CHAPTER 7

IRRIGATION – EXPANSION AND INTENSIFICATION (1905-1960s).

7.1 Introduction

In 1905, irrigation development was revitalised throughout Victoria in the wake of significant new legislation, the Water Act of 1905. A new visionary, Elwood Mead, also emerged to carry forth Alfred Deakin's vision of transforming the northern plains into verdant farmland. Mead was the Chairman of the newly-created State Rivers and Water Supply Commission, and sought to tie irrigation development to closer settlement. He also introduced a system of compulsory payments for water in irrigation districts, and shared Deakin's belief that drainage provisions should be deferred until they were deemed necessary. Mead's policies provided the basis for the steady expansion of irrigation development and intensification of land use in northern Victoria, which continued into the 1950s and 1960s as the construction of major storages on the Goulburn and Murray Rivers encouraged the ever greater use of irrigation water. This increasing irrigation activity was not without environmental repercussions, particularly as irrigators tended to use water inefficiently (e.g., Gutteridge *et al.* 1970, p. 30). However, until the end of the 1960s, it was assumed that waterlogging and salinity problems could be dealt with locally as they arose, and they were not sufficiently serious to warrant any slowdown of development.

The major themes of this period are, once again, the influential role of individuals in the evolution of the socio-environmental system of the Goulburn Valley, as well as national and global economic impacts, and the effects of institutional intervention on environmental feedback relationships and resource use decision-making at various levels within the system.

7.2 Perceptions of irrigation

7.2.1 The Water Act 1905

In response to the fiscal and administrative failings of irrigation in northern Victoria after the turn of the century, the industry was restructured in 1905 under a new Water Act (e.g., Martin 1955; McCoy 1988; Powell 1989, p. 147). Like the Irrigation Act of 1886, the new Act was a landmark piece of legislation that precipitated significant changes in the course of irrigation and land use in the Goulburn Valley and other irrigated regions of the State.

The centrepiece of the 1905 Act was that all community-based irrigation trusts (with the exception of the privately-administered First Mildura Irrigation Trust) were abolished, and responsibility for the supply and distribution of irrigation water in Victoria was centralised within a new government body, the State Rivers and Water Supply Commission (SRWSC). The three-man Commission was to combine "the authority of Government and the initiative of private enterprise" (East 1958, cited by McCoy 1988, p. 12), and it was empowered to undertake and administer all aspects of irrigation and water resources management in the State, including the planning, construction and operation of water supply systems; the provision of flood protection and drainage works; advising farmers on water supply, irrigation and drainage matters; and various surveying and research functions (e.g., McCoy 1988, p. 13).

The 1905 Act also provided for the allocation of water rights in irrigation districts. This system was employed in California as a means of legally tying water resources to land that was otherwise of little value, and had been advocated for Victoria by Alfred Deakin in his 1885 Report as a means of preventing the monopolisation of limited irrigation water resources by individual landholders (Deakin also thought it would encourage more careful use of water by its concentration upon smaller holdings)(Deakin 1885, p. 46). Under the 1905 Act, water rights amounted to a compulsory charge to be paid by landholders according to the assessed suitability of their land for irrigation and the supply of water available to it. The provision was not imposed immediately as the lands would first have to be surveyed (McCoy 1988, p. 13), but the intention behind it was that irrigation was to become a profit-making business for the State. The Minister for Water Supply, George Swinburne, recognised that this would take some years (he reckoned twelve), but it was generally assumed that with proper administration this goal would ultimately be reached (Davidson 1969, p. 59).

7.2.2 Elwood Mead's vision of irrigation

In 1907, Dr Elwood Mead, an American irrigation engineer-administrator, was appointed to head the SRWSC (succeeding Stuart Murray, who had been appointed the Commission's first Chairman, but was of retirement age). A "pushy technocrat" (according to Powell 1993, p. 31), Mead had been employed initially by the Victorian Government as a consultant, but he saw an opportunity to put into practice ideas generated from his experiences in the American West, where private irrigation developments had often been ruined by what he perceived to be human failings (Kluger 1992 p. 57; Powell 1993, pp. 31-32; Russ 1995 p. 66). As Tyrrell (1999, p. 155) observes, Mead's interests were less in the technical aspects of irrigation than in its potential to transform dusty landscapes into 'ideal' rural environments of small, aesthetically pleasing farms and close-knit communities. In Victoria, Mead served as SRWSC Chairman until 1915 and, like Alfred Deakin before him, emerged as a visionary individual who profoundly influenced the course of irrigation development in the State.

Like Deakin, Mead believed from the outset that irrigation was vital to Victoria's economic future. He perceived that irrigation water could be feasibly delivered to a million acres (approx. 400,000 hectares) of land, which would substantially boost regional employment, population and trade, and (importantly to the

Table 7.1: Changes in the areas irrigated during the tenure of Elwood Mead as SRWSC Chairman (1907-1915).

	Area irrigated (hectares)					
Year	Rodney	Shepparton	Tongala	Goulburn Valley TOTAL	VICTORIA TOTAL	VICTORIA Change
1905-6	12,797	-	-	12,797	87,792	+20,752
1906-7	9,350	-	-	9,350	41,712	-46,080
1907-8	24,472	-	-	25,472	93,893	+52,181
1908-9	14,630	-	-	14,630	71,580	-22,313
1909-10*	13,094	-	-	13,094	55,755	-15,825
1910-11	10,323	409	-	10,732	62,265	+6,510
1911-12	18,388	851	349	19,239	93,012	+30,747
1912-13	15,626	1,759	2,005	19,390	101,167	+8,155
1913-14	18,675	3,009	3,870	25,555	128,404	+27,237
1914-15**	31,755	5,162	7,337	44,274	324,345	+195,941
1915-16	17,103	4,409	5,053	26,565	288,007	-36,338

Source: SRWSC 1906-1916.

** Mead's closer settlement strategy introduced 1909-10.*

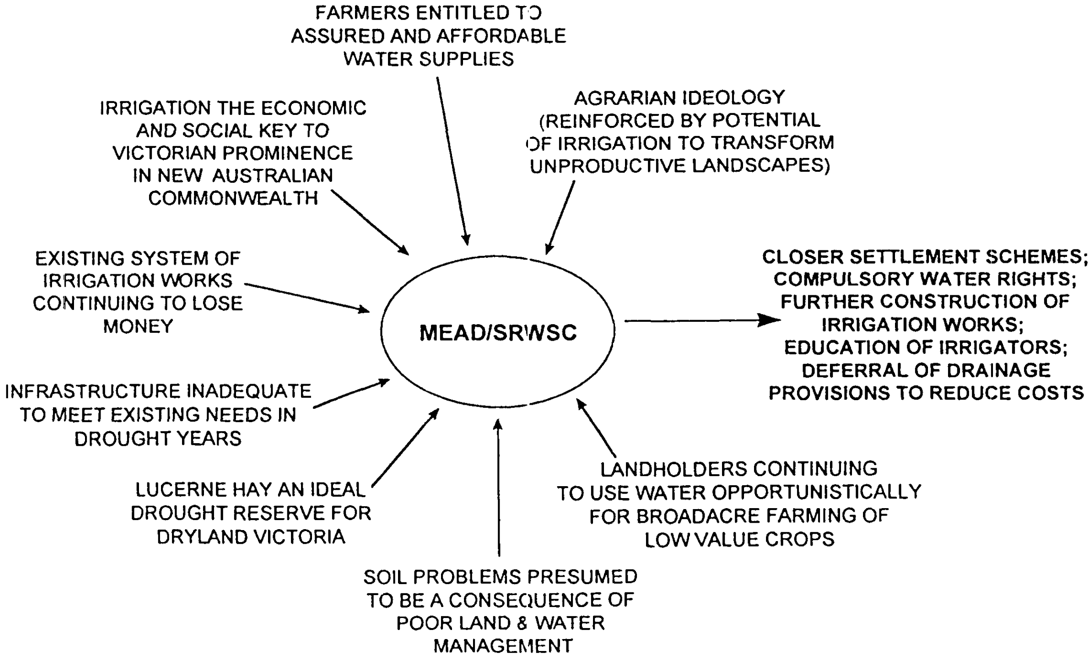
*** Drought year*

Victorian Government) help to secure for the State a prominent position within the new Commonwealth (Mead 1909). At the time of Mead's arrival, however, development in northern Victoria had reached a point of stagnation. In the Goulburn Valley, despite the extensive irrigation works, less than 10,000 hectares were watered in the 1906-7 season (Table 7.1), or only one-sixth of the area commanded by the channels. There were less people in some districts than before the channels were built, and of the water used, most was applied to cereal crops, lucerne or pastures, and often only on an irregular basis - in other words, irrigation of "the cheapest possible crops in the crudest possible way" (SRWSC 1908, p. 8).

Critical of the Victoria's existing irrigation legislation, but in concurrence with Deakin's ideals, Mead's conclusions and recommendations concerning irrigation development in the State were as follows (Figure 7.1):

1. Land settlement. The Trust system had failed because of faulty land settlement. Water had been provided across large areas primarily for the benefit of widely-spaced dryland farmers, who were averse to regular and efficient use of irrigation water. Further irrigation development could only be successful, and self-financing, if it was based on closer settlement and intensive, irrigation-dependent farming systems that made consistent use of the available water (Mead 1909, 1920).

Figure 7.1: Situational interpretation of SRWSC Chairman Elwood Mead regarding irrigation development in Victoria, 1907-15.



Mead recommended accordingly that land should be acquired in every irrigation district for subdivision and closer settlement. His principal idea was to develop 'model' settlements in carefully chosen but as yet under-developed areas with good soils and assured water deliveries for the intensive cultivation of orchards and lucerne. Holdings would vary in size (from 8 to 80 hectares) according to soil type and proximity to markets. Settlers would be found to farm these blocks, preferably from local areas, although also from overseas if necessary. The Government was to be repaid for the land and development costs, including land preparation and grading, but the terms of repayment should be liberal (McCoy 1988, p. 13; Rutherford 1974).

Mead's presence on both the SRWSC and the Lands Purchase and Management Board facilitated the development of these schemes, and by 1910 most of his suggestions had been adopted (Kluger 1992, p. 65; McCoy 1988, p. 14). Two main regions of the State were identified as suitable for irrigated closer settlement: the Murray Valley between Echuca and Swan Hill, and the plains between the Goulburn and Campaspe Rivers. The latter region, which included much of the Goulburn Valley, was well served by gravitational water supplies from the Goulburn system, and land was sought close to existing major channels to expedite development (Royal Commission on Closer Settlement 1916). Sites were chosen at Kyabram and Tongala for dairying and mixed farming, and 3,700 hectares of farm land were also purchased around Shepparton, where the fruit-growing settlements of Grahamvale, Orrvale and Shepparton East came into being between 1910 and 1912 (Tables 7.2, 7.3)(James 1938, pp. 33-35; Rutherford 1974; SRWSC 1913).

Table 7.2: Closer settlement in Goulburn Valley irrigation districts, 1915-16.

Settlement	Total area (hectares)	Original no. of holdings	No. closer settlement blocks	Average area (hectares)	No. of families/ blocks occupied
Shepparton*	3,741	21	249	14.8	245
Kyabram	1,234	7	31	12.9	25
Tongala	6,163	31	247	25.0	196
VICTORIA TOTAL	48,382	172	1,881	22.1	1,477

Source: SRWSC (1916).

** Includes Grahamvale, Orrvale and Shepparton East closer settlement estates.*

Table 7.3: Crop types in Goulburn Valley irrigation districts, 1915-16.

	Area irrigated (hectares)						
Settlement	**Cereals**	**Lucerne & perm-anent fodder crops**	**Sorghum & other annual fodder crops**	**Pastures/ grass**	**Vineyards orchards & gardens**	**Misc. (incl. fallow)**	**TOTAL**
Shepparton	393	2,245	417	-	1,225	130	4,409
Rodney	87	7,909	405	5,262	2,792	645	17,103
Tongala	401	2,936	254	629	512	320	5,053
Goulburn Valley TOTAL	883	13,091	1,076	5,892	4,529	1,095	26,565

Source: SRWSC (1916).

Mead had calculated that 30,000 new settlers would be required for irrigation in Victoria to become profitable (SRWSC 1909). However, immigration to the State was almost non-existent in the years immediately following Mead's arrival, and the existing urban population viewed irrigation as an arduous and risky venture (Kluger 1992, p. 65; Powell 1989, p. 155). Mead's response was to embark, in 1910, on a tour of Europe and North America to study irrigation and intensive culture methods, and to recruit settlers and farm labourers for Victoria's irrigation districts. Immigration to the State subsequently rose (e.g., 6000 people arrived in Victoria in 1910-11, compared to 1,500 in the three years previously), although Australia as a whole was attempting at that time to boost its population and Mead's specific contribution is debatable (Broome 1984, p. 132; Kluger 1992, p. 66; Rutherford 1974).

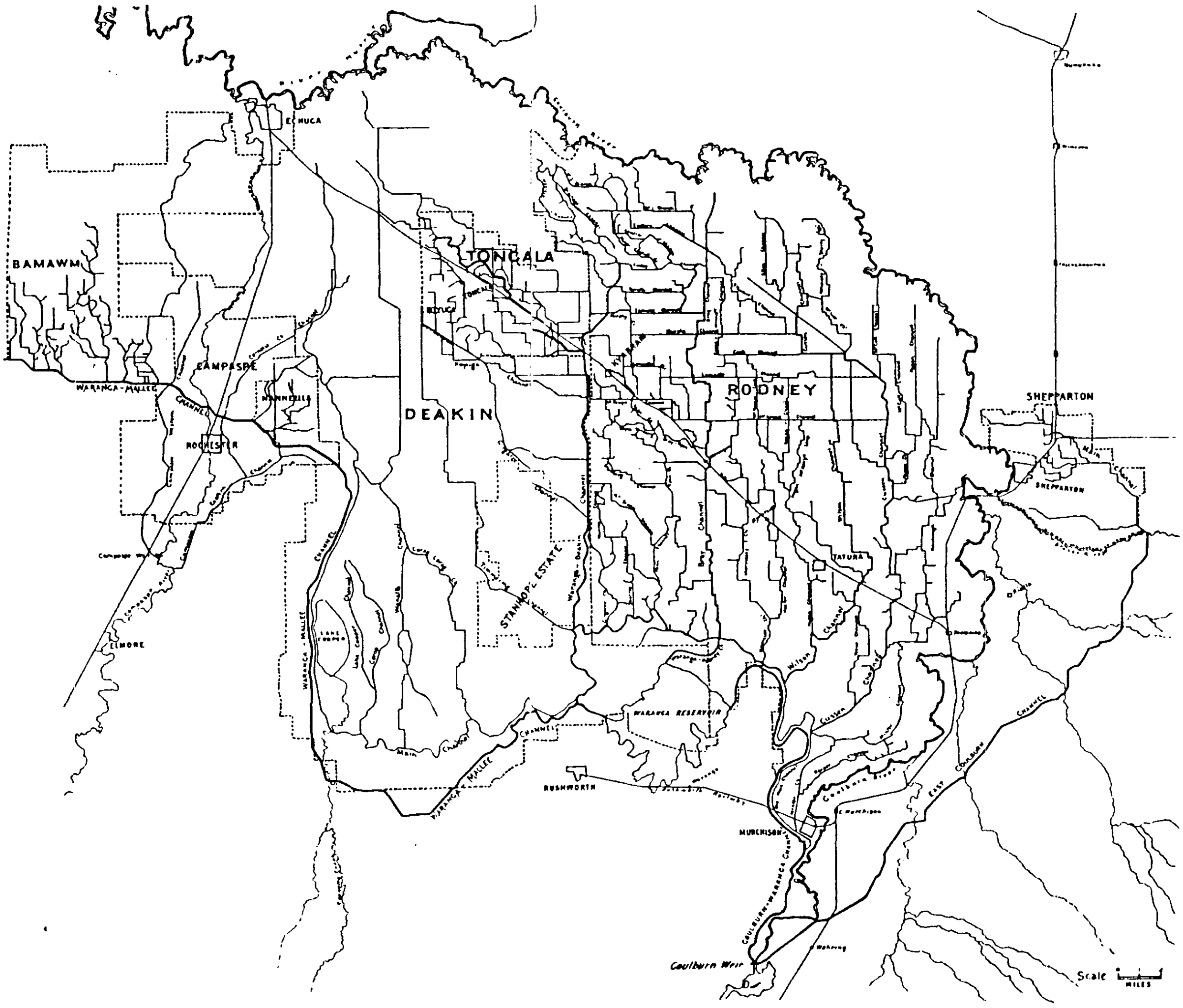
The number of settlers in the irrigation districts increased in any case after 1910, as did the area of irrigated land, with most of the increase occurring in the new closer settlement districts (Tables 7.1, 7.2). It helped that the rural economy was buoyant at that time, and prices for irrigated produce firmed as improved handling and transport facilities generated marketing opportunities both within Australia and abroad (Dingle 1984, p. 127; Rutherford 1974, p. 130). The State continued, meanwhile, to advertise for new settlers, and circulated booklets in Britain and North America that were full of Arcadian optimism. Would-be immigrants were assured that there was "practically no risk" for a families who farmed in Victoria on "sound and progressive principles" (Cherry 1913, cited by Broome 1984, p. 132), while Mead wrote, in *Handbook to Victoria* (1914), that the chances of success were even greater with irrigation, and that it was possible to make "a comfortable living off 10 to 20 acres [4 to 8 hectares] of land" (Mead 1914, p. 259).

2. Water supplies and infrastructure: Mead concluded that successful irrigation in Victoria had also been hampered by erratic river flows, and that more reservoirs and larger canals were needed to assure adequate and reliable supplies of water (Kluger 1992, p. 62).

In the Goulburn Valley, various channels were constructed during Mead's tenure, including, in 1910, the East Goulburn Main Channel, which enabled irrigation development to resume in the Shepparton district, 26 years after it was halted in the aftermath of the Pine Lodge disaster (Figure 7.2)(McCoy 1988, p.16; see page 120). The Waranga Basin storage was also completed in 1909, although plans were made within five years to increase its capacity as the existing Goulburn system was stretched beyond capacity during a severe drought in 1914. Mead complained that irrigation had by that time spread over too great an area (44,000 hectares, including 800 hectares of orchards in the Shepparton district) to be supplied by the available storages even in regular years. Construction was begun accordingly in the following year on a long-proposed large reservoir at Eildon, on the Upper Goulburn (e.g., Horsfall 1965). At the same time, Victoria, New South Wales and South Australia together with the Federal Government, negotiated an Agreement[1] to utilise the waters of the Murray River, and formulated plans for a series of storages, weirs and locks to be built on that river. Davidson (1969, pp. 76-77) suggests that it should have been evident by this time that the cost of the capital works would never be recovered, but each State considered that further investment in irrigation was necessary for further settlement of people on the land, and that farmers were entitled to assured and affordable supplies of water.

[1] River Murray Agreement, 1914. This allowed for the waters of the Murray River to be shared between the three States according to the following principles: South Australia, as the downstream State, was granted a guaranteed minimum flow; waters upstream of Albury were shared equally between Victoria and New South Wales; downstream tributaries belonged to the State in which they originated (Langford *et al.* 1999, p. 51).

Figure 7.2: Irrigation works in the Goulburn Valley, 1914 (from Mead 1914).



3. The education of irrigators: Mead perceived that successful irrigation development required more than engineers and irrigation works. Attention also needed to be given to economic and agricultural problems, as well as to the irrigators themselves, who were often without capital or experience, or were perceived as lacking the discipline required for success (Mead 1908a, 1909; Rutherford 1974).

Mead's solution, in part, was the publication of numerous articles for farmers on recommended irrigation techniques. These included furrow methods for orchards and row crops, and controlled flooding systems, such as the border-check and contour-check methods, for lucerne, broadacre crops and pastures (e.g., Mead 1908b, 1910; Kenyon 1908; Tolley 1911). The latter method involved the subdivision of paddocks into smaller bays via the erection of check banks along contour lines and at appropriate cross-intervals, and Mead thought it to be particularly suited to the gently sloping land of the Goulburn Valley (Mead 1908b).

Mead envisioned that horticulture and dairying would be the principal forms of land use in the new settlements, but he also advocated the growing of lucerne. In a series of articles in the Victorian Journal of Agriculture, he argued that lucerne hay was a superior winter feed that would enable stock carrying capacity to be substantially increased. The crop would also add nitrogen to the soil and improve soil physical characteristics, thereby promoting the success of irrigation of other crops. More importantly, however, Mead believed that Victoria's irrigated areas should serve to protect dryland pastoralists in times of drought, and that the production of lucerne hay was thus of economic necessity to the State (Mead 1908b, 1908c, 1910).

Mead's thinking was derived from his experiences in America, where lucerne was widely grown. He appreciated that Victorian growing conditions were different, but expected that local irrigators would be able to devise suitable methods of production, and would ultimately reduce their dependence on grazing in favour of hand-feeding lucerne hay to their stock (SRWSC 1908). As an incentive, he initiated a lucerne hay competition, and in the Goulburn Valley the SRWSC established two experimental and demonstration farms in 1910, on the Wyuna closer settlement estate and at Tatura, so that farmers could see these practices for themselves (Mead 1908c, 1910).

4. Compulsory water rights: As he continued to seek ways to make irrigation a profitable venture for Victoria, Mead raised the question as to whether it was better to leave conditions as they were, "thus avoiding opposition to change," or to take the steps necessary to bring about full development (Mead 1909, p. 494). His own opinion was that it was a situation where the welfare of the State should be placed above the inclinations of individuals, and he was certain that landholders would come to regard life under irrigation as "infinitely superior" once they understood its methods and recognised its advantages (Mead 1909, p. 494).

Worster (1985, p. 184) describes this approach to irrigation as more akin to empire building than agrarian reform. However, Mead's political overseer, George Swinburne, recognised the need for more forceful State involvement if Mead's policies (and Deakin's original vision) were to succeed (Tyrrell 1999, p. 156), and in 1909, the Victorian Government passed new legislation to impose compulsory water rights based on specific allocation volumes. Landholders in irrigation districts were obliged accordingly to pay for water whether or not it was used, and irrespective of land quality. By this means it was presumed that they would either learn to irrigate effectively or sell their holdings to others who were prepared to do so (McCoy 1988, p. 13).

Water allocations were to be based on the commandability and suitability for irrigation of the lands in each district, as well as the number of properties and the volume of water available for supply (McCoy 1988, p. 50). In the Goulburn Valley, in closely settled irrigation districts such as Tongala and Shepparton, water was allocated on the basis of one acre-foot per acre (3 megalitres per hectare) per year. In areas with larger holdings, as in Rodney and North Shepparton, the allocation was one acre-foot per five acres (0.6 megalitres per hectare)(McCoy 1988, p. 51).

The charges for water were to be based on the actual cost of supply. Mead's aim was to generate sufficient revenue to cover the cost of management and maintenance of irrigation works, interest and redemption of capital costs, and depreciation of machinery and structures (McCoy 1988, p. 13). As compulsory charges were opposed by landholders, however, amounts were brought down to about a quarter of Mead's original estimate, and much land was initially classified as unsuitable for intensive irrigation (Powell 1989, p. 155; Rutherford 1974). Political pressure from irrigators[2] helped to keep the charges consistently below the cost of supply in succeeding decades (i.e., irrigation water was regarded as a social rather than an economic good)(Kellow 1992, p. 33; Langford *et al.* 1999), and a 1932 Royal Commission into the financing of irrigation capital works upheld the principle that irrigators should not have to pay for capital costs, and that these should continue to be borne by taxpayers (Langford *et al.* 1999, p. 8; McCoy 1988, p. 61). For farmers who used all of their allocation, or sought additional supplies, the water was relatively cheap, and much was applied to low-value grazing land and areas of poor soils because irrigators were almost always guaranteed a financial return from its use (Kluger 1992, p. 64; Mehanni 1978; Russ 1995, p. 68).

5. Drainage issues: Provision for effluent disposal, both on-farm and on a district-wide basis, was an issue that had been alternately raised by engineers as a necessity (e.g., Christy 1863; Gordon & Black 1883, McKinney 1883, 1893; Smyth 1979), and dismissed by politicians (Deakin 1885; McColl 1883) as something that could be dealt with in the indeterminate future, should it become warranted. Mead upheld this latter view in Victoria, although his American experience had taught him of the ecological dangers inherent in irrigation schemes, and his SRWSC colleague, Commissioner John Dethridge, an engineer, was also well aware of the importance of drainage (Haskew 1996, p. 88; Worster 1985, p. 154).

During Mead's tenure in Victoria, perhaps the strongest warnings about the need for drainage came from the agricultural engineer Albert Kenyon, who pointed out that the experience of all other countries in which irrigation was practised was that irrigation and drainage were "inseparable," and of the two drainage was the more important. The same was already proving true in the Mildura district of north-western Victoria, where watertables had risen into the root zones of fruit trees, and in the poorly-draining Goulburn Valley, "it will not be long ere drainage will be compulsorily resorted to by orchardists" (Kenyon 1907, p. 207). Kenyon added that the need for subsoil drainage at Mildura had been masked by other mistakes (e.g.,

[2] As Kellow (1992, p. 33) notes, the Upper House of the Victorian Legislature long evinced a pro-rural bias, due in large part to the political leverage maintained by the rural-based Country (now National) Party as coalition partner to the State's predominantly Liberal Governments.

channel seepage, inappropriate varieties of orchard trees), but that the spectacle of such dry country requiring pipe drains should give food for thought to those either practising or advocating irrigation elsewhere in Victoria. Surface drainage systems were also necessary to deal with runoff arising from the occasional heavy rainfall that occurred across the northern plains (Gutteridge *et al.* 1970, p. 158; Haskew 1996, p. 48, p. 88).

The drainage problems in the Mildura district were compounded by salinity, which began to affect other irrigated parts of the Mallee around that time. In the Cohuna district, where the soils were inherently saline, the problem was considered serious enough by 1910 to warrant intervention, but the SRWSC remained reluctant to provide the necessary drains. The geological history of the State had not been determined at that time, so there was some debate as to whether the salting was caused by seasonal flooding or excessive water use on the part of irrigators, and it was not until 1913 that the construction of surface drains was finally begun. By that time the acreage affected by salinity had risen ten-fold, to nearly 500 hectares, or ten per cent of the Cohuna settlement district (Royal Commission on Closer Settlement 1916).

Mead's overriding concern, at Cohuna and elsewhere, appears to have been cost. He did not want the SRWSC to divert funds from irrigation development unless specific instances could be identified where drainage presented the only solution to watertable problems (Royal Commission on Closer Settlement 1916). Alfred Deakin had been of this mindset also, and it was embraced in Victoria by Irrigation Trusts, private developers, and Closer Settlement Boards, as well as the SRWSC. All of these organisations were involved with the subdivision and preparation of land for irrigation, and all preferred to omit drainage considerations from settlement plans as a means of keeping costs down and avoiding construction delays[3] (Russ 1995 p. 92; Wadham 1967, p. 141; Weston 1971).

On individual farms, drainage was assumed to be the responsibility of landholders. Complementary options included surface drains, constructed on low-lying ground to carry off surplus water, and sub-surface tile, or agricultural pipe drains. The latter were perceived as "old world" technology, and they were expensive to install (£6 to £7 per acre in the early 1900s), but they were also reasonably effective, particularly in more permeable soils once they became saturated (Kenyon 1907; Haskew 1996). As Kenyon observed, however, neither collective drainage works nor provisions for individual farms, were likely to eventuate unless better methods of irrigation were adopted and the profitability of irrigated

[3] This policy still applies in some jurisdictions. David Hopper, World Bank vice-president for South Asia, admitted in 1996 that rate-of-return criteria did not generally allow the Bank to support irrigation projects with adequate drainage in that part of the world "because the drainage added too much to present costs in relation to its discounted long-term benefits". Drainage in South Asia cost up to five times as much as an irrigation supply system, so, according to Hopper, the World Bank could only justify drainage projects once irrigated land had been taken out of production by waterlogging and salinity (Wade 1997, pp. 661-62).

agriculture increased to such an extent that drainage costs appeared insignificant by comparison (Kenyon 1907). The obstacle existed that at all levels of decision-making the disposal of waste water was perceived as a financial 'sinkhole' - an opportunity cost that offered no visible contribution to productivity or return on investment (Russ 1995, p. 88).

As at Cohuna, some drainage works were nevertheless undertaken in various localities to combat emergent problems. The SRWSC began construction of surface drains in the closely settled fruit-growing areas around Shepparton, for example, to remove surplus water following two excessively wet years in 1916 and 1917 (SRWSC 1916). A pattern was subsequently established of drains being constructed in response to local crises, while in dry seasons the attention of farmers and politicians alike invariably returned to irrigation matters (Barr & Cary 1992; SRWSC 1936). The SRWSC admitted in 1965 that although drainage had not been neglected, progress had lagged far behind storage and distribution. The ratio of the length of irrigation channels to surface drains needed to be 1 to 1 for fully effective drainage, but averaged only 1 to 0.435 across the Goulburn Valley, meaning that hundreds of miles of drains would eventually have to be constructed to remove storm waters and prevent waterlogging (Horsfall 1965).

Some parts of the Goulburn Valley ultimately came to be better protected than others. In the Shepparton district, where much of the land was used for intensive horticultural production, the ratio of channels to drains was 1 to 0.61 in 1936, and 1 to 1.03 by 1965. The land and its produce were perceived as being sufficiently valuable to be worthy of protection from waterlogging and salinity, and local prosperity meant that farmers could contribute to drainage schemes (Horsfall 1965; Russ 1995; SRWSC 1936). In the more extensively-farmed Rodney district, by contrast, the channel-to-drain ratio was only 1 to 0.16 in 1965, and in less productive districts outside the Goulburn Valley, notably Kerang and the Tragowel Plains, there were even fewer drains (Horsfall 1965). Costs in these areas were high relative to the perceived benefits, and the waste water was in some cases saline and posed additional problems of disposal. Farmers without access to drains were advised by the SRWSC to leave fallow strips at the end of their irrigation bays to receive surplus runoff, and to use this water either for stock dams or for the irrigation of adjacent paddocks (Webster 1961). The SRWSC otherwise argued that the laying of drains merely provided a further disincentive for irrigators to improve their management practices, and that progressively more drains would become necessary as ever greater volumes of effluent were produced (Blainey 1960).

7.2.3 Perceptions of landholders and independent experts

In the Goulburn Valley, as Mead had envisioned, land use in the new settlements at Kyabram and Shepparton was based on fruit growing, while at Tongala, Stanhope, and East Shepparton the main focus was on dairying, with larger mixed farming blocks on the outer fringes (Rutherford 1974). The transformation of the landscape in these districts - from dusty brown to luxuriant green - was widely commented upon, and was a source of widespread satisfaction and optimism (Mead 1920, p. 91).

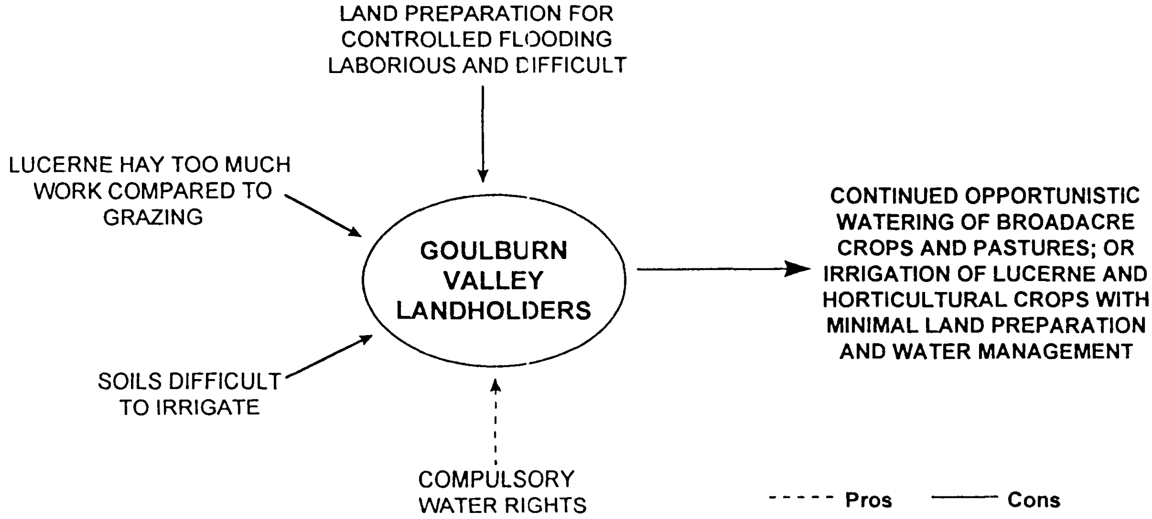
Outside of the closer settlement areas, however, the change was less remarkable (Figure 7.3). Despite the imposition of compulsory water rights, wheat growing remained profitable on larger holdings without the need for irrigation (SRWSC 1912). Many farmers continued to regard the availability of water merely as a convenience, and showed little inclination to develop their holdings for intensive culture. Some Rodney district landholders argued in newspapers that it was 'nonsense' that land should be intensively cultivated just because it was commanded by channels (Powell 1989, pp. 156-58).

Farmers who did use the water preferred to ignore the management recommendations of the SRWSC and other departmental 'experts' in favour of easier, less labour-intensive production systems. They did not share Mead's enthusiasm for lucerne hay, and nor was there widespread adoption of controlled flooding practices. In some cases, the recommended techniques (which were based on American irrigation systems) were unsuited to the soils of the northern plains (Barr & Cary 1992, p. 266; McClatchie 1903; Russ 1995, p. 91). Otherwise, as Kenyon (1908) observed, successful irrigation required both labour and attention to detail, but most irrigators simply let the water flow over their paddocks, so that it filled the hollows and left higher patches dry. Scarcely any lucerne land was graded, and this continued to be the case for some years, despite repeated advice to the contrary (Mead 1910). Equally scant notice was taken of the SRWSC's demonstration farms, and both Wyuna and Tatura sites were abandoned after a few years for lack of interest (Martin 1964).

Some irrigators in the Rodney district incurred financial losses and claimed that their land was unsuitable for irrigation (Mead 1909; Powell 1989, pp. 156-158). Department of Agriculture scientists agreed that many of the Goulburn Valley soils were difficult to irrigate due to their shallow surface horizons and poorly draining clay subsoils, and were either unsuited to irrigation or at least in need of careful preparation and water management (e.g., Kenyon 1908; Luffmann 1905; Tolley 1910). Gamble (1907) noted that soil organic matter was rapidly depleted under irrigation, necessitating the addition of animal manures or the ploughing in of green cover crops, such as peas or lentils. Kenyon (1907) drew attention to the fact that fruit trees were particularly susceptible to the injurious effects of shallow watertables that developed across the Goulburn Valley under wet conditions, while excessive flood irrigation of poorly graded land caused the subsoil to become waterlogged and sour, and then brick-like on drying out again. Lucerne was short-lived under such conditions, and Kenyon concluded that it could not possibly be grown profitably without good land preparation and drainage.

Mead himself acknowledged that not all soils were suited to irrigation, and that good water management was a necessary skill that could only be acquired through training and experience. He was disappointed, however, that successful irrigators in Rodney and elsewhere did not rise to defend the character of their soils or the value of the water applied to it (Mead 1909).

Figure 7.3: Situational interpretation of Goulburn Valley landholders regarding the adoption of irrigation, c. 1910.



7.2.4 Problems of closer settlement

Irrigators faced other problems besides those of land and water management. The year 1914 was one of severe drought, and water shortages occurred in the irrigation districts (in spite of the SRWSC's promises of ample supplies in all seasons)(Royal Commission on Closer Settlement 1916). Immigrant families on the closer settlement estates were also typically short of capital, and found themselves struggling to meet their debt repayment obligations as they waited for orchard trees to bear fruit on land that was crop-exhausted as well as difficult to irrigate (Kluger 1992, p. 71; Powell 1988, p. 50; Royal Commission on Closer Settlement 1916). Many of the new settlers abandoned their blocks, and were accused by a 1916 Royal Commission of failing to acquire the skills necessary for successful irrigation. The same Commission added, however, that the Closer Settlement Board and the SRWSC had purchased land without realistic consideration of the costs and returns of development, and had failed to provide the infrastructure and technical assistance promised in the SRWSC's promotional pamphlets. The irrigation settlements were also poorly surveyed, and crudely developed, and much land had been purchased without prior assessment of its suitability for intensive culture (Royal Commission on Closer Settlement 1916). In some cases, (e.g., along prior stream beds, where the soils were lighter textured and more permeable) the land proved fortuitously suited to the uses for which it was intended (Rutherford 1974), but in the desire for progress, expediency and other non-technical considerations had generally taken precedence over Mead's directives as to land quality. The SRWSC was not overly chastened by this, however, and Mead's successor as SRWSC Chairman, William Cattanach, was reluctant to concede that the "stiff" (non-porous) nature of the Goulburn Valley subsoils was a cause of difficulties on the Tongala and Kyabram estates. Cattanach maintained instead that lack of fertility and poor cultivation practices - both of which could be overcome - were more likely obstacles to agricultural production in those districts (Royal Commission on Closer Settlement 1916, pp. 23-24).

Elwood Mead himself had overseen the lands purchase process in an executive capacity, but blamed the Closer Settlement Board for failing to recognise the need for technical knowledge and experience in the purchase and development of lands, for offering farms to settlers without capital, and for its attempts at economising (Mead 1920, p. 84). He refused to concede that his system of irrigated settlement was unworkable, and believed that the greatest hindrance to success was "the very human imperfections of the settlers" (Mead 1920, p. 86). By this he meant that too few of them possessed the necessary intelligence, industry, and willingness to learn in order to succeed at irrigation farming. In his view the management of the Victorian settlements was "above all,... a human problem" (Mead 1920, p. 87).

Mead's position, in any case, became uncertain following the onset of hostilities in Europe in 1914. The flow of immigrants into Victoria slowed to a halt and the planning of further closer settlements was put on hold. Mead considered his work in Victoria unfinished, but decided in 1915 to accept a professorship in America[4]. His departure was regretted by the Victorian Government, who acknowledged that the revival of irrigation in Victoria was due solely to his enthusiasm (Kluger 1992, pp. 71-72). As Powell (1989, pp. 164-166) notes, Mead had established a basis upon which further rural development in Victoria could proceed, with the SRWSC positioned as a successful, centralised resource management agency that actively promoted irrigation and its associated industries. Mead had also overseen the subdivision of some 40,000 hectares for closer settlement and the establishment of 14 'model' irrigation estates (including those in the Goulburn Valley at Shepparton, Kyabram, Tongala and Stanhope), and appeared to have found the long desired means by which extensive forms of land use could be made to yield to more intensive agricultural practices. The economic benefits of irrigation had yet to be proven as the system was still losing money (e.g., Tyrrell 1999, p. 164), and the settlement process required some refinements, but SRWSC officials expressed confidence in 1916 that the biggest losses had been incurred in the pioneering phase, and that 80 per cent of the remaining settlers would succeed and prosper (Royal Commission on Closer Settlement 1916). SRWSC Commissioner John Dethridge added that the continuation of irrigation development remained the State's best option for encouraging population growth in the northern districts, and that the expenditure would ultimately be seen as a wise investment (Royal Commission on Closer Settlement 1916).

7.2.5 The soldier settlement imperative

As Mead departed Victoria for the United States, closer settlement was being promoted once again, and not only in Victoria but Australia-wide. This time it was to provide farming opportunities for the thousands of servicemen returning from the war in Europe. Arguments in favour of 'soldier settlement' were couched in the old agrarian rhetoric, and were helped by the fact that agricultural prosperity had been revived by

[4] Mead was eventually to become head of the US Bureau of Reclamation, serving in that position from 1924 until his death in 1936. He has been described as that country's "most illustrious reclamationist " (Reisner 1993, p. 147).

the war. Attention was also drawn to the fact that Australia remained vulnerable to invasion as long as its rural areas remained under-populated. The Federal Government considered accordingly that the 'debt of honour' owed to the nation's soldiers could be repaid most satisfactorily by placing them on the land (Dingle 1984, p. 182; Powell 1988, p. 101).

Victoria was as willing as any of the other States to accept federal funds for this form of rural development, and the lessons of even the most recent experience of closer settlement - that settlers needed capital, experience and suitable lands if they were to succeed - were "quietly ignored" (Royal Commission on Soldier Settlement 1925, p. 7). The fact that many diggers were physically and mentally unfit to farm was also overlooked, as all veterans arguably were owed the same 'debt' and interviewers were loathe to deny them land (Forster 1965, p. 108; Powell 1988, p. 108).

The keystone of the scheme in Victoria was to be irrigation, and to facilitate the settlement process the SRWSC was granted legislative authority in 1918 to purchase and subdivide land for irrigation development. In the Goulburn Valley, 306 soldiers were settled on horticultural blocks in the Shepparton district within the first four years, along with 232 on farms at Tongala and 297 in the Stanhope area (Horsfall 1965). Arrangements were subsequently made for ex-British Army officers to settle on land at Stanhope, Tongala and other places (Forster 1965, p. 104), while assisted passages and settlement opportunities were offered to general British immigrants from 1920 under the so-called Empire Settlement Scheme (Broome 1984).

By the middle of the 1920s, when the settlement programs reached a peak, the SRWSC's new subdivisions were supporting 20 times the population of the previous decade, including over 1000 new families in the Goulburn Valley (Table 7.4). The area of land irrigated in the region had also increased substantially, to around 65,000 hectares (Figure 7.4)(Horsfall 1965), and further settlement appeared to be dependent only upon the provision of additional water supplies (*Victorian Year Book* 1926, p. 477). Irrigation works were expanded accordingly to keep pace with the demand for water, with funding provided jointly by the State and Commonwealth Governments. In the Goulburn Valley, major supply channels were enlarged and extended during the 1920s, and the enlargment of Waranga Basin (to its present capacity of 411,000 megalitres) was completed in 1926, after setbacks due to leaks and storm damage. The new Eildon Reservoir, on the Upper Goulburn, was also filled for the first time in 1927, although a failure of the wall meant that its full capacity (377,000 megalitres) was not reached until repair work was completed in 1934 (Horsfall 1965; McCoy 1988, p. 18).

Powell (1989, p. 184) notes that the agricultural landscape of Victoria's irrigation districts at this time, between the wars, was essentially a creation of the SRWSC. Initial subdivision for closer settlement under the Land Acts of the 1860s and 1870s had created a farming landscape based on standard 320 acre (130 hectare) blocks, but further subdivision by the SRWSC for irrigation resulted in a more intricate lattice incorporating a greatly increased variety of farm sizes and enterprises (Figure 7.5). The Shepparton district was a showcase for Mead's policy of securing an 'efficient' mix of settlers, ranging from labourers without capital on garden-sized blocks, to more financially robust farmers on larger holdings in need of a workforce.

Table 7.4: Soldier and closer settlement in the Goulburn Valley, 1926.

Closer settlement district	Area subdivided (hectares)	Original no. of holdings	No. closer settlement blocks	Average area of CS blocks (hectares)	No. CS blocks occupied
Shepparton	5,735	33	389	13.8	376
East Goulburn*	704	2	23	29.1	23
Rodney	1,133	6	49	22.7	44
Stanhope	8,701	7	290	25.5	256
Kyabram	1,789	9	69	25.1	65
Tongala	7,616	40	314	23.5	296
GOULBURN VALLEY TOTAL	25,678	97	1,134	23.3	1,060
VICTORIA TOTAL	85,941	259	3,942	17.8	3,712

Source: SRWSC (1926).

* By the end of the decade, 21 large holdings comprising a total of 5400 hectares in the East Goulburn district had been subdivided into 156 closer settlement blocks, occupied by 136 families. No further subdivision occurred in the other Goulburn districts, and overall occupancy rates within the region either did not change or declined marginally between 1926 and 1930 (SRWSC 1931).

Figure 7.4: Area of irrigated land in the Goulburn Valley, 1915-16 to 1939-40 (Source: SRWSC Annual Reports, 1915-16 to 1939-40).

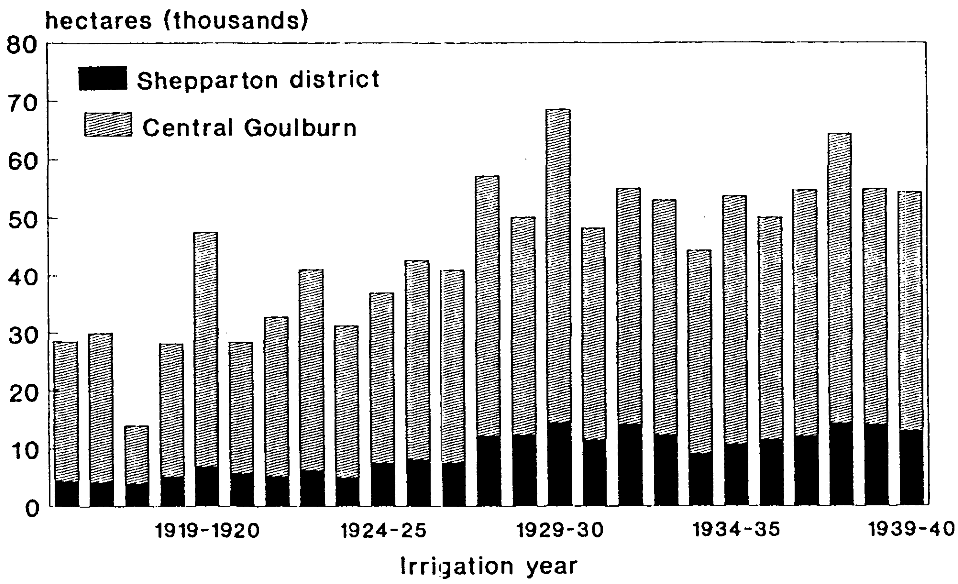
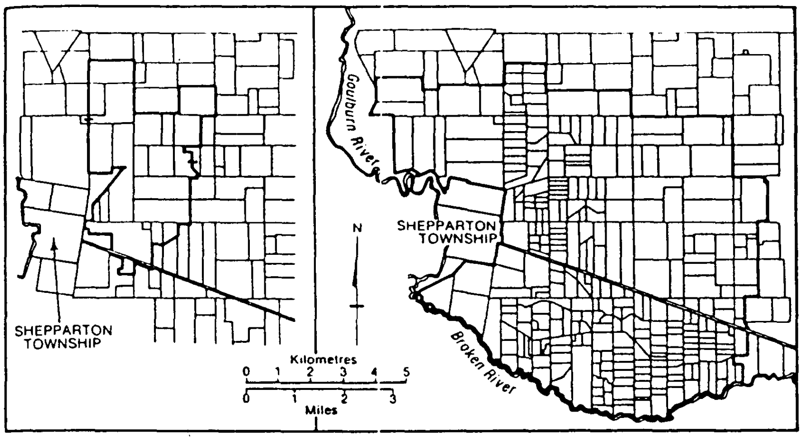


Figure 7.5: Intensification of landholding patterns in the Shepparton district, 1911-21 (from Powell 1989, p. 185).



As Powell (1989, p. 185) observes, the SRWSC assumed control of a substantial area of land during this period, with the impact of irrigated closer settlement evident in the closely textured patterns of the subdivision east of the township and north of the Broken River.

7.2.6 Problems of soldier settlement

Soldier settlement was ultimately no more successful than any of the State's previous closer settlement schemes. In part, this was for global economic reasons. Rural production had expanded world-wide after the War, and by the mid-1920s a glut of wheat, butter and fruits caused prices in Australia to collapse. In the Goulburn Valley, where settlers had been encouraged to plant orchards, fruit production had exceeded processing capacity as early as 1922. A new cannery was established at Kyabram, but international markets diminished as canned fruit exports rose from America (Bossence 1963, p. 112; Dingle 1984, p. 183; Powell 1989, p. 176). Well-established farmers faced financial hardship, and for the newcomers the situation was dire. Some 3,000 of Victoria's 8,000 soldier settlers were forced to abandon their blocks between 1917 and 1929, including 620 from irrigated districts (Report of the Closer Settlement Board 1927, p. 7). Powell (1988, p. 102) suggests that for many of the veterans, this was probably their worst defeat.

Investigations into the problems of soldier settlement were held at both State and Federal levels between 1925 and 1930. Concern was focused on the economic cost of the schemes and the huge burdens of debt and loss which had been imposed on the nation's taxpayers. The primary causes of failure were deemed accordingly to be economic: falling international commodity prices, the high start-up cost of the farms (due to the inflated demand for land, stock and equipment at the end of the War), and the high debt-to-equity ratio (up to 100%) carried by the soldiers (Powell 1988).

Other failings identified by the Royal Commissions echoed those of earlier periods, and were land related. Large acreages were required in areas where the best land was already in use, and in the haste to find new sites for settlement, preparatory land surveys were generally overlooked (Andrews 1939). Roads and irrigation works were extended into new areas, making previously undeveloped land available for closer settlement, although it was not always suitable for the uses proposed for it (Royal Commission on Soldier Settlement 1925, pp. 17-18). The SRWSC and Department of Agriculture had persisted in encouraging irrigators to grow lucerne hay to provide 'drought insurance' for the rest of the State, although the crop did not produce well under the systems of wild flooding practised by most irrigators, and was less profitable than other enterprises (Forster 1965, p. 105; Russ 1995, p. 85; Royal Commission on Soldier Settlement 1925, p. 17). Farm sizes had been determined by bureaucratic processes, and if there was "doubt whether an estate should be divided into five or six holdings, it seems the six would get it" (Royal Commission on Soldier Settlement 1925, p. 12). Many blocks were too small to be profitable, and did not allow farmers sufficient flexibility to adjust to changing market circumstances. Land preparation had also been inadequate for irrigation, and lack of drainage provisions caused problems in low-lying areas such as Stanhope (Forster 1965, p. 113; Royal Commission on Soldier Settlement 1925, p. 17). A 1933 Royal Commission into the problems of British settlers (who, as the latest arrivals, generally occupied the poorest and most remote blocks) added that, in the Goulburn Valley, just because intensive farming had been conducted successfully throughout much of the region, this did not mean that inferior land also should have been used for that purpose (Broome 1984, p. 145; Royal Commission on Migrant Land Settlement 1933, p. 20).

The official response to the settlers' problems, however, was to tinker primarily with the economics. Some debts were written off, struggling settlers were granted more generous repayment terms, and elaborate home price support schemes and export marketing systems were developed for to help as many farmers as possible remain on the land (Andrews 1939; Dingle 1984, p. 183). These placed a heavy burden on domestic consumers of fruit and dairy products, and also encouraged farmers to increase their output, thus contributing further to the problem of global surpluses (which persisted until the end of the 1930s and the outbreak of World War II). As Dingle (1984, p. 187) observes, however, "politicians still clung to the yeoman ideal, unwilling to face the harsh reality that it had been rendered unsound by changing circumstances in the international economy". Tyrrell (1999, p. 164) adds that without the intervention of the Government, Victoria's irrigation schemes are unlikely to have survived the 1920s, as suggested by the failure of similar schemes in California at that time.

7.2.7 Depression and recovery: soldier settlement revisited

Despite the seemingly chronic problems associated with closer settlement, irrigation, for all its expense and difficulties, continued to be viewed in a highly favourable light. As a weapon in the ongoing battle against an unpredictable environment, it was seen as finally making possible the secure settlement of the northern plains. The SRWSC reported in 1927 that rural populations had increased by 30,000 in the irrigated areas of Victoria since 1905, but had decreased in most other districts of the State. In the Goulburn Valley, the irrigated Shires of Rodney and Shepparton had experienced population increases in that period of 27 per cent and 29 per cent, respectively, while the adjacent non-irrigated Shires of Tungamah and Numurkah had suffered declines of 31 percent and 25 percent in the same period. It was noted that in the Shepparton district most of the increase had occurred in the closer settlement areas, providing a "striking example of the increased national wealth brought about by the judicious expenditure of money on closer settlement and the provision of water supplies for irrigation" (SRWSC 1927, pp. 38-39).

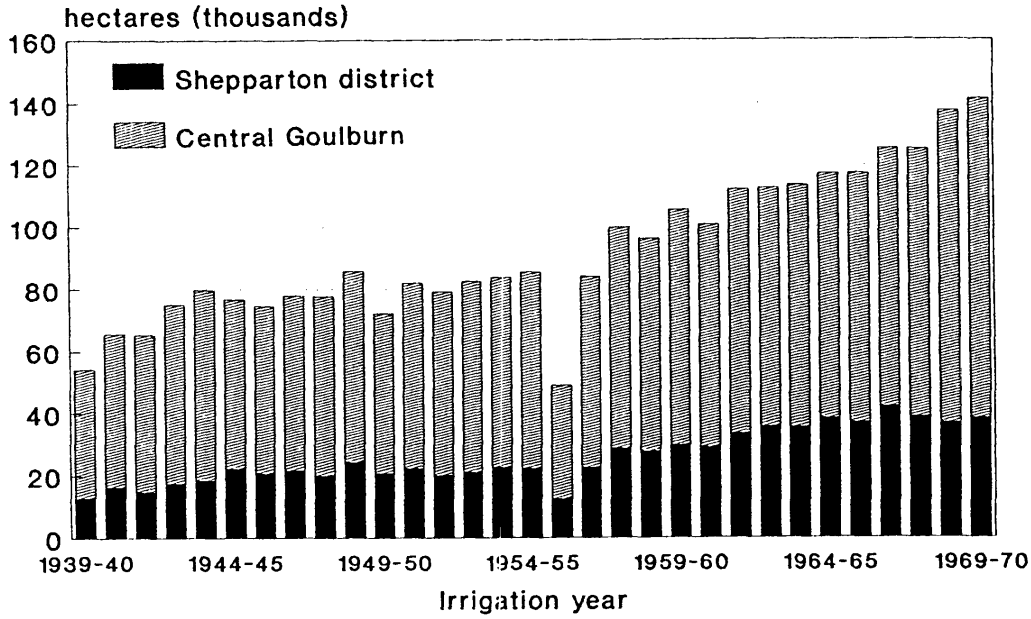
Further irrigation developments were suspended in the 1930s due to the Great Depression, although some long-proposed irrigation capital works were funded during this time, primarily as unemployment relief schemes. These included the completion of Eildon Reservoir on the Goulburn River (repairs completed in 1934), and the construction of Hume Reservoir and Yarrawonga Weir on the Murray River (completed in 1936 and 1939, respectively). Various drainage projects were also undertaken, including the construction of surface drains in the intensively developed Goulburn Valley districts of East Shepparton and Tongala, where tree losses due to waterlogging had been severe after unusually wet conditions in 1931 (Horsfall 1965; McCoy 1988; SRWSC 1934).

The Depression ended for Victoria's farmers with the onset of World War II, when the prices of rural products experienced a general recovery. Compulsory water rights also gained a new value after 1938, when a period of low river flow resulted in water shortages, and a further prolonged drought in 1944-45 saw Waranga Basin emptied (McCoy 1988, p. 17). Water deliveries were limited to holdings with water rights, and many dairy farmers who purchased water from the SRWSC only on a supplemental basis faced income losses at a time when butter prices were finally on the rise (McCoy 1988, p. 52).

On the northern plains, income security was equated accordingly with a reliable supply of water. Irrigators, who had complained during the Depression that water charges were too high, ceased their protests and lobbied for their water allocations to be increased (East 1954; McCoy 1988 p. 52). In the meantime, the area irrigated in the Goulburn Valley reached a new record of 79,714 hectares in the drought season of 1943-44 (breaking the previous record of 68,497 hectares set in 1929-30)(Figures 7.4, 7.6), and further expansion appeared to be limited only by the availability of regional water supplies (Aird 1940; Horsfall 1965; McCoy 1988, p. 54).

As World War II drew to a close, interest in irrigation was also revived at the bureaucratic level. The Rural Reconstruction Commission (1943-45) perceived irrigation as an essential factor in the recovery and development of rural Australia (Davidson 1969, p. 84; Wadham 1967, p. 142). Irrigation was also to provide the basis for new (more carefully administered) soldier settlement schemes. The rhetorical argument - the 'debt of honour' owed to the nation's servicemen - was similar to that of two decades

Figure 7.6: Area of irrigated land in the Goulburn Valley, 1939-40 to 1969-70 (Source: SRWSC Annual Reports, 1939-40 to 1969-70).



earlier (e.g., Bossence 1979, p. 339), and in Victoria, support was provided by the "tried and trusted arguments" that irrigation had helped to achieve the goals of closer settlement and decentralisation, as well as increasing rural production and various forms of tax revenue (Powell 1989, p. 249). This was exemplified by the fact that populations had continued to increase in the six irrigated shires supplied by the Goulburn System, but had declined in six neighbouring dryland shires.

The SRWSC, in association with the Soldier Settlement Commission (later the Rural Finance Commission), subsequently established new irrigation settlements, including over 1000 farms for soldiers in the new Murray Valley Irrigation District (north-east of the Goulburn Valley, and supplied by Yarrawonga Weir on the Murray River), at Dunbulbalane in the Shepparton Irrigation District of the Goulburn Valley, and in several other parts of the state (McCoy 1988, p. 28). The Dunbulbalane closer settlement area comprised some 6,900 hectares, which was subdivided into 186 blocks for horticulture and dairying (Horsfall 1965).

Greater attention was paid to drainage in the post-WWII irrigation settlements. The SRWSC proclaimed in 1965 that at Dunbulbalane there were 92 kilometres of drains for the 93 kilometres of delivery channels (Horsfall 1965). Detailed drainage plans were also produced for the Murray Valley as preliminary surveys had warned of potentially high water tables and associated salinity problems (Blackburn 1978). Drainage provisions were initially deferred in this region, nevertheless, to facilitate the settlement process. Almost immediately, the new settlers were obliged to press the SRWSC for remedial action as a series of wet years from 1951-56 caused localised flooding problems, and the necessary surface drains were still being constructed into the late 1960s (Weston 1971).

7.2.8 Big Eildon and post-war expansion

The wartime shortages of irrigation water had initiated debate in the meantime on the need for further storage facilities in Victoria. SRWSC policy was that irrigators should be able to expect delivery of at least 70 per cent of their water rights during the worst drought periods, and up to 130 per cent in most other years[5] (East 1955). The existing Victorian storages could barely meet basic demands, however, and further irrigation development was impossible without additional water conservation.

This had long been argued by SRWSC Chairman, L.R. (Ronald) East, who believed that all of Victoria's limited water resources should be tamed for the benefit of farmers and the state. "Vast natural resources do not themselves make a country great and prosperous," he wrote in the Commission's journal, *Aqua* (East 1954, p. 19). East had assumed his position at the head of the SRWSC in 1935 and had been influenced by the water-related public works programs carried out in the United States under Franklin Roosevelt's New Deal policies of the 1930s. During the wartime droughts he exploited the image of 'waterless farms' to gain public and political support for a series of major water storage projects (Russ 1995, pp. 78-79), and in his 28 years as SRWSC Chairman he oversaw the expansion of irrigation in Victoria from 200,000 hectares irrigated with 567,000 megalitres in 1935, to 445,000 hectares irrigated with 2,100,000 megalitres in 1964 (East 1965).

The largest of East's proposals was the enlargement of Eildon Reservoir so as to expand its storage capacity from 377,000 megalitres to 3,390,000 megalitres (East 1955). The intention was that it would not only be able to store the usual winter flows of the Goulburn River, but also floodwaters, which could be conserved for use in drier years. This would enable twice the quantity of water to be delivered to the various Goulburn Irrigation Districts as before, thus setting the stage for "another great surge forward in irrigation development" (East 1954, p. 17). East believed that the area irrigated should amount to whatever could be assured of full water requirements except in occasional years of severe and protracted drought. It was calculated that under this system 3.3 million more megalitres could be used over 20 years than if irrigation development was limited to the area that could be given full supplies in all years (East 1955).

East's dam-building proposals were facilitated by post-war improvements in the economy and changes in the national taxation system, which contributed to an increased availability of capital for major projects such as irrigation schemes (Davidson 1969). Although instigated by the States, these were generally deemed to be in the national interest, and were funded by the Commonwealth. This lessened the pressure on the States to ensure that the resultant revenues met the capital costs involved, since, as Davidson (1969, p. 86) notes, it was not until 1966 that detailed cost-benefit analyses were required of

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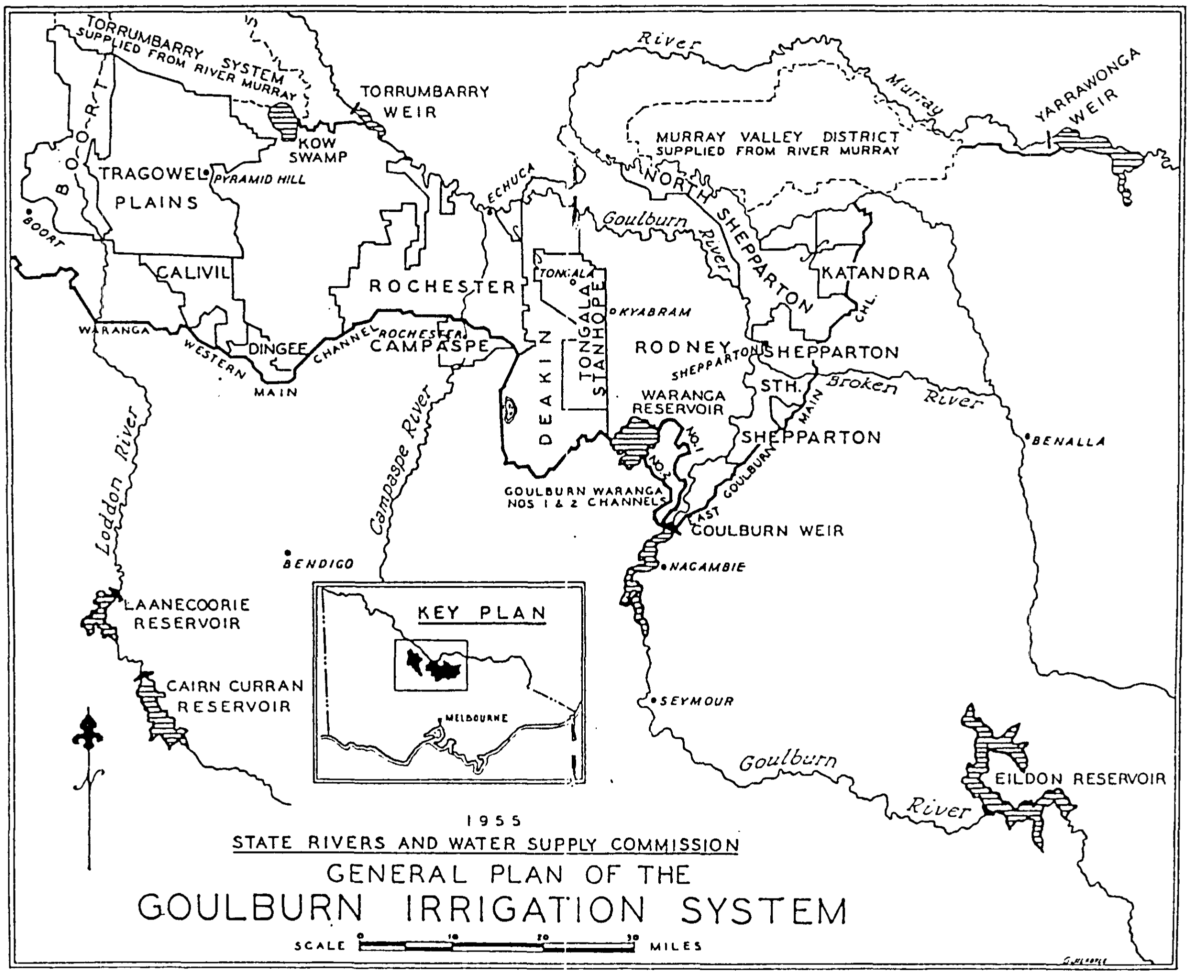
[5] Water delivered in excess of a holding's water right was termed 'sales' water.

Figure 7.7: The Goulbum Irrigation System, 1955 (from East 1955).



proposed irrigation projects by the Commonwealth Treasury.

In Victoria, the SRWSC embarked on period of construction not seen since the 1920s, with the focus of attention being the Goulburn system (Figure 7.7). Eildon Reservoir was enlarged in the first half of the 1950s and was operative by 1955. Cairn Curran Reservoir on the Loddon River was completed soon after, bringing the total storage capacity of the combined Goulburn-Loddon system to almost 4 million megalitres. The SRWSC proclaimed accordingly that it controlled "every drop of water" that flowed down the two rivers over long periods of years (East 1955, p. 3). Smaller storages were constructed at other locations around the State, raising the total water storage capacity in Victoria from 2.1 million megalitres in 1945, to 5.8 million megalitres in 1960 (e.g., Powell 1989, p. 225). Channel systems were also remodelled to facilitate the distribution of the additional water and some drains were constructed in high priority areas, although the general progress of drainage works continued to lag well behind that of storage and distribution (Horsfall 1965).

Improvements were also made in the efficiency of water distribution, which in the Goulburn System increased from 50 per cent in the mid-1950s to around 66 per cent in the mid-1960s (Dunk 1965; McCoy 1988, p. 57). In part this came about because of the further intensification of agriculture in the region, but it can also be attributed to better channel construction (and hence reduced seepage and distribution losses), as well as improved systems of operation and maintenance (including the use of herbicides to control weeds), and improved methods of measuring water. Previous to this, water measurements had been generally unreliable and did not encourage either careful water use by irrigators or careful accounting by the SRWSC (McCoy 1988, p. 57). Water losses due to seepage and other losses from channels had also been considered previously by the SRWSC to be of minor significance compared to water losses on farms - although it was acknowledged in some districts outside of the Goulburn Valley that the problem required attention (Read 1930).

East's philosphy was that none of the water flowing down the northern rivers should be allowed to go to waste, so water allocations were progressively increased after the completion of Big Eildon, and again in the 1960s (Table 7.5). Supplies were available, and the SRWSC hoped to encourage greater water use through further intensification of production (East 1955; Horsfall 1965; Powell 1989). The SRWSC also revised its systems of land classification, on the basis that 'modern' irrigation techniques rendered 400,000 hectares of land commanded by channels in existing districts suitable for irrigation, rather than the 270,000 hectares so classified in 1955. In the Goulburn Valley, this resulted in land reclassification and increased water rights in districts including Rodney, Deakin, Tongala, Shepparton, and Katandra (East 1955).

7.3 Land and water use

The overall results of the SRWSC's activities were that between 1954-55 and 1968-69 average water rights in the Goulburn-Murray System increased by over 70 per cent, or from 1.2 megalitres to 2 megalitres per hectare per year (Horsfall 1965; Powell 1989, p. 230). With extra water rights and supplementary sales, annual water applications in Goulburn Valley irrigation districts amounted to twice this figure at the end of the 1960s (Figure 7.8), while the area irrigated within each district had also increased substantially from the previous decade (Figure 7.6). A typical 40 hectare dairy farm in the region could at that time support 80 milking cows - a huge productivity gain on the 2 to 5 hectares required to run a single sheep a century earlier (Poussard 1967; see page 66). "Thriving country towns" such as Shepparton, Kyabram and Tongala had also emerged where mere villages or farms had existed prior to irrigation, and the Goulburn Valley overall had become one of the most economically significant irrigation areas in the nation, with the value of irrigation-related production estimated in 1964 to be in the order of £25 million (A$50 million)(East 1954; Horsfall 1965). The region was also known internationally for its canned fruits (McLennan 1936, p. 31; Read 1954).

Table 7.5: Progressive increases in water rights in Goulburn Valley irrigation districts.

Water rights before 1955:

Shepparton, Tongala, Stanhope	1 acre-foot per irrigable acre	(3 megalitres per hectare)
Rodney, South Shepparton	1 acre-foot per 4 irrigable acres (0.75 megalitres per hectare)	

Water rights, 1955 to 1960:

Minimum water rights in all districts increased to 1 acre-foot per 3 irrigable acres (1 megalitre per hectare).

Districts with higher allocations retained existing water rights.

Landholders could apply for extra water rights to increase their allocation to 1 acre-foot per acre (3 megalitres per hectare), up to a maximum of 100 acres (40 hectares).

Further liberalisations, 1960:

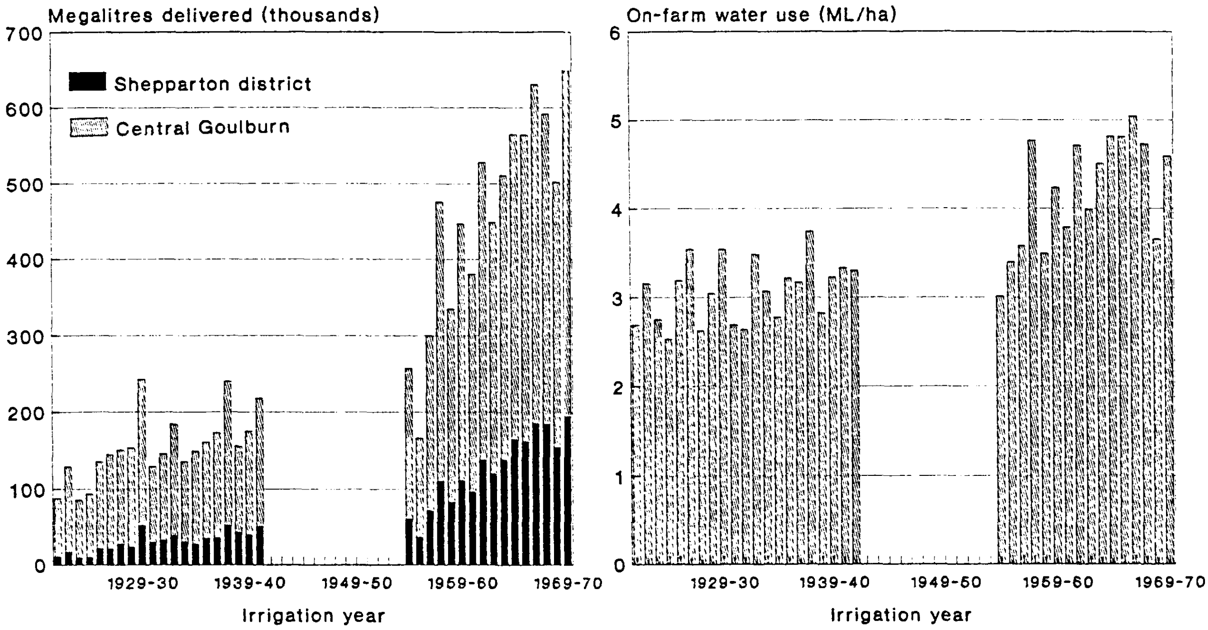
To accommodate orchardists, a new formula was introduced to provide for proportionately greater water allocations to holdings up to 40 acres (16 hectares), with proportionately decreasing allocations as holding size increased.

Water rights after 1963:

Size of holding	Total volume of water rights allocated	Probable type of culture
Not exceeding 16.2 ha	5.335 ML of commanded and suitable land	Orchards, market gardens, small dairy farms
16.2 ha to 40.5 ha	86 ML plus 3.048 ML/ha of land above 16.2 ha	Large orchards or averaged sized dairy farms
40.5 to 89 ha	160 ML plus 0.254 ML/ha of land above 40.5 ha	Dairy farms, beef cattle or mixed farming
More than 89 ha	172 ML plus 1.106 ML/ha of land above 89 ha	Sheep, beef or other diversified farming, including cropping

Sources: McCoy (1988); Poussard (1967).

Figure 7.8: Irrigation deliveries and on-farm water use* in the Goulburn Valley, 1921-22 to 1969-70 (Sources: Goulburn-Murray Water; SRWSC Annual Reports, 1921-22 to 1969-70).



** Based on total deliveries per hectare of irrigated land. No data before 1921 or for 1941-42 to 1953-54.*

The uses to which the land in the region was put did not change significantly from previous decades. The main effect was more, as Powell (1989, p. 225) describes it, the reinforcement or intensification of the existing texture of settlement, more or less according to Elwood Mead's original vision. The dominant enterprises continued to be dairying and fat lamb-raising on irrigated pastures, which comprised 85 per cent of the irrigated area of the region. Orchards and other horticultural crops dominated in areas of lighter soils, with canning fruits being of particularly importance. On some larger properties wheat and sheep production was carried out as in dryland areas, although irrigation water was generally applied to ensure an autumn break and to prolong spring growth. Irrigated cereals tended to comprise less than one per cent of the irrigated land in the region (Martin 1964, 1966).

In the extensively-irrigated districts, significant changes had occurred with respect to land and water management, however, as lucerne was replaced with clover-based pastures. This transpired as part of a nationwide "pasture revolution", based on grass-clover mixtures and superphosphate fertiliser, that occurred in both irrigated and dryland areas from the 1930s onwards (e.g., Rutherford 1963). In Victoria, irrigated pastures were based primarily on white clover (*Trifolium repens*), a summer-growing species, and perennial ryegrass (*Lolium perenne*), and they were grown on almost all Goulburn Valley dairy farms by the mid-1930s (Bartels 1933; Bartels & Ryland 1929).

Farmers were quick to appreciate that pastures flourished under wetter conditions than lucerne. The grass-clover combinations were also longer lived under grazing, provided a greater variety and continuity of feed, and generally required less labour to manage (Bartels & Ryland 1929). They also grew on a wider variety of soils, which made possible the extension of dairying in the Goulburn Valley onto 'cover floodplain' areas of heavier (clay loam) soils (Bartels 1933; Rutherford 1963). Many settlers considered accordingly that irrigated pastures had opened up a 'new era' for them (Bartels & Ryland 1929).

The relative ease of pasture management meant that even less care was taken with irrigation, however. Perennial pastures required frequent watering, particularly in summer, with overall water requirements averaging 600 to 900 millimetres per year (6 to 9 megalitres per hectare, including rainfall)(Martin 1966; Mehanni 1978). The Department of Agriculture and SRWSC continued to advocate the 'border-check' and other methods for the efficient flood irrigation of pastures, or, at the very least, the grading of land and the provision of 'drainage bays' at the end of paddocks to intercept runoff (MacLeod 1956). 'Wild flooding' practices continued, nevertheless, and most farmers favoured heavy, occasional water applications rather than shorter, more frequent irrigations. This saved on labour but tended to result in over-watering (i.e., water applications in excess of the infiltration capacity of the soil) (Blainey 1960; Gutteridge *et al.* 1970, p. 30, p. 50; Haskew 1996, p. 107). A majority of irrigators also failed to keep records of water applications, to provide on-farm drainage, or to keep their irrigation channels free of weeds, and on-farm irrigation structures, including Dethridge wheels, flood gates and dams, tended to be poorly maintained and prone to leakage (Aird 1940; Bartels 1929, 1945; Russ 1995, pp. 74-76).

The SRWSC argued that careful water managers would be rewarded with satisfactory pasture yields for twenty years or more (MacLeod 1956), but for many landholders the effort and expense involved were simply too great. Even in problem areas, such as the severely waterlogged Tragowel Plains, to the west of the Goulburn Valley, the best irrigation practices of the day were followed on only 20 per cent of the irrigable area in the 1950s (Powell 1993, p. 40). The extra work required in ground preparation and more regular attention to water applications were evidently unattractive to irrigators, who were unwilling to change their methods of watering pastures unless there were distinct financial advantages in doing so (Blainey 1960).

Greater care was taken in orchard districts, particularly after 1931 when unusually wet conditions and associated perched watertables resulted in the loss of substantial numbers of fruit trees in some parts of the Goulburn Valley (Skene & Freedman 1944). Those orchardists who could afford to do so responded by installing tile drains in areas with light soils and surface drains on heavier soils. Peach and apricot ground was also replanted with pears in many instances, as pears proved to be more tolerant of soil moisture fluctuations and were easier to irrigate on difficult soils (Harper 1945). Some orchardists also paid more attention to irrigation methods, although faulty layout and poor irrigation practices continued to be identified as major causes or poor production in Goulburn Valley orchards into the 1950s (Craig-Brown 1955; *Journal of Agriculture, Victoria* 1960).

7.4 Environmental impacts and responses

The steady increase in irrigation activity in Victoria from the time of Elwood Mead to the 1960s was not without environmental repercussions, particularly as drainage provisions remained generally inadequate, significant seepage losses occurred from supply channels, and careless watering practices prevailed on farms. In some irrigation districts, primarily in the north-west of the State, the warnings of the early engineers as to the potential dangers of such a system became a reality, as widespread waterlogging and salinity problems developed. In some cases, as at Cohuna, these emerged within a decade of the commencement of irrigation, and as will be seen in the next chapter, rising watertables and associated salinity problems were inevitably to characterise the Goulburn Valley also. In the 1960s, however, they had not yet manifested themselves within the region to any substantial degree, other than as "drainage difficulties" that were acknowledged by the SRWSC to exist generally across the northern plains (SRWSC 1951).

Major waterlogging problems in the Gouburn Valley had occurred occasionally, when seasons of unusually high rainfall caused the deaths of large numbers of orchard trees (Table 7.6). The SRWSC had reacted to these crises by constructing localised surface drainage works, and those orchardists who could afford it invested in on-farm drainage provisions. Soil investigations were also conducted in the region by the Department of Agriculture after the disastrous losses of 1931 (Jewell 1931), and district-wide soil surveys were undertaken from the 1930s onwards for the stated purposes of improving land and water use and settlement (Blackburn 1978; Skene & Freedman 1944; Skene & Poutsma 1962). Chronic problems in the north-west of the State had also prompted joint research by the SRWSC and Department of Agriculture from the 1920s into the difficulties confronting irrigation farmers, and resulted in the identification of soil chloride as an indicator of potential salinity hazards (Blackburn 1978). Haskew (1996, pp. 89-90) notes, however, that most research at that time was focused on problems identified by the SRWSC (as the senior institutional partner in the joint Irrigation Research Committee), and thus on matters of institutional concern, while on-farm problems such as soil variability were largely ignored. It was generally accepted within the Goulburn Valley, in any case, that tree losses in the orchard districts were

Table 7.6: Losses of peach trees in the Shepparton Region due to surface waterlogging.

Year	Number of trees lost	Percentage of total plantings
1931	30,000	14
1939	80,000	n.a.
1956	445,000	56
1963	125,000	10
1968	72,000	n.a.

Source: Trewhella & Webster (1978).

associated with perched watertables or the surface waterlogging of impermeable topsoils during wet seasons, and were a local and irregularly occurring problem incidental to irrigation (Bakker 1978).

Salinity in the Goulburn Valley was even less of an issue. Salt patches had developed on some low-lying and poorly drained pasture land in the Stanhope district as early as the 1920s (Forster 1965, p. 113), and symptoms of salt damage had been observed in pear orchards around Kyabram during the wet year of 1956, but salinity was not expected to pose a major threat to the region. In part, this was because much of the Goulburn Valley had already been irrigated for some decades without significant instances of salt damage in either orchards or pastures (Blackburn 1978; Skene & Poutsma 1962). A certain complacency had thus been engendered in the region, and was reinforced by regional differences in geology: soils west of the Goulburn Valley tended to have high native salt accumulations, reflecting the maritime origin of the underlying sediments, while those in the Goulburn Valley itself and to the east tended to have negligible salt, so that salinity was not deemed to be a hazard in those areas (Goudie 1950; Skene & Poutsma 1962; Tisdall 1961; Tolley 1910).

Paradoxically, the environmental concerns of the SRWSC in the 1930s and 1940s lay more with the dryland areas of the Goulburn Valley than the irrigation districts (e.g., Powell 1993, p. 36). Tree clearing and overgrazing in pastoral areas, as well as bare fallowing practices on cropping lands, had contributed to substantial erosion and runoff problems, particularly within the foothill areas of the Goulburn catchment where the slopes were steep and the skeletal sedimentary soils were prone to degradation (Brake 1940; Thomas & Andrew 1945). Such problems dated back to the early years of settlement, but they were not considered serious at an official level until the 1930s, when news of the 'Dust Bowl' in America received considerable publicity in Australia and focused attention on local conditions. In 1937, the Victorian Government appointed a Committee to investigate the extent and severity of erosion problems throughout the State, and in 1940 the State's first soil conservation legislation (including the creation of a Soil Conservation Board) was enacted (e.g., Brake 1940; Mosley 1972). As Bradsen (2000) notes, however, this did not obligate landholders to adopt non-erosive forms of land use, and in 1941 the SRWSC decided to address its concerns about siltation of reservoirs and winter flooding by means of an erosion control competition. Landholders in the Goulburn catchment were awarded points accordingly for the adoption of various on-farm erosion control measures, such as contour banks, contour ploughing, rabbit control and the elimination of long fallows. The ultimate prize was an annually awarded trophy, the Hanslow Cup (named after its instigator, Harold Hanslow, a practical-minded irrigation farmer and SRWSC Commissioner), and the results were highly publicised thoughout the 1940s (e.g., Thomas & Andrew 1945; Thompson 1949). The competition was not wholly successful, however, as it encouraged action on the part of individuals but not of groups, so that erosion problems across property boundaries tended to be left untreated. Many farmers also perceived that although the Hanslow Cup promoted SRWSC erosion control aims, the recommended measures were expensive to implement and contributed little towards the improvement of on-farm productivity (Barr & Cary 1992, p. 155).

The concerns of irrigators, in the meantime, were focused primarily on the problematic physical nature of much of the Goulburn Valley's soils. Read (1954) observed that most of the orchards planted in earlier decades were established on shallow topsoils with heavy underlying clay layers. These soils quickly lost their structure under cultivation and became so impermeable in summer that irrigation water would not penetrate below depths of about 20 millimetres, even after several days. Growers themselves believed that the careless practices of earlier generations of irrigators were to blame for a progressive deterioration in soil structure, and research had shown that irrigation was indeed capable of washing clay particles from the soil surface to lower layers (Harper 1945) The problem was compounded by the widespread introduction of tractors in the 1940s, which encouraged more frequent cultivation of the soil and contributed to further soil structural decline and surface impermeability (Cockroft & Mason 1987).

Researchers believed that such problems could be overcome. At Tatura, where a research institute had been established by the Department of Agriculture in 1936, experiments were undertaken with different systems of water applications (e.g., lighter, more frequent irrigations; shorter bays or furrows), soil treatments (gypsum, lime, chisel ploughing, deep ripping), and orchard cover crops (Heslop 1954; McColl 1959; Read 1954). Green manure crops, including Cape barley and peas, had in fact been advocated for orchard soils at the turn of the century (e.g., Pye 1902), but for some decades clean cultivation had been the standard practice as it was thought that weeds and other species dried out the subsoil at the expense of tree roots (e.g., *Journal of Agriculture, Victoria* 1952).

Orchardists resumed sowing cover crops between their trees in the 1950s, and also learned to use their tractors less and cultivate less frequently (Cockroft & Mason 1987). This did not solve the problem of poor soil structure in the Goulburn Valley, however, as decades of excessive water applications and inadequate drainage had exacerbated the sodic nature of the region's soils. In other words, the proportion of sodium ions (Na^+) present had increased relative to that of other ions (Ca^{2+}, Mg^{2+}) due to the mobilisation of sodium chloride naturally present in the soil, with further additions of salt from the irrigation water itself, and from rising saline groundwaters (e.g., Rengasamy & Olsson 1993). High sodium levels cause the dispersion of clay particles when soil is wet, adding to the surface crusting, poor aeration and drainage, and other soil structural problems already induced by repeated cultivation and rapid wetting. In duplex soils, such as those of the Goulburn Valley, sodic subsoil conditions limit both water penetration and plant root growth, so that crop yields are significantly reduced (So & Aylmore 1993). The presence of exchangeable sodium in soils had been noted at Tatura in the 1930s (Penman 1936, cited by Blackburn 1978), but the problems associated with sodicity were not widely studied until the 1970s. It may be presumed accordingly that prior to that time they were dismissed as merely another consequence of poor soil and water management on the part of farmers, and it was assumed they could be overcome through the application of gypsum ($CaSO_4$) and appropriate irrigation techniques.

7.5 An impending crisis

Waterlogging problems recurred in the Goulburn Valley in the meantime, and appeared to be increasing in both their frequency and severity. After the record wet winter of 1956, in which 56 per cent of the region's peach trees were lost, further abnormally wet seasons and associated waterlogging problems and tree deaths occurred in 1963 and 1969 (Table 7.6). Salt damage was also evident once again in the Kyabram district at these times (Blackburn 1978).

Orchardists were advised, as before, to install tile drains. However, for most this was still not an economically viable proposition, and even in the 1970s, only 400 hectares of Goulburn Valley orchards were protected by tile drains, out of total horticultural area of 10,000 hectares (Craig-Brown 1955; Trewhella & Webster 1978). Orchardists instead renewed their calls for the SRWSC to provide surface drainage. Landowners were supported by the Kyabram Preserving Company, which had an interest in saving the orchards, and major drainage work was undertaken in the early 1960s along the lower reaches of the Mosquito Depression (a 140 kilometre-long natural drainage course) between Tatura and Echuca (SIRLWMP 1988). The SRWSC declared in 1965 that further drainage of the Rodney area was a major task for the future (Horsfall 1965), but community pressure tended to be confined to those areas experiencing persistent flooding or salinity problems, and drainage was still considered by the SRWSC to be less essential in extensively irrigated areas (Gillard 1963). Landholders were also expected to meet the maintenance costs of community drains (about £75 per year for a 70 hectare property in the Rodney district), so that overall interest in drainage inevitably waned in drier seasons (Barr & Cary 1992, p. 224; Gillard 1963).

The SRWSC of the 1960s was nevertheless more concerned with drainage and salinity issues than it had been in the past. After the wet seasons of the 1950s a section was formed within the organisation specifically to investigate drainage and on-farm irrigation problems (Dunk 1961; Gillard 1963), and from the early 1960s observation wells were installed to monitor watertables in various irrigation districts, including Tongala-Stanhope in the Goulburn Valley and the Murray Valley Irrigation Area to the north-east (SRWSC 1961). The Commission also commenced groundwater pumping trials around Kyabram and in the Murray Valley from the mid-1960s as a possible means of reclaiming waterlogged and salt-affected land, and initiated research programs to reduce water losses both within the SRWSC distribution system and on-farm (SRWSC 1966, 1967; Webster 1968).

These activities remained incidental to the SRWSC's main focus, however, which under Ronald East's chairmanship continued to be water conservation and irrigation. Practical solutions were expected to be devised for the drainage problems on the northern plains, and the future of irrigation development seemed, as ever, to depend primarily on the availability of water (Dunk 1961, 1965). In 1963, shortly before East's retirement, the Victorian Government approved a 10-year, A$76 million plan to build a series of nine new storages for irrigation water, and it was anticipated that within 20 years all of Victoria's northern rivers would be used to their fullest extent (Dunk 1965; Russ 1995, p. 79; Tisdall 1973). In the mid-1960s, the institutional future of the SRWSC thus seemed assured, and its officers were highly confident that, in the Goulburn Valley and elsewhere, "the story of progress... made possible by a vigorous people, good engineering, thoughtful agronomists and good management [would] certainly go on" (Horsfall 1965).

7.6 Discussion: Institutional power and over-specification

The period described in this chapter could be summed up as one of tremendous social, economic and environmental change in the Goulburn Valley and beyond. Much of this change was either precipitated or hastened by national or global events (e.g., the World Wars) and changing economic and market circumstances (the Great Depression; rapid post-war economic growth) that were external to the Goulburn Valley itself, yet the region was profoundly affected by them. It was also changed by new, high-energy technology, as tractors and mechanised earth-moving equipment made possible physical transformations of the landscape and the exploitation of natural resources on a scale never seen before. Other changes were initiated more locally, and more directly, as the Victorian Government sought ways to make its expensive irrigation schemes economically viable, while continuing to pursue agrarian goals through a succession of closer settlement schemes. As in the time of Alfred Deakin, the region was also subject to the influence of powerful individuals - the SRWSC Chairmen Elwood Mead and Ronald East - who strove to implement their own particular visions of land and water use on the State's northern plains.

The most visible changes to the landscape that occurred in the Goulburn Valley during this period involved the expansion of the area of land irrigated, in association with increased agricultural settlement. This was accompanied by a gradual intensification of water use, and resultant increases in agricultural productivity. As discussed in the preceding pages, the impetus for the increases in irrigation and settlement activity was, variously, economic, ideological and social. It was also (arguably) institutional, as the SRWSC assumed a dominant position within the irrigation system. As in the past, the environment was a factor in the decision-making process only insofar that irrigation water was (or could be made) available from the Goulburn and other rivers, and the regional landscape was flat and hence commandable by channels. Other environmental factors, such as soil limitations and potential and actual watertable and salinity problems were discussed, but were not considered a hindrance to development. The conviction remained that the land could, and should, support farming families, and the region was constructed accordingly, and with great expediency, to fit the dreams of politicians, engineers, and farmers (Worster 1994). It was not an outcome of the dialogue between culture and nature, so that serious environmental problems, including chronic waterlogging, soil salinity and sodicity, were bound to ensue. The question remains as to why the emergence of these problems elsewhere in Victoria during this period did not evoke cognitive responses (i.e, structural changes) within the irrigation system, but merely localised reactions that did little to challenge the pro-irrigation paradigm within the State, or to avert the inevitable environmental consequences.

In 1905, environmental concerns were still far in the future. The irrigation system that had been instigated by Alfred Deakin was in danger of collapse, not from waterlogging but from financial instability and lack of maintenance (e.g., Martin 1955). With the drafting of the new Water Act 1905, the system effectively underwent a bifurcation and remerged with a hierarchical regulatory structure that included the SRWSC as a new intermediary component between landholders and the State Government. As discussed on page , this new organisation was responsible not only for practical and administrative aspects of water supply and distribution in Victoria, but also for formulating policies concerned with land and water use. In systems terms, it functioned as a higher order regulator (Rappaport 1977), and thus tended to be less involved with the on-farm (environmental and material) details of irrigation management than with engineering and more abstract policy and administrative matters. Rappaport (1977) notes that this is characteristic of high level subsystems, and occurs primarily for reasons of efficiency in information processing: higher order regulators do not need to 'know' all of the details that concern subsystems that are subordinate to them, and involve themselves directly with affairs usually managed by lower order subsystems only when those subsystems experience difficulty. The SRWSC thus tended to promote production systems (e.g., those based on lucerne hay) that served its own interests rather than those of landholders, and focused research attention on problems that affected its own operations, while on-farm concerns were considered to be the responsibility of irrigators (Haskew 1996).

In organisational terms, the SRWSC operated according to what Parker & Stacey (1995, p. 47) describe as 'ordinary management'. That is, a process of solving the problem of how to carry out strategy and achieve objectives according to a shared mental model or paradigm. The SRWSC's primary institutional goal, at least at the outset, was to make irrigation self-financing. SRWSC Chairman Elwood Mead perceived that for this to be achieved, maximum use had to be made of the available water. This required that the existing supply channels operate at full capacity, which in turn required that settlement in districts served by them be intensified, and that farmers in those districts rely "more on canals than clouds" (SRWSC 1908, p. 8). In other words, the SRWSC required "active partners" on the land (Worster 1994). Mead's colleagues evidently concurred, and he also received the support of the State Government, as its own goals of intensifying rural settlement and promoting the economic development of rural areas dovetailed neatly with those of the SRWSC (Powell 2000; Tyrrell 1999, p. 156). The State provided funds accordingly for irrigation capital works and estate development, and introduced regulatory legislation (including the imposition of compulsory water rights) as necessary.

As Pigram (1977) notes, decisions concerning the organisation of farming are often made with little reference to farmers themselves. Similarly, overall system goals are not necessarily those of individual components (Katz & Kahn 1969). Immigrant settlers on Mead's new closer settlement estates were prepared to learn the ways of irrigation, but most existing landholders in the Goulburn Valley were reluctant to change their farming practices, whether for financial, environmental or personal/cultural reasons. Mead was thus faced with the problem of radically changing resource practices in accordance with larger (SRWSC and State) policy objectives. Lacking the willing participation of landholders, who saw no personal gain from irrigation, Mead resorted to coercive measures. These took the form of compulsory water rights, and most landholders indeed felt compelled, sooner or later, to make use of their annual water allocations.

Firey (1960, p. 249) notes that coercive measures may help to validate resource development plans, but not legitimise them (in terms of gainfulness to resource users). Compulsory water rights were strongly opposed by landholders from the outset, although in the Goulburn Valley their legitimacy eventually came about of its own accord in the late 1930s, as long-depressed markets for irrigated produce improved just as severe drought conditions set in, and farmers reappraised the value of having guaranteed access to scarce irrigation water.

The imposition of compulsory water rights, in any case, had the desired effect (as far as the SRWSC was concerned) of changing the operational framework of landholders (i.e., the environmental and institutional setting within which farm-decision-making takes place) in favour of irrigation. Less desirably, from a systems viewpoint, compulsory water rights also weakened the feedback relationship between irrigators and the biophysical farming environment. Decisions as to whether or not to irrigate, and how much water to apply each year, were now in effect made by the SRWSC rather than the irrigators themselves, and on the basis of economic and institutional logic rather than soil type and seasonal conditions. This amounted to a major structural change in the system, as it induced significant changes in behaviour on the part of resource users, and reduced the adaptability of individual farmers to the environmental conditions on their particular holdings.

The feedback problem was compounded by the fact that most landholders were merely compliant with SRWSC policy, rather than committed to Elwood Mead's holistic vision of irrigation. They neither prepared their land appropriately, nor applied their water with the skill and care that crops such as lucerne required. Proper irrigation demanded a change in lifestyle and work patterns, and was both time consuming and tiring for little additional financial gain (Blainey 1960; Dunk 1965; Kenyon 1908; Pigram 1972). As in the past, 'satisficing', rather than optimising, behaviour thus prevailed (Simon 1969; see page x), which meant that irrigators took even less cognisance of environmental factors than they might have otherwise.

Equally significant from an environmental standpoint was the fact that compulsory water rights removed any incentive to conserve water. Having paid for a certain water allocation, irrigators felt compelled to use it all to promote maximum production. Price support schemes for irrigated produce, such as those introduced for fruit and dairy products during the Depression of the 1930s, compounded the problem (Andrews 1939). So too did the subsidisation of irrigation water, as farmers were generally able to purchase water over and above their allocation volumes, and like any underpriced commodity the water was used to excess (Auditor-General, Victoria 1993, p. 65; Kellow 1992, p. 9). These economic distortions were to have a profound environmental impact, as overwatering persisted as an almost universal practice throughout Victoria's irrigation districts (McCoy 1988, p. 14; Powell 1993, p. 32; Russ 1995, pp. 68, 72).

SRWSC and Department of Agriculture officials repeatedly called for more efficient methods of water application (e.g., Blainey 1960; Read 1930; Tisdall 1961). However, in spite of continuing educative efforts, most irrigators remained ignorant of the most appropriate techniques, or, more importantly, of the very need for improvement in their land and water management skills (Blainey 1960; Haskew 1996, p. 108). As Blainey (1960, p. 109) observed, "the ordinary grower has not really understood anything wrong with the present method of building up the watertable". Blainey was referring to orchardists in the troubled Mallee districts, but it may be presumed that landholders were at least as complacent in the Goulburn Valley, where the hazards of rising watertables and associated salinity problems were at that time (i.e., the late 1950s) still relatively uncommon. Mitchell (1979, p. 218) notes that hazard perception tends to be a function of various factors, most of which relate to personal experience and economic impact. Landholders who remain unaffected by a hazard thus tend to ignore it, or deny that it presents a problem. This appeared to be the case throughout much of the Goulburn Valley, as orchardists on higher ground remained unconcerned about rising watertables even into the 1980s (Clemings 1996, p. 139). It also helps to explain why collective agreement on the need for community drains was so difficult to obtain, other than in chronically waterlogged parts of the region such as Stanhope and along the Mosquito Depression (Dunk 1961; Russ 1995).

The situation in the Goulburn Valley thus accords with Pigram's (1977) observation that while the operational framework is a basic source of instability in agricultural systems, the overall character of a system is ultimately determined by the human component - that is, irrigators and their behavioural (including perceptive) responses. Clemings (1996, p. 50) adds that failure to anticipate this can undermine the most carefully planned irrigation scheme. Elwood Mead himself had gained an appreciation for this potential systemic weakness from his earlier experiences with irrigation systems in America (Kluger 1992). For this reason he expended considerable effort in Victoria towards the education of irrigators, and in devising financial and infrastructure arrangements that were conducive to settlement on his 'model' estates. Mead was also more aware than his predecessors (notably Alfred Deakin) of the potential environmental hazards associated with irrigation, but he seemed to have expected that experience and common sense would eventually lead irrigators to behave in an 'orderly' manner and manage their land and water according to his recommendations (Mead 1920). Worster (1985, p. 183) noted that Mead displayed a relentless "passion for orderliness" and was perennially frustrated by the fact that farmers did not behave as he believed they should, in the way that water, for example, could be made to flow through irrigation canals according to the laws of hydrology. Mead did not anticipate, in any case, that over-watering as a consequence of compulsory water rights might lead to environmental problems in the longer term. Similarly, he did not perceive the drainage problems at Cohuna to be anything but an 'error variance' in the course of irrigation development (Katz & Kahn 1969), and his preferred response was tighter internal control of the system - that is, further exhorting irrigators to improve their technique, rather than acknowledging the inevitable need for drainage provisions in all irrigated districts of the State, irrespective of how the water was being applied.

Haskew (1996, pp. 88) notes that Mead's colleague, SRWSC Commissioner John Dethridge, appears to have held a dissenting view on drainage requirements that surfaced to some extent in Mead's wake. Dethridge exhibited a considerable technical understanding of the nature (and inevitability) of on-farm waterlogging and salinity problems, and was a driving force behind the establishment of the Irrigation Research Committee in the mid-1920s. Dethridge died in 1926, however, and Haskew observes, as a corollary to the effect on systemic functioning of visionary individuals, that progress in the operation of government departments tends to lapse if leading personalities retire or die (Haskew 1996, p. 101).

Problems of perception, relating to both the behaviour of irrigators and to the biophysical environment, in any case, continued to characterise the SRWSC following Mead's departure. In part, this was because a new visionary, Ronald East, effectively defined the organisation for almost three decades, and also because of the SRWSC's detached position within the system as a higher order regulator (Rappaport 1977). However, cognitive failures may have occurred for institutional reasons as well. With the legislative support of the State Government, and irrigation as the perceived key to the success and security of agricultural settlement on the northern plains, the SRWSC became the dominant component in the overall irrigation system in Victoria. This had been facilitated in the beginning by Mead's presence on both the SRWSC and the Lands Purchase and Management Board (LPMB); it was strengthened in 1913 as responsibility for the subdivision and settlement of lands in irrigated areas was transferred from the LPMB to the SRWSC (SRWSC 1913); and it was further reinforced in 1918 as the SRWSC was granted authority to acquire and develop land for soldier settlement. The new wave of soldier and closer settlement schemes after World War II also favoured the SRWSC, as it continued to pursue its charter of providing and maintaining irrigation facilities for agriculture. Then-Chairman Ronald East was determined for ideological reasons (including the belief that experts could manage resources for public benefit) that all of Victoria's water resources should be put to productive use, but his programs of dam building and the further intensification of irrigation arguably helped to solidify the institutional position of the SRWSC. Langford *et al.* (1999, p. 11, 33) add that most of the SRWSC's Commissioners, although Government appointees, came from within the organisation, and were generally professional engineers whose interests and priorities were reflected in both the SRWSC's construction programs and its strong organisational culture.

Langford *et al.* (1999, p. 28) observe further that as the SRWSC represented the interests of water users, as well as being responsible for irrigation policy and regulation, it functioned in effect as both "poacher and gamekeeper" of Victoria's rural water resources. As an organisation, it also had a strong vested interest in the continuation of irrigation development, as it benefited financially from the increased revenue associated with increased water use, and operated without any particular financial or performance objectives being imposed by the Government (Langford *et al.* 1999, p. 11; Powell 1989, p. 250). The resultant lack of commercial discipline within the SRWSC has been suggested accordingly to have led to over-investment, and the construction of "too many irrigation schemes supplying water to low value enterprises" (Langford *et al.* 1999, p. 11).

Rappaport (1977) used the term 'over-specification' to describe the attempts of special purpose subsystems, such as the SRWSC, to promote their goals to positions of predominance in the larger systems of which they are part. He also noted that as such subsystems (and the individuals identified with them) become increasingly powerful, they are increasingly able to succeed. Over-specification may lead to maladaptation, however, since the overall system loses evolutionary flexibility in terms of its ability to adapt to changes in its environment, and thus to achieve the fundamental long term systemic goal of sustainability (The goals of the subsystem, in other words, may not coincide with those of the overall system over the longer term) (Rappaport 1977). Emery & Trist (1969) add that as bureaucratic subsystems, such as the SRWSC, typically rely on internal structural adjustments to cope with external challenges, they may also compromise their own ability to respond to newly emergent and unforeseen environmental changes, as the continued existence of the bureaucracy becomes an end in itself, rather than a means to an end within a greater system (Katz & Kahn 1969).

In Victoria, the SRWSC's implicit goals - initially to make irrigation pay for itself, and later, under Ronald East, the pursuit of irrigation for its own sake (Haskew 1996, p. 76) - effectively became the goals of the greater irrigation system. Development was impelled by a reinforcing (positive feedback) process in which water supply limitations were overcome through the construction of additional (or enlarged) storages, which in turn encouraged further subdivisions of land for irrigation and increases in water rights. The completion in the 1930s of the Hume Dam, for example, made available a vast store of water which obviously could not be allowed to "lie idle", although both domestic and international markets for irrigated produce were saturated at that time (Andrews 1939). Irrigation development thus tended to continue until water was once again in short supply (usually during drought years), and additional storage capacity was again deemed necessary.

Economic factors that could have tempered irrigation development, including Royal Commission findings that the financial returns from irrigated closer settlement areas were insufficient to recover the costs of development (Royal Commission on Closer Settlement 1916; Royal Commission on Soldier Settlement 1925), or that irrigation itself, as practised in Australia, was economically unviable (Andrews 1939;

Davidson 1969), hardly weighed against the rhetoric in support of continued development. The further expansion of irrigation schemes in the 1950s was justified nationally on the basis of the gross value of agricultural commodities that could be obtained for a given investment of capital. As Australia at that time was experiencing overseas balance of payments problems, calculations of net output per unit of capital invested were "conveniently ignored" (Davidson 1969, p. 89). State and Federal Governments were otherwise satisfied that irrigation offered numerous indirect benefits, including increased rural populations and associated infrastructure, increased output and diversity of agricultural produce, reduced food imports, and benefits for non-irrigated industries, such as secure fodder reserves in times of drought. As in the previous century, expenditure on irrigation was justified as a long-term investment in the nation's future (Andrews 1939; Royal Commission on Closer Settlement 1916).

Growing drainage and other problems in northwestern Victoria and, increasingly, the Goulburn Valley, also did little to alter the institutional conviction that irrigation development and the further intensification of water use should continue to proceed. Emergent problems were dealt as necessary with by the SRWSC in reactive fashion, while blame for their occurrence was generally directed at irrigators (e.g., Heslop 1954; Read 1930). Otherwise, it was believed within the organisation that technical solutions would be found sooner or later for rising watertables and associated salinity and soil problems, so that irrigation development should not be hindered in the meantime (Dunk 1961; Tisdall 1961). Not until the 1970s was it suggested that the SRWSC's efforts to bring ever more water to the northern plains might have been detrimental to the interests of the irrigators in the longer term (Blackburn 1978).

It may be argued in conclusion that the persistence of the basic systemic paradigm - that irrigation, and more of it, was good for Victoria, in spite of growing evidence to the contrary - can be explained by cognitive failings that relate primarily to the socio-economic goals of the State and Federal Governments, and to the institutional power of the SRWSC. These appear to have contributed, at least initially, to a continuation from the Deakin era of 'cognitive dissonance' - that is, an unwillingness to perceive that irrigation, properly conducted, could be other than beneficial (Mitchell 1979, p. 130; see page 76). This perception moderated in subsequent decades into the belief that the positive benefits of irrigation by far outweighed the costs (including negative environmental impacts). The latter view was no less significant from an environmental standpoint, however, as the problems associated with irrigation were perceived to be of lower priority than the expedient continuation of the development process. The remedial strategies that were implemented - belatedly-constructed drainage schemes, internal restructuring of the SRWSC to incorporate a trouble-shooting division - could be summed up accordingly as too little, too late, and as will be seen in the next chapter, the continued prosperity of the Goulburn Valley, and much of northern Victoria, was to be severely compromised as a result.

CHAPTER 8

WATER AND SALT (1970-2000)

8.1 Introduction

In the preceding chapters of this thesis it is suggested that, until the advent of irrigation, the biggest environmental problem facing European settlers in the Goulburn Valley was the limited nature and unreliability of the region's water resources. Ironically, the Goulburn Valley is now threatened by a growing excess of water, as the warnings of the early engineers of the potential dangers associated with irrigation have become a reality, and high watertables and salinity are impacting on increasingly large areas of farmland. The actual and potential severity of these problems was first acknowledged at an official level at the beginning of the 1970s, and various mitigating strategies were devised in response. Those proposed by the SRWSC focused solely on engineering solutions, but by the 1980s it was recognised by the Victorian Government that a new, more holistic (or systemic) approach was required, involving both extensive input from landholders, and consideration of the impact of salinity control measures in the Goulburn Valley on downstream salinity levels in the Murray River. This ultimately led to the development of comprehensive environmental management plans for the greater Goulburn-Broken catchment area (and other regions of the State). These rely on the cooperative involvement of all levels of government and the regional community, and fully operational feedback loops between all systemic components.

Major topics of discussion in this chapter include the hydrological circumstances leading to the development of high watertable and salinity problems in the Goulburn Valley. The changing official and landholder perceptions of the regional environment are also described, as are the innovative structural responses devised in Victoria to address not only the symptoms but the causes of the various regional systemic imbalances, in the hope that more sustainable land and water use might be achieved in the Goulburn Valley and elsewhere in the future.

8.2 The hydrological repercussions of European settlement and resource use

At the time of European settlement in the Goulburn Valley, watertables occurred at an average of 20 to 30 metres below the soil surface, although some variability occurred due to the geomorphic character of the region (see Chapter 2). Wells dug at Kyabram and Tatura during the Selection era were reportedly sunk to depths of almost 40 metres, for example, and another dug for a hotel in the Shepparton district was 35 metres deep (Bossence 1963, p. 44, 1969. p. 26, 1979, p. 156). It was otherwise reported that good water could be found throughout most of the Goulburn Valley at depths from 15 to 30 metres (Wallis 1873).

Higher watertables had occurred in the geological past, in the aftermath of the last Ice Age. After this period, they receded, apparently as a result of climate change, although the establishment of deep-rooted (eucalypt) vegetation around 8000 years ago may have been a contributing factor. The return of the trees is considered, in any case, to have marked the beginning of the modern pre-irrigation hydrological regime on the northern plains (Bowler 1990; Macumber 1978b).

The overall regional hydrological system is thought to have been in equilibrium at the beginning of European settlement, but small increases in the water budget due to the various changes in land use since that time appear to have been sufficient to bring about a steady increase in groundwater storage (Bowler 1990; Macumber 1978b). In the Murray Valley Irrigation District (north-east of the Goulburn Valley), where irrigation commenced in the 1950s, it was observed within a decade that watertables were rising at an average of 60 centimetres per year, and in some years by up to 1.3 metres (Gutteridge *et al.* 1970, p. 276). Similar trends were apparent in the Goulburn Valley, where high watertables (within two metres of the soil surface) had begun to impact large areas of the Kyabram and Stanhope districts during the 1960s (Gutteridge *et al.* 1970, p. 275). Across the greater Shepparton Irrigation Area (SIR, incorporating the Murray Valley and Rochester-Campaspe Irrigation Districts, as well as the Goulburn Valley)(see Figure 2.3, page 18), it was estimated in 1970 that high watertables underlay more than 30,000 hectares of farmland, or six per cent of the total area of the region (Gutteridge *et al.* 1970, p. 425). This figure has generally continued to increase since that time, with the Central Goulburn area (i.e, west of the river) particularly affected (Figure 8.1), and further increases are predicted into the future (Table 8.1).

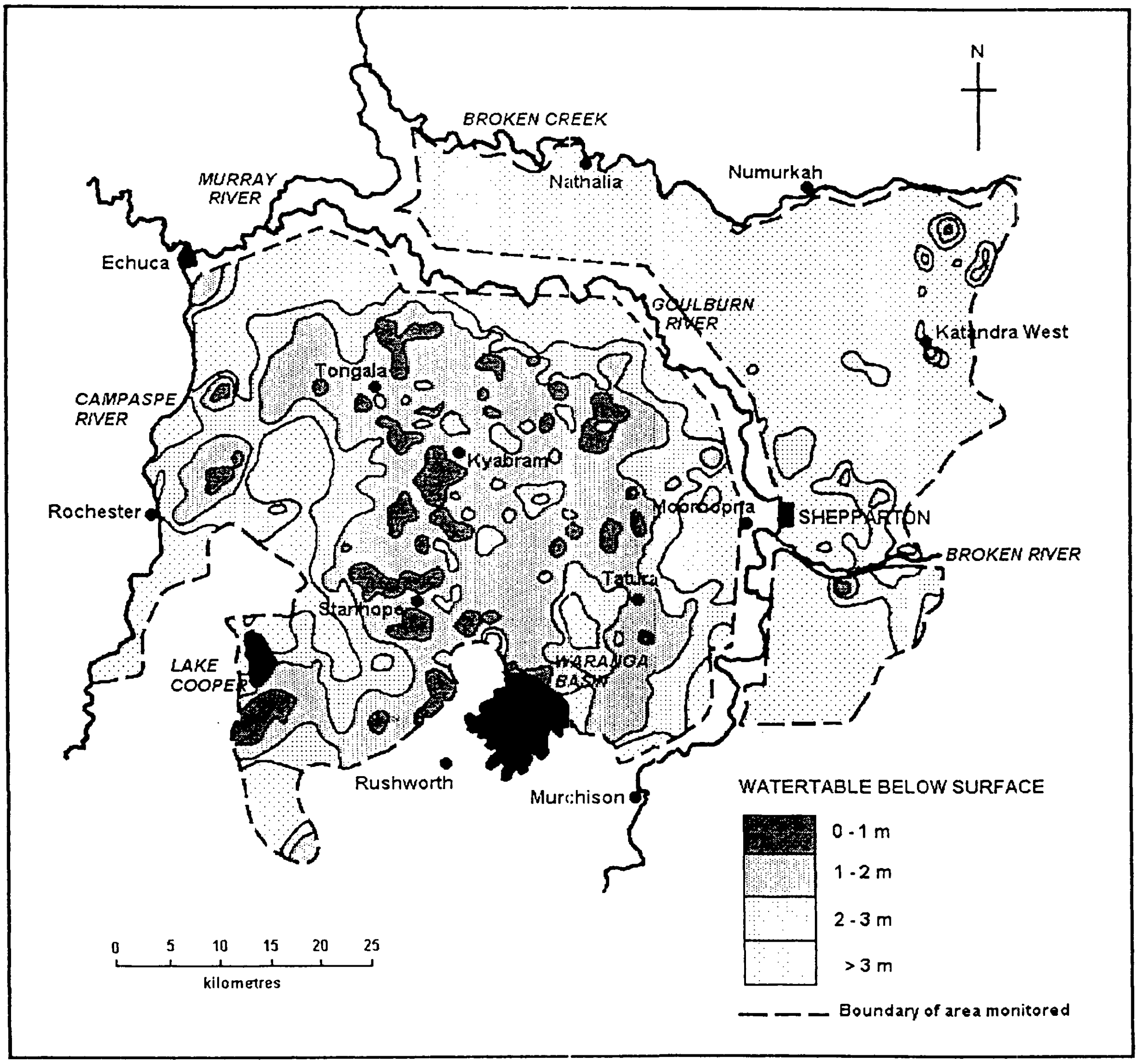
Table 8.1: Estimated extent of high watertables (within 2m of the soil surface) in the Shepparton Irrigation Region*.

Year	Area affected (hectares)	Per cent of SIR	Source
1970	30,000	6	Gutteridge *et al.* (1970, p. 425)
1979	50,000	10	Maunsell & Partners (1979)
1982	110,000	22	ACIL Australia (1983)
1996	250,000	50	Sampson (1996)
2000	175,000	35	Sampson *et al.* (2000)
2020**	300,000	60	Sampson *et al.* (2000)

** Total area approx. 500,000 hectares. Includes Goulburn Valley (i.e., Shepparton and Central Goulburn Irrigation Districts), also Murray Valley and Rochester-Campaspe Irrigation Districts.*

*** Projected.*

Figure 8.1: Watertable contours in the Goulburn Valley, August 1999 (Source: SIRIC 1999).



The primary hydrological causes of rising watertables on the northern plains appear to be: a) changes in evapotranspiration (ET) rates throughout the landscape following the widespread removal of native vegetation; and, b) the addition of water to the landscape by means of irrigation (e.g., Macumber 1978b, 1990). Both of these forms of hydrological disturbance are discussed in further detail below, but other, related causative factors include: the control and modification of river systems; the introduction of new agricultural practices; interruptions to natural surface drainage due to the construction of roads and irrigation channels; and the inadequacy of artificial surface drainage in irrigation areas (Gutteridge *et al.* 1970, p. 31; Macumber 1990; Mehanni 1978).

8.2.1 The impact of clearing

The hydrological impacts of clearing are associated with the reduction in evapotranspiration that occurs when native woodland vegetation is replaced by (primarily annual) crops, pastures and fallow periods. Agricultural species tend to have shallower rooting depths and shorter durations of canopy cover than the native species, so transpire less. They also intercept less rainfall (Cook 1992). This results in the increased percolation of water through the soil as well as increased stream flows, which contribute to rising watertables via the increased infiltration of water through stream beds in high recharge (i.e., groundwater intake) areas (Macumber 1978b). Actual increases in recharge rates following clearing appear to be relatively low (50 millimetres per year or less), particularly when compared to annual rainfall and evapotranspiration rates, but the resultant volumetric increases in groundwater accessions may be highly significant in terms of overall catchment hydrology (Cook 1992; Williamson 1983).

As discussed in Chapter 5, the clearing of trees and other native vegetation in the Goulburn Valley commenced on a widespread scale during the Selection era. The most extensive clearing occurred during the 1870s as much of the land in the region was prepared for agricultural purposes. The process continued into the twentieth century, and was undertaken with particular vigour during the 1950s and 1960s, when wool prices were high for a prolonged period (due in part to the Korean War). Any remaining woodland vegetation was seen at that time as an impediment to pasture improvement (Barr & Cary 1992, p. 80). As late as 1983, the clearing of trees on farms continued to be encouraged by special taxation deductions[1] (e.g., Auditor-General, Victoria 1993, p. 63), while the Victorian Department of Agriculture published regular articles for landholders on the most efficient means of felling, ringbarking and poisoning native trees (e.g., Drake 1957; Ferguson 1945, 1965).

Macumber (1978b) suggests that clearing associated with mining activities from the time of the gold rushes would also have made a significant contribution to hydrological changes in certain catchment areas. Within the Goulburn Valley, there were substantial diggings at Rushworth and Whroo from the 1850s onwards, and the destruction of the surrounding forest and scrub vegetation is reported to have been almost wanton (Hammond 1978, p. 122; Howitt 1972, p. 278; Smyth 1979, p. 28). There were also mines along the Upper Goulburn River, between Jamieson and Woodend, where clearing would have been equally substantial (Upper Goulburn Region Resources Survey 1951). Deforestation in these areas would have had hydrological impacts on the plains further north, as the major regional groundwater drainage from the Central Highlands flows northwards towards the Riverine Plain via the series of ancestral river courses known as 'deep leads' (see Chapter 2). Water in these aquifers moves in the order

[1] In a complete reversal of policy, taxation incentives were introduced by the Federal Government in 1990 to encourage the *planting* of trees on farms. This came about as trees were identified in the 1980s as a possible means of lowering water-tables in both dryland and irrigated areas, and tree-planting came to be equated in some government circles (if not by all landholders) with 'sustainable' agriculture (e.g., Barr & Cary 1992, p. 81).

of metres per year, and a rise in pressure associated with increased water intake upstream can be rapidly transferred downstream. This results in increased upward pressure and upward movement of groundwater (a rise in the 'potentiometric surface'), which is observable in bores and wells and has been measured in the Goulburn Valley at rates of between 0.1 and 0.2 metres per year (Macumber 1990). This water also tends to be saline, due to accumulation of salts washed down from the Central Highlands by the ancient rivers (Barr & Cary 1984, p. 7).

8.2.2 Irrigation impacts

In irrigation areas, the hydrological impacts of clearing are impossible to separate from the cumulative effects of decades of supplementary watering. Irrigation is almost certain to have been the most significant cause of rising watertables in the Goulburn Valley, nevertheless, because of the much greater volumes of water involved (Cary & Barr 1992; Macumber 1990; Pigram 1986). By the 1960s, for example, annual water deliveries to the region were almost as high as the average yearly rainfall (see Figure 7.8, page 168), with an estimated 30 per cent of the water ending up in drainage systems or percolating into the groundwater, rather than being used by crops (Dunk 1965).

Irrigators thus continued to be criticised for using inefficient watering practices that were likely to result in over-watering (Dunk 1965; Gutteridge *et al.* 1970, p. 30, p. 50; Haskew 1996). However, irrigation also contributes to the build up of watertables in other ways that are unrelated to irrigation technique. In particular, water from rainfall will percolate beyond plant root zones if the rain occurs immediately after an irrigation, or during a period when the water requirements of irrigated perennial plants are minimal (Mehanni 1978). In the Goulburn Valley, only about 20 per cent of accessions from heavier soils (i.e., cover floodplain soils) have been determined to be the result of poor irrigation practices, while the remainder appears to be directly attributable to rainfall (Lyle *et al.* 1986). This is explained by the fact that these soils have a low subsoil hydraulic conductivity, meaning that their capacity to absorb moisture from winter and spring rainfall is substantially reduced by autumn waterings (to the order of 100-200 mm per year), which in turn provides a greater opportunity for rainwater to pass through the soil into the groundwater (Lyle *et al.* 1986).

Another significant cause of irrigation-related water-table problems is channel seepage. This includes losses from on-farm distribution channels (which according to Mehanni 1978, were often poorly constructed), but also from major supply channels. Such losses can never be completely controlled, but in northern Victoria the problem has been exacerbated by the siting of many of the major channels along prior stream ridges. These locations were favoured by the early engineers because they commanded the highest elevations across the plains, but they also proved to be areas of highest soil permeability (See Chapter 2). Seepage problems have been made worse still by the flat terrain of the northern plains, which requires that the channels be large in cross-section to compensate for the slow delivery velocities (Haskew 1996, p. 54).

In the Goulburn Valley, seepage losses from main and district channels were calculated in the late 1960s to be in the order of 150,000 megalitres per annum, or approximately half of the estimated total groundwater accessions in the Shepparton, Rodney and Tongala-Stanhope irrigation districts (Table 8.2). The SRWSC estimated, more conservatively, that approximately one-third of the water delivered to irrigation districts was lost before reaching the farm, with half of this figure attributable to seepage from channels, and leakage and channel breaks, evaporation and regulation accounting for the remainder (Dunk 1965). Such losses are likely to have been even higher in earlier decades, as channel construction, lining and maintenance procedures were less sophisticated, and also of lower priority to the SRWSC (Gutteridge *et al.* 1970, p. 279; Haskew 1996; McCoy 1988; Read 1930).

Irrigation-related accessions to the groundwater from all of the above sources (i.e., over-watering, rainfall, seepage and other channel-related losses) are thought to have occurred on the northern plains from the very beginnings of irrigation. Recharge rates are also likely to have increased with time in association with increases both in the area irrigated and in the volumes of water delivered to the irrigation districts (Blackburn 1978; Gutteridge *et al.* 1970, p. 280; Mehanni 1978)(see Figures 7.4, 7.6, 7.8). Since monitoring commenced in the 1960s, some declines in watertable levels have been observed in years when annual rainfall has been substantially below average (i.e., 100 millimetres or more)(Lyle *et al.* 1986; Maunsell & Partners 1979). This includes much of the last decade (i.e., 1990-2000)(see Appendix 1). However, the overall long-term trend has been for the incidence of high watertables to increase (Table 8.1), with negative impacts on agricultural productivity in the areas affected

Table 8.2: Estimated seepage losses from irrigation supply channels in the Goulburn Valley, 1960s.

	Estimated seepage losses (megalitres per year)	
Irrigation district	**Main channels**	**District channels**
Shepparton	48,080*	12,400
Rodney	6,160	32,050
Tongala-Stanhope	n.a.	22,190
Deakin	20,950	3,700
TOTAL	75,190	70,340

Source: Gutteridge *et al.* (1970, p. 279).

** Four-year average for East Goulburn Main Channel (80 km long; 37 m effective width).*

8.2.3 The emergence of salinity

By the late 1960s, some irrigators in the Goulburn Valley were becoming aware of salinity (i.e., the presence of excess/harmful quantities of salt in soils and water)(see Appendix 2) as another emergent threat to their land and livelihoods. In the Goulburn Valley, where the soils are not inherently saline, this phenomenon arose as sub-surface salts mobilised by locally rising watertables were brought to the soil surface by capillary action and then concentrated whenever the rate of evaporation exceeded the downward flux of water (whether rainfall or irrigation water)(e.g., Mehanni 1978). The problem was thus not so much one of salt accumulation from outside the region, but the redistribution towards the soil surface of existing salt, whether from bedrock layers or saline groundwater aquifers (Allison *et al.* 1990; White 1997, p. 105).

As discussed on page 171, symptoms of salt damage in the Goulburn Valley had been observed in several Kyabram orchards after the wet winter of 1956, and were again reported after wet conditions in 1963 and 1969. In 1973, another unusually wet year, they were even more prevalent. The damage around Kyabram was described as "widespread" at that time, and there was also evidence of salinity problems in other horticultural districts of the Goulburn Valley, including Ardmona and Shepparton East (Bakker 1978). Pastures in the region were also showing signs of damage. In the Stanhope district, a group of 30 dairy farms were affected in 1973 by scattered salt patches totalling 100 hectares in extent, and by 1978 it was estimated that between 1000 and 2000 hectares of pastures across the Goulburn Valley were seriously affected by salinity (Blackburn 1978; Trewhella & Webster 1978).

In the Shepparton district in 1973, salinity was still a minor problem compared to waterlogging, which caused the losses of over 300,000 peach trees in that year (Trewhella & Webster 1978). Salinity symptoms became more widespread in 1974-75, however, with more than 3,000 hectares of pear trees affected, or about half the total pear plantings in the region. Saline water-tables were also found to be present within the root zones of orchard trees at the start of the growing season, suggesting that the situation was much more serious than was previously thought, and that all major horticultural areas within the region were potentially threatened by both waterlogging and salinity (Bakker 1978; Trewhella & Webster 1978). This was a major concern since, as Victoria's Auditor-General (2001, p. 19) points out, salinity can drastically reduce agricultural productivity and biological diversity, and can also have detrimental impacts on social cohesion. The removal of the salt from affected land and waterways also tends to be financially prohibitive, so that major environmental problems are created into the future.

8.3 Official perceptions and responses

8.3.1 The Gutteridge Report

In the late 1960s, as individual landholders in the Goulburn Valley were becoming aware of high watertables and salting on their farms, official concerns were being directed towards the condition of the Murray River. In 1967-68, a severe drought had resulted in abnormally high salinity levels in the river, causing serious difficulties for downstream irrigators in South Australia and for water users in the city of Adelaide, near the river mouth. These were different problems from those experienced in the Goulburn Valley, but as Haskew (1996, p. 205) observes, they were not mutually exclusive: the Murray comprised the only outlet to the sea for the entire Murray-Darling Basin, and served as the main drainage channel for all of the irrigation districts in northern Victoria and southern New South Wales. Effluent from these areas thus contributed to the natural salt load of the Murray River, and salinity levels seemed likely to increase as the incidence of salting and high watertables became ever more widespread across the riverine plains.

In Victoria, the Sunraysia district of the Mallee and the Barr Creek catchment near Kerang were quickly identified as the major Victorian sources of Murray River salinity, and salt interception works were begun in these districts in 1968 (e.g., McCoy 1988, p. 48). At the same time, a major investigation was commissioned by the River Murray Commission[2] into the waterlogging and salinity problems of all of the irrigation districts along the Murray Valley in Victoria, New South Wales and South Australia. This was undertaken by a team of consultants, Gutteridge, Haskins and Davey, who published an exhaustive report of their findings two years later (Gutteridge *et al.* 1970), and confirmed that waterlogging and salinity were no longer matters of local inconvenience but serious regional problems that were compromising the water quality of the Murray River.

For the Victorian Government, the Gutteridge Report was cause for serious concern. It had already been known for some time that shallow saline watertables underlay much of the Mallee and Kerang districts, but the extent of the problem was now quantified, and it was also clearly apparent that the highly productive Goulburn Valley was affected as well. Thirty thousand hectares of irrigated land across the Shepparton Irrigation Region were already subject to watertables within two metres of the surface, and the area of land affected across the Riverine Plains as a whole was predicted to treble within the next 50 years (Gutteridge *et al.* 1970, p. 425). The Gutteridge Report emphasised that without mitigating action to arrest the rise in watertables, irrigators in the Goulburn Valley and beyond would eventually have no option but to accept the incursion of high watertables and salinity onto their land, and adjust their income and productivity expectations accordingly (Gutteridge *et al.* 1970, p. 117).

[2] An inter-governmental body created to administer the 1915 River Murray Agreement.

Irrigation had at that time been under way in Victoria - and the Goulburn Valley - for more than eight decades, and warnings had been issued from the outset of the possibility of such outcomes as high water-tables and salinity (see Chapters 6 and 7). However, it was the Gutteridge Report that drew the first serious attention to the possibility that the existing system of land and water use on the northern plains might not be sustainable into the future. The release of the Report thus marked a turning point in Victoria with respect to perceptions of irrigation and its potentially damaging impacts upon the land.

8.3.2 SRWSC responses

Gutteridge, Haskins and Davey had concluded that if the productivity of the irrigation areas and the integrity of the Murray River were to be maintained into the future, definitive salinity control measures were required. For Victoria, they proposed major engineering works to intercept the flow of saline groundwater into the Murray from the Mallee and Kerang districts, as well as the extension of surface drainage and groundwater pumping provisions in the Goulburn Valley (provided the resultant effluent did not contribute to the salt burden of the Murray River), and general improvements in farm management and irrigation practices across the northern plains (Gutteridge *et al.* 1970).

For the SRWSC, the Gutteridge Report provided an opportunity for the organisation to re-invent itself. The proposed engineering schemes would not only solve the problems of the riverine plains and Murray River, but they offered the Commission a new focus and an opportunity to consolidate its position at a time when the value of irrigation was being questioned by the broader community. Environmental issues had become a source of growing social concern since the late 1960s, and irrigation had now been identified in the Gutteridge Report as a major factor contributing to the environmental and agricultural problems of the Murray Valley. In the wake of the failed Ord River scheme in Western Australia, critical attention was also being drawn by the nation's economists to the costs of irrigation schemes, including the fact that water supplies to farmers were heavily subsidised by taxpayers (Davidson 1969; Langford *et al.* 1999, p. 12).

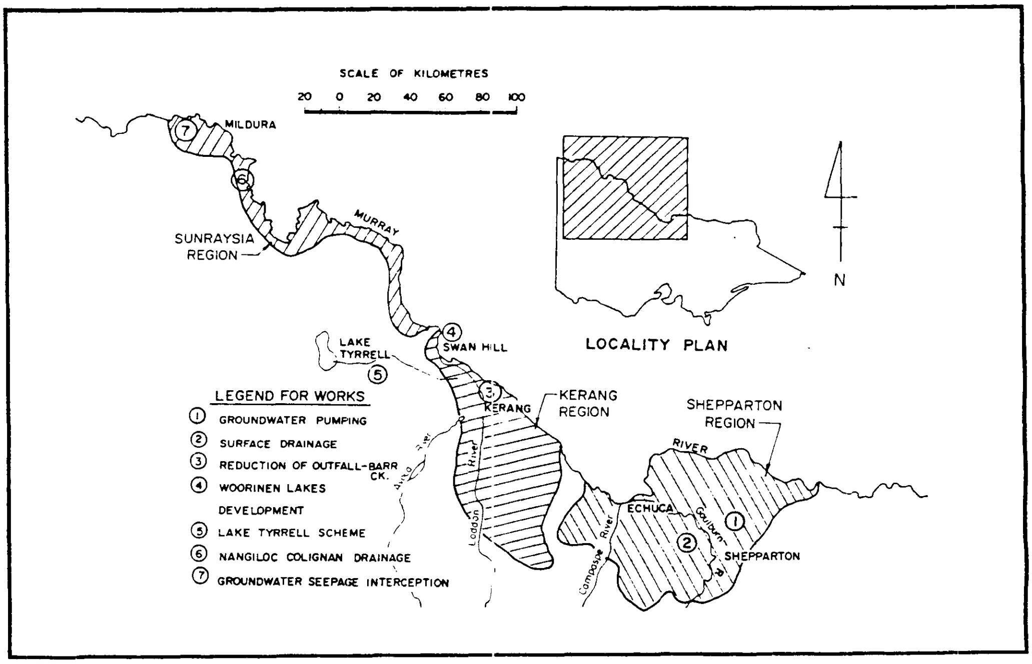
The Gutteridge Report thus foreshadowed the end of the dam-building era in Victoria, and effectively redirected the "visionary fervour" of the SRWSC's water managers and engineers away from the further expansion of irrigation and towards drainage schemes and the control of watertables (Russ 1995, p. 136; Tisdall 1973). The need for such a change was reinforced by the worsening of salinity and waterlogging problems in 1973, particularly in the Goulburn Valley, where the SRWSC was granted emergency funds for mitigation works. These included the extension of surface drainage provisions, and the establishment of an extensive grid of 150 groundwater pumps, known as the Phase A groundwater pumping scheme, in the Shepparton district (McCoy 1988, p. 49; Trewhella & Webster 1978). The latter had been devised after SRWSC trials in the 1960s had shown that such pumping could be a successful means of lowering watertables in locations where high-yielding aquifers occurred within 20 metres of the soil surface. Groundwater pumping also appeared to offer a means for achieving salinity control, as leaf chloride levels had been shown to decline as water tables receded and the concentration of salt left behind in the soil was not much higher than in pre-salinity situations (Bakker 1978). In the Goulburn Valley, the salinity of the pumped groundwater was generally in excess of the 350 milligrams per litre (500 µS/cm) maximum recommended for irrigation supplies (Mehanni 1978), but the SRWSC argued that most effluent from groundwater could be re-used after dilution in either the regional channel system or the Murray River (Trewhella & Webster 1978). Many landholders, in any case, already pumped groundwater for supplementary irrigation, and as it was reasonably economical (approximately A$100 per hectare in 1978) the SRWSC preferred it to tile drainage as an option for regional watertable control (Trewhella & Webster 1978).

As the Phase A works got underway, the SRWSC presented to the Victorian Parliament a A$40 million Salinity Control and Drainage Strategy for the Murray River and northern plains (SRWSC 1975). The Commission argued that such expenditure was necessary to protect the "massive" public and private investments in irrigation undertaken over the previous 90 years, as well as the livelihood of the 120,000 people in Victoria whose income and prosperity was derived from irrigated farming. Drainage provisions that were overlooked in earlier decades were now required as a matter of urgency, and the SRWSC considered that the $40 million should be viewed accordingly as "a deferred instalment in the overall cost of large-scale irrigation development", which the Victorian Government, as the prime developer, was morally obligated to provide (SRWSC 1975, p. 1).

The Strategy in effect comprised a "package deal" in which additional surface drainage and groundwater pumping schemes in Goulburn Valley horticultural areas would be complemented by engineering works in the Mallee and Kerang districts to intercept saline flows and dispose of them in evaporation basins away from the river (Figure 8.2). As the quality of both surface drainage water and groundwater in the Goulburn Valley was generally good (averaging 200 and 1500 mg/L, respectively), it was anticipated that most of the water extracted by pumping could be re-used for irrigation, and any additional salt burden on the Murray from surplus effluent would be counteracted by the proposed downriver interception works (SRWSC 1975).

No immediate action was forthcoming, however, as the plan was referred by the Victorian Government to the Parliamentary Public Works Committee for inquiry and report. Critics pointed out in the meantime that the SRWSC strategy in the Goulburn Valley focused solely on engineering works, and offered no measures for reducing on-farm accessions to the groundwater (Blackburn 1978). It would thus treat symptoms of the problem, but not deal with all of the underlying causes. The system of compulsory water rights, for example, was still in place, and the State continued to bear approximately two-thirds of the cost of supplying irrigation water to farmers (Kellow 1992, p. 32). This offered little incentive for increasing the

Figure 8.2: Works proposed under the SRWSC's 1975 Salinity and Drainage Strategy (from SRWSC 1976).



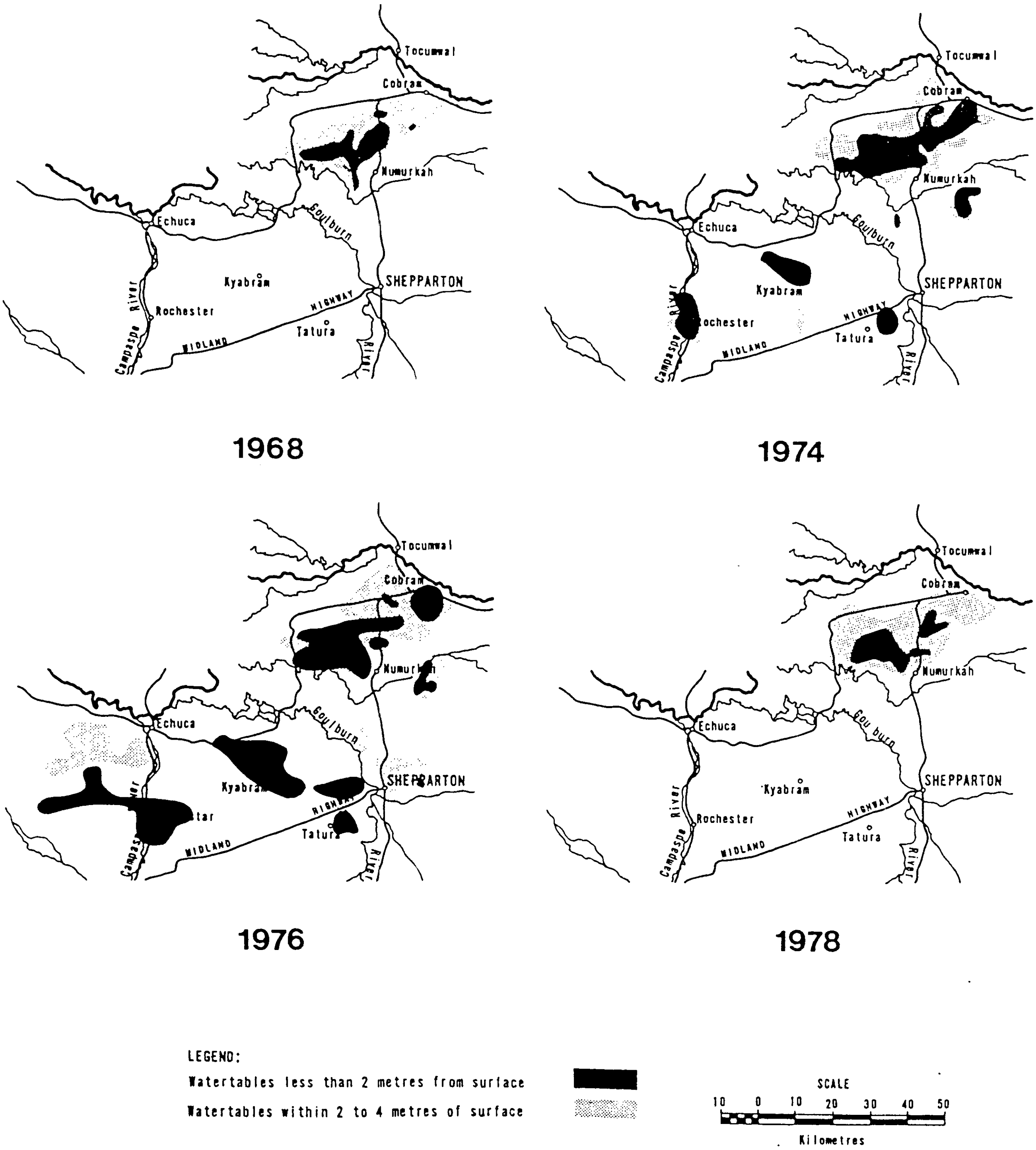
efficiency of on-farm water use, but the SRWSC was reluctant to change the structure of its water pricing policies, arguing that the major influence on groundwater levels appeared to be rainfall (Maunsell & Partners 1979, p. 76). Kellow (1992, p.10) adds that the water pricing issue was complicated by "institutional, equity and marketing considerations" (including the collapse of British markets for Australian produce in 1973, when the UK joined the European Economic Community) that posed significant obstacles to water pricing reform.

8.3.3 The Maunsell Report

By 1975, the salinity issue had become a proverbial "political football" among the Murray River States as each put forward their own proposals for engineering works to deal with the problem (Russ 1995, p. 139). Questions arose as to cost-sharing and Commonwealth assistance, so a further team of consultants, Maunsell and Partners, was engaged by State and Commonwealth Ministers in 1977 to provide an updated report on the problems of the Murray Valley and make recommendations for a co-ordinated plan of action for salinity control (Collett 1981; Maunsell & Partners 1979).

Published in 1979, the Maunsell Report concluded that the problems identified a decade earlier in the Gutteridge Report still required immediate attention, and in some instances had worsened (e.g., land salinisation was now recognised to be a growing problem in the Shepparton region, and the area subject to high water-tables had also increased (Figure 8.3)(Maunsell & Partners 1979). Progress on control works had been limited in the interim, primarily because of the large scale and high capital costs of the

Figure 8.3: High watertables in the Shepparton Region, 1968 to 1978 (from Maunsell & Partners 1979).



projects proposed and the inability of the State Governments to finance them without Commonwealth assistance. Further action required co-ordination between the States and the Federal Government, and the prioritisation of projects for funding and implementation on the basis of cost-benefit ratios (Collett 1981; Maunsell & Partners 1979; Russ 1995, p. 159).

In Victoria, the Maunsell Report separated the SRWSC 'package' of the Lake Tyrrell evaporation basin in the Mallee and the Shepparton drainage and groundwater pumping scheme into two proposals. The former was assigned a low priority, as it was determined to be of low economic value. Continuation of the Phase A groundwater pumping scheme to protect horticulture in the Shepparton region, by contrast, was deemed a high priority project, as it offered high economic returns, could be readily undertaken, and was also an immediate necessity, as groundwater levels had risen again after wet conditions in 1977-78 (Collett 1981; McCoy 1988, p. 49).

At the time of the Maunsell investigation, 55 of the proposed 150 groundwater pumps were operating around Shepparton (McCoy 1988, p. 49). The SRWSC had proposed in the meantime that a further 125,000 hectares of intensively irrigated farmland in the Goulburn Valley and adjacent districts be protected from salinity through the installation of 450 additional bores. Half of the resultant effluent would be disposed of into the channel system for re-use, while the remainder would be outfalled into the Murray. This would add to the salt load in the river arising from the Shepparton Region, but the increase would be offset by the further diversion of Barr Creek flows into the proposed Lake Tyrrell evaporation basin in the Mallee (Trewhella & Webster 1978). The Maunsell Report's dismissal of the Lake Tyrrell project was not considered an obstacle to this proposal. As the SRWSC pointed out, the Report was primarily intended to assist the Commonwealth in selecting State projects to receive capital funding assistance. It was not the final word on drainage and salinity control measures, nor would it determine which projects would be included in State plans (Collett 1981).

The disposal of effluent from the SRWSC's proposed works in the Goulburn Valley nevertheless remained a significant problem. In part, this was because surface drains were still not available in all areas of the region. Other difficulties related to the sensitivity of some crops and pastures to even moderately saline irrigation water (particularly under waterlogged conditions), and also to the effect of such water on soil permeability. In particular, the soil structural problems associated with soil sodicity (see page 172) were anticipated to increase as the proportion of sodium ions in the soil solution, and hence on the surface of clay particles, increased with the use of recycled saline groundwater (Bakker 1978). This would not pose a problem as long as the soil continued to be irrigated with effluent water, but the deleterious effects would become apparent as soon as the profile was leached free of salt - for example, after a period of heavy rainfall, or irrigation with non-saline water[3] - and the change in soil chemistry

[3] Lyle (1984, citing Ayers 1977) observed with some irony that the irrigation water in the Goulburn System was "too pure" to prevent soil permeability problems from developing.

caused the clay particles to disperse (Rengasamy & Olsson 1991). Severe structural degradation would then ensue, causing plant growth to be restricted because of poor soil-air and soil-water relations.

The Phase A groundwater pumping program, in any case, came to a halt in 1981. Prices for horticultural produce were declining, and the most valuable horticultural sites were now supposedly protected, so that orchardists who had remained unaffected by rising water-tables felt confident that their holdings were "immune" from the problem (Clemings 1996, p. 144; Russ 1995, p. 152). However, other previously unaffected districts of the Goulburn Valley were beginning to experience waterlogging and salinity problems by that time. In 1982, sixty per cent of the Girgarre district was determined to have suffered some loss of production in the previous year (Auditor-General, Victoria 1993, p. 107), and the district was threatened again by high watertables in 1984, along with Tongala and Stanhope (Russ 1995, p. 152). Three groundwater pumps were subsequently installed around Girgarre, and an experimental 30-hectare evaporation basin was constructed to determine if salt could be viably disposed of (i.e., without undue economic or environmental costs) in the broader region by this means in the future[4] (Auditor-General, Victoria 1993; Russ 1995).

The Goulburn Valley otherwise lacked an internal option for the disposal of saline groundwater effluent. One SRWSC estimate projected that over 1700 bores would be required for watertable control in the greater Shepparton Region by the year 2020 (Mehanni 1978), and while recycling pumped water offered "active [salinity] control within well-defined limits" (Bakker 1978, p. 252), much of the salt mobilised by pumping would still have to be drained into the Murray River to maintain a regional salt balance. Ideally, this would be done at times when the flow rate of the river was high and its salinity level low. However, the region at that time already contributed about 80,000 tonnes per year of salt to the Murray, and this quantity seemed likely to increase as watertable control measures were required across ever-larger areas (Lyle 1984).

8.3.4 'Salt of the Earth'

As engineers and scientists pondered over the practical difficulties posed by rising watertables and salinity in northern Victoria, salinity had been adopted as a political issue by the Victorian branch of the Australian Labor Party. This occurred in the lead-up to the State election of 1982, as Labor sought to raise its standing in several marginal rural electorates. The ruling Liberal-Country Party coalition, which had governed Victoria for the previous three decades, considered the irrigation districts well provided for, and had paid scant attention to their problems up to that time. Campaigning Labor politicians, however, saw salinity control programs and public drainage works as sources of employment in northern Victoria, and

[4] The Girgarre project was completed in 1987, and has been considered a success in terms of improving the productivity of previously degraded land in the district (Langford *et al.* 1999, p. 81).

learned from rural communities that salinity was an issue of increasing concern (Russ 1995, pp. 164-68).

The incumbent coalition Government was subsequently displaced, but for its successor, led by Labor Premier John Cain, salinity was much more than a political issue. It had developed into a major practical problem for Victoria following the signing, in 1981, of a new River Murray Agreement between the three river States and the Commonwealth Government. This Agreement, which replaced the outdated River Murray Agreement of 1915 (see page 149), was formulated with salinity as a major consideration, and incorporated a new system of water accounting based on quality (Kellow 1992). For Victoria, it meant that where the State had previously earned a credit for the (saline) water discharged into the Murray from Barr Creek, it was now debited by the amount of water required to dilute this flow. Disposing of the salt into the proposed Mineral Reserves evaporation basins in the Mallee had concurrently ceased to be an option, as farmers in the vicinity, fearing seepage, had expressed hostile opposition to the scheme and launched legal action to stop construction work proceeding (Kellow 1992, p. 19; Langford *et al.* 1999, p. 23; Russ 1995, p. 171). As Kellow (1992) observes, Victoria's salinity problem was thus internalised, and the incoming Government was faced with the challenge of devising an effective course of action that would also prevent further conflicts with landholders in the future.

The Cain Government's initial response was to form a Parliamentary Salinity Committee, which launched an exhaustive inquiry to evaluate the salinity problem from both a technical and a social perspective. This culminated in a report, Salt of the Earth, released two years later that conveyed not only the scope of the salinity problem in Victoria, including dryland areas, but also the extent of community concern over declining agricultural productivity and other, less obvious problems, such as the weakening of road foundations, corrosion of water pipes, and reduced quality of drinking water in rural areas (Kellow 1992, p. 23; Powell 1989, p. 257).

The Report also conveyed a considerable technical understanding of salinity, and outlined various techniques to combat it. The overall 'solution', as it appeared to the Parliamentary Salinity Committee, lay in establishing a new balance between the inputs and outputs of the soil-water system at a level that was both productive and sustainable. The Report did not dictate how this should be achieved, but presented a series of recommendations for regional control strategies in both irrigation and dryland areas, as well as provisions for planning and regulation, community education, extension, research and investigation, funding and inter-agency co-operation (Russ 1995, p. 178).

Importantly from a systems viewpoint, and unlike previous salinity reports (i.e., Gutteridge, Maunsell, the SRWSC's Salinity and Drainage Strategy), Salt of the Earth incorporated the views of individual farmers, farming organisations, local communities and special interest groups, as well as those of the SRWSC and other government agencies. As Russ (1995, p. 178) observes, its findings and recommendations were thus somewhat vague, but the Inquiry achieved its purpose of establishing a common basis upon which all groups could agree to work in the future. This was a substantial change from the past, in which government experts had regularly devised technical plans to solve local drainage problems, and the plans were just as often rejected by farmers, who objected to the costs involved, or the management changes required of them, or the fact that local knowledge had been disregarded (Baker 1997; Clemings 1996, p. 152). In the new 'consultative' approach, salinity was identified as a serious and continuing problem for which various technical solutions were available that could be implemented and managed by both government agencies and local communities. In the wake of the Mineral Reserves evaporation basin controversy in the Mallee (and the abandonment of that scheme in 1986), the involvement and support of these latter groups were clearly perceived by the Government to be essential requirements in the overall management of the salinity problem (Langford *et al.* 1999, p. 23; Russ 1995, p. 164, p. 177).

8.4 Landholder perceptions and responses

While governments argued over salinity priorities and funding throughout the 1970s and 1980s, some landholders and communities in affected districts began to take action of their own. In the wake of the extensive fruit tree losses that occurred in 1973, the Goulburn Irrigation Region Drainage Action Committee (GIRDAC) was formed in Mooroopna by orchardists, representatives of fruit processing companies and local council members. It was hoped that such a group, in representing the broader community, would exert sufficient political pressure for the region's drainage problems to be addressed seriously (Russ 1995, p. 142). GIRDAC subsequently made submissions to the Parliamentary Public Works Committee Salinity Control and Drainage Inquiry of 1976-81 and the later Parliamentary Salinity Committee Inquiry of 1982-84, and served as a precursor to the salinity action groups that were established as part of the State's regionally-based salinity control programs in the later 1980s (Russ 1995, p. 143).

Other landholders in the Goulburn Valley remained less concerned about the issue. A 1984 survey of dairy farmers in the Rochester and Stanhope districts revealed that many were unaware of the depth of the watertable on their land (Barr & Cary 1984). Many also did not anticipate their own holdings to be affected by salinity, particularly if they had not been affected up to that time. Those whose were affected felt that salinity was too big a problem for them to solve alone, and that the Government was obligated to help - for example, by upgrading drainage, instituting pumping schemes, conducting research, and offering incentives for efficient irrigation (Barr & Cary 1984). Farmers who remained unaffected were otherwise concerned primarily with "interest rates, the exchange rate, commodity prices, agricultural pests and markets". Salinity was of "virtually no interest" (cited by Russ 1995, p. 235).

Irrigators were experimenting in the meantime with new, more productive and labour-saving systems of land and water management made possible by new technologies. These included trellising systems in orchards, pressurised micro-irrigation systems, and the re-layout and laser-grading of pasture and crop land (Barr & Cary 1984; Chalmers & Van den Ende 1975; Halsall 1970; Rumble & Cornish 1975; Russ 1995, p. 207). Importantly for northern Victoria, micro-irrigation and laser-grading reduced the volumes of water required for irrigation, thus offering potential salinity control benefits, although most farmers viewed this as an incidental reason for the adoption of the new systems (Barr & Cary 1984).

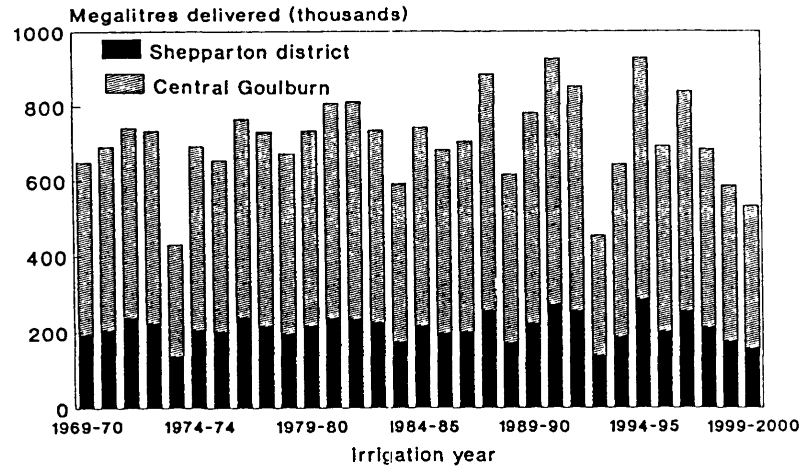
Micro-irrigation was a greenhouse technology that had been adapted in Israel for use in orchards and market gardens. Irrigation water was delivered to plants and trees by plastic micro-tubing at a rate which ensured that the upper root zone was kept close to field moisture capacity. The challenge for irrigators was to supply just enough water to satisfy the immediate needs of the plant without causing undue moisture stress or waterlogging (Halsall 1970). Gutteridge *et al.* (1970, p. 182) had dismissed this system as being too difficult to be practical in Victoria, but by the 1980s it had been widely adopted by Victorian orchardists as it could be inexpensively automated and it facilitated more uniform watering, improved irrigation scheduling and 'fertigation'. It also greatly improved the water use efficiency of horticultural enterprises as it reduced water losses due to evaporation and runoff (Austin & Goodwin 1997).

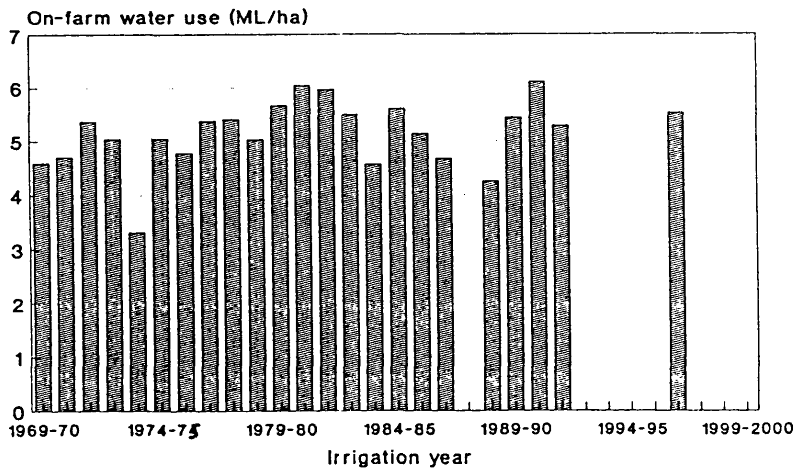
Laser-grading was developed in America, and has been described as a milestone in flood irrigation technology (Austin & Goodwin 1997). Its introduction to Victoria in 1977 was preceded by the development of high-powered tractors in the 1960s that made feasible the levelling and re-layout of irrigation land from many small contour-based drainage bays into fewer larger irrigation bays. This reduced the workload of irrigators, and also offered the possibility of increased pasture and crop productivity because of increased water use efficiency (Barr & Cary 1984). Laser-grading improved the system further still as earth-moving equipment was controlled by a rotating laser beam. This enabled large areas of land to be easily cut and tilled to a precise gradient, so that the rate of water movement along the bay (and hence the amount of infiltration) could be essentially pre-determined. For the irrigator, this meant that less water was required for each irrigation application, so that ponding and waterlogging were reduced. Irrigation bays could also be as wide as 100 metres, compared with about 20 metres previously, reducing the time required for irrigation (Haskew 1996, p. 108; Russ 1995, p. 207).

Laser-grading was heavily promoted by the Department of Agriculture (and, to a lesser extent, by the SRWSC) for salinity control purposes. It was relatively expensive, costing over A$1000 per hectare, but over 25 per cent of irrigation farms in Northern Victoria were laser-graded within a few years of the technology being introduced, and most irrigators in the greater Goulburn-Murray Irrigation District were using the method by the end of the 1980s (Barr & Cary 1992, p. 251; Russ 1995, p. 207). As a complementary measure, farmers were also encouraged to install irrigation re-use systems at the end of their laser-graded bays. This would enable fresh water running off the end of the bays to be collected and mixed with channel water for re-use on the farm, permitting further water savings (Russ 1995, p. 207). Subsidies and low interest loans were made available for laser-grading, irrigation re-use systems and improved on-farm drainage from 1982, and Department of Agriculture researchers demonstrated in the meantime that efficient watering with moderately saline water would not harm pastures.

However, the adoption of laser-grading in Victoria was not accompanied by improvements in irrigation bay design or water management guidelines (e.g., based on soil type), and the presumed environmental benefits (i.e., reduced groundwater accessions in flood-irrigated districts) have yet to be demonstrated (Austin & Goodwin 1997). The recycling of irrigation water also proved to be less-than-popular, at least initially, as irrigators instead called for more surface drains in pasture areas to intercept the increased run-off from their laser-graded paddocks (Russ 1995, p. 208). Those with groundwater pumps on their land were also reluctant to use the more brackish water produced by groundwater pumps, and felt that the Government should assist with its disposal (Barr & Cary 1984). As they also continued to pay each year for water rights, most irrigators preferred to make full use of the fresh water allocated to them through the channel system (Russ 1995, p. 208), and both water deliveries to the Goulburn Valley and on-farm applications of purchased water continued to reach new heights throughout the 1980s (Figure 8.4).

Figure 8.4: Irrigation water deliveries and on-farm water use in the Goulburn Valley, 1969-70 to 1999-2000 (Sources: Goulburn-Murray Water; SRWSC Annual Reports).





** No data available for 1987-88, 1992-93 to 1995-96, and 1997-98 to 1999-2000.*

8.5 Salinity management plans for the Goulburn-Broken catchment

Following the conclusion of Victoria's Parliamentary Inquiry into salinity in October 1984, it was decided by a Ministerial Task Force that a pilot salinity management program should be conducted in a chosen catchment to demonstrate the sort of mitigative action that was possible given government funding, community commitment and landholder cooperation. The primary intention was that the communities within the catchment would devise their own locally-oriented solutions to their salinity problems and implement them with government assistance. The program would also serve as a learning process for future community-based salinity control schemes elsewhere around the State (Kellow 1992, p. 43; Russ 1995, p. 224).

The region selected for the program was the combined Goulburn and Broken Rivers catchment area, incorporating the Goulburn Valley and districts as far south as Lake Eildon (see Figure 2.2, page 17). Salinity problems within the catchment were relatively minor compared with those elsewhere along the Murray Valley, and most local farmers were at that time concerned more by waterlogging than salting. However, the choice was officially justified on the basis that the Goulburn-Broken catchment was large enough for the links between the causes and effects of salinity to be taken into account, and that salinity problems were worsening in both irrigated and dryland areas of the catchment (Russ 1995, p. 225). Russ (1995, p. 226) adds that there were also unstated economic and financial reasons, as the Goulburn Valley was the "heartland" of Victorian agriculture, and the limited nature of the salinity problem in the region meant that the State stood to earn a better return on its investment from the Goulburn-Broken than any other catchment.

An equally significant factor in the selection of the Goulburn-Broken catchment was that landholder groups were willing to participate in the pilot program. These included GIRDAC and other farmer lobby and 'action' groups that had worked with government soil scientists to combat erosion and related problems in dryland areas since the 1950s (Kellow 1992, p. 43; Russ 1995, p. 225). In the case of salinity, the Government recognised that detailed responses needed to be tailored to local conditions, which required the cooperative involvement of landholders, not only for the successful implementation of control measures, but also because they possessed much of the necessary local knowledge (Kellow 1992, p. 45). Financial support was provided accordingly to facilitate the formation of local 'action and advisory groups' in salinity management areas. These groups comprised both landholders and government specialists, and were to become a vital component in the Government's overall salinity control strategy of the later 1980s (Kellow 1992, p. 29; Stone 1992).

A regionally-based 15-member Salinity Pilot Program Advisory Council (SPPAC) was also formed, in 1986, to assist the Government in devising salinity management strategies for the Goulburn-Broken catchment and other areas of the State. The Council comprised primarily landholders, but included representatives of local government, industry, educational institutions, and the media (e.g., Russ 1995, p. 228; Sampson 1996). SPPAC soon outgrew its advisory role and ultimately assumed primary authority over salinity management in the Goulburn-Broken catchment. This has been described as something of a government 'milestone' in Victoria, as it marked the first time that a community was directly involved in the task of devising the most appropriate means to deal with an environmental problem in its own local area (Auditor-General, Victoria 1993, p. 140).

Various strategies were employed by SPPAC to obtain input from the broader regional community into the development of the proposed salinity management plan. These included encouraging and assisting in the formation of landholder groups, regular consultations with municipalities and special interest groups (businesses, banks, service clubs, etc.) throughout the catchment, and the circulation of newsletters and media releases. A broad-based education campaign was also undertaken to increase regional awareness of salinity issues. This utilised a series of coloured 'creeping water-table' maps to draw attention to the problem of rising water-tables, which were relatively simple to explain and could be pointed to as the cause of salinity. This approach was sufficiently convincing that landholders, who in 1987 had seen almost no salinity in the region, came to believe by 1989 that most farms in the Goulburn Valley were at serious risk of salinisation due to the inexorable rise of the 'underground flood'. The education campaign was also extended to the region's schools, where students were encouraged to participate in local 'Watertable Watch' and 'Salt Watch' programs (Russ 1995, pp. 233-34; Sampson 1996; SIRIC 1998)

SPPAC also sought technical advice from the Rural Water Commission[5] for the irrigation areas. This provided the basis for the first draft of the Land and Water Salinity Management Plan (SIRLWSMP) that was produced in 1989 for the Shepparton Irrigation Region. The stated goal of the Plan was "to manage the salinity of land and water resources in the catchment in order to maintain and where feasible improve the social well-being, environmental quality and productive capacity of the region" (Sampson 1996; SIRLWMP 1988). The basic focus was to reduce the incidence of high watertables and control salinity by reducing accessions and removing water from the groundwater. This was to be achieved over a 30-year period through a combination of engineering works and on-farm measures that would lead to increased use of pumped groundwater, farm runoff and drainage diversions, thereby increasing the efficiency of irrigation both on-farm and within the distribution system. These measures would increase the salinity of the water used for irrigation within the region, but it was also intended that farm productivity should be maintained, if not actually improved, as the implementation phase of the Plan proceeded. Salt exports from the region would also be required to meet agreed inter-state constraints on Murray River salinity levels (e.g., Sampson 1996)(see page 208).

The engineering works appeared to offer the greatest potential for controlling watertables and salinity on a

[5] Successor to the SRWSC. See page 205.

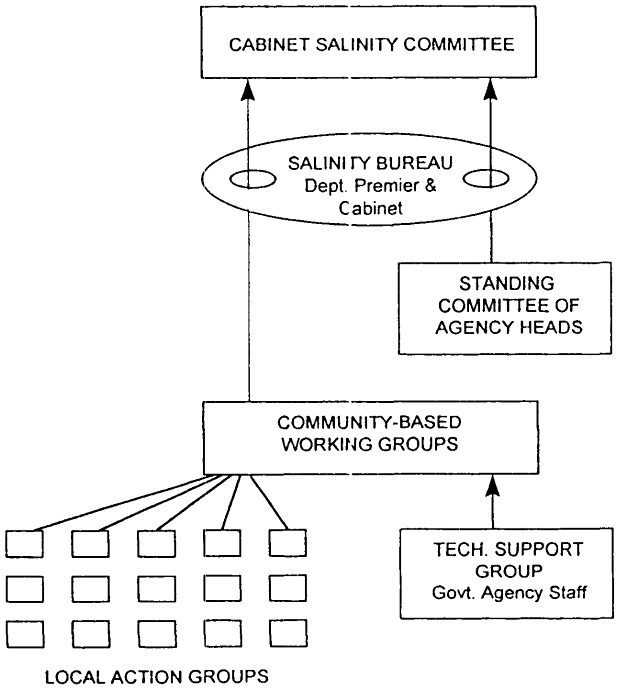
regional scale (Pigram 1986; SIRLWSMP 1997). Those proposed in the draft Plan included a sub-surface drainage program based on the Phase A and Phase B groundwater pumping schemes initiated by the SRWSC (the latter designed to protect 153,000 hectares of less sensitive horticultural and pasture land), as well as additional surface drainage works to service the 55 per cent of the region that remained undrained, and continuation of the Girgarre pilot evaporation basin project. Of these, the sub-surface drainage program was considered the most important as it was expected to have the greatest impact in terms of reducing watertables (SIRLWSMP 1997).

On-farm salinity control measures outlined in the draft Plan to complement the engineering works included improved irrigation management, whole farm planning, re-use of drainage water and pumped groundwater, and tree planting. All were aimed at improving the efficiency of on-farm water use as a means of reducing groundwater accessions, soil salinisation and waterlogging. Other elements of the Plan included environmental provisions concerned with the rehabilitation of wetlands and the protection of remnant vegetation and faunal species dependent on those ecosystems. A monitoring program was also adopted to provide data for prioritising and targetting works and to review the progress of implementation, along with a support program to provide for ongoing community education, as well as general administration and financial management of the Plan (Russ 1995, p. 236; Sampson 1996; SIRLWMP 1988; SIRLWSMP 1997).

The draft Plan proposed that all salinity control measures be prioritised on the basis of economic analyses, and that the A$10-15 million dollars required annually to implement them be shared between Government and local communities according to the principle of 'beneficiary pays' (Sampson 1996; SIRLWSMP 1997). The SIRLWSMP thus provided a set of financial 'tools' for salinity control within the Shepparton Irrigation Region. Importantly, it also provided a structure for coordinating the activities of government agencies and local communities in the planning and implementation processes (Figure 8.5). The proposed works and measures in the Plan were organised into four integrated 'action programs' (Sub-surface Drainage, Surface Drainage, Farm and Environmental Programs), each of which was administered by a Working Group comprised of community members and agency representatives. These four Groups were overseen in turn by a SPPAC sub-committee, the Irrigation Committee of the Shepparton Irrigation Region (SIRIC), comprised of community members, agency staff and local government representatives. SIRIC reported directly to the Cabinet Salinity Committee of the State Government without any other bureaucratic intermediaries - a structure that was considered essential to ensure continued community involvement and 'ownership' of the Plan during the subsequent years of implementation, with the Government primarily providing technical resources and financial support (Alexander & Collett 1996; Kellow 1992, p. 52; Sampson *et al.* 2000).

A separate but similarly structured salinity management plan was developed for dryland areas of the Goulburn-Broken catchment (GDSMP 1989). It attracted less initial public interest than the irrigation Plan,

Figure 8.5: Structural arrangements for the development and implementation of salinity management plans (from Alexander & Collett 1996).



but was important, nevertheless, as an estimated 70 per cent of the incoming salt load (99,000 tonnes per year) in the Shepparton Irrigation Region originated in the adjacent dryland sub-catchments. The area of farmland affected by dryland salinity within the catchment was also estimated at that time to be increasing at a rate of between two and five per cent per year (GDSMP 1989). The main technical approach advocated to curb the problem was to reduce rainfall accessions in high infiltration (recharge) areas through revegetation with trees or other deep-rooted perennial species, such as pasture grasses, which would also allow for increased agricultural production (GDSMP 1989).

The two draft Plans were presented to the regional community for comment at a series of public meetings, with only minor changes being suggested (Russ 1995, p. 235; Sampson 1996). The Plans were particularly welcomed by the Victorian Farmers' Federation, although conservation groups (e.g., the Australian Conservation Foundation) argued that too much reliance was placed on taxpayer-funded engineering solutions while too few changes were demanded of landholders. Kellow (1992, p. 53) suggests that this outcome was understandable, given the level of landholder involvement in the drafting of the Plans, but the support of the farming community was also an essential requirement if the salinity problem was to be addressed successfully.

The Government itself demanded some revisions to the cost-sharing arrangements, but otherwise endorsed the majority of the objectives, principles and actions outlined in the Plans, and affirmed its commitment to the Goulburn-Broken region in 1990 as the two Plans were officially 'launched' for implementation (Madden 1995).

8.6 Institutional and policy changes relating to land and water management

The development of the Goulburn-Broken salinity management plans was accompanied by a variety of related structural changes at both the government and landholder levels that were also to have implications for land and water management in the Goulburn Valley and elsewhere across the State. These included the release of a State-wide salinity control strategy, the rise of the Landcare movement, reforms of functional agencies within the Victorian Government, structural and policy reforms within the water sector, and inter-governmental actions concerning environmental management across the broader Murray-Darling Basin.

The growing waterlogging and salinity problems in the irrigation areas provided one impetus for these structural changes. Others were economic, and were associated to a large degree with the increasing globalisation of the Australian economy, which remained heavily dependent on the export of rural products. Many of these were still supported by subsidies instituted during the days of closer settlement, and after the floating of the Australian dollar in 1984, the low profitability of the irrigation enterprises in particular became clearly apparent (e.g., Langford *et al.* 1999). For the Victorian Government, this economic reality was heightened by the State's heavy burden of debt, which had built up during the period of major infrastructure construction (including irrigation works) after World War II, and added to the need for extensive structural and economic reforms.

8.6.1 'Salt Action: Joint Action'

As the drafting of the salinity management Plans proceeded in the Goulburn-Broken catchment, the Victorian Government in 1988 released a A$50 million strategy, *Salt Action: Joint Action* (SAJA), to deal with the problem across the State as a whole. Salinity was declared at that time to be the "single greatest threat" facing the Victorian environment, and the Government was determined that practical solutions be devised and implemented on a regional basis without further delay (Russ 1995, p. 240). The goal of the strategy was to manage the salinity of Victoria's land and water resources to protect social welfare, environmental quality and agricultural productivity into the long-term future (Sampson 1996). Modelled largely on the community consultation approach devised in the Goulburn-Broken catchment, it divided the State into nine catchment-based salinity control regions, and outlined a need for a total of 20 sub-regional management plans or strategies for irrigation and dryland areas that were either affected by salinity or contributing to salinity damage elsewhere. (In total, these areas comprised approximately 60 per cent of the State)(Sampson 1996; SIRIC 1998).

As in the Goulburn-Broken catchment, responsibility for the development of salinity management plans in each area was assigned to community working groups, each of which reported directly to a Cabinet

Salinity Committee. A Standing Committee of government agency heads was also established to provide technical advice to the Cabinet Committee. The Salinity Program was administered overall by a Salinity Bureau, which operated from within the Department of Premier and Cabinet (Figure 8.5), and was created in part to contain the rivalries between the various support agencies. The Salinity Bureau was primarily responsible for budgetary matters and funding allocations, although some of these responsibilities were later divested to the community working groups in each salinity management region (Alexander & Collett 1996; Kellow 1992, p. 40).

8.6.2 Landcare

The development of the SAJA strategy was accompanied at the landholder level by the emergence of Landcare - a 'grassroots' movement that first arose in the mid-1980s, initially in Victoria and Western Australia, in response to local environmental problems. Landcare groups typically consisted of landholder committees dedicated to raising awareness and promoting co-operative action to address localised issues concerned with the use of land and water resources, including weed problems, water quality, soil erosion and soil structural decline, as well as salinity and rising water tables. Other groups formed not so much in response in newly perceived environmental problems, but to address inappropriate government responses to problems in which local knowledge was often disregarded. Landcare thus emerged as a "bottom-up", community-driven response to specific environmental issues, challenging the traditional model of government experts telling locals what to do (Baker 1997).

Many of the Victorian Landcare groups subsequently became involved in the planning and implementation of salinity management plans in various regions of the State. In 1991, the movement also gained the formal support of the Federal Government, which provided funding for community-based works projects and educational programs through its 'Decade of Landcare' initiative (Commonwealth of Australia 1991, cited by Baker 1997). At the State level, technical and other support to Landcare groups was provided by scientists and extension officers from the government departments concerned with resource management. Landcare has been described accordingly as having evolved into a "partnership" between community and government (Baker 1997).

By 1998 in Victoria, there were approximately 890 Landcare groups, comprising upwards of 25,000 volunteers (Auditor-General, Victoria 2001, p. 52). In the Goulburn Valley, 12 groups have been involved in the implementation of the SIRLWSMP under the umbrella of the greater Goulburn-Murray Landcare Network - an organisation formed in 1995 to promote and coordinate Landcare works on the northern plains and assist with the implementation of regional resource strategies (Goulburn Murray Landcare Network 2001; Sampson *et al.* 2000; SIRLWSMP 1997).

8.6.3 Reforms of State agencies

Following the conclusion of the Salinity Inquiry in 1984, it was perceived by Victoria's new Labor Government that the existing State agencies responsible for land and water resources were no longer functionally appropriate to the changed social, economic and environmental conditions in the rural districts. This criticism applied to SRWSC in particular (see below), but the Department of Agriculture was also reorganised in 1986 into the Department of Agriculture and Rural Affairs (DARA), with a regionalised administrative structure and expanded responsibilities covering the broader social issues that affected rural communities. The restructuring process was extended to the Ministry of Conservation, Forests Commission and Lands Department, which were united to form the single Department of Conservation, Forests and Lands (DCFL). This amalgamation reflected the perceived inter-relatedness of the State's environmental problems, and meant in practice that the management of all non-agricultural lands was consolidated within the one department (e.g., Kellow 1992, p. 40; Russ 1995, pp. 178-79). Both DARA and DCFL subsequently shared responsibility for the State's salinity research and control programs, but the two departments rivalled each other for funding and project allocations, and offered sometimes conflicting advice to rural communities attempting to implement salinity control measures. The process of institutional restructuring continued accordingly into the 1990s, culminating in the creation in 1996 of the super-Department of Natural Resources and Environment (DNRE). With this move, it was hoped that any lingering conflicts, duplications and bureaucratic inefficiencies associated with natural resource management in Victoria would be satisfactorily minimised (Alexander & Collett 1996).

8.6.4 Structural reforms within the water sector

Much-needed reforms to the water sector in Victoria were undertaken throughout the 1980s and into the 1990s, primarily to increase the level of cost recovery within the water industry and facilitate its eventual commercialisation. It was also hoped that the profitability and environmental sustainability of irrigated agriculture could be improved as well through improvements in delivery services to irrigators (Langford *et al.* 1999).

In 1984, following a review process initiated by the State's previous Liberal Government, the SRWSC was abolished and replaced by a broadly representative eight-member Rural Water Commission (RWC). The responsibilities of this new agency were concerned primarily with the operation and maintenance of irrigation schemes. A separate Department of Water Resources (DWR) was established to carry out policy and regulatory functions. These structural changes helped reduce the engineering bias of the State's water management authority, and also paved the way for water pricing reforms in which water would henceforth to be treated as an economic, rather than a social, good (Langford *et al.* 1999, p. 37). The RWC was expected accordingly to achieve financial self-sufficiency by 2004, while irrigators would be faced with real price rises of two per cent per annum as water subsidies were phased out over the same 20-year period (D. Poulton, Goulburn-Murray Water, pers. comm.; Langford *et al.* 1999).

It was recognised as a corollary that the profitability of irrigated agriculture would have to increase if irrigators were to survive financially. Steps were thus taken to create a market for irrigation water that would expose the opportunity costs of the resource and enable the most viable irrigation enterprises to have the greatest access to it (Eigeland & Hooper 2000; Langford *et al.* 1999). This required the breaking of the longstanding legal bond between land and water in the irrigation districts so that the rights to each resource could be traded separately. From 1987, transferable water rights (TWEs) were introduced by the RWC, permitting irrigators to lease or (from the 1990-91 season) sell some or all of their water right, or purchase extra water allocations, either annually or on a permanent basis. By such means it was hoped to bring more flexibility to on-farm water management and allow for water to be transferred from less suitable or degraded (waterlogged or salinised) land to more productive areas (Langford *et al.* 1999, p. 48).

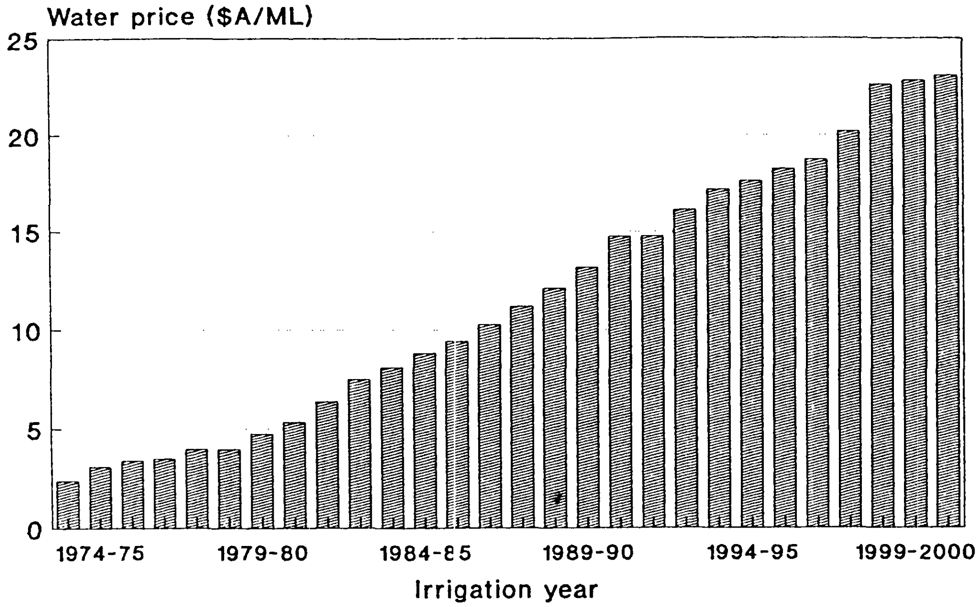
TWEs were slow to take off, however, and irrigators objected strongly in the meantime to the RWC's price increases - particularly in 1991 as global prices for agricultural commodities fell (Langford *et al.* 1999, p. 1). This prompted a Government review of the financial arrangements within the water sector and led to the replacement, in 1992, of the Rural Water Commission by the Rural Water Corporation. This new agency operated outside of the public service and was financially more accountable to irrigators than its predecessor, but it also retained the goal of achieving financial self-sufficiency by 2004.

After a change of State Government, the process of water reform continued with the division of the Rural Water Corporation in 1994 into four regionally-based statutory Rural Water Authorities. The largest of these, Goulburn-Murray Water (G-MW), assumed responsibility for water supply and drainage services in the Goulburn Valley irrigation districts (i.e., those within the Shepparton and Central Goulburn management areas) and in four other major areas supplied by the Goulburn-Murray system of works. G-MW remains the water management authority in the Goulburn Valley to the present day, and is required under the nationwide Water Reform Framework (agreed upon in 1995 by the Council of Australian Governments) to operate from the year 2001 as a financially self-sufficient corporation in terms of the operating, maintenance and renewal costs of the water services it provides (e.g., Mattila 1996).

For irrigators, the system of water rights (plus seasonally-dependent 'sales' allocations) remains in place, providing some security of supply to irrigators and facilitating the efficient management of water allocation and distribution on the part of G-MW and the other regional water authorities (e.g., Seker *et al.* 2000). However, prices are now based on the 'real' costs of the water services provided, with allowances for variability in sales volumes and maintenance costs between years (Scriven 1996). In some districts served by G-MW, the cost of irrigation water has gone down, but in others it has risen substantially (Figure 8.6), with further increases expected to occur as capital works are scheduled for renewal (Derek

Poulton, G-MW, pers. comm.). This is a source of financial hardship for many irrigators, and considerable structural adjustment assistance is expected to be required within the industry in the future (Langford *et al.* 1997, p. 5; Kularatne 1998).

Figure 8.6: Water prices in northern Victorian irrigation districts, 1973 to 2000 (Source: D. Poulton, G-MW, pers. comm.).



8.6.5 Inter-governmental initiatives within the Murray-Darling Basin

The Cain Government's embrace of the salinity problems in northern Victoria, and the processes of community consultation and institutional reform that were initiated in response, effectively provided the stimulus for broader inter-governmental action in response to land degradation and water quality problems throughout the greater Murray-Darling Basin (Kellow 1992, p. 55). This process officially began in 1985, when it was agreed by the twelve State and Commonwealth ministers responsible for land, water and other environmental resources within the MDB, that institutional responses at the federal level were required to deal with the Basin's increasingly pressing environmental management concerns. These generally extended beyond state boundaries, and were compounded by political infighting that stemmed in part from the fact that the economic consequences of salinity in the Murray River were greater in South Australia than in Victoria and New South Wales, and both of the 'upstream' States were reluctant to pay for costs that were largely incurred beyond their boundaries (Kellow 1992, p. 8; MDBMC 1987; Pigram 1986).

The 1985 ministerial meeting was followed accordingly by two years of intense discussion and negotiation, culminating in a new River Murray Waters Agreement, the stated aim of which was to achieve "equitable, efficient and sustainable use of the water, land and other environmental resources of the Murray-Darling Basin"(MDBMC 1990, cited by Lawrence & Vanclay 1992). To facilitate the process, the

Agreement provided for the establishment of three new institutions at the political, bureaucratic and community levels[6] - a major structural development following on from Victoria's community consultation approach to salinity management. Equally importantly, consensus between the States over the salt disposal problem in the Basin was achieved in the new Agreement through a salt-entitlement scheme - "a strange form of salt currency with credits and debits, which each State could barter and trade along the [Murray River] for federal and state funding of salt diversion schemes" (Russ 1995, p. 220). The historical contributions of each State to the present-day salt loads of the river were deemed to be of no further relevance, but every State would henceforth be held accountable for future actions affecting Murray River salinities. As Russ (1995, p. 222) observes, this still did not bring an end to inter-state arguments over the salinity issue, but after further protracted negotiations a new Murray-Darling Basin Agreement was signed in 1992 and legally reinforced by the Murray-Darling Basin Act, passed by the Federal Government in 1993.

For both the Goulburn Valley and the MDB as a whole, one of the key components of the 1992 Agreement was the Salinity and Drainage Strategy. First introduced in 1988, this redefined the salinity problem by linking salt allocations and in-stream water quality issues with land use problems such as soil salinity and waterlogging, and meant in practice that all States could anticipate benefits from expenditure on salinity control measures (Kellow 1992, p. 64; MDBC 2000). The Strategy was based, as before, on a system of salt credits and debits, although Victoria and New South Wales were permitted to dispose of more saline effluent than before as salt interception works, funded jointly by the States and the Commonwealth, were constructed in South Australia. It was then the responsibility of each State to allocate salt-entitlement shares to different regions, and to work within these constraints. In Victoria, upstream areas such as the Goulburn Valley thus incurred salt debits, while irrigators further west were obliged to deal with higher Murray River salinities but earned salt credits for the State through the operation of (pre-existing) regional evaporation basins, such as Lake Tutchewap, west of Kerang (Russ 1995, p. 223).

The Murray-Darling Basin initiatives meant overall that the problems of the Goulburn Valley were tied to those of the Basin as a whole. This was important because even though the region in the mid-1980s still contributed relatively small quantities of salt to the Murray, the increasingly large areas underlain by shallow watertables meant that the salinity of the effluent discharged into the river was likely to increase (Lyle 1984). The Goulburn Valley was now effectively accountable to the broader region of which it was a part, and any proposed salinity and watertable control measures would have to comply with MDB constraints.

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[6] Respectively, the Murray-Darling Basin Ministerial Council (MDBMC, an executive/policy body comprised of Federal and State Ministers responsible for land, water and environmental resources), the Murray-Darling Basin Commission (MDBC, a bureaucratic arm to advise the MDBMC and coordinate implementation of policies and programs), and a Community Advisory Committee (providing opportunities for community involvement)(e.g., Lawrence & Vanclay 1992).

8.6.6 The Cap

Water management in the Goulburn Valley and other irrigation districts has been impacted by other MDB initiatives in addition to the Salinity and Drainage Strategy. In 1995, a Cap was introduced by the MDBMC on all diversions of water within the Murray-Darling Basin. The Cap was defined as "the volume of water that would have been diverted under 1993/94 levels of development", and was considered an essential first step in the establishment of management systems to improve the health of the rivers and achieve sustainable consumptive uses of the limited supplies of water within the Basin (MDBC 1999). In Victoria, the approach taken to comply with the Cap has been to issue Bulkwater Entitlements to each of the four Rural Water Authorities, clearly defining their respective rights to water. Each Authority is responsible for the allocation of this water to the various users within their jurisdiction (e.g., Seker *et al.* 2000). For irrigators, this means a finite limit to the amount of water available to them, adding to the pressure for more efficient on-farm water use and also resulting in considerable seasonal variations in water prices, as low 'sales' allocations in drier years means that prices must be increased in order for full cost recovery to be achieved by G-MW and the other Authorities (D. Poulton, G-MW, pers. comm.).

Seker *et al.* (2000) observe that most irrigators served by G-MW have continued to use their full water right allocations, while the demand for additional 'sales' water depends primarily, as before, on seasonal climatic conditions (D. Poulton, G-MW, pers. comm.). Water trading under the TWE provisions appears to have had little impact on overall water use (Table 8.3), as increased water use associated with the activation of 'sleeper' (i.e., previously unused) water rights has been counteracted by a slight decrease in 'sales' arising from the Cap on Murray diversions (K. Sampson, DNRE, pers. comm.). The Cap itself has otherwise resulted, as intended, in a levelling off of water deliveries (Figure 8.4, p. 198).

Table 8.3: Water trading under the system of Transferable Water Entitlements (TWEs), 1994-95 to 1999-2000*. (Source: G-MW Annual Reports, 1994-95 to 1999-2000).

	Net volumes traded (water rights and 'sales' water)(Megalitres)			
	Temporary TWEs		Permanent TWEs	
Irrigation season	Shepparton District	Central Goulburn	Shepparton District	Central Goulburn
1994-95	17,092	34,903	385	1,713
1995-96	2,573	16,040	286	1,174
1996-97	3,548	8,442	-71	1,986
1997-98	14,841	33,031	544	768
1998-99	1,777	25,471	-277	694
1999-2000	1,680	19,844	-127	-544

** For comparative purposes, G-MW irrigation water deliveries to the Shepparton and Central Goulburn Districts in the 1999-2000 season were 154,766 ML and 378,261 ML, respectively.*

8.7 Current approaches to natural resource management within the Goulburn Valley

8.7.1 Reforms of catchment management arrangements

Into the early 1990s, the implementation of the Goulburn-Broken salinity management plans and the preparation of the other regional plans and strategies under the SAJA initiative proceeded as the primary focus of the Victorian Government's Salinity Program. In the Goulburn Valley, this meant the commencement of the 30-year program of on-ground works, whole farm planning, tree planting programs etc. outlined in the SIRLWSMP. However, some of the overall impetus for salinity control was reduced by ministerial changes within the Victorian Government, ongoing rivalries between the supporting functional agencies, and the emergence of new rural initiatives, including Landcare and sustainable development (Russ 1995, p. 273). New environmental issues also arose - in particular, concerns over water quality following a series of algal blooms in water storages in a number of the State's irrigation districts. In the Goulburn-Broken region alone, 61 toxic blue-green and other algal blooms occurred in the first half of the 1990s, while waterways within the catchments were found to carry significant nutrient loads arising from various forms of land use, including excessive irrigation runoff, urban stormwater, intensive animal industries, sewage treatment plans and other diffuse sources (GWQWG 1996)(Figure 8.7).

In 1992, after a change of State Government, the existing focus on salinity as a single environmental issue was questioned by the new ruling Liberal-National Party coalition. The SAJA strategy was subsequently reworked into a Government-sponsored Landcare initiative (the *Victorian Decade of Landcare Plan*) to provide a general blueprint for achieving 'sustainable' (i.e., non-degrading) land and water use across the State by the end of the decade (Auditor-General, Victoria 2001, p. 10; Russ 1995, p. 269). Ongoing structural changes associated with land and water/salinity management also occurred, as regional Catchment and Land Protection Boards (CLPBs) were established in 1995 to oversee all natural resource issues within designated catchment areas and develop regional catchment management strategies (GBCMA 1999; Sampson et al. 2000; SIRIC 1998). In the Goulburn-Broken catchment, the salinity management Plans were retained as important sub-programs of the regional strategy, and implementation of the SIRLWSMP continued under the direction of the pre-existing SIRIC committee (Sampson 1996)(see page X).

Further restructuring occurred in 1997 as the Catchment and Land Protection Boards were superseded by Catchment Management Authorities (CMAs). These were assigned the expanded role of achieving effective integration and delivery of all land and water management programs within their catchment area. SIRIC also expanded its charter at this time to provide for the implementation of strategies for other natural resource issues within the Shepparton Irrigation Region, including those for sustainable agriculture, nutrient management and water quality, biodiversity, soil structure and pest management (Figure 8.8) (SIRIC 1998).

Figure 8.7: Algal blooms and water quality in Goulburn Valley waterways, mid-1990s (after GWQWG 1996).

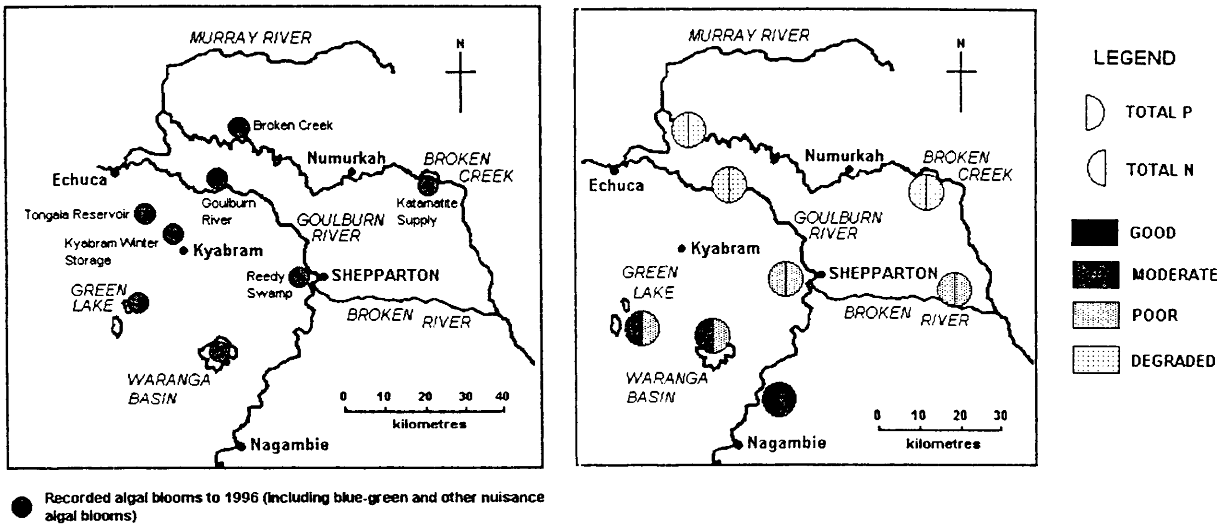
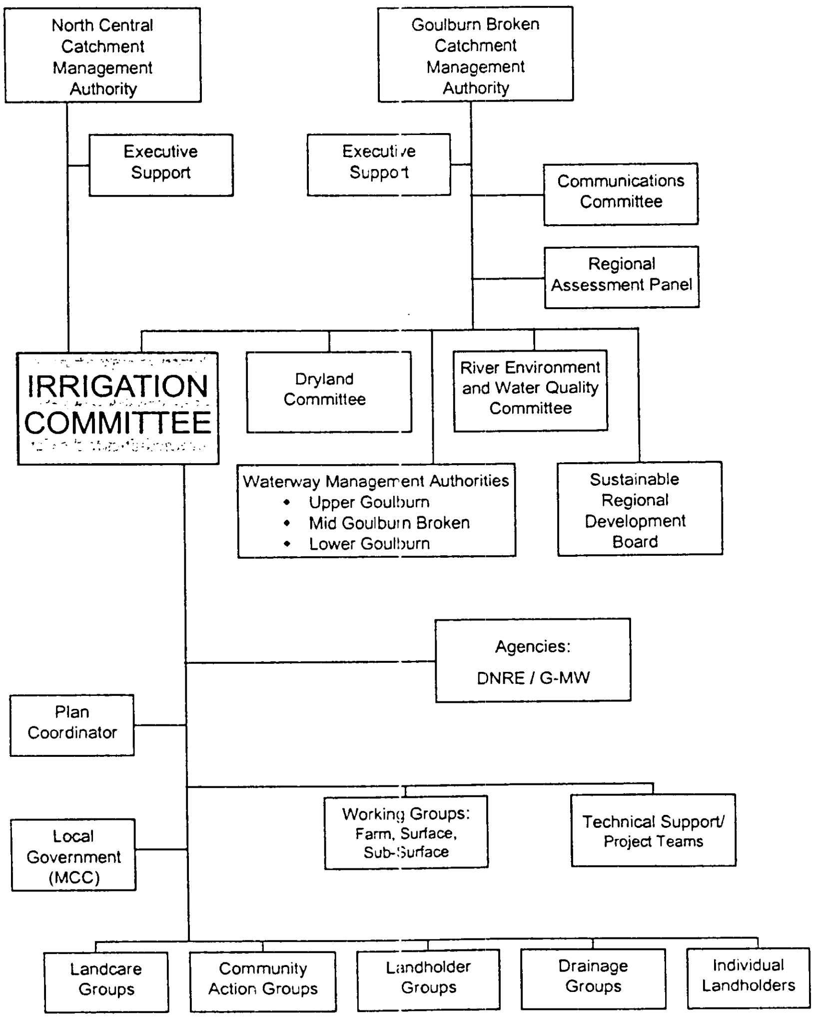


Figure 8.8: Administrative structure of the Shepparton Irrigation Region salinity program, 1997-98 (from SIRIC 1998).



8.7.2 The evolution of the Shepparton Irrigation Region Land and Water Salinity Management Plan (SIRLWSMP).

As the organisational framework around salinity and natural resource management in the Goulburn-Broken catchment has continued to evolve at the regional, State and Federal levels, the management Plans and strategies for the catchment have themselves been subject to an evolutionary process of review and adjustment. As Madden (1995) notes the Plans were never considered to be the definitive solutions to the region's salinity problems, but presented procedures and policies for efficient cooperative action by local communities and the State Government.

Changes to the two Goulburn-Broken Plans have occurred in response to the perceived success or otherwise of the control measures implemented in the first years, landholder participation in the various on-farm programs, changing institutional arrangements (including agency restructuring and Local Government amalgamations), and changing Government funding priorities. These were in association with other emergent rural issues and initiatives (e.g., a Natural Heritage Trust strategy was launched by the Federal Government in 1997, aimed at promoting sustainable agriculture and natural resource management on nationwide basis. The Goulburn-Broken catchment was also selected in 1994 for a pilot case study focusing on regional development and funded under the MDBC Irrigation Management Strategy)(ISIA 1997; Love 1995). Major reviews of the Surface Drainage and Sub-Surface Drainage Programs of SIRLWSMP were undertaken in 1995, when a strategic plan for the second five years of implementation was presented to (and subsequently endorsed by) the State Government. A further major review of the SIRLWSMP has been scheduled for 2001, while a broader State-wide review of salinity management in the 12 years since Salt Action: Joint Action is also to be undertaken at this time (DNRE 2000; SIRIC 1998).

The SIRLWSMP in its current form constitutes an integral component of the overall catchment management strategy for the Shepparton Irrigation Region. New programs have been introduced into the strategy to accommodate emergent issues, including a regional Nutrient Management Strategy, a Water Quality Strategy, and a Waterways Action Plan, with the latter two programs focusing on water quality, stream and floodplain management, and regional drainage issues. A draft Native Vegetation Management Strategy has also been developed for the catchment (GBCMA 1999; Sampson *et al.* 2000). As with salinity management, the preferred strategy for these and other environmental and resource management initiatives continues to be the adoption of a number of coordinated programs based on community involvement, education and cost-sharing between Governments (Federal and State), the regional catchment community and stakeholders, including landholders, industry, water authorities and municipalities.

8.7.3 Measures of success and challenges for the future

As Kellow (1992, p. 64) observes, the ultimate test of structural reforms is whether they deliver satisfactory resolutions to problems. In the Shepparton Irrigation Region, watertables have shown a declining trend over the past decade (Table 8.1, p. 182), which appears attributable, at least in part, to the salinity management initiatives undertaken in the irrigation districts, although lower-than-average rainfall over the past eight years is also likely to have been a significant factor (see Appendix 1). The true effectiveness of the management initiatives is likely to become known only in future periods of extended wet climatic conditions (Auditor-General, Victoria 2001, p. 126).

Sampson *et al.* (2000) draw attention in the meantime to the multitude of on-ground works achieved within the Shepparton Irrigation Region (and hence the Goulburn Valley) in the first nine years of implementation of the SIRLWSMP (i.e., 1990-99)(see Appendix 3), and note that all targets set by the regional community for on-ground salinity control works under the Plan have been met or exceeded to date. These achievements are considered to be indicative of the changed behaviour of land managers and increasing community understanding of environmental issues, which point further towards the success of the SIRLWSMP as a natural resource management program (Sampson *et al.* 2000).

Considerable scientific research and investigation work has also been undertaken in the region over the past 10 years, aimed at both economic and environmental improvements in natural resource management. This has been carried out primarily at DNRE's Institute of Sustainable Irrigated Agriculture (ISIA) at Tatura, which has expanded over the past decade to become Australia's largest irrigation research facility. Major projects have included (Austin & Goodwin 1997; Heuperman *et al.* 2000; ISIA 1997; Kularatne 1998; Sampson 1996):

* Quantification of the salt and waterlogging tolerance of a wide range of forage legumes, grasses, shrubs, as well as the effects of these constraints on productivity; selection and breeding of pasture and forage species and cultivars with greater waterlogging and salt tolerance; provision of agronomic and management solutions that reduce the impact of salinity and/or waterlogging on forage production.

* Determination of the effect of saline water on chemical and physical properties of major soil types in the Shepparton Irrigation Region; development of management strategies to maintain soil structure and productive potential.

* Investigation of management strategies for the sustainable use of groundwater; investigation of agricultural methods of concentrating saline groundwater (e.g., serial biological concentration methods); investigation of the use of irrigated agro-forestry as a land management practice to

utilise poorer quality irrigation water and control watertables; development of mechanisms for the disposal of groundwater.

* Investigation of improved irrigation technology and management systems (e.g., reduced deficit irrigation; 'topping up' methods; improvements in irrigation bay design; improvements in conveyance efficiency).

* Socio-economic studies, including structural adjustment needs, and the development of a Regional Business Plan for the SIR under the MDBC Irrigation Management Strategy.

Community involvement and extension in the research process have helped to keep these projects focused and relevant, facilitating on-farm trials and encouraging the implementation of promising findings (Sampson 1996). Some remedial measures initially proposed for salinity control have also been determined to be less than effective - for example, the use of trees as 'natural' groundwater pumps in irrigation districts, and the use of perennial pastures to control recharge in dryland areas (DNRE 2000; Heuperman 1995; Ridley 1994). Such results have been used to constantly refine the technical basis of the salinity management plans and update the range of management options available to landholders (Sampson 1996).

The Goulburn-Broken catchment as a whole, and the SIR in particular, has also been generously endowed with State Government funds for salinity management. Victoria's Auditor-General (2001, p. 94) observes that the Goulburn-Broken and North Central Catchment Management Authorities, which include the State's main irrigation districts, have received more salinity funding (approximately A$75 million) over the past decade than the remaining five (primarily dryland) CMAs combined. This is primarily a reflection of the high value of the agricultural assets in the irrigation areas (as DNRE now concedes, the original Salinity Management Plans, including the SIRLWSMP, were funded on the basis of their "business case" rather than the severity of local salinity problems). The likely effectiveness of the implementation measures and the capacity of the local communities to undertake the work have also been important factors in funding allocation (Auditor-General, Victoria 2001, p. 96). Sampson *et al.* (2000) add that the SIRLWSMP has also attracted funds from a variety of other sources, as funding bodies have recognised that the money will be spent on on-ground works. The Plan has also attracted considerable national and international attention as the proverbial flagship of the State's overall community-driven approach to water resource management and integrated catchment management, which has been deemed by the World Bank to be the best in the world (DNRE 2000).

Within DNRE, it is considered that "the effective management of irrigation salinity has been achieved", as the State's work over the previous 15 years has resulted in greatly improved understanding of salinity and other environmental management issues, which in turn has contributed to the evolution of salinity management in terms of the directions, targets and approaches taken (Auditor-General, Victoria 2001, p. 13). This does not mean that the problem is eradicable (particularly as salinity in adjacent dryland catchments now appears much more serious than was previously thought), but the official expectation is that it can be managed at an acceptable level into the future, provided that the present strategies involving the implementation of works, land use changes and landholder-community-government cooperation are continued over the longer term, with constant refocusing in the light of experience and new information (Auditor-General, Victoria 2001, p. 36; DNRE 2000).

8.8 Discussion: Towards a systemic approach

As the writer-ecologist William Dietrich (1999) observes, humans are so clever that what they wish for is often achieved. This could be said to have occurred in the Goulburn Valley, as irrigation brought unprecedented economic success and prosperity to an otherwise climatically unreliable region, and helped to fulfil the closer settlement and economic development visions of Alfred Deakin and Elwood Mead - at least for a while. Dietrich observes further, however, that because of the limits to human perceptions, such achievements often prove to be a disappointment or a mistake of an entirely different sort, as the consequences of decisions may differ dramatically over time, or spatially within a system, and may be of an unexpected nature in relation to the original action (a phenomenon known as 'dynamic complexity')(Mitchell 1979, p. 262; Senge 1990, p. 71). Dietrich's latter observation appears equally applicable to the Goulburn Valley as the triumphs of the irrigation system that had developed under Mead and Ronald East came to be undermined in the late 1960s and 1970s by growing concerns about the environmental consequences. Rising watertables and emergent salinity problems were increasingly obvious manifestations of a growing hydrological imbalance that threatened to destroy the productive base of the region, as well as contributing to the water quality problems of the Murray River and its downstream dependents. This imbalance was primarily the result of human disturbances - in particular, the imposition on natural hydrological cycles of linear hydraulic processes (in which water was transformed into agricultural produce), with minimal consideration for the effluent water produced.

Mackay (1990, p. *xvi*) attributes the problems of the Murray to "the tyranny of small decisions" - that is, the gradual accumulation of the effects of an increasing number of minor systemic insults resulting from years of unplanned and uncontrolled development. A broader systemic explanation is offered by Senge (1990), who observes that, since the behavioural responses of systems are determined by their structure, systems often cause their own crises. In the case of the Goulburn Valley, engineers had warned of the dangers inherent in excessive water applications and inadequate drainage provisions at the very outset of irrigation development in the region, but for multifarious (financial, institutional, satisficing and cognitive) reasons, their cautionary advice was repeatedly dismissed by both Government decision-makers and the landholders alike (see Chapters 6 and 7). Emergent biophysical indicators also failed to generate adequate adaptive structural responses, so that the broad-scale high water-tables and salinity problems that ensued appear as the inevitable outcome of a socio-agricultural system structured around the domination and exploitation of land and water resources without consideration for the longer-term consequences. The situation was further compounded by economic distortions (water subsidies, price support mechanisms for agricultural produce) and a free market system that made no allowance for the environmental costs of exploitive production processes. This contributed to the low overall level of awareness of the emergent biophysical hazards, and the resultant inadequacy of preventative measures (Mitchell 1979, p. 130).

Emery and Trist (1972, p. 25) observe that in situations where change begins slowly, people may "live with the future" for some time before recognising it as as such. In other words, as discussed repeatedly throughout this thesis, not all new information triggers a cognitive response, and a system may possess considerable tolerance for change without its structural integrity being compromised. A breakpoint may eventually be reached, however, beyond which further change precipitates the transformation of the system to a structurally different order (e.g., Firey 1960, p. 112). On Victoria's northern plains, this point appears to have been reached at the end of the 1960s, as the growing salinity problems of the Murray River forced a thorough examination of hydrological conditions in irrigation districts (including the Goulburn Valley) which relied on the river as a drain for the disposal of effluent water. The findings were detailed in the Gutteridge Report, which presented the first comprehensive picture of the damage wrought by the existing system of irrigation in Victoria to the land and water resources of the northern plains, and of the further deterioration that was likely to occur without appropriate remedial action (Gutteridge *et al.* 1970). The Gutteridge Report may be seen accordingly as being representative of a new systemic attractor that drew attention to the growing instability of the existing system and precipitated a change in evolutionary direction towards a new paradigm or goal state (i.e., the containment of watertable and salinity problems)(Capra 1996, p. 136). This did not involve any obvious changes in the landscape of the northern plains (c.f. the transformations that occurred after previous bifurcations), but resulted in a new perception of the Goulburn Valley and the other irrigation districts as regions in trouble.

The initial systemic responses to the resultant 'salinity crisis' were instigated primarily by the SRWSC, and were aimed at ameliorating water-table and salinity problems through engineering approaches (groundwater pumping, increased surface drainage, evaporation basins), but it was otherwise expected that irrigation should proceed in northern Victoria much as before. Water deliveries to the Goulburn Valley thus continued to rise throughout the 1970s and 1980s (Figure 8.4, p. 198), while the water pricing arrangements remained unchanged and continued to offer irrigators little incentive to use water more efficiently on their farms. The burden of the saline effluent produced in the region was effectively shifted in the meantime to areas downstream along the Murray Valley, which enabled the agricultural productivity of the Goulburn Valley to be maintained - at least in the short term - but did little to address the underlying hydrological imbalances. The SRWSC's 1975 Salinity and Drainage Strategy thus appears with hindsight to have been more resilient than adaptive to the changed conditions on the northern plains, and the symptomatic solutions offered merely fostered an increasing dependence on further engineering works, as ever more groundwater pumps were perceived to be required and farmers called for additional surface drains to remove the resultant effluent, rather than finding ways to re-use it on their farms.

The SRWSC was subsequently accused of "blindly peddling engineering solutions" to the State's salinity problems (Russ 1995, p. 174), and its proposed programs of works may indeed be seen as an institutional example of 'vertical thinking' (i.e., engineers continuing to build structures even when not solving the problem)(Mitchell 1979, p. 226). As noted above, however, the behaviour of a system is determined by its structure (i.e., the functional relationships between its components), and as the SRWSC continued to be the dominant component of the irrigation system in Victoria until 1984 (when it was replaced by the RWC), it remained the primary determinant of the State's responses to the salinity crisis until that time. Landholders who were affected by the problem were able to participate in the decision-making process only through the public inquiry held by the Parliamentary Public Works Committee after the SRWSC's Salinity and Drainage Strategy had already been devised (Alexander & Collett 1996). The cumulative impact of farm management on the underlying hydrological imbalance was otherwise given little formal consideration, as the SRWSC remained fixated on engineering solutions and preferred to overlook the basic relationships between irrigators and the environment.

The limitations of the Salinity and Drainage Strategy were apparent, in any case, by the beginning of the 1980s, as Victoria was obliged to conform to the water quality constraints imposed by the 1981 River Murray Agreement. Somewhat fortuitously, this Agreement came into effect as a new Government assumed power and was in a political position to question the functionality of the State's long-entrenched institutional structures - including the SRWSC - as well as the existing approaches to irrigation and salinity control within the State. The ensuing reforms within the water industry were particularly needed and stand as a considerable achievement, given the history of subsidies and the institutional power of the SRWSC. However, the Cain Government also perceived that the complexity of the salinity problem demanded greater inter-relationships between the various agencies responsible for the rural sector, and this became an important consideration in the subsequent processes of institutional restructuring, both in Victoria and across the broader Murray-Darling Basin (Kellow 1992, p. 40). The concurrent dispute over the SRWSC's evaporation basins also indicated, however, that the technical validity or otherwise of any salinity control measures proposed in the future would be a moot point if such measures did have the support of the landholders and communities involved (Mitchell 1979, p. 224; Russ 1995, p. 164). As Emery and Trist (1972, p. 123) observe, the highly complex problems ('metaproblems') faced by modern societies call for new modes of adaptation, and on the northern plains a new paradigm indeed seemed to be required.

The approach that was subsequently devised in the Goulburn-Broken catchment relied strongly on public participation, as rural communities were encouraged to become directly involved in the planning of salinity control measures appropriate for their own local areas. As the State's Auditor-General (1993, p. 140) observed, this was a radical departure from the previous models of government departments (or consultants) devising either solutions or preferred control options for salinity and waterlogging (and other environmental) problems. Instead the measures adopted appeared to incorporate the salient features of what may be described as a systems approach (e.g., Emery & Trist 1972; Parker & Stacey 1995; Senge 1990). This has come to include:

* more direct and open dialogue between communities and government (as facilitated by the organisational structures depicted in Figures 8.5 and 8.8);

* a shared positive vision of what needed to be achieved (rather than just avoided) and how actions might best be directed to achieve these goals;

* regular and candid assessments of results, with sensitivity to changing values and evolving goals;

* incorporation of science and other specialised knowledge into a flexible decision-making framework allowing for specific responsibilities to be assigned to areas of appropriate competence;

* emphasis on information, prediction and persuasion, rather than authoritative coercion, as a means of coordinating efforts by different system components;

* increased consideration of the potential repercussions of actions taken.

The new approach was formally embodied in the *Salt Action: Joint Action* strategy of 1988, and meant in practice that responsibility for addressing the salinity problem was assigned to a significant proportion of the rural populations involved. It proved to be an evolutionary process, as participating communities assumed increasing levels of control over the development, implementation and budgeting of the Salinity Management Plans that were ultimately devised for the Goulburn-Broken catchment and other regions of the State. In the Goulburn-Broken catchment, the goals of the system also broadened in the meantime from the control of high watertables and salinity to sustainable, integrated natural resource management, as various emergent environmental problems were recognised (at least at Government level) as being inter-related products of the overall resource use system. The organisational structure within the catchment (and in other regions of the State) was adjusted accordingly throughout the 1990s to meet the perceived changes in management needs, and further changes seem certain to occur in the future, as a result of internal review processes, political and economic changes, or the emergence of potential new environmental problems.

Victoria's Auditor-General (2001, p. 107) has identified a number of systemic informational links that could be strengthened. However, the current system of natural resource use in the Goulburn Valley appears to be one in which feedback loops between all of the major system components (landholders, government agencies, government policy makers) and the biophysical environment are functioning more effectively than at any previous time in the European history in the region. Perceptions of the regional environment have also shifted with the development and implementation of the Salinity Management Plans, such that systemic inter-relationships and processes of change, rather than single events and linear chains of cause-and-effect, are perceived by landholders and officials alike, and some attention is being focused on the means or processes of resource use and environmental management, as well as on possible outcomes (DNRE 2000; Parker & Stacey 1995, p. 52; Senge 1990, p.12). This is an important breakthrough, since, as the theory of nonlinear dynamics suggests, the future success of a system is determined not by prior intentions and plans, but by the manner in which the system evolves and the adaptability of its components to ongoing changes in the external operating environment (Parker & Stacey 1995, p. 4, p. 50).

A related and equally important aspect of the new approach to natural resource management in the Goulburn Valley is that the evolutionary direction of the regional socio-agricultural system is now supposedly being determined to a much greater degree by biophysical considerations. (This is suggested, for example, by the realisation that the only management options for some areas may be to 'live' with the salt, e.g., Heuperman *et al.* 2000). This may be seen as a highly positive adaptation, since, as argued throughout this thesis, the repeated failures of the Goulburn Valley's historical decision-makers to take cognisance of the biophysical limitations of the region have been a major systemic cause of its present-day environmental problems. As Parker and Stacey (1995, p. 38) point out, the environment in which a system operates also remains the ultimate determinant of whether a given system will successfully achieve its goals. In the case of the Goulburn Valley, the operating environment includes both socio-economic and biophysical components, but both are supposedly taken into account in the recently adopted 'sustainability' ethic, as this implies forms of resource use that are compatible with the perceived biophysical constraints of a region, while also being economically viable over the long term (e.g., Pigram 1990).

Pigram (1990) suggests that sustainable land and water use need require neither the cessation of economic growth, nor restrictions on the expansion of resource development, but "a more enlightened (perceptive) approach to regional development in which sustainable long term productivity is the underlying goal". Alternatively, it means using the land and water resources of the region with "attentive humility" rather than an "ethic of control" (Langston 1995, p. 280). In the Goulburn Valley, this may mean not so much conquering the watertable and salinity problems in all areas (which DNRE now concedes is impossible), but minimising the damage. Some authors (e.g. White 1997; Rolls 2000; Watson 1992) consider that this will require the cessation of irrigation (or flood irrigation, at the very minimum), pointing out that irrigation is not only a major cause of rising watertables and salinity problems, but involves the profligate use of energy, fertilisers, biocides, etc., and thus contributes to a broader range of environmental problems. Other authors take a less extreme view, believing that sustainability lies in what Meyer (1997) calls 'smarter irrigation', based on new technologies (e.g., genetically-engineered salt-tolerant crops), higher value crops, improved methods of water application, and adapting to the presence of salt - including retiring land from production where necessary (Austin & Goodwin 1997; Heuperman *et al.* 2000; Langford *et al.* 1997; Zhang & Blumwald 2001).

Smith (2000, p. 179) considers that sustainability is ultimately more about "commitment and sustained effort" than a precise vision of the future. Systems theory suggests accordingly that instead of long-term planning, the aim of natural resource management should be to create conditions conducive to processes of continuous change (Parker & Stacey 1995, p. 9). This requires comprehensive knowledge of the operating environment and the identification of constraints, so that production systems may be adopted that will not compromise the future productive potential within the region, but will also satisfy farmers' economic needs. The research being undertaken into improved systems of agricultural land and water management, and the various water-table and other environmental monitoring programs are an essential component of this process, as are continuing active networks of communication within the regional community, allowing for the possibility of 'double loop' learning, as the shared system goals remain open to scrutiny from all participants (Capra 1995, p. 82; Parker & Stacey 1995, pp. 50-51)(see page 50).

Rappoport (1977) cautions, however, that even if the cybernetics of a system are in good order, success is not guaranteed. For example, environmental management and resource use strategies that are appropriate at the catchment level (whether the Goulburn-Broken catchment or the greater MDB) may be not be appropriate for individual farms (Auditor-General, Victoria 2001, p. 106; Fitzhardinge 1994; Powell 2000). This will particularly be the case if such strategies are inconsistent with broader agricultural policies that continue to emphasise increases in both productivity and the efficiency of resource use (and hence intensification of land and water use)(Hollick 1990). Lawrence and Vanclay (1992) point out that Australia remains at the periphery of the global economy, and continues to rely upon primary produce as its major source of export income. The structure of the nation's agricultural sector is determined accordingly by external influences (i.e., foreign markets), and declining terms of trade favour the production of ever greater quantities of output by fewer, more technologically sophisticated farmers. This means that even if farmers believe in environmental stewardship, the economic environment in which they are obliged to operate effectively determines the opportunities for environmentally sound practices (Vanclay 1992).

The Goulburn Valley may thus be viewed as a convergence zone between the global capitalist economic system and the alternative local social ideal of public planning and community decision-making. Moreover, the conflict of regional interests is likely to continue as long as the social and environmental costs of agricultural production remain economic 'externalities'. As Fitzhardinge (1994) observes, some outcomes (agricultural produce) are expected and rewarded, while others (salinity control, land conservation) are expected but not rewarded. Capra (1996, p. 300) asserts, more bluntly, that the marketplace simply conveys the wrong information, and sustainability remains an unattainable goal because the required feedback is lacking. Fitzhardinge (1994) adds that even the Landcare movement accepts the existing socio-ecological relationship as it is, and will never be more than partially successful as long as land users continue to be rewarded for productivity but not for resource maintenance. Smith (2000, p. 179) suggests accordingly that society (i.e., taxpayers) should accept the costs of addressing environmental problems, including research and incentives for the adoption of remedial measures - although it may be argued also that farmers should not continue to be helped to "defy the forces of nature" (e.g., by continuing to practise irrigation while receiving subsidies for land protection efforts, such as tree planting)(Worster 1994, p. 113). Alternatives to this debate may lie in the approach proposed by Eigeland and Hooper (2000), in which a form of multivariate statistical analysis is used to rank farms on the basis of inputs (water, energy, nutrients, chemicals) and benefits (economic, social and environmental), with rewards and penalties (e.g., greater/less access to irrigation water) being assigned to the highest and lowest achievers. Such a method offers the potential, through the introduction of competition and rewards, to change on-farm management towards more environmentally and socially beneficial methods of production (Eigeland & Hooper 2000).

Landholders will continue, in any case, to make management decisions that satisfy their personal needs and interests, and the perceptual farming environment (including economic and regulatory constraints, but also personal and cultural factors) will always continue to be of greater significance than objective information about the biophysical landscape (Pigram 1972). As Worster (1979, p. 228) observed, the most persistent problem is not ignorance or incompetence but motivation - "farmers know how to farm better than they do", and in tight economic circumstances conservation is acceptable only so long as it pays a higher return than risk, and enhances rather than diminishes production. An added problem may be the continuing heavy emphasis in the salinity management plans on engineering solutions to watertable and salinity problems. Although groundwater pumping, in particular, is viewed as the primary means for controlling water-tables, it may foster landholder perceptions that certain areas have been rendered 'safe', thereby encouraging the continuation of inefficient irrigation methods, or even stimulating further intensification of production (Mitchell 1979, p. 206). Scientific improvements in management techniques may convey a similar message that sustainability can be achieved through more precise manipulation of land and water (better tools, crops, irrigation management), when the over-riding problem remains the overall socio-economic structure of agricultural production (Fitzhardinge 1994; Lawrence & Vanclay 1992; Worster 1979, p. 198).

Pigram (1990) points out, in any case, that not all landholders are likely to share an 'enlightened' perception of the land, and the pursuit of sustainability cannot yet be equated to excellence in the relationship between humans and their environment in the Goulburn Valley. The mistakes of the past are not so easily remedied, and people can become discouraged either by the perceived difficulties of bringing visions into reality, or because the vision is overwhelmed by current realities (for example, newly proposed constraints on farm dams in the Goulburn-Broken region, in order that water harvesting within the catchment comply with the MDB Cap)(GNERWCC 2000; Senge 1990, p. 227). Senge adds that visions can fade as ever more people become involved and the diversity of views dissipates focus, or unmanageable conflicts arise as different people see different ideal futures. This appears to have occurred to some extent within the Goulburn-Broken catchment, for example, as Landcare activities have not always coincided with the resource management priorities of the regional Catchment Management Authority (Auditor-General, Victoria 2001, p. 7). Visions may also weaken as political environments change - hence Sampson *et al.* (2000) urge that, in the Shepparton Irrigation Region, community empowerment and ownership of resource management plans be retained, with minimal bureaucratic interference.

While entrenched socio-economic obstacles appear to pose a continuing hindrance to the achievement of sustainability in the Goulburn Valley, environmental challenges will also be ongoing. Smith (2000, p. 177, p. 196) points out, as one example, that urban growth in the Shepparton area poses a much greater threat to farmland than salinity, yet resource management plans for the region remain focused on modifying agricultural land use to achieve sustainability. Global warming (if predictions are borne out) is also likely to have an impact on the hydrology of the region, as well as on future resource use options and the sustainability of current production systems. The existing environmental problems in the Goulburn Valley are expected to worsen in the meantime, in spite of the management efforts to date, as the incidence of dryland salinity throughout the remainder of the Goulburn-Broken catchment is projected to increase ten-fold over the next 50 years, with likely impacts on the irrigation areas and on stream and river salinities (DNRE 2000). The environmental sustainability of irrigated agriculture in the Goulburn Valley otherwise remains dependent on the continued export of salt from the region (subject to MDB constraints), while new research has suggested that groundwater pumping for water-table control is actually exacerbating the salinity problem as ever more salt is mobilised from sub-surface aquifers (Mason-Jones 2000; Haskew 1996, p. 186).

The concept of sustainable land and water use in the Goulburn Valley is thus pervaded, above all, by uncertainty. As Dovers (2000) points out, this is something that modern cultures of politics, management and science have not always handled well, as it requires contingency planning and open learning approaches rather than "done deals and neat fixes" (such as the SRWSC's Salinity and Drainage Strategy of 1975). Hope for the Goulburn Valley resides accordingly in the continued evolution of the regional catchment management plans, based on what Powell (2000) describes as "continuous, spatially informed dialogue between governments and people", and an overall flexible, systemic approach to natural resource management. These are concepts that the Shepparton Irrigation Region Land and Water Salinity Management Plan already embodies in principle. In practice, it means that biophysical considerations must ultimately assume as much importance as economic, socio-political and personal factors in resource use decision-making in the Goulburn Valley if 'sustainability' is indeed to be achieved.