and the identification of institutional and other barriers to the implementation of these measures. The framework involves five feasibility steps including three research components designed to study the biophysical, economic and institutional aspects, and a business analysis component which will lay the basis for the establishment of Regional Irrigation Business Partnerships (RIBP), which in turn are used to implement stakeholder agreed interventions in a business context.

• In the first phase, the hydrologic system is analysed and characterised. This entails the quantification of stocks and flows of water, pollutants and other constituents within the entire catchment water cycle. The understanding of the system dynamics achieve in this process is crucial in analysing the existing hydrologic situation of the system and formulating, calibrating and using modelling predictive tools to ascertain system responses to alternative system operational policies designed to address productive and environmental improvements.

• In the second phase, the economic, social and environmental outcomes from the hydrological systems are assessed. At this feasibility stage the markets for ecosystem services and economic trade offs between productive and environmental outcomes are evaluated.
In the third phase, the institutional aspects and mechanisms for change are investigated. In the following two boxes business plans are developed to exploit the findings from the research.

The last two phases involved establishment of Regional Irrigation Business Partnerships (RIBP) and development of new business plans based on detail biophysical, financial and socio-cultural analysis, which in turn are used to implement stakeholder agreed interventions in a business context.

Figure-1 Five Way Feasibility Leading to SHARP Implementation
1.1 Systems Thinking and Harmonisation
The main goal of System Harmonisation project is to connect a biophysical hydrological component and an institutional component to become some entity (or system) that is capable of being harmonised, in a practical situation. In this component it is important assess the biophysical hydrological component and to value the economic and environmental products that are derived from a socially driven irrigation scheme. Prior to detailing any individual components of this system it is necessary to come to terms with the what system thinking is all about, how to go about constructing a system model and how it could usefully be applied in the context of irrigation systems.

1.2 A Systems Approach and its Alternative
The many ways of thinking about an object or entity have occupied the minds of philosophers since Plato. These ways are so multitudinous, complex and varied, that a number of philosophers have reached the conclusion that the very existence of anything could be questioned. While not wanting to dismiss these thoughts entirely, but in the hope of clarifying them and moving forward, thinking about an object or entity in a logical manner can be classified into two broad and alternative categories.

The first is to take a marginalism approach, in which the major and important elements of an entity are identified. The less important, insignificant and peripheral elements are ignored. This approach has proved valuable, especially to scientists, as it allows an investigator to concentrate on what they consider to be important, relegating the unimportant to a constant status. In an ideal world, each element is separated and its influence evaluated. A major problem with this approach is one of “fundamental attribution error”, where the importance of a key trait is over estimated, while the context and situation in which it exists is underestimated. Another major problem with this approach is that if problems are not well defined and involve multiple players, such as many social planning issues, it may be impossible to define a solution.

The second alternative method is to analyse a situation using a “systems” approach, where all elements are considered important. Dillon (1990) defines a system is an organised unitary whole which is composed of two or more interdependent parts and
delineated by an identifiable boundary from the environment. Mathematically, a system can be defined as a set of elements, each of which is related, either directly or indirectly, to every other element and no subset of which is unrelated to any other subset.

Systems approaches are an all-encompassing way of looking at things. Systems are pervasive, complex and realistic. While the marginal approach involves reductionism and mechanism, the systems approach relies on expansionism. In a systems approach individual components, the links between them and the whole system need to be analysed. It is not just the sum of the parts. Consequently, in systems analyses, unlike the marginal method, a single disciplinary approach does not tend to dominate. The problem with the approach lies in understanding its complexity and modelling it such that it is useful and purposeful. It is also important to note that systems’ thinking is not just another way to get to the same ‘answer’ as the marginal approach. With systems thinking the idea of a single, knowable endpoint is questioned. However, it transpires from previous assessments that systems approaches are good for description purposes, but are not as useful an analytical tool as those derived from the marginal approach.

In reality, any study undertaken lies somewhere between these two extreme approaches. Describing a system and its important elements is crucial in undertaking a marginal study. Testing the links between different elements in a systems analysis requires all the tools that a marginal analysis would employ.

In this study the approach undertaken is closer to the systems alternative, while employing the tools of a marginal technique to assess individual components and the links between them. Most past studies of the irrigation sector could reasonably be classified as marginal analyses, where relatively small segments of the sector are assessed separately and in isolation to the rest of the sector. Many examples of this tendency exist. For instance rarely has the interaction between ground water and surface supplies been analysed. Further, until recently, due consideration of the hydrological inputs and economic outputs arising from irrigation were not assessed with equal importance, with greater emphasis being placed on one side or the other.
In addition, many studies of the institutional frameworks underpinning water have not been aligned with the hydrological constraints.

1.3 **An Approach to Modelling Systems**

To undertake a systems approach to irrigation it should be recognised that various disciplinary approaches are required, that they will need to be used appropriately and that all important components need to be evaluated and linked to one another. The difficulties that arise with this approach lie in deciding what elements are important and in splicing the various elements together. In other words, the fatal attribution error problem (by ignoring an important component and the context within which it exists within the system) needs to be avoided, while attempting to model a system that is not specified to be so complex that it defies estimation.

In modelling a system, many approaches could be taken. From Dillon (1992) the following steps could be followed:

1. Setting the boundary between the system itself and the environment as a whole.
2. Identifying the individual components within a system.
3. Identifying the influences or links between the components from both outside and inside the system.
4. Accounting for the resources of the system.
5. Formalising the goals of the system.
6. Describing the system.
7. Evaluating the performance of the system.

1.4 **Setting the Boundary**

In the case of an irrigation scheme, to set the boundary with the environment it is necessary to first define what it is and then what should be included becomes more apparent. Watson (1999) defines irrigation as:

*the (physical) movement of water in time and space that results in agriculture moving in time and space.*

Recognising that it is not only agriculture that is affected by the movement of water, that industry and households if not humanity as a whole could all be affected, the
purpose of the system must be widened to incorporate more than just agriculture. In addition, irrigation involves more than just the physical movement of water. There is a purpose to which it is directed, people who benefit and those who lose, sectors that are affected and constraints that impede its flow. Thus, to assess the physical flows of water alone would underestimate the extent of this system.

Consequently, a definition of an irrigation scheme could be:

\begin{quote}
A system that encompasses all activities involved in moving water in time and space and assessing the outcomes that arise from that act over time and space.
\end{quote}

It is accepted that this definition, \textit{per se}, is wider than that usually applied to irrigation. Irrigation schemes usually only relate to those constructed to facilitate agricultural pursuits. This definition could refer to any built water system. However, this definition is an improvement on those that are more narrowly defined, as it allows for the multiple outputs that arise from a scheme to be evaluated. Given that the approach outlined in this paper is applied to schemes that have a major agricultural component, it is the application of this approach to a specific problem that will constrain the definition. Despite this limitation, the definition specified above can be used to initially identify what should be in the system and what should be excluded.

It is necessary to curtail the exuberance of those (such as those who follow the Gaia philosophies of James Lovelock) who believe that water is essential to life. Defining the system in this way would necessitate including everything within the globe over the whole expanse of history. In this study two constraints can be imposed: those of time and space. A spatial constraint can be imposed by determining the region within which the scheme or system operates. So in the case of an irrigation scheme this could be at a micro-farm level and intermediate scheme level or at a more macro catchment level. A temporal constraint can be imposed by first observing the system as it currently exists. Thus, the sunk costs associated with previous investments and activities can be ignored. Furthermore, future investigations can be constrained to issues that affect those who are currently affected or likely to be affected by any change. In this study both the spatial and temporal constraints are defined by the relevant RIBP.
1.5 Identifying the Components

In identifying the components of a system, it is necessary to think about what needs to be modelled. In this system, three major components can be identified:

- Physical, involving framework, “clockwork and control mechanisms” of the water system. This includes where the water comes from, where it is directed to, where it is lost from the system, what it is used for (cropping, households industry) and the impacts it has when extracted from alternative use (the environment)

- Economic, social and environmental, involving assessing the impacts the physical component has on the system. This involves calculating the costs and benefits of operating the system from a monetary, community and natural perspective.

- Institutional settings (some of which will be enabling, while others are constraining), involving assessing the factors that control the system, particularly the legal aspects.

As each of these is important to the system, any one could not be considered to dominate any of the others. In addition, each could be modelled separately, as each emphasises a different aspect of the system. Finally, within each of these components, sub components will exist.

In terms of the whole system these three components could be aligned linearly. Using this approach, the biophysical Hydrological components feed into the valuation of the Markets and Products component, which in turn feeds into the Social, Cultural and Institutional component. However, such an approach does not adequately represent the dynamic interactions embodied in an irrigation system. This, more dynamic approach means that each component could be estimated separately, each using different techniques and then spliced together after each has been estimated. Care must be taken in specifying the links between each component (i.e. that a set of common units are employed, etc.).

Individual subsystems will exist within each individual component. What each sub-system requires is the establishment of a border that separates it from the rest of the system. In undertaking this task a definition of where one starts and the others finish
is required. For the Markets and Products component (or sub-system which is what it will become) this can be defined as:

*the quantification (valuation) of all the activities that arise from moving water in time and space within a specified region that pertains to the economic and environment sectors, as they relate to society’s needs.*

In other words, it is recognised that irrigation schemes are run for the benefit of the societies that build them. Society has multiple uses for the water (agriculture, industry, households, recreation and the environment) for which it derives benefits from and incurs costs in distributing the water in any selected or given way. It should be noted that the environment is taken to be another market (just like that for agricultural output) and the social aspects of this system are now incorporated in its ‘purpose’.

1.6 Identifying the Influences and Links in a Subsystem

Overseeing the choice of what should be included in each individual component within each subsystem is governed by what society deems to be important. Failure to be selective could lead to a degree of complexity that would render the model inoperable. Alternatively, too strict a set of choices would lead to a fatal attribute error. The importance of each component will need to be established and could usefully be done within each subsystem using the techniques available in each. For instance, in the Markets and Products subsystem a clustering approach could be used to verify the importance of individual components. The importance of each in this case is determined by the values society places on them.

An important element in estimating any system is the identification of the links between both the subsystems and the individual components within a subsystem. These links come in many forms and can be measured in many different ways. They are in some sense instruments that govern the system, some of which may be passive, but all which govern the way the system runs.

In the Markets and Products subsystem, the links from the physical component are the flows of ground and surface water and the environmental factors considered important to the system. Flows to the Markets and Products subsystem are biophysical elements measured in physical terms. Within the Markets and Products subsystem the links are
specified in terms of monetary costs and benefits. In other words, within the subsystem, the links can be isolated by observing the financial flows between components, which in turn are derived from the physical flows from both within and from outside the subsystem. It is implicitly assumed in the Markets and Products subsystem that supply and demand forces underlie all activities and flows. This even applies to the environmental outcomes, all of which are the outcome of some demand by members of society.

It may well be the case that the links between the subsystems are all very different. For instance, the outputs from the physical subsystem of the model could be specified in terms of quantities of water, yet those from the Markets and Products subsystem may all be in monetary units. Each would need to be converted using some form of yield equation, within each subsystem (where required) and placed individually within the meta model.
1.7 Key Characteristics of Regional Irrigation Business Partnerships

Part of the System Harmonisation program is to establish Regional Irrigation Business Partnerships (RIBP) across Australia to capture production and environmental gains from improved regional irrigation systems research. Four RIBPs sites across Australia are being established which are fully and enthusiastically endorsed by the industry partners. The RIBPs linked with System Harmonisation program include (i) South Australia; (ii) Murrumbidgee; (iii) Western Sydney; and (iv) Macintyre Brooke. The geographical location of all RIBPs study under System Harmonisation program is shown in Figure 2.

The first and most important characteristic of an RIBP is that it is fully and enthusiastically endorsed by our industry partners. The System Harmonisation program’s mandate is to improve productivity, profitability, and sustainability to irrigation Australia wide. In this instance, the focuses of activities are very strongly around specific industry partner needs.

Figure 2. The geographical location of Regional Irrigation Business Partnership
Other key characteristic include:

- There is enough surface and ground water data to enable a clear understanding of key water management issues;
- There is a demonstrated need to change or recognisable opportunity for improved productive and/or environmental outcomes through improved water management;
- There are clearly identified biophysical, social, economic and institutional issues which are likely to respond to the coordinated alignment which is suggested within the System Harmonisation program;
- An existing organisation or individual represents a potential champion for the process;
- Clear business opportunities are likely to be identified with potential funding partners available;
- The scale of the overall project is commensurate with the combined System Harmonisation and RIBP resources; and
- The time scale for change is in line with project objectives to deliver real change within a 4 year time frame.

1.8 Key Water Productivity and Environmental Issues

*Western Sydney RIBP*

(a) Water Productivity and Environmental Issues

- Increased demand for water due to urban development competing with water available for irrigation;
- Increasing levels of effluent due to urban development affecting health of catchment;
- Total water use now exceeds the long-term water yield of the catchment;
• Water in Hawkesbury-Nepean River System is at risk of further degradation due to development;

• Competing demands for water for environmental flow, primary production and urban needs;

• Future survival of primary production relies on guaranteed access to water;

• This project will improve water efficiency and productivity by bringing together data on using alternative sources of water to support the establishment of new business opportunities while sustaining viable primary industries and ensuring environmental sustainability;

• The issues cannot be solved by working with a few stakeholders in the catchment. It requires high level negotiation and coordination of key stakeholders with responsibilities in water supply and the end users;

• The project will focus on visible on-ground results with immediate benefits for suppliers, users and the community; and

• The issues being addressed in this project are recognised as needing urgent action by local community members, environmental groups and local, state and national decision makers.

• Principal Purposes:

• The RIBP proposal provides increased security for water to irrigators, opportunities for organisations to develop new businesses and enhance environmental flows and other environmental outcomes by:

• Compiling data to support use of alternative water supplies - existing effluent, stormwater and groundwater;

• Developing a sound rationale and expert advice for business investment in alternative water sources;

• Offering the RIBP framework/guidelines to help coordinate the process;

• Facilitating a forum for discussion about use of alternative water supplies;
• Providing monitoring services;
• Offering TBL reporting framework as a tool to help achieve sustainability of irrigation;
• Seeking ways to undertake harmonisation without jeopardising investment in existing systems; and
• Seeking opportunities to substitute alternative sources for potable supplies.

(b) Principal Outputs:
• Principal high level outputs
• Report on hydrological analysis of the region;
• Report on cost/benefit analysis of using alternative sources of water;
• Plan or guidance for water infrastructure development for irrigation in Western Sydney;
• Generic model for use of alternative sources of water that can be used elsewhere;
• Process for helping organisations to work together to achieve the use of alternative sources of water;
• Reassurance that use of alternative water sources would complement other options of achieving security of water supply and access; and
• Support for groups lobbying for use of alternative water sources.

South East South Australia RIBP

(a) Water Productivity and Environmental Issues:
Key productivity issues are:
• Improving water use efficiency with improved farm practice eg. Optimising existing surface irrigation systems or adopting alternative
application system technology such as pressurised or subsurface irrigation;

- Salinity (high water table) in upper South East catchment;
- Salinity of groundwater used for irrigation affecting crop production; and
- Enterprise mix and expansion into new high value industries.

Key environmental issues are:
- Maintenance of groundwater dependent ecosystems;
- High watertables, drainage;
- Soil salinity;
- Nitrate contamination of groundwater;
- What are the key environmental assets of the region and how does irrigator behaviour impact on the value of these assets?
- What environmental outcomes are being requested by the community but not yet being delivered - which the irrigation sector could become actively involved in delivering?
- Can transfer of irrigated activity from more environmentally stressed regions of SA – eg the Riverlands to the SE be achieved?
- How can development of the SE help to support state wide environmental goals?
- What level of sustainability reporting exists in the region and can this be enhanced to drive improved compliance – and importantly increased investment in environmental outcomes?

(b) Principal Purposes:

The RIBP will provide a business case for regional investment in:

- Expansion of new irrigation in SE of South Australia
• Improvement of environmental performance and economic performance from existing irrigation industry
• Increased security for investment in regional irrigation development.
• A detailed market analysis, with sensitivity testing, that accounts for opportunities and threats (risk levels) to irrigation development that may be caused by:
  ▪ Climate change influencing water availability
  ▪ Land use change influencing water availability
  ▪ Ecosystem services that may be paid for by other non-irrigation customers.

(c) Principal Outputs:

The project will provide investment product(s), which will attract profitable and environmentally sustainable irrigation expansion and redevelopment in the South East Region. A Business case for investing in the region will be provided including:-

• Costs and benefits
• Cost sharing across beneficiaries
• Risks and risk sharing
• Public/private partnerships
• Staged implementation

In summary the project will provide the business prospectus for new services and required infrastructure for delivery of viable water products to irrigators and environmental customers. This business case will build on a sound knowledge of the hydrologic cycle, land use trends, community profile, and the need to enable improved viability of irrigation farms and to service environmental needs. It will include consultation with stakeholders.

Macintyre Brook RIBP
(a) **Water Productivity and Environmental Issues:**

Key productivity issues are:

- One of the major issues for local irrigators is that the existing water management system – which was set up when tobacco was the main crop – is skewed towards the production of summer crops. In particular, because the current water year runs from October to September the highest allocations are announced too late in the season to provide certainty of supply for permanent horticultural crops.

- From the local perspective, this is reinforcing the traditional opportunistic approach to irrigation management. And more importantly it is stifling the potential to capitalise on strong market prospects for high value crops that would be favoured by the water year running from July to June.

- Currently some 30-40 per cent of the water allocated in Macintyre Brook is temporarily transferred each year to support the production of cotton and other summer crops further downstream.

- Beyond the issues surrounding the definition of the water year, the allocation of system losses is also a major issue. At present the water from Macintyre Brook Water Supply Scheme is shared amongst water users using a system of annual announced allocations. All system losses are shared amongst all users. At the end of each water year all unused allocation are redistributed across the system and reallocated as part of the next year’s announced allocation.

- Over time there has been a demand to provide greater control of allocation to individual users. The announced allocation system was modified by the introduction of continuous accounting. This enabled SunWater to provide services such as carryover, temporary transfer and forward draw. The introduction of continuous accounting therefore provided individuals with greater flexibility across water years.

- The existing announced allocation / continuous accounting approach is based on the principle that all water allocation holders are entitled to
use a share of the system yield in proportion to their water allocation irrespective of whether they use it or not within the current water year. Nonetheless, all operational losses are still apportioned across all users regardless of where and when the water is delivered.

- The next logical step towards individual management of water entitlements is the concept of capacity sharing. Capacity sharing minimises the impact of the behaviour of one individual user on another, and provides maximum flexibility for the individual within the constraints of existing resource caps.

Key environmental issues are:

- Capacity sharing will provide individual irrigators with greater certainty about the nature of their property rights. It will also give them the ability to better manage the risks associated with climate variability. Accordingly, it can be expected to encourage the full use of existing entitlements. It can also be expected to encourage greater water trade.

- In part, this project will look at opportunities to maintain current levels of environmental protection associated with water trade while investigating opportunities to reduce the transaction costs associated with that protection.

- At present, irrigators must prepare an individual land and water management plan before water can be transferred on to a property. However, Division 3 of the Water Act 2000 allows scope for the preparation of regional ‘Water Use Plans’, part of this project will involve investigating to what extent a water use plan could help to streamline the development of individual land and water management plans. Section 73 of the Water Act may allow scope to rule out the need for individual land and water management plans if a suitably prepared water use plan protects the environment.

- Greater use within Macintyre Brook would also mean a reduction or halt in the annual transfer of significant volumes of water further
downstream. The environmental implications of this need to be understood.

- Sun Water is authorised to develop and offer water services and products designed to facilitate the use of water in Macintyre Brook provided that the services and products offered do not result in the total water usage for the scheme exceeding the total announced allocation volume (including an allowance for carryovers and forward draws) in each water year.

- Capacity sharing rules would have to be drawn in such a way that they did not increase the total amount of water available for consumptive use. The change should be environmentally neutral in that regard.

(b) Principal Purposes:

Sun Water and the Macintyre Brook Irrigators Association are introducing capacity sharing as part of their desire to establish appropriate water business arrangements to service contemporary agricultural markets. In this context, the RIBP will provide a resource document to inform a business prospectus for regional investment. Its objectives are to:

- To develop flexible and reliable ways of managing sustainable production under capacity sharing.
- To develop methods to communicate to water users the attributes of capacity sharing, and how to manage these effectively
- To ensure the long-term viability of industries and communities through the protection of the quantity and quality of land and water resources.
- To enable the retention of the economic and social benefits from irrigation within the Macintyre Brook catchment.

(c) Principal Outputs:
• A detailed understanding of how to communicate the benefits to be derived from capacity sharing.
• A streamlined process to ensure that natural resources are protected during the establishment of new irrigation developments.
• Products that enable irrigators quickly to realise the potential offered by capacity

Murrumbidgee RIBP

(a) Water Productivity and Environmental Issues:

Key productivity issues are:

• Cold tolerance constraints mean that rice irrigation demand is concentrated in summer;
• Machinery and landforming investments for rice production limit the potential to opportunistically grow other crops;
• Best management practices offer opportunities to improve water use efficiency;
• Water delivery system management is currently orchestrated around rice production;
• Minimising constraints to adoption of improved farm practice resulting from delivery system management;
• Salinity (high water tables, salt mitigation, salt storage and salt export);
• Maintaining minimum leaching;
• Drainage access;
• Enterprise mix; and
• Property size.

Key environmental issues are:

• Influence of regionally dominant crops on flow seasonality;
• Environmental flows;
• Wetland watering;
• High watertables and soil salinity;
• Nutrient runoff to waterways;
• Floodplain connectivity to river system to maximise benefit of environmental flows; and
• On-farm biodiversity protection and enhancement of remnant vegetation.

(b) Principal Purposes:

The RIBP will provide a business evaluation (return on capital) of regional investment in:

• Real-time management of future water delivery systems
• The design interactions between on-farm and off-farm components of harmonized delivery systems
• Channel automation in the context of substantial system reconfiguration
• The environmental and production dividends that can be developed from new infrastructure eg. Ecological services, new service levels etc.
• Cost sharing mechanisms

A detailed market analysis, with sensitivity testing, that accounts for opportunities and threats (risk) levels that may be caused by:

• Climate change influencing water availability;
• Long term trends in economies of size in different irrigation industries relative to current property sizes for rice, horticulture, irrigated cereals, and rural residential;
• Standard of services needed for different groups (rice, horticulture, irrigated cereals and hobby/rural residential); and
• Environmental flow and other ecosystem services that may be purchased by new, non-irrigation customers.

(c) Principal Outputs:

A Business case for the implementation of channel automation including:-

• costs and benefits
• cost sharing across beneficiaries
• risks and risk sharing
• public/private partnerships
• staged implementation
2. The Water Cycle

The analysis and characterisation of hydrologic systems will involve hydrological characteristics of the region and seeks to build an interactive “Water Balance and Residual Waste Statement of the Water Cycle”.

2.1 Research Questions and Hypothesis

This research will address three over-arching questions:

- What is the most appropriate and comprehensive framework for assessing system harmonisation across a range of irrigation system typology?
- What are the tools needed to asses the impact of internal and external interventions on system harmonisation performance at a range of scales and irrigation systems settings?
- How to design intelligent monitoring systems that require least effort and provide information rich data, enabling the on-going assessment of system harmonisation performance at a range of scales and irrigation systems settings?

To achieve this broad aim, the following specific objectives are set out for this research:

a. To develop and test a comprehensive and adaptive framework to evaluate the current level of bio-physical harmonisation applicable to a wide range of irrigation system

b. To evaluate the current performance of RIBP systems and identify opportunities to improve system harmonisation through combined biophysical, institutional and policy measures

2.2 Conceptual Framework

It is recognised that the main harmonisation focus will vary between RIBP sites. This project’s methodology will be sufficiently comprehensive and adaptive to handle the site–specific nature of all the selected sites and other potential configurations.
Critical to identifying harmonisation opportunities is an assessment of the water and solute fluxes in the system together with the operational performance of the hydraulic infrastructure. The methodology to assess system performance will need to recognise a range of spatial scales and time scales. Spatial scales will range from farm to near-farm and their connectivity with river operation at the catchment level. Time scales will range from near real-time (1-7 days) to seasonal and to long-term river operation policy. Key activities include:

- The development of a conceptual framework that applies across a wide range of irrigation system and their surrounding landscape
- Identify system characteristics that are important for system harmonisation process
- Mapping of existing predictive tools against the comprehensive assessment framework
- The site-specific assessment of the biophysical performance of the selected RIBPs.

The System Harmonisation program aims to improve cross organisational communication and system-wide management to optimise productive and environment outcomes. It is identifying opportunities for improved management of surface and groundwater resources to satisfy environmental and consumptive demand in catchments with irrigation industries through Regional Irrigation Business Partnerships (RIBP). The CRCIF (through System Harmonisation) plans to develop critical intellectual and physical capacity in transferring knowledge across regional boundaries, and to build up excellent communication and networking within the irrigation research community, and between researchers and the industry. Conceptualisation of environmental framework is one of the challenges and the first milestone to achieve this goal.

A three-dimensional (3-D) conceptual model is developed for the Colleambally Irrigation Area RIBP to explain the hydrogeology of this region (Figure 3). It illustrates the geologic formations, hydrological flows in and out the irrigation system,
the capacity of the aquifers, and the surface-groundwater, agriculture and environment interactions.

The methodology used in the development of such a model includes software requirement, spatial data acquisition, data processing in ArcGIS, and model building in ArcScene.

Software Requirement

ArcGIS was chosen to serves as a tool that enables multiple types of data to be integrated for both analytical and visual analysis. It is a suite of integrated applications including ArcMap, ArcCatalog, ArcToolbox, ArcScene and ArcGlobe. Using these applications in unison, you can perform any GIS task, simple to advanced, including mapping, geographic analysis, data editing and compilation, data management, visualization, and geoprocessing.

ArcGIS Spatial Analyst, an optional extension to ArcGIS Desktop, provides powerful tools for comprehensive, raster-based spatial analysis. With ArcGIS Spatial Analyst, users can employ a wide range of data formats to combine data sets, interpret new data, and perform complex raster operations such as terrain analysis, surface modelling, surface interpolation, hydrologic analysis, statistical analysis, and much more.

ArcGIS’s 3-D Analyst adds functionality to ArcGIS to provide three-dimensional visualization, topographical analysis, and surface creation capabilities. ArcScene also allows advanced spatial data visualization and interaction in a 3-D environment.

Data Collection

A vast quantity of data/information from different data sources goes into the construction of a conceptual model. The basic data needed to construct the Coleambally 3-D model are listed as below:
(1) DEMs

The National 9 Second DEM grid was used to accurately represent surface shape, elevation and drainage structure. It was computed from topographic information (at 1:250 000 source scale). The grid spacing is 9 seconds in longitude and latitude (approximately 250 metres).

(2) Remotely sensed images

Colour composite of Landsat 7 bands 7, 4, 2 as red, green, blue was used to drape onto the DEM for better representation of basic geographical characteristics (e.g. landscape and land cover).

(3) Major rivers and towns

The vector coverages of major rivers and towns were added on top of the image drape to show geographic location of the irrigation system.

(4) Irrigation channels

The irrigation channel network was used to form the key framework of the irrigation system.

(5) Irrigation area boundaries

Irrigation area boundaries were used to define boundary conditions for the model domain.

(6) Groundwater table levels

Groundwater depth data of March 2004 were incorporated to show the subsurface watertable level.

(7) Geological formations.
The top elevations of hydrogeological formation layers, such as Shepparton, Calivil, Renmark and Bedrock, were used to form the hydrogeological framework of irrigation systems.

**Data Processing**

Data processing was conducted using ArcToolbox. Main procedures are:

1. **Surfaces interpolation**
   These included the interpolation of groundwater table and hydrogeological formation surfaces. The former one was interpolated based on point data of measured groundwater depth; and the later ones were based on the points digitised from structural contours on the hydrogeological maps of Australian Geological Survey. Kriging settings were optimized to yield/interpolate representative surfaces. Accuracy of these surfaces largely depends/relies on the density and accuracy of points, and the method used in automated surface interpolation.

2. **Data projection**
   Original data available for use in the 3-D conceptual model are of widely varying spatial reference, scales and accuracy. They were all projected to a geographic coordinate system (WGS84).

3. **Data conversion**
   This procedure converted all rasters (grids) into vectors (polygon features) for use in future extrusion. All floating-point grids have to be converted into integer grids before performing the Raster-to-Features conversion.

4. **Data analysis**
   Data analysis included two major steps: one is to intersect adjacent polygon layers to computer a geometric intersection of the input features; and the other is to calculate
“DEPTH” from the bottom of the upper layer to the top of the lower layer for the resultant polygon feature afterwards.

Model Building in ArcScene

All data layers (polygons and grids) were overlaid one upon the other in ArcScene. Several settings are critical for the model development and better visualization. They are:

- Symbology: Proper/suitable symbols were selected for best displaying each layer.
- Base Heights: Heights for a particular polygon layer were obtained from relevant surface. A z unit conversion factor was defined applied to place heights in same units as scene.
- Extrusion: Polygon layers were extruded using the “DEPTH’ calculated from previous processing. This turns polygons into blocks.
- Rendering: The drawing priority of features, related to other layers that may be at the same location, was determined. This helps to determine which feature gets drawn on top of the other.

A vertical exaggeration and a background color were applied when needed from the Scene Properties window. Interactive perspective viewing can be performed use the buttons of ArcScene Tools.

Finally, the hydrologic characteristics and properties were assigned to each layer to illustrate/reflect regional groundwater flow, vertical interactions between the formations, recharge due to irrigation and rainfall, leakage to and from the drainage channels, surface-groundwater, agriculture and environment interactions, and so on. The final 3-D conceptual model can also be animated fly-throughs, and exported for presentation and analysis.
Operational Analysis
The relevant spatial time scale depends on the system type. For instance, winter zone, heavily regulated systems will require changes to the seasonal river operation to reverse / modify existing flow pattern. Change in crop mix, hydraulic system improvements and on-farm en-route storages would be needed to achieve change. A large volume of effluent and stormwater is invariably available throughout the year and can often meet all the irrigation water needs but use is constrained by ability to transport the water to the point of use and other factors. Key activities will include:

The project will integrate existing environmental performance of the system and where available ecosystem responses to changes in system management. It will not conduct research on these aspects but rely on external research linkages such as CRC-eWater, Pratt Water, NWI.
Development of additional tools and/or adaptation of existing ones to fill the predictive capability gaps

Application of relevant predictive tools to inform the development of harmonisation measures and their impacts on productivity, markets and environmental dividends and development of business cases.

*Monitoring and Evaluation*

The ability to assess the existing and future position of system harmonisation hinges on the availability and quality of relevant data. Also, the sustainability and adoption of a future monitoring program by irrigation businesses will depend on the ease and cost effectiveness of the effort required for collecting the data. This means, we need to identify key and a minimum possible number of parameters that comprehensively describe the system characteristics and assist in analysing system behaviour.

Broadly the methodology will involve:

- Assessing the density, frequency and quality of monitoring data needed to meet the requirements of the comprehensive evaluation framework
- Devising data techniques to deal with situations of limited data, particularly in relation to the selected RIBP sites. In this regard, various levels of aggregation may be necessary depending on existing data available.
- Identify possible synergies with other system monitoring objectives to ensure full compatibility
3. Economic, Social and Environmental Components of System Harmonisation

The aim of the Products and Markets component of the System Harmonisation project is to value the economic and environmental outcomes from an irrigation scheme that is operated by and in the interests of society:

Economic, social and environmental systems are inextricably linked, and an understanding of all three and their relationships is necessary to manage large scale change in irrigation practice. Better understanding of these three system elements will increase the investment in the System Harmonisation Project, thus the overarching research question for this part of the project are:

“How do we best understand and define the economic, social and environmental systems which constitute irrigation in Australia?

Sub questions to address this include:

- What are the most appropriate approaches for understanding who and what are dealt within irrigation schemes?
- What are the most appropriate methods of establishing the importance of irrigation and water resources within a region with respect to the economic, environmental and social performance of the region?
- What outcomes, (environmental, economic and social) are acceptable/sought following any change in hydrological flows?
- Is there a ‘critical mass’ or minimum level (e.g. number of irrigators) of practice change among individuals that is necessary to bring about these outcomes?
- What is the current status of water productivity, the environmental systems, and the social values of the region under study?
- What environmental outcomes or regional values are primarily affected by irrigation practice?
• What is the value of individual ecosystem services that can be affected by irrigation management

• What are the risks and uncertainties that govern water use in the sector? What options are available to minimise risks?

• What are the transaction cost issues, how might they impact on the cost/benefit (triple bottom line version) of investments and what are the best ways of reducing these and dealing with any transaction cost impact issues?

By changing practices what could the irrigation operators do to improve environmental, social and economic outcomes (individually and collectively)?

It is recognised that society has multiple uses for the water (agriculture, industry, households, recreation and the environment) as well as non-use (intrinsic) values for which it derives benefits from and incurs costs in distributing the water in any select manner. (Figure 4). Further, it is assumed that the irrigation schemes are run for the benefit of society as a whole. Thus, there is a necessity to evaluate both the private and public costs and benefits associated with irrigation schemes.

In order to identify what society values from an irrigation scheme, it is argued that a social matrix approach is needed. This analysis allows for a clustering of the issues people feel is important to them regarding the use of an irrigation scheme. Such an analysis will allow identification of the perceived most and least beneficial activities connected to water allocation, economic modelling of the most productive activities, evaluation of externalities and Cost Benefit Analysis.

The net economic benefits that arise from irrigation need to be evaluated. The sectors where benefits are derived can be segregated into agriculture, households, the environment, recreation and industrial uses. The largest of these, by pure scale of the use of water, is agriculture.

A gross margins approach is used to evaluate the returns for water in the agricultural sector. In the industrial and household sectors, a simple evaluation approach is used where the quantity of water demanded is multiplied by the price paid in each sector.
Non-market valuation techniques are used to evaluate the recreational and environmental uses of water.

The difficulty that arises in this analysis is how to evaluate the performance of irrigation schemes, where the outcomes are multifaceted. A ‘meta’ model approach is suggested in which the different elements from the project are brought together and assessed using a technique derived from the theory surrounding production possibility frontiers. This technique can be used to hypothesise a value for the ecosystem services derived from an irrigation scheme.

The performance of an irrigation scheme is evaluated in terms of the suggestions raised to change it. Cost Effective Analysis is to be utilised to evaluate this performance.
3.1 Describing the System and Accounting for its Resources

Once constructed, a subsystem, and ultimately the system as a whole, needs to be described. What this would involve is a snapshot of how the system currently operates. This in turn would act as the baseline analysis for all future scenario testing. It should be noted that the assumption invoked by taking this approach to description is that all costs and benefits currently involved in the system are sunk. This assumption, when applied to irrigation schemes is not unrealistic.
The description of the subsystems should also allow for an audit of the resources of the system. These could well provide information that can be used to verify the system and each subsystem within it.

### 3.2 The Purpose of the Subsystem

Any system analysis needs to be undertaken with a clear view of the purpose(s) of the system in question. In terms of the irrigation system as a whole, there may well be multiple objectives, including maximising profit, sustainability of occupation or of the environment, lifestyle issues or any other purpose involved. In reality, all these uses serve the purposes proposed by society. The problem arises when there are multiple, and sometimes conflicting, societal goals. Adding to this complexity is the fact that each is measured differently, making an evaluation of the trade-offs between them difficult. So, while the systems purpose is governed by the desires of society, the very nature of society means that the system is required to satisfy many different demands.

### 3.3 The Performance of the System

The various components of the system, their linkages and valuation of economic and non-market benefits are shown in Figure 4. This economic and environmental evaluation framework aimed to answer the question: How is a systems performance evaluated? This depends on how one perceives a system and what one wants from it. It is the trade-offs between outcomes, with all its different measures, that has to be assessed within the Markets and Products component in order to assess the whole system. Thus it could be argued that people’s willingness to accept trade-offs is a measure of how certain performance measures are being met. The evaluation of the trade-offs, in light of proposed changes to the system, will determine the performance of the system.

Valuing anything can be achieved in a variety of ways. Some things, such as valuing a crop, can be achieved with a good degree of accuracy in a relatively easy manner. Other things, like the environment, are far more subjective and difficult to do. The purpose in the Section is to outline the methods that will be employed to value the activities that are derived from the irrigation sector. The activities reviewed are those
derived from the agricultural, household and industrial sectors, along with that associated with the environment and recreation.

### 3.4 Agricultural Output
Valuing agricultural output is best achieved using a gross margins approach. From the hydrological component, the area cropped and yields can be derived. By multiplying these two elements together, the level of production can be determined. This can then be multiplied by the ruling market/export price to determine the gross value of output. To determine the net value of production some idea needs to be gauged of the costs of production. Taking the costs of production from the returns provides an estimate of the returns per unit of water employed.

The model used to determine the net values of agricultural output was derived from Perry (*pers. comm.* IMWI, Colombo. November 2006) and developed in Davidson and Hellegars (forthcoming). The model has been developed from assessing farm level data to being capable of handling multiple regions over two seasons. The set up for each RIBP is to be determined from the hydrological component of the system. The information needed to populate the model can be derived from existing studies (usually undertaken by State Departments of Primary Industry). This use of secondary data is an acceptable practice.

It should be noted that the assumption using this approach is that the regardless of the quantities produced, the price of good in question will not change. This assumption is not necessarily unrealistic in this case. Does this approach accurately account for the value added by water? Not necessarily, but it should provide an indication of the marginal value of changing water allocations within a region.

### 3.5 Industrial and Household Users
Determining the value of industrial and household use is not nearly as easy as that involved in valuing agricultural output. In this study two regions (the Limestone Coast with water going to Adelaide and South Creek in Sydney) are the RIBPs where some effort is required.
It is impossible to place a value on water used by households. If water is taken to be essential to life, then it can not be valued adequately, as the answer would be that it has an infinite value. The simplest way of valuing water is to take the price paid by industrial and household users and multiply it by the quantity used. Such an approach is not ideal as presumably the own price elasticity of demand for industrial processes is not perfectly elastic. In addition, water is not the only input to the industrial process. Despite these deficiencies such an approach does provide an insight into the value of water. Once derived, by multiplying the amount used by the price paid by households and industrial users should suffice.

In both cases (industrial and household uses), it should be noted that the price consumers pay for water in many cases possibly does not reflects the true social cost of making that water available. But for that matter, agricultural users also do not pay a true social cost for water either. In general, industrial and household users tend to pay a higher price, as the costs of treatment and distribution are higher than for agricultural users. In addition, as the products going to different end uses have different characteristics, it must be asked if it is reasonable to compare them. To overcome the problem of price not reflecting the true social cost, an attempt needs to be made to derive the shadow (or unsubsidised) price. Given, that water used for industrial and domestic purposes is not the same as that destined for agricultural use, two different shadow prices need to be determined. These shadow prices can depend on many attributes, including reliability, quality, distribution infrastructure etc.

3.6 Recreation
Unlike the previous case, a market does not exist for the recreation value of water. If important a travel cost method would have to be employed. Once again, many studies have been completed using this approach (Sinden 1990). The price implied in these should be employed and multiplied by data obtained from the social components of this study. This is not an easy task, yet some data exists in the National water Audit.

3.7 Ecosystem Services
By far the most difficult component in this study is valuing the environmental components of irrigation activity. High on many researchers’ agendas is to place a
value on “ecosystem services” and that by doing this a value can be put on the environment. The very nature of ecosystems makes them difficult to value. Davidson and Wei (forthcoming) have attempted to assess this with respect to an assessment of water applicability and nitrogen fertilization on the North China Plain, and the methodology used there, provides a foundation for the present work.

A traditional market for ecosystem services does not exist for a variety of reasons. There are no identifiable buyers and sellers of these services and no one owns the ecosystem services. A commodity can not be transferred if any dispute exists as to who owns it. It is really this final point that is at the heart of the problems in valuing ecosystem services. The inadequate specification of property rights is a form of market failure that leads to no market existing at all. In the absence of a market, it is impossible to determine a market price and no way of achieving a value for the services provided.

The usual solution to this form of market failure is for the government to specify who owns the rights and then allow them to trade them in a market. A lot of clarification needs to be undertaken on the property rights before a market can be defined. Be that as it may, such confusion has led to two diametrically opposed views. The first would suggest that ecosystem services should be valued at nothing, as a market does not exist. Alternatively, it could be argued that ecosystem services are priceless and invaluable if lost. The truth surely lies somewhere between these two extremes.

The real shortcoming lies with gaining the information on prices. Without really knowing what constitutes an ecosystem service, it is impossible to know what it is worth. Attempts to value a system usually involve a survey of a small component of the ecosystem. Could this small segment of what is a complex system actually provide a true picture of its worth? This is known as the ecological inference or aggregation problem (King 1997). Furthermore, establishing the value of an ecosystem in this manner is an expensive activity. It certainly has none of the advantages of a market where prices are established in a relatively cost free environment. In reality, all a survey establishes is a picture of what could be there, and yet this picture could well be incomplete. It has little to do with establishing prices and hence values for ecosystem services. To do this requires an evaluation
process that is derived from the ‘meta’ model, something undertaken in the next Section.

3.8 Assessing Performance – The Use of Cost Effectiveness Analysis
The aim in this study is to evaluate the change in water allocations or uses have on different desired outcomes from each irrigation scheme. There are many ways of doing this, with arguably the ideal being to conduct a social Cost Benefit Analysis. However, undertaking a social Cost Benefit Analysis would involve converting every value into monetary terms. Given the problems associated with estimating the value of ecosystem services, and what was suggested in the Trade-off Analysis, this is not only difficult, but also not needed. A far more effective and illuminating method of determining the performance of the system is to employ a Cost Effective Analysis approach.

Cost Effective Analysis is used to evaluate different treatments. In this case a new treatment regime (for instance) is evaluated against an existing treatment. The cost effective ratio for each treatment is found by taking the cost of each treatment against its perceived benefits and then comparing the ratios.

In a Cost Effectiveness Analysis it is necessary to have some idea of the impact of irrigation on the economic, social and environmental outcomes from a catchment or system. From an economic perspective, the current net value of agricultural, industrial and domestic water use needs to be assessed and offset against the costs of providing that water. In addition, the known costs of environmental damage can also be included. Any change to the economic outcomes resulting from a change in the flow of water can be calculated from this base and the effects of changing water flows on social and environmental outcomes can also be hypothesised. Then it must be asked: Are the hypothesised changes (gains) to the environment and society worth the change (loss) in economic net benefits?

The benefits of a Cost Effectiveness Analysis over a social Cost Benefit Analysis go beyond the need to overcome data deficiencies. Cost Effectiveness Analysis also allows for a comparison between alternatives, with the existing situation. In addition,
there is no need to compare situations with a hypothesised ideal (Parato Optimal) position. Finally, the approach means that any benefits to either the environment or society that arise from changing water regimes must be articulated.

3.9 Future Analysis – Concerns of the RIBP

Before proceeding with the analysis the objectives pursued in various RIBPs need to be understood. A variety of economic tools may need to be employed if the problems in each RIBP are to be assessed. Taking into account the problems faced in each RIBP, the following should be noted:

- South East South Australia RIBP problems revolve around industry development projects designed to improve water quality. What is required is a catchment wide analysis of the net returns from irrigation and an assessment of the costs and benefits of introducing new technologies. In addition, an assessment of different market based instruments to pay for the innovations will need to be undertaken.

- Coleambally RIBP issues revolve around the impact of innovations that occur both on- and off-farm. On-farm they include factors that improve on-farm efficiency and change the range of outputs. For this type of analysis a gross margins analysis of different types of farms is required. For off-farm developments, such as managing outflows and stranded assets, a system wide analysis of the costs and benefits is required, before it can be included into a Cost Effectiveness Analysis.

- Sydney Urban/peri-urban RIBP is associated with using waste water in conjunction with existing supplies. A system wide analysis of the economic components is required. In addition, an assessment of the net benefits of investing in a range of measures designed to reuse and treat water is needed.

- Macintyre Brook RIBP involves assessing the impact of new water control and reliability measures. Once again, an assessment of different measures is required within a system wide analysis.
3.10 Environmental and Social Values

The reason for an irrigation system is perceived to be economic, a means of gaining productive outcomes and social benefit from natural resources. Being part of an extended system however, with wider social and environmental connections means that unintended or unknown outcomes can affect the value to the community of such activities. The term ‘sustainability’ is currently used to describe economic activities within a social and environmental framework. In understanding ‘sustainability’ the full value across a community (including for future generations), the compatibility with the environment and the risk to these values can be identified. An analysis of these factors is termed Triple Bottom Line analysis (TBL) (Harding 1998).

3.11 Conceptualization

Initially a generalized conceptual modeling framework for describing key environmental aspects in all RIBPs is needed. This will involve development of a systemic framework for irrigation environmental interaction regarding identified local issues through stakeholder and expert input through two stages.

Stage 1: Stakeholder Perceptions

Irrigation and its associated activities can interact with the environment in negative but also positive ways. It is usual to address these interactions in a direct manner, termed primary impacts, but these can flow on to social and economic consequences (Figure 5). It would be useful in terms of relevance and prioritization therefore to identify ‘flow on’ impacts when identifying the interaction between irrigation activities and the environment. A common and generic way to identify these interactions is to use an Environmental Impact Assessment (EIA) framework for predictive purposes or an Environment Audit (EA) framework for current irrigation activities. A general model can be established by identifying generic irrigation activities and generic environmental values to protect. As a start, lists of the latter can commonly be found in EIA and EA literature. A numeric process similar to a Leopold matrix (Harrop and Nixon 1999) can be used to rank the importance of these interactions. This method has been used recently and successfully to determine environmental impacts of the tourism industry. Environmental management
methodology uses assessment and audit is the basis for planning action to address revealed issues (for example, Standards Australia etc).

It is proposed to build upon the sustainability reporting process and framework where higher order sustainability and environmental principles have been identified, to develop a generic matrix and general model framework to be applied in each of the RIBP case study areas. This would involve appropriate CRCIF researchers, working with RIBP committees and other local stakeholders to develop (within the light of previous work) and to test the framework. The framework can then be used to assess local environmental values (and flow on social and economic effects) at each RIBP site. Various local groupings would be invited to participate, thus allowing understanding of specific interest grouping of the area to be accounted for. These may include: irrigators, government and local government personnel, business associated with connections to the water industry, environmental groups and the general community.

Stage 2: Systemic and Cause: Response Analysis

The causes of some environmental impacts are well documented (eg. nutrients and eutrophication). However, other impacts may be obscured by time lags and intermediate stages. These can be identified by systemic analysis which can be used not only to identify consequences but likelihood of occurrence (risk analysis). The pathways of interaction need to be identified by the scientific panel and verified in the data collection stages to follow. Specific aspects to model include salts, nutrients, biocides and water balance. Remediation actions will be identified and promoted. In the first instance, models of common issues need to be developed to allow refinement through insertion of data at the local level. A generic set of indicators to determine environmental condition can be developed by a scientific panel drawn from the partners.
3.12 Environmental Analysis Process

![Diagram of Environmental Analysis and Valuation Process](image)

Figure 5. Environmental analysis and valuation process

3.13 Implementation

Preliminary environmental framework implementation and baseline assessment of environmental situations will also involve two stages; data collection and analysis using the environmental framework:

Stage 1: Stakeholder Perceptions

In order to identify current and possible future impacts of irrigation activities on environmental values it is proposed to run a series of workshops with the various stakeholders associated with the irrigation industry and environmental custody. The
workshops will use the generic matrix as a starting point for identification of environment values; however, local values not generically identified can be added to the list by the participants. Understanding environmental values of different groups of stakeholders would require that the workshops be run on a particular interest group basis and hence at least six will be conducted.

Stage 2: Systemic and Cause: Response Analysis

Possible environmental impacts and perceptions of them identified by stakeholder analysis will be informed by the collection and collation of existing environmental data using standardised indicators identified by the CRCIF researcher panel and reference sources (e.g., water quality and soil health indicators). Additional data sets may be gathered where lag-times and indirect impacts may obscure stakeholder perceptions but not scientific analysis. Data gathered will be placed in the developed model framework to test interactions and potential change impacts.

Collation of existing bio-physical data will allow comparison with standard indicators of environmental condition of landscapes, soils and waterways. Quantitative data sets will be collected, modified and placed in the modeling framework. Gaps in knowledge will be identified and potential interactions between data types will be tested. The predictive capacity of the model will be tested.

3.14 Issues and Options Methodology

An integration of environmental framework and concepts for all RIBPs will be undertaken. First, there will be an integration of current situation analysis involving values analysis and scientific verification for each of the RIBPS collation and testing for common attributes in process and content. Then the theoretical framework is to be compared to the tested outcomes.

Refinement of environmental frameworks following workshops will involve:

- Refinement of environmental frameworks following workshops and biophysical model development
- Relate stakeholder perceptions to bio-physical indicator data across the four
RIBPs

- Identify matches and mismatches
- Identify data needs to confirm existing perceptions
- Identify clear cut causal relationships
- Identify critical points in the systemic relationships between irrigation practice and environmental responses
- Undertake risk assessment of irrigation activities on environmental values

With the final version of the environmental framework completed and the model verified through ongoing monitoring, issues and risk management processes will be identified and applied in the context of the water resource planning options at play in the RIBP sites.
4. Policy, Law and Mechanism for Change
This section focuses on two case study regions namely Coleambally and South East SA, and describes a huge array of formal and informal institutions and also an array of laws. The question addressed is to what extent is lack of harmonisation between these institutions and laws driving the sub optimal NRM outcomes.

4.1 Objective
The objective of this work is be able to assess the degree of harmonisation between the many stakeholders and the multiple objectives of NRM. The table below gives a summary of the current structures.

The preliminary work\(^2\) has demonstrated that individual growers in the case study regions have difficulty understanding and complying with the range of legal and policy instruments applying to them and the impact this has in:

- their ability to implement sustainable water management practices
- their willingness to use sustainable water management practices their ability to fulfill a social contract of being sustainable farmers and the ability to get that message across to the wider community
- their response to demands for environmental water flow, and
- the social cohesiveness and long term sustainability of farm businesses and rural communities

This work will examine the extent, role and impact of the emerging complexity in current water management regimes and will suggest ways to harmonise these regimes. This will enable an assessment to be made about the effect that legislative, policy and regulatory frameworks have on the social cohesion of the affected stakeholders and also assess the perception of the degree of harmonisation between groups and the impact of that on NRM achievements. To achieve these objectives we have formulated the following hypotheses:

1. the complexity of water laws since 1994 has led to confusion amongst stakeholders (stakeholders includes all persons in the community)

\(^2\) Filed work and meeting and numerous discussions over the past year
2. the confusion has led to sub optimal adoption of sustainable water management practices in Coleambally the Trade Practices Act trading out ruling will be considered in detail

3. sub optimal practices have reduced social sustainability of rural communities and

4. sub-optimal adoption reduces environmental. Social and economic sustainability of communities

4.2 The Water Planning Processes
Water governance in Australia is a complex process with a variety of institutional arrangements framed under the State laws for the provision of water services and to achieve NRM (Table 1). Massive institutional reforms in the Australian water sector have resulted in complete restructuring of the water supply businesses such as Coleambally. In addition, the policy to achieve ESD is coercive on each organisation as it is part of the law of each State and encouraged by Commonwealth.
## Table-1: The Organisational Structure of Regional NRM Bodies who draft Water Allocation, Use and Sharing Plans and the Water Supply Businesses in each Australian State

<table>
<thead>
<tr>
<th>State</th>
<th>Date of formation - number at 2007 - Type of regional body</th>
<th>WSB types&lt;sup&gt;3&lt;/sup&gt;</th>
</tr>
</thead>
</table>
| NSW   | 2003 - 13 - Catchment management authorities, create water plans. Locally driven with board reporting to minister and the primary means to deliver funding from the NSW and federal government and help land managers restore the environment of the state. Each board has a chair and 6 members selected on a skill base with a small team of professional staff.  
  • **Skill based with statutory duties** | 9 types with 74 bodies |
| VIC   | 1994 – 10 - Victorian Catchment Management Council (VCAT) is the peak advisory body and facilitates and integrates framework. It has its own act and uses the water act 1989. VCAT prepares regional strategy guidelines for the Minister which is applied by the Catchment Management Authorities (CMA’s). Each CMA needs to liaise with community, industry, environmental organisations state and federal agencies.  
  • **Confederation of emergent groups (no skill base for board members) with statutory duties** | 2 types of 23 bodies |
| QLD   | 2000-15 - not established by legislation but called regional NRM groups (RNRMG). These all differ vastly from each other in terms of corporate structure, stakeholder interests and their stage in planning and implementation of NRM activities. There is a collective of RNRMG consisting of the chairs and CEOs of the 15 which co ordinates a strategic approach to NRM issues across regional boundaries. The collective sits outside government and is funded by the regional bodies and some Commonwealth NHT/NHT funding.  
  • **Confederation of emergent groups( no skill base for board members) with no statutory duties** | 7 types with 115 bodies |
| SA    | 2004-11 - called Natural Resources Management Boards but exiting from 1997 as catchment management boards. These boards have a power to collect an NRM levy which is struck on the value of the land in urban areas and the amount of water used for farmers. The boards are skill based selections of all stakeholders in a region and need and there is the NRM council that advises the minister on the actions of the boards.  
  • **Skill based with statutory duties** | 1 type 7 bodies |
| WA    | 6 - 2001 - regional catchment councils (non statutory) and NRM council. The council co ordinates the delivery of NAP and NHT actions and fosters a consultative approach to ensure broad community involvement in NRM policy development. The local groups co ordinate the efforts of smaller more localised community groups and so the membership rules vary but Generally include community members, state agency officers and local government.  
  • **Skill based board with no statutory duties** | 5 types 22 bodies |


**Note:** NRM is natural resource management and this includes water. NAP is National Action Plan for Salinity and Drainage (Federal funding) and NHT is National Heritage Trust funding also supplied through the Federal Government.

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<sup>3</sup> There are 14 major types some are fully private such as some Irrigation companies Coleambally in NSW where the assets were transferred. Others are Government owned enterprises and are often used as cash cows by the relevant State Government see “My Bold Plan to save our Water”, *Weekly Times* National newspaper Jan 31 2007 p 16. Quote from Prime Minister’s speech.
The Regional delivery of NRM through 56 State constituted bodies is summarized in Table 2. There is only some harmonization of the underlying laws. The main mechanism for implementation is via the National Water Initiative (NWI). The Initiative uses coercive Federal power through section 96 to reward States with funding if they achieve components of a grand plan that totals 80 detailed components and among them include components focusing on water sharing plans and changing the allocation of water to a share of the consumptive pool. The latter gives farmers an annually determined right to a share of both surface and ground water. The sharing process aims to achieve ESD. The amount of water available for allocation is determined by a local water plan which is drafted by the local NRM Board or CMA. See Table 2. This phase, ESD, and indeed NRM are legally challenging and innovative in that they require unique laws and institutions and administrative arrangements. This project will make a contribution in assessing progress to date and in identifying from the perspective of many stakeholders the barriers to implementation and achievements.
Following is the highlights of the State NRM Acts:

### Table 2 - NWI Implementation Perpetual Share and Water Plans in Three States

<table>
<thead>
<tr>
<th>State</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Australia</td>
<td><em>Natural Resources Management Act 2004</em>. The aim of this act is to achieve ecologically sustainable development by establishing an integrated scheme to promote the use and management of Natural resources. State Natural resources Plan and regional NRM plans included detailed water allocation plans that define the consumptive and non consumptive use for each Catchment. Plans reviewed every 5 years and the schedule of review times has been published (SA Government 2005) and devised with consultation of the community.</td>
</tr>
</tbody>
</table>
| Victoria            | Victoria has committed over $900 million AUS to 110 initiatives to sustain and manage water at every stage of its cycle from Source to consumption, conservation and recycling. Specific initiatives include protection and legal rights given to stressed rivers and groundwater, pricing of water to encourage people to use it more wisely, permanently save urban water, secure water for farms through pioneering water allocation and trading systems and improve monitoring and reporting of water quality.  
  - Creation of water shares, delivery shares and water use licenses. Water access entitlement will be defined in districts so that individual farmers will have a tradable share of the resource |
| New South Wales     | - The process to implement the entitlement framework will be completed by end 2006. NSW had 31 regions where water was over allocated and has devised plans to share the water with the environment between users. The plans are available on [www.dipnr.nsw.gov.au](http://www.dipnr.nsw.gov.au). Plans for the remaining areas are expected to be completed by end 2006.  
  - The Water Management act 2000 section 5(3) requires first priority to protection of the environment and second to basic landholder rights.  
  - Environmental rights have been defined for 31 and groundwater plans and unregulated rivers will be complete by 2006 and 2008.  
  - New South Wales allowed irrigators to carry forward unused water to the next season and this was a major stumbling block to intra State trade.  
  - NSW Implementation Plan for the NWI 2006 Government of NSW |

**Sources:** Various NWI Implementation plans as required under Clause 8 of the COAG, [www.nwc.gov.au](http://www.nwc.gov.au)

### 4.3 The Relevant Legislation in SA and for Coleambally NSW

This section gives the objectives of the ESD laws to set the scene for the reader. The work will examine many legal rules in these acts in details

**SOUTH AUSTRALIA**

*Natural Resources Management Act 2004, SA*

The objects of the Act include assisting in the achievement of ecologically sustainable development in the State by establishing an integrated scheme to promote the use and management of natural resources in a manner that—
(a) recognises and protects the intrinsic values of natural resources; and
(b) seeks to protect biological diversity and, insofar as is reasonably practicable, to support and encourage the restoration or rehabilitation of ecological systems and processes that have been lost or degraded; and
(c) provides for the protection and management of catchments and the sustainable use of land and water resources and, insofar as is reasonably practicable, seeks to enhance and restore or rehabilitate land and water resources that have been degraded; and
(d) seeks to support sustainable primary and other economic production systems with particular reference to the value of agriculture and mining activities to the economy of the State; and
(e) provides for the prevention or control of impacts caused by pest species of animals and plants that may have an adverse effect on the environment, primary production or the community; and
(f) promotes educational initiatives and provides support mechanisms to increase the capacity of people to be involved in the management of natural resources.

Functions of NRM Boards

The NRM Boards need to draft plans which are consistent with South Australia’s Strategic Plan Creating Opportunity which has 6 objects viz;

- Attaining sustainability
- Growing prosperity
- Improving well-being
- Fostering creativity and innovation
- Building communities
- Expanding opportunity

The relationship is overseen by State NRM Council. A key function of the NRM Council is to ‘prepare, and to keep under review, the State NRM Plan, and to keep
under review the extent to which regional NRM plans and policies and practices adopted or applied by NRM authorities are consistent with the State NRM Plan’ (Section 17(1)(c)).

*The state NRM plan*

The State NRM Plan identifies a 50-year vision for natural resource management in South Australia. The State NRM Plan contains four goals:

(a) Landscape scale management that maintains healthy natural systems and is adaptive to climate change.

(b) Prosperous communities and industries using and managing natural resources within ecologically sustainable limits.

(c) Communities, governments and industries with the capability, commitment and connections to manage natural resources in an integrated way.

(d) Integrated management of biological threats to minimise risk to natural systems, communities and industry.

**NEW SOUTH WALES**

*NSW Catchment management Authorities Act 2003- SECTION 3*

The objects of this Act are as follows:

(a) to establish authorities for the purpose of devolving operational, investment and decision-making natural resource functions to catchment levels,

(b) to provide for proper natural resource planning at a catchment level,

(c) to ensure that decisions about natural resources take into account appropriate catchment issues,

(d) to require decisions taken at a catchment level to take into account State-wide standards and to involve the Natural Resources Commission in catchment planning where appropriate,

(e) to involve communities in each catchment in decision making and to make best use of catchment knowledge and expertise,
(f) to ensure the proper management of natural resources in the social, economic and environmental interests of the State,

(g) to apply sound scientific knowledge to achieve a fully functioning and productive landscape,

(h) to provide a framework for financial assistance and incentives to landholders in connection with natural resource management

(i) to provide a framework for financial assistance and incentives to landholders in connection with natural resource management

*Catchment Management Authorities Act 2003 - SECTION 15*

The Catchment Management Authority has the following functions

(a) to develop catchment action plans and to give effect to any such approved plans through annual implementation programs,

(b) to provide loans, grants, subsidies or other financial assistance for the purposes of the catchment activities it is authorised to fund,

(c) to enter contracts or do any work for the purposes of the catchment activities it is authorised to carry out,

(d) to assist landholders to further the objectives of its catchment action plan (including providing information about native vegetation),

(e) to provide educational and training courses and materials in connection with natural resource management,

(f) to exercise any other function relating to natural resource management as is prescribed by the regulations

**4.4 Overall Analytical Framework**

Environmentally Sustainable Development (ESD) has the three factors economic, social and environmental and is legally challenging in that to achieve all three will require unique laws and institutions and administrative arrangements. The laws exist and the administrative arrangements but how are they impacting the community? And what are the new formal institutions doing and are they being undermined by informal processes? (North, 1990; Di
Maggio and Powell, 1983) The imposition of laws to achieve ESD is an outcome of societal pressures, biodiversity catastrophes and drought and has been imposed on the organization by the law in order for the organisations to maintain its legitimacy with some influential sectors of modern Australian society (McKay 2006). The issue therefore is a Framework for System Harmonisation to evaluate if the institutions and organisations are achieving sustainable water allocation policies to document the barriers, positive factors and interrelationships and implementing these in NSW and SA.

The overall framework is a systems framework adapted from various sources and is presented in the Figure 6. The framework is based on the theory of Chaos (Marion, 1999); the Capitals Framework (Cocklin and Alston, 2003), work on Organisational Analysis (North, 1990), Social Discourse Theory (Dryzek, 1997, 1994), comparative water law, a conflict of laws, and finally work on social legal theory. However, there are feedback loops in this framework which will be developed and specified as the research progresses.
The framework for the two case studies will be as illustrated in Figures 7 and 8. Figures 7 and 8 describe the systems chart of relationships in Colleambally and the South East SA respectively. These figures provide the framework for System Harmonisation in the two study regions.
Figure 7: Framework for System Harmonisation in Colleambally – Systems chart of relationships

Note: There are feedback loops in this framework and these will be developed and specified as the research progresses.
Figure 8: Framework for System Harmonisation in the SE SA – Systems chart of relationships

Water Markets

Other Agricultural Sectors

Australian Wide Lobby groups (Eg. Forestry Lobby Groups)

Other Sectors

MIS

Social values towards:
- Natural resources
- Sustainability
- Commoditisation
- Bio-diversity protection
- NRM regulation
- Other regulations
- Shared values

Social capacity to:
- Adopt sustainable practices
- Understand markets
- Participate in regional initiatives
- Trust others

Environmental change

Drought

Water Sector Organisations & SE Catchment Board Planning (Pre 2005)

NRM Act 2004 (new plan)

Key Inputs

Agencies DWLBC

NRM Policy transitions
- Time
- Space
- Impact

Role of policy entrepreneurs

Note: There are feedback loops in this framework and these will be developed and specified as the research progresses
4.5 Methodology

Research design
This study is exploring multiple layers of attributes and organisations in two regions and therefore the case study approach is used as it is the best fit for this type of study. The case study research methods is an empirical inquiry that investigates a contemporary phenomenon within its real life context; when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used (Yin, 1994, pp130). Eisenhardt (1989) describes case study method as an approach which focuses on understanding the dynamics present within single settings and combines data collection methods such as archives, interviews, questions and observations. According to Stake 1995 case study is not a methodological choice but a choice of the object to be studied. In his view, the purpose of the case is not to represent the world, but to represent the case; particularly the researcher must understand the case itself, rather than being diverted by granted visions of theory building. In contrast, Yin’s point of view is authoritatively focusing upon preparing for data collection.

Research tools
There are three tools used in this order: (A) PhotoVoice process, (B) Structured questionnaires and (C) Key actor interviews.

(A) PhotoVoice

This is underway and we have workshops set up on 14th December in South East SA and 18th December in Coleambally in conjunction with UWS.

PhotoVoice method will be used with a selection of growers, non-growers and NRM regional board members in the two regions. The PhotoVoice participants will be given disposable cameras and a list of 'themes' or questions. The participants then use the camera to illustrate their perception to the specified themes/questions. After the photos are all processed, the participant’s workshop and discuss the experiences and points of view presented in the photos. PhotoVoice has been used in a number of disciplines and in many countries. It is very effective in getting a high level of stakeholder involvement in
the research process and is particularly successful in attracting individuals who might not ordinarily participate. One of the merits of PhotoVoice is that it is highly accessible. It is usual to produce a public display of the PhotoVoice pictures (with the permission and participation of the individual photographers). This display is likely to be in the form of posters or enlarged images with the photographer/participant’s thoughts and comments adjacent to it. The public display using the resulting photos will be developed and sited at a number of locations. We will be doing a display in the Adelaide Festival at ARTLAB in February to March 2008 and then in both regions with the co-operation of UniSA and CSU as well as Coleambally IT. It is anticipated that Photo Elicitation techniques will be used to gain further data from the wider public. This will be achieved by bordering the images of the display with a large blank surface (comments border) that viewers can write on at their leisure. After the presentation period, the comments will then be entered into computer and assessed for data value. Photo Elicitation is an approach where the researcher supplies the participant with a photograph rather than just a spoken or written question. The experiences of other researchers who have used Photo Elicitation have indicated that participants respond to the subject of the photograph on a much more personalised and involved manner. The Workshop for the participants of the PhotoVoice will also allow for Photo Elicitation questions and debriefing.

It is anticipated that the participant’s written observations on their submissions will be able to be content analysed to provide statistical evidence to further complement the data gathered with the photos and the workshop.

(B) Structured questionnaires

Structured questionnaires will be used to interview the growers and the broader community in the case study areas. Survey participants will be asked questions on a range of issues such as water allocations, the Environment, water trading, and Government policies and regulations. The questions have been broadly parsed into four broad categories viz;

a. Environmental and ESD Attitudes and Perceptions

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4 We have been supported in this by Cathy Hughes at Mt Gambier and also the Border watch newspaper.
b. NRM Management Attitudes and Perceptions

c. Social Attitudes and Perceptions

d. Demographic Information

The questions in the Survey have been designed to allow stakeholders to indicate what they perceive as the issues, obstacles, and desirable and undesirable outcomes and the survey consists a mix of questions types which includes:

- Graduated 5 point scale items
- Rank order type questions
- Short answer type
- Yes/No type questions
- Select answer from short list and
- A photo elicitation question using key photos from above

By using a combination of different types of questions we will be able to generate numerated values for the answers to the questions and then use Statistical Analysis techniques to find significant patterns and trends.

The survey will be conducted using the internet and some hard copy schedules. We have received tremendous co-operation to work out a list of respondents. This will be conducted February-March 2008.

(C) Key actor interviews

In addition to the above-mentioned tools, key actor interviews will be conducted at both study areas. According to USAID (1996), key stakeholder interviews are useful in the following situations:

- When there is a need to understand motivation, behavior, and perspectives of parties involved.
- When quantitative data collected through other methods need to be interpreted.
- When preliminary information is needed to design a comprehensive quantitative study.
- When a main purpose is to generate recommendations.
- When qualitative, descriptive information is sufficient for decision-making.
Similarly, in the present case the key actor interviews will be conducted to gather information about the issues pertaining to the theme of the study. Further, information provided by the key informants will help to augment the information gathered through the internet survey. The key actor interviews will be qualitative, in-depth interviews of knowledgeable sources, and loosely structured so as to allow a free flow of ideas and information.

**4.6 Outcomes and Work to Date**

It is anticipated that there will be important lessons from this work on institutional and organisational impediments to NRM policy making and NRM Instruments and these which will derive from the semi structured interviews and all the other data collected. This will be reported in a way to enhance the removal of the barriers.

Following tasks have been completed to date:

- Multiple site visits and discussions with CSU, UNE UWS and key actors in the regions
- Conceptualisation of socio, economic, environmental and institutional frameworks
- Formulation of potential hypothesis for quantitative part which will come last.
- Ethics Approval to proceed with the interviews
- Initiation of photovoice
- Establishment of list of respondents

**4.7 Change Management**

A simple guide to the ‘how and ‘why’ of voluntary public ‘triple bottom line’ reporting by users or managers of natural resources, which will provide:

1. a framework to understand the commercial/strategic motivations for such voluntary reporting;
2. information on the processes available and the issues involved in these processes;
3. live examples and case studies of the implementation, and the issues that have arisen; and

4. some indications of the strategic trajectory of both stewardship and formal accountability, and the implications of this for voluntary reporting in the primary sector.

**Potential output**

**Social License or private right?**

1. Social License or private right?
   a. Property and privilege – examples of the intersection of these issues and where social license issues eg water allocation, regulation and co-regulation, usufruct issues,
   b. Stewardship as a conceptual framework – where are the boundaries of expectations?
   c. Pricing of resources and social perception issues in setting of access costs and conditions,
   d. The exercise of administrative discretion over resource access
   e. The role of social brands in commercial markets
   f. The politics of regulation
   g. The commercial and strategic implications of all of this for those who own, control or use natural resources for commercial purposes

2. The trajectories of voluntary communication of stewardship
   a. Social branding and marketing of primary product – what is happening?
   b. Political campaigns over resource use and access – what is happening?
   c. Standards and certification of TBL performance: What is happening?
   d. New developments internationally and locally: what can Australian resource users expect?
3. How are boundaries to be drawn?
   a. The tensions between statutory/common law/ moral and managerial imperatives.
   b. The expectations of community: identification and understanding, and the problem of defining ‘reasonableness’ in a political context.
   c. Power relationships and the practical problem of expectations and power to force compliance.
   d. Conceptual frameworks to consider
   e. The practical (economic and managerial) implications of the choice of boundaries and accountabilities
   f. Is the focus rhetoric, or stewardship, and is this distinction real? How reporting changes behaviour.

4. Social branding and product branding
   a. Approaches to TBL standards and certification in the primary sector
   b. Current programs and developments
   c. The practical experience: Challenges and opportunities.
   d. Steps towards implementation of TBL standards

5. Social branding and corporate TBL reporting
   a. Local and international TBL reporting schemes
   b. Determining metrics
   c. Designing processes
   d. Communication and marketing the social brand
   e. Alternative approaches and their implications for resource managers
   f. The risks and the opportunities, based on practical examples
   g. A stepped program
6. Guidance for action
   a. The strategic evaluation of increasing accountability
   b. Risks and opportunities for resource managers and users
   c. A stepped approach: deciding what is feasible and desirable
   d. Examples and comments from innovators
   e. ‘Getting it right’: what does it take?

7. Resources and supports.

4.8 System Harmonisation Legal framework

This update and progress report reflects adjustments to the implementation of the CRCIF work plan intended to better accommodate the progress of the RIBPs and the overall Harmonisation program.

Other adjustments are attributable to the unavoidable complexities of the RIBPs and resultant timing variances from original expectations of their progress and requirements. We have found ways of adjusting our approach to accommodate the challenges that this has posed but naturally this has had an impact on scheduling.
5. Regional Irrigation Business Partnerships

The “Regional Irrigation Business Partnership (RIBP)” is key stakeholders groups, which includes irrigators, regional industry, water suppliers and other partners, enthusiastic to explore alternative business approaches for enhancing their profitability and environmental productivity for long term sustainability. RIBP is a new concept. It has been developed by the CRC for Irrigation Futures (CRC IF) to explicitly recognise the importance of engaging business in delivering improvements in multi-purpose water use productivity.

Regional Irrigation Business Partnerships™ provide a vehicle which directly links regional business opportunities with more sustainable natural resource management. The main role of the RIBP is twofold (i) provide necessary feedback to System Harmonisation program (CRC IF) in order identify the obstacles (hot spots) that slow business growth and possible intervention to boost business, (ii) take the research outcomes from the project in a sustainable and responsible fashion to attract business investment for implementation of regional business plans. These solutions are to be able to be used in any region to help it take advantage of its unique characteristics to develop a competitive advantage.

In general, the roles of RIBP, while working alongside with the System Harmonisation™ program, key stakeholders and industry, include:

- To make established industries more profitable and sustainable that can take the lead in attracting support industries in their region;
- Identify barriers to new industries/businesses starting up in regional areas, especially in water saving businesses, and how to overcome these barriers in a sustainable fashion;
- Identify various incentives that could make business more attractive in the regional area;
• To attract strategic public investment for increasing the effectiveness and flexibility of water supply

• To encourage improved water productivity and a willingness to share and trade water for multiple benefits.

• To develop opportunities to harmonise state and national level policies for ensuring sustainable economic and environmental outcomes for their regions;

• To structures regional areas for effective natural resource management to deliver improved services and better value for money through appropriate risk-sharing;

• Encourage public-private business for innovative technologies through spreading of risk;

• Provide supports, and wherever possible tools, for the successful decision-making processes and sustainable water use practices;

• Secure additional sources for funding maintenance of existing infrastructure and facilities;

• Create healthy competition, improved services and greater efficiencies in water delivery;

• Renewed confidence will bring greater engagement from irrigators and a greater sense of responsibility and stewardship;

• Build consensus with local irrigators, supporting business and other partners on best practices for efficient utilisation of available resources;

• Establish effective business networking with other industry partners, information sharing and promotion of the region’s competitive advantages;

• Platform for responding to Emerging NRM Issues such as adaptation to climate change; better industry, local government engagement in natural
resource management; and the enhancement of monitoring and evaluation arrangements; and

- Promote positive image of the agriculture and irrigation industry in the region and throughout the country.

### 5.1 Key Requirements for Sustainable RIBPs

According to *Psi-Detla*, Consultant in Water and Environment Business, the key requirements for sustainable RIBPs include:

- Strong local representation and local leadership;
- Suitable level of CRC input into decision and protection of RIBP intellectual property;
- Capacity to enter into agreements;
- Ability to define a works program, achieve prudent management of resources, monitor program performance and take corrective action;
- Flexibility;
- Understanding of issues related to System Harmonisation and the agencies and other stakeholders involved locally; and
- Acknowledged membership and operation that establishes the organisation as the legitimate organisation to deal with its program of work.

### 5.2 Propose Structure of Regional Irrigation Business Partnerships

At present RIBPs have had a loose structure, interim RIBP organisations are designated as steering committees. After studying several structures such as joint venture, locally lead, CRC lead, working through an existing agency, the *Psi-Detla*, Consultant in Water and Environment Business, has proposed locally lead incorporated organisation. The simple initial structure of RIPB to match its function is shown in Figure 9.
The Chairman of each RIBP:

- Chairs meetings
- Manages activity programs
- Controls local budgets

Appoints Executive Assistant

- Executive Assistant for each RIBP:
- Provides administrative services for RIBP
- Compiles data collected by members
- Produce newsletter notes
- Arrange researcher visits

In addition to the roles within each RIPB there is a coordination role within the CRC – perhaps called a client manager the role of which would be to:

- Ensure programs and outcomes are properly defined
• Ensure that CEC inputs are agreed and delivered as expected
• Monitor CRC manpower and financial budgets
• Maintain liaison with RIPB to ensure satisfaction with progress and to manage any problems which might arise

The RIPB Development Manager could provide oversight of these client managers. Client managers could manage more than one RIPB and might also be drawn from sections of the CRC that are not working on the RIBP.

5.3 Experience and Lessons of Sustainable Business Partnership

Australian Experience

Mary Dunkley (2003) presented a win–win case for Regional Victoria, where the Shire of Campaspe with support from the Department of Innovation, Industry and Regional Development has developed Campaspe Economic Development Board (CEDB). The Shire of Campaspe, like many Australian regional communities was undergoing drought conditions and broader economic and institutional restructuring such as private sector restructuring i.e. bank branch closures, factory closures; and public sector rationalisations. Partnership building is needed to ensure the sustainability of the towns within the Shire. Regional local governments have higher pressures and risks as they represent communities that are fighting for survival against the natural elements. The CEDB board focused on creating employment and business opportunities for the promotion of the region as an ‘Inland Sea Change’. Typical board activities include business attraction, major project facilitation, identification of import replacement opportunities, facilitation of government funding programs, facilitation of business development, local advocacy, confidential information and advice relating to business development, business networking and promotion of the Shire’s competitive advantages. The CEDB board had tremendous success more recently with the attraction of the second largest Australian retailer Woolworth’s establishing a Big W store, the near completion of an irrigation pipeline along the Mt Camel range, which is expected to provide economic benefits exceeding $100 million, $50 million expansion of Murray Goulburn
In 2003, Department of Environment has developed a Salinity Investment Framework (SIF) for Western Austria. The aim of the SIF is to ensure that public investment is directed to projects with the best potential to protect assets of high public value that are at threat from salinity. A simple conceptual model of the SIF is presented in Figure 10. The investment framework not only identifies investment priorities but as well as used in developing Natural Resource Management strategies, investment strategies and in business planning. Investment priorities in the SIF model are set based on asset values and levels of threats. For example, a high-value asset that is highly threatened and has only moderate feasibility may represent the best investment if objectives include both protection of high-value public assets and development of new technologies to improve our ability to combat salinity. Such an approach is likely to yield the best long-term public outcomes, rather than retreating to doing only those things that are most feasible.

Figure 10  Salinity Investment Framework: A Conceptual Model  
Source:  Department of Environment, 2003
In 1994, the Department of Treasury in the State Government of Victoria developed the Infrastructure Investment Policy (IIPV) to seek private investment in the provision of infrastructure and related facilities. The aim was to take advantage of new technologies and innovation, private sector management skills and a wide range of financing techniques; promote the growth of new and existing Victorian businesses and employment; and strengthen the State’s economy, producing social, cultural or other quality of life benefits (Government of Victoria, 1994). The Government undertook to promote private sector investment in the provision of infrastructure only where such involvement will clearly provide the most effective solution for the State. The Victorian experience under IIPV was mixed, with successes and failures. One area of failure was business collapse on the part of the private sector partner, and the need to ensure “step-in” rights for Government (Heiler, 2002).

Mckay (2003) has analysed regulatory structures in water sector that enable the most appropriate groups of individuals to provide essential services bearing in mind long term sustainability. Various case studies of urban and rural water authorities in Australia were studied. The case studies include Sydney Water NSW, Melbourne Water, SA Water, Goulburn Murray water, Rural and urban provider, Victoria, Murray Irrigation Ltd, SunWater. She found out that among various public private participation models, the most commonly used were concessions and lease contracts. Some of these have been successful, while others driven by State objectives have proven to not be successful in the long term. She recommended that it is particularly important to ensure that all utilities collect data on the same matters economic, environmental and social impact of water policy in a consistent way and agree on protocols of sharing the information, for Governments to be able to assess the environmental and economic effects of water trading policies in particular and be alert to monopolistic behaviour with respect to water rights. As the case studies show it is also important for Governments to be able to monitor the licence operating conditions and set protocols to ensure there are no more health issues with regard to water.
Department of Prime Minister and Cabinet (2006) have showed the importance of successful business investment by using a hypothetical example of Yanko Creek. With limited public sector funding available, the Yanco Creek community sought private sector investment in a major works program that would result in water savings representing over 20 per cent of the total water allocation in the community. From the private investors perspective the priority for the Yanco Creek project is to establish the business case by identifying a reliable source of income and a mechanism to capture and utilise that income. This case study was reviewed under three potential financing models - from the public sector, the private sector and a partnership between public and private. The partnership model was seen as the most viable option bringing together investors, governments and key stakeholders from the Yanco area.

Some water utilities in Australia also have assets that were funded and are operated by the private sector under a variety of arrangements including build own operate (BOO) and build own operate and transfer (BOOT) and other financing models. Seven examples within the urban water industry include:

- Prospect water treatment plant in Sydney operated by United Utilities
- Virginia recycled water scheme (SA) operated by Earthtech
- Yan Yean water treatment plant in Melbourne operated by United Water
- Power generator using sewage gas operated by Australian Gas Light Company (AGL) at Melbourne’s Western Treatment Plant
- Water treatment plants serving Coliban Water customers in Central Victoria are owned and operated by Veolia
- A sewerage treatment plant servicing Echuca is owned and operated by Earthtech
- Eastern irrigation scheme in Melbourne operated by Earthtech
In 1995, the South Australian Government established public-private business arrangement with United Water, a private consortium. The main objectives was to introduce best-practice management, create cost savings and increase the growth and sales of the water sector through the development of a viable export of water related technologies and services. Under this arrangement, the government owned utility while United Water is responsible for developing and managing the capital works program but the approval and funding for these works remains with SA Water. United water has achieved 99% compliance in relation to water quality, quality of wastewater discharged, response times to network events, restoration of interrupted service and new connections.

Filet et al. (2006) argued that local government has a crucial role in building effective partnerships among these groups to deal with salinity. They have presented a regional NRM framework for salinity management for Condamine-Balonne Catchment, Queensland (Figure 11). The central importance of partnerships and alliances in the framework is the partnerships required for effective NRM and roles and responsibilities of the major players, including Commonwealth, State and local government, Industry, the community and the education, research and development sectors.

The key points of the proposed regional NRM framework are:

- Clear separation between strategic frameworks and operational plans
- Central role of horizontal (equal) partnerships and alliances
- Information and consultation for developing strategic goals and targets
- Effective coordination and adequate resources for delivery
In September 2001, Queensland’s *Public Private Partnership Policy – Achieving Value for Money in Public Infrastructure and Service Delivery* was launched by the state government. This policy is a key strategic initiative that supports the Queensland Government’s central economic objective of achieving high and sustainable levels of economic growth and employment by providing efficient and effective services and infrastructure.

The objectives of this policy are to:

- deliver improved services and better value for money through appropriate risk sharing between public and private sector parties;
- encourage private sector innovation;
- optimise asset utilisation; and
- integrate whole-of-life management of public infrastructure.
In Australia, public-private investment experiences have shown mixed results. The main reasons for such mixed results are lack scientific understanding for short and long run of the potential consequences and long run commitment from the parties involved.

**International Experience**

Heiler in 2002 conducted a comprehensive review on public and private sector partnerships for the designing, planning, constructing, financing and/or operating and ownership of major public service infrastructures. The review was categorised in to developed – UK, Europe, Australia, Ireland, USA and Canada – and developing countries – Malaysia and developing member countries of the Asian Development Bank. It was observed that there is a strong interest amongst private sector players to be involved in PPP projects in irrigated agriculture, so long as the investment climate is supportive. The key feature for a successful PPP is the allocation of the project’s risks between the public and private sector according to each party’s ability to manage and bear them, without destroying the economic balance of the project.

The reasons postulated in support of the PPP model for infrastructure development include:

- Greater cost-effectiveness in managing project risks;
- Savings captured/benefits enhanced because of better time-to-delivery;
- Accesses private sector innovation and management skills;
- Lower demands on governmental operating budgets, reduced fiscal deficits;
- Better value-for-money for government and community.

The review noted that in all of the countries where PPP has become an increasingly important method of developing infrastructure projects, policy decisions have been based on extensive analysis, and subsequent specific support and procedures developed by Government. In some cases legislative change has been necessary.
Prefol et al. (2006) has developed four-box analytical framework to understand the risk and opportunities of public-private partnership in the irrigation and drainage sector (Figure 12). The framework mainly considers the public or private characteristics of their management and the level of commercial risk involved. The two dotted lines stand for indicative “thresholds” on both variables, the vertical one particularly separating public accounting systems from private accounting ones.

While utilising the framework they recommended that partnership should also concentrate on addressing risks properly, should try to raise the skills of the partners involved and the donors to be involved in the partnerships. Last now not least, the important point is not so much to find an “absolutely private” partner but rather a professional “third party” between farmers and government, whether it be public (e.g. a reformed and financially autonomous government agency) or private (e.g. a private service provider looking for business or a WUA turning into a private corporation).

Figure 12 The four-box analytical support diagram representing the commercial risk for the operator, depending on public vs. private management (Source Prefol et al. 2006)
Anwer (2003) has conducted a review on the institutional development, its achievements, challenges and constraint of the water supply and sanitation (WSS) sector in Yemen. The range of options public-private partnership such as service contracts, management contracts, lease contracts, transfer or build, operate and own; and complete sale of assets (divestiture) were discussed in detail. The main lessons learned from the study was that public-private partnership is new to Yemen and there is limited local know-how in this field. From this the author strongly recommends that donors should assist in building local know-how and learning from experiences of others prior to any decision on partnership.

Rabadi, (2003) analysed the Hashemite Kingdom of Jordan where major policy changes in the water sector, emphasizing water demand management and a major role for the private sector has been articulated. The government embarked upon a privatization program, the goal being to orient Jordan’s economy more towards the private sector and best present Jordan to the international financial community. The specific objectives of the program include increasing the efficiency of enterprises, consolidating public finance, attracting private investment into the economy and deepening the financial markets. The Water Authority of Jordan (WAJ), one of the authorities of the Ministry of Water and Irrigation (MWI), entered into a management contract with an international water services operator in April 1999 for the management of all water-related services within the governorate of Amman. MWI and WAJ have been considering other options for water and wastewater services in other governorates of Jordan. The lessons learned from the Amman management contract were extremely helpful in ensuring that the contracts for the northern governorates and Wadi Mousa are structured and drafted to meet all objectives sought, and perform better than the Amman contract.

Zouggari (2003) discussed exclusively hardships associated with private sector involvement in the financing and the management of infrastructures through delegated management in Morocco. He addressed obstacles and hardships hindering endeavours to speed up and rationalize the private sector’s involvement in the financing and
management of public infrastructure through delegated management. Despite the difficulties such as legal aspect and overcautions, it has not prevented Morocco from carrying on a bold policy of giving concessions throughout recent years.

Spielman and Grebmer (2004) while analysing public private partnership in agricultural research suggest that while incentives and perceptions do differ between sectors, sufficient common space exists or can be created through incentive structuring to facilitate greater partnership. However, both public- and private-sector partners inadequately account for and minimize the costs and risks of partnership. Similarly, partners discount the need for brokers and third-party actors to manage research collaborations and reduce competition between sectors. Finally, partners are operating without sufficient information on existing partnership experiences, lessons, and models, potentially contributing to a persistent or widening gap between sectors.

Forsth (2005) contributed to debates about climate change policy and technology transfer by analysing the success factors underlying collaboration between private companies and communities in developing countries. To date, much attention to capacity building for enabling environments — including public–private collaboration — under the climate change convention has focused on state-led initiatives and on the innovation and development of technologies. The study, instead, focuses on how private-sector investors and host communities may collaborate in the diffusion of technologies, by reducing the costs of technology transfer, and making technology more appropriate to developing countries. The article describes cases of collaboration concerning waste management and waste-to-energy in Thailand and the Philippines. The study argues that successful public–private partnerships between investors and communities depends on minimizing transaction costs, strengthening collaborative (or assurance) mechanisms, and in maximizing public trust and accountability of partnerships. Lessons are then drawn for enhancing capacity building for technology transfer under the climate change convention and applications such as the Clean Development Mechanism.
Al-Jayyousi (2003) analysed the transformations in water management after the introduction of public-private partnership using metaphors from ecology. Scenarios for water management were developed and assessed based on financial viability and political feasibility. The results of the scenarios indicated reduced government role and supportive financial environment, is likely to take place in the future. However, the authors warned against the corruptions and insist on practicing in more transparent environments.

Swonson (2003) has developed a framework that identifies the comparative strengths of public, private and nongovernmental organisations in carrying out different types technology transfer, human resources, and social capital development programs in developing countries. Figure 13 depictive the conceptual framework for public, private and NGO partnership. The framework has been developed on the facts that countries have limited resources available to invest in public sector. The main task of the public system should be human resources development that can equip stakeholders to solve their own problems and respond to new opportunities.

Based on the conceptual framework it is recommended that strengthening national extension system for 21st century policies and resources should reflect the comparative strengths of public extension, private fir, and NGOs. This could be most effective way to deliver different programs and services.

Zhang (2005) provided criteria for selecting the private-sector partner in public–private partnerships. A critical issue in public–private partnerships PPPs in international infrastructure development is the selection of the right private-sector partner. These identified criteria, which were based on rigours statistical analysis, were classified into four evaluation packages for PPP projects in general: financial, technical, safety, health, and environmental, and managerial.
France has achieved a high level of private involvement in the water sector. At the national level, the French Government is responsible for setting water quality standards, rules for tendering and competition laws and access rules where as at local levels over 37,000 municipalities or communes are responsible for water and wastewater services for setting prices and making decisions regarding the operation of the systems (Department of Prime Minister and Cabinet, 2006). There are three main types of contracts, plus a number of hybrid relationships that French municipalities use to manage private sector involvement in the water sector. However, hybrid intermediary forms of relationships are growing over time. The main difference between all of these contracts is the allocation of risks and responsibilities and the duration of the arrangements. All of these contracts allow a new entrant to manage but not own the assets.
In addition, lessons have been learned from some failed PPP projects, such as the two BOT transportation projects in Thailand (Ogunlana, 1997) and the failure of Malaysia’s privatized national sewerage project (Abdul-Aziz, 2001). The failure of this sewerage project was due to a number of reasons: the lack of competition and transparency in the selection of the concessionaire, low equity–debt ratio, over-generous “safety nets” extended to the concessionaire by the government, inefficiencies and management blunders of the concessionaire, frequent change of ownership of the concession company in a short period, and strong public opposition.

World Bank (2006) has conducted detailed investigation on underlying policy problems in water services and the challenge of getting private participation to work in various countries. It has also proposed models of private participation – management contracts, affermage-leases, concessions and divestitures, joint ownership (Figure 14). According to the World Bank, major challenges are the provider the ability and incentives to make good operating and investment decisions. This means giving the provider enough freedom to make decisions and exposing it to the related business risks, so that it gains when getting decisions right and loses when getting them wrong and protecting the operators from the risk of losing from the government changing the rules of the game rather than from bad operating and investment decisions.
In 1994, the World Bank started reforms for the provision of infrastructure services through the involvements of public sector (World Development Report, 1994). The World Bank advocates three measures: the wider application of commercial principles to service providers, the broader use of competition, and the increased involvement of users where commercial competitive behaviour is constrained. The Bank set out a menu of four options (i) public ownership and operation by enterprise or department, (ii) public ownership with operation contracted to the private sector, (iii) private ownership and operation often with regulation, and (iv) community and user provision. However, financing remains the cruel elements of all the options. Jimenez (1994) stressed on crafting more diverse policies about the public private balance in infrastructure
investment, depending on the nature of "public goods" characteristics for various types of infrastructure services, or even across activities for the same service (for example, power transmission versus distribution).

Zhang (2005) and Blackwell (2000) listed the evaluation criteria used in PFI projects in the United Kingdom. They include innovation, compatibility with operational approach, deliverability, flexibility, and risk transfer. The assessment areas depend on the nature of the project, which may include: risk transfer, planning/site considerations, design, redundant premises, consequential risk, occupancy risk, development risk, program, accommodation requirements, facilities management, alternative revenue streams, contract framework, and consortium structure.

The World Bank has provided reasons why many partnered infrastructure projects have been held-up: wide gaps between public and private sector expectations, lack of clear government objectives and commitment, complex decision making, poorly defined sector policies, inadequate legal/regulatory frameworks, poor risk management, low credibility of government policies, inadequate domestic capital markets, lack of mechanisms to attract long-term finance from private sources at affordable rates, poor transparency, and lack of competition (Asian Business, 1996).
6. Business Models for RIBPs

Irrigation is first and foremost a business. Therefore, the interaction between it and its natural resource base needs to be undertaken within a business context to deliver sustainable improvements in economic, social and environmental water productivity. The research outputs from the System Harmonisation program run the risk of delivering only dry academic tomes if not utilised in a meaningful fashion. Therefore, the strict relationship between the System Harmonisation program and the development of a business plan for improved water management within a particular area and its subsequent implementation by RIBPs in the region are crucial. Investment in regional partnerships and processes are required to realise and value environmental and social dividends. Without this, on and off farm investments in single purpose water productivity improvement will struggle to produce an adequate return-on-investment. This requires policy and institutional arrangements which the support of partnerships aimed at new businesses delivering true “Multi Purpose Water Productivity Gains”.

To effectively seize the business opportunities, by attracting new investments and guiding them in to successful regional businesses, a RIBP business model is proposed. The aim of the RIBP business model is to assist in optimising the potential of investment opportunities in a way that facilitates environmentally sustainable development. The core of the RIBP business investment model is its crucial links with stakeholder, research and policy aspects. It is centred on an appreciation of the biophysical, and socio-economic, policy and legal assessments — System Harmonisation. In this arrangement, the role of the RIBP is to provide a vehicle which directly links regional business opportunities with more sustainable natural resource management.

6.1 Regional Irrigation Business Partnership Business Model

The Irrigation Industry’s key challenge is to increase water productivity for all purposes in order to attract an ongoing flow of capital that supports coordinated investment in on-farm and off-farm infrastructure. Without this the environmental management of working
rivers, the social-cultural diversity of many regional areas, and a substantial component of our national economy are at risk.

Like any feasibility study successful execution occurs when a business entity has been established to meet the market demand in a profitable and sustainable fashion. Ultimately the success of the project is best evaluated by the liquidity of this entity and the growth in shareholder value. As mentioned in the five way System Harmonisation implementation framework, a key feature is to create a business model which manages to convert the largely public good nature of individually positive actions into a collective output which can be privately implemented and traded. A critical issue in regional irrigation business partnership is the development of right business model capable of selecting right business opportunities, which can be successfully translated into successful public-private business investment partnership.

The aim of the study is to develop RIBP business model capable of efficiently utilising research outputs and government policies in a harmonised way for sustainable public-private business planning and investment. Particularly,

- To review a range of alternative business planning processes and investment experiences used nationally and internationally.
- To understand the nature of a business planning process that best supports effective investment in the Australian irrigation industry?
- The development of a public-private business investment framework that applies across a wide range of irrigation system and their surrounding landscape
- To propose and assist manage business planning in order to maximise shareholder value
Unlike the other public-private partnership models where sound feasibility information is an important ingredient in determining investment priorities, the RIBP business model is based on robust assessment of bio-physical, hydrology, socio-economic, policy and legal aspects of water management. This business model is based on a sound knowledge of the hydrologic cycle, land use trends, community profile, and the need to enable improved viability of irrigation farms and to service environmental needs. Further, the development of RIBPs provides a crucial links between the research outcomes and investors to target risk free and potentially viable investment opportunities.

The proposed RIPB business model provides revamped institutional and business arrangements together with innovative models and tools to support the investments required by the Irrigation Industry to meet both industry and community commercial and environmental water productivity targets. The model combines together the “Research and Policy” and “Business Investment” frameworks, where both frameworks interact with each other to guide research and investment opportunities (Figure 15).

**Research and Policy Framework**

The first three boxes of System Harmonization play a key role in research and policy framework (see Figure 15). System Harmonisation aims to develop a better understanding of the water asset and its multiple values at a catchment scale and to implement practices that return economic, social and environmental benefits to the region through improved cross organizational communication. The research and policy framework is based on continuous iterative feedback with System Harmonisation program, government policies, key stakeholders, and RIBPs.

The research priorities for each regional irrigation business area under System Harmonisation program are determined after the consultations with the stakeholders such as irrigators, regional business and other partners and government policies such as National Water Initiatives (NWI), Prime Ministers $10Billion irrigation modernisation package. Based on extensive research on water cycle management, markets and productivity, and institutional and policy frameworks System Harmonisation research
program will help to identify opportunities such as on farm and off farm system level investment opportunities in water saving and new crop pattern for better use irrigation water, improved yield productivity, and improved ecosystem services. The RIBP will positively connect these opportunities and turn them into successful business partnerships to ensure better irrigation, a better environment and a better future.

**Business Investment Framework**

Regional Irrigation Business Partners are the centre for business investment framework. Business investment framework involves iterative feedback from research and policy framework, especially from the System Harmonisation program outputs. Having identified the market, defined the product and established a legislatively and institutionally acceptable route to market
Figure 15  Regional Irrigation Business Partnership’s Business Model
the feasibility process begins in earnest. The role of RIBP in business investment framework is to develop expertise with the assistance of System Harmonisation program in business marketing and management skills to attract new business and investment plans, and compete independently or develop partnerships.

The involvement of the private sector in water is dependent on, amongst other matters, the ability to make commercial returns in the target market. A key feature for attracting new investments and business requires demonstration of sound criteria for investment and their relevance. The relevant criteria include (i) sound economical and financial analysis such as internal rate of returns, net present values, breakeven analysis and payback periods, (ii) sound technical analysis such as quantification of water saving, appropriate on farm and off technology, and hot spots for interventions, (iii) environmental and social assessment such as changes in the environmental quantity and quality, community preferences, and protection of flora and fauna. The System Harmonisation research sub projects – water cycle management, markets and productivity, and institutional and policy frameworks – would provide the above mentioned evaluation criteria.

The role main of RIBP, as describe under the section 2, is to covert the new opportunities, identifying barriers to new industries/businesses starting up in regional areas, into successful business by attracting new regional business partners. Figure 9 present the business investment framework where RIPB and its local stakeholders, private investors and government investment and supports could potentially develop public private partnerships. The local stakeholders and established industries could potentially take the opportunities more profitable and sustainable business or other business such as could irrigation water supply businesses, identified water investors (e.g. Pratt Water), financiers and merchant banking organisations and infrastructure developers and construction firms (e.g. Leighton’s contractors) potentially utilise these opportunities to establish new business. In case, where priorities and net benefits are high but require considerable investments, State and Local Governments instrumentalities such as treasury, business development, and natural resource management departments can become regional business partners.
Although the System Harmonisation program provides robust scientific information about new business opportunities, which reduces the likelihood of serious risk and uncertainty associated with the investment, allocation of risk between public and private sector partnership remains crucial for successful business partnerships. The risks inherent with a capital-intensive water sector are compounded by other financial, regulatory, and political risks, some of which are particularly challenging. According to Quiggin (2005) and Davis (2005), a key requirement for a successful business partnership is the allocation of the risks between public and private sector partnership the according to each party’s ability to manage and bear them, without destroying the economic incentives.

It is clear that the irrigation project business planning processes will be largely controlled RIPB and the ultimate investors. The central of attention of this business model is the optimally desirable transfer of risk between the investors. The proposed business model is instigated on the belief that sharing risk, rewards, and responsibility coupled with sufficient investment incentives provide sufficient motivations for various key players in water management to invest in infrastructure and water saving irrigation technologies.
7. Conclusion and Recommendations

The System Harmonisation™ framework involves five feasibility steps, which aim to establish Regional Irrigation Business Partnerships (RIBPs) to capture production and environmental gains from research improving regional irrigation systems management. The purpose of this report is to propose a RIBP business model capable of effectively utilising research outputs and government policies in a harmonised way for sustainable public-private business planning and investment.

The review and lessons learnt from the past national and international experience in public-private partnership has showed mixed results. The main reasons for such mixed results are lack of long run commitment from the governments and other parties involved and lack of scientific understanding regarding short and long run of the potential biophysical and socio-economic, policy and legal consequences.

The propose RIBP business framework is based on better understanding of bio-physical, hydrology, socio-economic, policy and legal aspects of water management. The crucial links between System Harmonisation Program and Regional Irrigation Business Partners (RIBP), for business planning processes associated with investment opportunities, are best coordinated and managed under a necessarily iterative process. While the System Harmonisation program provides robust scientific information regarding new business opportunities, which reduces the likelihood of serious risk and uncertainly associated with the investment, spreading risk, responsibility and reward allows business partners to optimal share the risk. The generic business model could be effectively used in all 4 regional irrigation areas investigated under System Harmonisation™ Program.
References


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Partner Organisations

CHARLES STURT UNIVERSITY

GOULBURN-MURRAY WATER

CSIRO

Australian Government
Land & Water Australia

NSW Government
Industry & Investment

Queensland Government

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