5 Conclusion

The inclusion of the six new bores in the monitoring program has meant there is now a comprehensive groundwater monitoring network that covers the Timor West targeted area. This provides a means to assess hydrogeological processes contributing to the dryland salinity issues in the area. These processes include:

- Subdued watertable responses in the landscapes around Mount Hooghly due to extensively developed clayey sub-soils and weathered material with low permeability. In these areas, shallow perched watertables, surface waterlogging and excess runoff lead to salinity and erosion.
- Extreme watertable response in the metamorphic ridge around the Black Range. In some cases groundwater fluctuations of up to 3 m have occurred in one year. This is due to the deeply weathered and fractured nature of the Black Range.
- Discharge at the base of Black Range and Mount Hooghly is the result of local groundwater systems, where recharge (mid-lower slope) and discharge (base of slope) occur very close together. The change in morphology from hills to flat plains causes groundwater to discharge at the break-of-slope.
- Regional groundwater processes with excess groundwater entering the catchment area via the Bet Bet Deep Lead. This is also linked to surface conditions as the hydrograph behaviour exhibited in Bores 36 and 151 (Appendix 1) indicates surface climatic conditions affect the deep lead.
- Underlying basalt acts as a fresh water conduit between the alluvial and the underlying deep leads and Ordovician bedrock.

Groundwater levels have fallen considerably since 1996. Some bores (e.g. 5417, Appendix 1) are dry with the watertable having dropped below the base of these bores, which, in the 20 plus years of monitoring history in the Timor West targeted area, has never happened before.

Inclusion of the six new groundwater monitoring bores has developed a comprehensive monitoring network covering the Timor West targeted area. They also indicate that salinity in the targeted area is not just associated with the discharge sites at the break-of-slope, but high groundwater salinity in bores located away from major discharge sites (e.g. Bore 60244, Table 2, Figure 4).

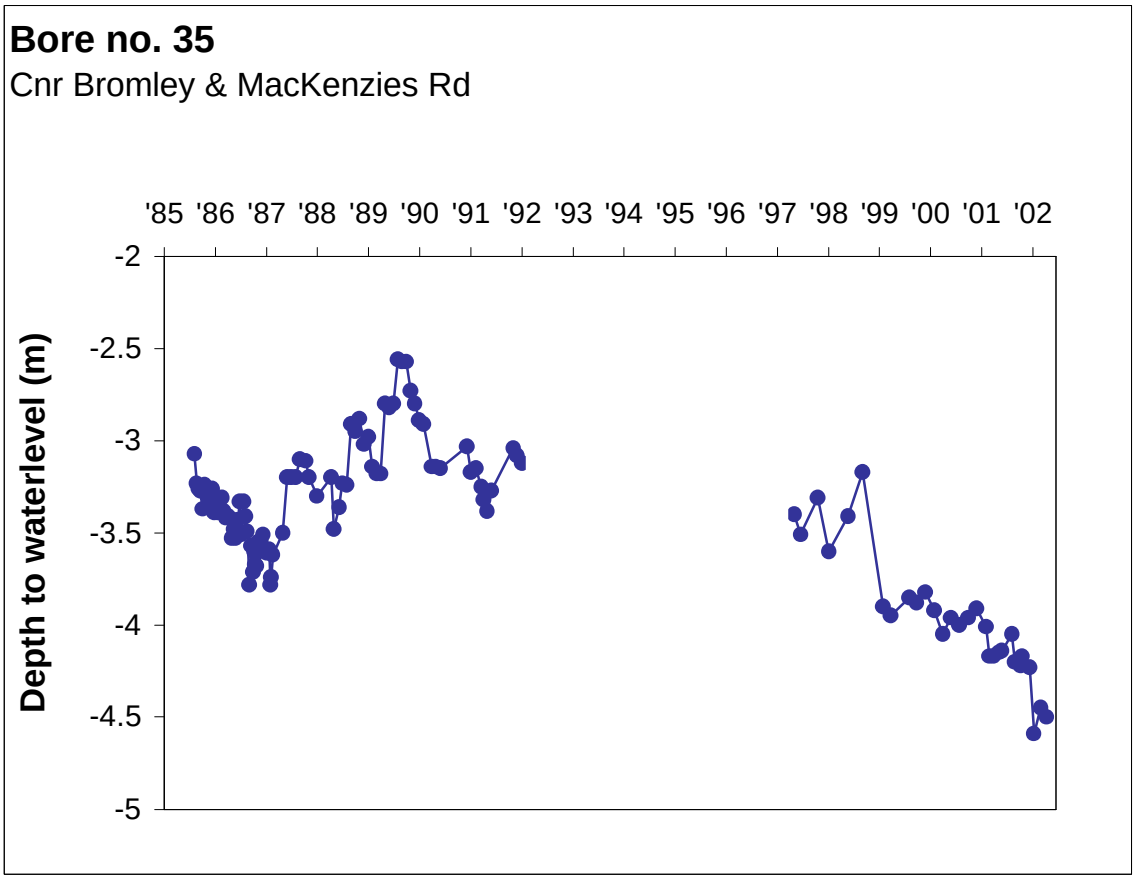
References

Coram JE, Dyson PR and Evans WR (2001) An evaluation framework for dryland salinity. National Land and Water Resources Audit Dryland Salinity Project, Bureau of Rural Sciences, Canberra.

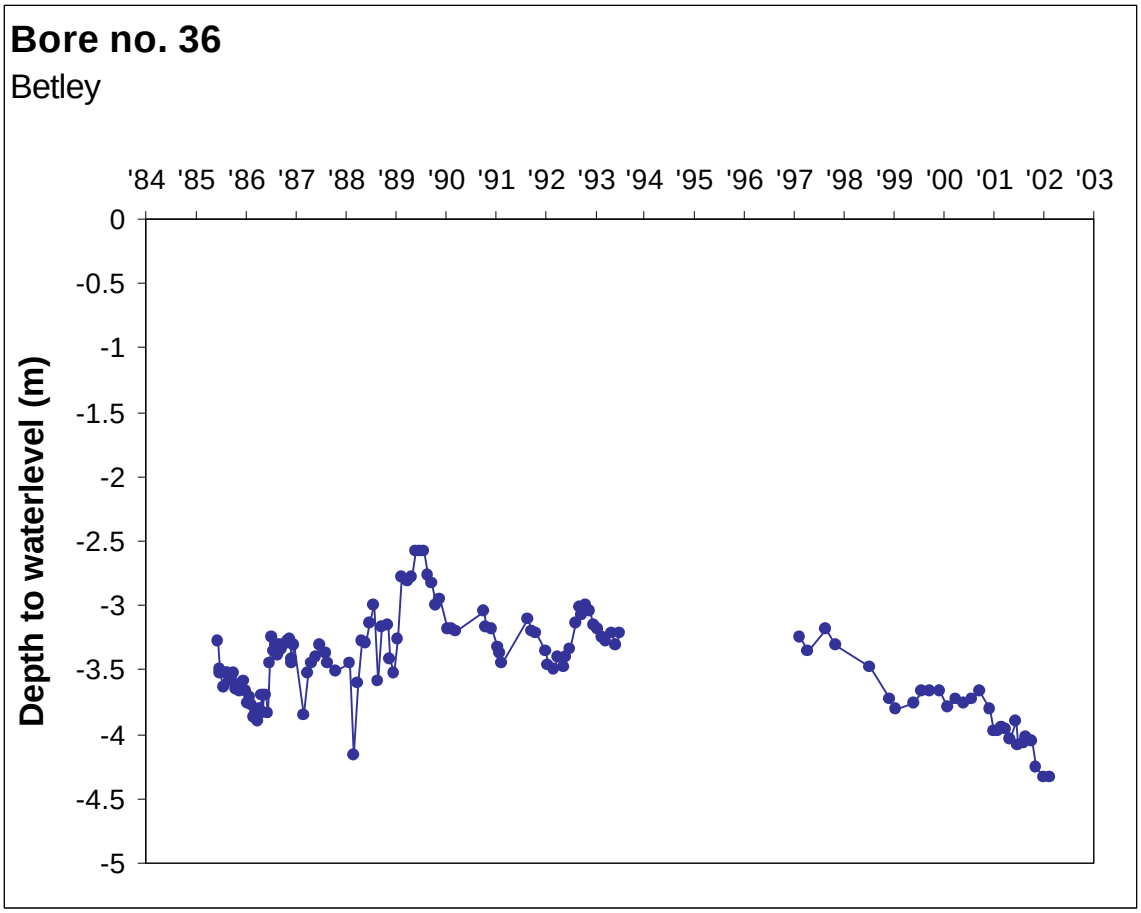
Day C (1985) A study of the geomorphic, soil and geohydrological conditions of the Timor West/Black Ranges area. Land Protection Service, Conservation Forests and Lands.

Perry R (2003) Timor West targeted salinity project brochure. Department of Primary Industries, Victoria

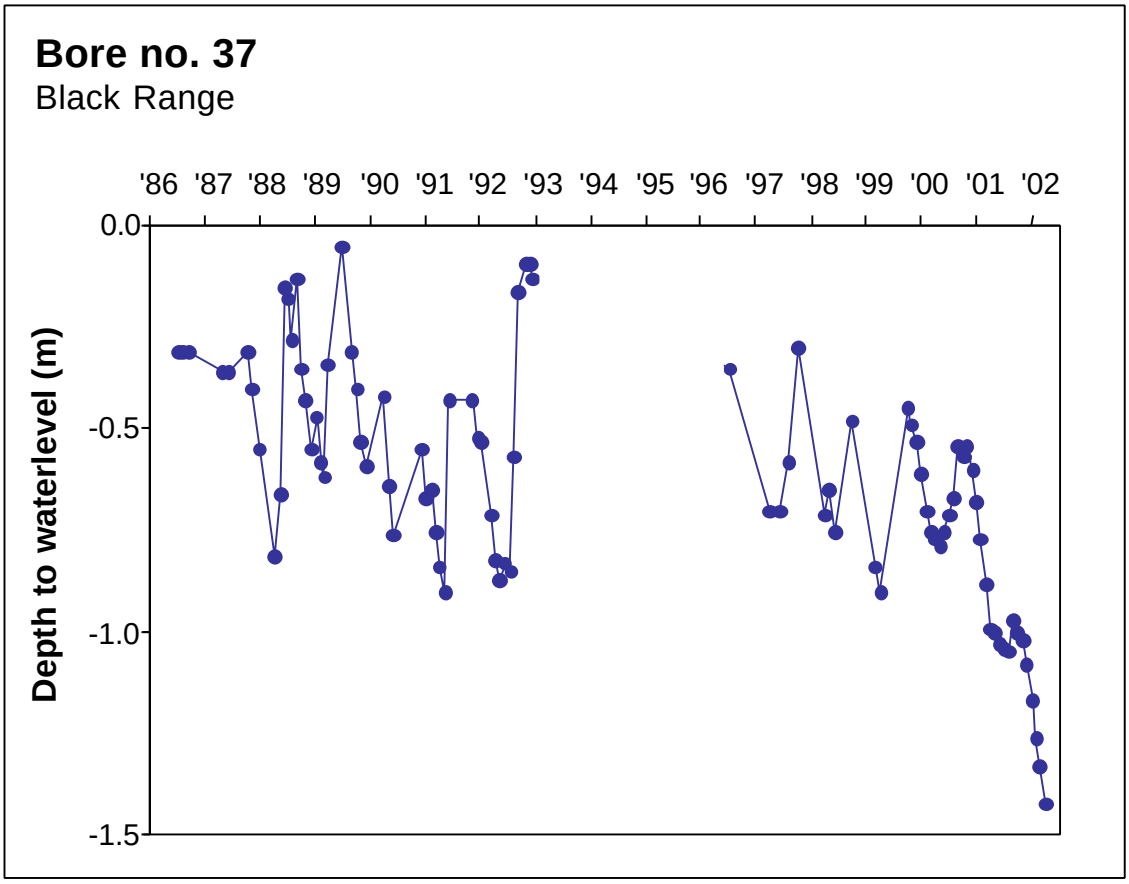
Appendix 1 Hydrographs of Timor West monitoring bores



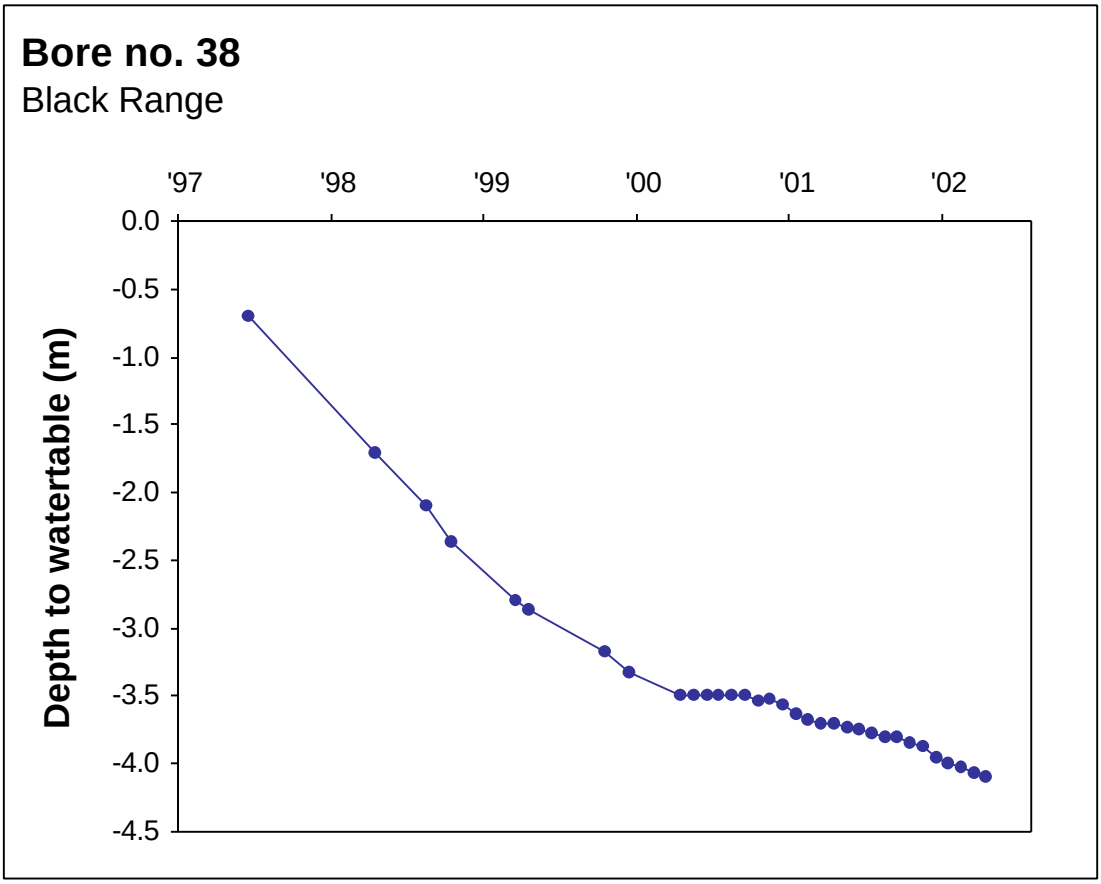
CLPR No:	35	Bore monitor:	DPI
Locality description:	Corner of Bromley and McKenzies Roads Located in Bet Bet Deep Lead Bore located on plain, flat landscape		
Geological description:	Shepparton Formation Fluvial clay, silt, sand and gravel		
Bore depth (m):	60	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	4.5	Salinity (EC) (µS/cm):	2700
Groundwater trend:	Responsive to seasonal climatic variation with an overall falling groundwater trend.		



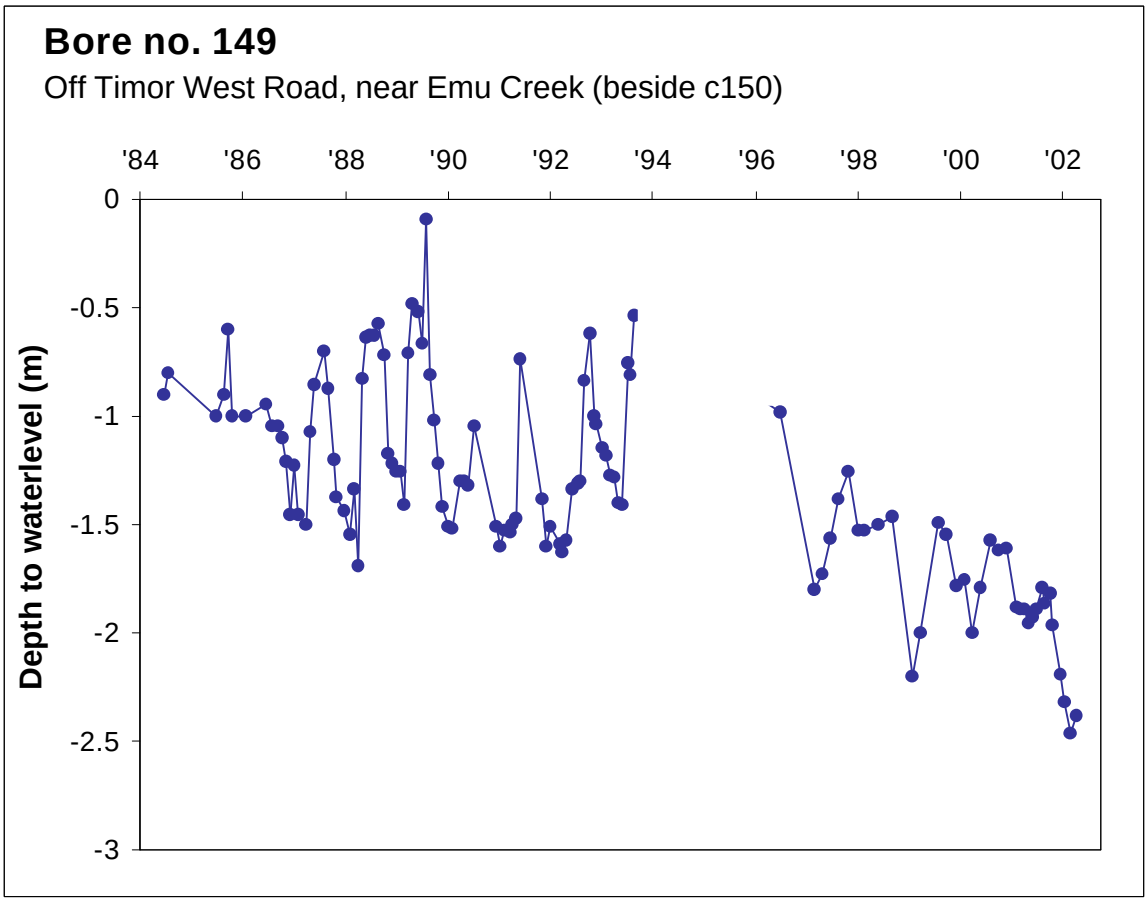
CLPR No:	36	Bore monitor:	DPI
Locality Description:	Betley Bet Bet Deep Lead Bore located in plain, flat landscape		
Geological description:	Shepparton Formation Fluvial clay, silt, sand and gravel		
Bore depth (m):	90	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	4.3	Salinity (EC) (µS/cm):	—
Groundwater trend:	Even groundwater trend, slight fall in waterlevel since 2002.		



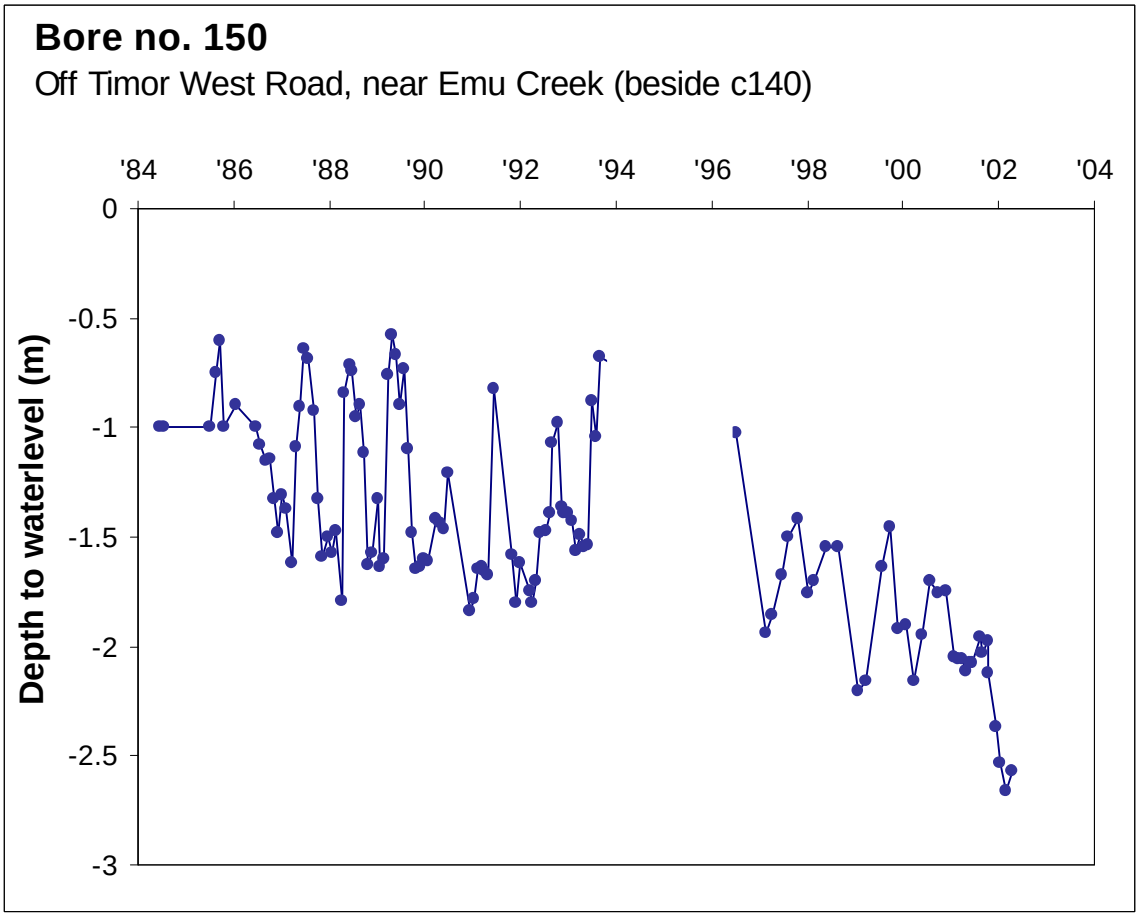
CLPR No:	37	Bore monitor:	Alex Wiseman
Locality description:	Black Range Bore located mid-slope		
Geological description:	Devonian granite and associated metamorphic rocks Clay, sand overlying hard, fresh, granite/metamorphic rock		
Bore depth (m):	18	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	1.8	Salinity (EC) (µS/cm):	—
Groundwater trend:	Very responsive to seasonal rainfall variation, falling trend overall, prominent since 1996		



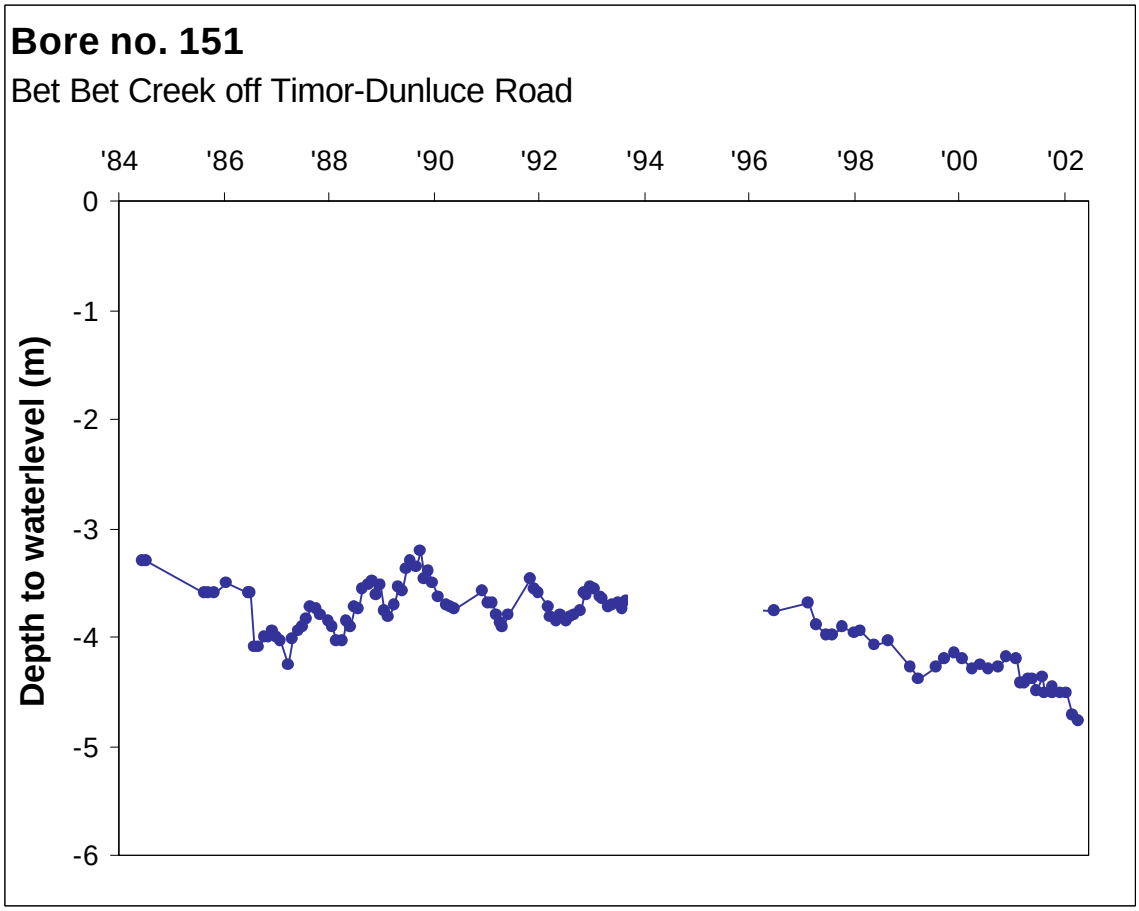
CLPR No:	38	Bore monitor:	Alex Wiseman
Locality description:	Black Range Bore located in plain, flat landscape		
Geological description:	Devonian Granite and associated metamorphic rocks Clay, sand overlying hard, fresh, granite/metamorphic rock		
Bore depth (m):	27	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	4.0	Salinity (EC) (µS/cm):	—
Groundwater trend:	Strong falling trend. Located beside 5121-22. Representative of the last six years.		



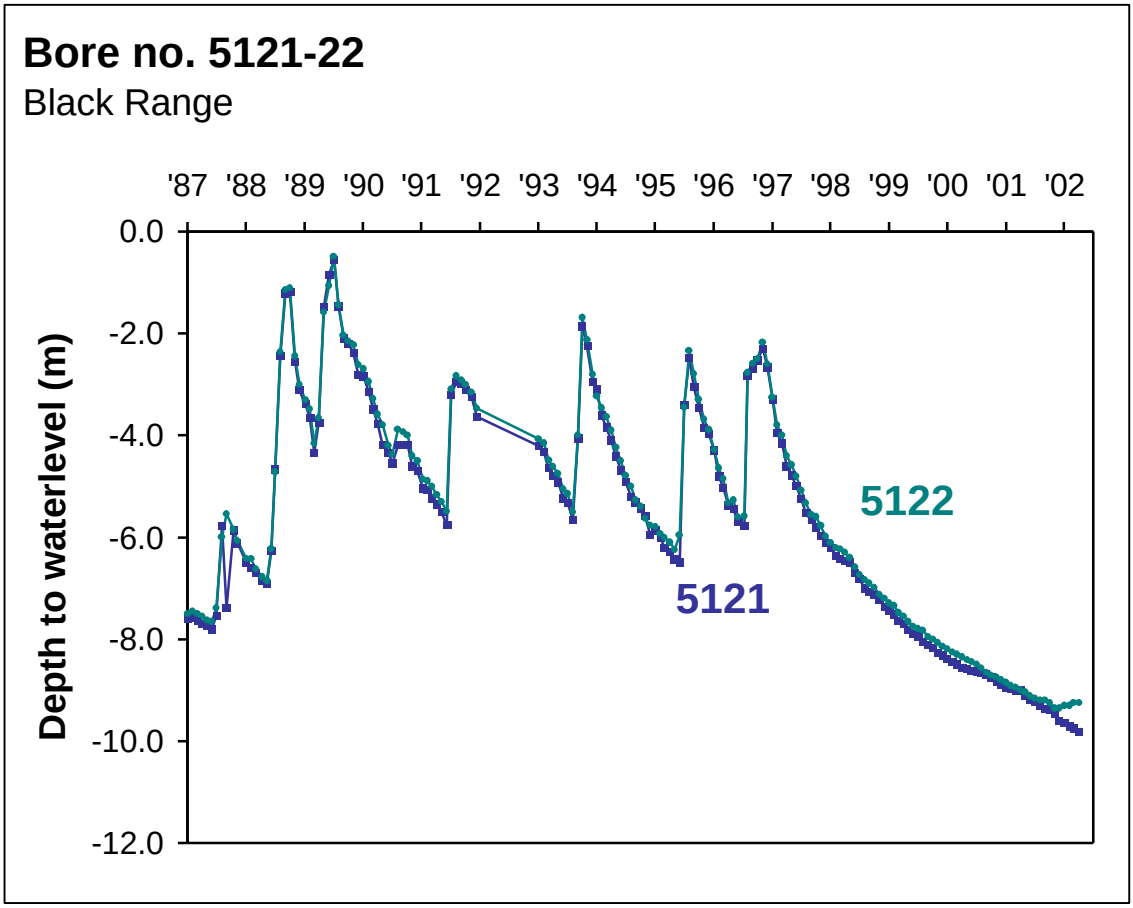
CLPR No:	149	Bore monitor:	DPI
Locality description:	Timor West Rd, Timor West Bore located on lower slope, river flat landscape		
Geological description:	Shepparton Formation Fluvial clay, silt, sand and gravel		
Bore depth (m):	15	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	2.5	Salinity (EC) (µS/cm):	—
Groundwater trend:	Strong response to seasonal climatic variation, overall falling trend, steeper falling trend since 1998.		



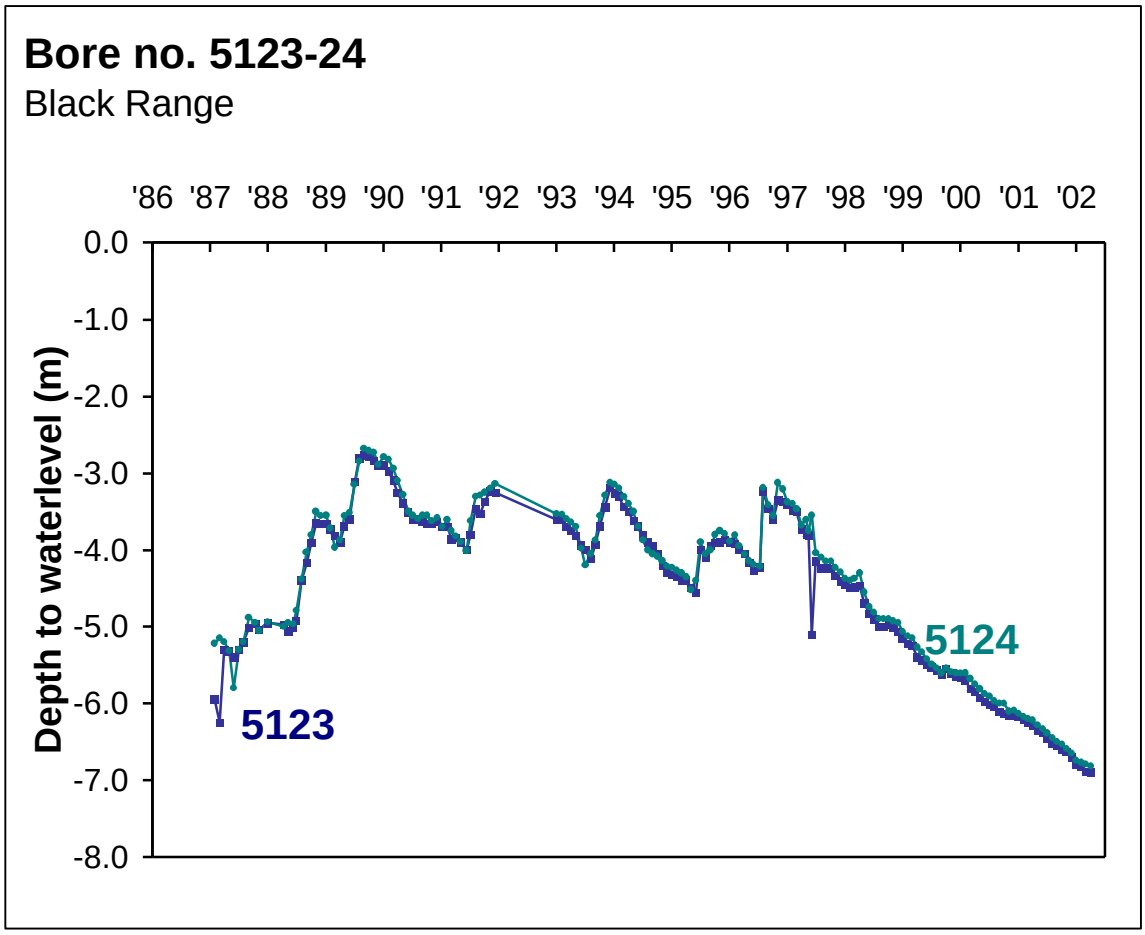
CLPR No:	150	Bore monitor:	DPI
Locality description:	Timor West Rd, Timor West Bore located on lower slope, riverflat landscape.		
Geological description:	Shepparton Formation Fluvial clay, silts, sand and gravel.		
Bore depth (m):	30.7	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	2.5	Salinity (EC) (µS/cm):	—
Groundwater trend:	Strong response to seasonal rainfall. Overall long-term falling trend, falling steeper since 1996.		



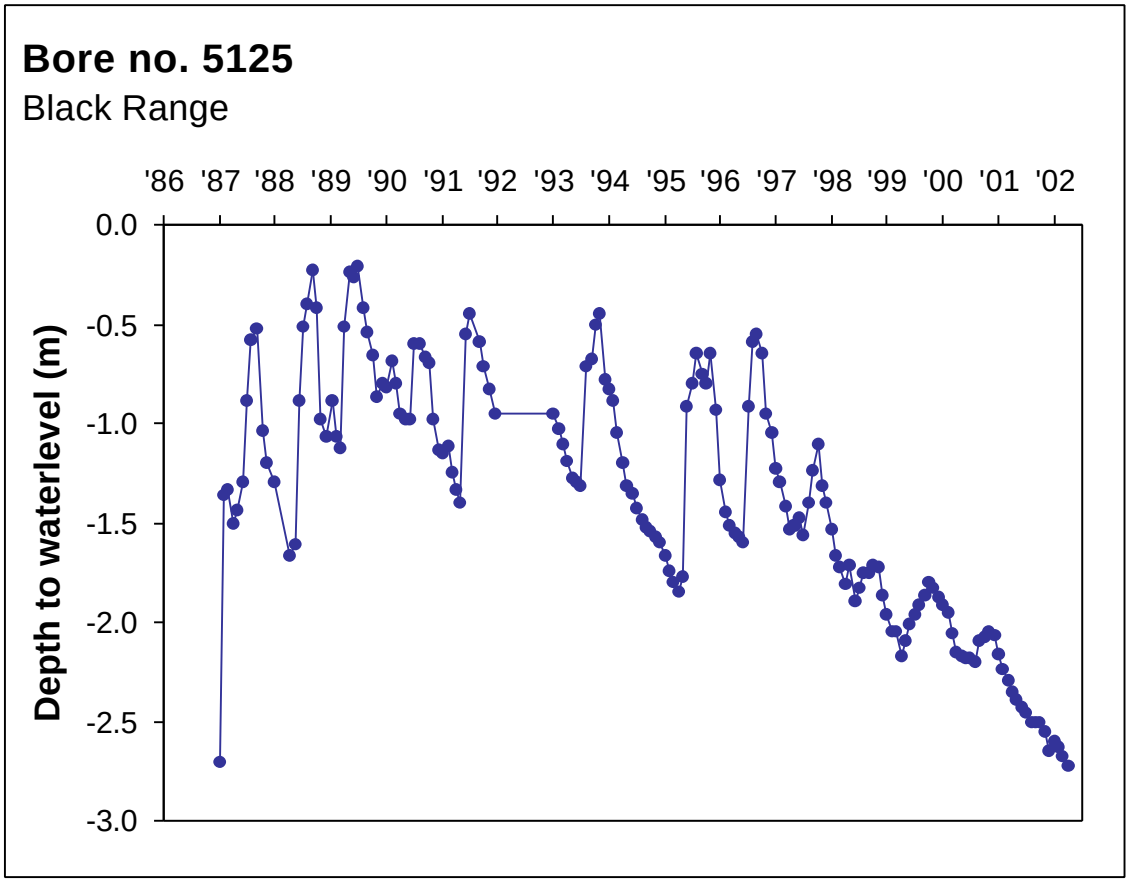
CLPR No:	151	Bore monitor:	DPI
Locality description:	Bet Bet Creek Bet Bet Deep Lead Bore located on lower slope, riverflat landscape.		
Geological description:	Shepparton Formation (fluvial clay, silt, sand and gravel) overlying deep lead deposits of coarse sand gravel overlying Tertiary deep leed sediments.		
Bore depth (m):	72	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	4.5	Salinity (EC) (µS/cm):	14 000
Groundwater trend:	Even trend. Some response to climatic variation. Slight falling trend since 1998.		



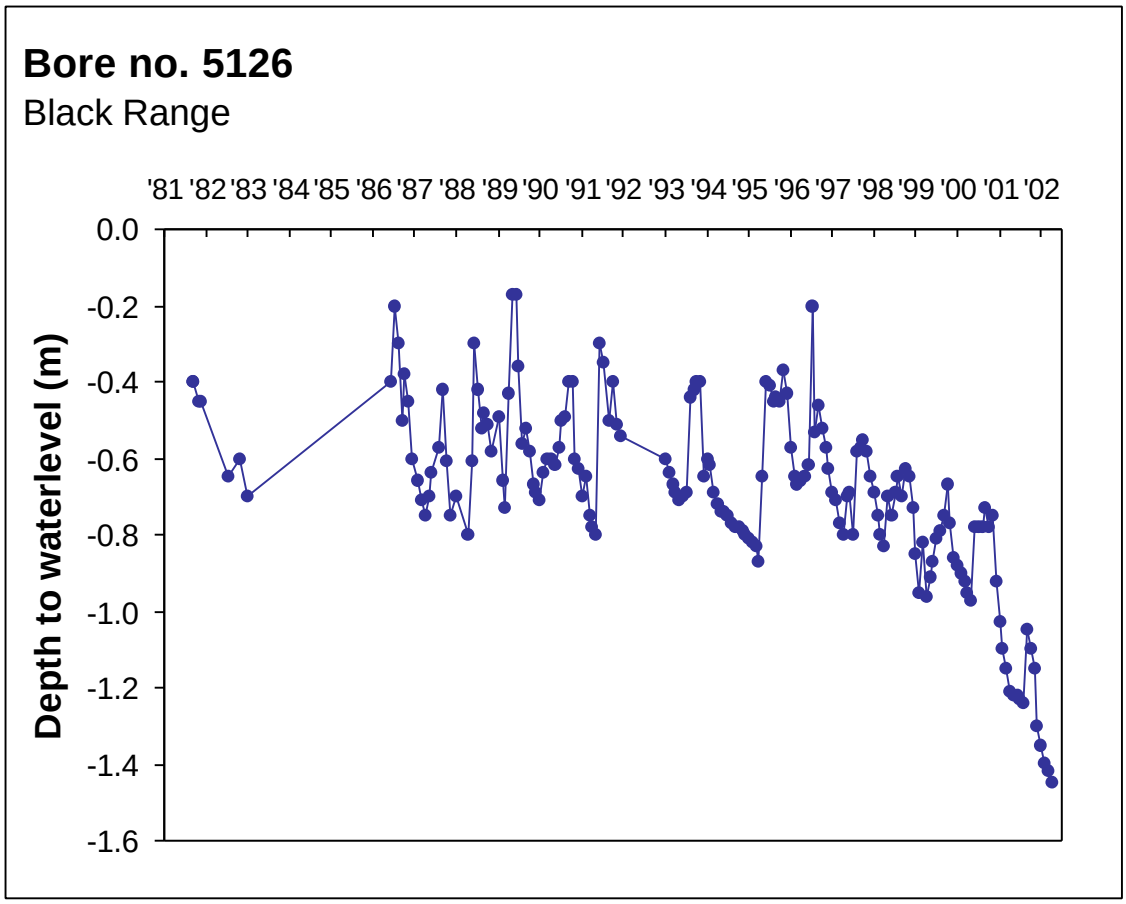
CLPR No:	5121, 5122	Bore monitor:	Alex Wiseman
Locality description:	Black Range Bore located mid-slope		
Geological description:	Devonian granite and associated metamorphic rocks Clay, sand overlying hard, fresh, granite/metamorphic rock		
Bore depth (m):	5121 = 18.5 5122 = 10.0	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	5121 = 9.8 5122 = 9.6	Salinity (EC) (µS/cm):	—
Groundwater trend:	Strong response to seasonal rainfall variation until mid 1997, very strong falling trend since late 1996.		



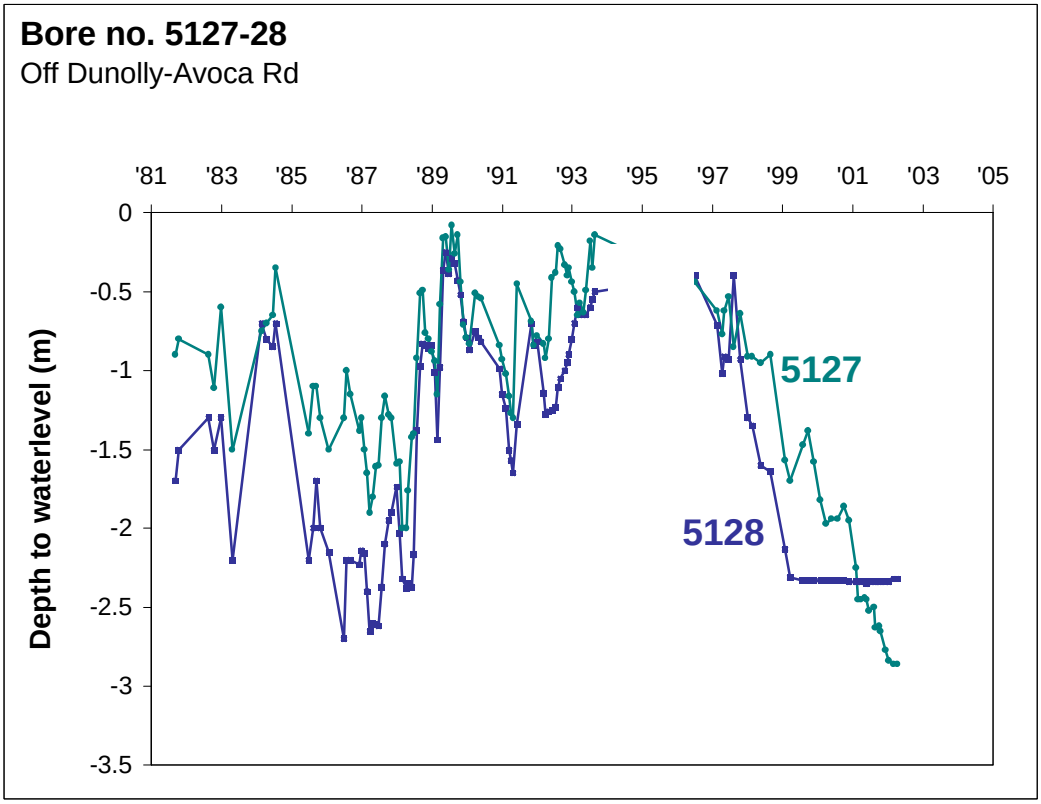
CLPR No:	5123, 5124	Bore monitor:	Alex Wiseman
Locality description:	Black Range Bore located lower slope		
Geological description:	Devonian granite and associated metamorphic rocks Clay, sand overlying hard, fresh, granite/metamorphic rock		
Bore depth (m):	5123 = 18.5 5124 = 10.0	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	5123 = 8.0 5124 = 8.0	Salinity (EC) (µS/cm):	5123 = 7930 5124 = 4370
Groundwater trend:	Strong response to seasonal rainfall variation until mid 1997, very strong falling trend since late 1996.		



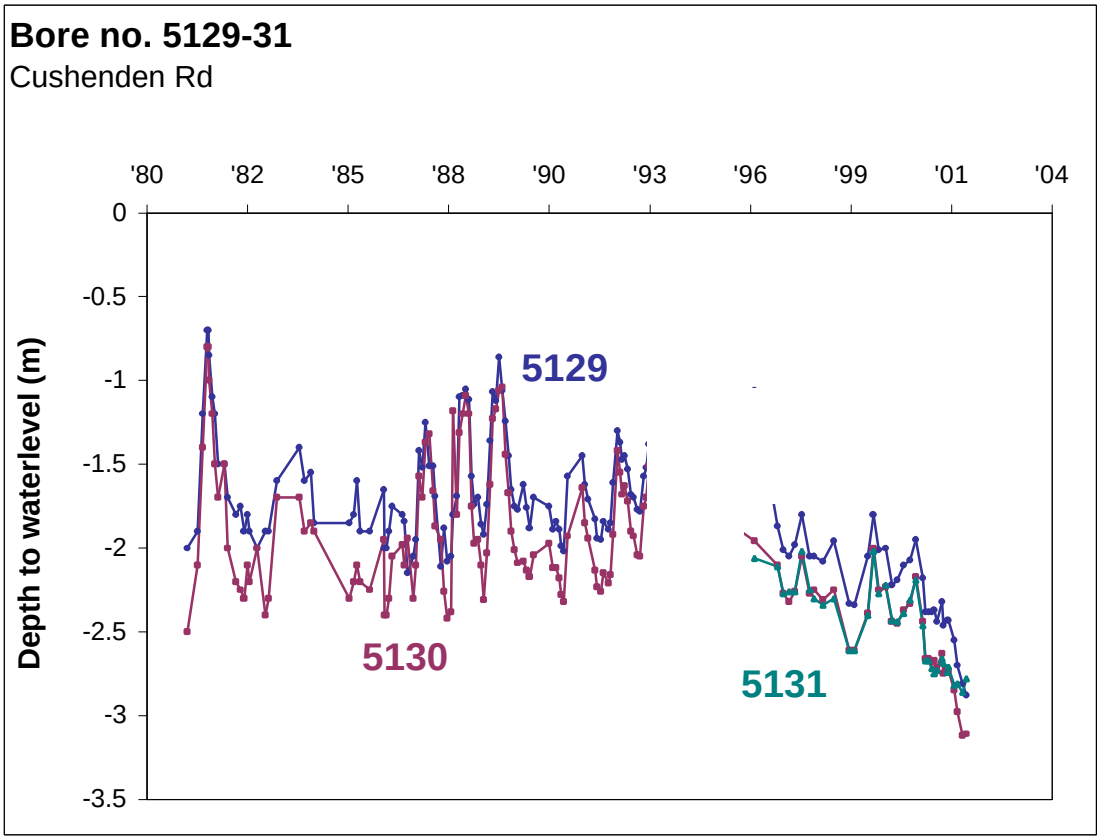
CLPR No:	5125	Bore monitor:	Alex Wiseman
Locality description:	Black Range Bore located in low-lying point, in discharge site		
Geological description:	Devonian granite and associated metamorphic rocks Clay, sand overlying hard, fresh, granite/metamorphic rock		
Bore depth (m):	6.0	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	2.7	Salinity (EC) (µS/cm):	5200
Groundwater trend:	Strong response to seasonal rainfall variation until mid 1997, very strong falling trend since late 1996.		



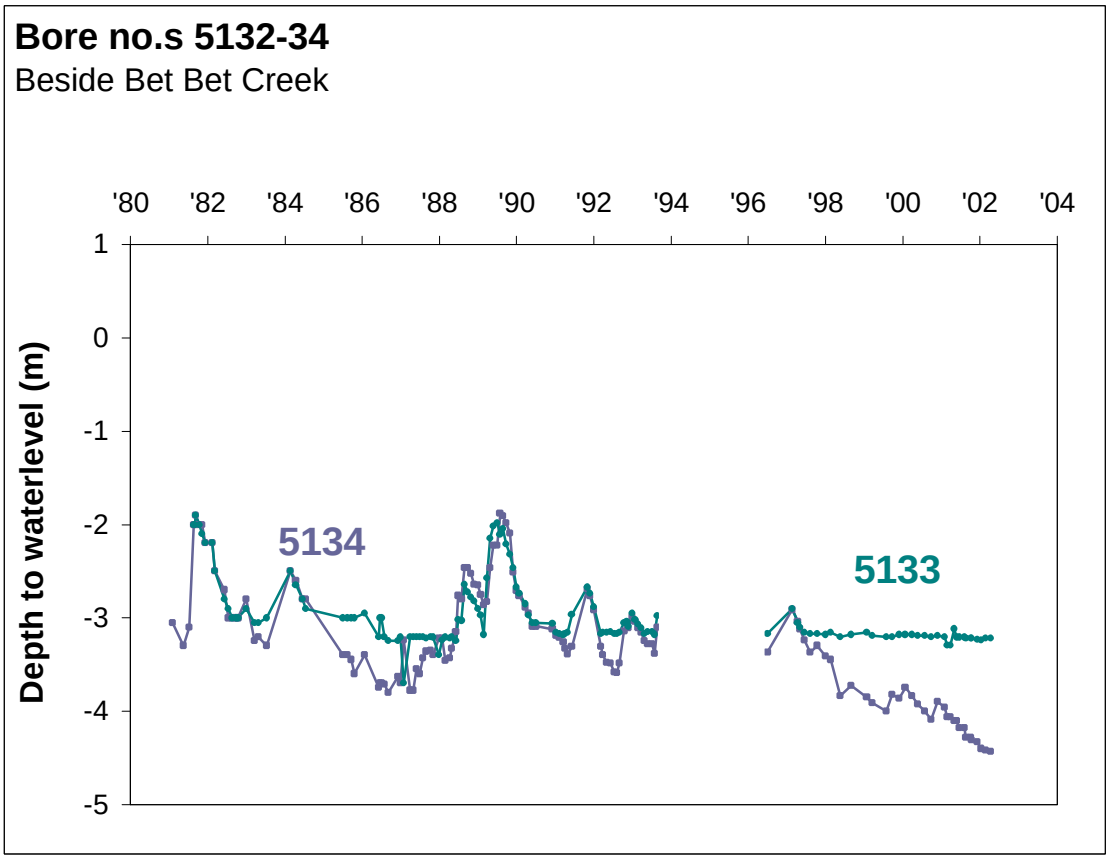
CLPR No:	5126	Bore monitor:	Alex Wiseman
Locality description:	Black Range		
Geological description:	Devonian granite and associated metamorphic rocks Clay, sand overlying hard, fresh, granite/metamorphic rock		
Bore depth (m):	6.0	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	1.4	Salinity (EC) (µS/cm):	14 020
Groundwater trend:	Strong response to seasonal climatic variation. Even trend until 1996, when there is a strong fall in the hydrograph.		



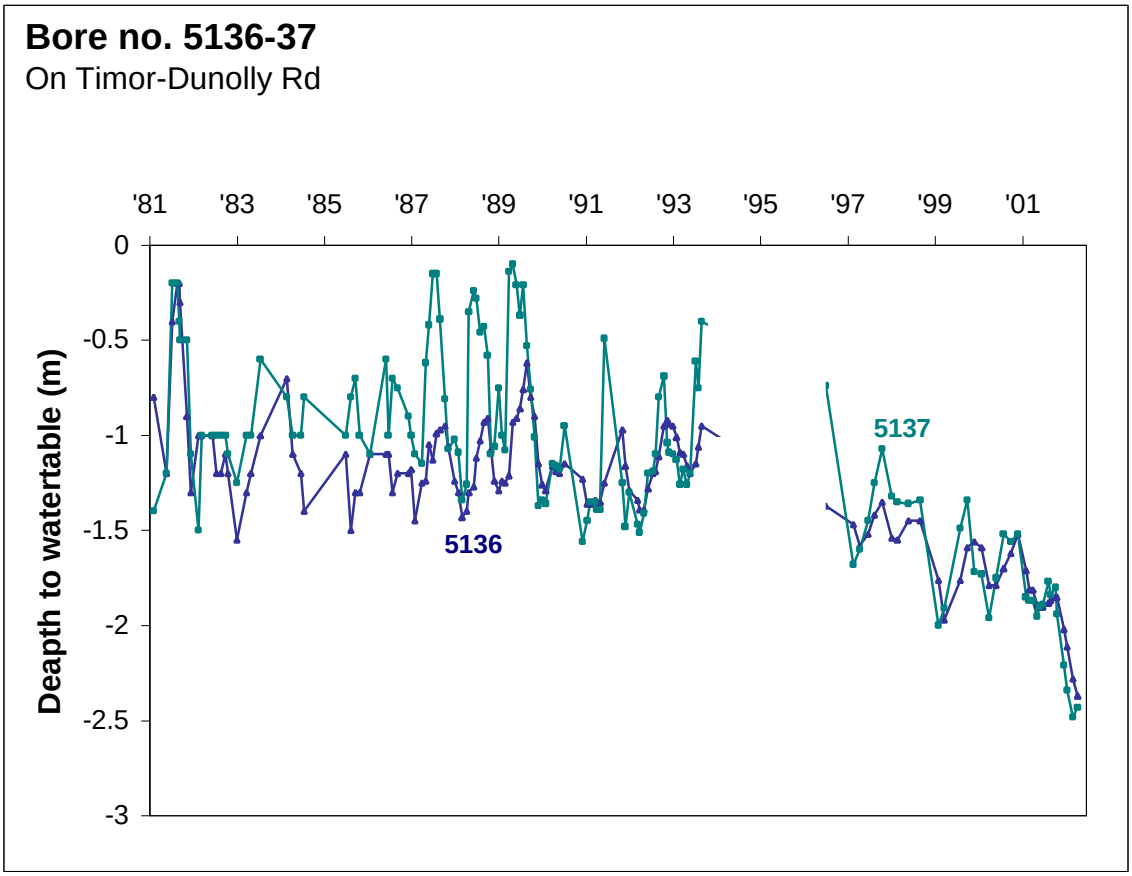
CLPR No:	5127, 5128	Bore monitor:	CLPR
Locality description:	Dunolly–Avoca Road Black Range		
Geological description:	Devonian granite and associated metamorphic rocks Clay, sand overlying hard, fresh, granite/metamorphic rock		
Bore depth (m):	5127 = 2.9 5128 = 2.3	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	5127 = 2.9 5128 = 2.3	Salinity (EC) (µS/cm):	5127 = 15 840 5128 = 6160
Groundwater trend:	Strong response to local climatic variation obvious in the hydrograph. In both bores the watertable has fallen below the bottom of each bore.		



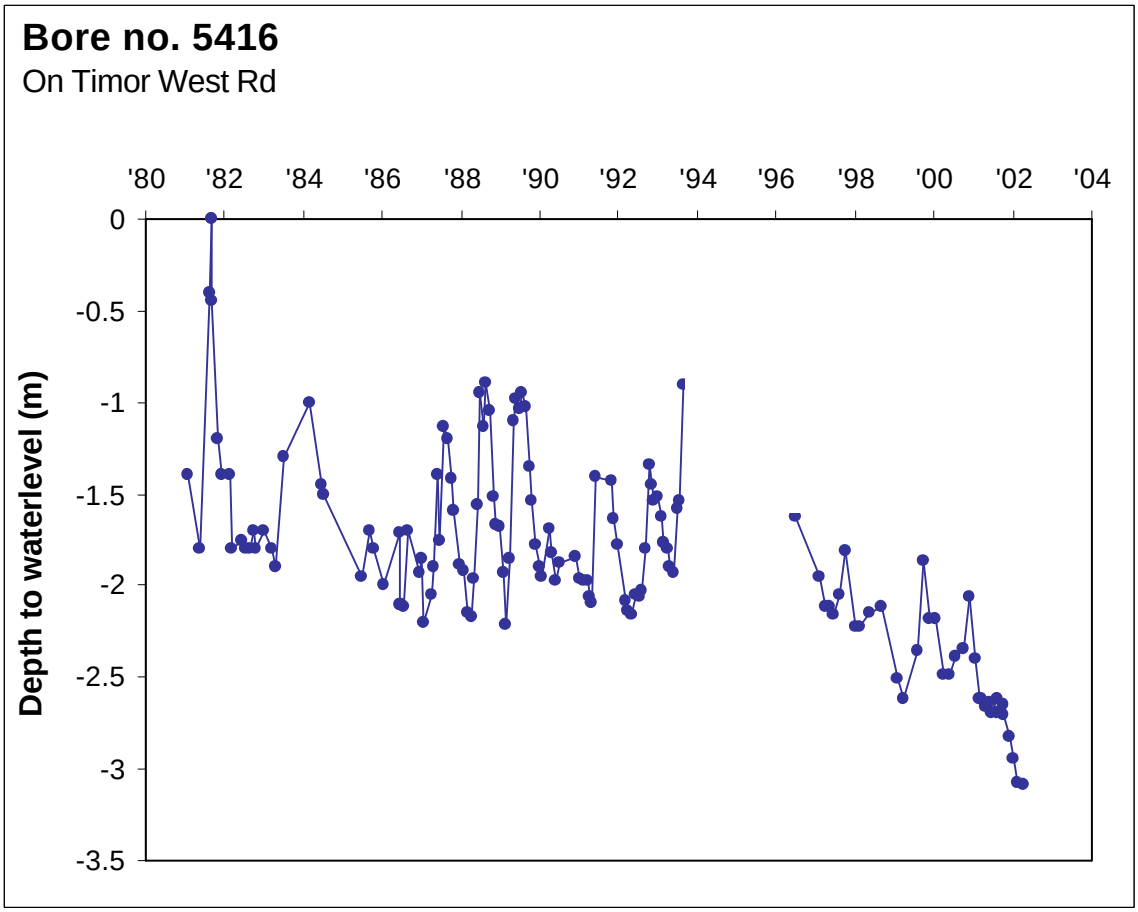
CLPR No:	5129, 5130, 5131	Bore monitor:	CLPR
Locality description:	Cushenden Road Timor		
Geological description:	Shepparton Formation (fluvial clay, silt, sand and gravel) overlying subsurface basalt flow (Quaternary olivine volcanics) overlying Ordovician sedimentary bedrock		
Bore depth (m):	5129 = 16.5 5130 = 6.7 5131 = 3.0	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	5129 = 3.2 5130 = 3.2 5131 = 2.7	Salinity (EC) (µS/cm):	—
Groundwater trend:	Strong response to local climatic variation with a strong overall falling observed since late 1996.		



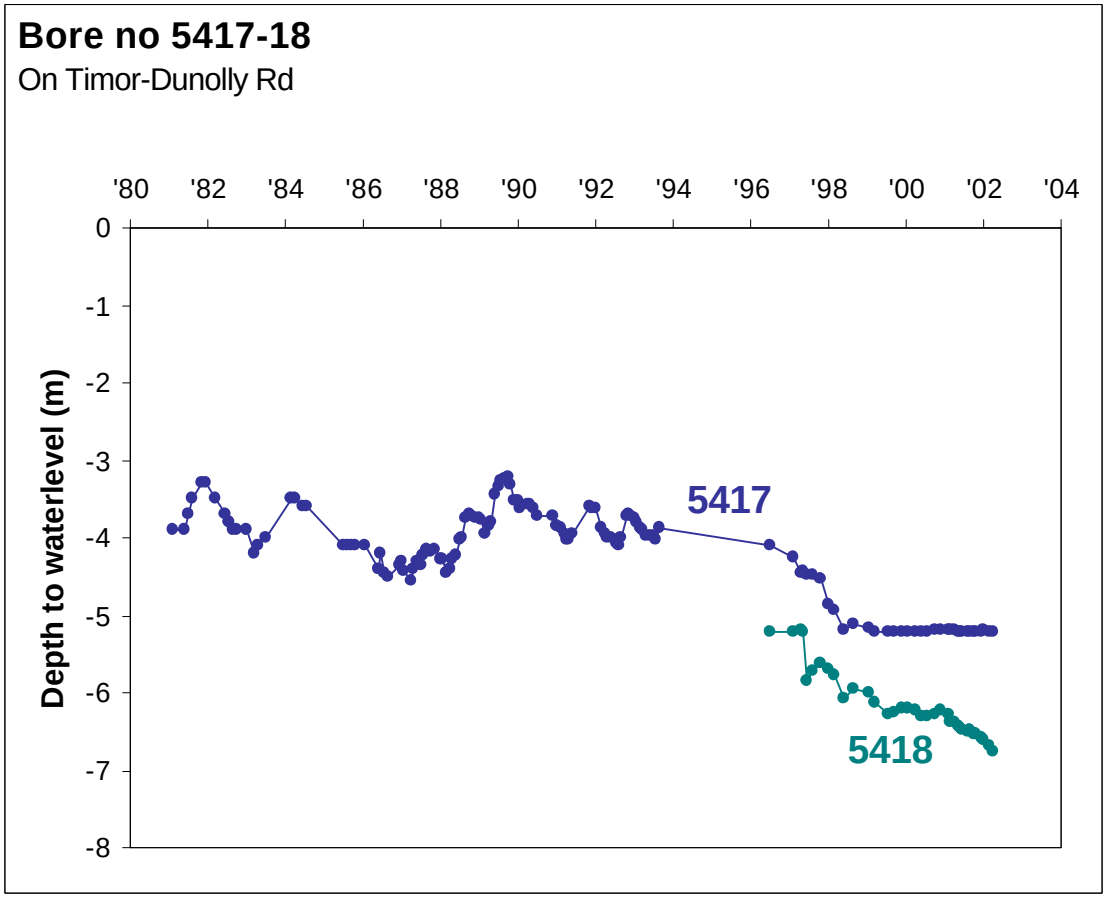
CLPR No:	5132, 5133, 5134	Bore monitor:	CLPR
Locality description:	Beside Bet Bet Creek		
Geological description:	Shepparton Formation (fluvial clay, silt, sand and gravel) overlying subsurface basalt flow (Quaternary olivine volcanics) overlying Ordovician sedimentary bedrock		
Bore depth (m):	5133 = 5.0 5134 = 3.0	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	5133 = 3.0 5134 = 4.0	Salinity (EC) (µS/cm):	5133 = 5150 5134 = —
Groundwater trend:	Varied response to local climatic variation. Relatively even trend. 5132 shows that the watertable has fallen below the bore depth, 5133 shows a slight falling trend since 1998 and 5134 shows a possible data error.		



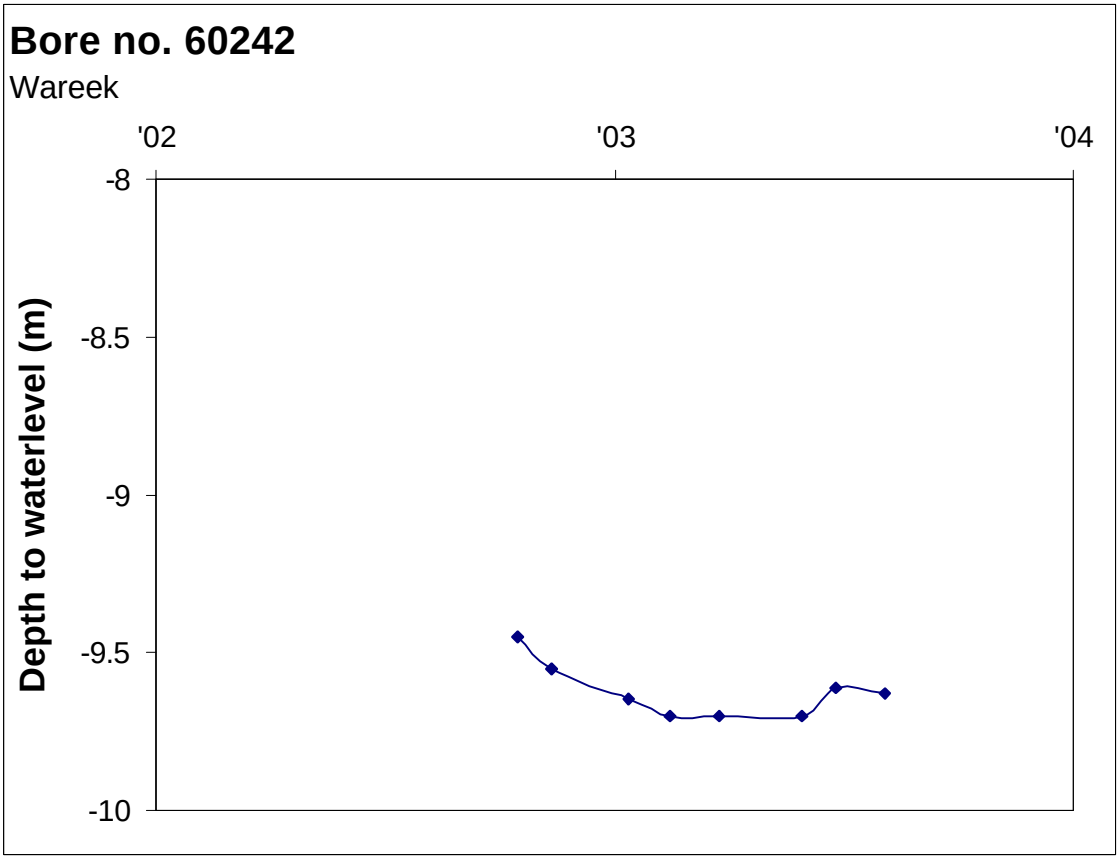
CLPR No:	5136, 5137	Bore monitor:	CLPR
Locality description:	Timor–Dunolly Road		
Geological description:	Shepparton Formation (fluvial clay, silt, sand and gravel) overlying subsurface basalt flow (Quaternary olivine volcanics) overlying Ordoviciansedimentary bedrock		
Bore depth (m):	5136 = 20 5137 = 3	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	5136 = 2.5 5137 = 2.5	Salinity (EC) (µS/cm):	—
Groundwater trend:	Strong response to local climatic variation. Strong fall in overall trend since 1996, even trend until 1996.		



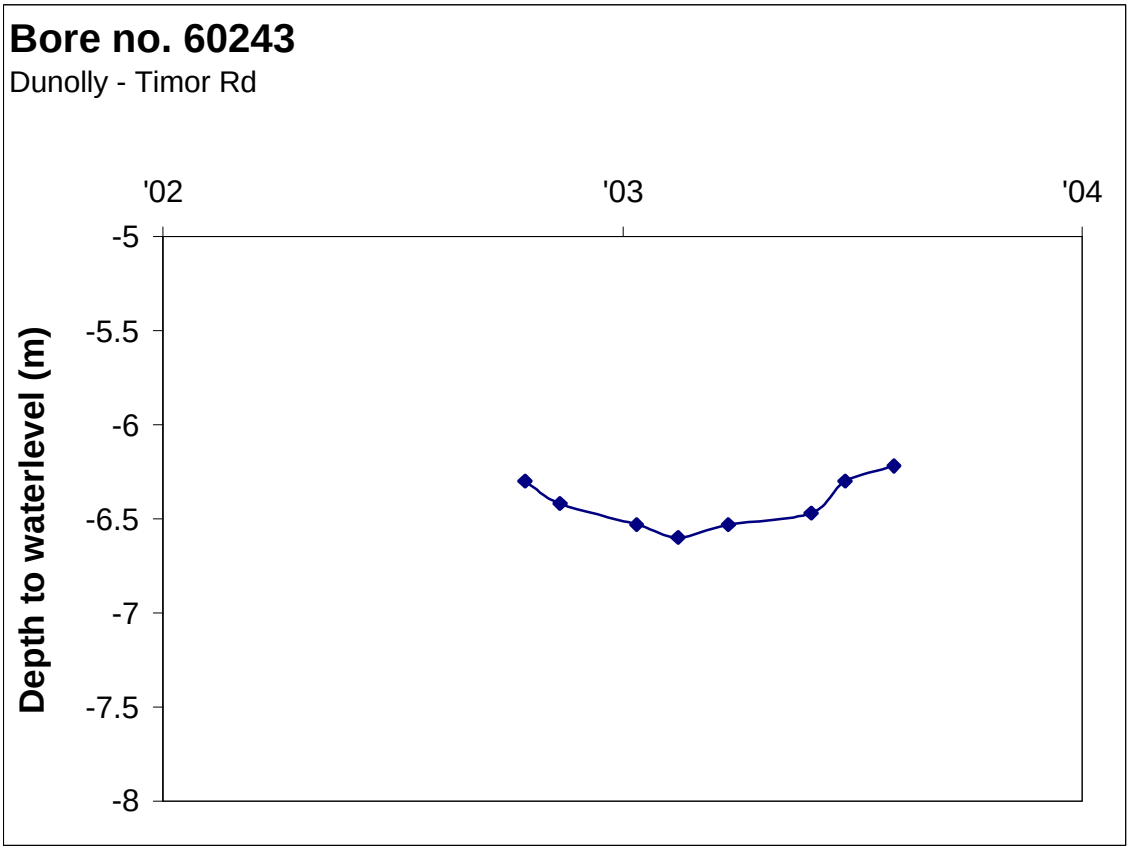
CLPR No:	5416	Bore monitor:	CLPR
Locality description:	Timor West Road Timor West		
Geological description:	Shepparton Formation (fluvial clay, silt, sand and gravel) overlying subsurface basalt flow (Quaternary olivine volcanics) overlying Ordovician sedimentary bedrock		
Bore depth (m):	4.41	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	3.1	Salinity (EC) (µS/cm):	3950
Groundwater trend:	Overall falling groundwater trend. Strong response to local climatic variation. Steeper fall in overall trend since 1996.		



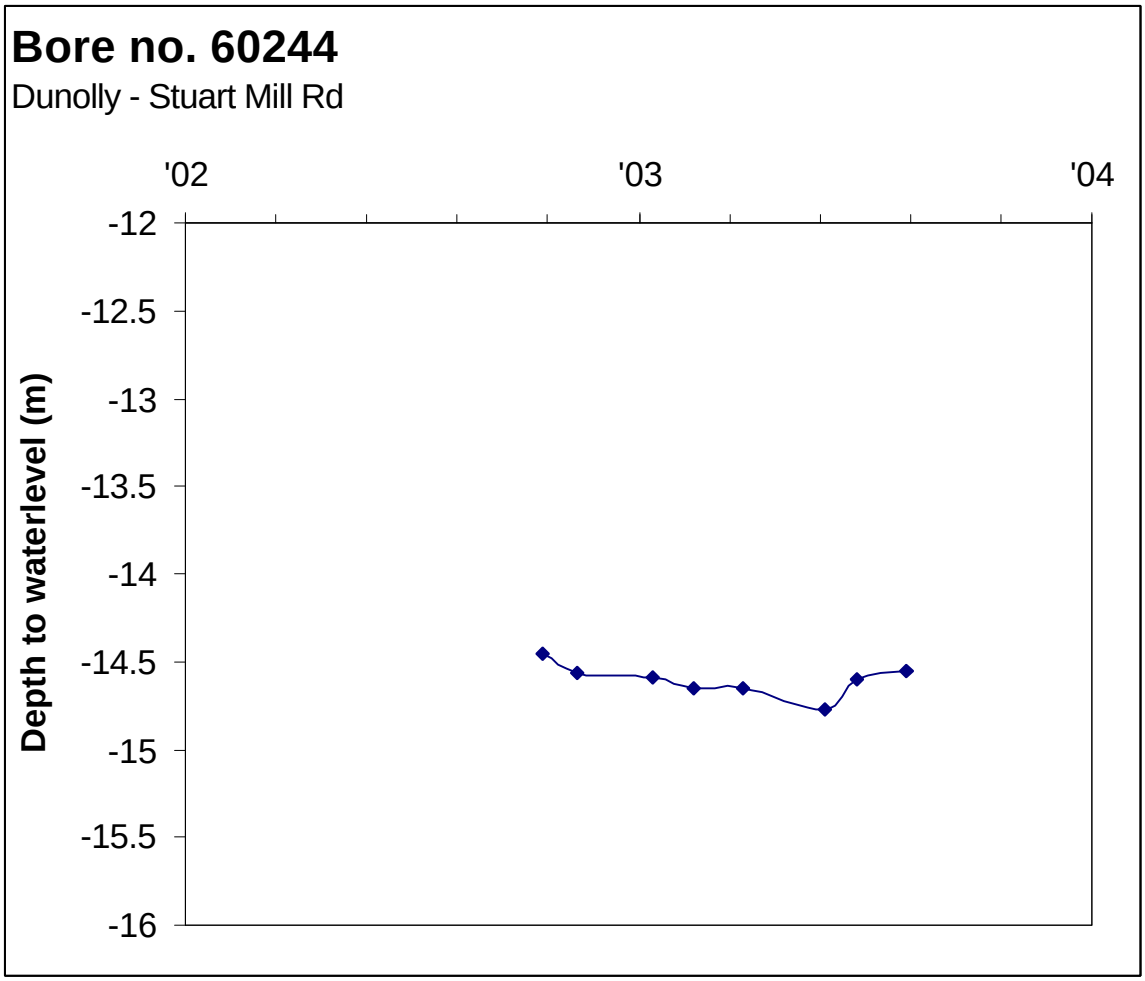
CLPR No:	5417, 5418	Bore monitor:	CLPR
Locality description:	Timor–Dunolly Road Timor		
Geological description:	Shepparton Formation (fluvial clay, silt, sand and gravel) overlying subsurface basalt flow (Quaternary olivine volcanics) overlying Ordovician sedimentary bedrock		
Bore depth (m):	5417 = 5.22 5418 = 17.1	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	5417 = 5.22 5418 = 6.8	Salinity (EC) (µS/cm):	5417 = 13 600 5418 = 8510
Groundwater trend:	Even groundwater trend with a slight response to local climate. Falling steeply since 1996. 5417, waterlevel has fallen below bore depth.		



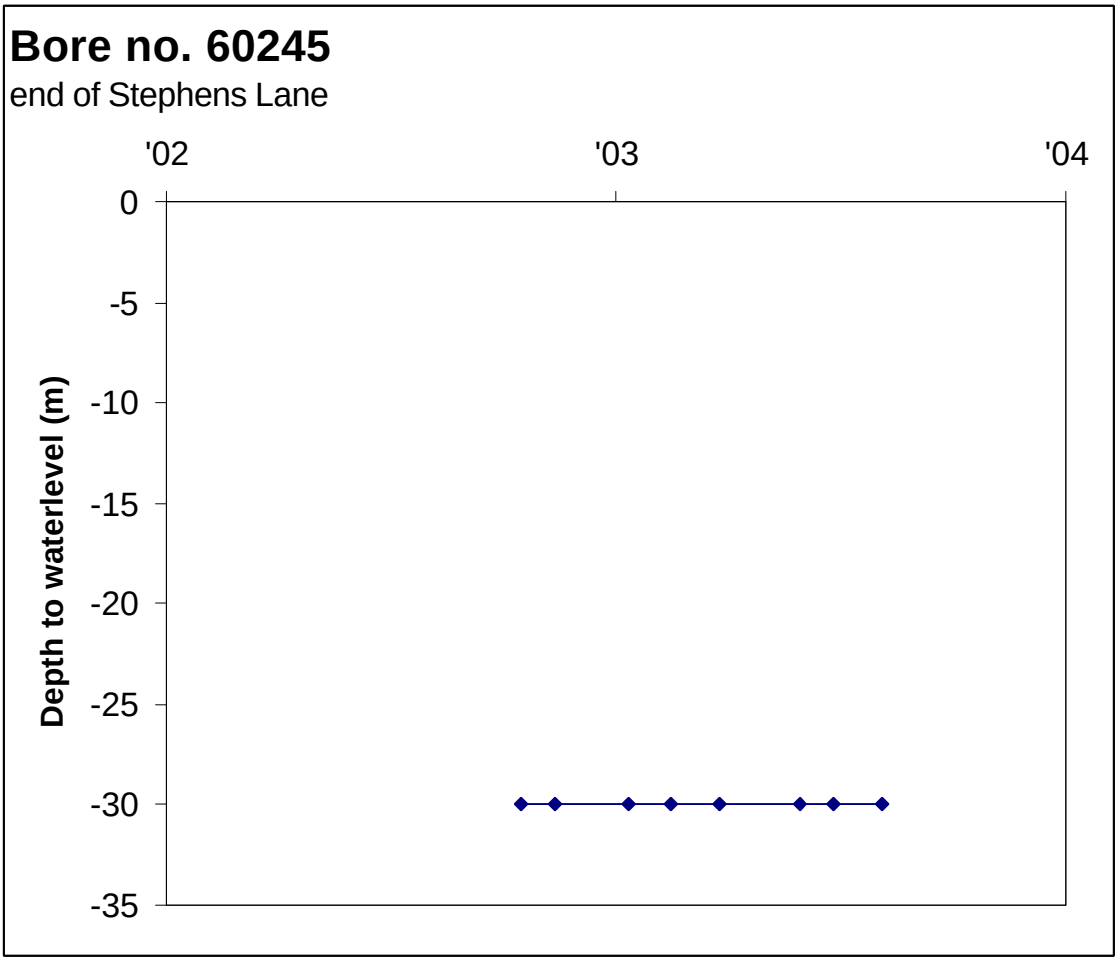
CLPR No:	60242	Bore monitor:	David Schuppan
Locality description:	Wareek Bore located in lower slope		
Geological description:	Shepparton Formation Fluvial clay, silt, sand and gravel		
Bore depth (m):	12	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	9.6	Salinity (EC) (µS/cm):	1800
Groundwater trend:	New bore. Shows a falling groundwater trend		



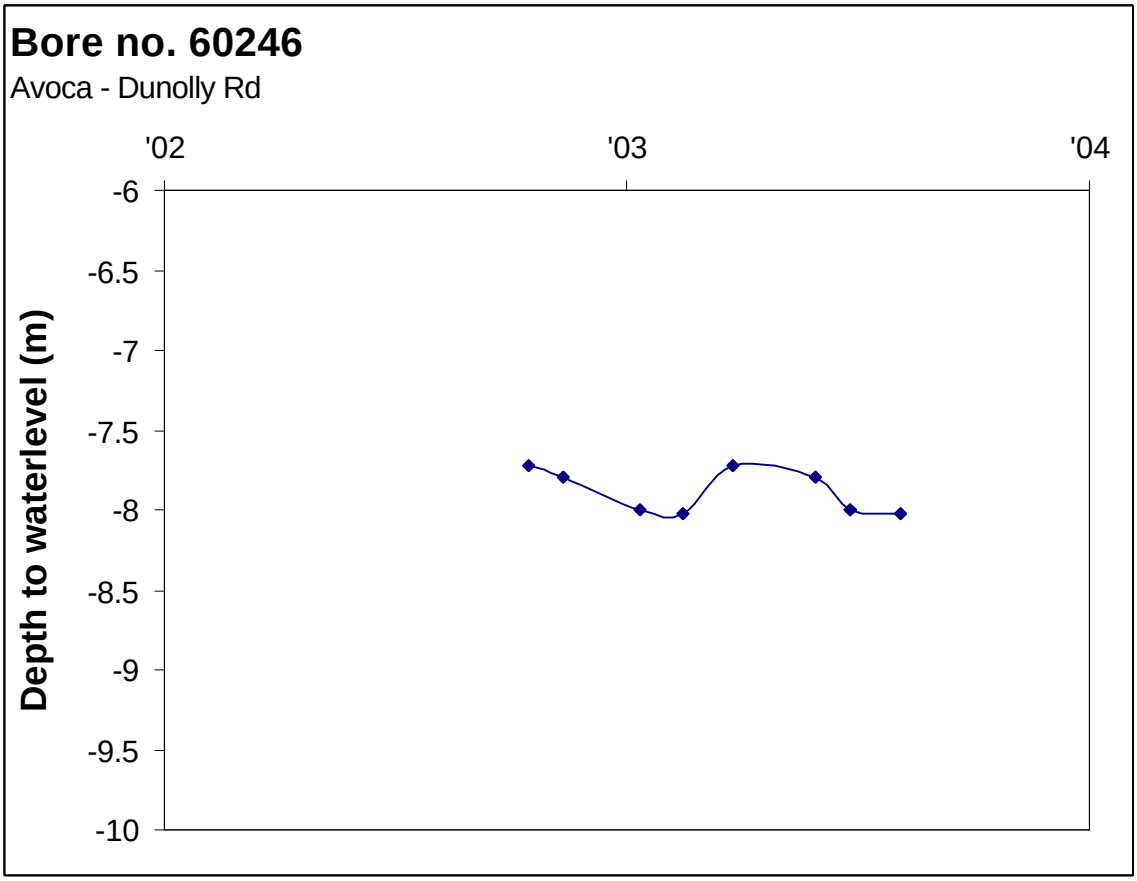
CLPR No:	60243	Bore monitor:	David Schuppan
Locality description:	Timor- Dunolly Road		
Geological description:	Shepparton Formation Fluvial clay, silt, sand and gravel		
Bore depth (m):	11.5	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	6.2	Salinity (EC) (µS/cm):	3000
Groundwater trend:	New bore. Shows an even groundwater trend. Waterlevel has risen in response to recent rainfall.		



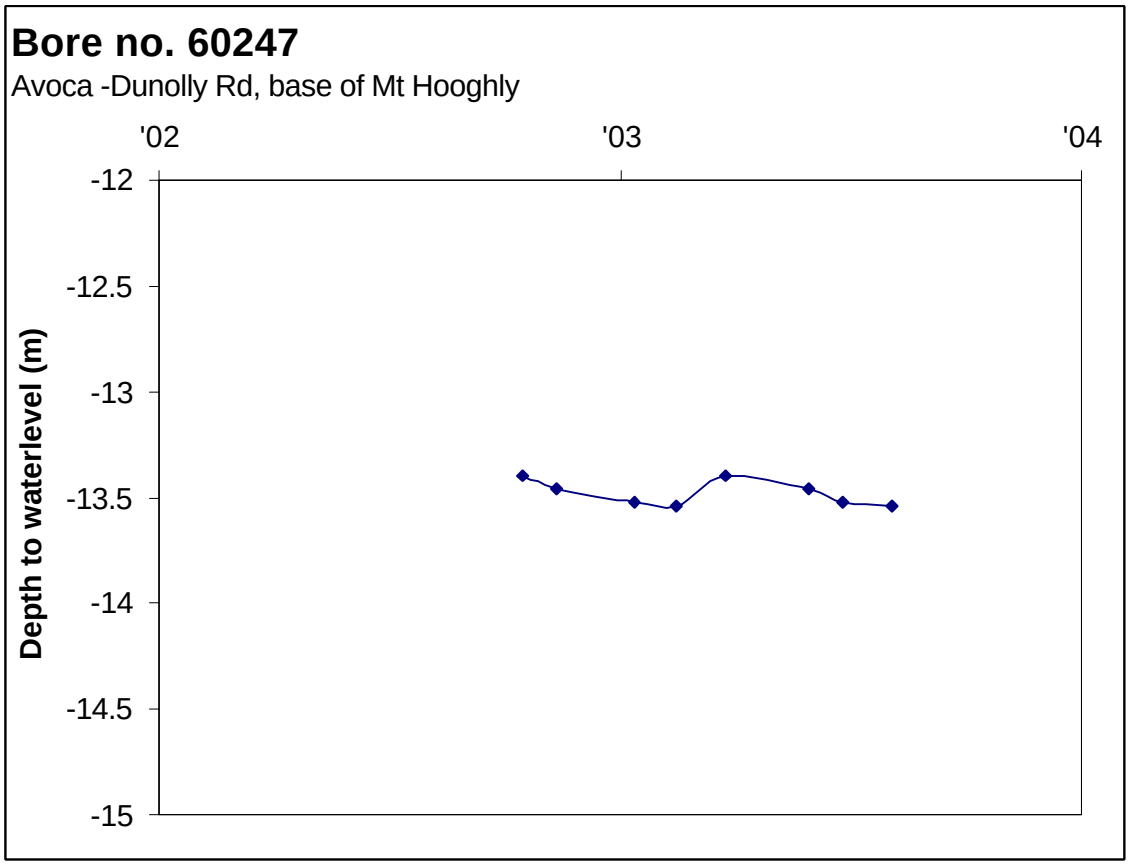
CLPR No:	60244	Bore monitor:	David Schuppan
Locality description:	Dunolly–Stuart Mill Rd Bore located in flat, plain landscape		
Geological description:	Shepparton Formation Fluvial clay, silt, sand deposits		
Bore depth (m):	20.5	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	4.6	Salinity (EC) (µS/cm):	13000
Groundwater trend:	New bore. Shows an even groundwater trend. Waterlevel has risen in response to recent rainfall.		



CLPR No:	60245	Bore monitor:	David Schuppan
Locality description:	North-west of Mr Hooghly. Bore located in mid slope, end of Stephens Rd		
Geological description:	Devonian granite and associated metamorphic rocks Clay, sand overlying hard, fresh, granite/metamorphic rock		
Bore depth (m):	30	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	Dry bore	Salinity (EC) (µS/cm):	Dry bore
Groundwater trend:	Dry bore. Watertable deeper than depth of bore.		



CLPR No:	60246	Bore monitor:	David Schuppan
Locality description:	Dunolly–Avoca Rd. Bore located mid slope.		
Geological description:	Devonian granite and associated metamorphic rocks Clay, sand overlying hard, fresh, granite/metamorphic rock		
Bore depth (m):	12	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	8.0	Salinity (EC) (µS/cm):	3100
Groundwater trend:	New bore. Shows a falling groundwater trend		



CLPR No:	60247	Bore monitor:	David Schuppan
Locality description:	Avoca–Dunolly Rd Bore located in lower, river flat		
Geological description:	Shepparton Formation Fluvial clay, silt, sand and gravel		
Bore depth (m):	17	Average rainfall (mm/yr):	449
Current water depth 2003 (m):	9.6	Salinity (EC) (µS/cm):	>20 000
Groundwater trend:	New bore. Shows a falling groundwater trend and responsive to local climatic variation.		