4.3 Impact of salinity on assets

A summary list of the key vulnerable assets that are exposed to salinity is given in Table 5. More detail on the impact on these assets is given in the following sections using the asset categories stated in the Regional Catchment Strategy.

4.3.1 Land and Production Assets

The extent and severity of mapped land salinity in the area is shown in Figure 6. The salinity was mapped across the region using vegetation characteristics as described in Matters and Bozon (1989). This method is consistent with the mapping conducted in the rest of the State and classifies salinity affected land into Class 1 (minor salting), Class 2 (moderate salting) and Class 3 (severe salting)[1]. Figure 6 is a composite map compiled from a number of data sources[2]. There are just over 24,000 hectares of mapped land salinity in the region (Table 4 – statistics from Figure 6). However, the figures in Table 4 are considered to underestimate the total land salinity, as some areas have not been comprehensively mapped (see Table 40) and Class 1 salinity can be difficult to map accurately.

- **Table 4: Area of mapped land salinity by Salinity Management Area**

Salinity Management Area	Salinity severity (ha)				Total salinity (ha)	Percentage of total regional salinity
	Class 1 (minor salinity)	Class 2 (moderate salinity)	Class 3 (severe salinity)	Undifferentiated		
Clydebank	2574	1744	1536	216	6070	25
Rosedale	1058	98	1335	1073	3563	15
Port Albert	334	1356	22	1806	3518	15
Nambrok	1848	427	0	915	3190	13
Bengworden	25	1846	434	83	2388	10
Reeve	22	16	1114	430	1582	7
Foster	771	45	0	481	1297	5
Maffra	879	57	0	0	936	4
Boisdale	394	172	0	0	566	2
Heyfield	386	118	0	0	504	2
Stratford	75	95	195	38	403	2
Trafalgar	0	0	0	142	142	1
Wellington	0	0	3	0	3	0
Walhalla	0	0	0	0	0	0
Wilsons Prom	0	0	0	0	0	0
Total WGCMA region	**8365**	**5973**	**4639**	**5183**	**24160**	**100**

[1] Vegetation characteristics are usually used for mapping dryland salinity. Irrigation induced salinity is more commonly mapped by analysing soil salinity levels (ECe) through soil sampling or EM38 surveys. As the area to be mapped was large, it was impractical to map salinity using these methods hence vegetation characteristics were used

[2] Salinity map source data:

- Salinity mapping of the Macalister Irrigation District and surrounding dryland areas conducted by Sinclair Knight Merz (2001a, 2001b, 2002a and 2002b);
- Salinity mapping of the South Gippsland area conducted by the then DNRE, Leongatha in 1999 and documented in the Draft South Gippsland Salinity Strategy (2000);
- Salinity mapping of the Bengworden area conducted by the then DNRE in 1991. This mapping was only conducted on properties of willing participants of the Bengworden Landcare Group and is, therefore, likely to be an underestimate of the actual salinity in the area;
- Salinity mapping conducted in the South Gippsland and Clydebank regions by the then DNRE between 1986 and 1999 as part of the statewide mapping of salinity; and
- Salinity mapping conducted by the then Conservation Forests and Lands (1988).

Table 5: Specific assets in West Gippsland at risk of being affected by salinity – further details about the current impact on assets is given in Sections 4.3 and 4.4. The future impact of salinity is described in Section 4.5.

Salinity Man. Area	Water	Infrastructure	Land/Production[1]	Biodiversity	People and Communities	Atmosphere and Climate
Bengworden	▪ Water table aquifer ▪ 120ha wetlands affected by salinity	▪ Bairnsdale railway line ▪ Steel cased groundwater bores ▪ Princes Hwy	▪ Agricultural land (appox $460,000/yr) ▪ 2600ha of agricultural land with <2m depth to water table (at risk of salinity) ▪ 2511ha mapped land salinity	▪ Gippsland Lakes ▪ Ramsar wetlands ▪ Blond Bay ▪ 160ha of depleted to endangered vegetation with <2m depth to water table	▪ Economic stress on families from reduced agricultural income	▪ Death of trees as a result of salinity potentially reduces carbon sink (secondary threat)
Boisdale	▪ Water table aquifer ▪ Avon River ▪ 30ha wetlands affected by salinity	▪ Bairnsdale railway line ▪ Steel cased groundwater bores ▪ Princes Hwy	▪ Agricultural land (approx $500,000/yr) ▪ 1280ha of agricultural land with <2m depth to water table ▪ 566ha mapped land salinity			▪ Death of trees as a result of salinity potentially reduces carbon sink (secondary threat)
Clydebank	▪ Nuntin Creek ▪ Water table aquifer ▪ Thomson River ▪ Latrobe River ▪ 110ha wetlands affected by salinity	▪ East Sale RAAF base ▪ Bairnsdale railway line ▪ Public Groundwater Control Pumps ▪ Steel cased groundwater bores	▪ Agricultural land (approx $1,660,000/yr) ▪ 6270ha of agricultural land with <2m Depth to water table ▪ 6070ha mapped land salinity	▪ Gippsland Lakes ▪ The Heart Morass ▪ Clydebank Morass ▪ Lake Kakydra ▪ Lake Melanydra ▪ Sale Common ▪ Curtin's Flat ▪ Morley Swamp ▪ Tucker Swamp ▪ 1000ha of depleted to endangered vegetation	▪ Economic stress on families from reduced agricultural income ▪ Decrease in tourism and associated economic benefits to local community	
Foster	▪ Water table aquifer ▪ Screw Creek ▪ Pound Creek ▪ 920ha wetlands affected by salinity	▪ Sea walls ▪ Jetties/Boat ramps ▪ Steel cased groundwater bores	▪ Agricultural land (approx $850,000/yr) ▪ 7530ha of agricultural land with <2m depth to water table ▪ 1297ha mapped land salinity	▪ 300ha of depleted to endangered vegetation with <2m depth to water table	▪ Aboriginal artefacts and historical sites	
Heyfield	▪ Water table aquifer ▪ Thomson River ▪ Macalister River ▪ 1890ha wetlands affected by salinity	▪ Glenmaggie Dam ▪ Steel cased groundwater bores ▪ Maffra-Rosedale Rd	▪ Agricultural land (approx $930,000/yr) ▪ 4090ha of agricultural land with <2m depth to water table ▪ 504ha mapped land salinity	▪ 100ha of depleted to endangered vegetation with <2m depth to water table	▪ Economic stress on families from reduced agricultural income	
Maffra	▪ Bundalaguah Main Drain ▪ Water table aquifer ▪ Macalister River ▪ 250ha wetlands affected by salinity	▪ Public Groundwater Control Pumps ▪ Steel cased groundwater bores ▪ Maffra-Rosedale Rd	▪ Agricultural land (approx $570,000/yr) ▪ 2190ha of agricultural land with <2m depth to water table ▪ 936ha mapped land salinity	▪ 70ha of depleted to endangered vegetation with <2m depth to water table	▪ Economic stress on families from reduced agricultural income	
Nambrok	▪ Water table aquifer ▪ Thomson River ▪ Latrobe River ▪ 270ha wetlands affected by salinity	▪ Bairnsdale railway line ▪ West Sale aerodrome ▪ Steel cased groundwater bores ▪ Princes Hwy ▪ Maffra-Rosedale Rd	▪ Agricultural land (approx $870,000/yr) ▪ 5990ha of agricultural land with <2m depth to water table ▪ 3241ha mapped land salinity	▪ 150ha of depleted to endangered vegetation with <2m depth to water table	▪ Economic stress on families from reduced agricultural income	

Salinity Man. Area	Water	Infrastructure	Land/Production[1]	Biodiversity	People and Communities	Atmosphere and Climate
Port Albert	▪ Merrimans Creek ▪ Water table aquifer ▪ Albert River ▪ 2220ha wetlands affected by salinity	▪ Sea walls ▪ Jetties/Boat Ramps ▪ Steel cased groundwater bores	▪ Agricultural land (approx $1,550,000/yr) ▪ 12,300ha of agricultural land with <2m depth to water table ▪ 3518ha mapped land salinity	▪ 20ha of depleted to endangered vegetation with <2m depth to water table	▪ Port Albert township ▪ Aboriginal artefacts and historical sites	
Reeve	▪ Lake Reeve ▪ Water table aquifer ▪ 520ha wetlands affected by salinity	▪ Seaspray flood mitigation structures ▪ Longford - Loch Sport Rd	▪ Agricultural land (approx $150,000/yr) ▪ 1550ha of agricultural land with <2m depth to water table ▪ 1582ha mapped land salinity ^	▪ Gippsland Lakes ▪ Ramsar wetlands ▪ 550ha of depleted/ endangered vegetation with <2m depth to water table ▪ Dolomite Swamp	▪ Seaspray township ▪ Economic stress on families from reduced agricultural income	▪ Death of trees as a result of salinity potentially reduces carbon sink (secondary threat)
Rosedale	▪ Flynns Creek ▪ Sheepwash Creek ▪ Water table aquifer ▪ Latrobe River ▪ 610ha wetlands affected by salinity	▪ Bairnsdale railway line ▪ Steel cased groundwater bores ▪ Princes Hwy ▪ Dutson Downs Sewerage Treatment Facility	▪ Agricultural land (approx $830,000/yr) ▪ 7570ha of agricultural land with <2m depth to water table ▪ 3563ha mapped land salinity	▪ Gippsland Lakes ▪ Dowd Morass ▪ 260ha of depleted to endangered vegetation with <2m depth to water table	▪ Rosedale township	▪ Death of trees as a result of salinity potentially reduces carbon sink (secondary threat)
Stratford	▪ Perry River ▪ Water table aquifer ▪ Avon River ▪ 360ha wetlands affected by salinity	▪ Bairnsdale railway line ▪ Princes Hwy	▪ Agricultural land (approx $180,000/yr) ▪ 1530 ha of agricultural land with <2m depth to water table ▪ 403ha mapped land salinity	▪ Red Morass ▪ Providence Ponds Flora and Fauna Reserve ▪ 100ha of depleted to endangered vegetation with <2m depth to water table		
Trafalgar	▪ Andersons Creek ▪ Bennetts Creek ▪ Water table aquifer ▪ Latrobe River ▪ 2490ha wetlands affected by salinity	▪ Bairnsdale railway line ▪ Princes Hwy	▪ Agricultural land (approx $70,000yr) ▪ Coal mining ▪ 142ha of agricultural land with <2m depth to water table ▪ 2511ha mapped land salinity	▪ 5ha of depleted to endangered vegetation with <2m depth to water table		
Walhalla	▪ Tanjil River East ▪ 2840ha wetlands affected by salinity					
Wellington	▪ Lake Wellington ▪ Lake Coleman ▪ Water table aquifer		▪ Agricultural land (approx $20,000/yr) ▪ 220ha of agricultural land with <2m depth to water table ▪ 3ha mapped land salinity	▪ Gippsland Lakes ▪ Backwater Morass ▪ Lake Wellington ▪ Lake Coleman ▪ Victoria Lagoon ▪ 240ha of depleted/ endangered vegetation with <2m depth to water table	▪ Decrease in tourism and associated economic benefits to local community ▪ Economic stress on families from reduced agricultural income	▪ Death of trees as a result of salinity potentially reduces carbon sink (secondary threat)
Wilsons Promontory	▪ 150ha wetlands affected by salinity			▪ Wilsons Prom NP ▪ 20ha of depleted/ endangered vegetation with <2m depth to water table		

[1] Area of less than 2 metres depth to water table indicates the area at risk of salinity whereas the area of mapped salinity is the area of actual salinity. Usually, the area at risk of salinity is greater than the area of actual salinity. However, in the case of the Reeve Salinity Management Area, the two figures are reversed due to the proximity to the coast and the effects of airborne salt and ocean influxes, which are not related to a high water table.

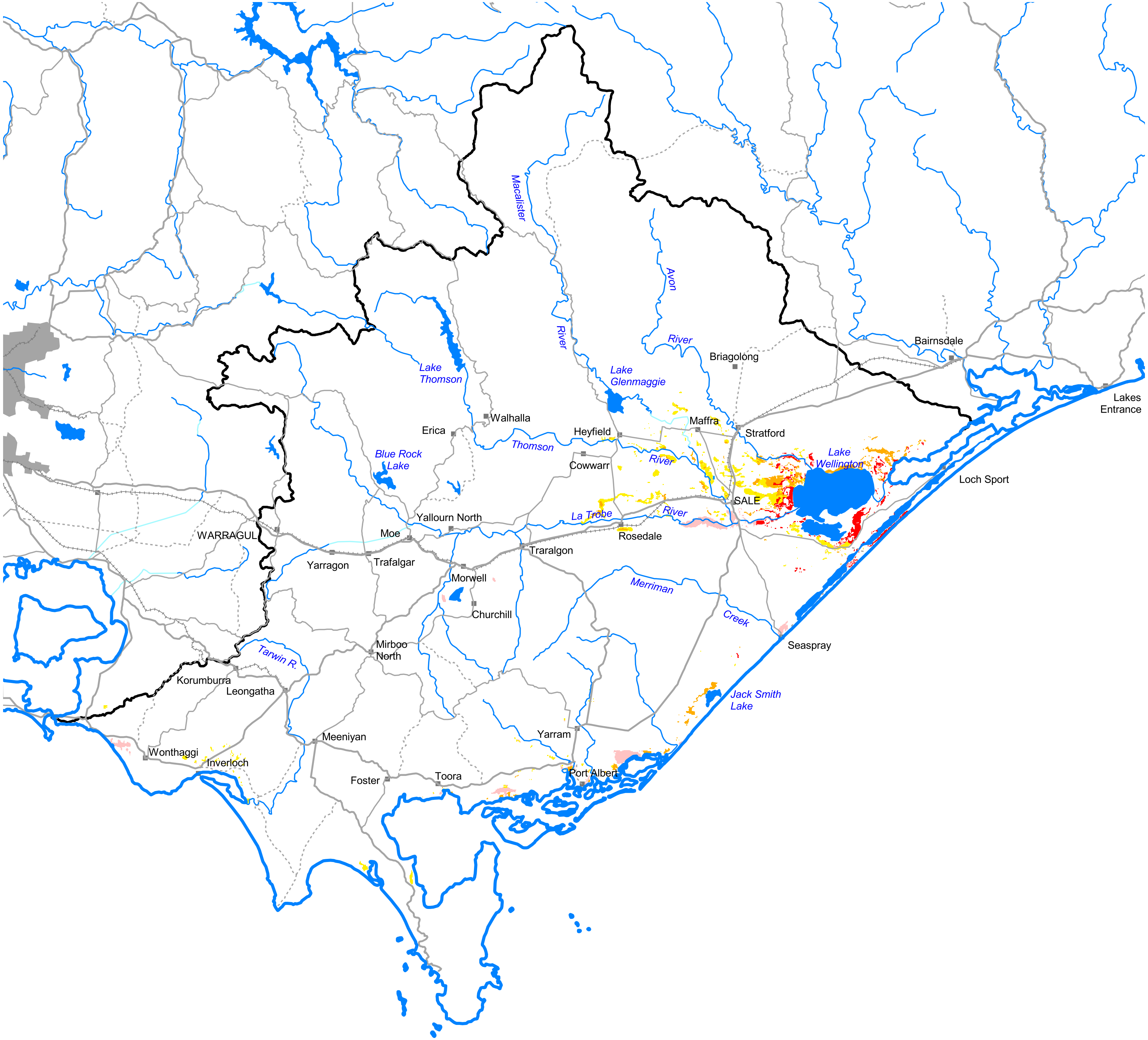

Figure 6

West Gippsland Catchment Management Authority

West Gippsland Salinity Management Plan

Mapped Land Salinity Severity (not including wetlands)

0 10 20 30 40 50 Kilometres

Salinity Severity (After DSE 1999)

- Class 3 (severe salinity)
- Class 2 (moderate salinity)
- Class 1 (minor salinity)
- Unclassed

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SKM

Refer to Sinclair Knight Merz document WCMS\wc02655\technical\gis\Wc02655t005.apr; Land Salinisation - Severity (Layout)

Land salinity affects both dryland and irrigated agriculture. The land salinity mapping shows that the key agricultural areas affected by salinity are:

- The irrigated agriculture and adjacent dryland areas occurring in and around the Macalister Irrigation District;
- The dryland agricultural areas in the coastal areas around Yarram and the Giffard Plains in the Port Albert Salinity Management Area;
- The dryland agricultural areas in the Wonthaggi and Inverloch areas;
- The dryland agricultural areas in the Bengworden Salinity Management Area;
- The dryland agricultural areas south of Lake Coleman and Lake Wellington in the Rosedale and Reeve Salinity Management Areas.

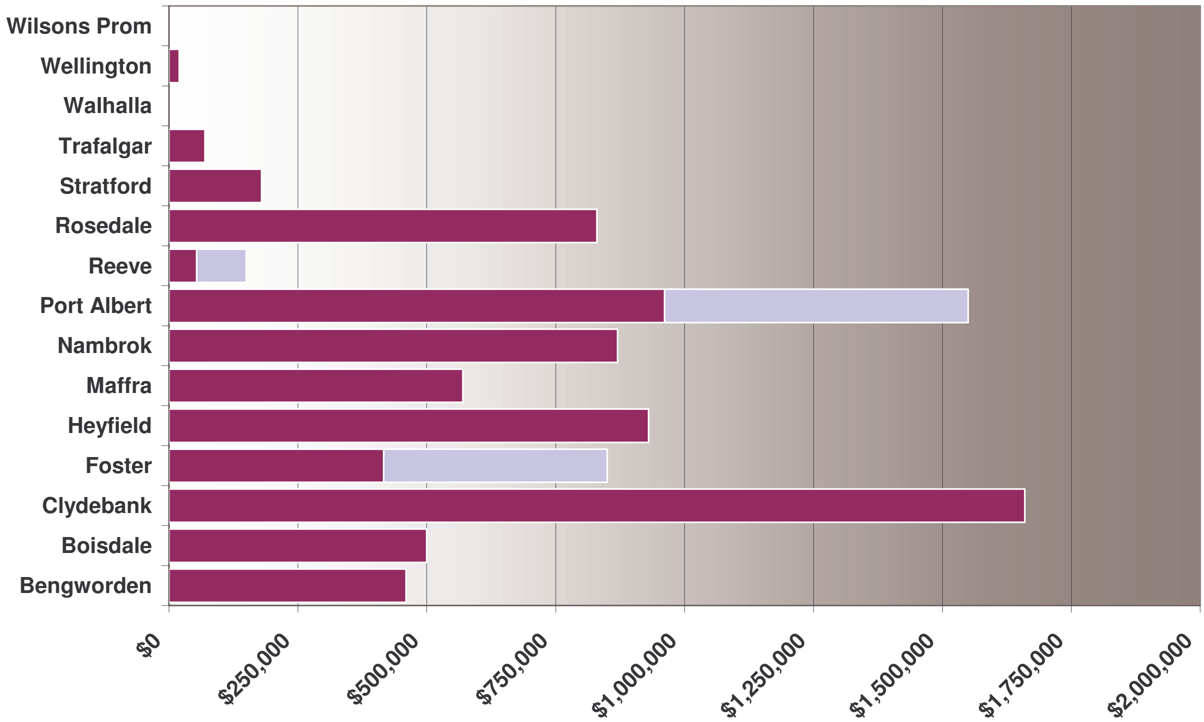
The impacts of salinity on farms is dependent on the salt tolerance of the particular crop and pasture types of the region (Wilson, 1999). The costs to farm businesses are wide-ranging and include:

- Damage to pastures and crops (considered the largest cost component);
- Damage to farm infrastructure, such as roads, fences, equipment and buildings;
- Secondary land degradation, in the form of soil erosion and soil structural decline;
- Farm management problems, such as weed invasion, reduced access due to waterlogging increased input requirements, and fencing off the affected areas;
- Reduced water quality of farm dams and streams, used for stock watering and irrigation; and
- Environmental degradation, in the form of reduced biodiversity, loss of shelter for stock and aesthetic values.

The current costs of salinity to agriculture in the West Gippsland region were estimated based on the salinity loss function method adopted in the Drainage Evaluation Model (MDBC, 1995). More detail on the methodology used in this assessment is included in SKM (2004d). The estimated current costs of lost production due to salinity are shown in Figure 7 for each Salinity Management Area. The total cost of salinity to agricultural production is estimated to be between approximately $7.6 million and $8.6 million per year or around 1% of total agricultural production in the region. However, it is important to note that the stated cost of salinity to agriculture in the Port Albert, Reeve and Foster Salinity Management Areas is in part related to primary salinity along the coastal tidal flats. The cost of salinity in these areas assumes that agricultural production in these naturally saline areas could potentially be equivalent to other non-saline areas. For this reason, the cost of primary salinity (light shading) has been shown separately in Figure 7 to the cost of secondary salinity (dark shading). Salinity in coastal areas of less than 2m elevation was determined to be primary although it may be exacerbated by secondary salinity. Therefore it is likely that the true cost of secondary salinity lies somewhere within this range.

Waterlogging and salinity are inextricably linked. In areas where there is waterlogging due to a high watertable, the costs have been included as part of the estimate of production losses due to salinity. The costs associated with waterlogging in areas with poor drainage have not been included in the estimated cost of agriculture shown in Figure 7. However, the costs to agriculture of waterlogging due to poor drainage are expected to be minimal relative to the cost of salinity.

▪ **Figure 7: Estimated Current Cost of Salinity to Agricultural Production ($ per year)***



*Light coloured bars indicate predominantly primary salinity costs, dark bars indicate predominantly secondary salinity costs

4.3.2 Water Assets

Lakes and Wetlands

There are numerous wetlands and lakes within the project area that have been affected to various degrees by salinity. Figure 8 shows the distribution of saline wetlands and lakes in the area broadly categorised into secondary (induced) salinity, primary (natural) salinity, a combination of primary and secondary and salinity of unknown origin. Figure 8 was created by comparing the DSE GIS layers of wetland status in 1788 and 1994. The extent of wetland salinity by Salinity Management Area is shown in Table 6.

- **Table 6: Wetland salinity in each Salinity Management Area (as determined from comparison of DSE GIS layers of wetland status in 1788 and 1994 – see Figure 8)**

Salinity Management Area	Area of natural wetland salinity (ha)	Total induced salinity (ha)	Unknown	Non-saline
Wellington	831	18820	0	0
Clydebank	426	3947	107	0
Rosedale	304	2366	577	29
Stratford	0	675	325	40
Nambrok	0	403	246	20
Reeve	9299	182	482	35
Foster	497	149	711	208
Bengworden	1710	19	117	2
Boisdale	0	1	23	5
Heyfield	0	0	165	1725
Maffra	0	0	233	21
Port Albert	9432	0	2148	76
Trafalgar	0	0	121	2364
Walhalla	0	0	12	2829
Wilsons Prom	82	0	153	0
Total WGCMA region	**22581**	**26561**	**5418**	**7354**

Salt can enter wetlands and other surface water bodies via:

- Runoff over saline land;
- Direct discharge of saline groundwater;
- Windblown salt from the ocean;
- Runoff from irrigation with brackish water;
- Direct or indirect discharge of brackish-saline water from groundwater pumps;
- Rainfall; and/or
- Ocean or lake inflow.

Table 6 shows that there are approximately 26,500 hectares of wetland or lake salinity that has at least some induced origin (statistics from Figure 8). Of this 26,500 hectares, approximately 19,000 hectares is Lake Wellington, which has been transformed from a fresh to brackish water body to a brackish to saline water body through the artificial connection to the ocean at Lakes Entrance. This leaves approximately 7,500 hectares of smaller wetlands and lakes that have become saline over the last 200 years. There are also approximately 5,400 hectares of wetlands that have an unknown status. The salinity status of these wetlands requires further investigation.

Lake and wetland salinity has an impact on biodiversity by changing the habitat of biota, which can limit or change the species of biota inhabiting the waterbody. The salinity management objectives and the threat salinity has on wetlands in West Gippsland are shown in Table 7. Table 7 also highlights the environmental significance of each of the wetlands.

It is very difficult to determine which wetlands are affected by primary salinity and which wetlands have become saline as a result of changed land management practices (including the artificial entrance at Lakes Entrance). A number of the wetlands to the east of Lake Wellington are thought to be naturally saline (i.e. affected by primary salinity - Figure 8). The threat posed by salinity on these wetlands is not really known as they have not been studied in much detail, however it is possible that the wetlands have become more saline due to the increased salinity of Lake Wellington.

Lake Kakydra is also thought to be naturally saline. The lake is hydraulically connected through a breach to the Lake Wellington Main Drain. Although the water in this drain is generally relatively saline, there is the potential for freshwater inflows during high flow to decrease the salinity of this lake, which is currently being managed as a saline lake.

Figure 8

West Gippsland Salinity Management Plan

Wetland Salinity Type

0 10 20 30 40 50 Kilometres

Wetland salinity
- Induced or Secondary Salinity
- Combination of Natural and Induced Salinity
- Natural or Primary Salinity
- Unknown
- Non-saline

Wetland salinity type has been interpreted from comparison between the DSE GIS layers of wetland status in 1788 and 1994

Refer to Sinclair Knight Merz document WCMS\wc02655\technical\gis\Wc02655t005.apr; Wetlands 1994 (Layout)

- **Table 7: Lakes/Wetlands in West Gippsland – environmental significance and salinity threats (modified from Nolan ITU and EnPlan (2002)**

Salinity Man. Area	Lake/Wetland	Salinity threats	Environmental significance*	Current salinity threat	Rate of change	Notes
Rosedale	**Dowd Morass** Large deep freshwater intermittent wetland (although presently more brackish than fresh). Area 1540 ha	Increasing salinisation of freshwater wetland Inundation from Lake Wellington	Ramsar wetland (part) (i) CAMBA (i) JAMBA (i) Register of National Estate (n) State Wildlife Reserve (s) Dwarf Galaxias (*Galaxius pusilla*) FFG listed as lower risk, near threatened species. (s) Listed in the Directory of Important Wetlands as a regionally significant example of a deep freshwater marsh (although now more brackish than fresh) (r)	High	Medium	
Clydebank	**The Heart Morass** Originally a large deep freshwater marsh. Dries out in most years. Area > 1500 ha.	Rise in regional saline groundwater. Saline surface inflows. Inundation from Lake Wellington	Public Land (350ha) Ramsar wetland (i) JAMBA(i) CAMBA (i) State Wildlife Reserve (s) Private Land CAMBA (i) JAMBA (i)	High	Medium	
Clydebank	**Clydebank Morass** Large (1420ha), heterogeneous, intermittent wetland. Originally reputed to be a deep freshwater marsh, but now brackish-saline.	High levels of salinity of freshwater wetland. Saline groundwater intrusion. Inundation from Lake Wellington.	Ramsar wetland (part) (i) CAMBA (i) JAMBA (i) State Wildlife Reserve (s)	High	Low	
Clydebank	**Lake Kakydra** Permanent saline lake. Often brackish during the spring – autumn period due to inundation from relatively fresh, nutrient rich irrigation run-off. Area 180 ha.	Impact of freshwater inflows from irrigation channels Discharge from groundwater pumps. Inundation from Lake Wellington.	CAMBA (i) JAMBA (i) Currently reserved under Crown Land (Reserves) Act and soon to become State Wildlife Reserve (s)	None	None	Naturally saline. Need to manage freshwater inflows from irrigation drains.
Clydebank	**Curtin's Flat -** Privately owned, small, degraded intermittent wetland which was reputedly a natural shallow freshwater marsh.	Groundwater discharge. Backflow from Lake Wellington.	CAMBA (i) JAMBA (i)			
Clydebank	**Sale Common -** covers an area of 308 ha and consists of about 70% freshwater marsh, which is shallow and may dry out occasionally.	Potential impacts from saline water backing up the Latrobe from L Well. High water table from upgradient irrigation	Ramsar wetland (i) CAMBA (i) JAMBA (i) State Wildlife Reserve (s)	Low	Low	
Clydebank	**Lake Melanydra -** was originally a freshwater marsh of 193 ha but because of past drainage works and dryland salting is now a semi permanent saline wetland of 7ha.	Historical drainage works causing decreased freshwater inflows		None		
Stratford	**Red Morass** Wetland of 271 ha which is entirely	Unknown	Ramsar wetland (i) CAMBA (i)			Naturally saline.

Salinity Man. Area	Lake/Wetland	Salinity threats	Environmental significance*	Current salinity threat	Rate of change	Notes
	landlocked and surrounded by freehold.		JAMBA (i) Reserved in 1880 for water purposes (s)			
Wellington	**Victoria Lagoon** Semi permanent shallow saline wetland. Drying cycle of approximately once in every 25 years.	Fluctuations in salinity levels likely to have detrimental impact on wetland biota. Drainage flows probably lengthening wet cycle and restricting biota	Ramsar wetland (i) CAMBA (i) JAMBA (i) State Wildlife Reserve (s)	Low	Low	Naturally saline.
Wellington	**Lake Betsy** Permanent saline wetland.	Unknown	Ramsar wetland (i) CAMBA (i) JAMBA (i) To become State Wildlife Reserve (s)	Low	Low	Naturally saline.
Wellington	**Snipe Wetland** Small saltmarsh.	Unknown	Ramsar wetland (i)	Low	Low	Unknown
Clydebank	**Morley's Swamp** Large (230 ha) shallow permanent wetland.	Unknown	Ramsar wetland (i)\ CAMBA (i) JAMBA (i) To become State Wildlife Reserve (s)	Unknown		Naturally saline.
Clydebank	**Tucker Swamp** 147 ha wetland.	Unknown	Ramsar wetland (i) CAMBA (i) JAMBA (i) To become State Wildlife Reserve (s)	Unknown		
Wellington	**Lake Coleman -** A series of shallow lagoons with a mosaic of open water, reeds beds and Swamp Paperbark	Lack of flushing	Ramsar (part) (i) CAMBA (i) JAMBA (i) To become State Wildlife Reserve (s)	High	Medium	
Wellington	**Backwater Morass**	The lower portion of the morass receives salty water from Lake Victoria. Salinity decreases upstream and the upper portion of the morass forms a significant deep freshwater marsh system.	Ramsar wetland (i) CAMBA (i) JAMBA (i) To become State Wildlife Reserve (s)	Unknown		Naturally saline.
Wellington	**Lake Wellington**	Salinity from McLennan Straits. Reduced river flows relative to natural conditions	Ramsar wetland (i) CAMBA (i) JAMBA (i)	Unknown		
Reeve	**Lake Reeve**	Saline seawater from the entrance	Ramsar wetland (i) CAMBA (i) JAMBA (i) Site of special scientific interest as it is one of Victoria's five most important areas for waders (s)	High		
Port Albert	**Jack Smith Lake**	High water table, proximity to the coast, groundwater discharge	Unknown	Unknown		Naturally saline.

* (i) indicates International significance, (n) indicates National significance, (s) indicates State significance and (r) indicates regional significance.

Surface Water

The water salinity of the rivers and creeks in the West Gippsland CMA region is monitored at gauging stations through the region. WATER ECOscience (2002) undertook a Water Quality Assessment for the WGCMA on rivers and creeks in each of the three major river basins in the region. The salinity at each gauging station was compared to the State Environment Protection Policy (SEPP) guidelines for stream water quality and ranked based on the percentage of time each station attained the 90th percentile for salinity under the SEPP (see Table 8). Where no regional SEPP objectives existed, the Waters of Victoria SEPP objectives were applied (WATER ECOscience, 2002). Where there were no SEPP objectives, the ANZECC 80th percentile guideline attainment rating was applied based on the classifications in Table 8 (WATER ECOscience, 2002).

- **Table 8: Classification of attainment of SEPP or ANZECC objectives (Modified from WATER ECOscience, 2002)**

Percentage of time SEPP 90th percentile (or ANZECC 80th percentile) for salinity attained	**Classification**
>95%	High
90-95%	Moderate
50-90%	Low
<50%	Very low

Appendix B shows the stream water salinity in the WGCMA region. The WATER ECOscience report did not analyse all stations in the WGCMA region. Five waterways draining irrigation water in the MID were also analysed for their compliance with their respective SEPP guidelines. They were Bundalaguah Main Drain, Nuntin Creek, Boggy Creek, Newry Creek and Serpentine Creek.

Table 78 (Appendix B) shows that overall, stream water quality in the region is good, however there are four stations that show moderate water quality, five stations that show low water quality and four stations that show very low water quality (ranging between 16% and 35% attainment). Table 78 (Appendix B) lists all the water quality monitoring stations with a less than 100% attainment of the SEPP guidelines.

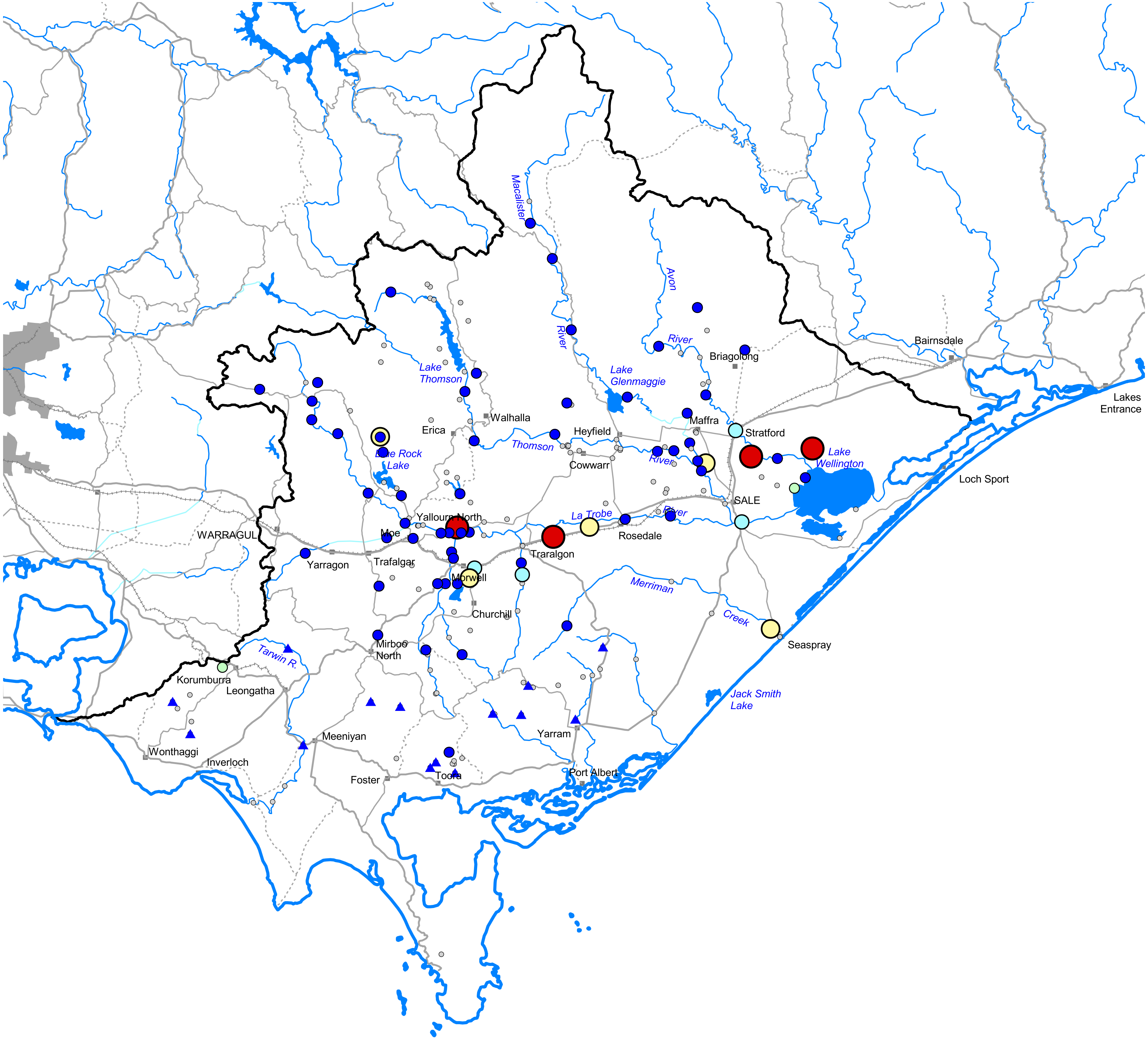
As with lakes and wetlands, stream salinity predominantly impacts on the instream and riparian habitats and biota. Some biota have a limited tolerance to salinity and may be replaced by other more tolerant species. The SEPP salinity limits are based primarily on protecting the habitat of the indigenous flora and fauna.

River salinity can also impact on diversions from the river for irrigation or industrial use. Increasing river salinity can decrease the potential use of river water.

Figure 9

West Gippsland Salinity Management Plan

Stream Water Quality



0 10 20 30 40 50 Kilometres

Compliance with EC 90th percentile SEPP
- > 95 (High)
- 90 - 95 (Moderate)
- 50 - 90 (Low)
- < 50 (Very Low)

Compliance with EC 80th percentile ANZECC
- > 95 (High)

Not enough data

Not Analysed

Refer to Sinclair Knight Merz document WCMS\wc02655\technical\gis\Wc02655t003.apr; Stream Water Quality (Layout)

Groundwater

Groundwater is an important asset in the region and is used for irrigation, stock and domestic and town water supply purposes. These uses are highly sensitive to the salinity of the groundwater and increases in salinity can severely restrict the use of the groundwater. For instance, prolonged irrigation with saline groundwater leads to land salinity. Domestic use of saline groundwater can lead to corrosion of pipes and other infrastructure and may reduce the life of appliances such as washing machines and hot water services. The use of groundwater as a potable water supply can also be adversely affected by increases in groundwater salinity.

The approximate groundwater salinity in the region is shown in Figure 10 based on the Statewide Beneficial Use mapping (DCNR, 1995).

It is difficult to distinguish between natural and induced groundwater salinity. Groundwater dissolves salts stored in the rocks and sediments and is often naturally saline. Conversely, groundwater can become saline through processes such as:

- Evaporative concentration of salt from a near surface and elevated water table;
- Influx of ocean water if the near coastal aquifers are over-pumped; and
- Concentration of salts occurring during the continuous cycle of irrigating with pumped groundwater which recharges the aquifer and is then pumped out again.

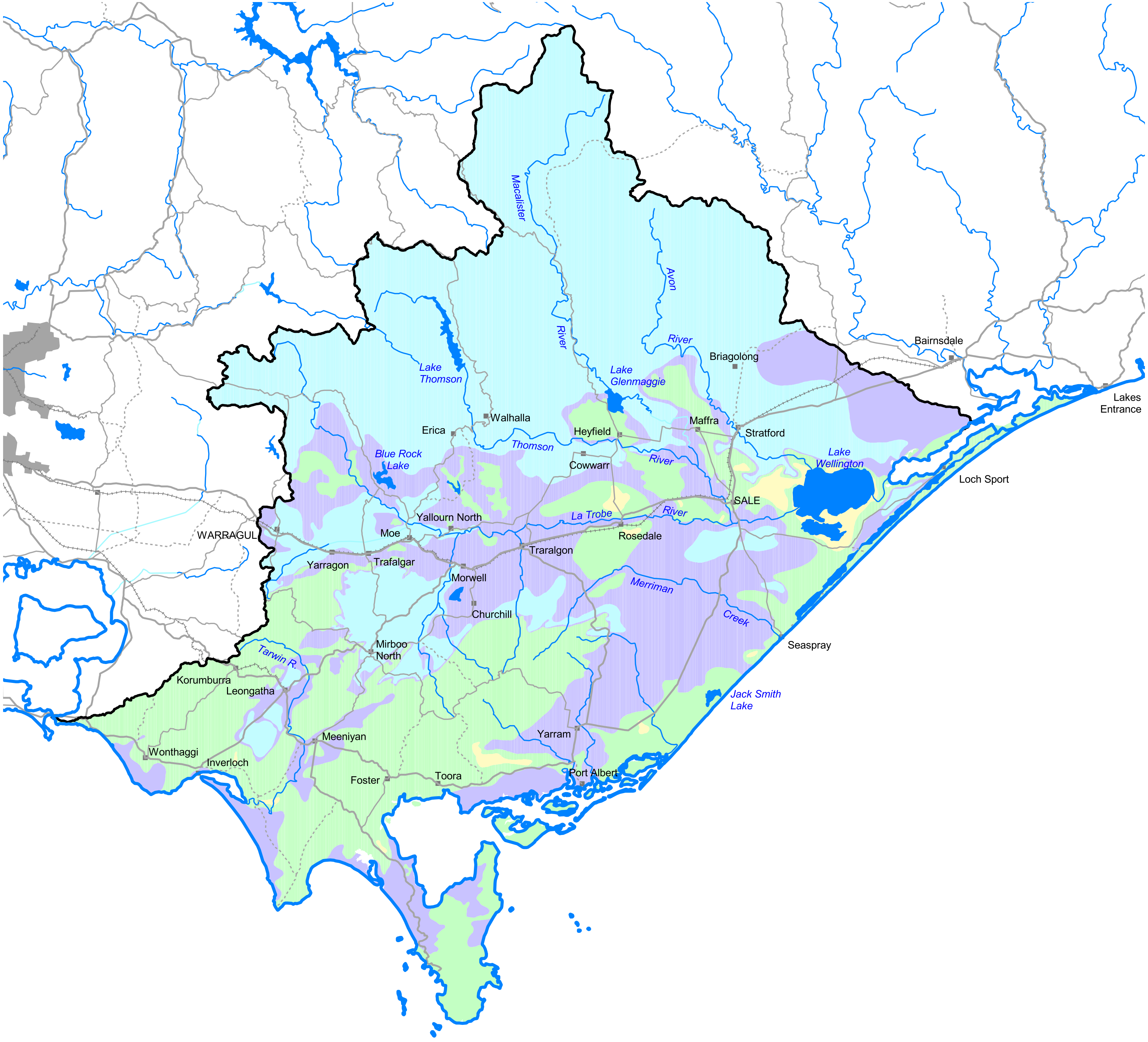
In West Gippsland, the key adverse salinity effects on the region's groundwater assets are:

- Increasing groundwater salinity in the shallow alluvial aquifer occurring in the high water table areas of the Clydebank, Nambrok, Heyfield and Maffra Salinity Management Areas as shown by monitoring data. This increasing salinity trend is likely to be caused either by concentration of salt in the near surface water table and/or the recycling effect of groundwater pumping and in-situ irrigation. The shallow alluvial aquifer in these regions is used for irrigation, stock and domestic purposes.
- The potential for increasing groundwater salinity in the Boisdale Aquifer in the Clydebank Salinity Management Area from the over-pumping of the aquifer and the drawing in of saline water from Lake Wellington. The Boisdale Aquifer underlies the shallow alluvial aquifer across most of the eastern half of the region. Monitoring data shows that water levels in the aquifer are currently below lake level mainly as a result of groundwater pumping. The degree to which lake water is drawn into the aquifer not only depends on the relative levels of lake and groundwater but also on the degree of hydraulic connection between the two. The degree of hydraulic connection is not currently known and is the subject of a current investigation. This is only a potential problem and the monitoring data does not indicate that this process is occurring yet. However, this process has the potential to affect a significant resource used for irrigation and the Sale town water supply. This issue is currently being addressed through Southern Rural Water's management program for the "Sale Water Supply Protection Area" which covers the Boisdale Aquifer in the Sale/Clydebank region and as such, no further mention is made of this issue in this plan.

Figure 10

West Gippsland Salinity Management Plan

Watertable Salinity



Salinity compiled from;
DCNR, 1995,
Victorian Groundwater Beneficial Use Map Series
Eastern Victoria Watertable Aquifers

Refer to Sinclair Knight Merz document
WCMS\wc02655\technical\gis\Wc02655t002.apr;
Watertable salinity (Layout)

4.3.3 Infrastructure Assets

Salt can be particularly damaging to infrastructure such as roads, buildings and underground services due to the acceleration of processes such as rust, corrosion and waterlogging.

The methodology adopted is based on previous economic studies in the area (Read Sturgess and Associates, 1999) and cost guidelines developed for the Murray-Darling Basin Commission and the National Dryland Salinity Program (Wilson, 2002). The cost of salinity on infrastructure has been separately quantified below for roads, buildings, underground services and other infrastructure.

- *Roads*

  The impact of salinity on roads is the result of water intrusion beneath the pavement, affecting pavement life and durability. This excessive moisture leads to deterioration in the durability of the pavement, causing an effect similar to a large increase in heavy vehicle traffic (Read Sturgess, 1999).

  Given the available information for the West Gippsland Salinity Management Areas on depth to watertable levels and the salinity concentrations, costs per length of road subject to watertables of less than 2m depth were based on 'moderate' salinity impacts (as quantified by Wilson (2002)) calculated separately for the length of highways, sealed and unsealed roads. Based on this methodology, the total costs of salinity damage to roads in the West Gippsland region is estimated to be between approximately $800,000 and $900,000 per year – over 40% of which is attributed to the Princes Highway. Additional costs to pavement would be expected at airstrips including the RAAF base near Sale.

- *Buildings*

  The principal cause of damage to buildings from high watertables and salinity is the damage to foundations and gardens. High watertables reduce the life of foundations, and damage walls and fittings due to foundation movement (Read Sturgess, 1999). Assuming a moderate cost impact, cost functions for households and commercial/retail/industrial buildings (based on Wilson (2002)) were applied to the study area. Costs were estimated based on the approximate number of buildings situated in areas affected by watertables that are within 2 metres of the land surface.

  Based on these assumptions, the additional cost of salinity and high watertables to households and commercial, retail and industrial buildings in the study area is estimated to be between approximately $800,000 and $900,000 per year.

- *Underground Services*

  Rising watertables and salinity may also affect the operating life, capacity, and maintenance costs of water-related infrastructure. Saline groundwater can be corrosive towards underground service pipes - which may include concrete and cast iron materials - reducing asset life. Assuming an additional cost due to salinity to underground services of $50 per building affected by shallow watertables per year (Read Sturgess, 1999), it is estimated that the current cost of salinity to underground services may be in the order of $100,000 to $200,000 per year across the West Gippsland region.

- *Other Infrastructure*
  According to Wilson (2002), additional funds may also be spent on various activities as a direct result of saline water supplies or high saline watertables, including:
  - Additional annual repairs and maintenance expenditure to infrastructure other than roads and buildings;
  - Construction of new infrastructure better suited to waterlogged and saline conditions;
  - Preventative works such as tree planting, sub-surface drainage and damp-proofing of existing buildings; and
  - Conducting salinity-related community education, research or extension programs.

  These additional costs, including preventative measures, have not been quantified but would also be considered an economic cost of salinity.

  Based on the above, the total infrastructure costs of salinity are estimated to be between approximately $1.6 million and $2.2 million per year. If the trends of future depth to watertable in mapped areas are applied to the whole of the study area, this cost is estimated to rise to between $3 million and $3.8 million per year in approximately 20 years' time.

4.3.4 People and communities

In recent public meetings convened to discuss the West Gippsland Regional Catchment Strategy, communities were generally aware of the salinity problem in the region, particularly in and around the Macalister Irrigation District and ranked salinity as the 20th most important natural resource management issue in the area.

There have been no direct investigations into the effect of salinity on people and communities in the region. However, anecdotal evidence from Landcare Groups and Implementation Committees of the West Gippsland CMA suggest that the main salinity impacts on people and communities in the region are the flow on effects from reduced agricultural output including:

- Increased economic stress on farmers and their families;
- Increased unemployment; and
- Decreased economic and social well being of towns due to reduced farmer spending.

The loss of environmental amenity, particularly the degrading of wetlands and rivers, can result in a decrease in tourism and the associated economic benefits to the local community. For instance, Lake Wellington and surrounding wetlands could attract a much greater number of tourists if their environmental value was not degraded by salinity. Read Sturgess (1999) estimated that the value of the wetlands may already have decreased by one third from the estimated value of the non-salinised state. Also, loss of environmental amenity can result in a decreased feeling of individual well being.

Damage to infrastructure such as roads and buildings can result in an increase in economic stress to families and local communities. This is especially the case in the township of Rosedale, which is purported by the local Landcare Group as suffering from salinity problems. No technical information is available on the salinity effects in the township of Rosedale to back this claim and the collection of this information is an action of the plan. Also, there is likely to be an inconvenience caused by repairs to roads and public buildings affected by salinity.

Increase in river and groundwater salinity can impact on town water supplies (eg Maffra and Sale) and other uses such as irrigation, stock and domestic use.

Salinity can also impact on cultural and heritage assets such as historical buildings and towns, lighthouses and Aboriginal sites.

4.3.5 Biodiversity Assets

The key effect of salinity and waterlogging on the biodiversity asset class in the region is the impact on wetland ecology particularly the loss of native vegetation and habitat for migratory birds and macroinvertebrates. This is particularly the case for the once freshwater wetlands of Lake Wellington, Clydebank Morass, Lake Coleman and others. Generally, indigenous vegetation such as *Melaleuca ericifolia* (Swamp Paperbark) requires water salinities less than approximately 1,500 µS/cm to regenerate. The salinity in many of the wetlands is mostly in excess of 1,500µS/cm. For example, the water salinity in Clydebank Morass is generally less than 1,500µS/cm for approximately 10% of the time (Sinclair Knight Merz, 2001). Current mapping of the ecological vegetation classes in the wetlands will help quantify the loss of native vegetation in some of these wetlands. However, there is strong evidence to suggest that there has been a significant loss of native vegetation in many of these wetlands since European settlement.

In addition to the wetlands, there are also significant occurrences of native flora and fauna that are being affected by salinity and waterlogging. A potential example is the impacts on the significant Gippsland Plains communities. Figure 11 shows the conservation status of native flora and fauna in the area. Appendix B shows the area of depleted, rare, vulnerable and endangered vegetation within areas mapped as saline. Appendix B also shows the area of native vegetation within saline areas categorised as having a conservation status of ‘least concern’. This category of native vegetation is still significant even though it has a ‘least concern’ conservation status mainly due to the large area it covers (Figure 11).

Table 79 (Appendix B) indicates that there are approximately 3,740 ha of native vegetation within mapped saline areas including 1,163 ha of native vegetation classified as rare, vulnerable, endangered or depleted. While, it is important to note that some of this vegetation could be salt tolerant native vegetation adapted to the saline conditions, the majority is expected to be native vegetation that is not particularly salt tolerant and therefore, at risk of being affected by salinity.

Surface water salinity can also adversely affect biodiversity through a change in the aquatic ecology and/or the riparian vegetation. Native fish and invertebrate species can be particularly sensitive to increases in salinity. Riparian vegetation can be important breeding grounds for important bird species. The threat to these ecological values from water quality issues is detailed in the West Gippsland Regional River Health Strategy (WGCMA, 2004).