Sunraysia Drainage Strategy

Issues Paper no.7 - Drainage Management Options Assessment

June 2002

Department of Natural Resources and Environment

GOULBURN-MURRAY WATER

SUNRAYSIA RURAL WATER AUTHORITY

LOWER MURRAY WATER

Mildura Rural City Council

EPA VICTORIA

MURRAY-DARLING BASIN COMMISSION

Contents

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1. Introduction and Background

This is the seventh Issues Paper in the series developed as part of preparation of the Sunraysia Drainage Strategy and Urban Stormwater Quality Management Plan. The paper encompasses:

- Further development of preliminary drainage disposal options presented in Issues Paper No 5 (ref 1);
- Comparative assessment of proposed disposal options;
- Recommended drainage disposal options;
- An overview of funding and cost sharing options for drainage works;
- Overview of possible institutional arrangements for drainage;
- Overview of implementation and monitoring requirements; and
- An outline of the draft Sunraysia Drainage Strategy.

2. Issues

2.1 Background

Issues Paper No 5, "Scope Management Options" (Ref 1), provided an overview of disposal options, and discussion of relevant previous studies and other documents. The following sections should be read in conjunction with that document.

2.2 Water Balances of High Value Waterbodies

2.2.1 Overview

Sinclair Knight Merz is currently finalising water balance modelling of the Lake Hawthorn Drainage Diversion Scheme (LHDDS) and Mildura Merbein Groundwater Interception Scheme (MMGIS) for Goulburn-Murray Water.

2.2.2 Impacts of Revised Operating Rules

Under the existing operational rules for the Scheme, releases from Lake Hawthorn to the Murray River are preferred to disposal to Wargan Basins when the following criteria are met (ref 8):

(i) flow in Murray at Mildura exceeds 15,000 ML/d;
(ii) salinity in Murray at Merbein is less than 420 EC;
(iii) the increment in salinity in the Murray downstream of the Darling Junction due to releases from Lake Hawthorn is less than 20 EC; and
(iv) no adverse effect is caused on the operation of Lake Victoria.

In practice, the first two criteria generally govern releases. For the purpose of modelling, criteria (iii) and (iv) were considered to have no affect.

Under the existing rules, outflows from Lake Hawthorn are evenly distributed between the Murray River and Wargan Basins, and the maximum storage level reached in Wargan is only 31% of capacity. There is therefore significant additional disposal capacity available at Wargan to allow a reduction in disposal to the Murray.

Victoria has therefore proposed to the MDBC that the scheme operating rules be revised (ref 8), to minimise releases from Lake Hawthorn to the Murray during periods of regulated or low flows, and maximise releases during periods of flood flows. Under the proposed revised rules, releases to the Murray will only be allowed when the level in Lake Hawthorn exceeds 35.50 m AHD (4405 ML). The average operating level of the lake is 35.08 m AHD. It is understood that this proposed change to the operating rules is almost certain to be implemented.

The impact of the proposed operating rule changes on volumes and salinities of the various waterbodies, and discharges between the various water bodies, with present day inflows, is shown in Table 2-1 and Table 2-2. Main impacts are:

- significant increases in the average and maximum volumes stored in Lake Hawthorn and Wargan Basins;
- marginal increase in the average and maximum salinities of Lake Hawthorn; and
- significant reduction in the average and maximum salinities of Wargan Basins.

2.2.3 Likely future Impacts

The model was then rerun, specifically for the present study, to assess the probable impacts of a likely future drainage scenario comprising:

- Adopted year 2050 urban development scenario;
- All runoff from the Irymple Basin pumped to either Lake Hawthorn or Lake Ranfurly (in accordance with Option C1, refer Section 3.2.3);
- No diversion to Lake Ranfurly or Lake Hawthorn of any drainage flows that currently gravitate to the River;
- Future scheme operating rules; and
- Average subsurface rural drainage flows reduced to 0.7 ML/ha/yr.

Results of this analysis are presented in Table 2-1 and Table 2-2. The results show:

- a dramatic increase in the salinities of Lake Hawthorn and Wargan Basins;
- a substantial reduction in the salinity of Lake Ranfurly East, due to additional urban runoff;
- a lower average storage volume in Lake Hawthorn. Lake Hawthorn would operate, on average, around 200mm lower than under existing conditions with existing operating rules; and
- no discharges to the Murray River.

The implications of these results are discussed further in Section 3.5.

■ **Table 2-1 Changes in Waterbody Volumes and Salinities due to proposed changes to Lake Hawthorn Operating Rules**

Waterbody	Storage Volume (ML)						Salinity of Stored Water (EC)					
	Average			Maximum			Average			Maximum		
	Existing[1]	Proposed[2]	Year 2050[3]	Existing[1]	Proposed[2]	Year 2050[3]	Existing[1]	Proposed[2]	Year 2050[3]	Existing[1]	Proposed[2]	Year 2050[3]
Lake Ranfurly West	321	321	429	681	681	933	99,500	99,500	80,971	386,000	385,300	365,397
Lake Ranfurly East	328	327	353	482	482	482	37,300	37,900	23,459	73,600	77,400	66,087
Lake Hawthorn	2,985	3,598	2,617	4,066	4,405	4,008	5,150	5,400	38,413	6,880	6,940	68,741
Wargan Basins	1,410	2,325	1,049	3,485	4,176	3,479	39,700	32,900	71,938	100,000	47,500	281,122

■ **Table 2-2 Changes in Transfer Volumes and Salt Loads due to proposed changes to Lake Hawthorn Operating Rules**

Transfer	Average Annual Flow (ML/a)			Average Annual Salt Load (t/a)		
	Existing[1]	Proposed[2]	Year 2050[3]	Existing[1]	Proposed[2]	Year 2050[3]
Lake Ranfurly West to Wargan	233	232	442	10,800	10,800	17,759
Lake Ranfurly East to Wargan	917	881	1,948	18,700	18,200	21,149
Lake Ranfurly East to Ranfurly West	11	10	590	160	155	38,371
Lake Hawthorn to Wargan	2,781	4,991	502	8,120	15,500	10,410
Lake Hawthorn to Murray	2,722	289	0	8,250	784	0

1. Existing operating rules – current inflows
2. Proposed operating rules – current inflows
3. Year 2050 development and inflows, proposed operating rules

2.3 Groundwater Issues

All significant water bodies in the Study Area have been assessed in a previous study (ref 6), as either receiving groundwater discharge, or discharging to groundwater (viz contributing to groundwater accessions), as follows:

- Waterbodies receiving groundwater discharges: Rifle Butts Swamp, Koorlong Basins, Psyche Bend Lagoon, Lake Ranfurly East, Lake Ranfurly West, Lake Hawthorn and Lamberts Swamp.

- Waterbodies discharging to groundwater (viz contributing to groundwater accessions): Kings Billabong, Wargan Basins (although base considered virtually impermeable), Cardross Lakes and Basin 12.

There is clearly some potential for additional inflows to any of the Study Area's inland waterbodies to increase groundwater accessions, particularly in cases where the waterbody is already a groundwater discharge source.

Whilst the previous study considered Basin 12 to be a groundwater discharge source, this is considered marginal under existing conditions. The operating level of the Basin is currently well below full supply level of 38 m AHD, and the regional groundwater level at the basin is around 37 m AHD. Groundwater levels on the escarpment immediately to the west of the Basin are likely to be significantly higher due to local topography.

Any new waterbodies, eg wetlands or reuse storages, will also have potential to contribute to groundwater accessions, depending on their depth, area, base material, and operating level relative to local groundwater levels.

Discussion of options in Section 3 includes consideration of wetlands and reuse storages on the Murray floodplain. Regional groundwater is highly saline, and groundwater is generally within 1.5 metres of the surface on the floodplain. Shallow ephemeral wetlands are unlikely to result in any significant additional groundwater accessions. Reuse storages, however, will need to pond water deeper and for longer periods. Excavation depths will be limited by groundwater, and storages may need to be lined to prevent groundwater accessions. A turkeys nest configuration may then be required to provide adequate volume, and impacts on flood levels might then become a consideration.

2.4 Reuse Considerations

The Current Situation Report (ref 5) noted that "very little of the irrigation or urban drainage water generated in the Study Area is reused, regardless of quality".

The Study Area's two irrigation authorities were consulted to determine their likely positions regarding reuse of either irrigation or stormwater drainage.

The key points of Sunraysia Rural Water's response were as follows:

- the Authority was generally keen to see reuse of either or both irrigation and urban drainage water;
- the major issue is acceptability of mixing drainage water with the existing supply. This is unlikely to be acceptable at the present time. The best alternative might be dual systems, that have access to stored stormwater when available, and to irrigation water at other times; and
- if a dual system were established, the water authority would be responsible for ensuring water quality. Even with treatment, it is unlikely that the community would accept mixing of drainage water with the irrigation supply.

Given these constraints, reuse could only be considered in conjunction with alternative disposal options.

At the time of writing, a response had not been received from FMIT.

Smaller scale reuse of stormwater on adjacent sporting fields or parks, or private scale reuse, is worthy of consideration. Given the need to alternative disposal options to cater for periods of inadequate quality, this is likely to be more cost effective in catchments with natural gravity outfalls.

2.5 Desalination

The feasibility of, and costs associated with, desalination have been raised as an issue on a number of occasions during the course of the Project.

Desalination costs depend on a number of factors including:

- salinity of source water;
- target salinity;
- capacity of plant;
- presence of trace elements. Some of these can prevent operation of reverse osmosis plants, or double costs; and
- disposal options for brine streams (on-site evaporation basins, or pumped disposal to remote sites).

Typical capital costs of plants designed to reduce salinity from 25,000 EC to 300 EC for potable use are as follows:

1 ML/d - $1 million;
0.4 ML/d - $0.5 million

Operating costs are typically $2,000 to $3,000 per ML produced. This is 20-30 times the cost of River water.

Whilst these costs might not appear viable at the present time, desalination costs for production of irrigation quality water are lower, and technological advances are resulting in further cost decreases as time proceeds. These should be monitored.

The benefits of having a reliable high quality supply, not subject to algal blooms, available in events when the River water quality is unacceptable or treatment plant capacity is limited due to River water quality, should be recognised.

2.6 Impacts of Storm Events on Inland Water Bodies

The potential for stormwater runoff from highly urbanised catchments to cause rapid increases in water levels of inland water bodies has been raised as a potentially significant issue. This is particularly relevant to Lake Hawthorn and Lake Ranfurly. If runoff from all landlocked catchments in the Irymple Basin is pumped to these water bodies, estimated water level increases following a 72 hour 100 year ARI (average recurrence interval) storm of 132 mm would be as indicated in Table 2-3. An average volumetric storm runoff rate of 40% has been assumed.

Table 2-3 Impacts of 100 year Storm on Water Levels in Lake Hawthorn and Lake Ranfurly East

Water Body	Surface Area (ha) (ref 6)	Year 2050 Developed Catchment (ha)		Runoff volume (ML)	Water level increase (mm)
		Gravity	Pumped		
Lake Hawthorn	214	424	660	570	270
Lake Ranfurly East and West	300	373	1332	900	300

Under the revised operating rules (refer Section 2.2.1), operating levels in Lake Hawthorn would only rarely exceed 35.5 m AHD. The estimated 100 year ARI flood level for Lake Hawthorn is 38.1 m AHD. A 100 year ARI local storm coinciding with an operating level of 35.5 m AHD, would only cause the level to rise by 270 mm to 35.77 m AHD, which is still well below the estimated 100 year flood level. In a worst case scenario of the Lake level being above 35.5 m AHD at the start of the storm, the storm would cause a level increase of less than 270 mm, due to the increased surface area of the Lake.

From these figures it can be concluded that the impact of very large storm events on water levels in these water bodies is relatively small. This analysis ignores the impacts of coincident drainage discharges from the subsurface system, which are expected to be relatively small.

3. Development and Assessment of Options

3.1 Introduction

Disposal options have been developed for discrete parts of the Study Area, based on options presented in Issues Paper 5 (ref 1), and discussion in meetings with the Steering Committee, Reference Group, and Project Working Group.

3.2 Option Development

Developed options are described in the following section. Figures 3.1 and 3.2 indicate locations of elements referred to in the following sections.

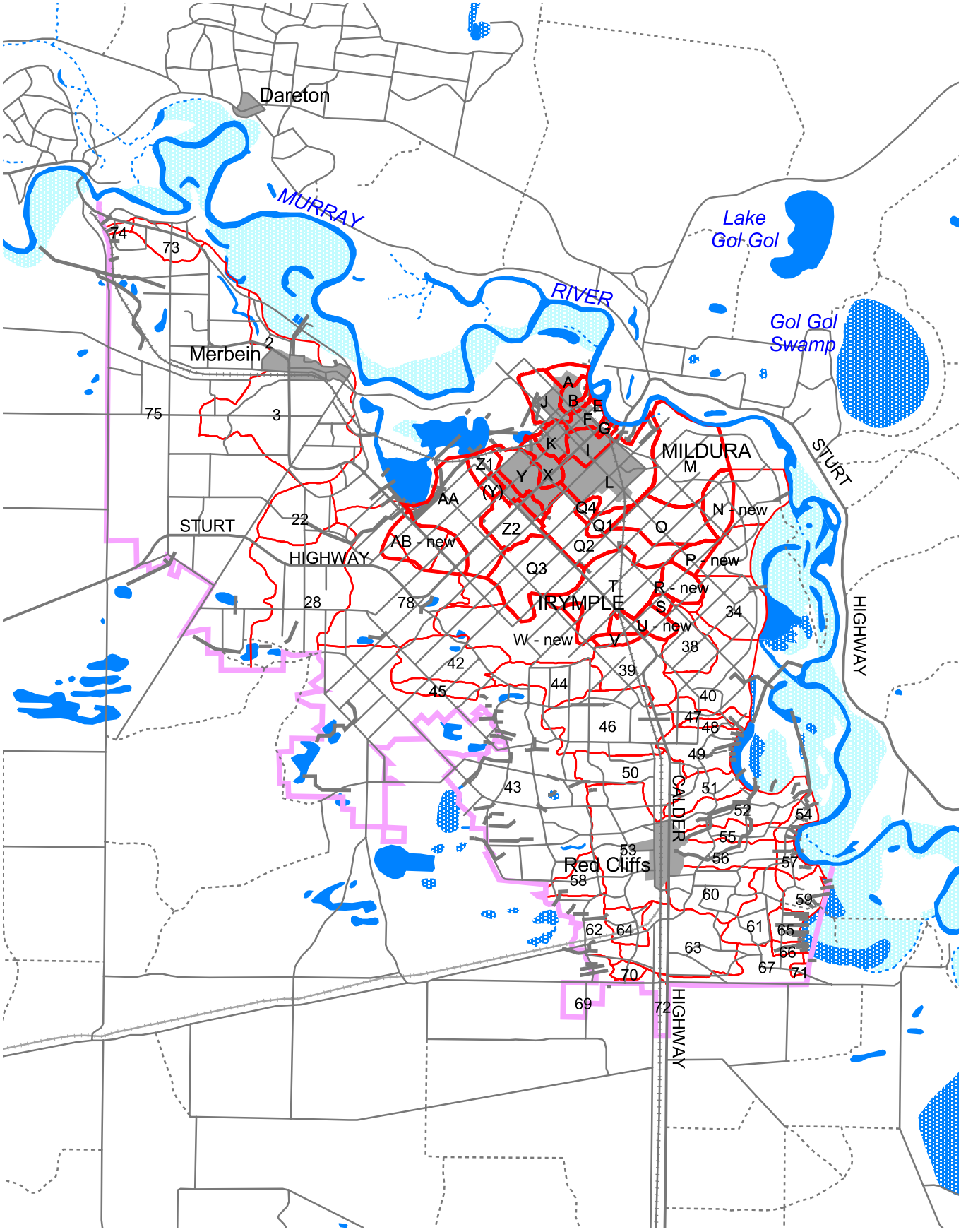
■ Table 3-1 Option costs and impacts

Area	Option	Costs			Changes relative to current disposal site[1]												
		Capital ($'000)	Annual Immediate ($'000/yr)	Annual 2050 ($'000/yr)	Waterbody	Immediate						2050					
						Flow		Salt Load		Nitrogen		Flow		Salt Load		Nitrogen	
						(ML/yr)	% Change	(t/yr)	% Change	(t/yr)	% Change	(ML/yr)	% Change	(t/yr)	% Change	(t/yr)	% Change
A. Urban Mildura draining by gravity to Murray River	A1. Etiwanda and San Mateo Drains through wetland	1200	10	10	Murray River u/s lock	0		0		-2.8		0		0		-2.8	
	A2. Redirect flows to Rifle Butts Swamp	3200	110	110	Murray River d/s lock	-110		-30		-0.6		-160		-50		-0.8	
					Murray River u/s lock	-820		-250		-4.1		-970		-290		-4.8	
					Rifle Butts Swamp	930	340%	280	290%	4.7	360%	1130	290%	340	290%	5.7	290%
	A3. Reuse in nearby gardens, parks, woodlots	2,100	20	20	Murray River u/s lock	-320		-140		-2.3		-310		-140		-2.3	
B. Mildura urban draining by gravity to Lake Hawthorn, Lake Ranfurly East and Rifle Butts Swamp	B1. Gravity discharge to natural outfalls																
	B2. As B1, with reuse in nearby gardens, parks, woodlots	720	40	40	Lake Hawthorn	-180	-3%	0	0%	0	0%	-270	-11%	-80	-4%	-1.4	-25%
					Lake Ranfurly East	-160	-45%	-50	-35%	-0.8	-50%	-210	-50%	-60	-45%	-1.0	-50%
C. Irymple Basin	C1. Pumped discharge to Lake Hawthorn and Lake Ranfurly East	6,100	130	150	Lake Hawthorn	90	1%	30	0.4%	0.4	0.5%	520	25%	160	7%	2.6	45%
					Lake Ranfurly East	650	180%	200	130%	3.3	210%	1590	370%	480	380%	7.9	380%
	C2. Pumped discharge to Cardross Lakes	10,900	180	200	Cardross Lakes	740	40%	220	10%	3.7	210%	2100	230%	630	60%	10.6	1180 %
	C3. C1 with reuse in irrigation system at Lake Benetook	9,000	140	160	Lake Hawthorn	0		0		0		100	4%	30	1%	5.0	90%
					Lake Ranfurly East	650	180%	200	130%	3.3	210%	1590	370%	480	380%	7.9	380%
D. Irrigated catchments draining to River upstream of lock	D1. Do nothing																
	D2. Pump part of catchment 1 to Cardross Lakes	1,900	60	50	Murray River u/s lock	-970		-1160		-0.1		-360		-430		-0.1	
					Basin 12	-970	-35%	-1160	-35%	-1.2	-45%	-360	-25%	-430	-25%	-0.6	-45%

[1] As a result only of drainage of flows from urban and irrigation areas.

Area	Option	Costs			Changes relative to current disposal site[1]													
		Capital ($'000)	Annual Immediate ($'000/yr)	Annual 2050 ($'000/yr)	Waterbody	Immediate						2050						
						Flow		Salt Load		Nitrogen		Flow		Salt Load		Nitrogen		
						(ML/yr)	% Change	(t/yr)	% Change	(t/yr)	% Change	(ML/yr)	% Change	(t/yr)	% Change	(t/yr)	% Change	
					Cardross Lakes	970	55%	1160	55%	1.2	65%	360	40%	430	40%	0.6	65%	
	D3. Redirect remainder of Catchment 7 to Kings Billabong	280	10	10	Kings Billabong	690	170%	830	170%	0.7	170%	240	120%	290	120%	0.2	100%	
					Murray River u/s lock	-350		-750		-0.6		-120		-260		0.2		
	D4. Discharge to large regional salinity interception pipeline																	
E. Irrigated catchments discharging to Cardross Lakes	E1. Do nothing																	
F. Irrigated catchments discharging to Koorlong Basins	F1. Do nothing																	
	F2. Divert parts of catchments 1C, 2A and 2B to Cardross Lakes	1,200	60	50	Cardross Lakes	860	50%	980	45%	0.8	45%	430	50%	490	45%	0.4	45%	
					Koorlong Basins	-860	-75%	-980	-70%	-0.8	-70%	-430	-75%	-490	-70%	-0.4	-65%	
G. Merbein District	G1. Redirect drainage shafts catchment to Basin 1	560	40	40	Murray River d/s lock	-150		-5400		0		-80		-2700		0		
					Basin 1	150		180		0.5		80		90		0.3		
	G2. MIDS – both pipelines	5,300	120	110	Murray River d/s lock	-1670		-12900		-1.4		-910		-9370		-0.7		
					Wargan Basins	1670		7680		1.6		910		6760		0.8		
	G3. MIDS – drainage shafts only	1,200	40	40	Murray River d/s lock	-150		-5400		0		-80		-2700		0		
					Wargan Basins	150		180		0.5		80		90		0.3		
	G4. MIDS - West and North West Drains, and Lamberts Swamp only	4,800	110	100	Murray River d/s lock	-1520		-7500		-1.4		-830		-6670		-0.7		
					Wargan Basins	1520		7500		1.4		830		6670		0.7		
	G5. Direct connection of Merbein town drainage to River	600	3	3														
	G6. Reuse of Merbein town drainage on LMW woodlots	600	3	3	Murray River d/s lock	-80		-20		-0.4		-170		-50		-0.8		

FIGURE 3.1 - SURFACE CATCHMENTS (URBAN AND RURAL)



SINCLAIR KNIGHT MERZ

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LEGEND

Rural and Urban Surface Catchments

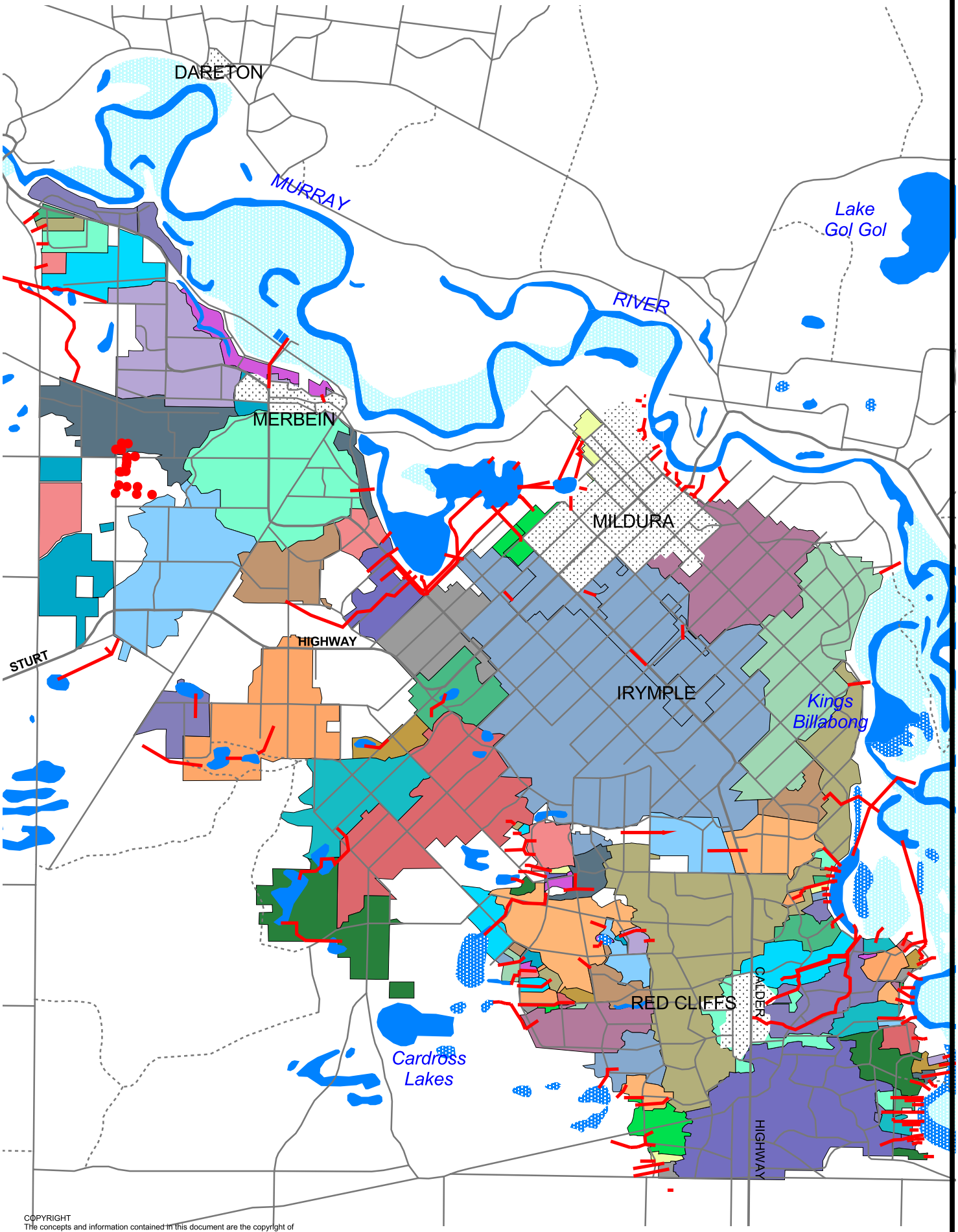
Drainage Outfalls

Study Area

N

2 0 2 4 Kilometres

FIGURE 3.2 - SUBSURFACE CATCHMENTS



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LEGEND

Drainage Shafts

Drainage Outfalls

N

2 0 2 4 Kilometres

3.2.1 Mildura Urban Area draining by gravity to the Murray River

Option A1 – Combine Selected Outfalls to Wetland

A constructed wetland on the Murray floodplain on south side of Etiwanda Avenue, designed to cater for flows from Catchments I (San Mateo Drain) and L (Etiwanda Avenue Drain). A shallow ephemeral wetland is assumed, so as to minimise impacts on groundwater accessions, and avoid groundwater discharges.

A conceptual design for the wetland has previously been completed for council. The wetland was designed to cater for 6 month events from the San Mateo drain (gravity drains into wetland). The Etiwanda drain required pumping into the wetland, and the volume of water treated would be governed by the pump capacity. There have also been recent discussions to move the wetland to the other side of Etiwanda Avenue, however details of this proposal are not yet known.

Further investigation of levels of FMIT drains servicing adjacent catchments to the east would be required to confirm whether these could be included.

Option A2 – Redirect Flows to Rifle Butts Swamp

- Redirect majority of flows from urban catchments A, B, D, F, G, H, I, L and M to Rifle Butts Swamp, using pumping stations and pipelines.
- Pumping stations and storages constructed at the outfalls from catchments A, B/D combined, F, G/H combined, and I/L/M combined.
- Storages at each pumping station/outfall sized to cater for first five minutes of runoff from a one-year storm. The intention is to ensure capture of the "first flush" and thus the majority of pollutants that would other wise discharge to the River. Pump station capacities have been determined on the basis of storages being pumped out over three days following a storm event.

Option A3 – Re-use in nearby parks and gardens, woodlots

- Reuse storage on the floodplain to collect runoff from urban catchments I and L. It is assumed that a turkeys nest storage would be required to provide the necessary volume without the need for excavation below groundwater level, and that the storage would need to be lined to prevent leakage and groundwater accessions.
- Small pump stations and pipework to enable reuse of stored runoff on adjacent parklands.

3.2.2 Mildura Urban Area Currently Draining by Gravity to Lake Ranfurly East, Rifle Butts Swamp and Lake Hawthorn

Option B1 – Gravity Drainage to Natural Outfall Water Bodies

This is, in effect, the do-nothing option.

Option B2 – As B1, with reuse in local parks and gardens

- Reuse storages upstream of both Lake Hawthorn and Lake Ranfurly East. It is assumed that the Lake Ranfurly storage comprises a retrofit of the existing lagoon system adjacent to the outfall of the existing Fifteenth Street Drain.
- Small pump stations and pipework to enable reuse of stored runoff on adjacent parklands.

3.2.3 Irymple Basin

In developing options for the Irymple Basin, no allowances have been included for use of spare drainage capacity in the FMIT subsurface system, as this is generally negligible relative to the required peak storm capacity required.

Option C1 – Pumped Discharge to Lake Ranfurly East and Lake Hawthorn

- Runoff from all landlocked catchments in the Irymple basin is pumped to either Lake Hawthorn or Lake Ranfurly. Runoff from landlocked catchments T, O, R, U, V, W, Q1, Q4 and Q2 is assumed to discharge to Lake Ranfurly East. Runoff from landlocked catchments Q3 and Z2 is assumed to discharge to Lake Hawthorn.
- Three major pump stations are assumed, at the low points of Catchments T (Irymple) and Q2 (Calder) discharging to Lake Ranfurly East, and at the low point of Catchment Q3 discharging to Lake Hawthorn.
- It has been assumed that basins are sized to cater for runoff from the 100 year 72 hour storm, and pump stations sized to evacuate basins in 10 days following the design storm.

Option C2 – Pumped Discharge to Cardross Lakes

- Runoff from all landlocked catchments in the Irymple Basin is pumped to Cardross Basins.
- As for Option C1, it has been assumed that basins are sized to cater for runoff from the 100 year 72 hour storm, and pumped stations sized to evacuate basins in 10 days following the design storm.
- Major pump stations were assumed as for Option C1.

Option C3 – Reuse in Irrigation System

- Pumping of 10% of all runoff from landlocked catchments in the Irymple Basin to a reuse storage adjacent to Lake Benetook, from the low point in Catchment Q3. In accordance with advice from SRWA that mixing of drainage water with irrigation water was unlikely to be acceptable, it has been assumed that the drainage water is pumped using a separate system. A site adjacent to Lake Benetook has been chosen for ease of incorporation into the irrigation system if this becomes acceptable. The costs of a separate supply system downstream of the reuse storage have not been estimated.

- Because the quality of the runoff cannot be guaranteed as suitable for irrigation, or that the reuse storage might be full at the time of the design storm, it has been assumed that a backup pumped disposal system is required. This is assumed to discharge to Lake Hawthorn/Lake Ranfurly East, as for Option C1.

3.2.4 Irrigated Catchments Draining to Murray River upstream of Mildura township

It should be noted that Options D2 and D3 relate to independent subareas. They could be combined to formulate a fifth option (D5), and the costs and benefits of this option would then be the sum of the costs and benefits of Options D2 and D3.

Option D1 – Do nothing

Included for comparison only.

Option D2 – Pump part of Red Cliffs subsurface Catchment 1 to Cardross Lakes

- Approximately 80% of this catchment is upstream (west) of the Calder Highway, and it is assumed under this options that this is pumped back to Cardross Lakes, via a pump station installed within the existing drainage system. (An existing 2.5 ML/day pump operates in much the same way to discharge from the same catchment to Cardross Basins from west of Red Cliffs township. Volumes pumped from this station have varied markedly over the past five years, from zero to more than 500 ML/year. A long term average of 250 ML/year has been assumed.)
- The pump station capacity has been determined assuming 150% of the current long term average drainage rate over the irrigation season.

Option D3 – Redirect FMIT Subsurface Catchment 7 to Kings Billabong

- Redirection of the remainder of irrigation drainage from FMIT Catchment 7 to Kings Billabong. It is assumed that this can be achieved using a gravity pipeline sized to cater for an assumed standard of service of 0.20 L/s/ha (ref 1). The feasibility of gravity discharge to the Billabong from somewhere near the drain outlet is still to be confirmed. If this is not possible, gravity discharge from further up the catchment should be considered instead. This will still be relatively effective in reducing nutrient discharge to the River.
- It is assumed that the drain would need to pass through a macrophyte swale prior to discharge to the Billabong, to provide some preliminary treatment.
- The rationale for this option is removal of nutrients upstream of and within Kings Billabong, and to provide some additional reuse of drainage water (part of this catchment already discharges to the Billabong).

Option D4 – Regional Groundwater Interception Pipeline from Colignan to Mourquong Basins (NSW)

This option was proposed in Issues Paper 5. The proposed pipeline is only one of a series of options under consideration as part of a current investigation of regional salinity disposal options. The intention of the option was to upsize the pipeline to cater for drainage water from the Study Area. This option will not be considered further, as it has been advised that it is most unlikely that disposal of Victorian surface drainage waters in New South Wales would be acceptable. The relatively large volumes of low salinity water also would make this option unattractive.

3.2.5 Irrigated Catchments Discharging to Cardross Lakes

Cardross Lakes are a series of wetlands of high environmental value, the viability of which is threatened by reductions in drainage volumes. A number of options formulated for other areas have sought to increase discharges to these Lakes. Irrespective of which options are adopted, it is recommended that the inlet works to the Lakes, and connecting works between the Lakes, are modified to maximise flow to the largest and most environmentally significant Lake (RWC 1, 2 and 3), and minimise losses in the less important Lakes. These works have not been costed.

Option E1 – Do Nothing

This "option" is included for completeness.

3.2.6 Irrigated Catchments Discharging to Koorlong Basins

Option F1 – Do Nothing

This option is included for completeness.

Option F2 – Diversion of Parts of FMIT Subsurface Catchments 1C, 2A and 2B to Cardross Lakes

- Pumping of approximately 80% of Catchment 1C, 80% of Catchment 2A, and 30% of Catchment 2B to Cardross Lakes, via three pumping stations installed within the existing subsurface drainage system.
- The pump station capacity has been determined assuming 150% of the current long term average drainage rate over the irrigation season.

3.2.7 Merbein District

It should be noted that Options G5 and G6, relate to areas independent of Options G1 to G4 inclusive. Either of Options G5 or G6, could be combined with any of Options G1 to G4, and the costs and benefits of any resultant options would be the sum of the costs and benefits of the component options.

Option G1 – Redirect Drainage Shafts Catchment Flows to SRWA Basin 1

- Seal drainage shafts in catchment on either side of Paschendale Avenue to the south of Fifth Street. Costs associated with sealing the shafts have not been estimated;
- Pump irrigation drainage to SRWA Basin 1 (near intersection of Sturt Highway and Meridian Road).

Options G2 to G4

These options are minor variants on options recommended in the Merbein Integrated Development Scheme (ref 7):

- Option G2 – Pumping stations and pipelines to convey drainage discharges from Lamberts Swamp, North West Drain, West Drain, and Drainage Shafts to a balancing storage on the Main Channel near the intersection of Meridian and Wargan Roads, and thence to Wargan Basins. For the purposes of option comparison, the balancing storage has been omitted.
- Option G3 – as Option G2, but with discharges from Drainage Shafts only.
- Option G4 – as Option G2, but with discharges from Lamberts Swamp, North West Drain, and West Drain only.

Option G5 – Direct Connection of Merbein Town Drainage to River

Flows from the Merbein town drainage system currently discharge to the floodplain. This option assumes extension of the outfall to the River, to reduce ponding on the floodplain, and resultant evaporitic concentration and pressures on regional groundwater systems . Treatment in an ephemeral wetland will be required to reduce nutrient and other contaminant loads prior to discharge to the River.

Option G6 – Reuse of Merbein Town Drainage on Lower Murray Water Woodlots

This option was suggested in the Current Situation Report (ref 5). It is assumed that a gravity pipeline can be used to redirect flows to the Lower Murray Water wastewater treatment plant.

Lower Murray Water has a long term strategy, likely to be implemented within 10 years, to transfer all Merbein township wastewater to an alternative site, and vacate the present site. It is therefore recommended that this option not be pursued.

3.3 Impacts of Options

Estimated capital and operating costs associated with the differential elements of each option are presented in Table 3-1, together with preliminary estimates of changes in drainage volumes, and salt and nutrient loads relative to the do-nothing disposal option. Costs that are common to all options within a particular area have not been included. These include, for example, costs of reticulated drainage, and costs of drainage basins to the Irymple area.

The do-nothing disposal option assumes current disposal sites for both urban and subsurface drainage systems. Urban drainage system flows are assumed to increase progressively to year 2050 based on the assumed development extents developed for Issues Paper 3 (ref 4). Subsurface drainage flows are assumed to decrease from the current 1.4 ML/irrigated ha/yr to 0.7 ML/irrigated ha/yr in 2050, as outlined in Issues Paper 3.

Salinities are in accordance with Issues Paper No 3 – 2050 Scenario (ref 4) as follows:

Urban drainage	500 EC
Irrigation drainage	2,000 EC

Nitrogen export rates have been estimated using rates quoted in the Mallee Water Quality Management Plan (ref 13) as follows:

Urban areas	5 mg/L
Horticultural areas	1 mg/L

Phosphorus export rates quoted in this reference are 10% of nitrogen rates for both land use types.

Wetlands are assumed to capture 90% of nutrient loads.

Reuse storages for Options A3 and B2 have been sized for 10% of annual runoff, and have been assumed to capture 50% of annual runoff; 50% of captured annual runoff is then is assumed to be reused, with the remainder lost to evaporation. These storages are assumed to capture 50% of mean annual salt and nutrient loads.

3.4 Assessment of Disposal Options

3.4.1 Overview

Many of the benefits of the proposed options cannot be meaningfully expressed in economic terms. This particularly applies to environmental and amenity values of inland water bodies. A multi criteria analysis approach has therefore been adopted for option evaluation, using the following criteria:

Cost criteria:
- capital cost; and
- recurrent costs; and

Benefit criteria:
- reduction in salt loads to the Murray River;
- reduction in algal blooms in the Murray River;
- environmental enhancement of inland water bodies;
- enhancement of amenity values of inland water bodies; and
- reuse opportunities.

The adopted method entails assigning a score between 0 and 1 to each criterion for each option. A pseudo benefit cost ratio is then determined by dividing the weighted sum of the benefit criteria scores, by the weighted sum of the cost criteria scores.

The assigned benefit criteria weightings, based on an average of weightings provided by:

- Environment Protection Authority (EPA);
- First Mildura Irrigation Trust (FMIT);

- Lower Murray Water (LMW);
- Mallee Catchment Management Authority (MCMA);
- Mildura Rural City Council (MRCC);
- Department of Natural Resources and Environment (NRE); and
- Sunraysia Rural Water (SRWA),

are presented in Table 3-2.

Table 3-2 Benefit Criteria Weightings

Criterion	Weighting (%)							
	EPA	FMIT	SRWA	MCMA	MRCC	NRE	LMWA	Ave
Reduction in salt load to Murray River	26	27	39	31	22	22	14	**26**
Reduction in algal blooms in Murray River	37	54	33	32	22	22	57	**37**
Environmental enhancement of inland water bodies	21	11	11	16	22	22	0	**15**
Enhancement of amenity value of inland water bodies	5	3	11	5	22	12	0	**8**
Reuse opportunities	11	5	6	16	12	22	29	**14**
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Scores and weightings assigned to each criterion are listed in Table 3-3. Scores are assumed to vary linearly between the tabulated values.

■ **Table 3-3 Criteria and Weightings**

Criterion	Weighting (%)	Measure for score of		Measure
		0.0	1.0	
Cost criteria				
Capital cost	17.1	$12 million	$0	$ capital cost
Recurrent costs	17.1	$626,000	$0	$ per year
Benefit criteria				
Reduction in salt load to Murray River	17.1	0	11,400	Tonnes per year
Reduction in algal blooms in Murray River	24.1	0	5.2	Reduction in Tonnes of N per year, discharging to River
Environmental enhancement of inland water bodies	9.7	0	11,400	Refer Section 3.3.3
Enhancement of amenity value of inland water bodies	5.5	0	7,100	Refer Section 3.3.3
Reuse opportunities	9.4	0	300	ML per year

3.4.2 Capital and Recurrent Costs, and Salt Loads to Murray River

It should be noted that the two cost criteria, and the "reduction in salt loads to Murray River" benefit criterion, can, for all effects and purposes, be expressed in pure economic terms. The scoring system for these criteria has therefore been adjusted such that by adopting the same weight for each, the net present value impact of each is the same. The weightings of all criteria have been adjusted to take this into account. The relativities of the benefit criteria have been preserved in accordance with Table 3-2. Assumptions used in this analysis are as follows:

- 5% discount rate;
- for recurrent costs – 50 year project life;
- for salinity loads to the Murray River – 1EC at Morgan equates to approximately 2,200 tonnes of salt per year, and around $120,000 per year.

Capital and recurrent costs estimates are approximate only, and include the following assumptions:

- power costs - $0.10 per kWhr;
- pump/motor efficiency – 70%;
- 20% on-costs (survey, design, etc), and 25% contingencies;
- capital costs of typical sized rising main pipelines:

  100mm - $35/m layed
  300mm - $180/m layed
  450 mm - $225/m layed

750 mm - $375/m layed
900 mm - $450/m layed
1000 mm - $500/m layed

- 1% of layed costs for pipeline easements;
- no allowances for any changes to pumping costs from Lakes Ranfurly/Hawthorn to Wargan Basins, as a result of diversions of flows to or from these Lakes;
- pump station and rising main operating costs include:

    - $27,500 pa for operator attendance
    - 3% capital cost pa for maintenance of civil, mechanical and electrical works;
    - 1% capital cost pa for pipeline maintenance.

3.4.3 Environmental and Amenity Values of Inland Water Bodies

The impact on the environmental and amenity value of inland water bodies was assessed using a matrix approach to determine a score as follows:

Sum (over all water bodies) of {(current value) * (area of water body) * impact}

where current value was assessed using ratings developed in Issues Paper 4. A single environmental value was assigned to each waterbody based on the average of the instream and riparian value, using a numeric scoring system based on low (1), moderate (2), high (3), very high (4), and similarly for amenity value averaging across each of recreational, "amenity", and tourism, refer Table 3-4.

Table 3-4 Waterbody Values

Waterbody	Environmental Value	Amenity Value	Surface Area (ha) (ref 6)
Kings Billabong	4.0	4.0	167
Psyche Bend Lagoon	1.0	1.0	104
Basin 12	3.0	1.7	75
Cardross Lakes	4.0	1.0	313
Koorlong Basins	1.5	1.0	87
Lamberts Swamp	1.0	1.0	16
Lake Ranfurly East	3.5	1.7	81
Lake Ranfurly West	3.5	1.0	219
Rifle Butts Swamp	2	1.3	20
Lake Hawthorn	3.5	2.7	214
Wargan Basins	3.5	2.0	690

Impact was assessed somewhat subjectively using a numeric scoring system as follows: small negative impact (-1), no impact (0), small positive impact (1), moderate positive impact (2), high positive impact (3), very high positive impact (4), taking account of:

- Need for additional water and/or improved quality.
- If there was a need, volume and quality of additional water relative to need.

3.4.4 Outcomes

The results of the assessment obtained using the preliminary weightings are presented in Table 3-5, including the resultant benefit : cost ratio. It should be noted that this is not a rigorous economic benefit : cost ratio, but rather the ratio of the weighted benefit and cost scores using the adopted multi criteria method. It has been calculated as the ratio of:

- the weighted sum of benefit criteria scores; to
- the weighted sum of (1- the cost criteria scores)

Because this is not an economic benefit : cost ratio, a ratio of greater than one does not necessarily imply that the proposed works should be implemented. Conversely, a ratio of less than one does not necessarily imply that the works should not be implemented. The ratio should only be used to compare the relative merits of proposed measures for a particular area.

Do-nothing options have only been included where they are real alternatives. In the Irymple Basin, for example, the do-nothing option is not acceptable, because urban drainage waters must be disposed of somewhere, as development proceeds.

3.5 Recommended Disposal Options

3.5.1 Results of Assessment Methodology

Based on the above, it is recommended that the following disposal measures be adopted:

- Treat runoff from Mildura urban catchments I and L in a wetland on the Murray River floodplain (Option A1);
- Pump runoff from the Irymple Basin to Lakes Hawthorn and Ranfurly East (Option C1);
- Pump part of runoff from part of Red Cliffs subsurface catchment 1 to Cardross Lakes (Option D2);
- Redirect remainder of FMIT subsurface catchment 7 to Kings Billabong (Option D3);
- Pump drainage flows from Lamberts Swamp, Merbein West and North West Drains, and drainage shafts to Wargan Basins (Option G2); and
- Connect Merbein Town Drainage directly to the River, via an ephemeral wetland (Option G5).

It should be noted that only the second of these measures is intended to cater for future development – all other measures are intended to cater for existing development.

Some modification to some of these options is recommended in the following paragraphs, in light of potential impacts on receiving waters, and other factors.

■ Table 3-5 Option Assessment

Criterion	Weighting	Option																			
		A1	A2	A3	B1	B2	C1	C2	C3	D1	D2	D3	D4	E1	F1	F2	G1	G2	G3	G4	G5	G6
Parameters																						
Capital cost ($000)	17%	1200	3200	2100	0	720	6100	11900	9000	0	1900	280		0	0	1200	560	5300	1200	4800	600	600
Recurrent cost ($000/yr)	17%	10	110	20	0	40	140	200	150	0	60	10		0	0	50	40	120	40	110	3	3
Reduction in river salinity ('000 t/yr)	17%	0	0.31	0.14	0	0	0	0	0	0	0.80	0.51		0	0	0	4.1	11.1	4.1	7.1	0	0.04
Reduction in algal blooms in River (t N/yr)	24%	2.8	5.2	2.3	0	0	0	0	0	0	0.10	0.45		0	0	0	0	1.05	0	1.05	0	0.6
Environmental enhancement of inland water bodies	10%	0	5477	0	0	0	11375	5008	7928	0	2279	0		0	0	2374	0	7245	2415	4830	0	0
Improvement in amenity value of inland water bodies	6%	0	3087	0	0	0	7002	1252	4907	0	499	0		0	0	539	0	4140	1380	2760	0	0
Ruse opportunities (ML/yr)	9%	0	0	160	0	260	0	0	130	0	0	240		0	0	0	0	0	0	0	0	60
	100%																					

A. Mildura urban to River
A1. Wetland on floodplain
A2. Divert to Rifle Butts
A3. Reuse storage on floodplain

B. Mildura urban to Lakes
B1. Do nothing
B2. Reuse storages upstream to Hawthorn and Ranfurly

C. Irymple Basin
C1. Pump to Hawthorn/Ranfurly
C2. Pump to Cardross
C3. C1 with reuse storage near L Benetook

D. Rural to river upstream Mildura
D1. Do nothing
D2. Pump Red Cliffs Catchment 1 to Cardross
D3. Divert FMIT Catchment 7 to Kings Billabong
D4. Regional groundwater interception pipeline

E Rural to Cardross

F. Rural to Koorlong
F1. Do nothing
F2. Pump part to Cardross

G. Merbein District
G1. Pump drainage shafts to Basin 1
G2. MIDS - both pipelines
G3. MIDS - drainage shafts only
G4. MIDS - all except drainage shafts
G5. Connect Merbein town drainage to River
G6. Reuse Merbein town drainage on LMW woodlots

Criterion	Weighting	Option																			
		A1	A2	A3	B1	B2	C1	C2	C3	D1	D2	D3	D4	E1	F1	F2	G1	G2	G3	G4	G5	G6
Scores																						
Capital cost ($000)	17%	0.90	0.73	0.83	1.00	0.94	0.49	0.01	0.25	1.00	0.84	0.98		1.00	1.00	0.90	0.95	0.56	0.90	0.60	0.95	0.95
Recurrent cost ($000/yr)	17%	0.98	0.82	0.97	1.00	0.94	0.78	0.68	0.76	1.00	0.90	0.98		1.00	1.00	0.92	0.94	0.81	0.94	0.82	1.00	1.00
Reduction in river salinity ('000 t/yr)	17%	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.04		0.00	0.00	0.00	0.36	0.98	0.36	0.62	0.00	0.00
Reduction in algal blooms in River (t N/yr)	24%	0.54	1.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09		0.00	0.00	0.00	0.00	0.20	0.00	0.20	0.00	0.12
Environmental enhancement of inland water bodies	10%	0.00	0.48	0.00	0.00	0.00	1.00	0.44	0.70	0.00	0.20	0.00		0.00	0.00	0.21	0.00	0.64	0.21	0.42	0.00	0.00
Improvement in amenity value of inland water bodies	6%	0.00	0.43	0.00	0.00	0.00	0.99	0.18	0.69	0.00	0.07	0.00		0.00	0.00	0.08	0.00	0.58	0.19	0.39	0.00	0.00
Reuse opportunities (ML/yr)	9%	0.00	0.00	0.53	0.00	0.87	0.00	0.00	0.43	0.00	0.00	0.80		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20
Surrogate benefit : cost indicator		6.54	4.18	4.49		3.85	1.21	0.23	0.86		0.92	15.43				0.79	3.26	2.85	3.31	2.21	0.00	5.04

A. Mildura urban to River
A1. Wetland on floodplain
A2. Divert to Rifle Butts
A3. Reuse storage on floodplain

B. Mildura urban to Lakes
B1. Do nothing
B2. Reuse storages upstream to Hawthorn and Ranfurly

C. Irymple Basin
C1. Pump to Hawthorn/Ranfurly
C2. Pump to Cardross
C3. C1 with reuse storage near L Benetook

D. Rural to river upstream Mildura
D1. Do nothing
D2. Pump Red Cliffs Catchment 1 to Cardross
D3. Divert FMIT Catchment 7 to Kings Billabong
D4. Regional groundwater interception pipeline

E Rural to Cardross

F. Rural to Koorlong
F1. Do nothing
F2. Pump part to Cardross

G. Merbein District
G1. Pump drainage shafts to Basin 1
G2. MIDS - both pipelines
G3. MIDS - drainage shafts only
G4. MIDS - all except drainage shafts
G5. Connect Merbein town drainage to River
G6. Reuse Merbein town drainage on LMW woodlots

Implementation of Option B2, reuse storages upstream of Lakes Hawthorn and Ranfurly East, has not been recommended above, despite a relatively high benefit: cost score. However the discussion in Section 3.5.2 below recommends that wetlands should be constructed to treat all urban runoff prior to discharge to these two water bodies. These wetlands could also be used partially as reuse storages, if a local recipient can be found for the water.

As noted previously, local basins will be required within each subcatchment in the Irymple Basin, irrespective of which disposal option is adopted. Small scale local reuse on parks and gardens around each of these basins should be encouraged. It should be remembered however that the basins' primary functions will be to temporarily store storm runoff. Any reuse storage volume must therefore be additional to the volume required to cater for the design storm event.

3.5.2 Impacts on Important Waterbodies

Lake Hawthorn

As indicated in Section 2.2.3, adopting Option C1 in combination with projected changes in drainage inflows and scheme operating rules, will result in a dramatic seven-fold increase in the average salinity of Lake Hawthorn in 2050, and a 40% reduction in the average salinity of Lake Ranfurly East. Lake Hawthorn has four species listed as having conservation significance, one of which is listed as vulnerable, and two others of which are listed under the Flora and Fauna Guarantee Act (ref 12). A salinity increase of the magnitude indicated in Section 2.2.3 would be expected to have a significant adverse impact on the current fish populations of Lake Hawthorn. It would also be likely to have a significant adverse impact on riparian vegetation.

As noted above, the proposed measures will result in an increase in the salinity of Lake Hawthorn, and a decrease in the salinity of Lake Ranfurly East. This imbalance could be at least partially redressed by pumping all flows from the Irymple Basin to Lake Hawthorn, and none to Lake Ranfurly East. Whilst detailed cost estimates have not been prepared, the locations and topography of these catchments is such that this is likely to be achievable for virtually no additional cost.

Simplified calculations (that were able to reproduce the year 2050 Lake Hawthorn average salinity figure presented in Table 2-1) were used to assess the impacts of this on Lake Hawthorn. These showed that pumping all Irymple Basin runoff to Lake Hawthorn would reduce the average year 2050 salinity to around 8,000 EC units, which is still around 60% higher than existing salinities. This is nevertheless a significant improvement, and it is therefore recommended that Option C1 be modified accordingly. A salinity of 8,000 EC units is likely to be marginal for the health of the fish species listed as having conservation significance. It may therefore be prudent to regularly monitor the salinity of the Lake, and top up with irrigation water if necessary.

If the potential impacts of urban subsurface drainage are included (refer Section 3.7.4), the 2050 salinity is expected to be slightly less at around 6,000 EC units.

Simplified calculations were also used to assess likely nutrient concentrations under modified Option C1, and showed that the long term concentration of total nitrogen in Lake Hawthorn was likely to be around 9 mg/L. This is likely to result in frequent algal blooms. It is therefore recommended that all urban runoff be passed through a wetland prior to discharge to Lake Hawthorn. This will reduce the long-term concentration of total nitrogen to around 2 mg/L, assuming 90% removal efficiency. It must be stressed that these calculations are approximate only.

It is likely that urban development will also result in similarly high nutrient concentrations in Lake Ranfurly East, although further studies would be required to confirm this. It is therefore recommended that the old sewerage lagoons on the shores of the Lake be retrofitted to form a wetland, and that this be used to treat all urban runoff prior to discharge to the Lake.

Wargan Basins

Wargan Basins are already hypersaline, and further increases in salinity (refer Table 2.2.3) are unlikely to have any significant impact on vegetation and bird populations.

Cardross Lakes

It appears very likely that, even with implementation of Option D2, reduced irrigation drainage rates resulting in significantly reduced flows to Cardross over time, will in turn result in consistently lower water levels, and higher salinities. It is almost certain that fresh water will need to be imported to Cardross to maintain water levels and salinities necessary to ensure the health of the four fish species listed under the Flora and Fauna Guarantee Act (ref 14). Previous water balance modelling (ref 14) showed that with historic drainage inflows (1.45 ML/ha/yr in 1997, ref 6), an additional 1,000 ML/year would be required to maintain a salinity of 6,400 EC during the critical breeding season. This is considered the absolute maximum salinity that could be tolerated by the Purple Spotted Gudgeon during this season. Drainage flows are expected to reduce significantly from 1997 levels, resulting in the need to import more additional water to maintain salinities at the required levels.

The likely volumes of freshwater required to be imported to Cardross in the future will need to be confirmed by additional water balance studies. It is likely that this will be significantly greater than 1,000 ML per year.

Kings Billabong

FMIT has historically pumped around 60,000 ML per year from the Murray River to Kings Billabong (ref 17). Option D3 will result in diversion of approximately 700 ML per year of additional irrigation drainage to the Billabong, which represents only around 1% of diversions from the River. It is therefore considered unlikely that Option D3 would result in any substantial overall increases in the salinity of Kings Billabong. Some localised salinity increases might be experienced in the northern arm due to lack of mixing near the proposed outfall, but the impacts of these are also likely to be relatively low.

Any potential concerns regarding the impact of additional drainage waters on the water quality in Kings Billabong could potentially be overcome by discharging to the wetland at the northern end of the Billabong. This is separated from the main waterbody by a levee. This levee holds water in the Billabong at a higher level, to prevent saline groundwater intrusion. The wetland receives some seepage water through the levee. This is understood to support a small frog population, which would benefit from any additional drainage water. Because the water level is lower in the wetland than in the Billabong, gravity diversion of drainage water is more likely to be feasible. Although the drainage water would not be reused, the wetland would still provide nutrient removal. An inlet macrophyte swale would provide additional treatment.

As a further variant, provision could be included for discharge to either side of the levee, to allow the affected wetland to dry out if desired. More detailed studies are required to assess the impacts of a range of flow regimes on flora and fauna in and around the wetland. Subject to the outcomes of these studies, it is recommended that this variant be adopted.

Murray River

The impacts of some of the options in reducing salt loads to the Murray River are very significant, particularly in the Merbein District, where the drainage shafts are currently estimated to be contributing some 5,400 tonnes of salt per year to the Murray. This load would be virtually eliminated by the proposed measures. To put this in context, the MDBC estimates (P Pfeiffer, pers comm) the total salt load to the Murray between Mildura and Lock 9 to be currently around 35,000 t per year.

The estimated total nitrogen export rate from the Study Area to the Murray River under existing conditions is around 13 t/yr (1.1 t/mth). This is expected to reduce to around 11 t/yr (0.9 t/mth) by 2050, due primarily to a reduction in irrigation drainage rates. Under existing conditions, approximately 50% of this load is exported from urban areas. This is expected to increase to 75% by 2050, due to a reduction in irrigation drainage rates, and increased urbanisation.

An analysis of limited flow and nitrogen concentration data for the Murray at Colignan, from 1997 to 2001, is presented in Table 3-6. There is little if any correlation in this data between TN and flow, so an average concentration of 0.6 mg/L was used to estimate flux.

Table 3-6 Nutrient Fluxes at Colignan

Flow percentile	Flow (ML/d)	TN Flux (T/mth)
Ten percentile	3100	56
Twenty five percentile	3700	67
Fifty percentile	4700	85

These figures show that even under low Murray flow conditions, the nutrient export rate from the Study Area is only around the order of 2% of the inflow from upstream.

It is recognised that at certain times of the year, particularly in summer, flow backs up in the Mildura weir pool, and Murray flows upstream of the weir will then be temporarily less than at Colignan. Even taking this effect into account, it should be recognised that there is limited potential for works in the Study Area to have any significant impact on total nutrient loads to the Murray River. Option A1, a wetland on the Etiwanda and San Mateo catchments, has the largest impact of any proposed measures, and even this is only estimated to reduce nutrient loads to the River by around 2.8 t/yr. This represents a reduction of only around 0.5% in total load under ten percentile low flow conditions.

However, the relationship between frequency of algal blooms and nutrient concentration is not linear, and bloom frequency is influenced by a large number of factors, including temperature, turbidity, degree of stratification, chemistry of bed sediments, and relative concentrations of phosphorus and nitrogen. It may well be that even small reductions in total export loads will have some impact in reducing bloom frequencies. It is therefore recommended that Options A1 and D3, and other measures that have a secondary effect of reducing nutrient export to the River, be pursued, despite the analyses presented above.

3.5.3 Other Measures

Where drainage is disposed to the River, existing and new pipes should generally extend completely to the waterline, in accordance with the recommendations of the Draft Nyah to the South Australian Border Salinity Management Plan (ref 18).

3.6 Rural Surface Drainage

A number of sites around Mildura are subject to rural surface flooding, and these have been identified in the Current Situation Report (ref 5, Figure 3). No additional sites have been identified during preparation of the Drainage Strategy. Common factors in many of these areas are:

- the landlocked nature of many of the catchments; and
- a lack of culverts under roads, railway lines and irrigation channels.

Whilst the total number of properties and buildings affected by these problems might be relatively large across the entire Study Area, only a relatively small number of properties is generally affected at each site. In many cases, particularly where the affected properties are at the low points of landlocked catchments, pumped disposal to remote sites, and other similar solutions that might be considered in urban areas, will not be cost effective.

It is recommended that each case be considered on its merits. Measures that should be considered either alone or in combination might include:

- installation of culverts. Care needs to be taken that this won't just transfer the problem downstream;
- small, property scale, on-site detention facilities in the catchment upstream of the obstruction, to reduce peak flows;

- construction of evaporative disposal basins at the low points of landlocked catchments. There may be some potential for reuse of stormwater runoff in such instances;
- allowing landholders to dispose of stormwater to the subsurface drainage system. This would need to be carefully controlled and monitored to ensure that discharge is only allowed when capacity is available, and that any adverse downstream water quality impacts are minimised;
- construction of low levees or floodwalls around individual houses. Small pumps would also be required to discharge stormwater from inside the floodwall/levee;
- raising of buildings to above flood levels. This will clearly not be practical for slab-on-ground construction;
- building relocation; and
- property acquisition.

Known and expected flood levels and extents should be clearly identified and documented by Council. Council should then ensure that new buildings are either:

- not located in areas of known or expected rural surface flooding; or
- have their habitable floor levels constructed at least 300 mm above known or expected flood levels.

In cases where rural surface drainage discharges to the floodplain, the need to connect this directly to the River will need to be assessed on a case by case basis. Issues to take into account will include cost, and potential EC impacts.

3.7 Urban Subsurface Drainage

Conversion of rural land to urban use in the Mildura region results in at least partial disruption of the sub-surface drainage network. Garden watering in urban areas has the potential to cause significant groundwater accessions. Hence there is a need to consider the potential need for sub-surface drainage in urban Mildura.

3.7.1 Need for Drainage

Rural blocks in the Mildura area have entitlement based on irrigation of 9 ML/ha/yr over the area of irrigation. Typical irrigation usage rates in an average year would be less than this, at about 7 ML/ha/yr.

Average annual rainfall in Mildura is 290mm (2.9 ML/ha/yr).

Urban house lots have an average out-of-house use of 270 kL per year (I Bryce, Lower Murray Water). Depending on the area of land, the application rate varies. Table 3-7 describes average application rates for different block sizes and assumed areas watered.

■ **Table 3-7 Estimated urban watering rates**

Area of House Block (sq m)	800	1000	1200
% of Area Watered	30%	35%	40%
Area Irrigated (ha)	0.024	0.035	0.048
Average Application (ML/ha)	11.25	7.71	5.63

Assuming that the efficiency of irrigation is 70% (including rainfall), then deep drainage generated over each house block will be (on average) between 100 and 130 mm/yr. If the reticulation system leaks in the order of 2% of the supplied volume, then the total drainage requirement is 110 to 140 mm/yr

Typically rural irrigation would result in 70% to 85% efficiency, which results in 150 mm/yr to 300 mm/yr in drainage, including rainfall.

Sub-surface drains are installed in areas where natural deep drainage is insufficient to remove rural deep drainage of 150 to 300 mm/yr. Generally drains are only installed in areas that are demonstrated not to have sufficient natural drainage.

Conversion of irrigation to urban use will lower the drainage requirement. In areas of poor natural deep drainage it is unclear whether this reduction would be enough to avoid the need for sub-surface drainage.

If sub-surface drainage is still required, then the disruption of existing drains during urban development may lead to waterlogging and salinisation in low lying parts of the urban development. It may not be immediately obvious as to whether any one

development needs to retain sub-surface drains. It is therefore prudent to assume that some level of sub-surface drainage will be required.

Sub-surface drains in urban areas should:

- provide relief from waterlogging caused by urban irrigation and rainfall;
- protect building structures from rising damp;
- protect soil from salinisation; and
- protect urban infrastructure from salt / waterlogging damage.

In irrigation areas, sub-surface drains generally control watertable levels to around the levels of the drains. A similar effect would be expected in urban areas. If sub-surface drainage is not installed in urban areas, watertable levels may increase, resulting in increased groundwater gradients to the River, and increased salt loads to the River. It is therefore considered prudent to install sub-surface drains in urban areas to reduce the risk of increased salt loads to the River.

3.7.2 Areas where drainage is required

Areas where urban subsurface drainage might be required will include:

- areas of known groundwater discharge and waterlogging; or
- topographic low points and swales; or
- areas where there is relatively little topsoil over the underlying clay (these will often be topographic low points)

in areas where the Blanchetown Clay is present. (The Blanchetown Clay covers the majority of the area of potential development to 2050 in Mildura/Irymple.)

In areas of new development, it is recommended that developers be required to commission a risk assessment to determine the need for subsurface drainage. This should be undertaken by a suitably qualified and experienced hydrogeologist or irrigation engineer.

It is expected that no more than about a third of the urban area will require subsurface drainage.

In areas of existing development, subsurface drainage will generally only be required in known problem areas.

3.7.3 Works Required

Areas that might require urban subsurface drainage will generally comprise parts of the FMIT Irrigation District that are excised for urban development. Reasonable attempts should be made to locate existing tile, collector and trunk subsurface drains, and to retain and use these where possible. To assist with this, it is recommended that a planning permit be required for removal of irrigated crops. Any new subsurface drains should be connected to the existing FMIT drainage system wherever practical, and preferably discharge to existing subsurface outfall drains. This may require pumping in some instances.

It is considered essential that new subsurface drains be located in street reserves, as this will avoid the problems associated with drains on private property, viz easements, access, maintenance difficulties, etc. As demonstrated in Section 3.7.1 above, required subsurface drainage rates in urban areas will typically be less than rates required in irrigation areas. Good subdivision design practice dictates that streets should generally be located in low points and grade towards drainage discharge points, such that they can act as floodways for flows in excess of the capacity of the piped stormwater drainage system. Streets will thus generally be ideally located for new subsurface drains. It may be necessary to lay sub-surface drains on both sides of the street reserve, and pumped outfall may be required in some instances. Tree planting should be controlled to reduce accessions and avoid blockages.

3.7.4 Impacts of Urban Subsurface Drainage

Whilst the existing piped urban drainage system certainly intercepts some subsurface drainage flows and associated salt loads, available evidence suggests that these are not likely to be particularly significant. Salinities in the Etiwanda Drain during low flow periods are typically around 3,500 EC units (by comparison, mean salinity of storm runoff in urban drains in Mildura is around 500 EC). The subsurface drainage interception rate of urban stormwater drains would be expected to be around 0.1 ML/ha/yr (see discussion below). The Etiwanda Drain has a catchment area of 503 ha, and contributes around two thirds of the total volume of Mildura urban drainage discharging to the River. Based on these assumptions, the Mildura urban drainage system would be expected to discharge around 150 t of salt associated with subsurface drainage flows, per year, to the River. By comparison, total salt export to the River from all irrigation and urban surface drainage in the Study is more than 10,000 t per year.

As noted elsewhere, subsurface drains in irrigation areas currently discharge around 1.4 ML/ha/yr. The rate for subsurface drainage in urban areas will be less than this, and adjustment is required to account for:

- lesser area watered - assume 35%, refer Table 3-7;
- different watering efficiencies - assume 70% for urban irrigation, and 80% for rural irrigation;
- only around 30% of the area of future development is expected to require subsurface drainage. It is expected that this might effectively drain around 50% of the developed area.

It should be noted that the same irrigation depth of 700 mm over the actual area irrigated (refer Table 3-7) is expected in both urban and rural areas.

On this basis, the subsurface drainage rate in urban areas is expected to average around 0.4 ML/ha/yr. The salinity of urban subsurface drainage would be expected to be similar to that for rural irrigation, viz around 2,000 EC. Under the proposed strategy, the vast majority of this would discharge to Lake Hawthorn. The adopted additional development area in Mildura/Irymple to 2050 is around 2,500 ha, so subsurface drainage of this would be expected to contribute an additional 1,000 ML per year of flow, and an additional 1,200 t/yr of salt, by 2050.

3.7.5 Institutional Issues

The need for urban subsurface drainage also raises a number of issues that will need to be addressed by institutional arrangements. Issues will include responsibility for maintenance of parts of existing subsurface drainage networks that no longer serve irrigation areas, but are required for urban subsurface drainage.

This will be less of a problem if a single authority assumes responsibility for all types of drainage across the Study Area. If separate urban and irrigation authorities are retained, then the two authorities will need to come to some agreement regarding:

- maintenance and replacement responsibilities for subsurface drains;
- fees payable to the irrigation authority for use of subsurface outfall drains by the urban drainage authority;
- treatment of, and responsibility for, redundant subsurface drains.

Institutional issues are covered in Chapter 5.

4. Funding of Drainage Works

4.1 Funding of Existing Works

The existing cost recovery framework for drainage in the Study Area was outlined in Section 6 of the Background Issues Paper (ref 2). In summary, existing sources of funds are as follows.

- Urban drainage works are funded by a combination of general rate revenue and developer's contributions. Developer's contributions are intended to cover the capital costs of off-site drainage works. Developers are responsible for funding and construction of all on-site works.

- Operation, maintenance and replacement of irrigation drainage works are funded by rate revenue from FMIT and SRWA customers.

There appears to have been little if any capital expenditure on rural surface drainage in recent times.

4.2 Potential Sources of Funds

Funds for drainage works might be available from a number of sources, as discussed in the following sections:

4.2.1 Urban Drainage

The capital and operating of urban drainage works can be funded at least partly by general rate revenue.

As noted in the Background Issues Paper, up until early 2001 Council had levied developers for the capital cost of off-site drainage works on a dollar per hectare basis. Since that time, Council has moved to charging developers for off-site drainage works under Section 173 of the Planning Act. These contributions are voluntary and subject to agreement with the developer prior to issue of a planning permit.

Council is now looking to move to collecting developer's contributions by establishing Developers' Contribution Plans (DCPs). Such a system would provide Council with much greater certainty, as the contributions are compulsory.

DCPs enable Councils to set developer contribution rates that are automatically indexed to CPI on a quarterly basis. Two basic options are available:

- municipal wide rate per lot. This option tends to suit metropolitan councils, where drainage costs do not vary greatly between locations within the municipality;

- large catchment based approach, where a rate per lot is set for each catchment. This is often more suitable for rural municipalities, where the costs of providing drainage services vary significantly between locations. The Study Area is a good example of this. For example, the landlocked Irymple basin can only be feasibly

drained by pumping, and is thus more expensive to service than an area that can drain by gravity to say the Murray River or Lake Hawthorn.

Some elements of the urban drainage system may be eligible for funding under the State Government Regional Infrastructure Development Fund. Funding is available for (ref 10) "capital works, whether partly privately or publicly funded", including "industry development including physical works to facilitate economic development". It should be noted that ineligible projects include those "requiring full funding where funding is normally provided from State, Commonwealth and/or Local Government sources". The normal elements of urban drainage infrastructure would then appear to be ineligible, but it may be possible to apply for funding for, say, reuse storages where the water was to be reused by industry. This should be investigated further.

4.2.2 Irrigation Drainage

FMIT and SRWA rate revenue are used to fund drainage services to those authorities' respective districts.

National Action Plan (NAP) funding is potentially available for any drainage works that result in a net reduction in salinity or nutrient loads to the Murray River. NAP is a joint Federal Department of Agriculture, Fisheries and Forests (AFFA), and Environment Australia project. Funds are generally available to CMAs via NRE, and can only be obtained via an accredited plan, such as a regional catchment strategy. AFFA's description of the Plan includes as follows (ref 11):

> *"The centre piece of the Action Plan is community-based regional bodies that will develop and implement integrated catchment or regional natural resource management plans. Government will support this regional approach through substantial "block" funding for strategic actions specified in catchment plans."*

Therefore to obtain NAP funding, the Sunraysia Drainage Strategy should be incorporated into the CMA's Regional Catchment Strategy.

4.2.3 Rural Surface Drainage

The line of demarcation between rural drainage and flooding is not well defined. Municipal Councils are generally responsible for rural surface drainage, and Catchment Management Authorities for mainstream flooding. The types of rural surface flooding experienced in the Study Area would generally be expected to come under the auspices of MRCC.

Other authorities from which funds might be available would be those whose assets were impeding overland flows, and thus possibly causing flooding. These might include:

- Vic Roads – major roads;
- Vic Track – rail lines; and
- Irrigation authorities – irrigation channels.

Legal precedent dictates that these authorities would not generally be responsible for funding works to solve inherited problems. For example, if a house was built upstream of an existing railway line, and was then subject to flooding due to inadequate

culverting, the rail authority would not generally be responsible for installing additional culverts to mitigate flooding of the house. However, if the house was built before the railway line, and the railway line caused the flooding, the rail authority would generally be responsible for funding mitigation works.

4.2.4 Environmental Funding Sources

Drainage works that provide some form of environmental benefit could potentially be funded through a number of programs.

Environment Australia (EA) provides funding for preparation and implementation of Recovery Plans for specific species. A Recovery Plan has been prepared for the Purple Spotted Gudgeon, which has previously been reported as having been found in Cardross Lakes. Recovery Plan funding requires State contributions. The AFFA fish rehabilitation program has also funded a recovery plan for the whole fish assemblage of the entire lower Murray below Hume reservoir. The MDBC has recently completed recovery plans for both Silver Perch and Catfish, both of which have been found in Cardross Lakes. These plans may provide funds for works associated with the Cardross system. It is considered doubtful whether Recovery Plan funding could be construed as implementation of Fish Recovery Programs.

National Heritage Trust (NHT) funding also comes under the auspices of Environment Australia, and funds programs including Bushcare, Endangered Species Program, National Landcare Program, National Wetland Program, Murray Darling 2001, and Farm Forestry Program. CMAs and community groups are the most common Victorian applicants. Applications close in January each year, and funding is conditional on matching State and local contributions.

The Murray Darling 2001 Program is a specific part of the NHT Program which aims to accelerate on ground actions within the Murray Darling Basin to improve river health, restore riparian land systems, wetlands and floodplains and improve water quality. Applicants should ensure funding proposals are part of an agreed Action Plan, and are integrated within regional strategies or integrated catchment management plans, and are encouraged to contact local catchment management committees (in this case the CMA) prior to preparing their funding applications.

NRE funding is potentially available for works that provide environmental benefit. NRE funding is subdivided into three categories – Statewide, Regional and CMA, and facilitates federal funding programs such as NAP and NHT by providing the State component of the funds. .

4.3 Cost Sharing

4.3.1 Principles

Cost sharing arrangements should be based on the 'beneficiary-pays' principle.

It is recommended that benefiting landholders should bear the cost of a basic drainage service, in both irrigation and urban areas, via the relevant drainage authorities. Because standards have changed over time, two definitions of drainage service are required as follows:

Existing Development

- the adopted standard of drainage service;
- disposal to the most cost effective available outfall;
- no treatment prior to disposal; and
- no reuse facilities.

Future Development

- As for Existing Development, but with treatment to remove nutrients and other contaminants prior to discharge to receiving waters.

If disposal of drainage waters is to other than most cost effective outfall, this alternative outfall will generally have been selected because it provides a benefit in addition to the basic drainage service, eg environmental enhancement of an inland water body. The relevant beneficiary should then bear the incremental cost of disposal to the alternative outfall, relative to the most cost effective outfall.

If treatment facilities have been provided, the cost of these should be borne by the relevant beneficiaries and/or polluters. The polluter pays principle would apply, for example, if wetlands have been provided to reduce algal blooms in the Murray River. A share of the incremental cost of these should be borne by the holders of the drained land, via the relevant drainage authorities. Some form of incentive is likely to be required for reuse facilities, where no net economic benefit can be demonstrated.

The distinction between existing and future development provides for cost sharing for retrofitting of existing systems to reduce impacts on the receiving environments. Without this, it is unlikely that such works would be implemented.

4.3.2 Options

If these principles are accepted, then options should focus on identifying methods for apportioning benefits, and thus costs, between beneficiaries. Again, if these principles are accepted, then the only costs that need to be apportioned, are the incremental costs over and above the costs associated with the basic drainage service. Although clearly dependent on the disposal option being considered, it should be noted that in most cases, the majority of the total drainage cost is associated with providing the basic drainage service. Therefore the options considered below are looking to assign

generally significantly less than half of the total drainage cost, between beneficiaries other than landholders.

Sets of beneficiaries associated with each of the benefit criteria listed in Section 3.4.1, are indicated in Table 4-1. The relevant groups that could potentially share the costs associated with these benefits are also indicated.

■ **Table 4-1 Benefits and Beneficiaries**

Benefit	Beneficiaries	Costs to be shared between
Reduction in salt loads to Murray River	Region, downstream users	State government (see note 2)
Reduction in algal blooms in Murray River (see note 1)	Lower Murray Water, SRWA, FMIT, private diverters, regional recreation and tourism industries	Drainage authorities, private diverters, local government
Environmental enhancement of inland water bodies	Local and wider community	Local, State, Federal government, depending on national, state, and local significance of values protected
Enhancement of amenity value of inland water bodies	Local and wider community	Local, State, Federal government, depending on national, state, and local significance of values protected
Reuse opportunities	Reusers – might include MRCC, LMW, private landholders	Reusers

Note 1: For drains servicing new development, cost to be borne by landholders as part of basic drainage service.
Note 2: State responsibility as proposed works are addressing the impacts of intensive development. If works were addressing land clearing (legacy of history), costs and benefits would be shared between Victorian, South Australian, New South Wales and Commonwealth governments.

Available options for apportioning benefits include:

A. On the basis of the multi criteria analysis approach used to assess options, as described in Section 3.4.

B. On the basis of rigorous economic analyses.

C. By consensus between stakeholder groups.

Each of these options is discussed further below.

A. Multi Criteria Analysis

Benefits would be apportioned at three levels:

(a) between benefit criteria;
(b) between beneficiary groups; and
(c) within beneficiary groups.

(a) Between benefit criteria

Under this option, benefits would be apportioned between benefit criteria on the basis of the weighted benefit scores from Table 3-5. For Option G2 for example, the relevant benefits would be assessed as indicated in Table 4-2.

■ **Table 4-2 Example of assigning benefits (Disposal Option G2)**

Benefit	Weighting	Score	Weighted Score	Proportion of total benefit
Reduction in salt loads to River	17%	0.98	0.17	55%
Reduction in algal blooms in River	24%	0.20	0.05	16%
Environmental enhancement of inland water bodies	10%	0.64	0.06	19%
Enhancement of amenity value of inland water bodies	6%	0.58	0.03	10%
Reuse opportunities	9%	0.00	0.00	0%
TOTAL			**0.31**	**100%**

In cases where discrete works that form all or part of an option provide only one benefit, then the relevant beneficiaries should bear the total cost of those discrete works. For example, the costs associated with construction, operation and maintenance and replacement of a reuse storage that forms one part of an overall disposal option, should be borne by the reusers, irrespective of the costs and benefits associated with any other works. Therefore for Option C3, for example, the capital and ongoing costs of the reuse storage component of this option are $2.9 million capital and around $10,000 per year respectively and would be borne by the reusers.

It should be noted that in the case of reuse storages and similar standalone works for which there is only one beneficiary group, it will be necessary to demonstrate that there is a clear net economic benefit associated with these works. If this cannot be demonstrated, users will need some form of incentive to provide their cost share.

(b) Between beneficiary groups

A number of groups are listed in the right hand column of Table 4-1. Where more than one group is listed for a particular benefit, costs associated with individual benefits need to be equitably apportioned between each of these groups. This could be done in a number of ways.

Under the multi-criteria analysis method, it would be logical to apportion benefits on the basis of the relative importance assigned to benefit factor by that beneficiary, in accordance with Table 3-2.

(c) Within Beneficiary Groups

Benefits will also sometimes need to be apportioned within beneficiary groups. For example, where water users have been identified as benefiting from a reduction in algal blooms in the River, the benefits might be apportioned between the users in accordance with the average annual volume diverted from the River downstream of the relevant outfall location.

B. Rigorous Economic Analysis

Benefits could also be assigned on the basis of rigorous economic analysis, undertaken following completion of the strategy. One of the problems with this approach is that many of the benefits are relatively intangible, eg environmental enhancement, and do not readily lend themselves to rigorous economic analyses.

The issues identified in the Table 4-1 would be looked at in detail from an economic standpoint. An example is that of algal bloom economic analysis which may include:

- costing installation and operation of a temporary activated carbon plant to treat Lower Murray Water's River offtake;
- assessing the need for and cost of water carting, in cases where private diverters are unable to safely irrigate due to a bloom;
- recreation and tourism impacts;
- impacts on amenity value; and
- the reduction in annual probability of algal blooms due to implemented measures.

Due to the data limitations of the analysis, appropriate sensitivity testing needs to be completed before drawing conclusions on the results.

C. By Consensus between Stakeholders

Benefits could also be assigned by consensus between stakeholder groups. It is, however, often likely to be difficult to reach a consensus, given that each group will be keen to minimise its own cost share.

Recommendations

The Steering Committee and Reference Group resolved that methods for assigning benefits should not be recommended in the Draft Strategy. The difficulties associated with quantifying benefits were recognised. This particularly applies to benefits of nutrient reduction to downstream users.

4.4 Tariffs

Drainage tariffs need to cover all costs including capital, operating, maintenance, renewals, administration and loan servicing. Tariffs should specifically recognise costs associated with providing a drainage service.

Tariff options for urban and irrigation drainage are presented and discussed below.

4.4.1 Urban Drainage

As noted previously, urban drainage works have historically been funded by a combination of general rate revenue and developers' contributions.

To ensure that the general ratepayers do not meet the capital cost of providing headworks infrastructure for new urban subdivisions, it is strongly recommended that

Development Contribution Plans be prepared as soon as possible. This action will also ensure a flow of funds for construction of future major drainage works. The plans should set contribution rates on a catchment basis, to provide an equitable means of differentiating drainage costs between areas, particularly where pumping is required. Rates should ensure adequate capital funding for off-site drainage works. It should be noted that developers' contributions cannot be used to fund future operating or maintenance costs. It is understood (D Fitzgerald, pers comm) that Council has already started working with consultants to prepare Development Contribution Plans. Rates should make allowances for borrowing to fund capital works.

Operation, maintenance and replacement of the drainage system could be funded either from general rate revenue, or from a specific drainage rate. General rate revenue is based on property valuation, and does not provide an equitable means of charging for drainage service. If there is a move to charge a specific drainage rate, it is recommended that this be based on property area, which is a far more relevant measure of the relative contributions of properties to drainage.

The ongoing costs associated with provision of the drainage service will generally be significantly higher in catchments where pumped disposal is required, and this needs to be considered in developing drainage tariff options. Two options are available:

1. Average the additional costs over all ratepayers, such that there is no differential rating between gravity and pumped catchments.
2. Apply a differential drainage rate, such that ratepayers in pumped catchments pay a higher rate per unit area, than ratepayers in gravity catchments.

Option 1 is administratively simple, but not particularly equitable. Whilst Option 2 is equitable, it will inevitably result in neighbours paying very different drainage rates, which is likely to lead to disputes. The most equitable other option would be for future pumping costs to be incorporated into developers' contributions, such that future pumping costs become built into land prices. However, as noted above, this is not possible under existing legislation. Under these circumstances, Option 1 is considered the most appropriate alternative.

4.4.2 Irrigation Drainage

Irrigation drainage works within the three Irrigation Districts are funded from SRWA and FMIT rate revenue. Separate irrigation and drainage rates are levied by SRWA, and these have been adjusted in the current year to provide a truer reflection of the actual costs associated with irrigation supply and drainage. FMIT charges a 20% access fee and an 80% delivery fee, and doesn't differentiate between irrigation and drainage.

SRWA rates are based on water delivered, whereas FMIT rates are based on water entitlement.

Whilst the current tariff structure encourages irrigators to use less water, it doesn't provide any specific incentive for them to minimise drainage flows. This could best be achieved by basing the drainage tariff on actual drainage discharges from

individual properties, but this is unachievable due to the impracticality of metering individual discharges.

Drainage flow rates would be reduced by conversion of furrow irrigation to drip or overhead systems. The capital costs of conversion are however relatively high, and may be beyond the means of many landholders without some financial assistance. It is recommended that some consideration be given to introducing incentives for conversion to drip and overhead system. CoAG principles require that this is not cross- subsidised.

The most equitable means of rating for drainage would involve a two-part tariff system, and it is recommended that this be considered for implementation viz.:

- Service cost - a "fixed infrastructure access fee" to cover capital replacement, maintenance and administration. This should be a rate per hectare, as infrastructure is generally designed to cater for a fixed flow rate per unit area. The administration component would generally be relatively small and intended to cover preparation of rate notices and similar property related administrative items.

- An operational factor – an operational charge based on volume of water delivered per unit area. This should be on a stepped scale to encourage efficient irrigation infrastructure and practice. A certain minimum watering rate is generally required to ensure adequate leaching. Watering in excess of that rate is wasteful, and should be penalised by a higher rate per unit volume per unit area. The drainage tariff scale may need to vary across the irrigation area to account for different soil types.

  One possibility is a rate based on the equation

  R*S

  where:

  S is an area charge
  R is a normalisation factor equal to the ratio of water applied, to what should have been applied

  Eg, if 10 ML/ha was applied, but only 8 ML/ha was required by the crop after due allowance for leaching, then R would be 1.25.

If this method were adopted, some rationalisation would be required to ensure the authority didn't need to keep rigorous records of detailed crop types, soil types, etc.

It should be noted that, despite undulating terrain, there is currently relatively little pumped irrigation drainage in the Study Area. This has been achieved by installing very deep drains in some areas. Whilst this may have been economical when drainage was installed in the 1930s, it would certainly not be economical today. Therefore, when replacement of these drains becomes necessary, they will almost certainly be replaced by a system of relatively shallow collector drains, and outfall pump stations and rising mains.

Because there is relatively little pumped drainage at present, particularly in the SRWA systems, the current operational costs of the drainage system are relatively low. Therefore if a sliding scale drainage tariff was to be introduced now, it would probably be relatively ineffective in reducing water use and drainage flows, as the operational charge would be a relatively small proportion of the total charge. However, as gravity drains are replaced by pumped systems, operational costs will increase significantly, and the sliding scale tariff may then be expected to be more effective in reducing water use and drainage flows.

5. Institutional Arrangements

5.1 Existing Arrangements

Existing institutional arrangements were outlined in Issues Paper 1, "Background", (ref 2). They are briefly summarised in the following sections.

5.1.1 Urban and Irrigation Drainage

Mildura Rural City Council is responsible for providing and maintaining the urban drainage system. Council is also generally responsible for rural surface flooding at the scale of problem typically experienced in the Study Area. (Mallee CMA is responsible for addressing flooding from the Murray River.)

FMIT and SRWA are responsible for providing and maintaining the irrigation drainage systems in their respective Districts. There are a number of private drainage systems within the Districts, particularly in the western part of the Red Cliffs District.

Irrigated areas outside the Districts, most of which have some form of private drainage include:

- Private diverters, grouped into Yelta, Riverside, Old Mildura, Bruce Bend (part of which is drained by a community scheme, part is undrained, and part drains to the River), and miscellaneous others scattered through the Study Area.

- Areas supplied from the Merbein system including:
  - a new irrigation area between the western boundary of the District and Meridian Road. Ten percent of this area is required to be set aside for drainage disposal in accordance with the requirements of the Nyah to the South Australian Border Salinity Management Plan;
  - properties of the north side of the Calder Highway and Chaffey Avenue, draining to the floodplain; and
  - properties on the eastern side of McEdward Street draining to Lake Hawthorn.

- A recent irrigation area on the south west fringe of the Red Cliffs District, and supplied from the Red Cliffs system. Ten percent of this area is also required to set aside for drainage disposal in accordance with the requirements of the Nyah to the South Australian Border SMP.

5.1.2 Inland Water bodies

Water bodies on Private Land

Some water bodies are owned, managed and predominantly used by a single authority. These water bodies are on private land, and the management is the sole responsibility of the owning authority.

Water bodies on Crown Land

The Land Conservation Council's Final Recommendations of 1977 and 1989 included as follows:

- That the portions of areas considered necessary for drainage disposal within Crown allotments surrounding *Wargan Basins, Cardross Lakes* and the *South East Drainage Basin*, continue to be used as such, under the management of SR&WSC (now SRWA and G-MW). Remaining areas within these allotments should be managed by the then Department of Conservation, Forest and Lands, now NRE, or, in the case of Wargan Basins, consideration be given to their alienation.

At the present time, it is generally understood by informal agreement, that the discharging irrigation authority manages the waterbody below the waterline, and NRE undertakes management of the riparian zone. It is unclear whether "areas considered necessary for drainage disposal" have been clearly defined.

The Land Conservation Council's Recommendations also refer to wetlands on the wildlife reserve in the vicinity of Kings Billabong. The Recommendations state that *Kings Billabong* (and *Basin 12* and *Psyche Bend Lagoon*) be used:

(a) primarily to conserve native animals, and for public education and recreation where this does not conflict with the primary aim and that:
(b) the use of waterways and pump installations to supply irrigation water to Mildura continue
(c) in the southern part of the area, the disposal of saline drainage water continue to be permitted for the time being,

and that it be permanently reserved under Section 14 of the Land Act 1958 and managed by the Fisheries and Wildlife Division.

There is a lack of detail in agreements between NRE and FMIT/SRWA regarding management of these water bodies for water supply and drainage purposes.

The Wetland Operational Plan for Kings Billabong is currently being finalised. This should be referred to when making decisions on the management of the water body.

Mildura Merbein Groundwater Interception Scheme and Lake Hawthorn Drainage Diversion Scheme

The former Rural Water Corporation transferred responsibility of its assets to the various Rural Water Authorities in 1994. "The salinity mitigation and disposal works, including the land on which the works are situated, that are associated with the protection of water quality in the major waterways of the State and the River Murray, and comprising...Mildura-Merbein Seepage Interception works, including Lake Hawthorn Disposal Basins" were transferred to G-MW.

The *Wargan Basins* were set up as part of the Lake Hawthorn Scheme in the late 1960's (and as MMGIS in the 1970's) using State and/or Federal funds. The MDBC

has funded some upgrades to the MMGIS since 1990, but does not control or own this scheme. While portions of the land at Wargan Basins are Crown Land reserved for Water Supply Purposes, G-MW manages much of this land, with the remainder managed by NRE. To the extent that its statutory powers allow, G-MW owns and operates, the Mildura Merbein Groundwater Interception Scheme (interception pumps, pipelines, valves, fittings, Ranfurly East and West Pump Stations and embankment etc), the Lake Hawthorn Drainage Diversion Scheme (Pump Station, pipelines, valves, fittings) and the Wargan Basins (Basins 1, 2, 3, 4, pt 5, pump stations etc).

Lake Ranfurly land is owned by MRCC. Council also manages the land surrounding the Lake. When the Mildura-Merbein Groundwater Interception Scheme was originally constructed, the former Shire of Mildura and SR&WSC entered into an agreement regarding Lake Ranfurly, by exchange of letters dated January 1984. This agreement included as follows:

> *"2. The Commission shall have full control over:*
>
> *(a) the water in Lake Ranfurly up to and including the level EL 35.00 metres; and*
> (b) *existing and future discharges into and flows from the Lake.*
>
> *3. The Commission shall remove from the Lake the quantity of water which is pumped into it by the Commission and shall also remove any surplus flows generated by Commission works."*

The ownership and management details of *Lake Hawthorn* are complicated. FMIT is the registered proprietor for a large section of the water body, while SR&WSC (now G-MW) and College Lease have freehold title over a small portion. G-MW currently manages the water level and is clearly stated as having the right to remove water from the Lake. G-MW however has no statutory role in the "management" of the Lake. The right of FMIT to store and remove water is not clear. There is also a section of college lease land, however the rights of this landowner with regards to the water body are not known.

Funding for the Schemes is provided 75% by the Victorian irrigators along the Murray, and 25% by the partners to the Murray Darling Basin agreement.

5.2 Existing Issues

5.2.1 Urban and Irrigation Drainage

A clear management arrangement must be sought for assets where more than one body discharges drainage water to the same system, or those discharging water do not own the land or assets receiving the water. This issue will arise, for example, if Council discharges urban runoff to irrigation drains that have spare capacity due to conversion of land use from irrigation to urban. The Study Area is probably unique in Victoria with respect to the urban and subsurface irrigation drainage networks servicing the same geographical areas.

Responsibilities for the proposed urban subsurface drainage system need to be defined.

There is currently little or no institutional control over private irrigation drainage systems outside the declared irrigation Districts. Some of the physical problems identified as being associated with these systems, eg discharge to the floodplain, could be overcome by revised institutional arrangements.

5.2.2 Inland Water bodies

Water bodies on Private Land

The management and ownership details of these water bodies are clearly identified and there are no apparent issues.

Water bodies on Crown Land

Whilst it is generally understood by informal agreement, that the discharging irrigation authority manages the waterbody below the waterline, and NRE undertakes management of the riparian zone, it is not always clear what is meant by management in this sense, and for what purpose the water body is managed. It is also unclear whether "areas considered necessary for drainage disposal" have been clearly defined.

The wildlife reserve, including Kings Billabong, is managed by NRE (unlike the other basins that were intended to be managed by SR&WSC). This water body is however still used for water supply and drainage purposes. There is lack of detail in agreements between NRE and FMIT/SRWA regarding management of these water bodies for water supply and drainage purposes.

Mildura Merbein Groundwater Interception Scheme and Lake Hawthorn Drainage Diversion Scheme

There is a lack of record of formal agreements between the various water bodies.

- SRWA discharges to Lake Hawthorn, which is an FMIT basin. There appears to be no agreement on the volume, timing and quality of water discharged. Urban drainage will soon become a similar issue for MRCC.
- G-MW does not appear to have any agreement to operate levels in Lake Hawthorn.

G-MW pumps irrigation drainage and urban stormwater from Lakes Ranfurly and Hawthorn to Wargan Basins, without charging any fee to SRWA, FMIT or Council.

5.2.3 Overall Strategy and Coordination

There is no overall drainage strategy for the Study Area, and a lack of co-ordination between the various authorities with drainage related functions. The Drainage Task Force has taken on a role in developing a Strategy, however the Task Force has no legal standing, and limited future funding options.

5.3 Future Management Options

5.3.1 Urban and Irrigation Drainage

Parts of the following are the result of a review of Victorian Legislation that relates to sub-surface drainage and urban land, as occurs in the Mildura area. This is NOT a legal opinion and does not purport to be a legal opinion. It is a non-expert view of the legislation for discussion purposes.

Existing Legislative Arrangements

Relevant existing legislative arrangements for drainage in the Study Area are as follows:

- Mildura Rural City Council is responsible for provision of property and road drainage in accordance with Schedule 1 of the Local Government Act 1989; and
- FMIT and SRWA are responsible for provision of irrigation and drainage services within their respective districts in accordance with Part 11 of the Water Act 1989. Responsibilities include "to provide, manage and operate systems for the supply of water to irrigable lands and for the appropriate drainage and protection of those lands".

Deakin Project

The proposed Deakin Irrigation Project Feasibility Study (ref 9) recommended the establishment of a new authority, to be known as the Deakin Development Authority. The report notes that the Authority "may be established under an Act of Parliament." The proposed Authority would take over all functions currently performed by FMIT and SRWA under the Water Act, as well as playing a wider role in the development of the region. Although not making a firm recommendation, the report also raised the question as to whether the new Authority should also assume the functions of Lower Murray Water, in providing potable water, and wastewater management.

This new Act of Parliament could be an amendment to the Water Act or a new Act.

Objectives

As noted above, the existing management arrangements are inadequate with respect to, in particular, arrangements for discharge of urban stormwater to irrigation drainage systems, and vice versa. It is perhaps interesting to note the provisions of Clause 8 of the Mildura Irrigation and Water Trusts Act 1969, which relates to subdivision of land within the Trust's District for residential or other purposes. This requires a subdivision plan to be submitted for approval by the Trust, showing, amongst other things, any required drainage easements.

Other issues include lack of institutional arrangements for proposed urban subsurface drainage, and lack of institutional control over private drainage systems outside declared Irrigation Districts.

Revised institutional arrangements are therefore required. The objectives of these arrangements should be to:

- provide clear definition of roles and responsibilities of authority(s) with drainage functions in the Study Area, well understood by customers;
- include responsibilities for all types of drainage including urban, subsurface irrigation, subsurface urban, and rural surface, in all parts of the Study Area;
- include responsibilities for all relevant drainage functions including planning, design, operation, maintenance, and renewal;
- include an adequate mechanism for application of necessary relevant planning controls;
- include a mechanism for adequate interfacing with other relevant authorities on relevant issues including environmental management, salinity, groundwater, land management, flooding, and statutory planning;
- provide cost effective implementation;
- provide cost effective operation on an on-going basis.

Table 5-1 provides summary comment on each of these seven criteria for each option discussed below. Comment is also provided on mechanisms for equitable cost recovery.

Development of Options

The following options have been considered:

Working with existing arrangements

- Do-nothing.
- Establishment of formal arrangements between MRCC, FMIT and SRWA for disposal of urban drainage to irrigation drains, and, if necessary, vice versa.

Application of provisions of existing legislation

- Transfer of urban drainage functions to Lower Murray Water
- Community Drainage Scheme under the Water Act 1989.
- Waterway Management Authority with Regional Drainage functions under the Water Act 1989.
- Transfer of drainage functions of irrigation authorities to Council.
- Transfer of urban drainage functions, and (where relevant) irrigation drainage functions, to existing authority other than Council (SRWA, FMIT, or CMA)
- Transfer of urban drainage functions, and irrigation drainage functions, to new Authority

Whilst not institutional options, there are also two provisions of legislation that might potentially assist the process:

- Water Management Scheme under the Water Act 1989.
- Special Area Plan under the Catchment and Land Protection Act 1994.

Within each of these options are various possibilities for management of drainage by:

- Multiple existing authorities (as existing), with different authorities having control of different types of drainage and/or in different areas;
- One existing authority; or
- One new authority.

The number of drainage authorities required, whether they are existing or new authorities, and who these authorities might be, are summarised for each option in Table 5-1. Brief comment on each of the proposed options is provided below.

Working with existing arrangements

Do-nothing

The do-nothing option is considered unacceptable, and is included for completeness only. The current arrangements for capacity sharing between urban and irrigation drainage systems have not been formalised, and there are no institutional arrangements for urban subsurface drainage. There is lack of vision and focus on drainage issues, and related cooperation and resource sharing is also lacking. This is leading to short-term, ad hoc rather than integrated, long-term and sustainable solutions being implemented.

■ Table 5-1 Assessment of Institutional Options

Option	Authorities			Assessment Criteria							Other
	Number of	Existing (E) or New (N)	Authority(s)	Clearly Defined Roles	All Types of Drainage	All Drainage Functions	Planning Controls	Interfacing with other Authorities	Cost Effective Implement'n	Cost Effective Operation	Equitable Cost Recovery
Work with Existing Arrangements											
Do nothing	3	E	MRCC, FMIT, SRWA	Subsurface urban, particularly redundant, not defined	Urban Subsurface not defined. Unsatisfactory for redundant subsurface drainage	Distributed across three authorities.	Reasonable mechanisms	Reasonable mechanisms	Simple - as existing	Simple – as existing	No provision for recovery of costs for discharge of urban drainage to subsurface system, and vice versa
More formalised capacity sharing, disposal arrangements, interface guidelines	3	E	MRCC, FMIT, SRWA	Continuing problem with redundant subsurface drains	Redundant subsurface likely to remain a problem.	Would continue to be distributed across three authorities	Reasonable mechanisms	Reasonable mechanisms	Relatively simple	Relatively simple, depending on cost recovery arrangements	Difficulties in defining equitable capacity share or other similar arrangements
Work with Existing Legislation											
Transfer of urban drainage functions to Lower Murray Water	3	E	LMWA, FMIT, SRWA	Subsurface urban, particularly redundant, not defined	Subsurface urban and redundant subsurface not well defined	Would continue to be distributed across three authorities	Reasonable mechanisms	Reasonable mechanisms	Moderate	Moderate	Remaining problems with recovery of costs for discharge of urban drainage to subsurface system, and vice versa
Community drainage scheme (Water Act 1989)	1	E	Committee or any Authority under the Water Act	Act is broadly enabling	Permitted under the Act	Permitted under the Act	Not mentioned in this section of the Act	Not specifically mentioned in this section of the Act	Difficult, requires community agreement registered on Title	Act allows for functions and powers to be transferred to a Council or other Authority.	Permitted under the Act

Option	Authorities			Assessment Criteria							Other
	Number of	Existing (E) or New (N)	Authority(s)	Clearly Defined Roles	All Types of Drainage	All Drainage Functions	Planning Controls	Interfacing with other Authorities	Cost Effective Implement'n	Cost Effective Operation	Equitable Cost Recovery
Waterway management authority with regional drainage functions (Water Act 1989)	1	E	Any Authority under the Water Act, except Council	Act is broadly enabling	Act is broadly enabling	Permitted under the Act	Requires formation of catchment co-ordination groups, which should include Council	Requires formation of catchment co-ordination groups	Would depend on which existing Authority took it over.	Would depend on which existing Authority took it over.	Permitted under the Act
Transfer of irrigation authority's drainage functions to Council	1	E	MRCC	Act is broadly enabling	Act is broadly enabling	Permitted under the Act	Council is the planning authority	Not specifically mentioned in this section of the Act	Relatively easy	Relatively easy	Permitted under the Act
Transfer of all drainage functions to existing authority (other than Council)	1	E	FMIT, or SRWA, or LMWA, or MCMA	Act is broadly enabling	Act is broadly enabling	Permitted under the Act	Water Act non-specific for Irrigation drainage.	Water Act non specific for irrigation drainage	Moderate	Moderate	Permitted under the Act
Transfer all drainage functions to new authority	1	N	New authority	Act is broadly enabling	Act is broadly enabling	Permitted under the Act	Water Act non-specific for Irrigation drainage.	Water Act non-specific for Irrigation drainage.	Moderate to difficult	Moderate to difficult	Permitted under the Act
Other Legislative Provisions (could be used in conjunction with some other options)											
Water management scheme (Water Act 1989)	1	E	Any Authority under the Water Act	Act enables wide range of roles	Permitted under the Act	Permitted under the Act	Planning and Environment Act referred to in this Section of the Water Act	Mentioned in this section of the Act	Requires investigation by community committee	Local Government Act allows for Council to operate the Scheme	Permitted under the Act
Special area plan (Catchment and Land Protection Act 1989)	3	E	MCMA takes a coordinating role. Act broadly enabling otherwise	Act is enabling. More focussed on land management	Act is enabling for land management coordinating functions	Act is broadly enabling for land management coordinating functions	CMA can recommend changes to the Planning Scheme	Land managers required to take plan into account	Relatively easy	Relatively easy	Permitted under the Act

Do-nothing with formalised arrangements for drainage capacity sharing

Under this option, Council, FMIT and SRWA would retain responsibilities for urban and irrigation drainage respectively. Formal arrangements would be established between, in particular, FMIT and Council, for capacity sharing of each other's drainage assets. This would most likely comprise a fixed annual service fee.

The responsibility for subsurface urban drainage, if required, would need to be assigned. It would seem most logical that Council assume this responsibility, as part of its overall urban drainage responsibility.

Application of provisions of existing legislation

Section 98 (1) of the Water Act 1989 enables the Minister to transfer "any part or the whole of the property, rights, liabilities, obligations, powers and functions under this Act of one or more Authorities, and any staff of those Authorities …. in any way that the Minister thinks fit", to a council, catchment management authority, or any existing or new Authority under the Act.

It is assumed that there is nothing in legislation to prevent transfer of urban drainage works, powers and functions from Councils to another Authority. The drainage functions of Councils are listed in Schedule 1 of the Local Government Act 1989, in the same phrase as water, sewerage, gas and electricity. As most Councils don't hold any of these latter four functions, it would not seem unreasonable to assume that Councils aren't compelled to hold drainage functions either. Section 98 (3) of the Water Act 1989 allows the Minister to transfer works used by Council in performing its functions under any other Act (eg the Local Government Act) to another Authority under the Act, but makes no reference to transfer of powers or functions. It may be necessary to obtain a legal opinion on this issue.

Transfer of urban drainage functions to Lower Murray Water

Lower Murray Water is responsible for provision of potable water and wastewater services in urban parts of the Study Area. These services, together with a local drainage service, are generally provided at the time of development. However lack of coordinated drainage outfalls has often resulted in development proceeding without a comprehensive drainage outfall system. Because these three services are generally required to be established in developing areas at the same time, there may be some advantage in Lower Murray Water also assuming responsibility for urban drainage.

Community Drainage Scheme under the Water Act 1989

Sections 244 to 246 enable a group of landholders to voluntarily establish "a community drainage or salinity mitigation scheme to combat drainage or salinity problems in their area". The Act requires the community agreement to be capable of being registered under the Transfer of Land Act 1958, and is thus binding on successors in title. Because this is a significant process, community drainage schemes have generally only been established in rural areas, where the number of landholders

is relatively small. The use of this legislation is purely voluntary and requires 100% cooperation of all those rated, over the duration of the agreement. It is not considered practical in a large area including significant numbers of both rural and urban landholders.

Waterway Management Authority with Regional Drainage functions under the Water Act 1989

Part 10 of the Act relates to waterway management. The Minister may establish waterway management districts, and then assign waterway management functions within that district, to a new or existing authority (other than a Council) under the Act. The Minister can also assign:

- regional drainage; and/or
- floodplain management,

functions within the district to the assigned waterway management authority.

The Minister is also able to delegate his floodplain management functions under the Act, in areas outside declared waterway management districts, to another Authority.

The Nangiloc Colignan drainage area, immediately to the south of the Study Area, is a declared waterway management district. SRWA is the waterway management authority for that district. Regional drainage functions have not been assigned to the district.

It is interesting to note that seven of the nine catchment management authorities in Victoria have had waterway management districts declared across their entire jurisdictions. The two exceptions are Mallee and Wimmera, although the Minister has delegated her floodplain management functions to these CMAs across their respective areas. It is considered likely that Mallee and Wimmera will eventually be declared waterway management districts in line with the other seven CMAs. This is complicated by the existence of the Nangiloc Colignan waterway management district, as it is not possible to have two waterway management districts, covering the same area. Two options appear to be available to resolve this:

- the CMA takes over waterway management responsibilities in Nangiloc Colignan from SRWA; or
- the Mallee waterway management district includes the entire CMA area except for Nangiloc Colignan.

It appears possible under the Act to declare the entire Study Area to be a waterway management district, and to then assign waterway management and regional drainage functions to an Authority across this district. However it is considered unlikely that this would be acceptable to the Minister, given the likely intention to eventually declare a waterway management district covering the entire Mallee CMA area.

CMAs have generally been reluctant to assume responsibility for operating and managing drainage systems. Reasons for this include:

- need to assume responsibility for aging infrastructure. Although a due diligence assessment is usually undertaken prior to transfer, and assets are either updated, or suitable financial arrangements made, aging drainage systems are still often perceived as problematic;
- need to rate for provision of a drainage service; and
- lack of necessary personnel and equipment.

CMAs' roles have, however, sometimes included overview of the downstream water quality impacts of drainage discharges.

Transfer of drainage functions of irrigation authorities to Council.

Section 98 (1) of the Water Act enables a council take over the irrigation drainage functions of the two irrigation authorities.

Transfer of urban drainage functions, and (where relevant) irrigation drainage functions, to existing authority other than Council (SRWA, FMIT, or CMA)

All drainage functions under the Water Act could be taken over by an existing Authority under that Act. As discussed above, it is assumed that the urban drainage functions of Councils could also be taken over by an Authority under the Water Act. Relevant authorities would include CMA, LMW, SRWA, or FMIT. Lower Murray Water has no current drainage functions, and no functions at all in rural areas. The option of LMW assuming all drainage functions is not therefore considered further.

Transfer of urban drainage functions, and irrigation drainage functions, to new Authority

Similarly, a new Authority could take over responsibility for all types of drainage.

Other Legislative Provisions

Water Management Scheme under the Water Act 1989

Division 5 of Part 10 of the Act relates to "Water Management Schemes". The Minister's functions under this Division include "to cause schemes for the improved management of waterways, drainage and floodplains to be prepared and implemented". Investigation of water management schemes requires establishment of a committee, at least half of who are owners or occupiers of land within the area under investigation.

The provisions are more intended to provide a mechanism for investigation. Approved schemes still need to be managed by Authorities with appropriate powers and functions.

Section 201 of the Local Government Act 1989 specifically enables Councils to "construct, operate, control, manage or maintain any works or undertakings which

form the whole or part of a scheme declared to be an approved (water management) scheme under section 216 of the Water Act 1989."

The Act enables the Authority responsible for the scheme to collect tariffs from benefiting landholders, and to require contributions from other Authorities or Councils, on a wide range of bases.

The Act requires the Authority responsible for an approved scheme to:

- notify "all responsible authorities under the Planning and Environment Act 1987, that are likely to be affected by the scheme"; and
- the responsible authorities "must, in relation to any planning scheme, have regard to the provisions of the approved scheme".

It may be advantageous to use these provisions in conjunction with the proposed institutional option. The main advantage would be to emphasise the new role of an existing authority, and thus possibly soften the impact of any new rates or tariffs.

Special Area Plan under Catchment and Land Protection Act 1994

Division 2 of Part 4 of the Catchment and Land Protection Act 1994 enables the CMA to recommend to the Minister that land in its region, be declared a special area having regard for "how the existing or potential use of that land may adversely affect the quality and condition of land, or … aquifer recharge areas or aquifer discharge areas".

Whilst the provisions might enable the CMA to take a more active role in integrated drainage management, drainage functions would remain with the three authorities with existing drainage functions. There would then be an opportunity to incorporate the Drainage Strategy into the CMA's Regional Catchment Strategy, and thus provide an avenue for NAP and other funding (see also Section 4.2.2).

Assessment of Options

Based on the above, the following options are considered worthy of further assessment:

A. *Do-nothing with formalised arrangements for drainage capacity sharing*
B. *Transfer of urban drainage functions to Lower Murray Water*
C. *Transfer of drainage functions of irrigation authorities to Council*
D. *Transfer of urban drainage functions, and (where relevant) irrigation drainage functions, to existing authority other than Council (SRWA, FMIT, or CMA)*
E. *Transfer of urban drainage functions, and irrigation drainage functions, to new Authority*

Before considering these further, it is perhaps worth considering the advantages and disadvantages of:

- Single drainage Authority (Options C, D and E), relative to multiple drainage Authorities (Options A and B); and

- Existing Authority (Options A to D) relative to a new Authority (Option E).

Advantages of a single drainage authority:

- Co-ordination of all types of drainage, including urban subsurface drainage functions, if required;
- Integrated resource utilisation;
- Ease of planning;
- Ease of asset management;
- Ability to assume responsibility for redundant infrastructure;
- Less difficulties with discharging urban drainage to irrigation drains, and vice versa;
- Ease of understanding by community and customers in longer term, viz one stop shop.

Advantages of multiple drainage authorities:

- Retention of links between irrigation, and irrigation drainage functions;
- Lesser implementation costs;
- Lesser asset transfer costs and associated issues;
- Less disruption and stress to staff and community.

Advantages of an existing authority:

- Less confusing. There is a possible community perception that there are already too many authorities in the Study Area.
- Lesser establishment costs.

Advantages of a new drainage authority:

- Strong focus on drainage, if this is the Authority's only function;
- Rationalisation of assets.

Recommendations

It considered vital that the links between irrigation and irrigation drainage be retained.

The issues associated with coexisting urban and irrigation drainage infrastructure could be adequately overcome by formalised agreements between FMIT and Council. Responsibility for urban subsurface drainage could be assumed by an existing authority.

Lack of institutional control over private irrigation drainage systems outside the Irrigation Districts, could be overcome by the assigning responsibility for these systems to the existing irrigation authorities.

Wholesale institutional change is not therefore considered necessary, and the following institutional changes/assignments are recommended:

- responsibility for subdivision scale urban subsurface drainage should be assumed by Council. Responsibility for larger scale works should be rationalised between Council and FMIT using the principles outlined below;
- ownership and management of irrigation drains in urban areas should be rationalised between FMIT and Council. This is discussed further below. Responsibility interfaces , viz physical locations in the drainage system, should be clearly defined, and regularly reviewed. Likely future maintenance requirements should be equitably accounted for in any asset transfer arrangements;
- in cases where irrigation drainage discharges to a subsurface drain for which ownership has been transferred to Council, or where urban drainage (generally subsurface) discharges to a drain owned by FMIT, infrastructure use fees should be payable by the discharging authority to the owning authority. This fee should be based on a rate per hectare. Existing drainage standards should be maintained for current users;
- responsibility for private irrigation drainage systems outside the Irrigation Districts should be investigated further. This responsibility could, if necessary, be assumed by the adjacent irrigation authority. The Old Mildura area lies between the Merbein and Mildura Districts. It already has some association with SRWA as the diversion licensee, and responsibility for irrigation drainage in that area could therefore be assumed by SRWA;

A number of factors need to be taken into account in rationalising ownership of existing subsurface irrigation drains between Council and FMIT. The capacity of these drains will generally only be sufficient to cater for urban subsurface drainage. Peak design storm flows from urban catchments will generally far exceed available capacity, with the occasional minor exception of initial urban development in a large subsurface drainage catchment. Factors to be accounted for in rationalising ownership will then include:

- relative proportion of irrigation and urban land use;
- identifiability of interface point. Interface points should be clearly identifiable physical locations, such as junction pits;
- location of drain relative to Irrigation District boundary. Segments of drain that lie within an urban area might be better owned and managed by Council, even if the catchment in predominantly irrigated. Rural discharge could then continue by agreement;
- number of interface points. This should be minimised where practical.

5.3.2 Inland Water bodies

Waterbodies on Private Land

There are no issues to resolve. Ownership of land assets should remain with individual authorities.

Waterbodies on Crown Land

More detail is required in agreements between NRE and SRWA / FMIT regarding uses of Kings Billabong and Basin 12 as water supply and drainage basins.

Ownership of land assets should remain with individual authorities, with access managed by way of agreements.

The obligations of the managers of each water body should be clearly defined and formalised, on a case by case basis.

Mildura Merbein Groundwater Interception Scheme and Lake Hawthorn Drainage Diversion Scheme

It is important that there is a clear understanding of the current arrangements. The gaps in the current understanding appear to be:

- management of levels in Lake Hawthorn;
- understanding between adjacent landowners and Council regarding use of Lake Ranfurly; and
- formal agreements on discharge rights to Lake Hawthorn.

These "gaps" should be addressed and appropriate arrangements put in place.

The other questions to be addressed are:

- which authority(s) should own and manage the water bodies in the future; and
- how to equitably recover irrigation and urban drainage related costs associated with operation of the schemes.

There would not appear to be any pressing reasons for the schemes to be operated by authorities other than G-MW. G-MW already has the necessary plant and equipment, and personnel with the necessary understanding and experience in operating the system. The advantage of keeping the current situation in place is that it is easy to implement, and requires few institutional changes. This does however still require many agreements between many different authorities, making arrangements and management complicated.

There would also appear to be no pressing reasons for transferring land ownership from existing authorities to G-MW. Arrangements would however need to be established between G-MW, and FMIT, SRWA and the Department Education (College Lease Land), regarding implications of water body management on freehold land.

It is recommended that G-MW recover the proportion of scheme operating costs that can be assigned to urban and irrigation drainage, from Council, FMIT and SRWA. This is further reason for assigning responsibility for private diverter drainage to the Irrigation Authorities. Fees should be proportional to actual annual volumes of drainage water discharged to Lakes Hawthorn and Ranfurly. This will require metering of most major drainage outfalls.

5.3.3 Overall Strategy and Coordination

- It is recommended that an agreed coordinating group be appointed to provide the lead role in implementation, management and monitoring of the Strategy.

One possible option would be to declare a Special Area Plan for drainage, across the Study Area, under the provisions of the Catchment and Land Protection Act 1994.

The Task Force could continue to play a lead role in implementing the Strategy in the short term, with a view to transferring this responsibility to the new coordinating group as soon as practicable. It is recommended that the Mallee CMA assists the Task Force/new coordinating group in sourcing appropriate funding for coordination of the Strategy.

The proposed relationships between the Strategy and other relevant planning and strategy documents is shown on Figure 5-1 and Figure 5-2.

Whilst some indication of the potential impacts of the Strategy on a range of water bodies was presented in Section 3.5.2, further detailed investigations may be undertaken under the auspices of the wetland operational plans. The concept of wetland operational plan should be applied to all major water bodies relevant to the drainage network (these may be called drainage basins operational plans where the prime purpose is drainage disposal).

Figure 5-1 Relationships between Sunraysia Drainage Strategy and other relevant Planning and Strategy Documents, Part 1

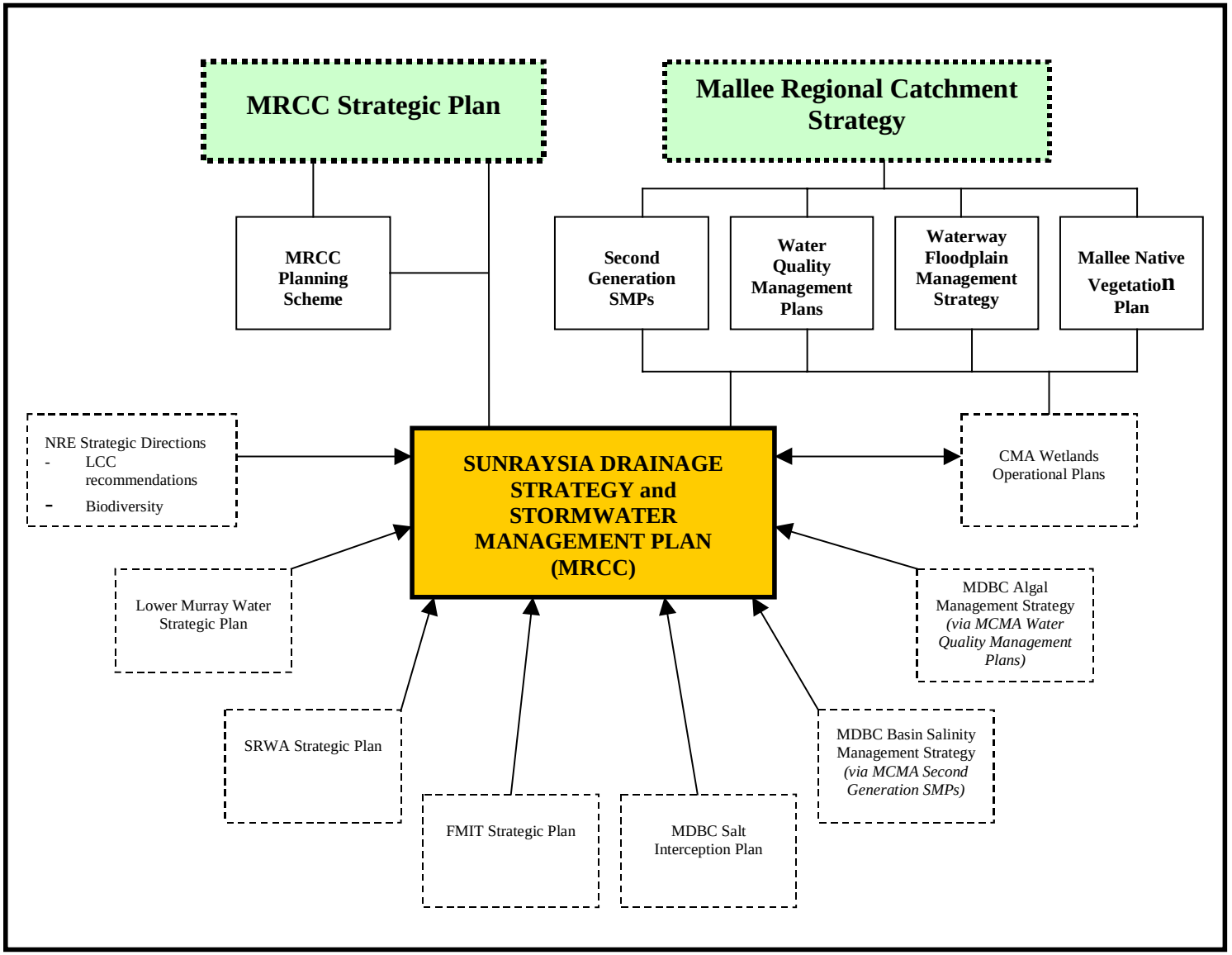
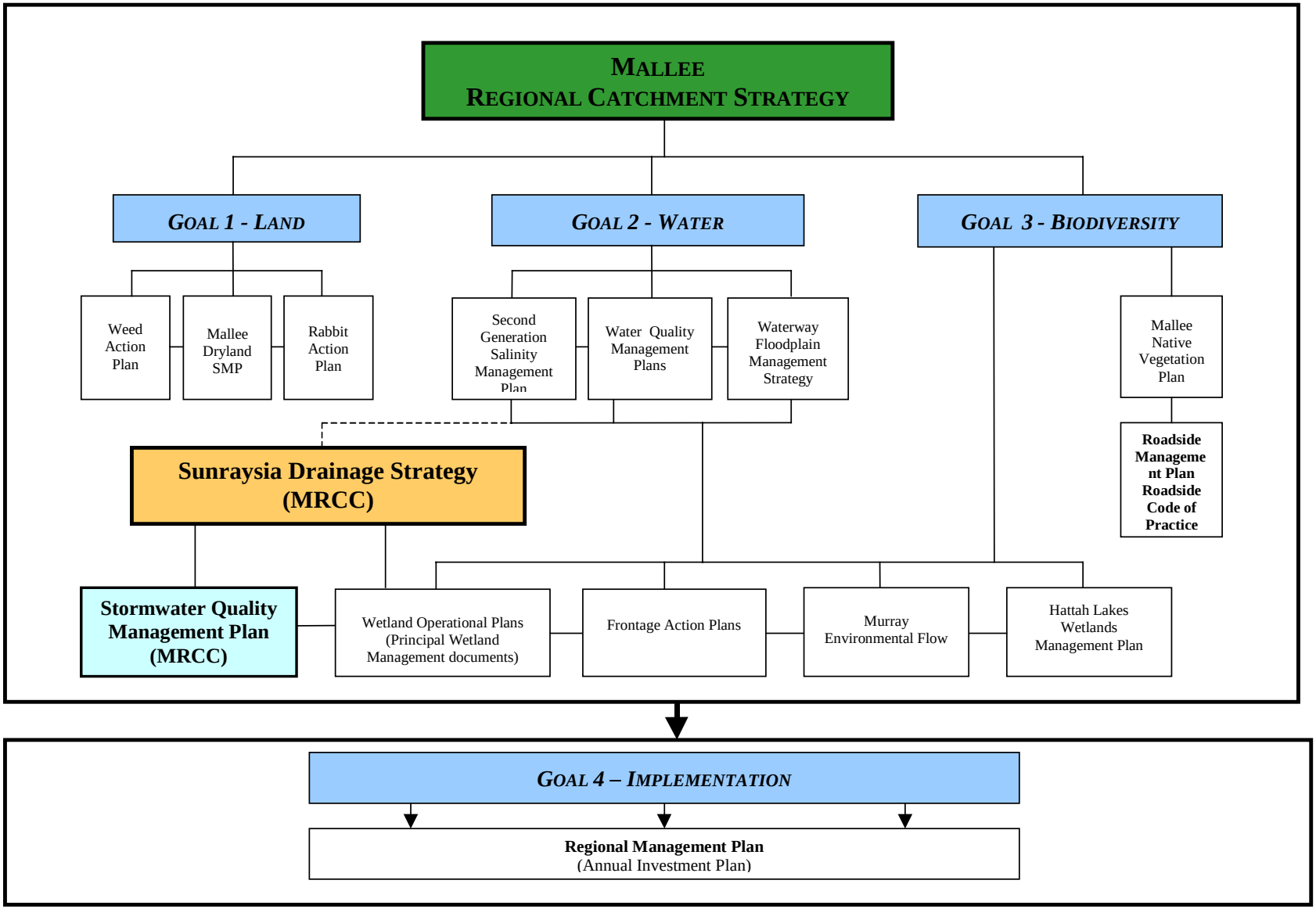


Figure 5-2 Relationships between Sunraysia Drainage Strategy and other relevant Planning and Strategy Documents, Part 2



6. Implementation and Monitoring

6.1 Implementation

Likely types of and specific implementation measures will include as follows.

6.1.1 Financial

- Completion and implementation of Development Contribution Plans to enable adequate funding of off-site drainage works.
- Further researching of measures required for accessing of external funds for construction of major recommended works that are unrelated to urban development and which can thus proceed immediately, eg diversion of drainage shafts to Wargan Basins, diversion of Red Cliffs Catchment 1 back to Cardross Lakes.

6.1.2 Physical and Planning

- Reservation of appropriately located land for drainage basins required for planned urban development, particularly in the Irymple Basin.
- Reservation of easements for rising mains and gravity trunk drains required to service planned urban development. This should be undertaken in consultation with Lower Murray Water and other relevant supply authorities, to minimise overall easement requirements.
- Liaison with Council to plan for release of land for urban development, as far as practical and within the constraints of the Planning Scheme, on a subcatchment basis. The aim of this will be to minimise the lead times between construction of major infrastructure, and development of land to be serviced by that infrastructure.
- Ongoing liaison with other groups to ensure consistency of major works components of the strategy with other relevant strategies, including, for example, the updated Mallee Regional Catchment Strategy, and the Second Generation Salinity Management Plan.
- Planning, additional studies, design and construction of major works unrelated to urban development.

6.1.3 Institutional

- Agreement amongst stakeholders regarding preferred institutional arrangements. It is acknowledged that this may take some time, and require significant consultation beyond Steering Committee level.

- Assuming the recommendations presented in Section 5 are accepted and adopted, other implementation activities will include rationalisation of ownership and management of subsurface irrigation drains in and around urban areas, between Council and FMIT.
-
- Clarification, further detailing, and establishment, where required, of agreements between authorities regarding management of drainage, including

- arrangements between G-MW, and FMIT, SRWA, Council and Department of Education for management of the Mildura Merbein Groundwater Interception Scheme, and Lake Hawthorn Drainage Diversion Scheme;
- agreements between NRE, and FMIT/SRWA regarding use of Kings Billabong and Basin 12 as water supply and drainage basins;
- agreements between Council and FMIT for discharge of drainage to existing subsurface drains.

6.2 Monitoring

6.2.1 Institutional

It is recommended that the new coordinating group, with the assistance of the Mallee CMA, regularly monitors and reviews the Strategy to:

- assess progress in implementing the Strategy relative to agreed timetable;
- monitor success of implemented measures. Key performance indicators should be established at the outset; and
- if necessary, amend the Strategy in accordance with outcomes of reviews.

6.2.2 Physical

Monitoring of the quality and quantity of water in drains and receiving water should aim to:

- establish long term trends in flows per unit area, nutrient loads and salt loads in major drains, and whether these are in accordance with assumptions used in preparing the strategy. This will need to be taken into account in periodical reviews of the strategy;

- establish long term trends in levels, salinity and nutrient concentrations in key receiving waters, particularly Lake Hawthorn, Cardross Lakes, Kings Billabong, and Lake Ranfurly. This will again confirm whether these are consistent with assumptions used in preparing the strategy. More frequent monitoring will also be required to establish need to purchase water to top up and dilute waterbodies with high environmental and amenity values, or where possible to amend operating rules;

- establish effectiveness of wetlands in removing nutrients. If wetlands are not as effective as expected, it will be necessary to establish possible reasons for this. These might include inadequate maintenance, short circuiting, higher than expected inflow loadings. Remedial measures might include improved maintenance, or capital modifications;

- establish urban and irrigation drainage flows to Lakes Hawthorn and Ranfurly, to enable G-MW to equitably charge relevant authorities for operation of relevant proportions of the Mildura Merbein Groundwater Interception Scheme, and Lake Hawthorn Drainage Diversion Scheme.

7. Draft Strategy Outline

A broad proposed outline of the Draft Strategy is presented below.

VOLUME 1 – DRAFT STRATEGY

Executive Summary

- No more than 10 pages. Able to be read as a standalone document.

1. Introduction and background

- Brief history and background to the project.
- Reference to the Steering Committee, Working Group and SKM.
- Note concurrent USWQMP.
- Reference to Current Situation Report and Issues papers.

Part A – Current Situation

2. The Study Area

- Brief description of Study Area.
- Urban areas
- Irrigation districts
- Private diverters
- Summary of areas of urban and irrigation development, and areas of different types of horticulture and irrigation

3. Existing drainage system

- Broad descriptions of urban and irrigation systems and disposal sites
- Note general lack of formal rural surface drainage
- Comment on current standard of service

4. Economic, social and environmental values and impacts

- Reference to and summary of values documented in USWQMP
- Current quantity and quality of outfall waters, and impacts of drainage

5. Existing drainage management and cost recovery framework

- Current roles and responsibilities
- Current ownership and management arrangements
- Current cost recovery frameworks for urban and irrigation drainage systems

6. Existing issues

- Summary of existing issues (Issues Paper 1 and Current Situation Report), subdivided into physical (quantity/quality), management/institutional.

Part B – Future arrangements

2. Year 2050 development scenario

   - Summarise logic used to develop scenario, and present outcome (map)

3. Standard of service

   - Summarise issues and risk
   - Present adopted standards

4. Drainage management options

   - Summarise disposal options that have been investigated
   - Summarise adopted assessment methodology, and application
   - Summarise recommended disposal measures
   - Summarise other works required to achieve standard of service (viz basins, trunk drains, etc)

5. Institutional arrangements

   - Summarise main existing issues
   - State objectives
   - Summarise options investigated
   - Present recommended option

6. Cost sharing and tariffs

   - State cost sharing principles
   - Summarise benefits and beneficiaries
   - Summarise cost sharing options investigated
   - Present recommended cost sharing option
   - Tariff principles and options, including developer contributions

7. Implementation and monitoring

   - Strategy implementation
   - Staging of required works
   - Monitoring and review of strategy
   - Required objectives of water quality and quantity monitoring

8. Further investigations

References

Appendix A Steering Committee, Reference Group and Project Working Group membership

VOLUME 2 – SUPPORTING DOCUMENTATION

Current Situation Report

Issues Paper 1 – Background Information

Issues Paper 3 – 2050 Scenario

Issues Paper 5 – Scope Drainage Management Options

Issues Paper 7 – Drainage Management Options Assessment

Surface Catchment Plans

8. References

1. Sinclair Knight Merz (2001), "Sunraysia Drainage Strategy and Urban Stormwater Management Plan, Issues Paper No 5, Scope Management Options", draft 1, prepared for Mildura Rural City Council, August 2001.

2. Sinclair Knight Merz (2001), "Sunraysia Drainage Strategy and Urban Stormwater Management Plan, Issues Paper No 1, Background", draft 1, prepared for Mildura Rural City Council, June 2001.

3. Kinhill (1998), "Mildura Rural City Council, Final Stormwater Strategy Report", April 1998.

4. Sinclair Knight Merz (2001), "Sunraysia Drainage Strategy and Urban Stormwater Management Plan, Issues Paper No 3, 2050 Scenario", draft 1, prepared for Mildura Rural City Council, July 2001.

5. Mildura Rural City Council (2001), "Sunraysia Drainage Strategy 2000, Stage 1, Current Situation Report", April 2001, Final Report.

6. Sinclair Knight Merz (1998), "Sunraysia Salinity Management Plan Implementation Group, S154, Sunraysia Technical Support: Evaporation Basin Risk Assessment, Sunraysia Region Evaporation Disposal Basins Risk Assessment".

7. Sunrise (1997), "Merbein Integrated Development Scheme Feasibility Study and Cost Benefit Analysis", PJ Hallowes and Associates, in association with Gutteridge Haskins and Davey.

8. Sinclair Knight Merz (2001), "Report on REALM Modelling", for Mildura Merbein Sustainability Study for Goulburn Murray Water, Draft B.

9. Deakin Irrigation Development Committee (2001), Feasibility Study", Final Report, May 2001, SMEC.

10. Victorian Government (2001), "Regional Infrastructure Development Fund, Guidelines".

11. AFFA (2001), website reference affa.gov.au.

12. Sinclair Knight Merz (2001), "A Management Plan for the Improvement of Urban Stormwater Quality for the Mildura Rural City Council, Volume 2, Draft", prepared for Mildura Rural City Council, September 2001.

13. Mallee Catchment Management Authority (2000), "Water Quality Management Plan, Investigation Report", August 2000.

14. Cardross Lakes Task Group (1997), "Management Plan for the Cardross Lakes System and the Associated Fish Assemblage", by Water ECOscience Pty Ltd, December 1997.

15. NRE (2001), “Sustainable Water Resource Management and Irrigation Farm Dams”, www.nre.vic.gov.au, last updated 26/7/2001.

16. Farm Dams (Irrigation) Review Committee (2001). Final Report, April 2001.

17. Sinclair Knight Merz (1996), “Kings Billabong Historical Seepage and Evaporation Loss Estimates”, FMIT, November 1996.

18. Nyah to the South Australian Border Community Salinity Group (1992), "Draft Salinity Management Plan from Nyah to the South Australian Border", May 1992.

Appendix A Legislation

Excerpts from relevant legislation are presented in the following sections. All legislation has been sourced from www.dms.dpc.vic.gov.au.

LOCAL GOVERNMENT ACT 1989

8. Functions and powers

(1) A Council has the following functions--
(a) the functions specified in Schedule 1;

200. Drainage of land

(1) A Council may give the owner or occupier of any building or land a notice requiring that person to carry out any work for the
drainage of a building or of surface or storm water on any land.
(2) If the owner or occupier of the building or land does not carry out the work to the satisfaction of the Council, the Council may
carry out the work.

201. Approved schemes

S. 201(1) amended by Nos 81/1989 s. 3(Sch. item 30.3), 125/1993 s. 37(1)(a).

(1) A Council may construct, operate, control, manage or maintain any works or undertakings which form the whole or part of a
scheme declared to be an approved scheme under section 216 of the Water Act 1989.

SCHEDULE 1

FUNCTIONS OF COUNCILS

The functions of Councils include the following:

4. Property services including--

(1) Water, drainage, sewerage, gas and electricity;

6. Roads including—

(4) Lighting and drainage of roads;

MILDURA IRRIGATION AND WATER TRUSTS ACT 1969

8. New section 35E substituted in Principal Act For section 35E of the Principal Act there shall be substituted the following section--

'35E. Conditions of subdivision of land

(1) No person shall subdivide into separate holdings any land within the First Mildura Irrigation District except in accordance with a
plan of subdivision sealed by the Trust under this section.
(2) A person (hereinafter referred to as "the applicant") who intends to subdivide into separate holdings any land in the district shall
submit to the Trust notice in writing of his intention together with a plan showing--
(a) the allotments into which it is proposed to subdivide the land;
(b) the easements proposed to be provided in connection with the supply of water for irrigation to or the drainage of water
from each allotment or, in the case of allotments intended to be occupied for residential or commercial purposes, in
connection with the supply of water to or the drainage of water from each allotment.
(3) On receipt of the notice and plan the Trust shall (having first referred the plan to the Mildura Urban Water Trust for advice in
the case of any plan showing allotments intended to be occupied for residential or commercial purposes) notify the applicant of--
(a) any modification required by the Trust to be made in the plan; (b) the nature and extent of all works which will be
necessary to be constructed (whether by the Trust or, where it appears that the land or any part thereof will come to form
part of the Mildura Urban Water District, by the Mildura Urban Water Trust) for the supply of water to each allotment and
the measurement of water so supplied, for the drainage of water from each allotment and for the provision of access to or
within such allotment by means of a crossing or other suitable structure;

WATER ACT 1989

PART 1 - PRELIMINARIES

"Authority" means any person empowered to carry out any function under this Act in relation to--

(a) floodplain management; or
(b) irrigation; or
(c) regional drainage; or
(d) sewerage; or
(e) waterway management; or
(f) water supply--

and includes the Authorities listed in column 1 of Schedule 12, a council appointed under section 98(1)(a) and a Catchment Management
Authority appointed under section 98(1)(ab);

"bore" means any bore, well or excavation or any artificially constructed or improved underground cavity used or to be used for the
purpose of--

(a) the interception, collection, storage or extraction of groundwater; or
(b) groundwater observation or the collection of data concerning groundwater; or
(c) the drainage or desalination of any land; or
(d) in the case of a bore that does not form part of a septic tank system, the disposal of any matter below the surface of the
ground; or
(e) the recharge of an aquifer--

but does not include a bore that is used solely for purposes other than those specified in paragraphs (a), (b) and (d);

PART 2 – RIGHTS AND LIABILITIES

10. Right to construct or operate works

(1) An Authority or any other person may, in accordance with this Act, construct or operate works for, or which may result in--
(a) the drainage of any land; or
(b) the collection, storage, taking, use or distribution of any water; or
(c) the obstruction or deflection of the flow of any water.

PART 6 – AUTHORITIES

Division 2--Authorities and Districts

96. New water, sewerage and waterway management systems

(1) If a council proposes, or two or more councils jointly propose, to have water supply, sewerage or waterway management
works constructed for the whole or any part of its or their municipal district or districts, the council or councils may submit the
proposal to the Minister.
(2) If an Authority (other than a council) proposes--
(a) to set up a new water, sewerage or waterway management district; or

S. 96(2)(b) amended by No. 50/1992 s. 7(a).

(b) to extend its existing water, sewerage, waterway management or irrigation district--

the Authority may, subject to sub-sections (3) and (4), submit the proposal to the Minister.

(3) An Authority must not submit a proposal for a new or extended water, sewerage or waterway management district if the area
to be covered is within the area of interest[30] of another Authority.
(4) An Authority must not submit a proposal for--
(a) a new or extended sewerage district unless the area to be covered is within the Authority's water district; and
(b) a new or extended waterway management district unless the area to be covered is within the catchment for the
Authority's water district--

unless the Minister in writing exempts the Authority's proposal from the operation of this sub-section.

98. New and restructured Authorities

(1) The Minister may, by Order published in the Government Gazette--

S. 98(1)(a) amended by No. 65/1995 s. 16(1).

(a) appoint a council or an existing Authority or Melbourne Water Corporation; or

S. 98(1)(ab) inserted by No. 25/2001 s. 5.

(ab) appoint a Catchment Management Authority; or

(b) constitute a new Authority--

to take over any part or the whole of the property, rights, liabilities, obligations, powers and functions under this Act of one or more
Authorities, and any staff of those Authorities, and may by that Order or another Order published in the Government Gazette provide for
that taking over in any way that the Minister thinks fit.

(2) An Order must not be made under sub-section (1) unless--

S. 98(2)(a) amended by No. 65/1995 s. 16(2).

(a) the Minister has agreed the terms and conditions with each body affected by the Order; or

S. 98(2)(b) amended by No. 121/1994 s. 191(1).

(b) the Order will not result in the transfer of works from a council (other than works used by that council in performing its functions or

exercising its powers under this Act).

S. 98(3) substituted by No. 121/1994 s. 191(2).

(3) The Minister may, by Order published in the Government Gazette, transfer to an Authority--

(a) works used by a council in performing its functions or exercising its powers under any Act other than this Act; or

(b) works vested in any other public statutory body by or under any Act other than this Act.

PART 7 – GENERAL POWERS

124. Particular powers of Authorities

(1) The powers of an Authority that has a water supply district include the powers set out in Part 8.

(2) The powers of an Authority that has a sewerage district include the powers set out in Part 9.

(3) The powers of an Authority that has a waterway management district include any of the powers set out in any Division of Part

10 that applies to that Authority.

(4) The powers of an Authority that has an irrigation district include the powers set out in Part 11.

(5) An Authority is not obliged to perform any function conferred by this Act, unless this Act expressly provides otherwise.

S. 124(6) amended by Nos 50/1992 s. 10(Sch. item 11.17), 49/1994 s. 5(1)(d), 65/1995 s. 22(f).

(6) It is a function of an Authority to construct, complete, operate and maintain any works of water supply, drainage or salinity

mitigation for which funding is provided to it under any other Act or which, under any other Act, it is authorised or directed to

construct, complete, operate or maintain.

144. Serviced properties

(1) An Authority may, by notice in writing, declare any land to be a serviced property for the purposes of this Act if--

(a) in the case of land within a water district, the Authority has made provision for water supply services to the land; or

(b) in the case of land within a sewerage district, the Authority has made provision for sewerage services to the land; or

S. 144(1)(c) amended by No. 50/1992 s. 7(j).

(c) the land is within the Authority's irrigation district and the Authority has made provision for irrigation of the land or for drainage or salinity mitigation services; or

S. 144(1)(d) amended by Nos 50/1992 s. 7(k)(i), 65/1999 s. 3(1).

(d) the land is within the Authority's waterway management district and the Authority has made provision for regional drainage or floodplain management services that are of direct benefit to that land;

PART 10--WATERWAY MANAGEMENT

Division 1--Preliminary

185. Application of this Part

(1) This Part applies to--

(a) an Authority that has a waterway management district (in respect of Division 2, and in respect of Divisions 3, 4 and 5 to the extent provided in those Divisions); and

S. 185(1)(b) amended by No. 121/1994 s. 190(1).

(b) an Authority appointed by the Minister (in respect of Division 6); and

S. 185(1)(c) inserted by No. 121/1994 s. 190(1).

(c) Melbourne Parks and Waterways (in respect of Divisions 2 and 3).

(2) For the purposes of this Part, "water management" means the management of waterways, drainage or floodplains.

Division 2 – Waterway Management

189. Functions of Authorities

An Authority that has a waterway management district has the following functions in relation to designated waterways and designated land or works within that district--

(a) to identify and plan for State and local community needs relating to the use and to the economic, social and environmental values of land and waterways;

(b) to develop and to implement effectively schemes for the use, protection and enhancement of land and waterways;

(c) to investigate, promote and research any matter related to its functions, powers and duties in relation to waterway management;

(d) to educate the public about any aspect of waterway management.

196. Owner finance

(1) An Authority may require the owner of any property in its waterway management district to meet or contribute to the present day cost of any works used for or in connection with or as incidental to the carrying out of its functions for that district.

197. Finance for increased use of services

(1) An Authority may require the owner of a property in its waterway management district to contribute to the present day cost of any works used for or in connection with or as incidental to the carrying out of its functions for that district if the use of those works increases, or will increase, because of development of the land or any other change, or proposed change, in the use of the land.

Division 3--Regional Drainage

198. Application of Division

(1) This Division applies to--

S. 198(1)(a) repealed by No. 54/1992 s. 56(f), new s. 198(1)(a) inserted by No. 121/1994 s. 190(17)(b).

(a) Melbourne Parks and Waterways; and

(b) any Authority--
(i) that has a waterway management district; and
(ii) to which the Minister, by Order, declares that this Division applies.

S. 198(2) inserted by No. 121/1994 s. 190(17)(c).

(2) In this Division "Authority" includes Melbourne Parks and Waterways and a reference to the district of an Authority must be construed in relation to Melbourne Parks and Waterways as a reference to the area or areas referred to in section 110(1)(b) of the Water Industry Act 1994 to which the Minister, by Order published in the Government Gazette, declares that this Division applies.

199. Functions of Authorities

(1) An Authority has the following functions--
(a) to provide, operate and protect drainage systems, including the drainage of water into all designated waterways and all

designated land or works within its district and, with the consent of the Minister, the drainage of water from that district into

any waterway outside that district;

(b) to develop and implement programs for the protection and enhancement of instream uses;

(c) to investigate, promote and conduct research into any matter related to its functions, powers and duties in relation to

drainage;

(d) to educate the public about any aspect of drainage.

(2) An Authority must perform its functions in an environmentally sound way.

Division 5--Water Management Schemes

213. Functions of the Minister

The Minister has the following functions in relation to water management schemes throughout the State--

(a) to cause assessment and investigations connected with water resources and the environment in connection with waterways to

be undertaken;

(b) to cause schemes for the improved management of waterways, drainage and floodplains to be prepared and implemented;

(c) to develop public education programs for promoting broad community awareness of the role of waterway management

authorities in the overall resource conservation and development in Victoria.

214. Investigations

(1) The Minister may, if he or she decides that an investigation in relation to water management should be carried out, publish in the

Government Gazette and in a newspaper circulating generally in the affected area a notice which--

(a) states the intention of the Minister to appoint a community-based committee to carry out the investigation; and

(b) briefly describes the proposal to be investigated; and

(c) describes the general area affected by the proposal.

215. Water management schemes[50]

(1) When it has completed an investigation into a proposal the committee may prepare a water management scheme for the area

affected by the proposal.

(2) When it has prepared a water management scheme the committee must publish in the Government Gazette and in a newspaper

circulating generally in the area affected a notice which--

(a) states that the scheme has been prepared; and

(b) states where the scheme is available for inspection; and

(c) states the nature of the scheme and a description of it;

216. Approval of schemes

S. 216(1) amended by No. 52/1998 s. 311(Sch. 1 item 105.28).

(1) At least 6 weeks after the notice required by section 215(2) is published, and after any applications to the Tribunal have been determined, the Minister may by Order published in the Government Gazette and in a newspaper circulating generally in the area affected--

(a) declare the scheme to be an approved scheme; and

S. 216(1)(b) amended by No. 12/1996 s. 11(1).

(b) nominate the Authorities or, with its or their agreement, the council or councils responsible for implementing the scheme.

S. 216(2) amended by Nos 12/1996 s. 11(2), 46/1998 s. 7(Sch. 1).

(2) After an Order has been published, an Authority or council nominated in the Order must notify the Secretary to the Department of Infrastructure and all responsible authorities under the Planning and Environment Act 1987 that are likely to be affected by the scheme.

(3) A responsible authority referred to in sub-section (2) must, in relation to any planning scheme, have regard to the provisions of the approved scheme.

(4) Any area that benefits from or is affected by the scheme may be identified in the Order as an area for which the Authority may, in accordance with Part 13, impose fees under a tariff or require contributions from other Authorities or councils under Part 13 to fund the scheme.

(5) The period (if limited) for which the tariff may be imposed must be specified in the Order.

S. 217 amended by Nos 12/1996 s. 11(3), 52/1998 s. 311(Sch. 1 item 105.28).

PART 11--IRRIGATION

220. Application of this Part. This Part applies to an Authority that has an irrigation district.

221. Functions of Authorities

(1) An Authority that has an irrigation district has the following functions in relation to the district--

(a) to provide, manage and operate systems for the supply of water to irrigable lands and for the appropriate drainage and protection of those lands;

(b) to identify community needs relating to irrigation, drainage and salinity mitigation, and to plan for the future needs of the community relating to irrigation, drainage and salinity mitigation;

(c) to develop and implement programs for improved irrigation practices, improved drainage practices and improved salinity mitigation practices;

(d) to investigate and research any matter related to its functions, powers and duties in relation to irrigation, drainage and salinity mitigation.

(2) An Authority may, with the approval of the Minister, exercise its functions outside its district.

PART 12 ACCESS OVER LANDS

244. Community drainage and salinity schemes

(1) In this section and sections 245 and 246--

"committee" means a committee set up under a community agreement to act on behalf of participating landowners;

S. 244(1)

def. of "community agreement" substituted by No. 62/1995 s. 35(1).

"community agreement" means an agreement by which a group of landowners voluntarily establishes--

(a) a community drainage or salinity mitigation scheme to combat drainage or salinity problems in their area; or

(b) a community water supply scheme whose primary purpose is to supply water to farms.

245. Powers of committee

(1) A committee may collect levies, in accordance with the community agreement, from participating landowners.

246. Powers of Corporation and councils for community schemes

(1) An Authority or a council in whose municipal district land affected by a community drainage or salinity mitigation or community

water supply scheme is situated may, if requested by the committee to do so, exercise the powers and perform the functions of the committee.

PART 13 – FINANCE AND ACCOUNTABILITY

Division 5 – Payment for Services

259. Tariffs

(1) An Authority may impose fees under--
(a) a tariff on serviced properties within its district; and
(b) a development tariff on unserviced properties within its district; and

S. 259(1)(c) amended by Nos 62/1995 s. 41(1), 110/1997

s. 24(2).

(c) a tariff for irrigation, drainage or salinity mitigation purposes on any properties within its district[56];

The long title for the Bill for this Act was "A Bill to re-state, with amendments, the law relating to water in Victoria, to repeal the Dandenong Valley Authority Act 1963, the Drainage of Land Act 1975, the Geelong Waterworks and Sewerage Act 1958, the Groundwater Act 1969, the Latrobe Valley Act 1958, the Mildura Irrigation Trusts and Sunraysia Water Board Act 1958,

CATCHMENT AND LAND PROTECTION ACT 1994

PART 2--CATCHMENT AND LAND PROTECTION ADVISORY SYSTEM

Division 2--Regional Catchment and Land Protection Boards

10. Catchment and land protection regions

11. Establishment of Authorities

S. 11(1) amended by No. 39/1998

s. 6(1).

(1) As soon as practicable after an area is determined to be a region under section 10, the Minister must by instrument establish a Catchment Management Authority for that region.

13. Functions of an Authority. An Authority has the following functions--

(a) to prepare a regional catchment strategy for the region and to co-ordinate and monitor its implementation;

(b) to prepare special area plans for areas in the region and to co-ordinate and monitor their implementation;

(c) to promote the co-operation of persons and bodies involved in the management of land and water resources in the region in

preparing and implementing the strategy and special area plans;

(d) to advise the Minister, and, if requested by any other Minister, that other Minister--

(i) on regional priorities for activities by and resource allocation to bodies involved in the management of land and water

resources in the region; and

(ii) on guidelines for integrated management of land and water resources in the region; and

(iii) on matters relating to catchment management and land protection; and

(iv) on the condition of land and water resources in the region;

(e) to promote community awareness and understanding of the importance of land and water resources, their sustainable use,

conservation and rehabilitation;

(f) to make recommendations to the Minister about the funding of the implementation of the regional catchment strategy and any

special area plan;

(g) to make recommendations to the Minister and the Secretary about actions to be taken on Crown land managed by the

Secretary to prevent land degradation;

(h) to advise the Minister and provide information to the Minister on any matter referred to it by the Minister;

S. 13(i) amended by No. 39/1998

s. 6(2)(Sch. 1 item 4(b)).

(i) to carry out any other functions conferred on an Authority by or under this Act or any other Act.

PART 4--CATCHMENT PLANNING

Division 2--Special Area Plans

27. What are special areas?

S. 27(1) amended by No. 39/1998

s. 6(2)(Sch. 1 item 7(a)).

(1) An Authority may recommend to the Minister that--

(a) land in its region should be declared a special area; or
(b) the declaration of a special area in its region should be revoked or amended.

S. 27(2) amended by No. 39/1998

s. 6(2)(Sch. 1 item 7(b)).

(2) In its recommendation the Authority may classify the special area as a special water supply catchment area or in any other way
it considers appropriate.
(3) The Minister must consider the recommendation, having regard to how the existing or potential use of the area may adversely
affect--
(a) the quality and condition of land; or
(b) water quality or aquatic habitats; or
(c) aquifer recharge areas or aquifer discharge areas.

S. 27(4) amended by No. 39/1998

s. 6(2)(Sch. 1 item 7(c)).

(4) After complying with sub-section (3) the Minister may accept or reject the Authority's recommendation.

28. What is a special area plan? A special area plan is a document, prepared and approved in accordance with this Division and
Schedule 2, setting out a plan to deal with specific land management issues in a special area.

29. Can two or more plans apply to the same area?

(1) Two or more special area plans may apply to the same special area.
(2) If there is an inconsistency between provisions of special area plans applying to the same special area, the provisions of the later
approved plan prevail.

30. Contents of plan

(1) A special area plan must--
(a) identify the land management issues to be dealt with in the plan; and
(b) state the program of action to be taken to deal with those issues, and the costs and benefits of that action; and
(c) state the targets to be achieved by that action; and
(d) allocate responsibility for taking that action and for bearing the costs of taking that action; and
(e) provide for the review of the plan.
(2) A special area plan may--
(a) specify the most suitable land uses for the special area, having regard to the public interest; and
(b) state what land in the area can be used for what purpose; and

(c) exempt land or a class of land, or a land owner or a class of land owners, from section 20(2); and

(d) identify the need for land use conditions under Division 3.

(3) If a special area plan identifies a need for land use conditions it must--

(a) give a general description of the properties to which they are to apply; and

(b) state the general nature of those conditions; and

(c) give a general estimate of the total cost of compliance with those conditions, including any decrease in the value of land

or financial loss likely to result as a direct reasonable and natural consequence of compliance; and

(d) provide a method for apportioning the total estimated cost of compliance between land owners and other persons or

bodies who will directly benefit from the implementation of the plan and for apportioning that part of the cost to be borne by

land owners between the properties to which the conditions are to apply.

31. Status of plan. An Authority that prepares a special area plan may recommend to a planning authority under the Planning and
Environment Act 1987 amendments to a planning scheme to give effect to that plan.

32. Land managers to take special area plan into account

(1) In carrying out a function involving land management--

(a) on behalf of the Crown; or

(b) under an Act--

a Minister or public authority must have regard to any special area plan applying to the land.

(2) Sub-section (1) is in addition to and does not take away from any other duty or power of the Minister or public authority to

take matters into account.

Appendix B Cost Estimates

Wc01738
Avril Horne
2:55 PM25/10/2001

	Pipe costs					Pump stations/Basins					TOTAL	Operating Costs		
Option	Sub-total	easements	On-costs	Contingency	Total	Sub-Total	On-costs	Contingency	Land Acquisition	Total	COST	Now	2050	Average
A2	$916,000	$9,160	$229,000	$286,250	$1,440,410	$1,136,000	$284,000	$355,000	$19,416	$1,794,416	**$3,234,826**	$105,237	$108,637	$106,937
A3						$1,310,000	$327,500	$409,375	$87,771	$2,134,646	**$2,134,646**			
B2						$420,000	$105,000	$131,250	$68,571	$724,821	**$724,821**			
C1	$2,543,000	$254,300	$636,000	$795,000	$4,228,300	$1,193,000	$298,000	$373,000		$1,864,000	**$6,092,300**	$133,903	$149,403	$141,653
C2	$5,976,000	$597,600	$1,494,000	$1,868,000	$9,935,600	$1,258,000	$315,000	$393,000		$1,966,000	**$11,901,600**	$195,336	$213,036	$204,186
C3	$3,106,000	$310,600	$777,000	$971,000	$5,164,600	$2,339,000	$585,000	$661,000	$288,000	$3,873,000	**$9,037,600**	$144,496	$159,996	$152,246
D2	$984,000	$98,400	$246,000	$308,000	$1,636,400	$159,000	$40,000	$50,000		$249,000	**$1,885,400**	$55,934	$54,834	$55,384
F2	$510,000	$51,000	$128,000	$160,000	$849,000	$246,000	$62,000	$77,000		$385,000	**$1,234,000**	$56,240	$51,940	$54,090
G1	$252,000	$25,200	$63,000	$79,000	$419,200	$90,000	$23,000	$28,000		$141,000	**$560,200**	$37,822	$36,922	$37,372
G2-1	$2,784,000	$278,400	$696,000	$870,000	$4,628,400	$424,000	$106,000	$133,000		$663,000	**$5,291,400**	$123,074	$109,674	$116,374
G2-2	$660,000	$66,000	$165,000	$206,000	$1,097,000	$70,000	$18,000	$22,000		$110,000	**$1,207,000**	$43,470	$42,670	$43,070
G2-3	$2,544,000	$254,400	$636,000	$795,000	$4,229,400	$354,000	$89,000	$111,000		$554,000	**$4,783,400**	$114,114	$101,614	$107,864

MILDURA DRAINAGE STUDY

EVALUATION OF COLLECTION AND DISPOSAL OPTIONS

OPTION A2

										Efficiency	$/kWhr														
Pump Stations										0.7	$ 0.10								Liner or						Storage+PS
No.	**Capacity**	**Vell Volum**	**005 Annua**	**050 Annua**	**NSL @ PS**	**OWL**	**HGL @ PS**	**Head**	**kW**	**kWhr/ML**	**$ pa**	**$ pa**	**torage D**	**Operating D**	**Area**	**Dia**	**Type**	**Excavate**	**Concrete**	**Est Cost**	**Pump**	**Est Cost**	**Est Cost**	**Power**	**Est Cost**
	(L/s)	*kL*	*ML*	*ML*	*m AHD*	*m AHD*	*m AHD*	*m*			*2005*	*2050*	*m*	*m*	*sq m*	*m*		*cub m*	*cub m*	*Civil*	*Type*	*Mech*	*Elec*	*Supply*	*Total*
1	27	7000	637	851	37	31	63.0	32.0	12.1	124.4	$ 7,900	$ 10,600	4	2	3500	66.8	Earthern	14000	Liner	$ 340,000	SS	$ 75,000	$ 25,000	25000	$ 465,000
2	2.2	580	51	73	38	32	51.8	19.8	0.6	77.0	$ 400	$ 600	7	4	145	13.6	RC	1015	149	$ 140,000	SS	$ 15,000	$ 15,000	5000	$ 175,000
3	2.7	710	60	91	40	34	52.6	18.6	0.7	72.3	$ 400	$ 700	7	4	178	15.0	RC	1243	165	$ 157,000	SS	$ 15,000	$ 15,000	5000	$ 192,000
4	2.5	660	79	84	42	36	56.2	20.2	0.7	78.6	$ 600	$ 700	7	4	165	14.5	RC	1155	159	$ 151,000	SS	$ 15,000	$ 15,000	5000	$ 186,000
5	0.9	230	24	30	40	34	57.8	23.8	0.3	92.6	$ 200	$ 300	7	4	58	8.6	RC	403	94	$ 83,000	SS	$ 15,000	$ 15,000	5000	$ 118,000
Totals	**35.3**										**$ 9,500**	**$ 12,900**												**Subtotal**	**$ 1,136,000**
																								Land acquisition	$ 19,416
																								On-costs	$ 284,000
Pipelines	**Length**	**U/S NSL**	**D/S NSL**	**High Point**	**igh Point C**	**Max Flow**	**U/S HGL**	**D/S HGL**	**Flow**	**HGL**	**I Dia (mm)**	**Select**	**Depth**	**Going**	**Rate**	**Capex**									Contingency	$ 355,000
	km	*m AHD*	*m AHD*	*m AHD*	*m from U/S*	*L/s*	*m AHD*	*m AHD*		*(m/m)*	*C=120*	*ND mm*			*$/m*										**Total**	**$ 1,794,416**
1 to 5	1.3	37	40	40	1.3	27	63.0	57.8	Pumped	0.0040	207	300	Nominal	Urban	$ 180.00	$ 234,000.00										
5 to 4	0.4	40	42	42	0.4	27.9	57.8	56.2	Pumped	0.0040	207	300	Nominal	Urban	$ 180.00	$ 72,000.00										
4 to 3	0.9	42	40	42	0	30.4	56.2	52.6	Pumped	0.0040	207	300	Nominal	Urban	$ 180.00	$ 162,000.00										
3 to Outfall	0.3	40	40	40	0.3	33.1	52.6	51.4	Pumped	0.0040	207	300	Nominal	Urban	$ 180.00	$ 54,000.00										
2 to Outfall	0.1	38	40	40	0.1	2.2	51.8	51.4	Pumped	0.0040	79	100	Nominal	Urban	$ 35.00	$ 4,000.00										
Outfall to HP	1.1	40	47	47	1.1	35.3	51.4	47	Pumped	0.0040	207	300	Nominal	Urban	$ 180.00	$ 198,000.00										
HP to Outlet	1.6	47	37	47	0	35.3	47	37	Gravity	0.00625	209	300	Nominal	Rural	$ 120.00	$ 192,000.00										
1 to Outlet	**5.6**															***$ 916,000***										

Easements	$	9,160
On-costs	$	229,000
Contingency	$	286,250
Total	**$**	**1,440,410**

Operating Costs		**Now**	**2050**
	Percent	***$ pa***	***$ pa***
Operator Attendance	50%	$ 27,500	$ 27,500
Power	100%	$ 9,500	$ 12,900
Civil/Mech/Elec Maintenanc	3%	$ 53,832	$ 53,832
Pipeline Maintenance	1%	$ 14,404	$ 14,404
Total		**$ 105,237**	**$ 108,637**

Renewals	**Years**
Mechanical	15
Electrical	15
Civil	30
Pipelines	75

Option A3										
64 ML Basin with Irrigation for 5 ha				**Cost Estimates:**						
Basin	64	ML	Turkey Nest				Unit	Qty	Rate	Amount
Assume	3.5	m deep		Basin Earthworks - imported fill			cub m	46278	$ 20.00	$ 930,000
Area	18286	sq m		Pumps and pipes for irrigation			item	1		$ 50,000
L x W	135			Liner System			sq m	21943	$ 15.00	$ 330,000
Wall	4	m wide		**Subtotal**						**$ 1,310,000**
Slope	0.33	1 in 3							On-costs	$ 327,500
Freeboard	0.7	m							Contingenc	$ 409,375
Wall height	4.2	m							Land Aquis	$ 87,771
Bank Toe	29.5	m							**Total**	**$ 2,134,646**
Area	70.3	sq m								
Volume	46278	cub m								
Assumptions:	SWD laid to the basin - no cost to connect from town.									
	Replace liner every 25 years									

Option B2										
50 ML Basin with Irrigation for 7 ha				**Cost Estimates:**						
Basin	50	ML	Cut to Fill				Unit	Qty	Rate	Amount
Assume	3.5	m deep		Basin Earthworks - imported fill			cub m	21429	$ 10.00	$ 210,000
Area	14286	sq m		Pumps and pipes for irrigation			item	1		$ 70,000
L x W	120			Beaching			sq m	17143	$ 8.00	$ 140,000
Wall	4	m wide		**Subtotal**						**$ 420,000**
Slope	0.33	1 in 3							On-costs	$ 105,000
Freeboard	0.7	m							Contingenc	$ 131,250
Crest height	4.2	m							Land Acqu	$ 68,571
Cut	1.5	m	Cut Volume	21429	cub m				**Total**	**$ 724,821**
Fill height	2.7									
Bank Toe	20.4	m								
Area	32.9	sq m								
Volume	18404	cub m								
Assumptions:	SWD laid to the basin - no cost to connect from town.									
	No liner required									

MILDURA DRAINAGE STUDY

EVALUATION OF COLLECTION AND DISPOSAL OPTIONS

OPTION C1

										Efficiency	*$/kWhr*																
										0.7	$ 0.10																
Pump Stations		**Min**																	Liner or							**Storage+PS**
No.	**Capacity**	**Well Volume**	**2005 Annual**	**2050 Annual**	**NSL @ PS**	**OWL**	**HGL @ PS**	**Head**	**kW**	**kWhr/ML**	**$ pa**	**$ pa**	**Storage D**	**Operating D**	**Area**	**Dia**	**Type**	**Excavate**	**Concrete**	**Est Cost**	**Pump**	**Est Cost**	**Est Cost**	**Power**	**Est Cost**
	(L/s)	***kL***	***ML***	***ML***	***m AHD***	***m AHD***	***m AHD***	***m***			***2005***	***2050***	***m***	***m***	***sq m***	***m***		***cub m***	***cub m***	***Civil***	***Type***	***Mech***	***Elec***	***Supply***	***Total***
1	721	649	571	1349	48	42	72.0	30.0	302.8	116.7	$ 6,700	$ 15,700	7	4	162	14.4	RC	1136	158	$ 149,000	SS	$ 250,000	$ 120,000	$ 100,000	$ 619,000
2	123	111	68	230	48	42	62.8	20.8	35.7	80.7	$ 500	$ 1,900	7	4	28	5.9	RC	194	65	$ 56,000	SS	$ 70,000	$ 45,000	$ 50,000	$ 221,000
3	280	252	89	525	49	43	73.0	30.0	117.6	116.7	$ 1,000	$ 6,100	7	4	63	9.0	RC	441	98	$ 88,000	SS	$ 100,000	$ 90,000	$ 75,000	$ 353,000
Totals	**1124**		**728**	**2104**							**$ 8,200**	**$ 23,700**												**Subtotal**	**$ 1,193,000**
																								On-costs	$ 298,000
																								Contingency	$ 373,000
Pipelines	**Length**	**U/S NSL**	**D/S NSL**	**High Point**	**High Point CH**	**Max Flow**	**U/S HGL**	**D/S HGL**	**Flow**	**HGL**	**I Dia (mm)**	**Select**	**Depth**	**Going**	**Rate**	**Capex**									**Total**	**$ 1,864,000**
	km	***m AHD***	***m AHD***	***m AHD***	***km from U/S***	***L/s***	***m AHD***	***m AHD***		***(m/m)***	***C=120***	***ND mm***			***$/m***										
1 to 2	2.1	48	48	48	0	721	72.0	62.76	Pumped	0.0044	708	750	Nominal	Rural	$ 375.00	$ 788,000									
2 to Outlet	3	48	50	50	3	844	62.76	49.56	Pumped	0.0044	752	900	Nominal	Rural	$ 450.00	$ 1,350,000									
3 to Outlet	1.8	49	46	49	0	280	73	46	Pumped	0.0150	384	450	Nominal	Rural	$ 225.00	$ 405,000									
																$ 2,543,000									
															Easements	$ 254,300									
															On-costs	$ 636,000									
															Contingency	$ 795,000									
															Total	**$ 4,228,300**									

Operating Costs		**Now**	**2050**
	Percent	***$ pa***	***$ pa***
Operator Attendance	50%	$ 27,500	$ 27,500
Power	100%	$ 8,200	$ 23,700
Civil/Mech/Elec Maintena	3%	$ 55,920	$ 55,920
Pipeline Maintenance	1%	$ 42,283	$ 42,283
Total		**$ 133,903**	**$ 149,403**

Renewals	**Years**
Mechanical	15
Electrical	15
Civil	30
Pipelines	75

MILDURA DRAINAGE STUDY

EVALUATION OF COLLECTION AND DISPOSAL OPTIONS

OPTION C2

											Efficiency	*$/kWhr*														
Pump Stations		**Min**									0.7	$ 0.10								Liner or					Storage+PS	
No.	**Capacity**	**Well Volume**	**2005 Annual**	**2050 Annual**	**NSL @ PS**	**OWL**	**HGL @ PS**	**Head**	**kW**		**kWhr/ML**	**$ pa**	**$ pa**	**Storage D**	**Operating D**	**Area**	**Dia**	**Type**	**Excavate**	**Concrete**	**Est Cost**	**Pump**	**Est Cost**	**Est Cost**	**Power**	**Est Cost**
	(L/s)	*kL*	*ML*	*ML*	*m AHD*	*m AHD*	*m AHD*	*m*				*2005*	*2050*	*m*	*m*	*sq m*	*m*		*cub m*	*cub m*	*Civil*	*Type*	*Mech*	*Elec*	*Supply*	*Total*
1	721	649	571	1349	48	42	75.6	33.6	339.0		130.6	$ 7,500	$ 17,600	7	4	162	14.4	RC	1136	158	$ 149,000	SS	$ 280,000	$ 130,000	$ 100,000	$ 659,000
2	123	111	68	230	48	42	76.6	34.6	59.6		134.5	$ 900	$ 3,100	7	4	28	5.9	RC	194	65	$ 56,000	SS	$ 75,000	$ 50,000	$ 50,000	$ 231,000
3	280	252	89	525	49	43	74.8	31.8	124.8		123.8	$ 1,100	$ 6,500	7	4	63	9.0	RC	441	98	$ 88,000	SS	$ 110,000	$ 95,000	$ 75,000	$ 368,000
Totals	**1124**		**728**	**2104**								**$ 9,500**	**$ 27,200**												**Subtotal**	**$ 1,258,000**
																									On-costs	$ 315,000
																									Contingency	$ 393,000
Pipelines	**Length**	**U/S NSL**	**D/S NSL**	**High Point**	**High Point CH**	**Max Flow**	**U/S HGL**	**D/S HGL**	**Flow**	**HGL**	**I Dia (mm)**	**Select**	**Depth**	**Going**	**Rate**	**Capex**										**Total**	**$ 1,966,000**
	km	*m AHD*	*m AHD*	*m AHD*	*km from U/S*	*L/s*	*m AHD*	*m AHD*		*(m/m)*	*C=120*	*ND mm*			*$/m*											
Outlet to HP	5.5	65	46	65	0	1124	65.0	46	Gravity	0.0035	879	900	Nominal	Rural	$ 450.00	$ 2,475,000										
HP to J2	3.4	49	65	65	3.4	1124	71.4	65.0	Pumped	0.0019	913	1000	Nominal	Rural	$ 500.00	$ 1,700,000										
J2 to J1	1.4	48	49	49	1.4	844	73.9	71.4	Pumped	0.0018	819	900	Nominal	Rural	$ 450.00	$ 630,000										
3 to J2	2	49	49	49	0	280	74.8	71.4	Pumped	0.0017	555	600	Nominal	Rural	$ 300.00	$ 600,000										
2 to J1	1.7	47	48	48	1.7	123	76.6	73.9	Pumped	0.0016	393	450	Nominal	Rural	$ 225.00	$ 383,000										
1 to J1	0.5	49	48	49	0	721	75.6	73.9	Pumped	0.0033	722	750	Nominal	Rural	$ 375.00	$ 188,000										
																$ 5,976,000										
															Easement	$ 597,600										
															On-costs	$ 1,494,000										
															Contingenc	$ 1,868,000										
															Total	**$ 9,935,600**										

Operating Costs		**Now**	**2050**
	Percent	***$ pa***	***$ pa***
Operator Attendance	50%	$ 27,500	$ 27,500
Power	100%	$ 9,500	$ 27,200
Civil/Mech/Elec Maintena	3%	$ 58,980	$ 58,980
Pipeline Maintenance	1%	$ 99,356	$ 99,356
Total		**$ 195,336**	**$ 213,036**

Renewals	**Years**
Mechanical	15
Electrical	15
Civil	30
Pipelines	75

MILDURA DRAINAGE STUDY

EVALUATION OF COLLECTION AND DISPOSAL OPTIONS

OPTION C3

											Efficiency	$/kWhr															
Pump Stations		**Min**									0.7	$ 0.10								Liner or							**Storage+PS**
No.	**Capacity**	**Well Volume**	**2005 Annual**	**2050 Annual**	**NSL @ PS**	**OWL**	**HGL @ PS**	**Head**	**kW**	**kWhr/ML**	**$ pa**	**$ pa**	**Storage D**	**Operating D**	**Area**	**Dia**	**Type**	**Excavate**	**Concrete**	**Est Cost**	**Pump**	**Est Cost**	**Est Cost**	**Power**	**Est Cost**
	(L/s)	***kL***	***ML***	***ML***	***m AHD***	***m AHD***	***m AHD***	***m***			***2005***	***2050***	***m***	***m***	***sq m***	***m***		***cub m***	***cub m***	***Civil***	***Type***	***Mech***	***Elec***	***Supply***	***Total***
1	721	649	571	1349	48	42	72.0	30.0	302.8	116.7	$ 6,700	$ 15,700	7	4	162	14.4	RC	1136	158	$ 149,000	SS	$ 250,000	$ 120,000	$ 100,000	$ 619,000
2	123	111	68	230	48	42	62.8	20.8	35.7	80.7	$ 500	$ 1,900	7	4	28	5.9	RC	194	65	$ 56,000	SS	$ 70,000	$ 45,000	$ 50,000	$ 221,000
3	280	252	89	525	49	43	73.0	30.0	117.6	116.7	$ 1,000	$ 6,100	7	4	63	9.0	RC	441	98	$ 114,000	SS	$ 100,000	$ 90,000	$ 75,000	$ 379,000
L Benetook Basin	210	ML													**253**										$ 1,968,000
Totals	**1334**		**728**	**2104**							**$ 8,200**	**$ 23,700**												**Subtotal**	**$ 1,219,000**
																								On-costs	$ 305,000
																								Contingency	$ 381,000

Pipelines	**Length**	**U/S NSL**	**D/S NSL**	**High Point**	**High Point CH**	**Max Flow**	**U/S HGL**	**D/S HGL**	**Flow**	**HGL**	**I Dia (mm)**	**Select**	**Depth**	**Going**	**Rate**	**Capex**
	km	***m AHD***	***m AHD***	***m AHD***	***km from U/S***	***L/s***	***m AHD***	***m AHD***		***(m/m)***	***C=120***	***ND mm***			***$/m***	
1 to 2	2.1	48	48	48	0	721	72.0	62.76	Pumped	0.0044	708	750	Nominal	Rural	$ 375.00	$ 788,000
2 to Outlet	3	48	50	50	3	844	62.8	49.56	Pumped	0.0044	752	900	Nominal	Rural	$ 450.00	$ 1,350,000
3 to Outlet	1.8	49	46	49	0	280	73	46	Pumped	0.0150	384	450	Nominal	Rural	$ 225.00	$ 405,000
3 to Benetook	3	49	48	50	1.5	160	66.0	48	Pumped	0.0060	375	375	Nominal	Rural	$ 187.50	$ 563,000
																$ 3,106,000
															Easements	$ 310,600
															On-costs	$ 777,000
															Contingency	$ 971,000
															Total	**$ 5,164,600**

Operating Costs		**Now**	**2050**
	Percent	***$ pa***	***$ pa***
Operator Attendance	50%	$ 27,500	$ 27,500
Power	100%	$ 8,200	$ 23,700
Civil/Mech/Elec Maintenar	3%	$ 57,150	$ 57,150
Pipeline Maintenance	1%	$ 51,646	$ 51,646
Total		**$ 144,496**	**$ 159,996**

Renewals	**Years**
Mechanical	15
Electrical	15
Civil	30
Pipelines	75

Option C3		Basin at Lake Benetook																								
210 ML Basin				Cost Estimates:																						
Basin	210	ML	Cut to Fill				Unit	Qty	Rate	Amount																
Assume	3.5	m deep		Basin Earthworks - imported fill			cub m	54000	**10**	**$ 540,000**																
Area	60000	sq m																								
L x W	244.949			Beaching			sq m	72000	**8**	**$ 580,000**																
Wall	4.0	m wide		Subtotal						$ 1,120,000																
Slope	0.3	1 in 3							On-costs	$ 280,000																
Freeboard	0.7	m							Contingency	$ 280,000																
Crest height	4	m							land acquisi	288000																
Cut	0.9	m	Cut Volume	54000	cub m				**Total**	**1968000**																
Fill height	3.3																									
Bank Toe	24	m																								
Area	46.2	sq m																								
Fill Volume	49701.77	cub m																								
Assumptions:	SWD laid to the basin - no cost to connect from town.																									
	No liner required																									

MILDURA DRAINAGE STUDY

EVALUATION OF COLLECTION AND DISPOSAL OPTIONS

OPTION D2

												Efficiency	*$/kWhr*																
Pump Stations		**Min**										0.7	$ 0.10									**Liner or**							**Storage+PS**
No.	**Capacity**	**Well Volume**	**2005 Annual**	**2050 Annual**	**NSL @ PS**	**OWL**	**HGL @ PS**	**Head**	**kW**	**kWhr/ML**	**$ pa**	**$ pa**	**Storage D**	**Operating D**	**Area**	**Dia**	**Type**	**Excavate**	**Concrete**	**Est Cost**	**Pump**	**Est Cost**	**Est Cost**	**Power**	**Est Cost**
	(L/s)	***kL***	***ML***	***ML***	***m AHD***	***m AHD***	***m AHD***	***m***			***2005***	***2050***	***m***	***m***	***sq m***	***m***		***cub m***	***cub m***	***Civil***	***Type***	***Mech***	***Elec***	***Supply***	***Total***
1	61	55	468	359	66	54	79.2	25.2	21.5	98.0	$ 4,600	$ 3,500	7	4	14	4.2	RC	96	46	$ 39,000	SS	$ 50,000	$ 45,000	$ 25,000	$ 159,000
Totals	**61**		**468**	**359**							**$ 4,600**	**$ 3,500**													**$ 159,000**

																												On-costs	$ 40,000
																												Contingency	$ 50,000
Pipelines	**Length**	**U/S NSL**	**D/S NSL**	**High Point**	**High Point CH**	**Max Flow**	**U/S HGL**	**D/S HGL**	**Flow**	**HGL**	**I Dia (mm)**	**Select**	**Depth**	**Going**	**Rate**	**Capex**													**Total**	**$ 249,000**
	km	***m AHD***	***m AHD***	***m AHD***	***km from U/S***	***L/s***	***m AHD***	***m AHD***		***(m/m)***	***C=120***	***ND mm***			***$/m***														
Cnr to Outlet	2.1	61	44	61	0	61	61.0	44	Gravity	0.0081	244	300	Nominal	Rural	$ 120.00	$ 252,000													
PS to Cnr	6.1	66	61	66	0	61	79.2	61.0	Pumped	0.0030	300	300	Nominal	Rural	$ 120.00	$ 732,000													
																$ 984,000													
															Easements	$ 98,400													
															On-costs	$ 246,000													
															Contingenc	$ 308,000													
															Total	**$ 1,636,400**													

Operating Costs		**Now**	**Cost**
	Percent	***$ pa***	***$ pa***
Operator Attendance	50%	$ 27,500	$ 27,500
Power	100%	$ 4,600	$ 3,500
Civil/Mech/Elec Maintena	3%	$ 7,470	$ 7,470
Pipeline Maintenance	1%	$ 16,364	$ 16,364
Total		**$ 55,934**	**$ 54,834**

Renewals	**Years**
Mechanical	15
Electrical	15
Civil	30
Pipelines	75

MILDURA DRAINAGE STUDY

EVALUATION OF COLLECTION AND DISPOSAL OPTIONS

OPTION F2

										Efficiency	*$/kWhr*																
Pump Stations										0.7	$ 0.10								Liner or								Storage+PS
No.	**Capacity**	**Well Volume**	**2005 Annual**	**2050 Annual**	**NSL @ PS**	**OWL**	**HGL @ PS**	**Head**	**kW**	**kWhr/ML**	**$ pa**	**$ pa**	**Storage D**	**Operating D**	**Area**	**Dia**	**Type**	**Excavate**	**Concrete**	**Est Cost**	**Pump**	**Est Cost**	**Est Cost**	**Power**	**Est Cost**
	(L/s)	***kL***	***ML***	***ML***	***m AHD***	***m AHD***	***m AHD***	***m***			***2005***	***2050***	***m***	***m***	***sq m***	***m***		***cub m***	***cub m***	***Civil***	***Type***	***Mech***	***Elec***	***Supply***	***Total***
1	18	16	279	139	43	31	66.0	35.0	8.8	136.1	$ 3,800	$ 1,900	4	2	8.1	3.2	Rc	32.4	20	$ 17,000	SS	$ 40,000	$ 25,000	5000	$ 87,000
2	30	27	477	239	49	37	60.3	23.3	9.8	90.6	$ 4,300	$ 2,200	7	4	6.75	2.9	RC	47.25	32	$ 27,000	SS	$ 50,000	$ 30,000	5000	$ 112,000
3	6	5	102	51	48	36	52.3	16.3	1.4	63.3	$ 600	$ 300	7	4	1	1.3	RC	9	14	$ 12,000	SS	$ 15,000	$ 15,000	5000	$ 47,000
Totals	**54**										**$ 8,700**	**$ 4,400**												**Subtotal**	**$ 246,000**
																								On-costs	$ 62,000
																								Contingency	$ 77,000
Pipelines	**Length**	**U/S NSL**	**D/S NSL**	**High Point**	**High Point CH**	**Max Flow**	**U/S HGL**	**D/S HGL**	**Flow**	**HGL**	**I Dia (mm)**	**Select**	**Depth**	**Going**	**Rate**	**Capex**								**Total**	**$ 385,000**
	km	***m AHD***	***m AHD***	***m AHD***	***km from U/S***	***L/s***	***m AHD***	***m AHD***		***(m/m)***	***C=120***	***ND mm***			***$/m***										
1 to 2	1.5	43	49	49	1.5	18	66.0	60.3	Pumped	0.0038	179	250	Nominal	Rural	$ 100.00	$ 150,000.00									
2 to 3	2.1	49	48	50	1	48	60.3	52.3	Pumped	0.0038	260	300	Nominal	Rural	$ 120.00	$ 252,000.00									
3 to Outfall	0.9	42	40	42	0	54	52.3	48.9	Pumped	0.0038	272	300	Nominal	Rural	$ 120.00	$ 108,000.00									
																$ 510,000									
															Easements	$ 51,000									
															On-costs	$ 128,000									
															Contingency	$ 160,000									
															Total	**$ 849,000**									

Operating Costs		**Now**	**2050**
	Percent	***$ pa***	***$ pa***
Operator Attendance	50%	$ 27,500	$ 27,500
Power	100%	$ 8,700	$ 4,400
Civil/Mech/Elec Mainte	3%	$ 11,550	$ 11,550
Pipeline Maintenance	1%	$ 8,490	$ 8,490
Total		**$ 56,240**	**$ 51,940**

Renewals	**Years**
Mechanical	15
Electrical	15
Civil	30
Pipelines	75

MILDURA DRAINAGE STUDY

EVALUATION OF COLLECTION AND DISPOSAL OPTIONS

OPTION G1

											Efficiency	$/kWhr															
											0.7	$ 0.10															
Pump Stations		**Min**																		**Liner or**						**Storage+PS**
No.	**Capacity**	**Well Volume**	**2005 Annual**	**2050 Annual**	**NSL @ PS**	**OWL**	**HGL @ PS**	**Head**	**kW**	**kWhr/ML**	**$ pa**	**$ pa**	**Storage D**	**Operating D**	**Area**	**Dia**	**Type**	**Excavate**	**Concrete**	**Est Cost**	**Pump**	**Est Cost**	**Est Cost**	**Power**	**Est Cost**
	(L/s)	***kL***	***ML***	***ML***	***m AHD***	***m AHD***	***m AHD***	***m***			***2005***	***2050***	***m***	***m***	***sq m***	***m***		***cub m***	***cub m***	***Civil***	***Type***	***Mech***	***Elec***	***Supply***	***Total***
1	10	9	151	76	49	37	69.6	32.6	4.6	126.9	$ 1,900	$ 1,000	7	4	2	1.7	RC	16	19	$ 15,000	SS	$ 35,000	$ 25,000	$ 15,000	$ 90,000
Totals	**10**		**151**	**76**							**$ 1,900**	**$ 1,000**													**$ 90,000**
																								On-costs	$ 23,000
																								Contingency	$ 28,000

Pipelines	**Length**	**U/S NSL**	**D/S NSL**	**High Point**	**High Point CH**	**Max Flow**	**U/S HGL**	**D/S HGL**	**Flow**	**HGL**	**I Dia (mm)**	**Select**	**Depth**	**Going**	**Rate**	**Capex**
	km	***m AHD***	***m AHD***	***m AHD***	***km from U/S***	***L/s***	***m AHD***	***m AHD***		***(m/m)***	***C=120***	***ND mm***			***$/m***	
HP to Outlet	2.1	62	41	62	0	10	62.0	41	Gravity	0.0100	117	150	Nominal	Rural	$ 60.00	$ 126,000
PS to HP	2.1	49	62	62	2.1	10	69.6	62.0	Pumped	0.0036	150	150	Nominal	Rural	$ 60.00	$ 126,000
																$ 252,000
															Easements	$ 25,200
															On-costs	$ 63,000
															Contingenc	$ 79,000
															Total	**$ 419,200**

Operating Costs		**Now**	**Cost**
	Percent	***$ pa***	***$ pa***
Operator Attendance	50%	$ 27,500	$ 27,500
Power	100%	$ 1,900	$ 1,000
Civil/Mech/Elec Maintena	3%	$ 4,230	$ 4,230
Pipeline Maintenance	1%	$ 4,192	$ 4,192
Total		**$ 37,822**	**$ 36,922**

Renewals	**Years**
Mechanical	15
Electrical	15
Civil	30
Pipelines	75

Total	**$ 141,000**

MILDURA DRAINAGE STUDY

EVALUATION OF COLLECTION AND DISPOSAL OPTIONS

OPTION G2-1

										Efficiency	*$/kWhr*																
Pump Stations		**Min**								0.7	$ 0.10									**Liner or**						**Storage+PS**	
No.	**Capacity**	**Well Volume**	**2005 Annual**	**2050 Annual**	**NSL @ PS**	**OWL**	**HGL @ PS**	**Head**	**kW**	**kWhr/ML**	**$ pa**	**$ pa**	**Storage D**	**Operating D**	**Area**	**Dia**	**Type**	**Excavate**	**Concrete**	**Est Cost**	**Pump**	**Est Cost**	**Est Cost**	**Power**	**Est Cost**
	(L/s)	*kL*	*ML*	*ML*	*m AHD*	*m AHD*	*m AHD*	*m*			*2005*	*2050*	*m*	*m*	*sq m*	*m*		*cub m*	*cub m*	*Civil*	*Type*	*Mech*	*Elec*	*Supply*	*Total*
NWDPS	45	41	706	353	33	27	77.0	50.0	31.5	194.6	$ 13,700	$ 6,900	7	4	10	3.6	RC	71	39	$ 33,000	VT	$ 50,000	$ 35,000	$ 25,000	$ 143,000
LSPS	9	8	140	140	38	32	79.7	47.7	6.0	185.5	$ 2,600	$ 2,600	7	4	2	1.6	RC	14	18	$ 14,000	VT	$ 25,000	$ 20,000	$ 10,000	$ 69,000
WDPS	43	39	675	337	38	32	75.4	43.4	26.1	168.9	$ 11,400	$ 5,700	7	4	10	3.5	RC	68	39	$ 32,000	VT	$ 50,000	$ 35,000	$ 25,000	$ 142,000
DSPS	10	9	151	76	48	42	70.7	28.7	4.0	111.5	$ 1,700	$ 800	7	4	2	1.7	RC	16	19	$ 15,000	SS	$ 25,000	$ 20,000	$ 10,000	$ 70,000
Totals	**107**		**1672**	**906**							**$ 29,400**	**$ 16,000**												**Subtotal**	**$ 424,000**
																								On-costs	$ 106,000
																								Contingency	$ 133,000
Pipelines	**Length**	**U/S NSL**	**D/S NSL**	**High Point**	**High Point CH**	**Max Flow**	**U/S HGL**	**D/S HGL**	**Flow**	**HGL**	**I Dia (mm)**	**Select**	**Depth**	**Going**	**Rate**	**Capex**								**Total**	**$ 663,000**
	km	*m AHD*	*m AHD*	*m AHD*	*km from U/S*	*L/s*	*m AHD*	*m AHD*		*(m/m)*	*C=120*	*ND mm*			*$/m*										
Outlet to HP	4.6	58	38	65	0	107	58.0	38	Gravity	0.0043	344	375	Nominal	Rural	$ 187.50	$ 863,000									
HP to J2	1	55	58	58	1	107	60.9	58.0	Pumped	0.0029	375	375	Nominal	Rural	$ 187.50	$ 188,000									
J2 to J1	5.6	49	55	49	1.4	97	74.3	60.9	Pumped	0.0024	375	375	Nominal	Rural	$ 187.50	$ 1,050,000									
DSPS to J2	3.2	55	49	49	0	10	70.7	60.9	Pumped	0.0031	150	150	Nominal	Rural	$ 75.00	$ 240,000									
LSPS to WDPS	1.7	38	33	48	1.7	9	79.7	75.4	Pumped	0.0025	150	150	Nominal	Rural	$ 75.00	$ 128,000									
WDPS to J1	0.5	33	49	49	0	52	75.4	74.3	Pumped	0.0022	300	300	Nominal	Rural	$ 150.00	$ 75,000									
NWDPS to J1	1.6	45	49			45	77.0	74.3	Pumped	0.00170	300	300	Nominal	Rural	$ 150.00	$ 240,000									
1 to Outlet	**16.5**															***$ 2,784,000***									
															easements	$ 278,400									
															On-costs	$ 696,000									
															Contingenc	$ 870,000									
															Total	**$ 4,628,400**									

Operating Costs		**Now**	**2050**
	Percent	***$ pa***	***$ pa***
Operator Attendance	50%	$ 27,500	$ 27,500
Power	100%	$ 29,400	$ 16,000
Civil/Mech/Elec Maintenar	3%	$ 19,890	$ 19,890
Pipeline Maintenance	1%	$ 46,284	$ 46,284
Total		**$ 123,074**	**$ 109,674**

Renewals	**Years**
Mechanical	15
Electrical	15
Civil	30
Pipelines	75

MILDURA DRAINAGE STUDY

EVALUATION OF COLLECTION AND DISPOSAL OPTIONS

OPTION G2-2

										Efficiency	*$/kWhr*																	
Pump Stations		**Min**								0.7	$ 0.10									**Liner or**						**Storage+PS**	
No.	**Capacity**	**Well Volume**	**2005 Annual**	**2050 Annual**	**NSL @ PS**	**OWL**	**HGL @ PS**	**Head**	**kW**	**kWhr/ML**	**$ pa**	**$ pa**	**Storage D**	**Operating D**	**Area**	**Dia**	**Type**	**Excavate**	**Concrete**	**Est Cost**	**Pump**	**Est Cost**	**Est Cost**	**Power**	**Est Cost**
	(L/s)	*kL*	*ML*	*ML*	*m AHD*	*m AHD*	*m AHD*	*m*			*2005*	*2050*	*m*	*m*	*sq m*	*m*		*cub m*	*cub m*	*Civil*	*Type*	*Mech*	*Elec*	*Supply*	*Total*
DSPS	10	9	151	76	48	42	70.9	28.9	4.0	112.4	$ 1,700	$ 900	7	4	2	1.7	RC	16	19	$ 15,000	SS	$ 25,000	$ 20,000	$ 10,000	$ 70,000
Totals	**10**		**151**	**76**							**$ 1,700**	**$ 900**												**Subtotal**	**$ 70,000**
																								On-costs	$ 18,000
																								Contingency	$ 22,000
Pipelines	**Length**	**U/S NSL**	**D/S NSL**	**High Point**	**High Point CH**	**Max Flow**	**U/S HGL**	**D/S HGL**	**Flow**	**HGL**	**I Dia (mm)**	**Select**	**Depth**	**Going**	**Rate**	**Capex**									**Total**	**$ 110,000**
	km	*m AHD*	*m AHD*	*m AHD*	*km from U/S*	*L/s*	*m AHD*	*m AHD*		*(m/m)*	*C=120*	*ND mm*			*$/m*											
Outlet to HP	4.6	58	38	65	0	10	58.0	38	Gravity	0.0043	150	150	Nominal	Rural	$ 75.00	$ 345,000										
HP to J2	1	55	58	58	1	10	61.1	58.0	Pumped	0.0031	150	150	Nominal	Rural	$ 75.00	$ 75,000										
DSPS to J2	3.2	55	48	49	0	10	70.9	61.1	Pumped	0.0031	150	150	Nominal	Rural	$ 75.00	$ 240,000										
																$ 660,000										
															Easements	$ 66,000										
															On-costs	$ 165,000										
															Contingenc	$ 206,000										
															Total	**$ 1,097,000**										

Operating Costs		**Now**	**2050**
	Percent	***$ pa***	***$ pa***
Operator Attendance	50%	$ 27,500	$ 27,500
Power	100%	$ 1,700	$ 900
Civil/Mech/Elec Maintenar	3%	$ 3,300	$ 3,300
Pipeline Maintenance	1%	$ 10,970	$ 10,970
Total		**$ 43,470**	**$ 42,670**

Renewals	**Years**
Mechanical	15
Electrical	15
Civil	30
Pipelines	75

MILDURA DRAINAGE STUDY

EVALUATION OF COLLECTION AND DISPOSAL OPTIONS

OPTION G2-3

										Efficiency	*$/kWhr*																	
Pump Stations		**Min**								0.7	$ 0.10									**Liner or**						**Storage+PS**	
No.	**Capacity**	**Well Volume**	**2005 Annual**	**2050 Annual**	**NSL @ PS**	**OWL**	**HGL @ PS**	**Head**	**kW**	**kWhr/ML**	**$ pa**	**$ pa**	**Storage D**	**Operating D**	**Area**	**Dia**	**Type**	**Excavate**	**Concrete**	**Est Cost**	**Pump**	**Est Cost**	**Est Cost**	**Power**	**Est Cost**
	(L/s)	*kL*	*ML*	*ML*	*m AHD*	*m AHD*	*m AHD*	*m*			*2005*	*2050*	*m*	*m*	*sq m*	*m*		*cub m*	*cub m*	*Civil*	*Type*	*Mech*	*Elec*	*Supply*	*Total*
NWDPS	45	41	706	353	33	27	77.0	50.0	31.5	194.6	$ 13,700	$ 6,900	7	4	10	3.6	RC	71	39	$ 33,000	VT	$ 50,000	$ 35,000	$ 25,000	$ 143,000
LSPS	9	8	140	140	38	32	79.7	47.7	6.0	185.5	$ 2,600	$ 2,600	7	4	2	1.6	RC	14	18	$ 14,000	VT	$ 25,000	$ 20,000	$ 10,000	$ 69,000
WDPS	43	39	675	337	38	32	75.4	43.4	26.1	168.9	$ 11,400	$ 5,700	7	4	10	3.5	RC	68	39	$ 32,000	VT	$ 50,000	$ 35,000	$ 25,000	$ 142,000
Totals	**97**		**1521**	**830**							**$ 27,700**	**$ 15,200**												**Subtotal**	**$ 354,000**
																								On-costs	$ 89,000
																								Contingency	$ 111,000

Pipelines	**Length**	**U/S NSL**	**D/S NSL**	**High Point**	**High Point CH**	**Max Flow**	**U/S HGL**	**D/S HGL**	**Flow**	**HGL**	**I Dia (mm)**	**Select**	**Depth**	**Going**	**Rate**	**Capex**
	km	*m AHD*	*m AHD*	*m AHD*	*km from U/S*	*L/s*	*m AHD*	*m AHD*		*(m/m)*	*C=120*	*ND mm*			*$/m*	
Outlet to HP	4.6	58	38	65	0	97	58.0	38	Gravity	0.0043	344	375	Nominal	Rural	$ 187.50	$ 863,000
HP to J2	1	55	58	58	1	97	60.9	58.0	Pumped	0.0029	375	375	Nominal	Rural	$ 187.50	$ 188,000
J2 to J1	5.6	45	58	49	1.4	97	74.3	60.9	Pumped	0.0024	375	375	Nominal	Rural	$ 187.50	$ 1,050,000
LSPS to WDPS	1.7	38	33	48	1.7	9	79.7	75.4	Pumped	0.0025	150	150	Nominal	Rural	$ 75.00	$ 128,000
WDPS to J1	0.5	45	38	49	0	52	75.4	74.3	Pumped	0.0022	300	300	Nominal	Rural	$ 150.00	$ 75,000
NWDPS to J1	1.6	45	49			45	77.0	74.3	Pumped	0.00170	300	300	Nominal	Rural	$ 150.00	$ 240,000
1 to Outlet	**13.3**															***$ 2,544,000***
															easements	$ 254,400
															On-costs	$ 636,000
															Contingenc	$ 795,000
															Total	**$ 4,229,400**

Operating Costs		**Now**	**2050**
	Percent	***$ pa***	***$ pa***
Operator Attendance	50%	$ 27,500	$ 27,500
Power	100%	$ 27,700	$ 15,200
Civil/Mech/Elec Maintenar	3%	$ 16,620	$ 16,620
Pipeline Maintenance	1%	$ 42,294	$ 42,294
Total		**$ 114,114**	**$ 101,614**

Renewals	**Years**
Mechanical	15
Electrical	15
Civil	30
Pipelines	75