Miscellaneous Publication 12/2004
ISSN 1447-4980
June 2004

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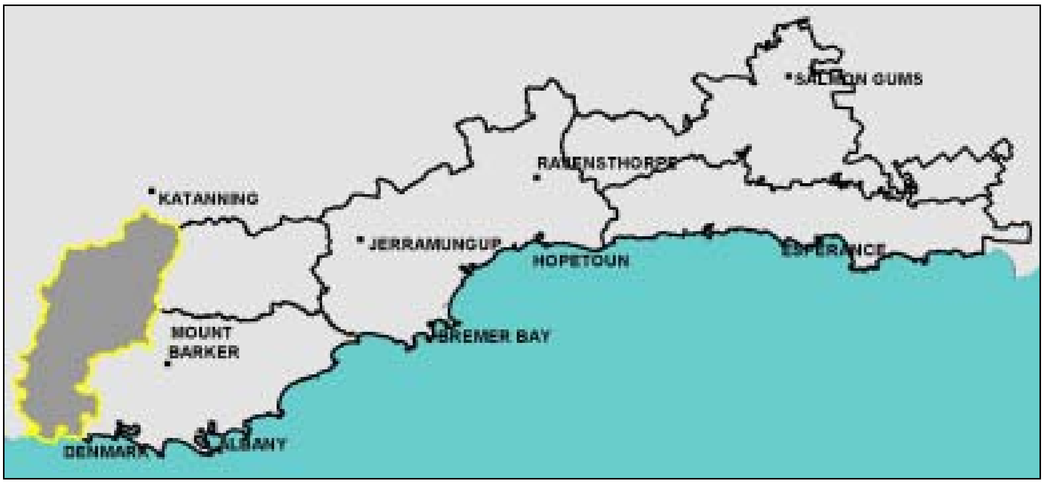

Department of Agriculture
Government of Western Australia

Groundwater trends in the Kent-Frankland sub-region

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The South Coast Regional Initiative Planning Team (SCRIPT) has divided the South Coast region of Western Australia into six sub-regions. Kent-Frankland covers the catchments of the Frankland, Gordon and Kent Rivers. Approximately two-thirds (450,000 ha) has been cleared for agriculture. This publication describes the groundwater trends, risk of shallow watertables, and technical feasibility of salinity management on agricultural land.

Soil-landscape zones are spatial units based on geology and geomorphology. Since most groundwater processes in WA are controlled by the geologic and regolith properties, these zones can be used for allocating hydrological attributes, such as groundwater characteristics and trends. The hydrological attributes are then used to assess the risk of shallow watertables and technical feasibility of salinity management.

Refer to *Further Information* for description of groundwater flow systems, risk analysis and technical feasibility of salinity management.

Background

The Frankland River is the fourth largest in the South West of WA. It is brackish and flows into the Nornalup Inlet before entering the Southern Ocean. Mean stream flow salinity has increased from 110 to 500 mS/m over the last 42 years.

The Kent River is being managed by the Water and Rivers Commission as a future water resource for the South Coast.

The Muir Highway runs east-west through the small townsite of Rocky Gully dividing the sub-region. To the north of the Muir Highway, agricultural activities predominate with State forests to the south.

Climate and rainfall

The sub-region has temperate, moderately dry winters and warm summers. Cold fronts from the south-west bring most winter rainfall providing a growing season of six to eight months. Annual rainfall varies from 1300 mm/yr at the coast near Nornalup decreasing gradually to 450 mm/yr near Broomehill. Rainfall reliability decreases inland in a northerly direction from the coast. Average annual rainfall for the Frankland-Gordon River catchment has decreased from 820 to 650 mm/yr since 1940.

Southern Zone of Rejuvenated Drainage (257)

The Southern Zone of Rejuvenated Drainage covers 49% of the Kent-Frankland sub-region. It consists of dissected areas with undulating upland rises. Dolerite dykes and shear zones are common, usually crossing the landscape in a north-west to south-east direction. Regolith depth varies from less than 15 m in areas where there has been rejuvenation to greater than 15 m in areas that are deeply weathered and have had little rejuvenation.

Groundwater flow system

The groundwater flow system is predominantly local. The aquifers are separated by basement highs composed of granite. Salt storage of the regolith is related to its thickness. A shallow regolith means less salt stored in the soil and consequently lower groundwater salinities. Groundwater discharge occurs mainly in the lower slopes and creeklines. Geological structures influence groundwater movement, leading to salinity in the form of hillside seeps, spring lines and seeps along creeklines.

Groundwater quality, depth and trends

Depth to groundwater varies from 0.5 to 10 m below the surface. Groundwater salinity varies from 600 to 3,000 mS/m with average pH of 5.1. Groundwater levels respond to seasonal conditions and rise and fall throughout the year. In and around creeklines, groundwater is at or near the surface displaying large seasonal fluctuations with a static trend (Figure 1: bores PV12i95 and PV2i95). In lower slope areas where groundwater varies from 1-3 m, the response to periods of below or above-average rainfall is smaller. Generally levels are rising at 0.10-0.15 m/yr (Figure 1: bores PV20i95 and PV23i95).

Bores close to catchment divides with depths to groundwater between 5 and 10 m have rising trends between 0.1 and 0.2 m/yr. Some bores on catchment divides are dry indicating that groundwater is not connected across the divide.

Risk of shallow watertables

The risk of shallow watertables is high in the creeklines and adjacent areas. Areas away from the creeklines have a moderate to low risk. It is likely that in 20 to 30 years, salinity will have reached equilibrium.

Technical feasibility of salinity management

Management options are currently available to manage and contain the spread of salinity. The effectiveness of these options is high due to the responsiveness of the local aquifers.

Stirling Range Zone (248)

Stirling Range Zone covers 6% of the Kent-Frankland sub-region. It consists of catchment divides and broad flat plains with creeklines overlying sedimentary and granitic rocks. Pinjalup Creek is one of the main creeklines draining to the Gordon River. This drainage makes this part of Zone 248 slightly different to the North Stirling Pallinup sub-region.

Groundwater flow systems

The aquifers in these systems are local to intermediate, discharging into nearby creeks and depressions on the plains.

Groundwater quality, depth and trends

Depth to groundwater is shallow, 0.5 to 3.5 m below ground. Groundwater salinity ranges from 550 to 3,500 mS/m with a pH of 6.4. Fresher groundwater is usually associated with local aquifers. Groundwater trends range from 0 to -0.10 m/yr with many bores showing static or falling trends (Figure 1: bore C13d97).

Groundwater levels are responsive to seasonal rainfall and fluctuate accordingly. The low rainfall in both 2001 and 2002 has caused reductions in rates of groundwater rise.

Risk of shallow water tables

The area has a high risk of shallow watertables with many areas already having groundwater within 2.5 m of the surface.

Technical feasibility of salinity management

Moderate success in containing salinity can be achieved in areas with some relief using existing salinity management techniques (planting perennials and surface drainage). Good prospects exist for revegetating areas that are already salt-affected with plants adapted to saline environments.

Warren-Denmark Zone (254)

The Warren-Denmark Zone covers 45% of the Kent-Frankland sub-region. The main landforms are lateritic plains, hills, dissected terrain, swampy hills and coastal dunes. These are based on sediments and colluvium over granitic rocks.

Groundwater flow systems

The groundwater systems are usually local with boundaries similar to the surface water catchment divides.

Groundwater quality, depth and trends

Depth to groundwater varies from 0-1 m in depressions and creeks to 14 m near catchment divides. Groundwater salinity varies with rainfall. In areas with less than 500 mm annual average rainfall, salinities are greater than 2,500 mS/m, with an average pH of 4.6 (slightly acid). In areas with rainfall greater than 700 mm, salinities are less than 1,300 mS/m with an average pH of 5.8. Groundwater levels near creeklines and depressions respond quickly to rainfall, showing a strong seasonal fluctuation with slight rising trends to 0.05 m/yr (Figure 1: KE16d85). Groundwater levels in mid-slope areas exhibit smaller seasonal fluctuations but respond to below-average and above-average rainfall years (Figure 1: bores AH02i and FH01d). Episodic recharge occurs in years with large rainfall events and above-average rainfall (Figure 1: bore BU9i84).

Trends are mixed and range from a falling trend of 0.10 m/yr to a rising trend of 0.15 m/yr, indicating the aquifer’s responsiveness to rainfall and land use. Groundwater levels near or on catchment divides show steady rising trends of 0.10 m/yr with fluctuations due to variations in annual rainfall (CP2d93).

Risk of shallow watertables

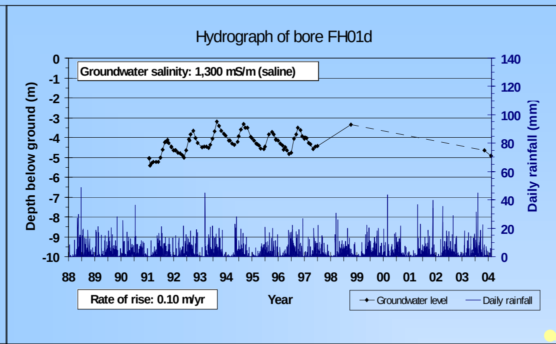
The zone has a moderate to high risk of salinity with most expected to develop fully within 10 years. Main occurrences will be in valley floors and as hillside seeps. Dolerite dykes and shear zones contribute to these effects.

Technical feasibility of salinity management

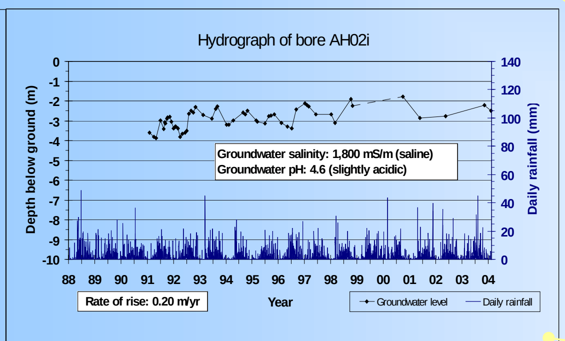
With current management practices, the technical feasibility of recovering salt-affected areas is moderate and containment is excellent.

SCRIPT sub-region	Soil zone (No.)	Proportion of sub-region's agricultural land (%)	Time until potential salinity fully develops[SIF]	Salinity management technical feasibility[SIF]		
				Recovery	Containment	Adaptation
Kent–Frankland	Southern Zone of Rejuvenated Drainage (257)	49	Short-medium term (20–30 yrs)	Moderate	Good	Good
	Warren–Denmark (254)	45	Imminent (<10 yrs)	Good	Excellent	Excellent
	Stirling Range (248)	6	Imminent (<10 yrs)	Moderate	Moderate	Good

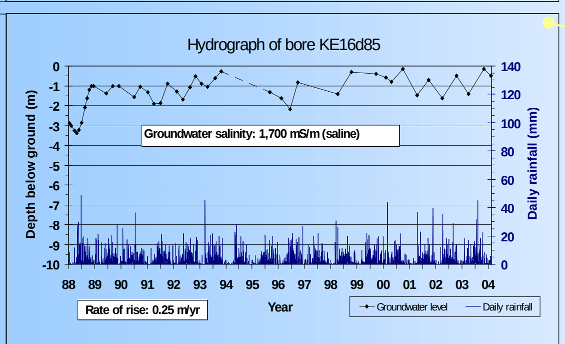
Location: North of Frankland; Frankland River Catchment
Soil-landscape system: Frankland Hills (254Fh)
Soil: Loamy gravel
Land use: Cropping / pasture
Landform: Upper slope
Average annual rainfall: 550 mm



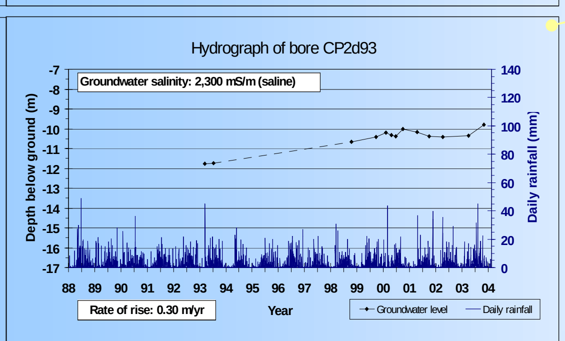
Location: East of Frankland; Frankland River Catchment
Soil-landscape system: Yarraleena (254Ya)
Soil: Duplex sandy gravel
Land use: Cropping / pasture
Landform: Mid-slope
Average annual rainfall: 550 mm



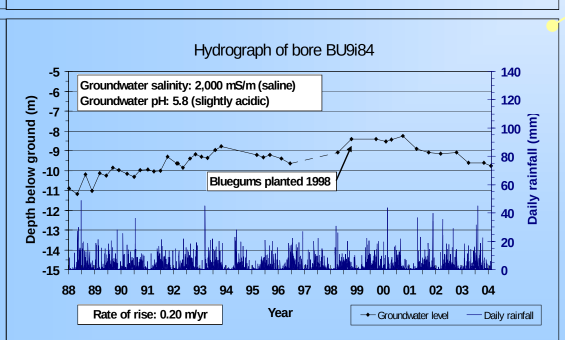
Location: Lake Poorrarecup south-east of Frankland; Kent River Catchment
Soil-landscape system: Kent (254Ke)
Soil: Saline wet soil
Land use: Native vegetation
Landform: Broad flat
Average annual rainfall: 575 mm

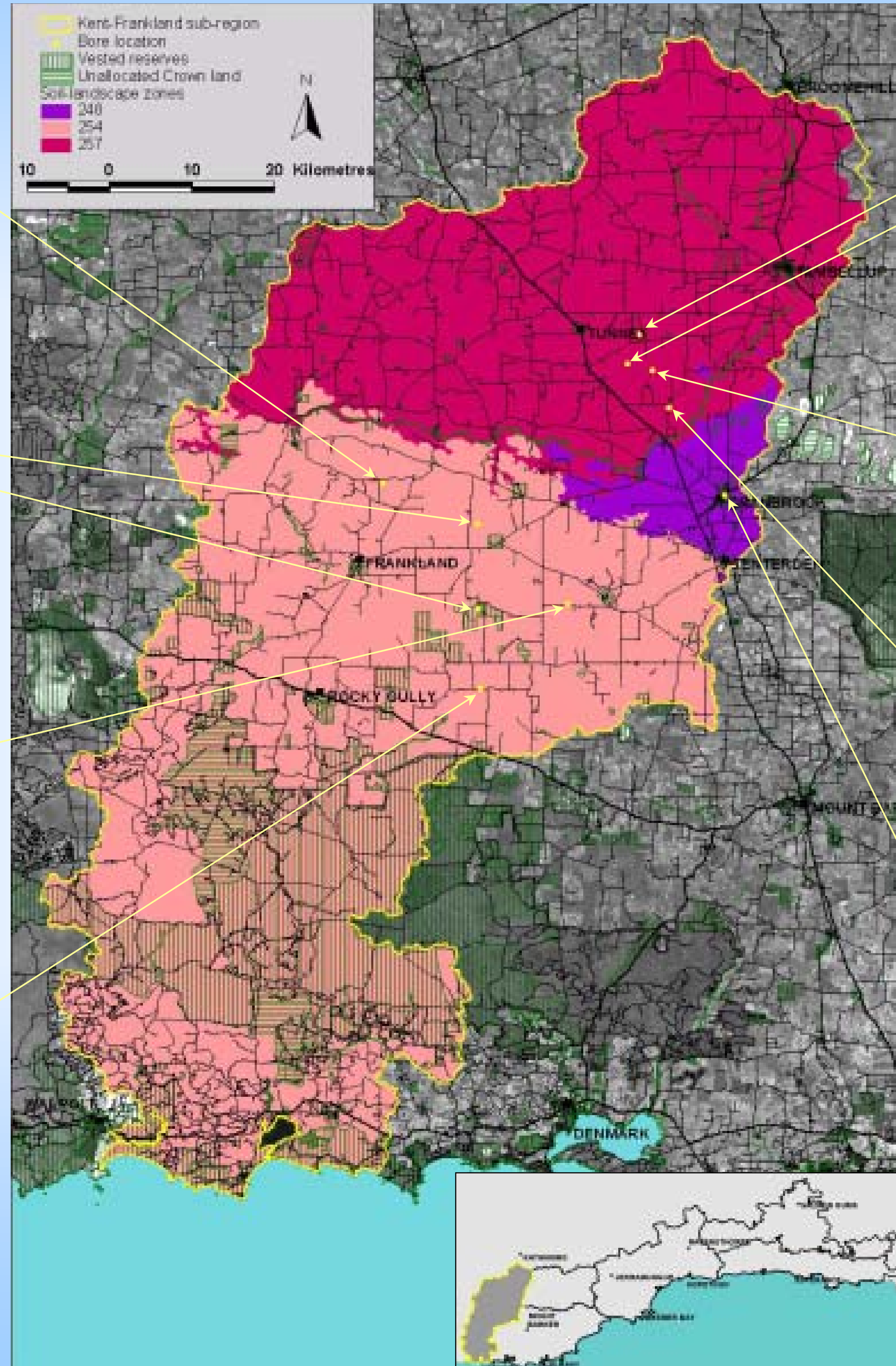


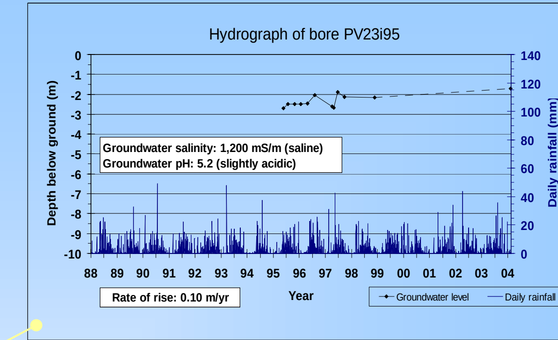
Location: West of Kendenup; Kent River Catchment
Soil-landscape system: Kent (254KE)
Soil: Duplex sandy gravel
Land use: Cropping / pasture
Landform: Upper slope
Average annual rainfall: 550 mm



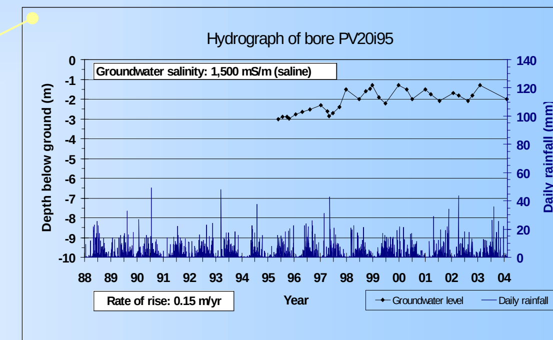
Location: North-west of Mt Barker; Kent River Catchment
Soil-landscape system: Kent (254Ke)
Soil: Duplex sandy gravel
Land use: Cropping and pasture then Bluegums
Landform: Upper slope
Average annual rainfall: 625 mm



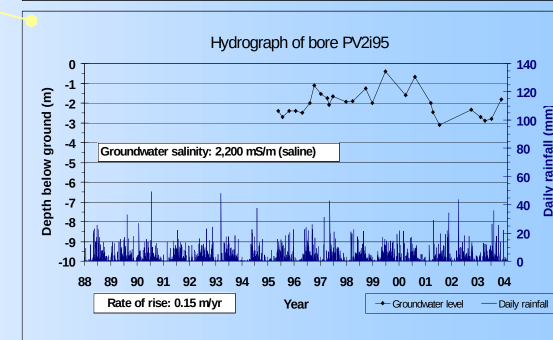




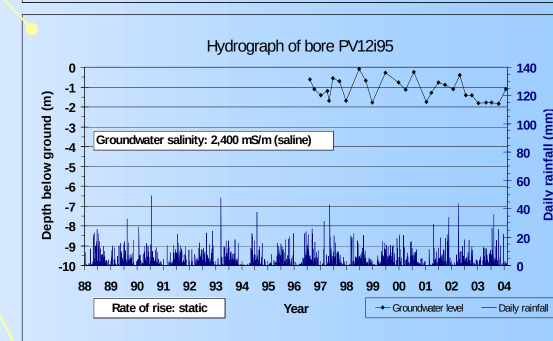
Location: East of Tunney; Gordon River Catchment
Soil-landscape system: Farrar (257Fa)
Soil: Grey deep sandy duplex
Land use: Cropping / pasture
Landform: Mid-slope
Average annual rainfall: 450 mm



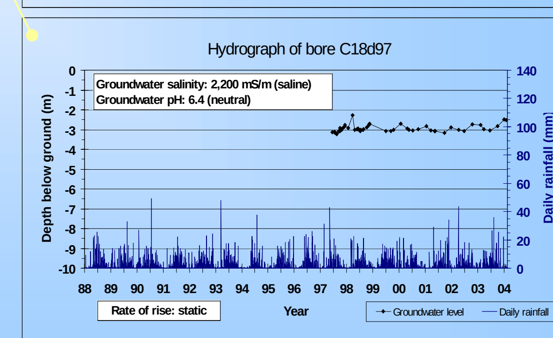
Location: South-east of Tunney; Gordon River Catchment
Soil-landscape system: Farrar (257Fa)
Soil: Grey sandy duplex
Land use: Cropping / pasture
Landform: Mid-slope
Average annual rainfall: 450 mm



Location: South-east of Tunney; Gordon River Catchment
Soil-landscape system: Carrolup (257Ca)
Soil: Grey deep sandy duplex
Land use: Cropping / pasture
Landform: Mid-slope
Average annual rainfall: 450 mm



Location: North-west of Cranbrook; Gordon River Catchment
Soil-landscape system: Carrolup (257Ca)
Soil: Grey sandy duplex
Land use: Cropping / pasture
Landform: Lower slope
Average annual rainfall: 450 mm



Location: South-east of Cranbrook; Gordon River Catchment
Soil-landscape system: North Stirlings (248Nt)
Soil: Grey deep sandy duplex
Land use: Native vegetation
Landform: Broad flats
Average annual rainfall: 475 mm

Figure 1: Groundwater trends in the Kent–Frankland sub-region

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Table 1: Risk of shallow watertables for systems in the Kent-Frankland sub-region

Soil-landscape zone	Soil-landscape system	% of sub-region's agricultural land in system	Risk of shallow watertables[NLWRA]			Proportion of system with low-lying areas (0–0.5 m)[LMP]
			2000	2020	2050	
Southern Zone of Rejuvenated Drainage (257)	Carrolup (257Ca)	23	M	M	H	15
	Farrar (257Fa)	17	M	M	M	10
	Gordon Flats (257Gd)	5	NA	NA	NA	45
	Jingalup (257Jp)	2	M	M	H	5
	Mooliup (257Mp)	1	M	M	H	20
Warren–Denmark (254)	Kent (254Ke)	19	M	M	H	20
	Frankland Hills (254Fh)	13	M	M	H	10
	Yaraleena (254Ya)	5	M	M	H	5
	Perup Plateau (254Pp)	3	NA	NA	NA	5
	Walpole Hills (254Wh)	2	L	L	M	10
	Broke (254Br)	1	H	H	H	25
	Kentdale (254Kd)	1	M	M	H	10
Stirling Range (248)	Jaffa (248Jf)	3	NA	NA	NA	10
	North Stirlings (248Nt)	2	H	H	H	55
	Stirling Range (248St)	1	L	L	L	5

Source: Short and McConnell (2001)

NLWRA and LMP: Refer to *Further Information* for definitions and risk categories

Further information

Soil-landscape zones and systems

Soil-landscape mapping in south-western Australia is based on a hierarchical system that enables correlation between surveys at different scales and maintains a consistent approach for dealing with areas of varying complexity in both landscape and soil patterns.

The first two levels of the hierarchy, *regions* and *provinces,* are based on the descriptions and framework introduced by the CSIRO Division of Soils in 1983 for the whole of Australia. The remaining four levels - *zones, systems, subsystems* and *phases* are based on mapping conducted by the Department of Agriculture. At higher levels in the hierarchy the mapping units are based on regional geomorphological differences and at lower levels the individual soil and landscape components become more important.

The level of mapping unit is implicit in its label and as the scale of mapping increases, the label (in brackets) becomes more detailed. For example, the South Coast region falls into the Western Region (2) and predominantly within the Stirling Province (24) with some overlap into the Avon Province (25). Zones within these provinces are defined using geomorphological and geological criteria, and areas in these zones with recurring patterns of landforms, soils and vegetation, are grouped into systems. For example, the Kent-Frankland sub-region contains predominantly the Warren–Denmark Zone (254), which comprises a number of systems, including Kent (254Ke). The information in this publication pertains to the soil-landscape zone and system levels.

Groundwater flow systems

Groundwater processes causing salinity can be categorised according to their flow systems because the scale (local, intermediate or regional) of the system reflects the ease with which salinisation can be managed.

Local groundwater flow systems are those where recharge and discharge of groundwater are in close proximity to each other — usually within 1–3 km. These systems are very responsive to land use changes.

Intermediate groundwater flow systems have a horizontal extent of 5–10 km and generally occur across several properties.

Regional groundwater flow systems have groundwater recharge and discharge areas separated by distances of 50 km or more and consequently are very slow to respond to land use changes. Regional groundwater flow systems can be overlain by local and intermediate systems.

National Land and Water Resources Audit (NLWRA)

The NLWRA was established in 1997 under the *Natural Heritage Trust Act* to collect and collate primary data and information related to natural resource management. The extent and impacts of dryland salinity were identified as part of the NLWRA.

Risk of shallow watertables

Risk of shallow watertables was assessed using groundwater level trend data from the Department of Agriculture's AgBores database. Risk of shallow watertables (Table 2) was applied to entire system units based on an assessment of the most frequently occurring groundwater depth and trend data for each unit.

Table 2: Definition of risk categories

Risk	Groundwater level and trend
High (H)	<2 m 2–5 m and rising
Moderate (M)	<2 m and falling 2–5 m and static or falling 5–10 m and rising >10 m and rising
Low (L)	5–10 m and static or falling >10 m and static
No risk	>10 m and falling
Not assessed (NA)	Insufficient groundwater data to make an assessment

Land Monitor Project (LMP)

LMP was a satellite and terrain-based assessment combined with mapping of salinity, topography, and vegetation extent and change.

Low-lying areas

A digital elevation model was used to determine 'height above flowpath' in order to map low-lying areas. Height above flowpath measures the vertical elevation from flowpaths, which are areas where water flow accumulation is high (not just creeklines). Once the flowpath is defined, the low-lying areas within a discrete (0.0–0.5 m) height class above the flowpath can be identified. Low-lying areas may be at risk of flooding, inundation and waterlogging, and where groundwater levels are rising, indicate areas with potential to develop shallow watertables.

Salinity Investment Framework (SIF)

The SIF was undertaken to guide public investment in salinity management initiatives. As part of the process, an assessment of the range of salinity management options was undertaken for each soil-landscape zone. The options included existing engineering and plant-based practices or systems that will deliver the maximum impact on the extent and severity of salinity.

Timing of salinity

Hydrological equilibrium occurs when the groundwater in an area of risk ceases to rise and the area of groundwater discharge ceases to expand. The average time required for a zone to reach hydrological equilibrium (Table 3) was assessed on the basis of available groundwater trend data and analyses prepared for the National Land and Water Resources Audit.

Table 3: Timing scales of salinity

Term	Time until potential salinity fully develops
Imminent	<10 years
Short-term	10–20 years
Short-medium term	20–30 years
Medium-term	30–75 years
Long-term	>75 years

Technical feasibility of salinity management

Technical feasibility is a measure of the availability and capacity of salinity management options to recover, contain or adapt to salt-affected land. The technical feasibility factors are largely qualitative and were based on published data and assessments by hydrologists from the Department of Agriculture. The technical feasibility is based on the average hydrological responsiveness of the entire zone.

Definitions of technical feasibility are:

- recovery – reverse the salinisation process and recover degraded land and water resources
- containment – manage salinity so that further impacts are minimised
- adaptation – live with and adapt to the consequences of salinity and minimise the losses.

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Acknowledgments

Thanks to Nick Middleton for spatial analysis and image production; John Simons for compiling the technical definitions and descriptions; Angela Alderman for editing and graphic design.

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