Report No. 99

# INSTITUTIONAL ARRANGEMENTS IN THE SHEPPARTON IRRIGATION REGION VICTORIA, AUSTRALIA



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April 2000
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# FOREWORD

Socioeconomic development and poverty alleviation in many developing countries depend on water. Governments and Development Agencies recognized this issue and, invested heavily on water resources development projects during the Twentieth Century. Presently, opportunities for further water resources development are limited, either due to the absence of water or due to lack of financial resources. The demand for food is continuously increasing due to a steady rise in population. Irrigated agriculture, which consumes 69% of all freshwater resources, and produces 40% of all food, will require additional 17% water to meet the demand for food. This water is not available from primary sources (rain, snow melt, groundwater). Further, freshwater consumption in irrigated agriculture decreased to meet increasing demand of freshwater for domestic and industrial requirements. Therefore, water from all primary as well as secondary sources (drainage, sewage) will be used conjunctively in agriculture. The conjunctive water use has its implications as evaporation and transpiration of water will concentrate salts and pollutants and threaten environmental sustainability of agricultural lands. Proper institutional and technical strategies must be in place to manage water conjunctively to minimize threat to the environment. This study aims to address this concern.

The broad goals of the study are to, 'Identify *combinations* of institutions and technical strategies to manage surface and groundwater at regional scale, to promote environmental sustainability and to maximize agricultural productivity of water ('crop per drop'), initially in the Rechna Doab in Pakistan and Murrumbidgee Region in Australia'. This report reviews conjunctive water management issues in the Shepparton Irrigation Region, Victoria, Australia.

The study is being carried out by IWMI in collaboration with Pakistan Council of Research Water Resources (PCRWR), and CSIRO Land and Water, Griffith, NSW, Australia. The study is financially is sponsored by the Australian Council of International Agriculture Research, Australia.

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# 1 INTRODUCTION

The selected area for review in Australia is the Shepparton Irrigation Region (SIR) located in northern Victoria at the confluence of the Goulburn and the Broken rivers, Figure 1. This region is part of the Murray-Darling Basin system. It is one of the largest regions in Australia both in area irrigated and water used.

**Figure 1. Locality map for the Shepparton Irrigation Region**


The SIR has an average annual rainfall of about 500mm. The rainfall is highly variable ranging ± 180mm. Annual evaporation averages 1,350mm/yr and exceeds rainfall for nine months of the year. Irrigation is therefore essential for summer crops and is desirable for autumn and spring growing crops. Surface water supplies are held in major storages on the Goulburn and Campaspe rivers. These supply in excess 1,200,000 ML annually. The SIR totals 430,000 ha suitable for irrigation of which about 280,000 ha is irrigated in any year. Pasture production for dairying occupies 88% of the area.

The main problem for agricultural sustainability in the region is waterlogging and soil salinisation. Prior to irrigation, watertables in the SIR were some 25 metres below the surface. Now they are typically within 2 metres. The impact of waterlogging and salinisation is non-uniform over the landscape depending upon the landform, which affects soil type and natural drainage conditions. The solution to waterlogging and salinity problems includes the development of a surface drainage network, tile drains for horticulture and shallow groundwater pumping for pasture and horticulture. Water from groundwater pumping is disposed of if of low quality or used conjunctively with surface water if of good quality.

There are varied organizations that have jurisdiction or influence in the allocation and use of water resources in the SIR. These organisations are local community groups, Rural Water Authority (irrigation water provider), Catchment Management Authority and State Government. Also, since the SIR is within the Murray Darling Basin it is influenced by the policies of the Murray Darling Basin Commission, which is a multistate, Federal Government Organization.

The main controlling body of the SIR is the Catchment Management Authority, which controls the implementation of the SIR Land and Water Salinity Management Plan (SIRLSWP), a key policy instrument for the region. The SIRLWSMP was developed by the State with the local community in 1990 to halt the spread of waterlogging and salinity and ensure the long-term sustainability of the region. A key part of this plan is the use of shallow groundwater pumping to control soil salinisation. This groundwater if of acceptable quality is mixed with surface irrigation water for reuse either on-farm or through the main supply network. This conjunctive water use of surface and groundwater provides the opportunity for the analysis of the institutions involved in conjunctive water management.

The chapter 2 and 3 of the report describe the biophysical and socioeconomic environment of the SIR. The context of how irrigation water is used, economic returns and the ensuing problems of high watertables and soil salinisation form part of chapter 2 and 3. Chapter 4 describes the institutional arrangements for water management in the region, including State level and supra State level influences. The two key policy instruments that guide conjunctive water use in the region, the SIRLWSMP and the Groundwater Supply Protection Management Plan (GSPMP), are described in some detail in chapter 5.

An analysis of the implementation of conjunctive water use in the context of the SIRLWSMP and GSPMP is presented in chapter 6. This includes the resulting biophysical and socioeconomic conditions and issues of concern for future sustainability and equity of groundwater pumping. In light of these findings the institutional arrangements used for water management in general and implementation of the SIRLWSMP in particular are analysed in chapter 7.

The analysis is followed by a general discussion of conjunctive water management in the context of irrigation induced salinity control in chapter 8, followed by a short summary of the key elements required for effective conjunctive water management in the SIR.

# 2 THE BIOPHYSICAL ENVIRONMENT

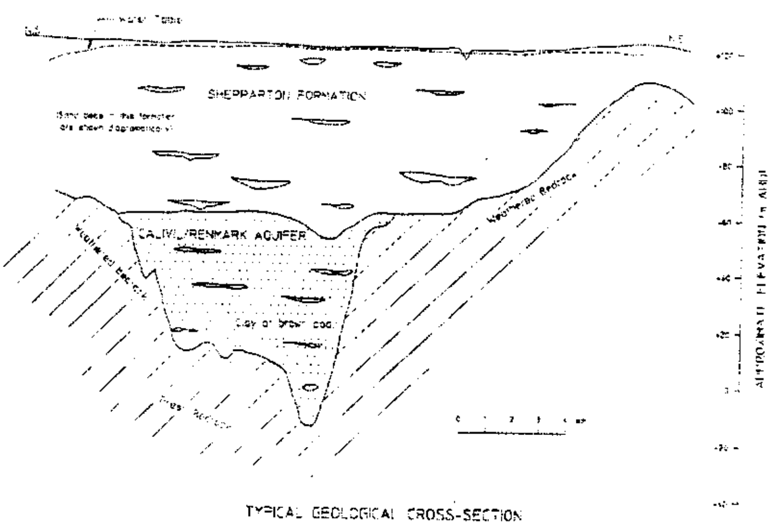
The SIR is a large area with diverse land use and management. The size of properties and water use varies widely. The impact of waterlogging and salinisation is non-uniform over the landscape depending upon the landform, which affects soil type and natural drainage conditions. The solutions to waterlogging and salinity problems include the development of a surface drainage network, tile drains for horticulture and shallow groundwater pumping for pasture and horticulture. Water from groundwater pumping is disposed of if of low quality or used conjunctively with surface water if of good quality.

## 2.1 Hydrogeology

The riverine plains of the Shepparton region are alluvial deposits having a comparatively flat surface and a general northwesterly slope of 1:2,500.

The depth of the alluvium above the bedrock varies, typically ranging from 20 to 120 metres. The alluvial deposits are divided into three principal geological units: The Renmark Group, Calivil Formation and Shepparton Formation, Figure 2.

**Figure 2. Typical geological profile for the Shepparton Irrigation Region. [10]**




The Renmark Group and the Calivil Formation, which are often considered as one hydrogeological unit, consist of unconsolidated gravels and sands which lie on weathered pre-Cenozoic basement rock. These sediments were deposited during the Tertiary Period along broad valleys by rivers flowing from the highlands onto the plain. The Renmark Group/Calivil Formation form three major aquifers that generally follow the course of today's Murray, Goulburn and Campaspe Rivers and are commonly referred to as the 'Deep Leads'. These aquifers broaden towards the north and west and merge to form a continuous sheet under most of the southeastern Murray Basin.

Pressures in the deep lead system are rising. These rises are believed to be due to a combination of increased inflows from upstream areas, local recharge within the region and rising groundwater pressures in the regional discharge zones to the north and west. Since the 1982/83 drought there has been a significant increase in Deep Lead groundwater extraction for irrigation mainly in the

Campaspe Valley and the eastern Murray Valley. This increase has by and large stabilized deep pressures over large sections of the region and, in the process, helped to maintain or improve deep drainage. Significant rising pressure trends, probably accentuated by the wet climatic effects of recent years, are still being recorded in areas more distant from pumping, such as between Numurkah, Tallygaroopna and Bamawm.

The Shepparton Formation overlies the Calivil/Renmark aquifer and forms the uppermost geological formation over most of the region and is usually 80 to 100m thick. The Shepparton Formation consists predominantly of alluvial silts and clays interspersed with meandering channels of sand and gravels up to 5 m thick that are often discontinuous. The aquifers of sand and gravel are locally capable of supplying significant quantities of water. However, due to the highly variable lithology of the Shepparton formation, the occurrence of good quality groundwater available in useful quantities is highly irregular, Table 1.

**Table 1. Water yield and quality. [2]**

| | Aquifer | Yield | Salinity | Remarks |
|---|---|---|---|---|
| Shallow aquifers | Murray Valley | 1.5-4 ML/d | 0.5- 4 dS/m | These are the highest yielding aquifers |
| | Goulburn Valley | 1-2 ML/d | 1– 20 dS/m | Many and varied aquifers |
| | Campaspe Valley | 1 ML/d | 1 – 20 dS/m | Aquifers are not transmissive |
| | | | | Aquifers are extensive to the north |
| Deep leads | Goulburn Valley | | < 3.3 dS/m in south, increasing to over 5 dS/m in north and north-west | Salinity increases down gradient away from historical recharge areas |
| | Corop Basin | | >20 dS/m | Some recharge occurs by leakage from the semi-confining Shepparton Formation |

Evidence so far is that only a small part of the local recharge finds its way by deep seepage to the deeper aquifers. Most of the local recharge is dissipated from the shallow watertable and by groundwater discharges associated with flows in the shallow aquifers. However, continuing rises in the deep aquifer pressures would exacerbate the problems in management of the shallow watertables by reducing the deep drainage occurring. This would increase the volumes and salt loads, which need to be pumped from the shallow aquifers.

For the groundwater management plan (Section 5.2.2), aquifers that are wholly or in part within 25 m of the surface are defined as ‘shallow aquifers’ and aquifers at greater depth than that are defined as ‘deep aquifers’ [2].

## 2.2 Current Land and Water Use

### *2.2.1 Land use*

The SIR totals about 500,000 ha with some 487,000 ha of farm holdings. Of this, 430,000 ha is suitable for irrigation and about 280,000 ha is irrigated in one year. Of the irrigated area, the largest proportion is used for pasture production for dairying (88%). A small proportion is used for perennial horticulture crops high in value (3%) such as grapes, stone fruit and pommes. The remainder of the area is used for grain crops, seed crops, lucerne, forage crops and vegetables (8%).

Of the 7,300 farms in the Region, 3,600 are mixed farms (livestock and cropping), 3,100 are dairy farms and 650 are perennial horticulture farms.

The latest survey of production by sub-region is shown in Table 2. An average farm has 81ha in total of which 54 ha is perennial pasture (67%), 21 ha annual pasture (26%), 4 ha dry-land (5%) and 2 ha crop (2%). The mean herd size is 156 cows (a median of 135 cows) or 2.5 cows/ ha [1].

**Table 2. Number of farms and estimated production from agriculture in the Shepparton Irrigation Region - 1996. [1]**

| **Sub region** | **Central Goulburn**[1] | | **Rochester** | | **Shepparton** | | **Murray Valley** | |
|---|---|---|---|---|---|---|---|---|
| **Enterprise** | No. | Production | No. | Production | No. | Production | No. | Production |
| Cereals (tonnes) | 46 | 4,106 | 105 | 21,534 | 65 | 7,474 | 153 | 18,622 |
| Oilseeds (tonnes) | 7 | 509 | 11 | 814 | 7 | 698 | 19 | 2,061 |
| Tomatoes (tonnes) | 34 | 24,708 | 20 | 58,610 | 6 | 515 | 1 | 5 |
| Orchards (tonnes) | 255 | 87,171 | 3 | 14 | 483 | 83,658 | 185 | 32,709 |
| Dairy cattle (No.) | 824 | 161,941 | 324 | 62,629 | 279 | 45,520 | 538 | 107,061 |
| Meat cattle (No.) | 712 | 49,694 | 350 | 30,710 | 329 | 25,262 | 525 | 39,692 |
| Sheep & lamb (No.) | 87 | 60,416 | 123 | 80,061 | 84 | 52,842 | 154 | 90,202 |
| Pigs (No.) | 22 | 21,087 | 16 | 6,489 | 7 | 4,653 | 23 | 13,998 |

### *2.2.2 Irrigation methods*

A complex channel system exists to distribute the water from the dams located in the highlands. The system is more than 100 years old and has expanded as additional water has been stored and made available. Most irrigation is carried out by flood irrigation using border check systems. There are also small areas of furrow and pressurized irrigation, Table 3. Irrigation of pasture has an average interval of 8 days with a range of 6-18 days [19]. There is limited use of formal irrigation scheduling and most farmers rely upon their experience and a time based interval.

**Table 3. Irrigation systems in the Shepparton Irrigation Region in the 1992/1993 season. [19]**

| System | Area (ha) | Area (%) |
|---|---|---|
| Border check | 214,956 | 97.4 |
| Furrow | 2,338 | 1.0 |
| Moving irrigator | 132 | 0.1 |
| Over tree sprinkler | 211 | 0.1 |
| Under tree sprinkler | 1,001 | 0.4 |
| Micro/drip | 2,339 | 1.0 |
| Total | 220,617 | 100 |

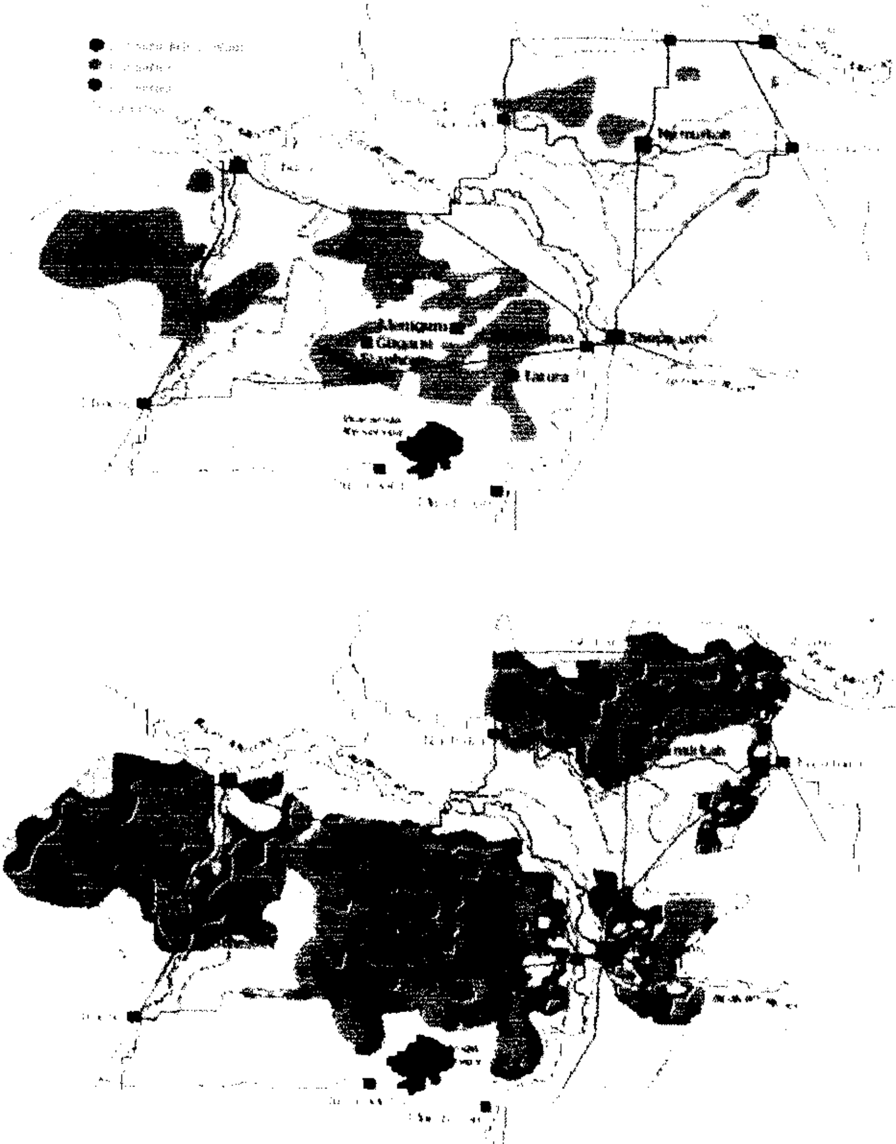
[1] Rodney and Tongala

The irrigation season officially opens on August 15 and closes on May 15. Dry weather conditions may extend the season either by an early start or late finish in some years.

### *2.2.3 Watertables*

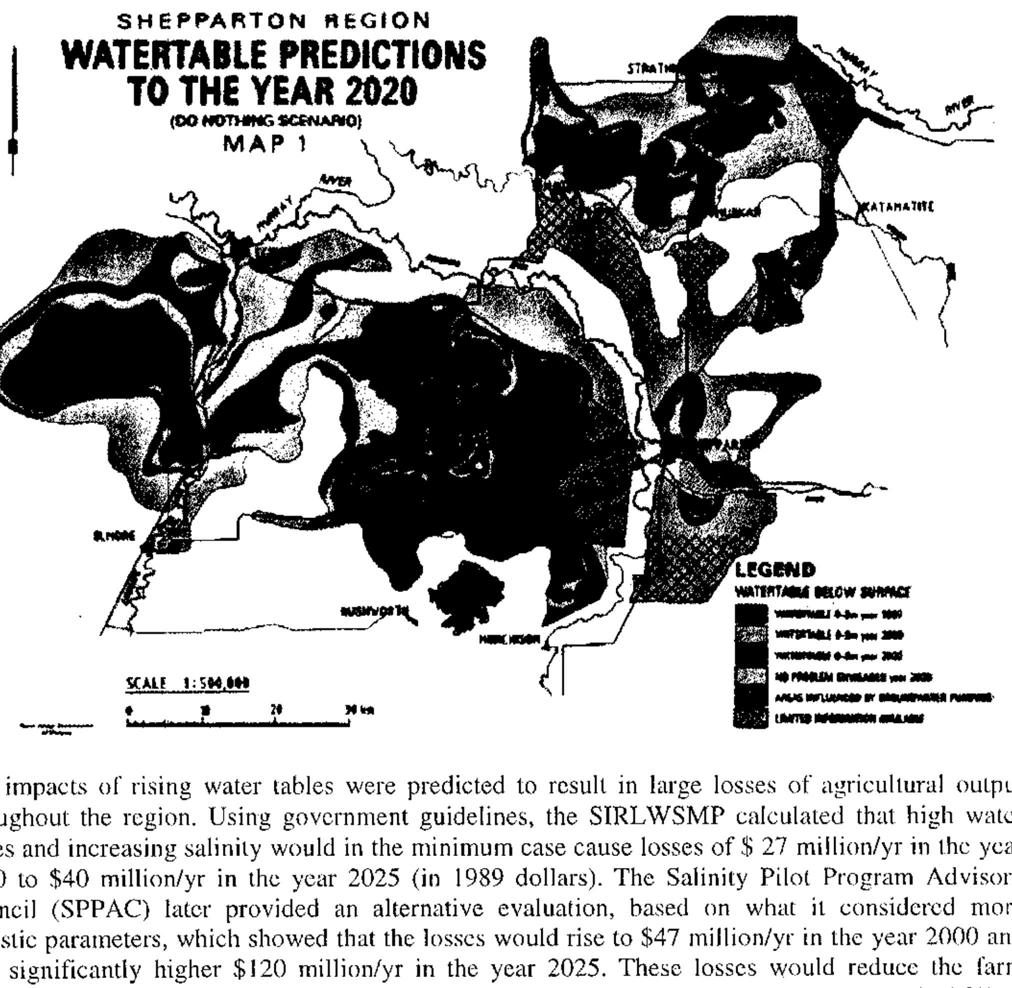
Prior to irrigation, watertables in the Shepparton Region were some 25 metres below the surface. In the consecutive high rainfall years 1973, 1974 and 1975, watertables rose to within 2 m from the surface [14]. Now they are typically within 2 metres. Their rapid rise has been described as 'The Underground Flood'. Figure 3 shows the situation in the Shepparton irrigation area in 1982 and 1990 [15]. Although seasonal variations impact on the watertable, is rising steadily. In 1997, the long-term watertable trend for the region was still upward [16] and 45% of the area had watertables within 2 m of the surface [17] compared to 33% in 1988 [10].

**Figure 3. Watertables in 1982 and 1990. [15]**



Predictions are that watertables will continue to rise. The area within 2m of the soil surface was about 160,000ha in 1989, this is predicted to increase to an estimated 218,000ha in the year 2000 and 247,000ha in the year 2025, Figure 4. This would have serious impact upon the productivity of the region. To combat this, the Shepparton Irrigation Region Land and Water Salinity Management Strategic Plan (SIRLWSMP) was developed in the late 1980's and had Government endorsement for implementation in the 1990's. A key part of this plan has been to encourage shallow groundwater pumping to control watertables. See section 5.1.

**Figure 4. Predicted watertables for 2020. [18]**




The impacts of rising water tables were predicted to result in large losses of agricultural output throughout the region. Using government guidelines, the SIRLWSMP calculated that high water tables and increasing salinity would in the minimum case cause losses of $ 27 million/yr in the year 2000 to $40 million/yr in the year 2025 (in 1989 dollars). The Salinity Pilot Program Advisory Council (SPPAC) later provided an alternative evaluation, based on what it considered more realistic parameters, which showed that the losses would rise to $47 million/yr in the year 2000 and to a significantly higher $120 million/yr in the year 2025. These losses would reduce the farm weekly earnings from 94% of the average in 1989 to 58% of the average in 2000 and only 26% of average in 2025. Job losses were predicted to be 1600 by the year 2000 and 3500 by the year 2025.

### *2.2.4 Water use, quality and prices*

Water right available per irrigated hectare averages 3.57 ML/ha with a high of 3.97 in Tongala Irrigation Area and a low of 3.33 in the Rochester Irrigation Area. Average actual application rate of surface water supplies is around 5.5 ML/irrigated ha/yr or about 3.5 ML/ha/yr of land commanded. Total deliveries to the region average about 1,400,000 ML/yr. Before the 1990's most irrigation was surface irrigation and some deep lead pumping. However, after implementation of the SIRLWSMP shallow groundwater pumping has become extensive. Farmers have mainly adopted groundwater pumping as an additional water source for irrigation although the overall aim is salinity control.

There are some 1,100 licensed bores in the region with allocations in excess of 2,600,000 ML annually. Most of this (75%) is allocated against the Upper Shepparton Formation (shallow aquifer), principally the Murray Valley and the Tongala/Kyabram areas. These allocations from the shallow aquifers have been part of the SIRLWSMP to control soil salinisation.

The lower Shepparton Formation (deep aquifer) has limited development across the region, accounting for 2% of licensed groundwater usage. Licensed extraction from the Calivil/Renmark aquifer (deep lead) is 53,500 ML or 23% of total groundwater allocation, with the majority of that volume accounted for in the Campaspe Valley. Groundwater from the deep lead has historically been allocated purely as an irrigation resource. It is considered that the connection between the deep lead aquifer and shallow surface aquifers is not sufficiently well developed to assist in soil salinity control.

The total groundwater allocation is about 18% of the surface water allocation. Various surveys suggest that average irrigation usage is 20 to 50% of allocation but usage increases markedly in dry years. It is estimated to be about 45,000 ML/yr or 3.75% of the surface water application. Table 4 shows the licensed groundwater extractions for 1997. The reuse of surface drainage water is significant, totaling about 77,500 ML/yr or 6.5% of the surface water allocation. This occurs in about 52% of the area with groundwater extraction.

**Table 4. Licensed groundwater extractions 1997. [2]**

| Use | ML/yr |
|---|---|
| Irrigation | 256,000 |
| Dewatering | 800 |
| Dairy-washing | 370 |
| Urban | 530 |
| Others | 3,080 |

The typical annual water use for various crops in the region is shown in Table 5. Perennial pasture is the dominant crop and requires about 10ML/ha/yr. Due to the long growing season of pasture and the lack of surface water supplies in late autumn, winter and early spring groundwater is especially useful for irrigation at these times.

**Table 5. Annual water use for the major crops. [3]**

| Crop | Water requirement (ML/ha) |
|---|---|
| Perennial pasture | 10 |
| Annual pasture | 4 |
| Lucerne | 10 |
| Fruit trees | 7 |
| Eucalyptus | 10 |

The quality of surface water is very good, in the order of 0.05-0.13 dS/m, as it originates from the alpine areas of eastern Victoria. The groundwater quality is not as good and highly variable, 0.8 dS/m being typical of the best quality, generally being around 2 dS/m, but ranging to in excess of 15 dS/m. Low salinity occurs in the shallow aquifers beneath heavily irrigated light soils. High salinity commonly occurs in deeper aquifers, which have not been flushed by rainfall or irrigation. The poor quality of groundwater requires mixing with the fresher surface water before use. Generally on-farm use of groundwater is restricted to groundwater with salinity less than 3 dS/m. Groundwater more saline than this is only pumped for salinity control and is disposed of into surface irrigation supply channels or directly into surface drains which flow to the river system as part of the SIRLWSMP.

The cost of surface water in the SIR is $20.71/ML, measured volumetrically at the farm gate. Currently surface water can be traded for $275/ML as a permanent transfer, this varies between seasons, but the value is increasing steadily. The costs of temporary transfers vary widely between seasons and within seasons, from over $100/ML to less than $5/ML.

Groundwater is charged at an annual allocated fee of $1.34/ML. Currently usage is not metered and as such there are no usage fees. It is estimated that the electricity cost of pumping groundwater in 1986 was about $6/ML. The installation of groundwater pumps is of the order of $50 – 60,000 depending upon site factors. At present the trading of groundwater is not possible. Table 6 summarizes water usage cost and quality in the SIR.

### 2.2.5 *Water security*

On the Goulburn River system (supplying the Shepparton area) 100% or more of water right and license volume will be supplied in 97 years out of 100. The lowest seasonal allocation in the last 100 years would be about 75% of water right and license volume. Very low seasonal allocations only occur at the end of drought sequences lasting a few years. High seasonal allocations (around 200%) would occur in 60 out of 100 years [4].

**Table 6. Water use, cost and quality**

| Water usage and quality | Surface water | Ref. | Groundwater | Ref. | Drainage water | Ref. |
|---|---|---|---|---|---|---|
| Total use (ML/yr) | 1,200,000 | 8 | 45,000 | 2 | 77,500 | 8 |
| Use per unit area, average (ML/ha) | 3.57 | 10 | 2.16 (License) | | | |
| Water quality (dS/m) | 0.05-0.13 | 8, 9 | 0.8-15 | 2 | 200-1,200 | 8,9 |
| **Water costs** | | | | | | |
| Volumetric cost ($/ML) | 20.71 | 4 | Private: 20$/ML<br>Public 3,800$/yr = 100 ML | 11 | | |
| Licensing costs | | | *Irrigation bores*:<br>$223.10 per bore + $1.34 per ML allocated<br><br>*Other bores*:<br>$111.55 per bore plus $1.34 per ML allocated | 9 | *Surface drainage*:<br>Service fee: $92.40, Area fee $4.6269/ha,<br>Volumetric fee $ 2.7419/ML<br>*Sub-surface drainage*:<br>Service fee: $0.2096/ML used,<br>Area fee $2.8003/ha,<br>Volumetric fee $0.4830/ML | 8, prices for 1998/99 |
| Operation and maintenance costs | | | Electricity costs $6/ML | 10 | *For whole SIR*:<br>Surface 6.18 M$<br>Sub-surface 37.15 M$ | 11 |
| Installation costs | | | Private: ~$57,000<br>Public ~$113,000<br>Evaporation basin ~$34,000 | 11 | *For whole SIR*:<br>Surface: 44.97 M$<br>Sub-surface: 35.38 M$ | 11 |
| Water transfer costs | ~$275- permanent<br>~$90- temporary<br>$310 property amalgamation | 4 | Not possible | | Not possible | |

# 3 SOCIOECONOMIC ENVIRONMENT

The SIR has a fairly good economic environment with the dairy industry and horticulture performing reasonably well in the agricultural context. Water availability is key to productivity. Surface water supplies are generally reliable and farms have generally invested capital to use all their available water. Augmenting water supplies with groundwater is attractive and water trading is becoming more active. There are considerable challenges to the region with small farms struggling to survive and an aging farming population.

## 3.1 Regional Level

The SIR economy is substantially based on the agricultural sector. Agriculture is predominantly large-scale production of dairy, fruit and vegetables for fresh market and processing, cattle, pigs and poultry products. Cereal crops and sheep are also significant but much less than in adjacent non-irrigated regions. A large proportion of agricultural production is processed within the region prior to export. These processing activities dominate manufacturing in the region and contribute most to manufacturing exports.

Directly, irrigated agriculture contributes approximately 24% of gross regional product (value added) ($488.5 million) and 24.3% of regional employment (10,300 jobs). When indirect effects are accounted for, the contribution of the industry is almost 45 % of gross regional product ($912 million) and over 43% of regional employment (over 18,300 jobs) [20].

Less than 5% of the people over 15 years of age have tertiary qualifications, while some 70% of this group have no formal qualification [21].

## 3.2 Farm Level

Most properties in the catchment are smaller holdings and approximately 80% of the farms have been classified as sub-economic [22], Table 7. The properties defined as sub-economic are limited primarily by total farm size and available irrigation allocation.

**Table 7. Distribution of property sizes and economic viability in the Goulburn Broken catchment, 1995/1996. [22]**

| Enterprise | Total number of properties | Number of sub-economic properties | Percentage of sub economic properties |
|---|---|---|---|
| Irrigated dairy | 2,206 | 1,192 (<50 ha, 246ML) | 54 |
| Horticulture | 437 | 298 (<20 ha, 77ML) | 68 |
| Irrigated other | 2,975 | 2,724 (<150 ha, 277ML) | 91 |

The true farm household financial picture is much better in many cases as off-farm employment is available. Average whole farm income is $223,000 [19]. Household incomes within the Shepparton Region are significantly lower than the state of Victoria as a whole, Table 8.

**Table 8. Incomes in the SIR compared to incomes in Melbourne. [10]**

| Region | Lower quartile | Median | Upper Quartile |
|---|---|---|---|
| Shepparton | $12,000 | $20,500 | $32,000 |
| Melbourne | $17,000 | $27,500 | $40,000 |

Average whole farm margins for the dairy farms are $136,000/yr, which is $196/ML.

Farm gross margins are given in Table 9 and Table 10. Gross margins are highest for horticulture in terms of $/ha and $/ML and lowest for mixed farms. Table 10 shows that larger farms have higher gross margins per ML water than small farms, as they are more water efficient.

**Table 9. Gross margins for horticultural products in the SIR. [1]**

| Crop | Yield (t/ha) | Price ($/t) | Gross margin ($/ha) | Gross margin ($/ML) |
|---|---|---|---|---|
| Peaches | 36 | 450 | 4,987 | 997 |
| Apples | 32 | 4,000 | 5,884 | 1,176 |
| Pears | 31 | 350 | 4,177 | 835 |
| Tomatoes | 46 | 445 | 13,435 | 2,239 |

**Table 10. Gross margins for dairy and mixed farms in the SIR. [1]**

| Enterprise size | Dairy | | Mixed Farms | |
|---|---|---|---|---|
| | $/ha | $/ML | $/ha | $/ML |
| 80 ha | 60 | 597 | 4 | 24 |
| 150 ha | 96 | 884 | 14 | 72 |

Capital requirements for different farms are given in Table 11. Dairy and horticultural farms require more capital than mixed farms but have higher gross margins. They are high input-high output farms while the mixed farms are low input, low output farms.

**Table 11. Estimated Annual operating capital requirement for irrigated farm enterprises in the Shepparton Irrigation Region. [1]**

| Enterprise size | Dairy | | Mixed Farms | | Enterprise size | Horticulture | |
|---|---|---|---|---|---|---|---|
| | $/ha | $/farm | $/ha | $/farm | | $/ha | $/farm |
| < 40 ha | 3,190 | 113,000 | 1,580 | 53,000 | < 20 ha | 5,295 | 55,000 |
| 40-80 ha | 2,770 | 143,000 | 1,452 | 78,000 | 20-40 ha | 4,945 | 80,000 |
| 80-120 ha | 2,485 | 195,000 | 1,358 | 102,000 | 40-80 ha | 4,370 | 130,000 |
| > 120 ha | 2,268 | 216,000 | 1,260 | 116,000 | > 80 ha | 3,925 | 168,000 |

# 4 INSTITUTIONAL ARRANGEMENTS FOR WATER MANAGEMENT

## 4.1 State Legislation

At State level, the Water Act, 1989 is the key law for management of water. Among other things the Water Act defines the rights to water, it gives the Crown (i.e. the State) the right to the use, flow and control of all water in a waterway and all groundwater. Thus the State owns and has control over all water. Individuals and organizations are only given the right to allocation of water for use, and not ownership.

Under the Water Act the Minister may issue licenses for the use of water. In irrigation areas bulk water entitlements for groundwater and surface water are issued to the Rural Water Authorities. An Authority has the right to take the amount of water that is made available to it. The Rural Water Authority has the right and responsibility to divide the bulk entitlement for surface and groundwater and deliver it to end-users.

## 4.2 Organizations Involved with Water Management

There are varied organizations that have jurisdiction or influence in the allocation and use of water resources in the SIR. These organizations are local community groups, the Rural Water Authority (irrigation water provider), the Catchment Management Authority and the State government. Also, since the SIR is within the Murray Darling Basin it is influenced by the policies of the Murray Darling Basin Commission, which is a multi-state, Federal Government Organization. This is unique in the Australian context as normally water resources fall entirely within the jurisdiction of the States with no Federal Government involvement.

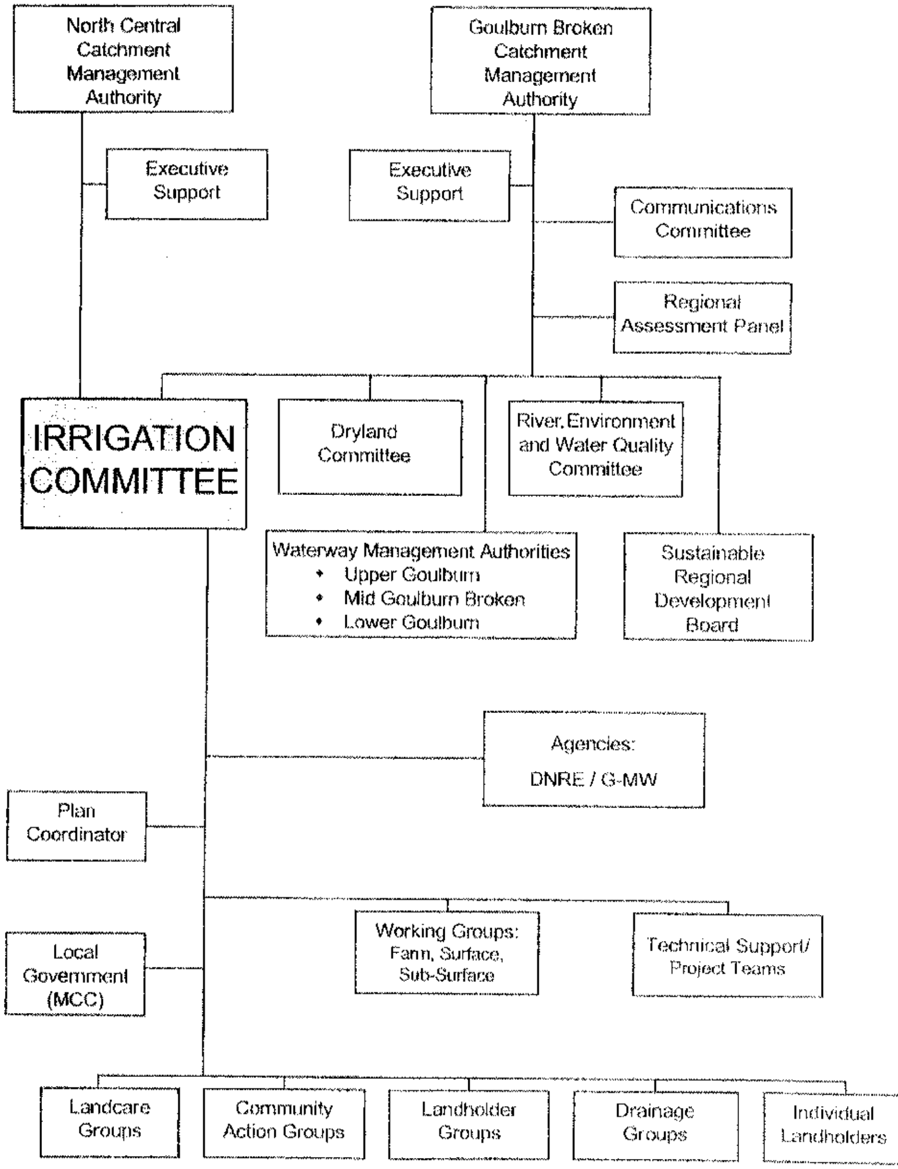
The main controlling body in the SIR is the Catchment Management Authority, which controls the implementation of the SIR Land and Water Salinity Management Plan (SIRLSWP) which is the key policy instrument for the region. The SIRLWSMP was developed by the State with the local community in 1990 to halt the spread of waterlogging and salinity and ensure the long-term sustainability of the region. A key part of this plan is the use of shallow groundwater pumping to control soil salinisation which provides the opportunity for analysis of the institutions involved in conjunctive water management.

All actions with regard to water resource management in the SIR are controlled by the Catchment Management Authority through its' Irrigation Committee which ensures that all actions are aligned with the objectives of the SIRLWSMP. The irrigation committee is responsible for the implementation of the SIRLWMSP but has delegated the responsibility for most of the on-ground implementation of the SIRLWSMP to Goulburn Murray Water, the Rural Water Authority in the area. During the implementation of the SIRLSWMP Goulburn Murray Water identified the need for a groundwater management plan to compliment the SIRLWSMP and as such is also responsible for administering and enforcing the groundwater management plan.

Figure 5 shows the various institutions/groups/parties directly involved in implementing the SIRLWSMP. Providing the overall context or framework for the SIRLSWMP is the Victorian Department of Natural Resources and Environment (DNRE) which provides the State input to the plan. The Murray Darling Basin Commission in general, in terms of water allocations and river water quality (which impacts on salt disposal allocations), provides the overall constraints to the SIRLWSMP and the SIR. The roles of the key organizations are described in the rest of this section with regard to their implementation of the conjunctive water management aspects of the

SIRLWSMP. A detailed description of the technicalities of the SIRLWSMP and the groundwater management plan are in chapter 5.

**Figure 5. Diagrammatic representation of institutions involved in the implementation of the SIRLWSMP [8]**



## 4.3 Catchment Management Authorities

The Shepparton Irrigation Region is located in the areas of two Catchment Management Authorities, the Goulburn Broken Catchment Management Authority and the North Central Catchment Management Authority.

The Catchment Management Authorities (CMA) operate under the Water Act[2]. Catchment Management Authorities have responsibility for the coordination and management of floodplains, rural drainage (including regional drainage schemes), water quality, Crown frontages and heritage rivers outside of national parks. They are also the major advisory body to the government regarding funding priorities for catchment management.

CMA's operate with an underlying structure of Implementation Committees, which tackle the catchment issues identified in the Regional Catchment Strategies [24]. The Committees act as a link between the board and the people of the catchment ensuring natural resource management reflecting the views and concerns of the community [25]. In the context of the SIRLWSMP the Implementation Committee is known as the 'Irrigation Committee' which is responsible for the development of detailed work programs and oversight of on-ground program delivery. The CMA's, through the Irrigation Committee work in partnership with the Department of Natural Resources and Environment and Goulburn-Murray Water on the delivery of the SIRLWSMP [25].

Funding for the CMA's is derived from State and Federal sources and via a Waterway Tariff levied on all landholders in the catchment[3].

Board members are drawn from within the region with experience and knowledge of primary industry, land protection, water resource management, waterway and floodplain management, environmental conservation, local government, food industry and business/financial management [(25, 26]. Nominations for positions on the board are advertised, but the minister appoints the board members.

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[2] Water Act, 1989; Act No. 80/1989 - This Act has the following purposes-to re-state, with amendments, the law relating to water in Victoria, to provide for the integrated management of all elements of the terrestrial phase of the water cycle, to promote the orderly, equitable and efficient use of water resources, to make sure that water resources are conserved and properly managed for sustainable use for the benefit of present and future Victorians, to maximise community involvement in the making and implementation of arrangements relating to the use, conservation or management of water resources, to eliminate inconsistencies in the treatment of surface and groundwater resources and waterways, to provide better definition of private water entitlements and the entitlements of Authorities, to foster the provision of responsible and efficient water services suited to various needs and various consumers, to provide recourse for persons affected by administrative decisions, to provide formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses and to provide for the protection of catchment conditions.

[3] The following tariffs for 1998/1999 have been set according to the Water Act 1989.

a) a tariff of 0.022 cents in the dollar of the capital improved property value

b) a minimum tariff of $20 per rateable assessment

c) a maximum tariff of $75 per rateable assessment

Source: Goulburn Broken Catchment Management Authority, Brochure: Protecting rivers, Promoting prosperity.

### *4.3.1 Irrigation Committee*

The Irrigation Committee is the Implementation Committee of both the North Central and the Goulburn Broken Catchment Management Authority for the Shepparton Irrigation Region. As such it is the key institutional body in water resource management in the region.

The major role of the Irrigation Committee is the implementation of the SIRLWSMP but the Committee has also taken an additional role of implementing the water quality and biodiversity strategies for the catchment, along with pest management. The Committee has delegated the responsibility for most of the on-ground works to Goulburn Murray Water.

The Irrigation Committee has had major input into a number of policy and planning exercises i.e. the development of the Regional Catchment Strategies and the preparation of the Groundwater Supply Protection Management Plan (GSPMP) [8]. It is the key forum for the development of policies and work programs for the implementation of the Irrigation Strategy.

The committee is made up of local community representatives and agency staff, representatives of irrigator Water Service Committees, local government and environmental groups. It coordinates activities of government agencies and authorities and provides community input to planning and works.

The members of the Irrigation Committee meet eight times a year (6-week cycle). The Irrigation Committee comprises of:

- 3 members of the Goulburn Broken Catchment Management Authority
- 1 member of the North Central Catchment Management Authority
- 11 other community representatives with specific representation of the Goulburn-Murray Water Service Committees, VFF, Local government and environmental organizations.

In general, the Committee members were nominated because of their specific skills and their links with community networks [17].

## 4.4 Agencies - Victorian State Government

There are two Victorian State Government agencies involved in the SIRLWSMP and GSMP.

### *4.4.1 Department of Natural Resources and Environment*

The Department of Natural Resources and Environment (DNRE) is responsible for the integrated management of Victoria's natural resource base, including land identification, resource development and utilization and the protection, conservation and management of Victoria's natural environment.

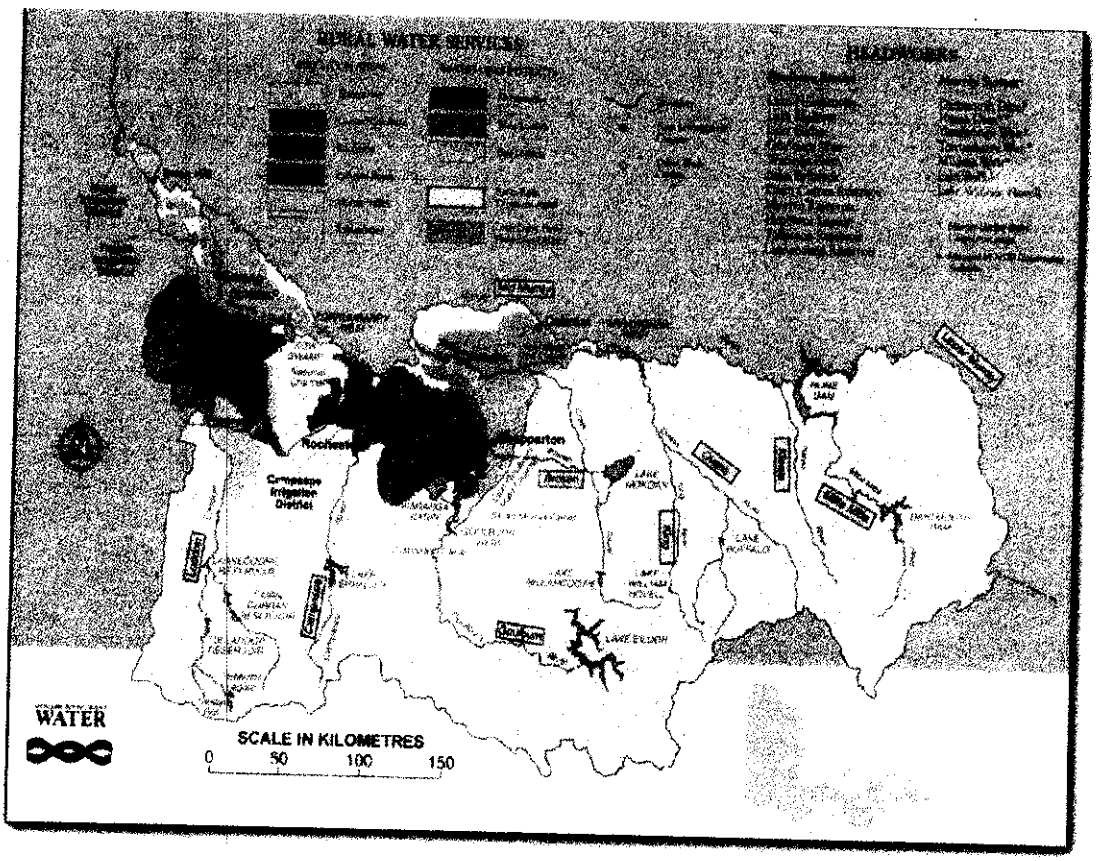
With regard to the SIR it has important roles of reviewing surface water and groundwater allocations. Under the Water Act 1989 it has to provide bulk allocation of surface water to the Rural water Authorities and define permissible groundwater extraction values for aquifers.

DNRE also provides State input into the development and implementation of the SIRLWSMP and groundwater management plans. An important contribution of DNRE to the SIRLWSMP has been the 'Institute for Sustainable Irrigated Agriculture' for provision of technical expertise, local research and extension facilities. This is a long established agricultural research facility that addresses problems of the region. This institute has a wide research base in irrigated agriculture productivity, sustainability and economics and as such has been able to provide the required research support and technical expertise in the development and implementation of the SIR Land and Water Salinity Management plan. The key research in understanding the possible role of shallow groundwater pumping was undertaken at the institute, as is ongoing work on conjunctive water management. The institute also hosts plan coordinators, community liaison and others associated with the implementation of the SIRLWSMP.

### *4.4.2 Goulburn Murray Water*

The Shepparton Irrigation Region is located within the area of Goulburn Murray Water (GMW), a 'Rural Water Authority', Figure 6, which operates under the provisions of the Water Act and is responsible to the Minister for Agriculture and Resources. The Authority submits its Corporate Plan to the Minister each year to ensure compatibility between its business directions and Government policy.

**Figure 6. Locality map for the service area of Goulburn Murray Water.**




Within its region GMW provides rural water and drainage services to approximately 24,000 properties. It is responsible for the management of the major water systems within the SIR, provision of supplies to urban areas, delivery of irrigation water, domestic and stock supplies and provision of drainage services. GMW also undertakes a number of natural resource management activities closely related to its core business, for example salinity and water quality management, for Government on a cost recovery basis [27].

GMW is headed by a Board which includes the Chief Executive and seven Directors appointed by the Minister and selected for their expertise in a variety of fields including business, finance, engineering, irrigation farming, water systems and environmental management [28]. The organization is structured into groups that reflect their primary functions: Business Development, Headworks, Water Services, Production and catchment, Corporate Services and Finance [28].

GMW has established 17 Water Services Committees (WSCs) to represent customers in the six Irrigation Areas[4], ten river basins and the Waterworks Districts. The key functions of these committees, whose members have been elected by their peers, are to: negotiate customer service agreements, prioritise asset maintenance and investment, address environmental issues, develop communication strategies, and participate in customer communications. In addition, the Area WSCs are responsible for negotiating prices and budgets with the Board, and developing Area Business Plans [28].

GMW raises its revenue by imposing charges and fees under tariffs for the services it provides and has transformed rapidly from a heavily subsidized state government department to a self-sufficient state owned business enterprise.

GMW has been delegated responsibility by the Catchment Management Authority for most of the on-ground implementation of the SIRLWSMP. This includes design and implementation of a number of technical programs such as irrigation supply upgrade, surface drainage improvement, groundwater pumping investigations and installation.

Most importantly GMW is responsible for the allocation of all groundwater and surface water within its' region. This gives it substantial control and power to affect natural resource management outcomes.

#### *4.4.2.1 Surface water allocation*

GMW is responsible for allocating water for use in a particular irrigation season. The water right against which the allocation is set is a permanent volume. This is maximum of 9ML/ha with not more than 6 ML/ha of groundwater. The volume of water available for allocation at any time is the volume actually held in storage, minus losses, which will be incurred in storing and delivering the water. Water is first allocated for high security stock and domestic, urban and industrial uses. Water is then allocated to cover as much of the current irrigation seasons' water right and diversion license volume as possible. If the volume of water available is greater than 100% of water right and license volume (as is usually the case), enough water is reserved to meet 100% of the next irrigation seasons' water right and license volume. Additional inflow to the storage, equal to approximately the lowest inflow on record, is assumed to be available to help meet this requirement for the next irrigation season. This inflow will exceed in 99 out of 100 years. If, after allowing for water right and license volume in ongoing and the next irrigation season, there is extra water available, water is allocated as *sales water* in the current irrigation season [5].

#### *4.4.2.2 Groundwater*

Groundwater can be allocated for conjunctive use purposes under the SIRLWSMP. The aim of these licenses is to provide salinity control to farms. The allocation required for salinity control purpose is about 1ML/ha/year but historically allocations have been 3ML/ha/year to promote groundwater

[4] Four of them are located in the Shepparton Irrigation Region. These are the Shepparton, Central Goulburn Murray Valley and Rochester area. The other irrigation areas are the Pyramid-Boort and the Torrumbarry areas.

pumping with farmers. The pumped groundwater is mixed with irrigation supplies either on-farm or in the irrigation channels. Groundwater pumping may also be allocated solely for the purposes of salinity control, where the water is disposed of to the drainage system, in which case a Salinity Disposal Allocation (SDA) is required.

#### *4.4.2.3 Water trading*

The ability to transfer water in Victorian Irrigation Districts was introduced in the late 1980's. In the 1994/95 irrigation season, the ability to trade between water right and diversion licenses was confirmed, and water was traded between a larger number of areas. Proposed water trades are assessed to determine if the channel system can deliver the additional water without unduly affecting other customers, and maximum water application rates are checked to ensure the transfer will not exacerbate salinity problems. GMW can prevent water trading if more than 2% of the total water right is traded out of an area in any irrigation season. This provision protects remaining irrigators from substantial rises in price that may be necessary to cover water delivery system costs in the event of a rapid reduction in water supplied in an area [7]. Table 12 shows the volume of water traded in the 1997/1998 season.

**Table 12. Water trade during the year ended 30 June 1998.** [13]

| District/ area | Internal transfers within area | | Total transfers from other areas within Goulburn Murray Water Authority | | Total transfers to other areas within Goulburn Murray Water Authority | | Total transfers from districts of other water authorities | | Total transfers to districts of other water authorities | | Net increase for area |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | ML | No. | ML | No. | ML | No. | ML | No. | ML | ML |
| **Permanent** | | | | | | | | | | | |
| Shepparton | 11 | 219 | 12 | 971 | 20 | 647 | | | | | 324 |
| Central Goulburn | 20 | 419 | 23 | 751 | 10 | 402 | | | | | 349 |
| Rochester | 11 | 596 | 13 | 1,240 | 4 | 89 | | | | | 1,151 |
| Murray Valley | 11 | 363 | 3 | 270 | 2 | 54 | | | | | 216 |
| **Temporary** | | | | | | | | | | | |
| Shepparton | 354 | 10,866 | 161 | 8,216 | 103 | 4,535 | 5 | 381 | 1 | 87 | 3,975 |
| Central Goulburn | 533 | 18,572 | 291 | 15,689 | 55 | 1,703 | 7 | 473 | | | 14,459 |
| Rochester | 201 | 10,167 | 123 | 6,940 | 39 | 1,750 | 3 | 295 | | | 5,485 |
| Murray Valley | 254 | 13,440 | 397 | 22,860 | 58 | 2,447 | 73 | 7,075 | | | 37,489 |
| **Total** | 1,342 | 53,043 | 972 | 53,706 | 255 | 10,435 | 88 | 8,224 | 1 | 87 | 61,408 |

Recently GMW identified that the groundwater-pumping program of the SIRLSWMP was jeopardized as the use of groundwater was being dominated by pumping for irrigation supply without regard to the salinity control. GMW found that it required further powers to administer groundwater pumping effectively and implemented the process of declaration of the area as a Groundwater Supply Protection Area. This has required the development of a groundwater management plan that they are responsible for administering. GMW manages the allocation from the aquifers within the permissible extraction value set by DNRE [6]. GMW is currently moving from indefinite licenses to 5-year licenses that will be reviewed at expiry in terms of any changes in water quality. Groundwater pumping may also be allocated solely for the purposes of salinity control in which case GMW allocates a Salinity Disposal Allocation (SDA), which ensures that the SIR does not exceed its' salt disposal allocation to the Murray River.

### *4.4.3 Environment Protection Authority*

The Environment Protection Authority (EPA) is a statutory body established under the Environmental Protection Act of the Victorian Parliament[5] in response to community concern about pollution [23]. The Act replaced statutory provisions scattered through more than 25 existing acts.

The EPA is clearly responsible for the quality of the groundwater, but at present has only a very minor role in water resource management, mostly in the monitoring the quality of surface drainage water. The role of EPA in managing salinity is unclear and as such they have concentrated on point source problems, leaving salinity to other bodies responsible for natural resource management.

## 4.5 Local Government

Local governments realizing the long-term economic threat of salinity to the region have formed regional body Municipalities against salinity in Northern Victoria (MASNV) and appointed a Municipal Salinity Liaison Officer to coordinate local government participation in the SIRLWSMP. The municipalities have developed uniform planning regulations for the implementation of drainage works under the SIRLWSMP. Furthermore, the local governments pay 17% of the annual costs of public salinity works constructed under the plan and have used provisions of the Local Government Act[6] to support community salinity control projects (surface and sub-surface drainage) [8].

The role of the Local Government continues to increase in significance, especially as it provides the legal foundation of key elements of the SIRLWSMP in the following ways:

- Uniform planning regulations for salinity irrigation works on farms
- Protecting agricultural land provided with sub-surface drainage under the SIRLWSMP from subdivision
- Administration and finance of community salinity control projects such as community surface drains and community groundwater pumps
- Development and implementation of strategy plans and planning schemes [17].

Apart from the threat to the local area income, local government is concerned about the high cost of damage to roads, bridges, buildings and other infrastructure caused by shallow saline watertables.

## 4.6 Farmer, Community and Environmental groups

There are numerous local groups to represent farmer and environment interests including; National Farmers Federation [29], Victoria Farmers Federation [30], Sustainable Regional Development

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[5] Environmental Protection Act, 1970, Act No. 8056/1970 - The purpose of the Act is to establish an Environmental Protection Authority, to make provision with respect to the powers, duties, and functions of that authority and to make further provision for the protection of the environment and for other purposes.

[6] Local Government Act 1989, Act No. 11/1989 - The purpose of this Act is to provide for a democratic, efficient and effective system of local government in Victoria, give Councils powers which will enable Councils to meet the needs of their communities, provide for an accountable system of local government and reform the law relating to local government in Victoria.

Board [31], Australian Conservation Foundation [35], Goulburn Valley Environment Group [36] and Landcare.

Landcare is a community-based approach of resolving environmental problems and protecting natural resources. There are more than 4,250 Landcare groups across Australia and about one in every three farmers are members of a Landcare group. Landcare groups in rural areas invariable start in response to common problems - salinity, gully erosion, rabbits or weeds - which span a number of properties [32].

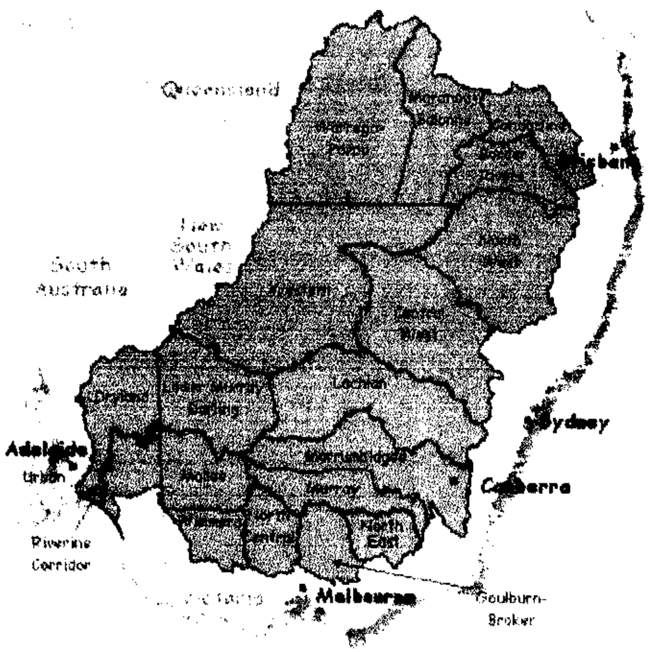
The National Landcare Program supports collective action by communities to manage the environment and natural resources sustainably in partnership with the government [33].

In the Shepparton Irrigation Region there are 31 local Landcare groups [34] covering 80% of the land area [22].

## 4.7 Supra State Level

The Rivers Murray and Darling are shared between four states, the whole catchment area is known as the Murray-Darling Basin. The SIR sits in the southeastern corner of the Murray Darling Basin, Figure 7. Due to the complexity of sharing and resource management in this system the Commonwealth together with the States of Victoria, New South Wales, and South Australia joined together in an agreement which established the Murray-Darling Basin Initiative. This is unusual in that the Commonwealth Government of Australia does not normally have powers to intervene in natural resource management issues unless they affect international obligations.

**Figure 7. Locality map for the Murray Darling Basin. [37]**




The Murray-Darling Basin Agreement established the Murray Darling Basin Initiative in 1987with the Governments of the Commonwealth, New South Wales, Victoria, and South Australia. The agreement was ratified by identical legislation that has been enacted by the Parliaments of all signatory governments[7]. With the revision of the Agreement in 1992, Queensland became a signatory, with the Australian Capital Territory being added in 1998. Appendix 1.

The purpose of the Agreement is "*to promote and coordinate effective planning and management for the equitable, efficient and sustainable use of the water, land and other environmental resources of the Murray-Darling basin*".

The Agreement recognized that no one government or group of people was able to deal with the basin's emergent problems and that the existing management arrangements were inadequate. The Murray-Darling Basin Commission has therefore developed a number of Natural Resources Management Strategies. The most important in the CWM context is the Salinity and Drainage Strategy.

Salinity was one of the first major issues considered by the Murray-Darling Basin Ministerial Council and Murray-Darling Basin Commission. The outcome was the Salinity and Drainage Strategy (SDS) signed by the Commonwealth, South Australian, Victorian and New South Wales governments in 1988. The Strategy was later included as Schedule C to the Murray-Darling Basin Agreement 1992. Completion of the Strategy marked the first occasion on which state governments had agreed to tackle a specific environmental problem through common effort across their borders, including spending money outside their jurisdiction.

The SDS provides the framework for the coordinated management of salinity in the River Murray and land salinisation and waterlogging in the Murray-Darling Basin, especially in many of the irrigation areas of the Murray and Murrumbidgee valleys. The objectives of the Strategy are to:

- improve water quality in the River Murray for all beneficial uses - agricultural, environmental, urban, industrial and recreational
- control existing land degradation, prevent further land degradation, and where possible rehabilitate land resources, to ensure the sustainable use of these resources in the Murray and Murrumbidgee Valleys
- conserve the natural environment of these Valleys and preserve sensitive ecosystems with respect to salinity

The Salinity and Drainage Strategy is based on a balance between engineering solutions (salt interception schemes) and non-engineering solutions (land and water management plans).
Under the Salinity and Drainage Strategy, no State can construct or approve any proposal that would have an adverse impact[8] on the salinity of the River Murray unless it has previously earned "salinity credits" by contributing to salinity mitigation works.

The SDS is the major 'policy' constraint on salt disposal in the SIR. The SDS provides each State with "salinity credits", these have been allocated to various areas throughout the state. In implementing the SIRLWSMP the options for salinity control must not exceed salt disposal to the

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[7] Murray-Darling Basin Act, 1993, Act No. 39/1993 - The purpose of this Act is to approve and provide for carrying out an agreement entered into between the Commonwealth, New South Wales, Victoria and South Australia with regard to the water land and other environmental resources of the Murray-Darling Basin.
[8] . A 'significant impact' is one that changes the average salinity in the River Murray by 0.1 EC at Morgan.

River Murray than the agreed salinity credits. It is this constraint that has caused conjunctive use of groundwater with surface water supplies to be a major part of the plan.

An important development in 1992, was the development of a comprehensive Irrigation Management Strategy (IMS) for the Murray-Darling Basin. The objective of the IMS is: *to establish an economically, self-sufficient and environmentally sustainable irrigation industry in the southern Murray-Darling Basin by the year 2010, through regionally tailored and integrated programs of development based on water industry reform, industry profitability and sustainable natural resources management* [47].

There are two components to the Strategy: water market reform and a regional approach to implementation.

1. Water market reforms - deal with water property rights, water charges and the trade of water property rights. This component of the IMS is consistent with the water market reform mechanisms agreed to by the Council of Australian Governments (COAG). The Commission has a particular role to play in facilitating and promoting the interstate trading of water. This can have long term implications for the viability of the SIR and implementation of the SIRLWSMP unless carefully managed.

2. Regional implementation - a critical element of the IMS is its regional approach to implementation. This focuses on the particular characteristics of a region, identifies what its needs are, nominates opportunities for future development, and tailors a detailed program of measures necessary to achieve a sustainable future. Implementation of the Strategy was initially through case studies in the Sunraysia and Shepparton regions of Victoria, where programs were developed by Sustainable Regional Development Boards (SRDB) involving relevant local, state and federal government agencies with considerable community and industry involvement. In the SIR the SIRLWSMP has been adopted for natural resource management by the SRDB.

In June 1993, the Ministerial Council directed the Commission to undertake "a water audit on the continuing increase in water diversions from the rivers of the Murray-Darling Basin".
The Audit confirmed the concerns of the Ministerial Council both in terms of the level of diversions and the consequent decline in river health. The Audit also indicated that diversions were continuing to rise. In response to the issues raised by the Audit, the Ministerial Council at its June 1995 meeting decided to introduce a cap on diversions of water from the Murray-Darling Basin. The cap was seen as the first step in establishing management systems to achieve healthy rivers and sustainable consumptive uses. The Ministerial Council formalized "The Cap" on July 1, 1997.

There are two primary objectives behind the decision to implement the Cap:

1. The need to maintain and, where appropriate, improve existing flow regimes in the waterways of the Murray-Darling Basin to protect and enhance the riverine environment
2. To achieve sustainable consumptive use by developing and managing Basin water resources to meet ecological, commercial and social needs.

The Ministerial Council agreed that the Cap be defined as "the volume of water that would have been diverted under 1993-94 levels of development".
In terms of each State, it was agreed that:

- In New South Wales and Victoria, the Cap is the volume of water that would have been diverted under 1993-94 levels of development. It is not the volume of water that was used in 1993-94. Rather the Cap in any year is the volume of water that would have been used with the infrastructure[9] that existed in 1993-94 taking into account the climatic and hydrologic conditions that were experienced in the year.
- In South Australia, diversions should be capped at the level that enables the development of its existing high security entitlements. This represents a small increase in diversion over 1993-94 levels of development;
- In Queensland the Cap should be determined after an independently audited Water Allocation Management Planning (WAMP) process had been completed.

[9] Pumps, dams, channels, areas developed for irrigation, management rules, etc.

# 5 THE SIR LAND AND WATER SALINITY MANAGEMENT PLAN AND GROUNDWATER SUPPLY PROTECTION MANAGEMENT PLAN

In the SIR there are two key policy instruments related to conjunctive water management, the SIR Land and Water Salinity Management Plan (SIRLWSMP) and the Groundwater Supply Protection Management Plan (GSPMP) which now come under the auspices of the Regional Catchment Strategy administered by the Catchment Authorities. In 1994 the Catchment and Land protection Act[10] was passed that Catchment Authorities are required to prepare, coordinate and monitor a Regional Catchment Strategy. The Catchment authorities adopted the SIRLWSMP and GSPMP to satisfy this requirement with regard to irrigation [22].

The SIRLWSMP was initiated in 1990 due to community and governmental concern for increasing salinisation in the area. The local community, especially farmers have been intimately involved in the development of the SIRLWSMP from the outset.

The Groundwater Supply Protection Management Plan (GSPMP) is a much more recent initiative, starting in 1996. Goulburn Murray Water initiated the GSPMP after considering their role in implementing the SIRLWSMP. They found that the management of groundwater allocation and pumping in the region was inadequate in terms of meeting the SIRLWSMP objectives and thus have used the GSPMP to bring groundwater resource management under their control and to align it with the SIRLSWMP objectives.

## 5.1 Shepparton Irrigation Region Land & Water Salinity Management Plan

### *5.1.1 Introduction*

The Shepparton Irrigation Region Land & Water Salinity Management Plan (SIRLWSMP) was developed under the community based Salinity Pilot Program Advisory Council (SPPAC) with guidelines provided by the Victorian Government. The SPPAC comprised fifteen members representing landholders, local government, education and industry personnel. The SPPAC was appointed on the basis of recommendations from the catchment community [8].
This process came under Victoria's Salinity Program, a major ongoing initiative of the community and the State Government since 1986. In 1988 "Salt action: Joint Action" the state strategy for managing land and water salinity in Victoria was released.

The long-term goal of the program was:" *...to manage the salinity of the land and water resources throughout Victoria in order to maintain, and where feasible, improve the social well being of the communities and the environmental quality and productive capacity of the regions".*

The preparation of salinity management plans was a major emphasis and achievement of the salinity program in the first years. The SIRLWSMP was one of the first sub-regional plans endorsed under this program.

From this process the SIRLWSMP developed its goal: *"To manage the salinity of land and water resources and the quality of water in the Shepparton Irrigation Region in order to maintain and*

[10] Catchment and Land Protection Act, 1994, Act No. 52/1994 - The Act provides a framework for the integrated management and protection of catchments, to encourage community participation in the management of land and water resources, to set up a system of controls on noxious weeds and pest animals and to repeal and amend various Acts concerning catchment and land management.

*where feasible improve social well being, environmental quality and productive capacity of the Region".*

The original SIRLWSMP is now an integral part of the Regional Catchment Strategies of the North Central and Goulburn Broken Catchment Management Authorities [42]. The Irrigation Committee of the Catchment Management Authorities is charged with the implementation of the SIRLSWMP [10]. Goulburn Murray Water has been delegated responsibility for most of the on-ground implementation of the SIRLWSMP.

In general terms the objectives of the SIRLSWMP are to:

- Maintain the productive base of the region
- Protect the environment from further degradation
- Prevent social costs which will occur if high water tables and salinity are allowed to continue to develop

The development of the SIRLWSMP has been controlled by four major objectives. These are:

1. ***The environmental objective***: The plan has to address current and future environmental problems resulting from high watertables and salinity within the region. Maintain salinity control activities and where possible, enhance existing ecological processes.
2. ***The social objective***: Wherever possible, the plan has to provide the community with equal access to decision making and the economic resources required to implement salinity control works. The plan has to reduce inequities resulting from uncontrolled salinity impacting differently on individuals.
3. ***The economic objective***: Where works are undertaken to protect the region from high watertables and salinity, the value of their benefits, both measurable and non-measurable, should exceed their costs.
4. ***The financial objective***: The plan has to be both equitable and affordable to the individual, the regional community and the nation, now and in the future.

It is an integrated salinity management plan with four programs:

1) Farm action program
2) Sub-surface drainage action program
3) Surface drainage action program
4) Environmental action program

There are also two complementary programs of monitoring and program support. The SIRLSWMP programs and their results since 1990 are outlined below.

### *5.1.2 Farm Action Program*

The farm program has the goal of reducing groundwater accessions, soil salinisation and waterlogging on farms. The farm program allows farmers to proceed with farm improvement activities. [10]

The main components of this program include whole farm planning, irrigation redevelopment (grading, channel and drain reconstruction, micro irrigation, drainage reuse and automation), improved water management, environmental enhancement, tree growing (planting and protection of remnants) and improved productivity.

Table 13 shows the targets of the farm program and the costs and incentives available to reach these targets. Other actions are farm restructuring to allow irrigators to concentrate water on their better land to optimise productivity. This will play a vital role in areas where salinity control is difficult and hence likely to be uneconomical. Further, a water pricing system is envisaged that encourages the use of alternative sources such as groundwater and surface drainage water. Table 14 shows the progress of the farm program for the period of 1990-1995.

**Table 13. Targets costs and available resources for the farm program. [10]**

| Action | Target | Costs (M$) Total | Costs (M$) Annual | Incentives available |
|---|---|---|---|---|
| Whole farm plans | Every farm | - | - | - |
| Landforming and farm drainage | 75% of perennial pasture and 50% of annual pasture<br>Total area requiring action 106,000 ha | 137 | 2.7 | 10% of capital outlay |
| Drainage reuse systems | Installed on 50% of farms in areas which are currently drained | 13.2 | 1.6 | 30% of capital outlay |
| Tree planting | 14,000 ha, equivalent to 5% of irrigated area | 45.6 | | 30% of total capital outlay |

**Table 14. Achievements of the farm program. [8]**

| Action | Achievements 1990-1995 | Total in 1995 |
|---|---|---|
| Whole Farm Plans | 697 covering 46,773 ha | 1245 covering 82,156 ha |
| Laser grading | 43,000 ha | 57% |
| New farm channels | > 1,200km | |
| Improved farm drains | > 1,800km for 36,000 ha | |
| Re-use systems* | > 980 | > 2,500 |
| Tree planting | > 1,160,000 | |
| Micro irrigation installations | > 1,400 ha | |

*It is estimated that the installed reuse systems capture 150,000 ML/yr of farm runoff. These reuse systems provide recycling capacity for almost 50% of the irrigated area.

### *5.1.3 Environmental Action Program*

The environmental program has the goal of protecting and, where possible rehabilitating the natural environment of the region with high watertables and salinity. The main components are protection and enhancement of wetlands and remnant vegetation and therefore the fauna species that rely on these ecosystems.

The program with a total cost of $8.7 million includes environmental protection activities (Table 15), a farm tree program aiming to plant 5% of the region with trees and research, investigation and monitoring activities to support the protection activities.

**Table 15. Environmental protection activities and their costs. [10]**

| Environmental protection activity | Total cost (Million $) |
|---|---|
| Protection of floodplain wetlands of high value by construction of suitable drainage outfalls, drainage re-use and water allocation for flushing | 9.0 |
| Protection of riverbanks by provision of groundwater control along 21km of Goulburn Campaspe river frontages | 2.1 |
| Protection of existing wetlands along drainage courses by modification of drainage alignments | 3.8 * |
| Creation of new wetlands along drainage courses by development of a significant number of meander loops as cut-off wetlands | 2.0 **. |
| Protection of isolated wetlands (about 100) by a variety of methods, including flushing, diversion works, groundwater control and establishing fringe vegetation | 10 |
| Protection of about 1,500km of streams from salinity by establishing treed buffer zones on both banks | 15.0 |

* From surface drainage program

** From surface drainage program + incentives to encourage landholders to maintain these areas

Initially most activities were related to assessing and mapping environmental features and developing management plans for sensitive areas. Now the emphasis has moved into works and implementation of these plans. Habitat protection works have now been completed for 80 ha on 23 farms and management plans have been implemented on 4 wetlands, protecting almost 2,000 ha of wetlands.

### *5.1.4 Surface Drainage Action Program*

The surface drainage program has the goal of providing by the year 2020, a surface drainage service to the 65% of the area which currently does not have surface drains. The main components will be Goulburn-Murray Water arterial drains, community owned and managed spur drains and water harvesting, drainage course declaration and drainage diversion, Table 16.

**Table 16. Surface drainage program. [10]**

| Surface drainage strategy | Area drained | | Capital cost |
|---|---|---|---|
| | ha | % | (Million $) |
| Existing G-MW drains | 183,100 | 35 | NA |
| New G-MW drains | 74,600 | 14 | 11.6 |
| Community drains | 236,200 | 46 | 47.3 |
| Water harvesting with channel discharge | 13,400 | 3 | 10.2 |
| Water harvesting without channel discharge | 12,700 | 2 | 8.6 |
| Length of drainage course declarations (km) | | | 11.1 |
| Additional work (outfall upgrading, etc.) | | | 29.1 |
| **Total** | **520,000** | **100** | **222.4** |

The surface drainage program has been revised since 1989, shifting the emphasis from predominantly expensive arterial drains to a balanced mix of arterial plus comparatively cheaper community drains.

In the period 1990-1995, 41km of arterial drains and 212km of community drains have been constructed. These provide drainage outfall for 25,000 ha. Many more drains have been designed and are ready for construction. However, the funds available for the community surface drains are limited and only 60-70km can be constructed annually.

### *5.1.5 Sub-surface drainage Action Program*

The sub-surface drainage program has the goal of where possible and justified, protecting and reclaiming the Shepparton Irrigation Region land and water resources from salinisation through management of the region's groundwater. Sub-surface drainage will be provided by activities of individual farmers under the farm program and by community activity in priority project areas where pump operation will be managed to provide seasonal watertable control in conjunction with regulated disposal of salt both within the region and to the river Murray.
The main components of this program are installation of groundwater pumps, tile drains and low capacity pumps, and disposal (farm use, regional channel and drain network, evaporation basins and river Murray). These groundwater pumps can be either private if the groundwater salinity is less than 3.5 dS/m or public when the groundwater salinity is more than 3.5 dS/m.

The plan provides for the following sub-surface drainage activities:

- The protection of 85,000 ha by installing 426 public groundwater pumps and some 50 evaporation basins (30 years, $35 million)
- Protection of another 85,000 ha by providing management arrangements and salt disposal opportunities for 395 existing and 365 new private groundwater pumps of which 150 are expected to be installed as part of the farm program.
- Tile drainage and low capacity groundwater pumps to protect the productive capacity of up to 8,000 ha in the difficult to pump areas.

In the period 1900-1995, 66 new private groundwater pumps have been installed and 30 upgraded to provide groundwater protection and water for irrigation of pasture. 12 additional groundwater pumps were installed on horticultural blocks along with 9 ha of tile drains and 7 public pumps have been commissioned while 20 are at various stages of investigation and construction. This amount has risen to 91 private groundwater pumps and 14 public groundwater pumps in 1999.

This program is one of the most readily adopted parts of the SIRLWSMP, especially the private pumps. This has been due to the great support for this aspect of the plan, including a previous waiving of all statutory charges on groundwater use by the Minister and the attraction of a supplementary water supply to farmers. The public pumps have not been as readily adopted, as these cannot be used for water supply. However, the demand for public pumps has risen as the community becomes more aware of and educated about the threat of salinity. At present the demand for both private and public pumps outstrips the funds available and hydrological investigation capacity of Goulburn Murray Water.

### *5.1.6 Monitoring Program*

The monitoring program aims to review outcomes achieved by implementing the plan, provide data for prioritizing and targeting works and for regular plan reviews and to identify the impacts of salinity and nutrient pollution where no plan activity has been undertaken.
The monitoring program is considered an integral part of the plan as it provides relevance and accountability to each of the programs.

### *5.1.7 Program Support*

This program was established for the management and coordination of the SIRLWSMP. A full time plan coordinator is employed together with two other officers. Key tasks are to provide technical and administrative support to the Irrigation Committee, coordinate and communicate new policies and most importantly increase awareness and involvement of the community in the plan. Key to success of the plan is including the community through a framework of community education and support such as WatertableWatch, a community awareness program regarding watertables. WaterWatch is another program, for water quality monitoring program. It aims to: increase community awareness and understanding of water quality issues, increase community involvement in water management decisions and encourage collaborative action between the community and water resource managers. WaterWatch brings together community groups, schools, landholders, councils and water authorities to assess the quality of their local stream or water body.

Another community awareness program is SaltWatch which is one of the longest running community-monitoring programs. SaltWatch encourages rural and urban communities to learn about salinity and other catchment issues. Each group collects ten samples from their local rivers, creeks, dams bores and any other water source in the area. Staff from various State organizations visits the groups to assist in testing the samples and to provide information about salinity and land care.

There are 35 community action groups across the SIR, indicating the level of community organization and support that has been generated for the SIRLWSMP.

During the preparation and subsequent implementation of the SIRLWSMP, particular emphasis was placed on ensuring broad community input into its development and on-going refinement, and ensuring continued community support for its implementation. This has been a major strength of the Plan.

### *5.1.8 Financial Contributions and Distribution*

The plan as a whole has a cost sharing agreement of 45% from landholders, 10% from local government, 25% from State Government and 20% from Federal Government [42]. The Local Government contributions are raised by a general rate imposed on the local community. Accumulated expenditure by the Government and the regional community for the first seven years of Plan implementation has been calculated at $60.7 million and $162.6 respectively [42]. The current balance between government and community investment in the SIRLWSMP is closer to 1:2 than 1:1, reflecting buoyancy in the dairy industry at present and current community enthusiasm for the plan. As innovative farmers implement their whole farm plans, a slowing may occur in this high level of investment [43].

The total budget funding from all government sources has risen from $11.7 million in 1995/19996 to $13.1 million in 1999/2000 [43].

**Table 17. Budget breakdown for SIRLWSMP projects. [43]**

| Program | % |
|---|---|
| Farm | 17.1 |
| Environmental | 2.4 |
| Surface drainage | 47.2 |
| Sub-surface drainage | 19.6 |
| Monitoring | 3.9 |
| Program support | 9.8 |

| Activities | % |
|---|---|
| Works | 70 |
| Research and investigations | 14 |
| Extension | 2.4 |
| Program management | 3.1 |
| Community education | 0.8 |
| Community support | 2.2 |
| Planning/economics | 3.7 |
| Monitoring | 3.8 |

## 5.2 Groundwater Management

### *5.2.1 Introduction*

The SIRLWSMP relies heavily upon groundwater pumping as its' major strategy for preventing soil salinisation. This watertable and salinity control based on on-farm pumping and re-use of groundwater for irrigation offers substantial benefits, such as:

- It is a salinity control method that can potentially apply to a substantial part of the area.
- It provides the ability to maximize the productive use of groundwater and thereby minimizing the amount of salt disposed to the Murray River.
- Greater flexibility of irrigation management including the opportunity to irrigate during winter [44].
- Reduced costs to public - farm owned and operated pumps cost less to the public than State owned pumps.

The SIRLWSMP has promoted groundwater pumping from the beginning of the plan in 1990. However, in promoting groundwater pumping farmers were encouraged by increased water availability for irrigation rather than the salinity control objective. This has been successful in promoting groundwater pumping amongst farmers, but the emphasis needed to be returned to the salinity control aspects of groundwater pumping. To do this the Groundwater Supply Protection Management Plan (GSPMP) was initiated with the primary objective of supporting the implementation of the SIRLWSMP.

The Shepparton Irrigation Region was declared a Groundwater Supply Protection Area under the Water Act on 14 September 1995 [2]. The GSPMP will be used to encourage and support regular and responsible pumping of groundwater to provide salinity control while protecting both the groundwater resource and the rights of groundwater resource users. The plan gives priority to regular or consistent[11] and responsible groundwater pumping for salinity control and discourages the "locking up" of groundwater allocations for drought security purposes. Goulburn Murray Water is responsible for administering and enforcing the groundwater management plan, including establishing and collecting fees and charges.

### *5.2.2 The Groundwater Supply Protection Management Plan*

The Groundwater Management Plan (GSPMP) aims to encourage and support regular and responsible pumping of groundwater to provide salinity control while protecting both the

[11] 'Consistent use' is that at least 65% of the licensed irrigation allocation should be pumped each year.

groundwater resource and the rights of groundwater resource users [2]. Prior to the existence of the GSPMP there was not a suitable mechanism to monitor or manipulate groundwater use and management. This led to groundwater being used purely as a water resource and as such the benefits of groundwater pumping for salinity control were jeopardized. Farmers tended to pump only in dry years when additional supply was needed.

In the SIR it has been established that watertable levels at or about 1 m below surface are safe for most existing land uses in the region, provided that the shallow groundwater is not saline. Changes of more than 1 m in groundwater level are to be avoided where possible as they can significantly impact on system capacity for existing bore owners because of the shallow depth of the aquifers and the general use of surface mounted centrifugal pumps.

Salinity plan bores are:

1. Shallow bores which have received capital assistance from the Salinity Plan, either at their time of installation or a post installation upgrade[12]
2. Other shallow irrigation or dewatering bores, of which the owners have agreed to operate consistently within Salinity Plan guidelines
3. Deep irrigation bores which have been licensed on 30 June 1997, and whose owners agree to meet the operating requirements of the Salinity Plan
4. Deep irrigation bores licensed after 30 June 1997, if they have been shown to provide a net benefit to the Salinity Plan and the owners agree to meet the operating requirements of the Salinity Plan.

Salinity plan bores fall in three categories depending on their usage and ownership:

1. Salinity control irrigation bores: Licensed primarily for irrigation, but their license may include a requirement or allowance for off-site discharge in accordance with Salinity plan guidelines.
2. Private dewatering bores: Licensed primarily for off-site discharge under Salinity Plan guidelines or for discharge to an on-farm disposal area, but their license may include some allocation for irrigation.
3. Public (GMW) dewatering bores: Operated by Goulburn Murray Water and licensed for off-site discharge to GMW channels and drains, GMW managed disposal areas or Community Surface Drains.

### *5.2.3 Private groundwater pumping*

Private groundwater bores are installed when the shallow groundwater salinity is less than 3.5dS/m, and the water can be used for irrigation after it has been diluted with surface water to a salinity of

[12] For new systems, grants are available to cover most of the capital costs of installing a groundwater system for irrigation use and approved disposal. The level of grant is $200/ML of groundwater which can be pumped and used safely in a season up to 65% of the total capital cost for approved pumping works or a maximum of $30,000. Works eligible for a grant include the wellpoints, headerline, permanent pump, meter and permanent delivery line. Part of the cost of connecting power to the new site may also be included.
For existing systems, grants may be available to increase the capacity of an existing groundwater system, such as adding extra well points or extending a pipeline to command more land. These works may attract a grant of $200/ML of increased safe usage of groundwater in a season. [45]

0.8dS/m. Irrigation water of 0.8dS/m has been adopted as the critical level, as research in the area has shown that it does not cause any productivity loss for pasture Table 18.

Pumped groundwater allocated for irrigation must be used in an environmentally sustainable manner. The GSPMP requires that:

- Licensed allocation can only be granted or renewed for water use on land which is suitable for irrigation and well managed
- Maximum application is specified and consistent with best practice to minimize wastage
- The salinity of applied irrigation does not cause land degradation.

**Table 18. Salinity levels and water requirement for the major crops to calculate the safe salinity level. [3]**

| Crop | Safe irrigation water salinity (dS/m) | Water requirement (ML/ha) |
|---|---|---|
| Perennial pasture | 0.8 | 10 |
| Annual pasture | 0.8 | 4 |
| Lucerne | 1.2 | 10 |
| Fruit trees | 0.5 | 7 |
| Eucalyptus | *First year:* 3.0 | 10 |
| | *Subsequent years:* 5.0 | |

All irrigation bores (both deep and shallow) which are classed as Salinity Plan bores are required to consistently use 65% of their irrigation allocation and to consistently discharge off-site in accordance with the Salt Disposal Allocation (SDA) allocated to them.

The irrigation and SDA volumes are reviewed every three years. The review criteria will take into consideration:

- Pumping performance compared to allocated volumes
- The need for disposal from the area
- Groundwater salinity trends

The irrigation volume is dependent on:

- safe salinity level that can be used for continuous irrigation with no productivity loss on a medium textured soil (Table 18)
- dilution water volume[13]
- dilution water salinity[14]
- seasonal water requirement (Table 18)
- flow rate of the groundwater pump (which is the average flow rate that can be maintained over the period of pumping assumed)
- salinity of the groundwater
- supply flow rate (which is the flow rate from the meter outlet)
- MNRT discretion [3]

The irrigation volume is the lowest of:

[13] equal to 180% of water right

[14] for Murray system 0.1 dS/m and for Goulburn system 0.15 dS/m

1. Salinity limit
2. Groundwater reuse intensity
3. Water right limit
4. System limit which are the physical constraints of the location and the pump

The calculations used to derive these limits are given in Table 19.

**Table 19. Variables and formulas that are used for the calculation of the irrigation volume.**

| Criteria | Formula | Variables |
|---|---|---|
| Salinity limit | $Vgw = \frac{Vi\ (ECnet - ECc)}{(ECgw - ECc)}$ | • volume of water which can be used in a season on the area commanded by the pump (Vi = A x crop water requirement where, A is the area of each crop that can be commanded from the pump and diluted if necessary<br>• ECnet is target value for irrigation water - 0.8dS/m |
| Groundwater reuse intensity | Vgw = A x 3 | • Volume of groundwater must not exceed 3 ML/ha[15]<br>• ECgw is salinity of the groundwater |
| Water right limit | $Vgw = \frac{Vc\ (ECnet - ECc)}{(ECgw - ECnet}$ | • Vc - water available for dilution, maximum 180% of property water right |

Calculation of salt disposal allocation (SDA)

SDA is an allocation based upon the need for salt disposal from an area. The salt disposal allocation is dependent on:

- the irrigation volume to calculate the area of recharge[16]
- the irrigation intensity which is the average irrigation usage within the area of recharge[17]
- limits on SDA[18]
- availability of disposal to surface supply or drainage channels

Disposal is only allowed if:

- The average salinity in the channel stays less than 0.5dS/m.
- Maximum salinity for 7 consecutive days should be less than 0.75 dS/m
- Maximum salinity on any one day should be less than 0.85 dS/m [10,9].

[15] 3ML/ha is DNRE recommendation

[16] Assumed to be 1 ha per ML of the irrigation volume plus 30% to allow for additional groundwater being drawn from beyond the area being recharged

[17] SDA = Mass x 1000 / (ECgw x 600) ML where Mass = Volume of surface water x EC x 600/1000)

[18] The minimum SDA is 5ML, the SDA can not be more than 30% of total volume pumped which is equal to 43% of the Irrigation volume. Pumps with groundwater EC < 1 dS/m are not permitted to dispose while pumps with groundwater salinity between 1 and 2 dS/m have a reduced SDA. Pumps above 2 dS/m have a full SDA. Where the calculated area of influence of a pump intersects that of a public pump, the required salt disposal is to be from the public pump. Where areas of influence of existing pumps overlap, the SDA is shared equally.

### *5.2.4 Public Groundwater Pumping*

Public groundwater pumps are installed when the salinity of the shallow aquifer is higher than 3.5 dS/m on the basis that this water can not be used for irrigation. To date 14 public groundwater pumps have been installed.

Beneficiaries of the works meet 50% of the annual costs of existing pumps. All irrigators as indirect beneficiaries, would meet 50% of the annual costs via a regional levy (service fee) on channel water use.

The area directly benefiting from public groundwater pumps is determined by conducting a two-month pump test, after which the area is divided into 4 service levels:

- A – drawdown of more than 2 m
- B – drawdown of more than 0.3 m
- C – drawdown of more than 0.1 m
- D – drawdown of less than 0.1 m

The total rate charged to a beneficiary is the sum of the local area rate, the local water rate and a service fee, Table 20.

**Table 20. Determination of beneficiary rates for public groundwater pumps.**

| Components | Calculation | Fee for 1996 |
|---|---|---|
| Local area rate | Average level of service x property area x local area fee | Local area fee = $2.83/area unit |
| Local water rate | Average level of service x water use x local benefit water use fee | Local benefit water use fee = $0.56/water unit |
| Service fee | Water use x service fee | Service fee = $0.48/ML |

### *5.2.5 Deep Aquifer Management*

Current technical understanding suggests that:

- The existing level of deep groundwater pumping is providing a regional benefit in stabilizing deep aquifer pressures over large areas
- A large increase in pumping from areas with good quality groundwater would not result in interference between bores and degradation of groundwater quality (at least in some areas)
- Additional pumping in some areas of more saline groundwater would assist further in controlling deep aquifer pressures, but there may be some risks in disposing of the groundwater for irrigation.

In accordance with the above it has been resolved that, further resource management policies for the deep aquifer should be based on resource conservation priorities rather than salinity control priorities unless a specific benefit to salinity management has been demonstrated.

# 6 IMPLEMENTATION OF CONJUNCTIVE WATER MANAGEMENT FOR THE SIRLWSMP

## 6.1 Improved Water Availability

The key element of strategies developed for the sustainability of the SIR includes conjunctive use of surface and groundwater for salinity control. The effectiveness of these strategies in the existing institutional and social framework is analysed in this section. The analysis is based on some key benefits that are expected from implementing conjunctive water use, such as; improved availability of water, reduced waterlogging and salinity improved production and equity and optimized expenditure on rehabilitation. In general terms, both the community and local institutions view the efforts to improve resource management as being successful

### *6.1.1 Volume*

Initially, the main reason farmers adopted groundwater pumping in the SIR was to increase water availability. The benefit due to salinity control also occurred but probably was not the main reason for farmers to adopt groundwater use. This was especially the case during the early period of implementation of groundwater-pumping strategy since farmers were not as aware of salinity issues as they are today. Groundwater pumping shows an increase of 2 ML/ha in the total amount of water applied, in the Tongala project, from 10 ML/ha to almost 12 ML/ha. The SIRLWSMP suggests a doubling of the number of private groundwater pumps (400 to 800), increasing groundwater use to 95,000 ML/yr. [8] providing significant benefit to the region.

However, the amount of groundwater available or used may not increase the total volume of available water in the region since a portion of the recharge results from the inefficient use of surface water and channel seepage. An increase in the efficiency of the delivery and use of the surface water system could therefore, in part, lead to the same benefits. The Farm Program aims to increase water use efficiency and decrease recharge.

Improved water availability by groundwater pumping can increase incomes in the SIR by allowing the irrigation of additional land, or permitting increased irrigation intensities or the sale of surplus surface water. Groundwater pumping can also provide flexibility for changes in cropping patterns, especially for crops with high water demands such as rice or cropping patterns which allow farmers to optimize their combination of rain fed and irrigated crops.

The additional irrigation water resource made available is the main reason for farmers to initiate groundwater pumping. In the past, to further encourage pumping, there was no charge for groundwater and there were no volumetric restrictions. This policy was effective in encouraging farmers into groundwater pumping which was one of the objectives of the SIRLWSMP in controlling watertables and salinisation. However, since the salinity of the groundwater is higher than the surface water, farmers tended to use groundwater more in periods of drought when surface water supply was limited. Farmers were well aware of the increased risks associated with use of more saline water and hence tended to restrict their groundwater use to drought periods, when they would pump as much as they could. Furthermore, due to restricted surface water supplies in drought periods groundwater was not always diluted with surface water as was intended.

***This was an institutional shortcoming of the organization responsible for managing groundwater, which was used more for managing large aquifers rather than small aquifers for irrigation induced salinity control.*** In general there was little monitoring of groundwater usage or of quality change over time, as there were no fees and there was little to meter groundwater pumping or keep record timing of usage or quality.

The desire to encourage groundwater pumping led to a loss of control and the desired objectives of salinity control were jeopardized. Thus, the SIR Groundwater Supply Protection Area declaration was required to develop a groundwater management plan and give control to Goulburn Murray Water, responsible for implementation of much of the on-ground works of the SIRLSWMP. The GSPMP has been developed to ensure that groundwater is used in a responsible and consistent manner aligned with the SIRLSWMP objectives.

Due to the "Cap", no additional surface water rights will be allocated. For areas where groundwater pumping is impossible, an increase in total water availability can only be obtained by purchasing water. Trading of water is limited by a number of factors such as the supply channels limiting the total amount of supply. Also Goulburn Murray Water has the right to stop water trading when it may affect the economic viability of providing infrastructure to an area. So far, it is unclear what the effects of water trading will be but it is expected that it will lead to an increase in water use efficiency and a relocation of water to the more productive irrigation areas. Although water-trading records are kept, it is still difficult to ascertain where water is going. Trading of surface water out of areas may affect the capability to implement groundwater pumping due to the need for a dilution component. ***This*** may affect the long-term sustainability of certain areas. ***This*** could be seen as part of the structural adjustment. The trading of groundwater rights is unlikely in the Shepparton Irrigation Region due to the localized nature of aquifers and the primary objective of pumping for waterlogging and salinisation control.

### *6.1.2 Timeliness*

In the SIR surface water deliveries are generally reliable, with farmers receiving all their allocations in most seasons and delivery to farmers is efficient. There are few problems regarding delivery as channels are well managed to ensure all users receive their water when ordered and the delivery time after order is generally only one day. The greatest restriction in surface supply is in the off season when channels are drained for maintenance. Thus irrigation supply is only possible for nine months of the year. There may be periods during the off season when it may be advantageous to irrigate pasture. Thus, a key benefit of groundwater use is that it can be used when surface water is unavailable e.g. in a dry winter or at the end or beginning of an irrigation season or when surface water is limited e.g. during a drought period. However, in these cases where surface water supplies are restricted, the groundwater may not be diluted to a safe salinity limit and can therefore lead to soil degradation and accelerated aquifer salinisation.

Under the groundwater management plan, farmers now have to pump consistently, at least 65% of the allocation each year. This provides better salinity control than previous management but considerably reduces the flexibility and timing of use. In wet years when groundwater pumping is most required to control water tables and soil salinity farmers are least likely to use groundwater. Even under the GSPMP rules they will only use the minimum 65% of allocation. Conversely in dry years when watertable and salinity control is less necessary the farmers will very likely use 100% of allocation. Although this will probably not result in the best achievement of the aims of the SIRLWSMP this may be the practical reality of ensuring that groundwater pumping by farmers is continued.

### *6.1.3 Salinity*

The groundwater salinity is higher than that of the surface water supplies. This is one of the main reasons that farmers prefer surface water even when it is more expensive than groundwater. The applied irrigation water needs to be ***'shandied'*** to a salinity of 0.8 dS/m on the basis that this salinity level results in low productivity losses, less than 15%. This value has been derived for pasture on Lemnos Loam soil. Although this is the dominant soil type in the area, it does not mean that this value is valid or adequate for each site, soil type and crop. The use of higher salinity water will lead to soil degradation and an accelerated salinisation of the aquifer.

In practice, a loss in production due to salinity can be offset by the increased irrigation intensity. The use of saline water in this case will not lead to production loss but can have significant impacts on the environment and especially the soil. This impact especially aquifer salinisation may be long term and irreversible.

In practice groundwater is not always diluted to 0.8dS/m because:

- Farmers do not measure the salinity of water from groundwater pumps; often assuming the salinity remains at the level when the bore was installed. Often these farmers do not understand the importance of measuring the water quality. For example, a large portion of the farmers does not return samples for water quality control by Goulburn Murray Water. In a particular case a farmer used saline water for a number of years until pasture death started to occur.
- Farmers will use more groundwater in dry years when not enough surface water is available for dilution. For them, reduced production due to saline water is better than no production at all. However, this factor disregards the soil salinity control objective and reduces the long-term opportunity for conjunctive water use by increasing the rate of aquifer salinisation.
- Farmers use groundwater when surface water is not available at all e.g. in a dry winter or at the beginning or end of the irrigation season.

Education and awareness programs for the farmers are needed to ensure that farmers use groundwater appropriately. This includes an appreciation of the long-term implications of over pumping groundwater in terms of aquifer salinisation. Better monitoring and implementation of conjunctive water use 'rules' in the SIR will also help to reduce these problems.

Groundwater pumping has lead to a higher salinity of the aquifer in the long term, this together with disposal of saline groundwater from public pumps will lead to a higher salinity in the supply and drainage channels. These higher salinity figures reduce the potential to dilute other groundwater pumping to the appropriate level. This brings into question the licensing of groundwater extractions, which are based on the availability of surface water for dilution. It is assumed that water from the Goulburn River has a salinity of 0.15 dS/m and water from the River Murray 0.1 dS/m. In reality surface water in the supply channel has a higher salinity. Disposal of water into channels is allowed to increase the salinity to a maximum of 0.8 dS/m and an average of 0.5 dS/m. These levels limit the opportunity to dilute groundwater to 'safe' salinity and increase the risk of the use of more saline water. Furthermore, it is expected that the salinity of the surface water will rise because of salinity problems in the hinterland (mainly dryland salinity in the Goulburn catchment). These long-term consequences need to be planned for conjunctive water use to be sustainable and equitably available in the long term.

### *6.1.4 Cost*

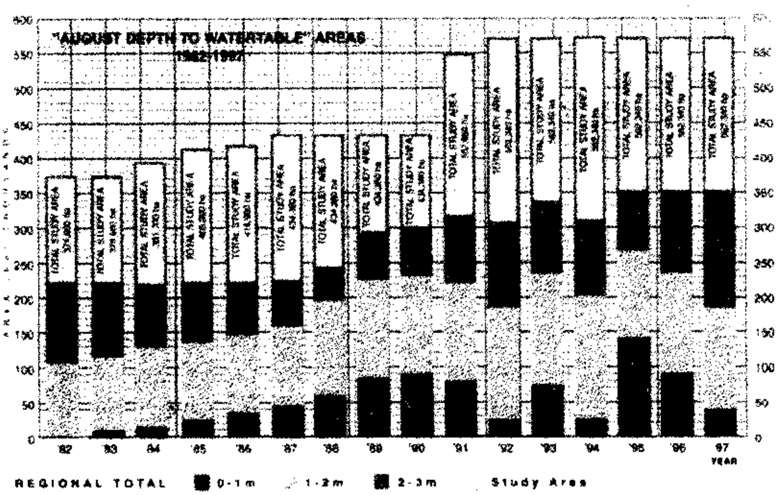
Although the installation of a groundwater pump requires a large investment, groundwater can be cheaper than surface water [48] and subsidies are available for the installation of groundwater pumps. These large subsidies are probably critical in developing and maintaining interest in groundwater pumping. For dairy and horticultural farms, the costs for water are only a small portion of the total costs, therefore water availability and quality is a more important issue than price.

## 6.2 Watertable and Soil Salinity Control

### *6.2.1 Watertable Control*

Groundwater pumping aims to induce or maintain a downward gradient/flux, which is important for salinity control and a local lowering of the watertable. The main criterion for measuring the performance of the SIRLWSMP and groundwater pumping is the depth to watertable over the region. Figure 8 shows the area of shallow watertables in the SIR between 1982 and 1997. The underlying long term trend is upwards for the region, however since 1995 there has been a general decrease in all categories. This can be a result of the implementation of the SIRLWSMP but also reflects the seasonal conditions of low rainfall experienced at that time. It can therefore not be said that the plan has effect.

**Figure 8. Total area under study and comparison of the areas at watertable depths of 0-1m, 1-2m and 2-3m. [8]**




More detailed analysis has shown that in some areas of the SIR groundwater pumping is having a positive effect on the lowering of watertables. These are areas with many groundwater pumps in aquifers with high yields and good natural drainage. It is possible that these areas are naturally adequately drained and do not need groundwater pumping for watertable or salinity control. Groundwater pumping has thus been for increased supply.

A lowering in the pressure in the shallow aquifer might lead to a positive difference in the head of the deeper aquifer (not the deep lead) and the shallow aquifer. Recharge areas will then become discharge areas. Because the deep aquifer is more saline than the shallow aquifer it results in a vertical/upward transport of salts. Lowering of the watertable also promotes lateral flow from more saline areas and thus imports of salts. The groundwater management plan prefers a lowering of the watertable of less than 1m to protect other users but this may be inadequate to control long term salinisation.

Although there has been a significant increase in Deep Lead groundwater extraction for irrigation mainly in the Campaspe Valley and the eastern Murray Valley, pressures in the deep lead system are rising. The increase in deep lead pumping has helped to maintain or improve deep drainage by stabilizing deep pressures over large sections of the region. However, significant rising pressure trends, probably accentuated by the wet climatic effects of recent years, are still being recorded in areas more distant from pumping. Continuing rises in the deep aquifer pressures will exacerbate the problems in management of the shallow watertables by reducing the deep drainage and increasing the volumes and salt loads, which need to be pumped from the shallow aquifers.

### *6.2.2 Salinity control*

Changes in soil salinity in the SIR are not monitored at the regional level. Specific areas of concern are monitored. There is little data to indicate the long-term trend in soil salinity in the region. Case studies have shown that groundwater pumping is effective in reclaiming saline areas, the Tongala project for example found that the topsoil (0-60 cm) salinity decreased from 2,400 to 1,200 mg TDS/kg dry soil [44].

In the SIR it is generally accepted that reuse of groundwater for irrigation will lead to an increase in aquifer salinity of 0.02- 0.05 dS/m per year [48]. In recharge areas, groundwater pumping has a positive influence on salinity as it lowers the watertables and salinity levels, due to flushing with fresh water. In discharge areas, on the other hand, groundwater pumping results in increased salinity levels. It is expected that some discharge areas will eventually go out of production as the groundwater salinity increases. Lowering of the watertable in the shallow aquifers promotes flow vertically from the deeper more saline aquifers and laterally from adjacent more saline aquifers. This increases the rate of salinisation of the aquifer and threatens long-term conjunctive water use.

Some groundwater pumping in the SIR has led to rapid salinisation of the aquifer, leading to dramatically reduced pumping or abandonment. This was found to occur where pumps were installed into small fresh water aquifers surrounded by larger saline aquifers. After pumping for some time the fresh water was degraded by intrusion of saline water. In these cases conjunctive water use by groundwater pumping could have been considerably extended if the pumping had been at a minimal level just sufficient for salinity control and groundwater mining would not have taken place. Monitoring of groundwater extraction and changes in quality has been minimal in the past. A new initiative since the Groundwater Supply Protection Management Plan inception is the introduction of five yearly reviews of licenses. The procedures for the review and withdrawal of licenses if necessary have not yet been determined. The problem of aquifer degradation is likely to be a major challenge.

Re-use of groundwater over an area smaller than the area of influence of the pump tends to concentrate salt under the area of reuse. This can occur when the groundwater is reused on a particular farm, whereas the area of influence of the pump often extends well beyond the farm boundary. Reusing the groundwater over as large an area as possible, maximizes the potential for mixing with good quality channel water which minimizes irrigation water salinity and resulting root zone salinity. Presently there is no mechanism to ensure that the groundwater is re-used over the entire area of influence. Also at present groundwater is reused by downstream irrigators when the groundwater is discharged in the supply channel. They receive higher salinity irrigation water without any benefit from reduced watertables and hence their sustainability is reduced.

The SIR has a Salt Disposal Allocation (SDA) from the MDB agreement that allows it to maintain a salt balance by exporting the salt load that enters in the incoming irrigation water. The minimum amount of salt that has to be removed from aquifers is the amount of salts that enter the area via surface water plus vertical and lateral regional groundwater inflow. Salt disposal for salt balance only takes account of the salt coming into the system from irrigation. Thus salt disposal may prevent groundwater degradation in an aquifer that has no inflow from the surrounding areas or lower aquifers and where groundwater is applied to the entire area of influence of the pump. Due to the complexity and small scale of the aquifer systems even with SDA's, the salinity of the groundwater around the pump site will increase, however, the average salinity of the aquifer will be protected' [49].

The present groundwater pumping regimes extract about 2-3ML/ha, which is considerably more than the 1ML/ha, which is generally accepted as the requirement for salinity control. This together with the current use of SDA's will result in accelerated aquifer degradation and thus reduce the period for which conjunctive water use will be possible. This is a critical trade off in the conjunctive use of groundwater for salinity control and willingness of farmers to pump. This may be acceptable in the interest of providing an incentive to adopt groundwater pumping. However management of the situation will be required to ensure that the long-term sustainability is not sacrificed for short-term gain

## 6.3 Improved Production, Equity and Return on Investment

### *6.3.1 Production*

Increased available water through groundwater pumping can be used for higher irrigation intensities or additional land being brought under irrigation and thus an increase in production. In the Tongala project, it was found that groundwater pumping increased the butter fat production from about 300 to 390 kg/ha. This was attributed to the combined effect of a reduction in average soil salinity in the top 60 cm of the profile and an increase in irrigation water use from less than 10 ML/ha to nearly 12 ML/ha [44].

For the region as a whole groundwater pumping is currently 45,000 ML/yr. and is expected to more than double by 2020. In these terms conjunctive water use is likely to contribute significantly to the economic development of the region. However, within the area there are large differences in productivity, larger farms are more water efficient and a large percentage of farms are too small and not economically viable. In these circumstances conjunctive water use should increase the economic sustainability of farms. However the gains from conjunctive water use may be wasted on those farms that are not economically viable, as there is a risk that those farms will be more likely to exploit the aquifer resource for short-term gain.

### *6.3.2 Equity*

#### *6.3.2.1 Social*

The SIRLWSMP and the GMP initiatives are based on farmers/community initiative and incentive schemes, rather than enforcement. This has some inherent advantages for the well-informed and large land (and water right) owners. Although there are subsidies, money has to be invested by the farmers themselves and since for a large percentage of farms it is not economically viable this may exclude many of the farmers from taking up incentives for implementation.

In general terms community involvement has been a keystone of water resource management in the SIR. 3.5% of SIRLWSMP expenditure is spent on extension of the plan. Other activities such as WaterWatch, SaltWatch and Landcare have also been effective in raising community awareness of resource management issues.

#### *6.3.2.2 Between Areas Within the Shepparton Irrigation Region*

The SIRLWSMP, GMP and other initiatives cannot protect the whole area against long term salinisation. In many areas groundwater pumping is impossible, as there are no adequate aquifers and the only alternative to groundwater pumping is sub-surface pipe drainage but this is more expensive and only feasible for high value horticultural crops. At the regional scale the programs for the SIR will enhance sustainability, but 10-20% of the area will be difficult to manage [50]. Plan managers accept that some land will go out of production. The community however, is not really aware of this and the structural adjustment that will occur.

#### *6.3.2.3 Between upstream and downstream areas*

Saline groundwater from public pumps is mixed into the supply and drainage channels for reuse by farmers downstream. These farmers thus receive more saline irrigation water and may not be in the area of influence of the groundwater pumping. This will reduce their sustainability due to increased salt accumulation in the soil and also reduces their opportunity to use groundwater by dilution. There is no overall plan or structure to address these issues as groundwater pumps are allocated on the basis of farmers making a request. As the implementation of groundwater pumping relies on farmer initiative, those who request a groundwater pump early in the process are more likely to be successful than those later in the process when the opportunity for groundwater dilution is reduced. In such a case alternative disposal such as evaporation basins may be required.

#### *6.3.2.4 Between regions*

Implementation of the surface and sub-surface drainage programs of the SIRLWSMP leads to an increase of the salinity of the river Murray and thus imposes a cost on downstream users.
The agreements in the salinity and drainage strategy of the MDBC set the salt disposal allocation for the region. The SIRLWSMP projects require 19.7 EC disposal units to the river Murray, however the salinity and drainage strategy has only allocated 10 units. This differential will have to be accrued by salt interception works elsewhere or by negotiation of salt disposal units with the Murray Darling Basin Commission and other users.

## 6.4 Optimising Expenditure

### *6.4.1 Capital costs*

Private pumps use less community funding than public pumps as the farmer pays majority of the cost and the authorities only provide a partial subsidy. However, the location of private pumps may not give the optimal density/distribution for groundwater control and hence the total costs are higher. This is due to reliance on farmer initiative in implementing pumping. However, the development of a plan of the optimal distribution of pumps would require an extensive investigation of all aquifers in the area, which would take considerable time and would be costly. This would probably delay the implementation of the program.

### *6.4.2 Short term versus long term gains*

The implementation of groundwater pumping for the SIR at present provides considerable gain in irrigation water and reclamation of salinised land. The trade off between these gains and long term aquifer salinisation is not clearly stated. At present, farmers can pump more than is necessary for salinity control. This increases the likelihood of lateral and vertical inflow of salts into the aquifer, resulting in increased rates of soil and aquifer salinisation. For long term sustainability the rate at which the finite resource of aquifer quality is consumed is important. Best estimates are that even with optimal groundwater management, aquifer salinity will increase at about 0.05dS/m per year. At present most management may be sub-optimal. However, if groundwater pumping is more restricted then farmers may not see a pump as a profitable investment and implementation of groundwater pumping will be limited.

In the long term education to promote salinity control and sustainability of groundwater pumping will be important, this may lead to a reduction in licenses to levels necessary for salinity control (average 1 ML/ha). More recently there does appear to have been a change in attitude as farmers are already starting to apply for subsidies for groundwater pumps more for salinity control reasons than supply.

To date most of the effort has been in implementing groundwater pumping. A new process of license review is now starting to address issues such as aquifer salinisation, proper dilution of groundwater and pumping management that is better aligned with salinity control objectives.

# 7 ANALYSIS OF INSTITUTIONAL ARRANGEMENTS

In the previous sections the key institutions and policies have been described together with some of the key issues/outcomes associated with conjunctive use of groundwater. It appears that for the present the objectives for conjunctive water use are being achieved but there are some long-term sustainability issues such as aquifer and soil salinisation. In this chapter the water management institutions are analyzed to examine if the institutional arrangements enhance or retard effective implementation and sustainability of conjunctive water use. Water management institutions discussed are laws and policies, water allocation rules and principles, water markets and management and regulatory organizations. Community participation and the communication structure between authorities are also considered.

Because the SIRLWSMP and the GWMP provide the basis for conjunctive use of water for salinity control, the arrangements for these plans are also analyzed in this chapter.

## 7.1 State Level

At a general level there is a clear and established legal framework for the ownership and management of water under the Water Act. All ownership of water is with the State that has allowed government institutions to manage surface and ground water. Private individuals need to have licenses before taking or using water. It is this arrangement that has allowed the government to control water use.

Thus it is the role of government to formulate a framework that allows for the integrated management of surface and ground water. This has not happened in the SIR in the past as groundwater was the responsibility of DNRE whilst surface water was controlled by GMW. It was only in 1995 under the Groundwater Supply Protection Management Plan that groundwater and surface water came under the control of one organization - GMW. The separation of control previously led to difficulties in that DNRE did not consider important the licensing and control of the shallow groundwater pumps with low volume installed for the SIRLWSMP. This may have been due to DNRE not having a very local outlook on management of large aquifers over big areas as their key role. This led to poor record keeping and a curtailing of the salinity control objectives in shallow groundwater pumping in the SIR.

DNRE still maintains overall control of water allocations in the State but does not provide individual allocations of water within irrigation areas. It is appropriate that there should be State control over the regional allocation of water to ensure regional and inter-regional environmental issues are adequately considered. It also ensures compatibility with State Government policy.

DNRE also regulates and controls the activities of G-MW. Annual reporting is required and each year it has to submit its' Corporate plan to the Minister for Agriculture and Resources to ensure compatibility with Government policy [13]. There is a clear separation of powers between the management authority (G-MW) and the regulatory authority (DNRE), minimizing the possibility for conflicts of interest.

## 7.2 Murray Darling Basin Level

The Murray Darling Basin Agreement is critical to water management as a whole. It acknowledges that water resources are shared between States and that activities in one State can have negative influences on downstream states. This agreement makes integrated management of water resources in the basin possible. As all decisions need a unanimous vote, these can not be imposed on the State of Victoria. The State Government therefore does not lose ownership or control over water within the State. However, the State has to manage salt disposal to the river within its' limits. The Salinity and Drainage Strategy of the MDBC sets the maximum amount of salts that can be discharged and thus ensures that the combined effect of different salinity plans in the Murray Darling Basin will not lead to an increase in salinity in the river Murray. This guarantees that improvements in salinity in upstream areas do not lead to problems in the downstream areas of Murray.

This has imposed restrictions upon the SIRLWSMP in that all saline drainage water cannot be simply disposed of to the river. This then requires conjunctive water use and reuse. When reusing saline water on farm or across the region the risks of environmental degradation in that area are increased. Effective institutional arrangements are required to be in place to manage the process.

New initiatives by the Murray Darling Basin Commission including "The Cap" and water market reform have the potential to fundamentally change the water resource allocation system and the cost of water. This may create a period of rapid change and structural adjustment. This will put pressure on the existing institutions to manage this process to minimize the environmental and socioeconomic impacts.

As the 'Cap' does not currently include groundwater, this may lead to an increased use of groundwater. As this water is likely to be more saline than surface supplies the Salinity and Drainage Strategy has to ensure that this does not lead to increased salinity in the rivers.

## 7.3 Regional Level

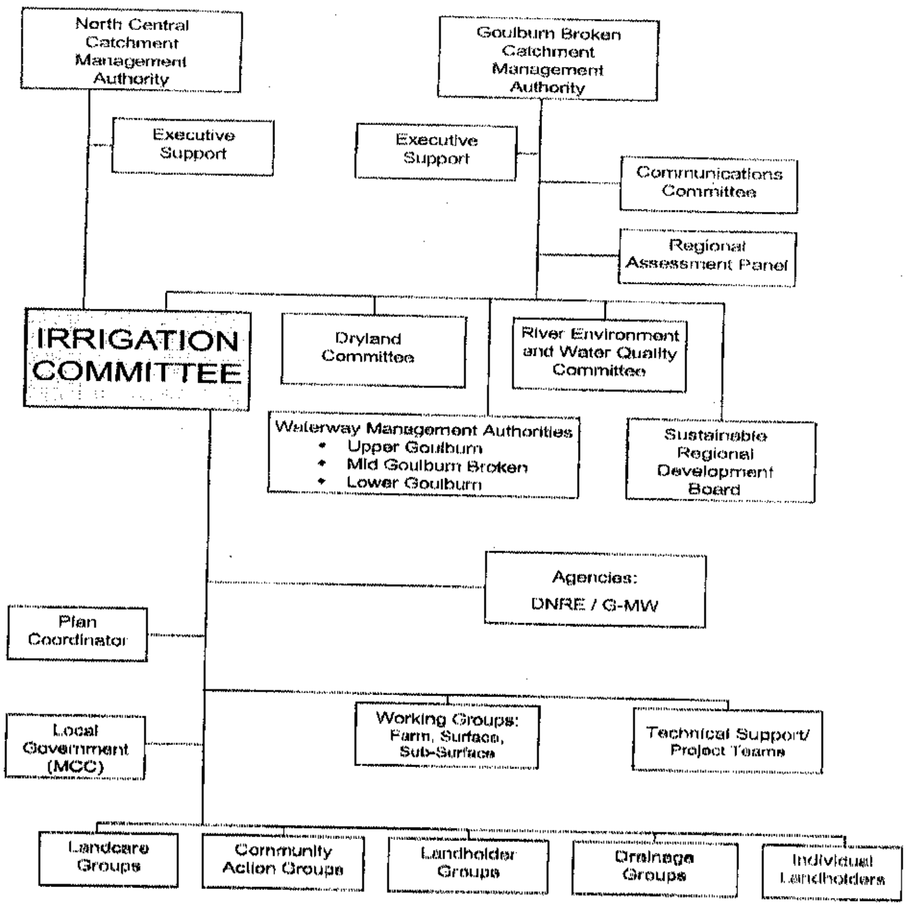
In the SIR the most important policies are the SIRLWSMP and the GWMP. The SIRLWSMP has been generally successful in implementing many on ground works by gaining the cooperation of many organizations. The SIRLWSMP started as a State and community plan, which the State has continually funded and supported. As new institutions such as CMA's have been introduced they have adopted the SIRLWSMP as their own for natural resource management in the irrigation areas. These plans therefore provide the focus for and integration between other policies. Importantly GMW has been a technically, financially and institutionally sound organization that has taken on most of the SIRLWSMP implementation.

G-MW as the management organization in the area, is now responsible for the allocation of surface and groundwater (since GSPMP implementation), providing integration of surface water and groundwater management systems and thus the ability to coordinate, control, plan and manage conjunctive water use. This provides for effective conjunctive water management with the integration of surface and groundwater management systems under one authority. Through the delegation of the responsibility for on-ground works of the SIRLWSMP to G-MW and its' requirement to meet environmental objectives such as watertable control in its' role as a Rural Water Authority.

The integration of the regional salinity plan into the catchment strategy is also essential, as aquifers (and natural systems in general) do not stop at administrative borders. Being a part of the catchment strategy and falling under the responsibility of the catchment management authority guarantees that the management of natural resources in the Shepparton Irrigation Region is not taken in isolation but as part of the wider environment. This increases the likelihood that influences from outside the region, such as increased salt inflow due to increased dry land salinity in the upper catchment, are considered. Furthermore, the integration of salinity mitigation actions with other environmental protection programs is more likely. If the SIRLWSMP were only a water management and allocation program outside the general catchment strategy, it may be successful in water management but may have a negative impact on water quality, ecology and wetlands. At present, the recycling of groundwater and drainage water under the SIRLWSMP can lead to increased nutrient levels in the water which affects the outcomes of the water quality program of the catchment strategy. However, the SIRLWSMP is part of the catchment strategy and thus the effect of these two programs on the objectives of the other is monitored and the strategies aligned to achieve the best outcome for both.

When considering the success of the SIRLWSMP it may be attributed to a number of factors such as the institutions responsible for it being at a local level rather than at a regional or distant national level, Figure 9. This high level of local control has also been maintained by the influence of the local landholders on the Irrigation Committee. This is most important for effective natural resource management. Funding from State Government for SIRLWSMP and the revenue generating capability of G-MW reflects the financial availability for the infrastructure developments, which are required to control salinity. Policies are developed at the regional, catchment, State and Murray Darling Basin Level. Both the State and the CMA's have adopted these plans and incorporated them in their policies.

**Figure 9. Institutions involved in the implementation of the SIRLWSMP [8]**




The SIRLWSMP and the GWMP were developed in close consultation with the community. The community is also involved in reviewing and adjusting the plans. The involvement of local government, including financial contributions to implementation of the plans, also ensures that the wider community is involved in the management of the regional natural resources. Salinity is therefore not an issue of farmers alone. This is a positive situation, in the Murrumbidgee Irrigation Area (NSW). For example the wider community was not prepared to contribute to the salinity management program through a general levy. It is beneficial that the whole community contributes to the solution, as salinity issue is not solely a farm-related problem. Salinity leads to environmental degradation and damages buildings and roads, affecting the wider community. Furthermore, farmers are not solely responsible for creating the problem, in the sense that society cleared catchment areas and developed irrigation areas so it has a role to play in restoring and protecting them[19]

Community awareness programs such as WaterWatch, WatertableWatch, SaltWatch have increased awareness and knowledge of environmental problems. This high level of awareness, together with a high level of community involvement and participation in the development and implementation of the management plans has resulted in the ownership of and acceptance of the plans by people in the Shepparton Irrigation Region. ***This enthusiasm is reflected in the current balance between government and community investment in the SIRLWSMP that is closer to 1:2, than the stated 1:1 cost-sharing objective for the implementation.***

As the plans have been developed in close consultation with the community, the community accepts them and will implement them. For example, groundwater pumping up to 3ML/ha is allowed while only 1 ML/ha is needed for salinity control. A trade off between environmental protection and community acceptance has thus been made. This additional pumping has been used to make groundwater pumping attractive to farmers for implementation. However, since this jeopardizes long-term sustainability, the allocation is now likely to be reduced, as the need for a greater incentive to pump is not required as the community accepts the benefits of groundwater pumping for salinity control.

The management plan is based on incentive schemes, community participation and farmers' initiative rather than rules and obligation. That is why it has been successful in encouraging community participation. At present there are no arrangements to deal with those areas that need salinity control measures in which farmers are unwilling or unable to implement pumping. As the plans are still in their 'initial phase' it is practical to use resources initially in areas where farmers are willing to implement the plan but this may become a problem in the future.

Presently there is no enforcement to ensure that farmers pump only their allocation or dilute groundwater to an appropriate level. Probably increasing awareness and knowledge of the farmers on the long-term consequences of over pumping and the use of more saline water will be more effective than attempts at strict enforcement. It has to be seen whether farmers will pump as required at least 65% of their groundwater allocation each year. This can be monitored if there are meters on the pumps, which are now being installed. ***This data is already collected for charging for groundwater use, thus compliance can than be dealt with through the licensing system.***

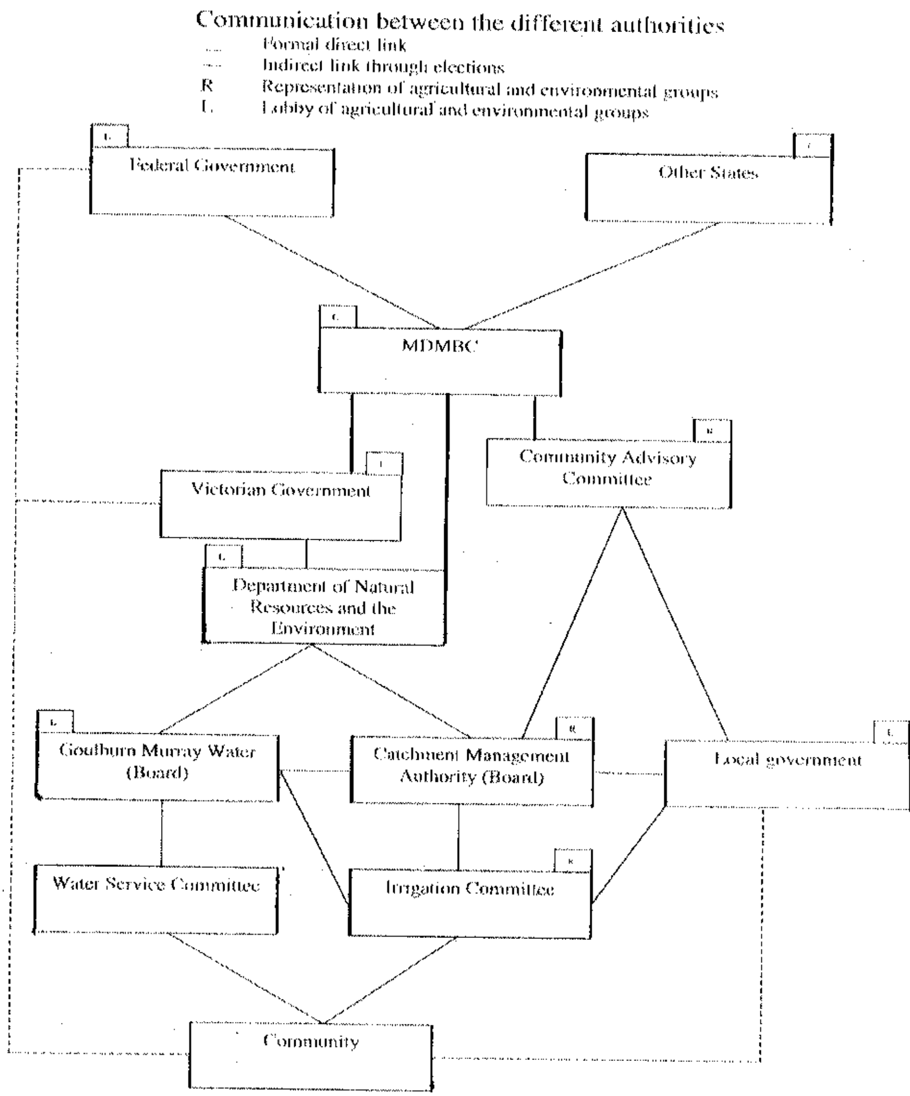
## 7.4 Linkages Between Authorities and Community Participation

There are many government agencies and committees for various plans and policies involved in the management of water resources in the SIR; good communication between them is essential for the development and implementation of coherent and integrated policies. In the SIR most authorities and organizations are represented on the boards or committees of others, or have responsibilities to each other. Thus there are many linkages, Figure 10. As often the same people meet each other on

[19] Dr Tom Hatton in: CSIRO Land and Water press release (13/5/1999) 'Australia losing battle against menace of salinity'

different committees and boards, there appears to be good linkages and communication between the different members and institutions [48].

**Figure 10. Formal linkages between the different authorities and the community in the SIR.**




Community involvement and participation is essential to develop policies that reflect the needs and wishes of society and suit the region, thus making effective implementation possible. Table 21 shows how membership is determined for the major institutions affecting the SIR, whether members are elected and if these members are drawn from the local region. Active communication between the authorities in the region and the community takes place mainly through the Irrigation Committee and Water Service Committees. As most decision-makers are drawn from the region it is to be expected that they have good informal communication with the community members as well.

Furthermore, they probably have a personal commitment to the region. This leads to measures that are more likely to suit the area.

Both the Goulburn Broken Catchment and North Central Catchment are members of the Community Advisory Committee (CAC) of the MDBC. The CAC only has an advisory role and thus can not prevent the development of MDBC policies that have a negative impact on the region. The Ministers on the MDBMC all have veto powers and thus can stop policies that have a negative impact on their State. As such representation of the community views of the Shepparton region at the MDBC is not strong and could lead to MDBC policies that slow the implementation of conjunctive water use in the Shepparton Irrigation Region. The MDBC can therefore by water allocation changes and other policies influence the acceptance, willingness and ability of the community to implement the SIRLWSMP.

The interests of the environment are represented in the CMA's through members of environmental groups on the board and a representative on the IC. The environment is represented in the CAC of the MDBC through the representatives of the Australian Conservation Foundation and the Australian Landcare Council.

**Table 21. Analysis of appointment to, and make up of key institutions.**

| | Appointed by | Elected by | Reports to / responsible to | Community consultation | Representatives drawn from |
|---|---|---|---|---|---|
| **Government** | | | | | |
| **Federal** | - | Australians | - | - | Australia |
| **State** | - | Victorians | - | - | Victoria |
| **Local** | - | Inhabitants | - | - | Shire |
| **CMA** | | | | | |
| Board | Minister | - | Minister** | - | Catchment |
| IC | CMA Board | - | CMA Board | Yes | Sub-catchment |
| **G-MW** | | | | | |
| Board | Minister | - | Minister | - | Catchment |
| WSC | - | Water users | G-MW Board | Yes | Sub-catchment |
| **MDBC** | | | | | |
| MDBMC | Relevant State ministers | | - | - | States |
| MDBC | MDBMC | - | MDBMC and states | - | States |
| CAC | MDBMC | - | MDBMC | Yes | Murray Darling Basin |

*C = from the catchment, R = from the region

**The community nominates the board members of the CMA's for appointment by the minister.

## 7.5 Water Allocation and Trading

Water allocation and trading is a critical area for conjunctive water management. Water trading is in its infancy and water allocation policies are being reviewed nationally. This has created a state of flux and uncertainty amongst irrigators.

At present the Minister allocates bulk water entitlements for surface and groundwater use in irrigation areas to the Rural Water Authorities. In the Shepparton Irrigation Region the bulk entitlement is divided amongst farmers in the area by G-MW. All allocations are volumetric and their maximum usage is set. Since payment is by usage, and the volume limited this encourages efficient water use.

The allocations for surface water are more or less historical while the shallow groundwater allocations are based on the surface water allocations (see 5.2.3). This provides safeguards against overuse of groundwater. It also should prevent farmers using water that is too saline, but this is not always achieved (see 6.2.2) and is impossible to enforce see **Error! Reference source not found.**. This is an area of concern in the allocation system as it could lead to an increased rate of soil and aquifer salinisation.

Water trading of surface water is possible but trading of groundwater is not allowed as groundwater pumping for salinity control takes places from small, shallow, localized aquifers. Thus trading a groundwater allocation to another area will not lead to the same salinity benefits for the area initially allocated. Trading of surface water is useful in moving water away from less productive land, thus reducing pressure on the requirement for groundwater pumping in those areas where salinity control is more difficult and expensive.

Groundwater Management Plans are currently being developed for the Campaspe and Murray Valley deep leads and transferable water entitlements will be considered as part of these plans. The groundwater management plans for the deep will estimate the sustainable yield and define conditions applying to licenses and to manage reductions in licenses when necessary. Trading within a deep lead system is a sensible proposition as the deep leads extend over large areas and are of reasonable to good conductivity. As pumping mainly takes place for water supply (control of the deep pressures is the secondary general benefit) the exact point of extraction is not critical.

Trading of surface water reduces the overall control of G-MW on the point of use of surface water and it can also reduce the State control over water as water can be traded out of the State. However, water trading provides an incentive for increasing water use efficiency and relocates water to the most productive areas. This assists in increasing water use efficiency and reducing accessions to groundwater and is therefore a useful tool in the control of watertable rise.

Although water trading is registered there is not an overview of where water is moving to, leading to uncertainty amongst farmers and water managers. G-MW and farmers need more information regarding the water trading process, especially interstate water trading. Furthermore the establishment of a regulatory body is required to control and monitor water trading.

# 8 DISCUSSION

## 8.1 Conjunctive Water Use for Salinity Control

Conjunctive water use in the SIR aims to prevent or mitigate salinity problems caused by over irrigation which has led to high watertables resulting in waterlogging and salinisation. Shallow groundwater pumping has been adopted rather than deep groundwater pumping for salinity control because the connection between the shallow and deep aquifer is poor in most areas.

Groundwater pumping for conjunctive water use has increased the total availability of water, increasing production and profitability of farms. This is not entirely an increase in available water to the SIR but more an increase in water available to the plant as a large part of the groundwater that is pumped is the irrigation loss component. Importantly in the SIR groundwater use provides more flexibility to the farmers as they can decide when to pump and irrigate. In the SIR conjunctive use of groundwater with surface water is necessary to lower the salinity of the groundwater to an acceptable level for irrigation. Use of groundwater alone for irrigation would only be possible in the short term. By conjunctive water use the continued use of groundwater for irrigation can be much extended. This is critical, as at present groundwater pumping is the only cost-effective salinity control measure for many areas.

The only alternative to conjunctive water use for watertable and salinity control in the SIR is to use tile drainage or groundwater pumping and discharge to the river. This alternative is restricted due to the constraints of the Murray Darling Basin agreement that restricts salt disposal to rivers. Thus groundwater has to be reused in the SIR as pumping and discharging all groundwater would lead to an unacceptable increase in river salinity. The overall need for groundwater pumping can be minimized if recharge through increased water use efficiency and surface drainage is reduced. The farm program and the surface drainage programs of the SIRLWSMP address these issues.

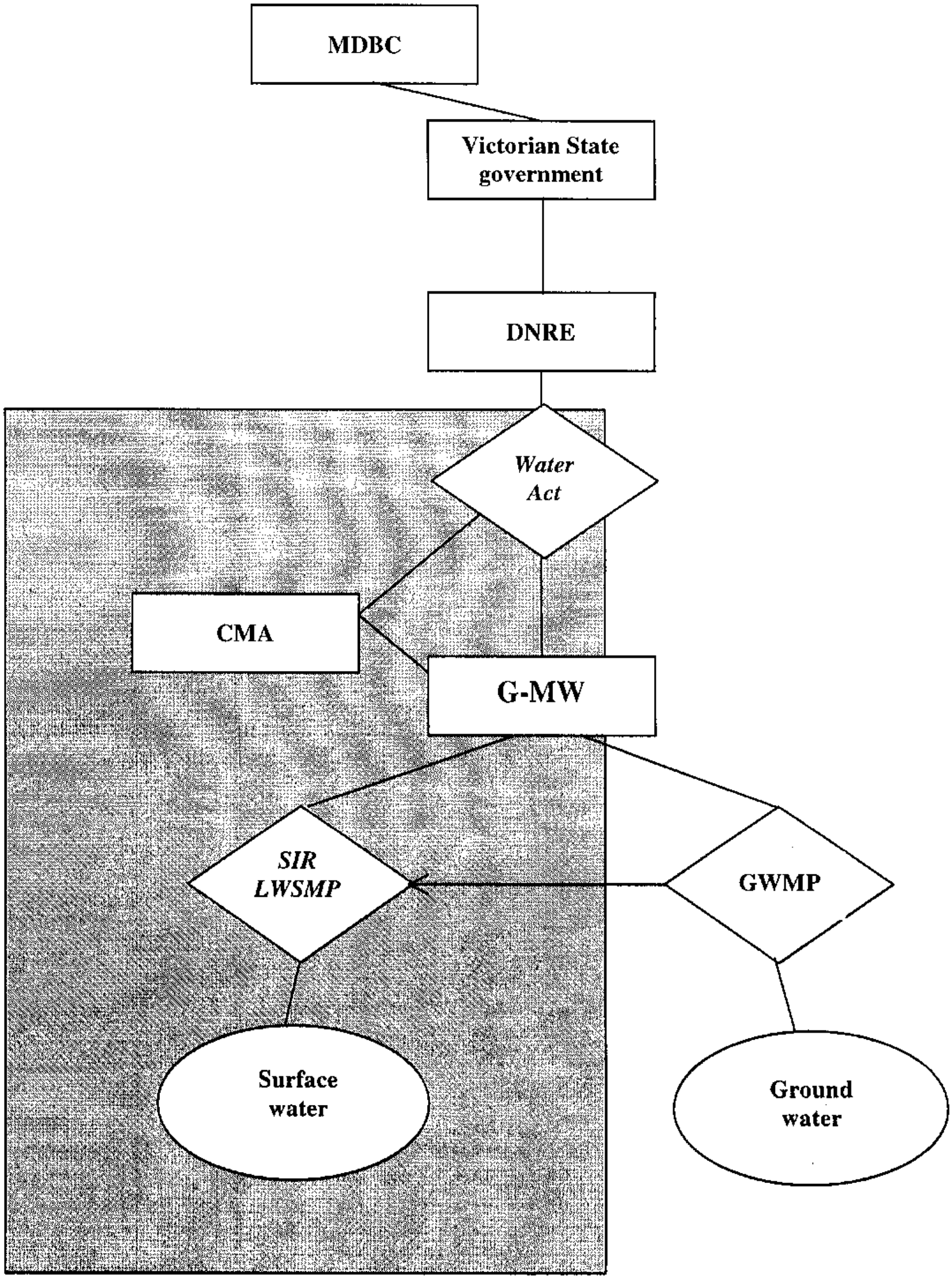
## 8.2 Institutional Arrangements

In the State of Victoria, ownership and control of water, both surface and groundwater, is vested in the State. This is fundamental to effective conjunctive water management as control over extraction and use must be clearly defined. It has then been up to the government to provide institutions for the effective and environmentally sustainable use of water.

Victoria has adopted the use of Catchment Management Authorities that oversee natural resource management issues in the entire catchment. Considering conjunctive water use for irrigation, the use of CMA's works reasonably well where irrigation is a significant part of the catchment. In the SIR the CMA's have been useful in providing integration between water management and other environmental management issues and between the irrigation area and the rest of the catchment. This is critical to having effective natural resource management; otherwise solutions to problems in one area of a catchment often lead to problems in the downstream area.

Conjunctive water use is the use of very different sources of water for different purposes. In the SIR there is a large supply of good quality surface water that is used for irrigation, groundwater pumping of poorer quality water has been implemented for salinity control. This requires the integration of surface water and groundwater management systems under one planning authority or user group. Historically separate authorities have controlled surface and groundwater, resulting in poor coordination and a lack of common objectives. This problem was identified in the SIR during mid 1990's, when control of groundwater was passed from a State agency to the local irrigation water supply authority. Thus now one central authority, Goulburn Murray Water, manages both surface water and groundwater. The institutional arrangements for the control of water in SIR are shown in

**Figure 11. Institutional arrangements in SIR (shaded area indicates MDBC authority)**



Before the Groundwater Supply Protection Area was declared, G-MW did not have control over groundwater, ***this*** was with a separate arm of the Rural Water Authorities at State level. ***This*** led to poor co-ordination and conjunctive management, as salinity protection was not being implemented properly. The key area of concern was that G-MW could not ensure that groundwater was pumped in a consistent and responsible manner as required for salinity control. Now G-MW is responsible for the management of both surface water and groundwater, implementation of the groundwater pumping options of the SIRLSWMP should be more effective.

In general terms in the SIR water allocation is effective in terms of sound principles and rigorous implementation by G-MW. Water use above allocation is not allowed and all water use is volumetrically measured and charged for. This provides clear incentives to increase water use efficiency. These water savings can be used to increase production or alternatively water trading.

Water trading is a new National initiative in Australia to maximise returns from water. This has provided a significant incentive to increase water use efficiency. Water trading takes place at a fairly large scale in the SIR, however these are private transactions with minimal assessment of environmental impacts by G-MW. Trading of the shallow groundwater is not allowed which is necessary for the salinity control objective that drives groundwater pumping in the SIR.

There is a high level of community involvement in salinity management that has been regarded as one of the main reasons for the success of the SIRLSWMP. Also interestingly the whole community (not just farmers) are involved and contribute financially to salinity management. Conjunctive water use is voluntary and there are incentives available for pumping groundwater thus enforced groundwater pumping is not required. However, the manner of pumping and use of water is not always as required. Strict enforcement is not considered the best option; instead the SIRLSWMP is implementing educational campaigns.

## 8.3 Sustainability Issues

Salt disposal is the key problem for the SIR (and most other irrigation regions in the Murray-Darling basin) as there is a limit to the total salt load the region can send to the river Murray system. Conjunctive water use of groundwater reduces the need for salt disposal and hence allows more widespread pumping. This enhances the effectiveness of shallow groundwater pumping as a widespread salinity management strategy for the SIR.

Although conjunctive water use is implemented to prevent or reduce salinity problems it can also exacerbate them. In the SIR, the greatest risk is that groundwater pumping leads to gradual aquifer salinisation. If groundwater pumping is properly managed then the process becomes slow, an increase in salinity of 2.5% per year or less. However, if there is over pumping or inappropriately sized aquifers are selected then the salinisation process can be much more rapid. These risks need to be carefully managed through adequate institutional arrangements, continued monitoring and farmer education. In the SIR there is a good linkage between organizations involved in managing groundwater pumping and between the community and these organizations. This is primarily due to inclusive implementation structures and the clear focus provided to the region by the SIRLWSMP. Especially the CMA's that provide regional direction and primarily the Irrigation Committee that has a good mix of farmers and agency people which ensures that implementation has a high level of local input.

# 9 CONCLUSIONS

From this analysis of conjunctive water use and management in the SIR it would appear that there is an appropriate mix of technological solutions with institutional measures to make conjunctive water use effective for salinity control in the region. Table 22, summarizes the key aspects of conjunctive water use and management in the SIR.

**Table 22. Summary of conjunctive water use and management**

| | |
|---|---|
| **Conjunctive water use** | |
| Surface water ~ 4 ML/ha | Yes |
| Groundwater ~ 2 ML/ha | Yes –shallow (<20m) |
| Objective of groundwater use | Salinity control |
| **Benefits of conjunctive water use** | |
| Salinity control | Yes |
| Increased supply (groundwater must be mixed with surface water) | Yes |
| Increased flexibility | Yes |
| Reduced costs | Insignificant |
| **Water management institutional issues** | |
| State owns and controls both groundwater and surface water | Yes |
| Groundwater and surface water managed by same organisation | Yes |
| Integration with whole of catchment | Good |
| Integration with other environmental issues | Good |
| Community involvement in environmental and water management | Good |
| **Water Allocation** | |
| Metered groundwater* | Yes |
| Metered surface water | Yes |
| Specified maximum allocation groundwater * | Yes |
| Specified maximum allocation surface water | Yes |
| Excess usage of groundwater allowed* | No |
| Excess usage of surface water allowed | No |
| Fixed fee groundwater* | Yes |
| Usage fee groundwater* | Yes |
| Fixed fee surface water | Yes |
| Usage fee surface water | Yes |
| Trading surface water | Yes |
| Allocation system promotes water savings | Good |
| **Sustainability** | |
| Aquifer salinisation | Potential long and short term problems |
| Salt export | Allowed within MDBC set levels |

* For groundwater these regulations have been in place but until recently have been inadequately enforced

As can be seen from the table the key conditions for effective management of a mix of water sources is present. Importantly, water is allocated, controlled and managed by the same authority, making effective implementation of conjunctive water use possible. As the purpose of groundwater pumping is for salinity control it seems appropriate and necessary that the same management authority is also responsible for salinity management, thus combining water management and environmental management. This has been effectively achieved in the SIR by use of G-MW.

Natural resource management is a catchment wide issue, as such the use of CMA's to provide the regional direction for this is important. They have been able to integrate the SIRLWSMP into the catchment strategy; thus conjunctive water use for salinity control in the SIR is integrated into total environmental management and into the total catchment.

Most importantly the community is highly involved in the salinity management and mitigation program. Involvement of the community is seen by the organizations as the key to success. Without the good will of the community the best institutional arrangements will not lead to effective implementation.

Considering these key elements it would appear that the SIR has the right mix of institutional arrangements for the effective implementation of conjunctive water use. Implementation of the institutional measures regarding monitoring and charging for groundwater have been weak in the past but are now being more effectively addressed. If this issue is effectively addressed then there does not appear to be any major hindrances in the successful conjunctive water management in the SIR.

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# 11 APPENDIX 1

## 11.1 Structures of the Murray Darling Basin Initiative

The Murray-Darling basin Ministerial Council is made up of ministers from each of the signatory governments and is the Initiative's decision-making forum. The Murray-Darling Basin Commission is the executive arm of the Ministerial Council, giving advice to the Council and carrying out its decisions. The Community Advisory Committee was established by the Ministerial Council to provide it with advice from the basin's wider community and to provide a two-way communication channel between the Council and the community. The involvement of the community is recognition of the fact that the governments can not fulfil the tasks on their own.

### *11.1.1 The Murray-Darling Basin Ministerial Council*

The Murray-Darling Basin Ministerial Council (MDBMC) is the policy-determining forum for the Murray-Darling Basin Initiative. Its prime functions are generally to consider and determine major policy issues of common interest to the contracting Governments. This concerns effective planning and management for the equitable efficient and sustainable use of the water, land and other environmental resources of the Murray-Darling Basin. Also to develop, consider and, where appropriate, to authorize measures for the equitable, efficient and sustainable use of such water, land and other environmental resources.

Being a political forum, the Ministerial Council has the power to make decisions for the Basin as a whole. Resolutions of the Council require a unanimous vote. This means that decisions taken by the Council represent a consensus of governmental opinion and policy across the Basin [38,39].

The Council consists of ministers responsible for land, water and environmental resources in each of the signatory or contracting governments with each government limited to a maximum of three members. An ACT Government Minister may participate in the deliberations of the Council but not in its decision-making. The Ministerial Council meets at least once in each year [38].

### *11.1.2 The Murray-Darling Basin Commission*

The Murray-Darling Basin Commission (MDBC) is the executive arm of the Murray-Darling Ministerial Council.

The prime functions of the Commission are to:

1. advise the Ministerial Council in relation to the planning, development and management of the water, land and other environmental resources of the Murray-Darling Basin;
2. assist the Ministerial Council in developing measures for the equitable efficient and sustainable use of the water, land and other environmental resources of the Murray-Darling Basin; and
3. equitably and efficiently manage and distribute the water resources of the River Murray in accordance with the Murray-Darling Basin Agreement to obtain the highest achievable quality and efficiency of use of such resources.

The Commission has the mandate to initiate, support and evaluate integrated natural resources management across the Murray-Darling Basin.

The Commission is an autonomous organization equally responsible to the governments represented on the Ministerial Council as well as to the Council itself. The MDBC consists of an independent president and two commissioners from each of the contracting Commonwealth and State Governments, these normally being chief executives or senior officials of the agencies responsible for water, land and environmental resources. An ACT representative may participate in the deliberations of the Commission but not in its decision-making.

The Commission draws upon a network of more than twenty working groups and committees, made up of experts in the various aspects of natural resources management and other areas for which the Commission is responsible. The staff of professional, technical and administrative officers has been divided into two groups:

- The River Murray Water Branch, operating as River Murray Water, which is responsible for operating and managing the River Murray System and its structures. Its primary services are water storage and delivery, salinity mitigation (operation of salt interception schemes), navigation and recreation and tourism.
  River Murray Water was set up from 1 January 1998 as an internal business unit of the Commission. A Board operating as a committee of MDBC guides the activities of River Murray Water. This arrangement is a first step on the path to creating River Murray Water as a statutory corporation [40].
- The Natural Resources Management Branch administering the provisions of the Murray Darling Basin Agreement, regulates the Water Business, and is responsible for Managing the Natural Resources of the Murray-Darling Basin through the Natural Resources Management Strategy and the Basin Sustainability Program [37,39].

### *11.1.3 The Community Advisory Committee (CAC)*

The Community Advisory Committee (CAC) was established at the first meeting of the Murray-Darling Basin Ministerial Council to advise the Council and to provide a two-way channel of communication between the Council and the Basin community.
The terms of reference of the CAC are to advise the Council and Commission:

- on natural resource management issues referred to the CAC by the Ministerial Council or Commission
- on the views of the Basin's communities on matters identified by the CAC as being of concern

Currently, the CAC comprises an independent Chairperson and 26 members, namely:

- twenty one state representatives chosen on a catchment/regional basis
- a representative from each of four special-interest "peak" organizations: the National Farmers Federation, the Australian Conservation Foundation, the Australian Local Government Organization, and the Australian Landcare Council
- a representative of the Aboriginal communities

The states and the ACT are responsible for nominating representatives to the CAC using guidelines set out by the Ministerial Council [41].