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MRT statewide groundwater monitoring network: Preliminary results for data collected between December 2003 and September 2005

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DEFINITIONS

Baseline — The natural groundwater storage/baseflow water level, not affected by artificial discharge.

Dataflow data logger — Device originally installed in boreholes in 1995 to record pressure and temperature measurements that can be used to calculate the water level in the borehole over time.

DPIWE — Department of Primary Industries, Water and Environment.

MRT — Mineral Resources Tasmania, a Division of the Department of Infrastructure, Energy and Resources.

NAP — National Action Plan for salinity.

NHT — Natural Heritage Trust.

Odyssey data recorder — Device commissioned by MRT in 2003 to record pressure and temperature measurements that can be used to calculate the water level in the borehole over time. *Odyssey* data recorders have gradually replaced the *Dataflow* data loggers over several years.

REV (representative elementary volume) — Volume of water to be removed from a borehole before a sample is collected for laboratory chemical analysis.

Troll data recorder — Device used to record water level in the borehole, adjusted for barometric pressure.

WL (water level) — The height of the water table in the borehole with respect to the site-specific ground level at the base of the borehole collar.

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Executive Summary

This report contains water level and water chemistry data collected from the MRT statewide groundwater monitoring network between December 2003 and September 2005. Observations about the data are contained in six regional summaries and short comments are provided on individual monitoring sites.

Interpretations of hydrographs in this report are limited because they are based on incomplete data without reference to rainfall and stream-flow data, which is not regularly accessible nor in the scope of this report. Further investigation of groundwater and surface water interactions are still required to adequately manage Tasmanian water resources.

Pumping of private boreholes in close proximity to the baseline monitoring boreholes has affected the hydrographs of monitoring sites in the northwest (Trowutta, Togari and Montagu) and potentially in the midlands (Tunnack), southeast (Snug) and central north regions (Barrington and Hagley). Sampling techniques have also affected the inflow hydraulics of the Calder and Tunnack boreholes, which may have compromised the functionality of the sites with regards to long-term baseline water level. Sampling events have also affected the hydrographs for the South Forest, Calder, Osmaston, Cressy, Lilydale, Pipers River, Melton Mowbray, Ross and Port Arthur monitoring sites, where recovery curves were recorded after sampling the borehole.

The data interpreted as baseline at individual monitoring sites in the six regions suggest that the response to recharge varies based on the nature of the host materials (solid rock and/or unconsolidated sediments), location in the catchment, and the depth of the monitored aquifer level(s).

Considering the external influences on recorded baseline data identified above, potential exists for the over-extraction of Tasmanian groundwater resources in the northwest, central north, midlands, east and southeast regions of the State. Most monitored aquifers currently appear to be completing recovery cycles, although long-term drawdown is occurring in the Branxholm, Barrington, Jetsonville, Bicheno, South Forest, Montagu, Trowutta, Togari, Snug and Pawleena Road aquifers. Data recorded from the Montagu site indicate that the proposed expansion of irrigation could rapidly deplete this aquifer.

Scope

This report provides stakeholders with an update summary of the MRT statewide groundwater monitoring network and incorporates data collected from December 2003 to September 2005. The focus of this report is on describing observations of water levels and groundwater quality in the six monitored regions across Tasmania.

Introduction

The MRT statewide groundwater monitoring network consists of 35 boreholes divided into six regions. These boreholes have been monitored since the early 1990's. MRT also currently records time-series data in the area of the Lawrence Vale landslip, South Launceston, and from two long-term irrigation networks near Devonport.

Prior to September 2005, MRT collected time-series data from four salinity groundwater networks (Waterhouse, Tunbridge, Coal River and the greater Launceston urban salinity networks). The remaining functional *Dataflow* hardware and the responsibility for collecting time-series data for all four salinity groundwater networks has been transferred to the Land Management Division of DPIWE. This Division of DPIWE also collects groundwater time-series data (using the *Troll* system) from boreholes within the north and south Midlands NAP salinity groundwater flow system networks.

Maintenance

Funding is still required to undertake borehole maintenance as outlined in Ezzy (2004).

Groundwater quality sampling

Groundwater quality sampling was undertaken during the March and September 2005 monitoring rounds. The REV groundwater sampling procedure was applied where flow rates were sufficient (in accordance with Australian/New Zealand Standard AS/NZ 5667.11:1998). Where appropriate, boreholes with low flow rates were sampled as close as possible to the recommended REV. The Cressy and Calder holes were sampled by the bailing technique to avoid affecting the inflow hydraulics of the borehole.

Appendix 1 contains the laboratory results for the March and September 2005 monitoring rounds. Results for all sites are within the standard deviations stated in Ezzy (2004).

Manual WL readings

Manual WL was measured as part of both the 2005 monitoring rounds. Updated manual WL graphs are contained in Appendix 2.

Automatic pressure and temperature data

All groundwater time-series data collected from the statewide network from 1995 to 2005 (using the *Dataflow* and *Odyssey* systems) has been migrated into two Microsoft Access 2000 databases. Both databases have been provided to the Water Management Division of DPIWE.

Dataflow system

The final *Dataflow* data logger in the statewide network, located at Winnaleah, was decommissioned

and replaced with an *Odyssey* data recorder during the September 2005 monitoring round. The remaining *Dataflow* data loggers in the salinity boreholes have been transferred to DPIWE. All data previously collected from the salinity networks, the still operational *Dataflow* hardware (three NHT rural networks [8 units] and one NAP urban network [11 units]) and software was provided to the Land Management Division of DPIWE.

Odyssey system

Hydrographs of the *Odyssey* data recorded since commissioning in December 2003 are contained in Appendix 3. A CD-ROM is available on request from MRT containing all groundwater time-series processed data as a Microsoft Access 2000 file, as at October 2005.

Observations concerning regional groundwater conditions and individual borehole hydrographs

Figure 1 shows the location of individual boreholes and monitored parameters. More detailed site descriptions are provided in Ezzy (2004). Summaries of the aquifer characteristics of these regions, with comments on individual borehole hydrographs, are given below. The hydrographs are presented alphabetically in Appendix 3.

Northwest region summary

Monitored aquifers in the northwest region show the influence of groundwater extraction and/or natural baseline conditions. With the expansion of irrigation sourced from groundwater resources, it is recommended that a detailed hydrogeological study of the aquifer hydraulic properties be undertaken in this region.

Trowutta — Feature ID 16530

No data was collected from this site between March and September 2004 due to the ingress of water into the data recorder. Data was recorded from December 2003 to March 2004 and September 2004 to September 2005. The hydrograph was affected by local pumping from December 2003 to July 2005, as seen by the recovery patterns on the graph. Baseline conditions (not affected by local pumping) occurred during the winter months between mid-July and September 2005.

Togari — Feature ID 16531

A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. The hydrograph for this monitoring borehole clearly indicates local groundwater extraction during drier irrigation months and recharge in winter months.

Montagu — Feature ID 16532

A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. A borehole used for stock watering was drilled 30 metres to the northeast of the monitoring borehole in 2000. Two new irrigation boreholes have been drilled during 2005 within 800 metres of the monitoring borehole. It is proposed by the owner to use one of the new irrigation boreholes (reported to yield 39 litres/second) to supply groundwater to a 450 metre pivot irrigator, starting in December 2005.

The influence of the stock watering borehole (set to a daily pumping cycle) can be clearly seen on the hydrograph. Considering the current data available on this aquifer and proposed future extraction rates for irrigation, detailed monitoring is required to sustainably manage the resource.

South Forest — Feature ID 16527

A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. A short recovery curve can be seen on the hydrograph after the March 2004 sampling event. This hydrograph is not affected by local pumping and is a good example of monitoring baseline winter recharge and falling WL during drier months.

Calder — Feature ID 16533

A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. Sampling events during 2004 have significantly affected the inflow to this borehole. This has disrupted the ability to compare baseline WL data over that 12 month period. The borehole has been sampled using the bailing technique (instead of the down-hole pumping technique) during 2005 and this time interval on the hydrograph appears to indicate baseline conditions. The bailing sampling event in March 2005 shows on the hydrograph as a drawdown from 17 to 19 metres. The inflow to the borehole is not altered and, after recovering, the WL appears to reflect baseline conditions. The long-term manual WL graph shows an anomalous net rising trend, which may be a result of the lack of development at the time of drilling and past sampling events affecting the inflow to the borehole.

Mooreville Road — Feature ID 16535

A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. Winter recharge on the hydrograph for 2005 indicates that this aquifer has recovered from the drier summer and autumn months. As the WL in the monitoring borehole does not appear to be affected by local pumping, this is a good site to monitor baseline groundwater conditions.

Hampshire — Feature ID 16534

A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. Main winter recharge events (between June and September) and two summer recharge events (in late January) can be

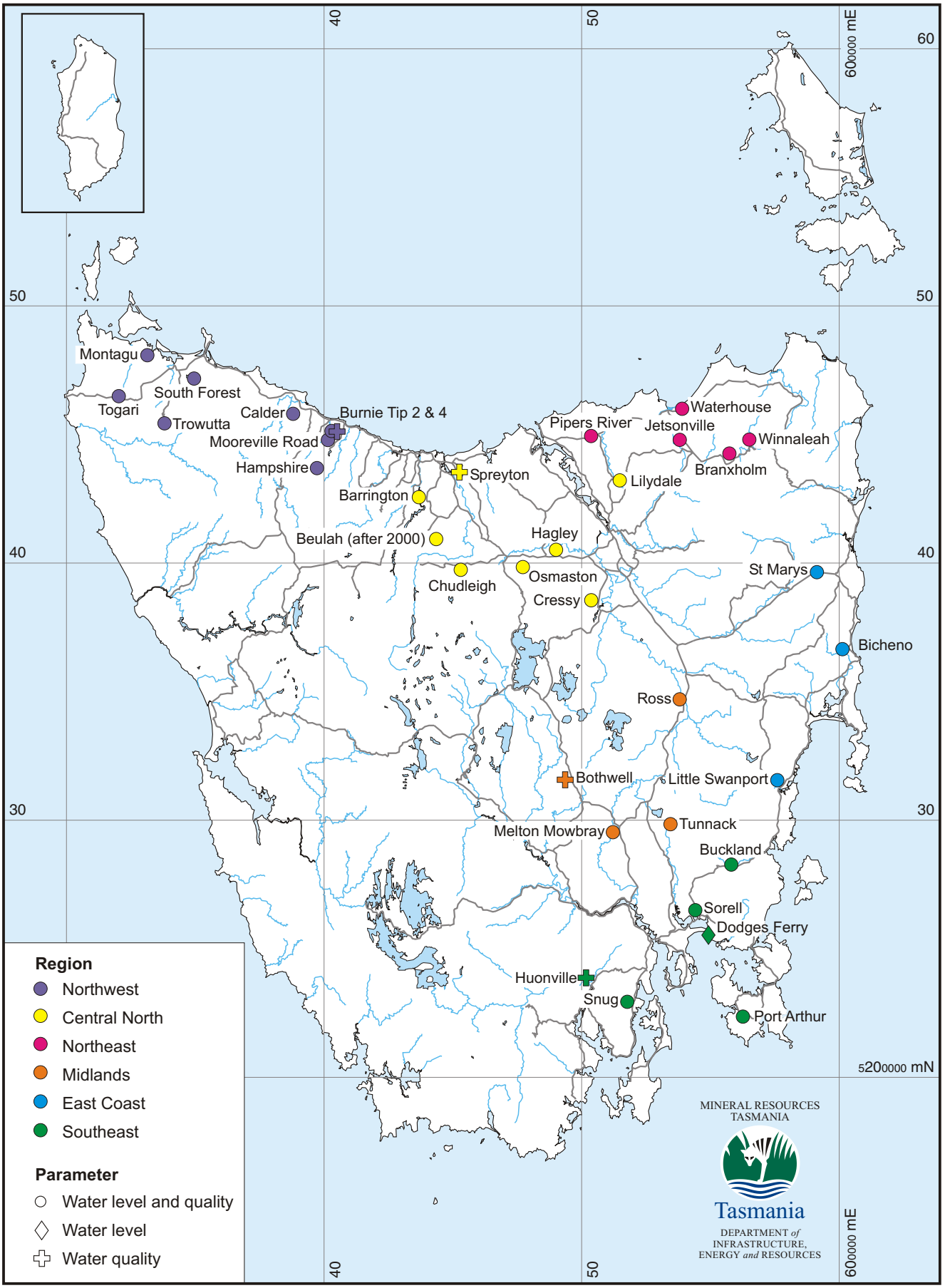


Figure 1

Location of monitored bores.

seen on the hydrograph for this borehole. Based on the size and frequency of the peaks (not on rainfall data) the WL in this borehole appears to have a rapid reaction to rainfall.

Central north region summary

Monitored aquifers in this region all experienced good winter recharge events. Local pumping may be overprinting baseline conditions on the hydrographs for the Barrington and Hagley sites. The Spreyton monitoring borehole, which is monitored for water quality, provided an artesian flow during both 2005 monitoring rounds.

Barrington — Feature ID 16536

Except for the last two weeks in March 2004, when the memory capacity of the data recorder was exceeded, a continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. Considering the number of boreholes drilled in the local area and without surveying groundwater extraction rates, it is difficult to interpret the hydrograph for this site. The hydrograph possibly indicates main recharge events as high peaks and local pumping as lower repetitive movements. The long term manual WL graph shows a net decline of 1.5 metres over the last thirteen years.

Beulah — Feature ID 4290

Due to hardware failure, only six months of data were collected from this site between September 2004 and March 2005. More data are required to gain an understanding of the aquifer hydraulics.

Chudleigh — Feature ID 16538

Due to hardware failure, data for the winter recharge between June and September 2005 were not recorded at this site. A continuous data record exists from the commissioning of the *Odyssey* system in December 2003 to the June 2005 download. Existing data indicate that the borehole is not affected by any local pumping and the hydrograph indicates baseline conditions.

Osmaston — Feature ID 16539

A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. A very short recovery curve can be seen on the hydrograph after the March 2004 sampling event. The smooth nature of the 2004 recharge and the beginning of the 2005 recharge again suggests that this borehole is monitoring deep aquifer levels (Ezzy, 2005).

Hagley — Feature ID 16540

A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. Local pumping during the irrigation period is most likely affecting the water level in this borehole (Ezzy, 2004). More information is required on the usage of local boreholes to determine potential hydraulic influences on this monitoring site.

Cressy— Feature ID 16541

A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the March 2005 download. Six months of data between March and September 2005 were not collected due to hardware failure. The hydrograph shows that the borehole took up to two weeks to recover after the March and September 2004 sampling events (even when sampled using the bailing technique).

Lilydale — Feature ID 16542

No data was collected between September 2004 and March 2005 due to hardware failure. Data was recorded between December 2003 to mid March 2004 and March to September 2005. Recovery curves from the March 2004 and 2005 sampling events can be seen on the hydrograph. Winter recharge events for both 2004 and 2005 appear on the hydrograph as a sequence of peaks. The rapid recharge seen in both years during the last half of July may be the result of rapid direct recharge via cracks in the clayey soil profile.

Northeast region summary

Significant winter recharge of the aquifers has occurred in this region during 2005, with those aquifers not influenced by groundwater extraction probably completing a recovery cycle.

Pipers River — Feature ID 16543

No data was collected between March and June 2005 due to hardware failure. Data was recorded between December 2003 and mid March 2005, and June and September 2005. A recovery curve for the March 2004 sampling event can be seen on the hydrograph. The smooth shape of the hydrograph for this site implies that the borehole is monitoring deep aquifer levels, which might be less affected by rapid recharge events.

Waterhouse — Feature ID 16544

Except for the last two weeks in March 2004 when the memory capacity of the data recorder was exceeded, a continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. The hydrograph shows limited movement between winter and summer months with a gentle seasonal oscillation of water level. The casing is full of silty sand at 14 metres and no aquifer levels were recorded at the time of drilling. This implies that the hydrograph may only represent a record of the uppermost aquifer level.

Jetsonville — Feature ID 16545

The six months of data between September 2004 and March 2005 were not recorded due to hardware failure. Data was recorded between December 2003 and mid March 2004, and from March to September 2005. Winter recharge events for both 2004 and 2005 indicate rapid responses to rainfall events; e.g. up to five metres of WL rise in one day.

Branxholm — Feature ID 16546

Six months of data between September 2004 and March 2005 were not recorded due to hardware failure. Data was recorded from December 2003 to mid March 2004, and March to September 2005. Winter recharge during 2005 appears to be more intense than that recorded in 2004, with the manual WL reading being the highest on the long-term record. This implies that the aquifer has completed a recovery cycle during the significant recharge winter months of 2005.

Winnaleah — Feature ID 16547

The *Odyssey* system was not installed in this borehole until September 2005 and no hydrograph is presented.

Midlands region summary

Aquifers monitored in this region show limited WL movement in the short and long term, which may be due to low rainfall producing stable hydraulic properties within the aquifers. The Bothwell monitoring borehole provided an artesian flow during both the 2005 sampling events.

Ross — Feature ID 16553

Data was not recorded between June and September 2005 due to hardware failure. A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to June 2005. A recovery curve for the March 2004 sampling event can be seen on the hydrograph. The hydrograph shows less than one metre of movement of the WL between winter and summer months, implying stable hydraulic properties within the aquifer.

Melton Mowbray — Feature ID 16529

Six months of data between September 2004 and March 2005 were not recorded due to hardware failure. Data was recorded from December 2003 to September 2004, and from March to September 2005. A recovery curve for the March 2004 sampling event can be seen on the hydrograph. The hydrograph for this site also suggests stable hydraulic properties within the aquifer.

Tunnack — Feature ID 16550

Except for the last two weeks in March 2004, a continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. This hydrograph is strongly affected by the September 2004 sampling event (and to some degree the March 2005 event) which changed the inflow properties to the borehole. Due to this alteration to the hydraulic properties of the borehole it is difficult to compare the WL data pre and post-September 2005. Drawdown from local boreholes close to the monitored site may also be affecting the baseline data record.

East Coast region summary

The significant recharge event in late January 2004 remains the main feature seen on the short-term hydrographs produced from the *Odyssey* data in this region. Limited winter recharge suggests that if extraction activities are not closely regulated, aquifers in this region may easily become depleted.

St Marys — Feature ID 16526

A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download, except for the last two weeks in March 2004 when the memory capacity of the data recorder was exceeded. The hydrograph implies that the aquifer has limited WL movement, with only one major recharge event observed in late January 2004. Shallow blockages in the borehole may be producing the limited response to winter recharge events. Rainfall and stream-flow data are required to further interpret the hydrograph for this site.

Bicheno — Feature ID 16548

No data was collected between September 2004 and June 2005 due to ingress of water into the data recorder. Data was recorded between December 2003 to September 2004 and July to September 2005. The hydrograph implies that the WL has limited seasonal variation and response to recharge.

Little Swanport — Feature ID 16549

A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. The main feature in this hydrograph is the major recharge event in late January 2004, with a resulting prolonged elevated water level.

Buckland — Feature ID 16551

No data was collected between March and September 2005 due to ingress of water into the data recorder. A continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the March 2005 download. Again, the main feature in this hydrograph is the major recharge event in late January 2004. Unlike the Little Swanport situation, this aquifer quickly fell to pre-recharge WL height.

Southeast region summary

Some aquifers in this region continued to have declining or depleted WL. This demonstrates that aquifers in this region are vulnerable to over extraction. The Huonville monitoring borehole remained artesian during both 2005 sampling events.

Pawleena Road (Sorell) — Feature ID 16554

No data was collected between commissioning of the *Odyssey* system in December 2003 to March 2004 due to hardware failure. A continuous data record exists for this site from March 2004 to the September 2005 download. This aquifer continues to recover as a result of decreasing extraction rates following the construction of a large dam. The WL still remains

approximately 2.5 m below the original depth at the time of drilling in 1991.

Port Arthur — Feature ID 16528

Except for the last two weeks in March 2004, when the memory capacity of the data recorder was exceeded, a continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. Recovery after drawdown due to sampling can be seen from the March and September 2004 sampling events. Recharge and post-recharge WL on the hydrograph imply that this aquifer has an hydraulic retention period of weeks to months.

Snug — Feature ID 17773

Except for the last two weeks in March 2004, when the memory capacity of the data recorder was exceeded, a continuous data record exists for this site from the commissioning of the *Odyssey* system in December 2003 to the September 2005 download. The manual long-term WL records show that the WL continues to decline in this aquifer. This is most likely due to over extraction from local boreholes, which also appears to be affecting the baseline record at the site. Surveying groundwater extraction rates, rainfall and stream-flow data are required to further interpret the hydrograph for this site.

Summary

This report provides observations on hydrographs of time-series WL data and also includes groundwater quality data collected during 2005 from the MRT statewide groundwater monitoring network.

The *Dataflow* system is no longer used by MRT to monitor groundwater water level, with the remaining data logger at Winnaleah being replaced by an *Odyssey* data recorder. A number of the *Odyssey* units have failed at some point, apparently as a result of ingress of water into the data recorders. Advice from the supplier suggests that this might not be a supplier or installation fault, but could result from actions undertaken by a third party.

In some cases the collection of groundwater samples has affected the inflow to specific boreholes. This has altered the hydraulic properties of the borehole and changed the functionality of the site to compare long term baseline water levels.

Interpreted baseline records from the six regions suggest that the response to recharge varies based on the nature of the host materials (solid rock and/or unconsolidated sediments), location in the catchment, and the depth of the monitored aquifer level(s). No anomalous results occurred within the groundwater quality data for March and September 2005.

As commented in Ezzy (2004) "key points still to be addressed include legal accessibility to sites, upgrading the current network, identifying groundwater over extraction 'hot spots' and suitable sites for future boreholes (with respect to current rainfall stations and stream flow monitoring sites)". This would aid the process of regulating and sustainably managing Tasmanian groundwater resources.

Funds are required to redesign the Tasmanian groundwater monitoring network to international standards.

References

EZZY, A. R. 2004. An overview of the Mineral Resources Tasmania statewide groundwater monitoring network. *Record Tasmanian Geological Survey* 2004/4.

EZZY, A. R. 2005. MRT statewide groundwater monitoring network: Data collection — September 2004. *Record Tasmanian Geological Survey* 2005/1.

[10 January 2006]

APPENDIX 1

Laboratory results for the March and September 2005 monitoring rounds

Analyses by L. Hay, Mineral Resources Tasmania, Rosny Park

March 2005

Lab. Anal. No.	20050114	20050115	20050116	20050117	20050118	20050119	20050147	20050148	20050123	20050120	20050121	20050122
Location	Barrington	Beulah	Bicheno	Bothwell	Branxholm	Buckland	Burnie Tip 1	Burnie Tip 4	Free's Bore	Calder	Chudleigh	Cressy
Date Sampled	03/03/2005	03/03/2005	10/03/2005	04/03/2005	10/03/2005	11/03/2005	01/03/2005	01/03/2005	01/03/2005	02/03/2005	03/03/2005	08/03/2005
Date Analysed	08/07/2005	08/07/2005	08/07/2005	08/07/2005	08/07/2005	08/07/2005	08/08/2005	08/08/2005	08/07/2005	08/07/2005	08/07/2005	08/07/2005
pH	7.2	7.1	7.5	7.6	7.2	6.8	7.7	7.5	7.4	6	6.9	7.2
Conductivity (µS/cm)	222	169	6240	1230	118	2080	394	139	171	151	61	3060
Item (mg/L)												
Ca^{++}	10.5	6.8	190	115	0.7	12	27	5.6	7.6	6.2	2.6	110
Mg^{++}	9.8	12	220	48	5.7	37	20	5.3	6.1	3.2	1.3	80
$Fe^{++(+)}$	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	3.8	<0.1	<0.1
Al^{+++}	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Na^{+}	19	7.1	720	71	12	320	21	11.5	13.5	16	5.4	320
K^{+}	0.8	1.4	9.1	2.6	1.2	7.6	3.1	1.3	2.3	2.1	0.2	26
Cl^{-}	12.5	12.5	1900	140	21	600	39	19.5	27	27	10.5	910
F^{-}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SO_4^{--}	<5.0	<5.0	120	130	<5.0	25	<5.0	<5.0	<5.0	11.5	<5.0	<5.0
NO_3^{-}	10	<10	<10	<10	<10	<10	10	10	10	10	<10	10
CO_3^{--}	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
HCO_3^{-}	91	76	280	370	19	19	150	31	36	11.5	10.5	67
TDS	161	104	3960	794	64	1210	245	96	106	146	47	1850
Perm. Hardness	nil	<5.0	1150	185	9.4	170	25	10	14.5	26	<5.0	550
Temp. Hardness	67	62	230	300	15.5	15.5	125	26	30	9.4	8.8	55
Alkalinity	74	62	230	300	15.5	15.5	125	26	30	9.4	8.8	55

March 2005

Lab. Anal. No.	20050124	20050125	20050126	20050127	20050128	20050129	20050130	20050131	20050132	20050133	20050134	20050135
Location	Hagley	Hampshire	Huonville	Jetsonville	Lilydale	Little Swanport	Melt. Mowbray	Montague	Mooreville Road	Osmaston	Pawleena Road	Pipers River
Date Sampled	03/03/2005	01/03/2005	22/03/2005	08/03/2005	08/03/2005	11/03/2005	04/03/2005	02/03/2005	01/03/2005	03/03/2005	23/03/2005	08/03/2005
Date Analysed	08/07/2005	08/07/2005	08/07/2005	08/07/2005	08/07/2005	08/07/2005	08/07/2005	08/07/2005	08/07/2005	08/07/2005	08/08/2005	08/08/2005
pH	8.1	7.7	7.1	5.7	7.1	8.1	7.5	7.5	5.1	7.1	7.7	6
Conductivity (µS/cm)	533	179	950	136	396	2980	2140	1620	71	1410	2460	561
Item (mg/L)												
Ca^{++}	33	11	53	1	24	76	75	95	0.3	41	110	16.5
Mg^{++}	24	5.6	17.5	2.1	6.5	74	62	39	1.2	29	89	7.6
$Fe^{++(+)}$	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Al^{+++}	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Na^{+}	33	12.5	91	19	40	450	270	150	9	165	240	73
K^{+}	1.1	2	7.1	0.9	3.1	7.1	3.6	8.7	0.3	17.5	2.1	3.1
Cl^{-}	51	17.5	200	30	21	610	420	340	14	340	520	135
F^{-}	<0.1	<0.1	<0.1	<0.1	<0.1	0.8	0.1	<0.1	<0.1	<0.1	0.4	<0.1
SO_4^{--}	<5.0	<5.0	39	<5.0	95	55	58	79	<5.0	28	31	12
NO_3^{-}	25	10	<10	<10	<10	<10	<10	<10	<10	50	10	<10
CO_3^{--}	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
HCO_3^{-}	195	54	155	<5.0	51	590	430	230	<5.0	87	490	5.4
TDS	312	87	584	70	285	1660	1170	976	32	854	1480	307
Perm. Hardness	18.5	6.1	76	9.3	45	12.5	88	210	5.1	150	240	69
Temp. Hardness	160	45	130	<5.0	42	480	350	190	<5.0	72	400	<5.0
Alkalinity	160	45	130	<5.0	42	480	350	190	<5.0	72	400	<5.0

March 2005

Lab. Anal. No.	20050136	20050137	20050138	20050139	20050140	20050141	20050142	20050143	20050144	20050145	20050146
Location	Port Arthur	Ross	Snug	South Forest	Spreyton	St Marys	Togari	Trowutta	Tunnack	Waterhouse	Winnaleah
Date Sampled	23/03/2005	07/03/2005	22/03/2005	02/03/2005	03/03/2005	10/03/2005	02/03/2005	02/03/2005	07/03/2005	09/03/2005	10/03/2005
Date Analysed	08/08/2005	08/08/2005	08/08/2005	08/08/2005	08/08/2005	08/08/2005	08/08/2005	08/08/2005	08/08/2005	08/08/2005	08/08/2005
pH	7	8	7.1	6.1	7.6	7.9	7.6	7.8	7.2	7	8
Conductivity (µS/cm)	379	4240	1590	145	522	1330	1110	255	1060	614	366
Item (mg/L)											
Ca^{++}	9.9	46	46	2.5	57	33	110	17.5	83	12	0.7
Mg^{++}	7.5	170	43	4.7	17	34	51	8.3	45	16	0.5
$Fe^{++(+)}$	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	0.8	<0.1	<0.1	<0.1	0.8
Al^{+++}	0.7	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	2.8
Na^{+}	58	620	195	14	23	190	52	18.5	61	76	80
K^{+}	0.7	5.3	4.1	3.3	7.8	1	7.1	1.1	4.7	2.7	7.5
Cl^{-}	53	990	400	25	21	230	125	27	74	140	21
F^{-}	<0.1	0.4	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.2	<0.1	<0.1
SO_4^{--}	19.5	74	100	9.6	<5.0	67	110	12.5	340	38	10.5
NO_3^{-}	< 10	50	<10	10	<10	<10	10	<10	<10	<10	10
CO_3^{--}	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
HCO_3^{-}	88	720	54	<5.0	260	300	330	81	105	31	160
TDS	255	2450	988	81	259	752	757	162	804	348	246
Perm. Hardness	nil	240	250	23	nil	nil	210	11	300	71	nil
Temp. Hardness	60	590	44	<5.0	210	220	270	67	88	26	21
Alkalinity	72	590	44	<5.0	210	250	270	67	88	26	130

September 2005

Lab. Anal. No.	20050266	20050267	20050268	20050269	20050270	20050271	20050299	20050275	20050272	20050273	20050274	20050276
Location	Barrington	Beulah	Bicheno	Bothwell	Branxholm	Buckland	Burnie Tip 4	Free's Bore	Calder	Chudleigh	Cressy	Hagley
Date Sampled	14/09/2005	14/09/2005	07/09/2005	15/09/2005	06/09/2005	07/09/2005	06/09/2005	14/09/2005	13/09/2005	14/09/2005	05/09/2005	12/09/2005
Date Analysed	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005
pH	6.7	6.7	7.5	7.4	5.4	6.1	6.8	6.5	5.7	4.7	6.8	7.9
Conductivity (µS/cm)	114	154	6430	1290	109	2220	161	116	147	72	2960	525
Item (mg/L)												
Ca^{++}	6.5	7.4	220	135	2.3	18.5	7.3	4.2	5.6	1.2	115	38
Mg^{++}	4.7	11	240	53	1.9	43	6	3.5	3.6	2.4	83	24
$Fe^{++(+)}$	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Al^{+++}	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Na^{+}	7.7	6.7	730	69	12	340	12.5	10.5	16.5	4.3	320	35
K^{+}	0.3	1.2	9	2.6	2.6	8.5	1.9	1.7	1.5	0.8	28	1.1
Cl^{-}	10.5	14	1950	145	21	650	23	16	21	16	890	50
F^{-}	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SO_4^{--}	7.9	<5.0	115	135	<5.0	30	<5.0	<5.0	11	<5.0	<5.0	<5.0
NO_3^{-}	10	<10	<10	<10	10	<10	25	25	10	<10	10	25
CO_3^{--}	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
HCO_3^{-}	28	61	320	390	<5.0	26	30	12.5	13	<5.0	69	200
TDS	77	95	4080	833	58	1270	107	75	124	28	1750	310
Perm. Hardness	14	13.5	1250	240	12.5	200	18.5	15	18	12	570	33
Temp. Hardness	23	50	260	320	<5.0	21	25	10	10.5	<5.0	57	160
Alkalinity	23	50	260	320	<5.0	21	25	10	10.5	<5.0	57	160

September 2005

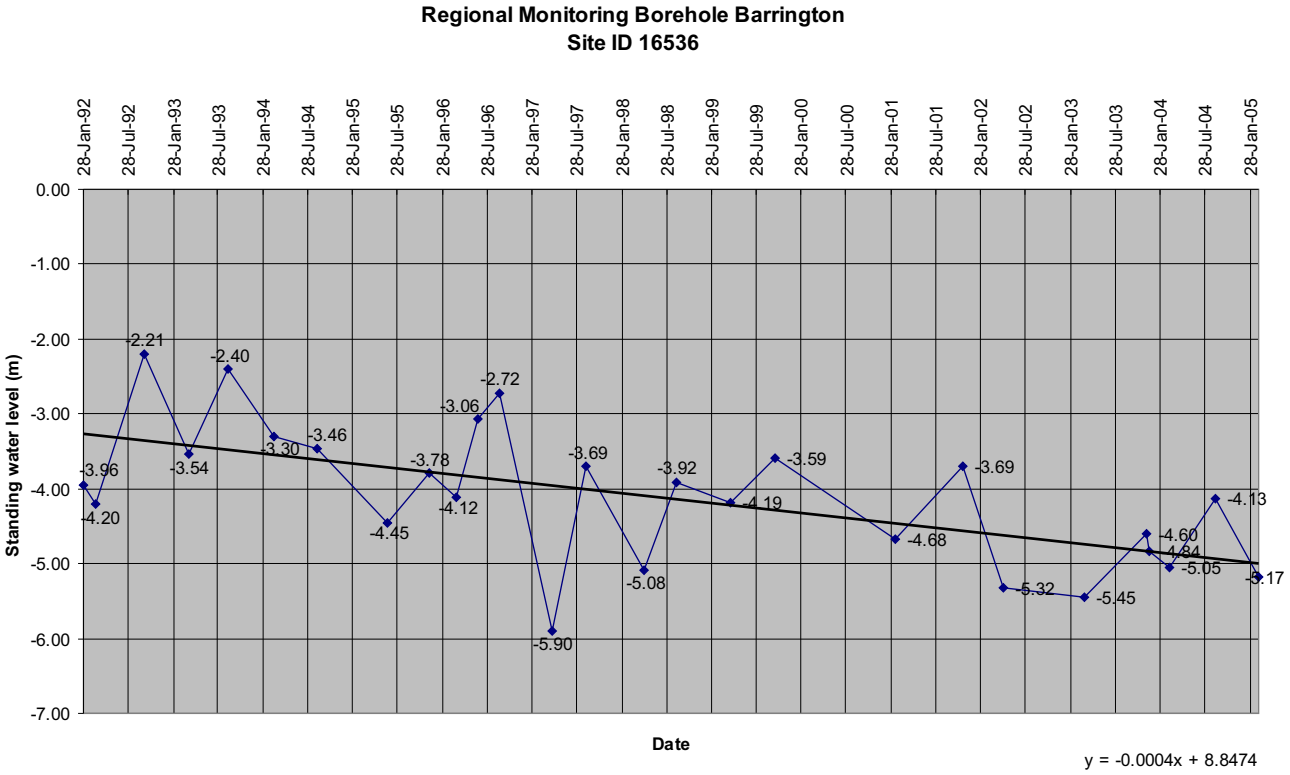
Lab. Anal. No.	20050277	20050278	20050279	20050280	20050281	20050282	20050283	20050284	20050285	20050286	20050287	20050288
Location	Hampshire	Huonville	Jetsonville	Lilydale	Little Swanport	Melt. Mowbray	Montague	Mooreville Road	Osmaston	Pawleena Rd.	Piper's River	Port Arthur
Date Sampled	14/09/2005	02/09/2005	06/09/2005	05/09/2005	07/09/2005	08/09/2005	13/09/2005	14/09/2005	12/09/2005	14/09/2005	14/09/2005	07/09/2005
Date Analysed	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005
pH	6.1	6.9	6.2	4.5	7.9	7.8	6.6	4.9	5.5	7.8	5	7.5
Conductivity (mS/cm)	137	977	90	199	3050	2220	753	66	408	2440	419	462
Item (mg/L)												
Ca^{++}	6.7	64	2.3	4.2	92	100	42	0.9	6.6	120	4.4	11.5
Mg^{++}	4	18.5	2.6	3.8	78	63	20	1.2	8.8	94	6	8.9
$Fe^{++(+)}$	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	1.7	<0.1	<0.1	<0.1	1.2	0.3
Al^{+++}	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.5	<0.2
Na^{+}	10.5	100	9.5	18.5	450	270	70	7	44	250	43	71
K^{+}	2	7.2	1.6	2.7	7.6	3.7	9	0.4	15.5	1.9	28	0.6
Cl^{-}	21	210	14	14	660	430	115	< 10.0	57	520	90	69
F^{-}	<0.1	<0.1	<0.1	<0.1	0.9	0.1	<0.1	<0.1	<0.1	0.4	<0.1	<0.1
SO_4^{--}	<5.0	42	<5.0	33	49	59	115	<5.0	27	33	10	23
NO_3^{-}	25	<10	25	10	<10	<10	<10	10	50	25	25	<10
CO_3^{--}	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
HCO_3^{-}	9.2	120	<5.0	nil	600	500	68	nil	5.4	500	<5.0	105
TDS	90	605	62	167	1720	1230	478	44	312	1530	288	287
Perm. Hardness	26	140	15	26	53	98	135	7.7	49	280	38	nil
Temp. Hardness	7.6	97	<5.0	nil	500	410	56	nil	<5.0	410	<5.0	66
Alkalinity	7.6	97	<5.0	nil	500	410	56	nil	<5.0	410	<5.0	86

September 2005

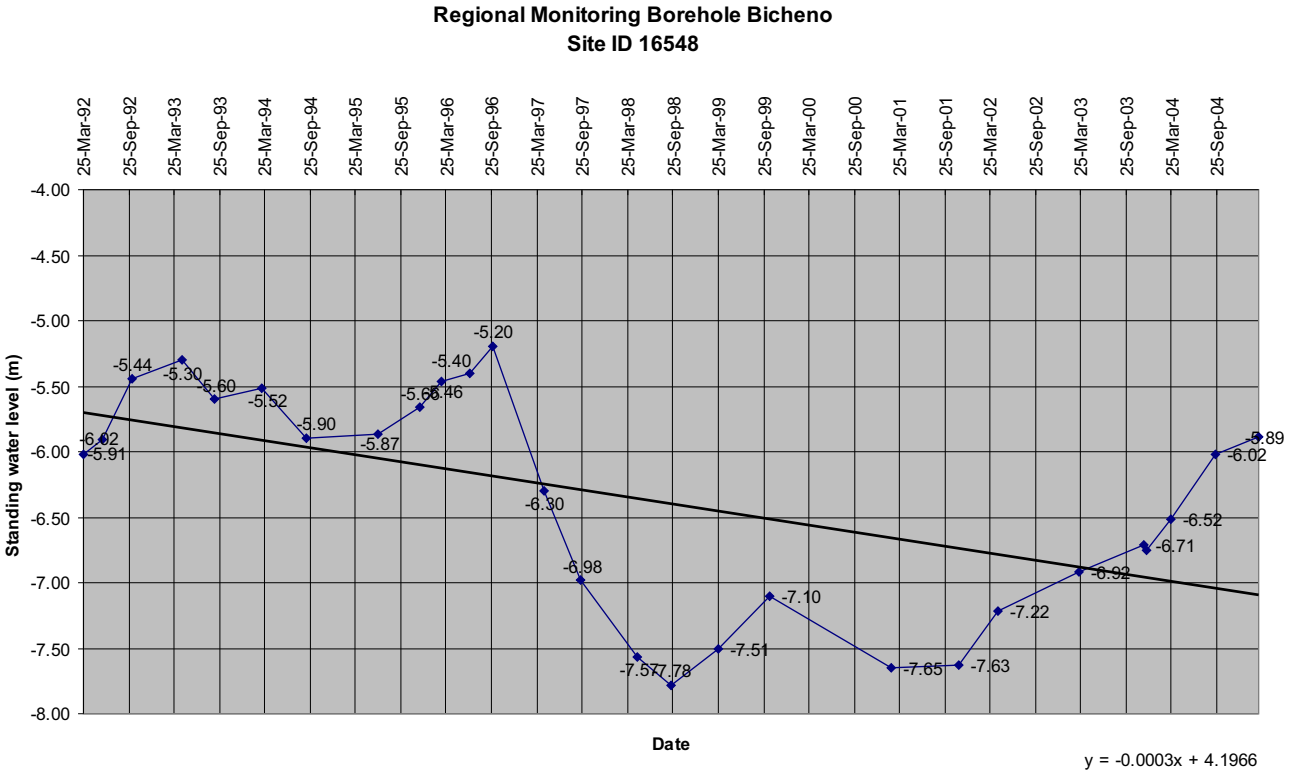
Lab. Anal. No.	20050289	20050290	20050291	20050292	20050293	20050294	20050295	20050296	20050297	20050298
Location	Ross	Snug	South Forest	Spreyton	St Marys	Togari	Trowutta	Tunnack	Waterhouse	Winnaleah
Date Sampled	15/09/2005	06/09/2005	07/09/2005	13/09/2005	14/09/2005	05/09/2005	14/09/2005	12/09/2005	14/09/2005	02/09/2005
Date Analysed	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005	22/11/2005
pH	8	6.8	5.6	7.8	7.5	7.3	7.5	6.9	6.7	7.9
Conductivity (µS/cm)	4010	1530	150	524	1260	1090	230	1060	606	336
Item (mg/L)										
Ca^{++}	51	45	3	71	36	125	14.5	95	13	1.1
Mg^{++}	160	41	4.7	16	30	47	7.3	42	15.5	0.7
$Fe^{++(+)}$	<0.1	<0.1	<0.1	<0.1	<0.1	1	<0.1	<0.1	<0.1	0.4
Al^{+++}	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.2	0.3
Na^{+}	550	185	14	23	180	47	18	63	76	73
K^{+}	5.5	4.9	3.9	9	1.1	7.6	1.3	5.2	3.2	8.3
Cl^{-}	930	380	27	23	210	115	25	78	135	23
F^{-}	0.4	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1
SO_4^{--}	75	91	10.5	<5.0	64	110	15	360	39	<5.0
NO_3^{-}	50	<10	25	<10	<10	10	<10	<10	<10	25
$CO3^{--}$	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
HCO_3^{-}	650	50	<5.0	300	290	320	62	98	31	140
TDS	2320	960	85	289	695	802	142	812	368	211
Perm. Hardness	250	240	24	nil	nil	240	16	330	71	nil
Temp. Hardness	530	41	<5.0	240	220	270	51	80	25	8.2
Alkalinity	530	41	<5.0	240	230	270	51	80	25	115

APPENDIX 2
Updated manual SWL graphs

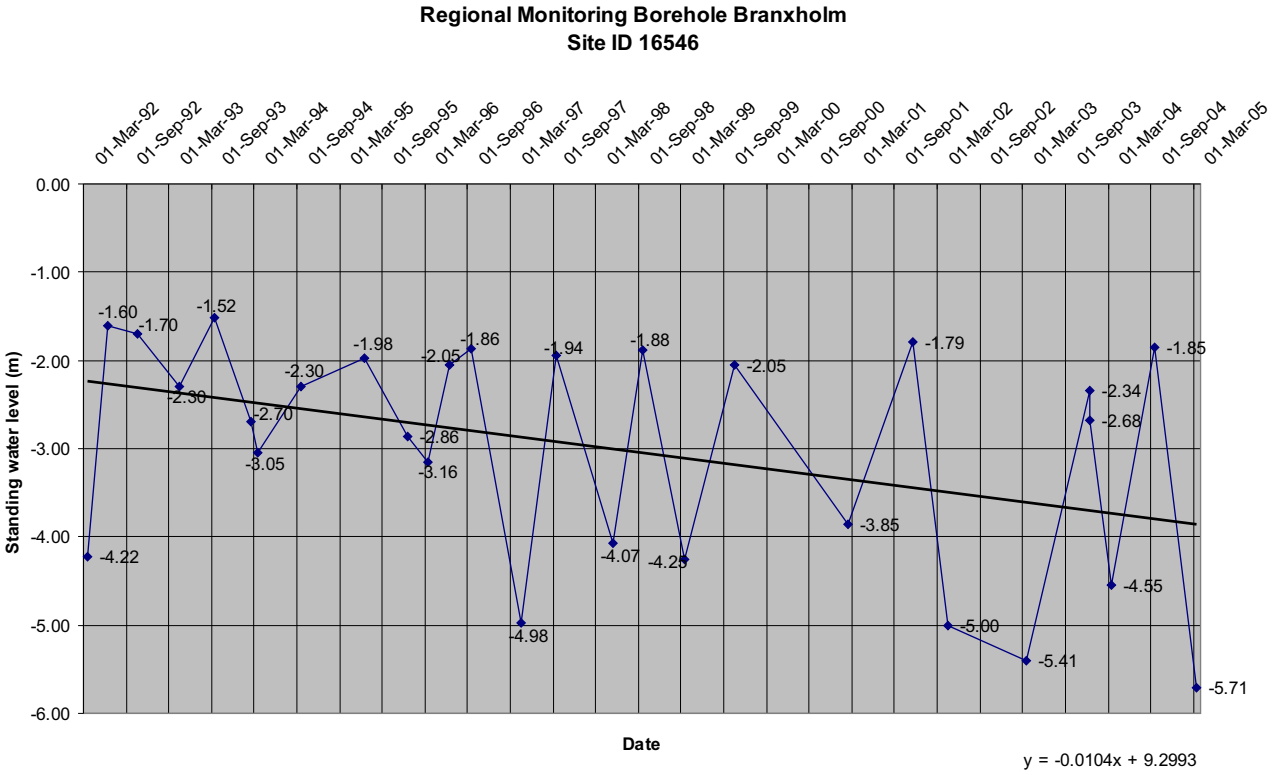
Barrington



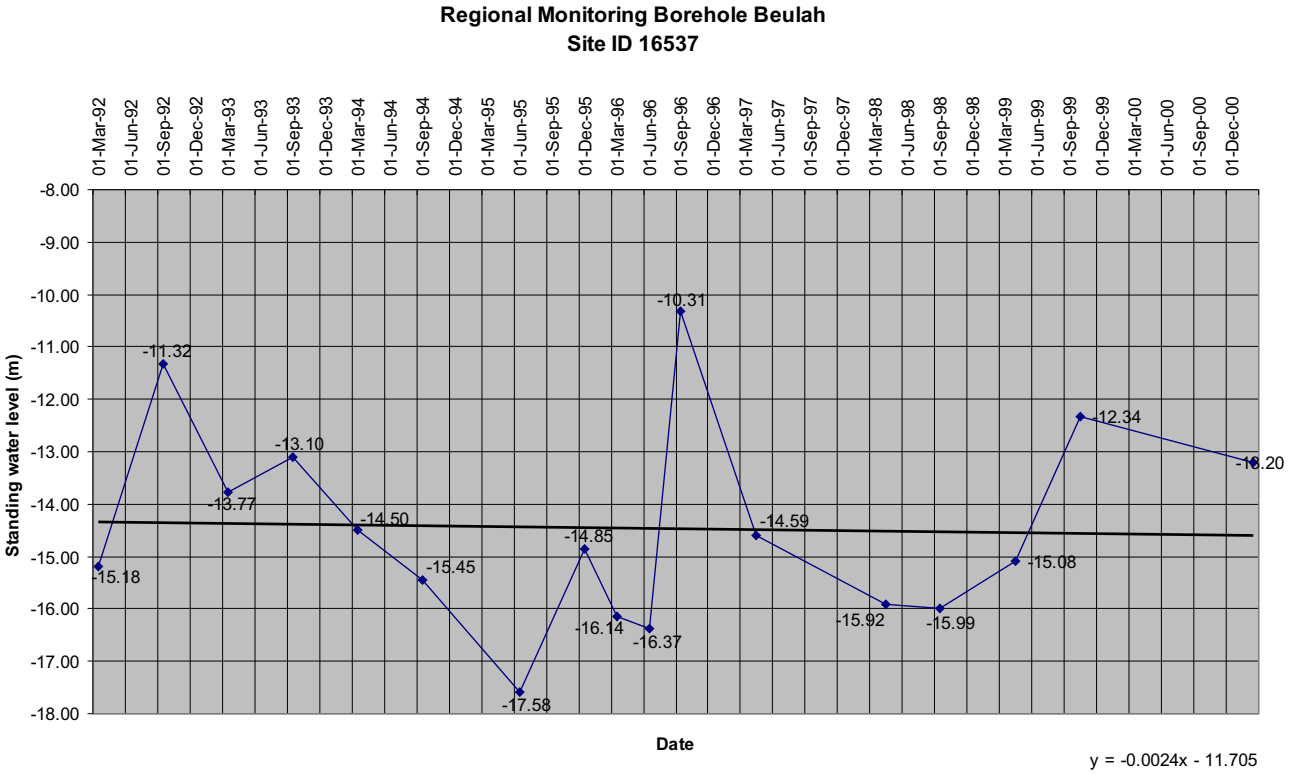
Bicheno



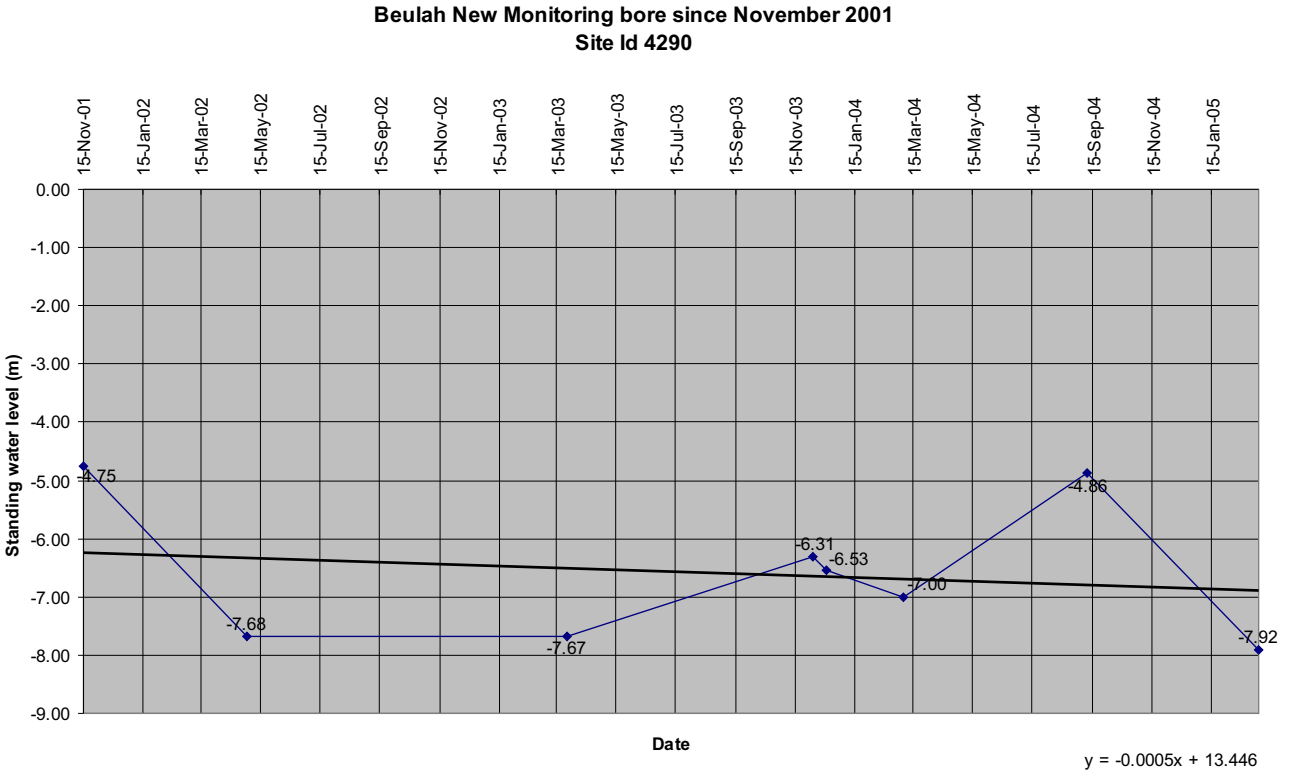
Branxholm



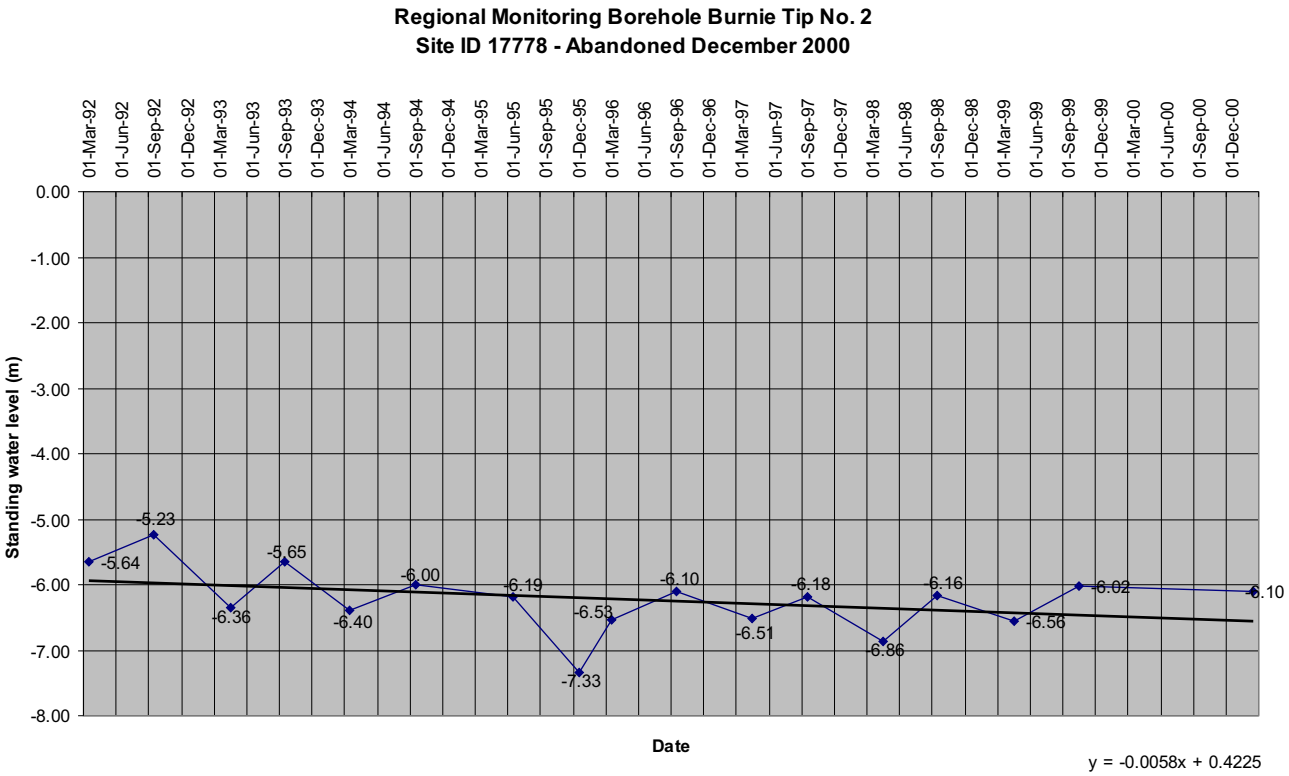
Beulah (old)



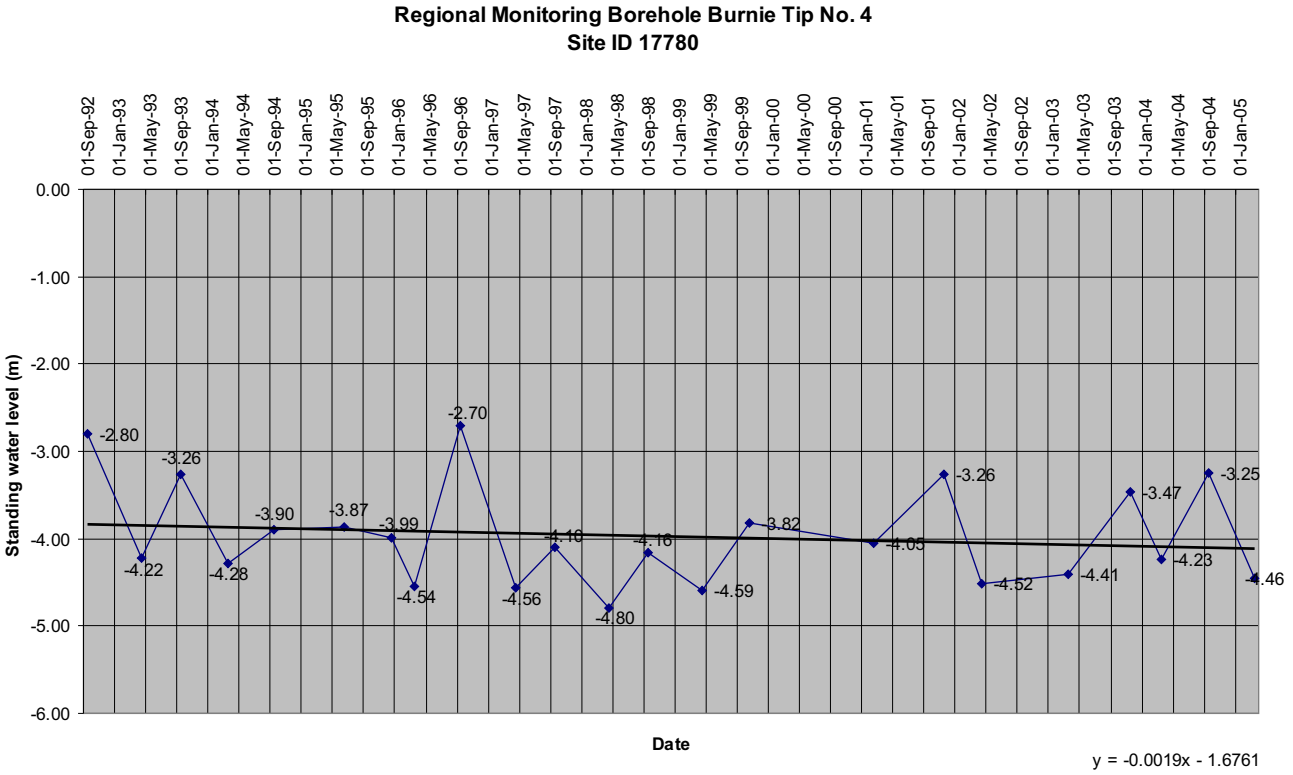
Beulah (new)



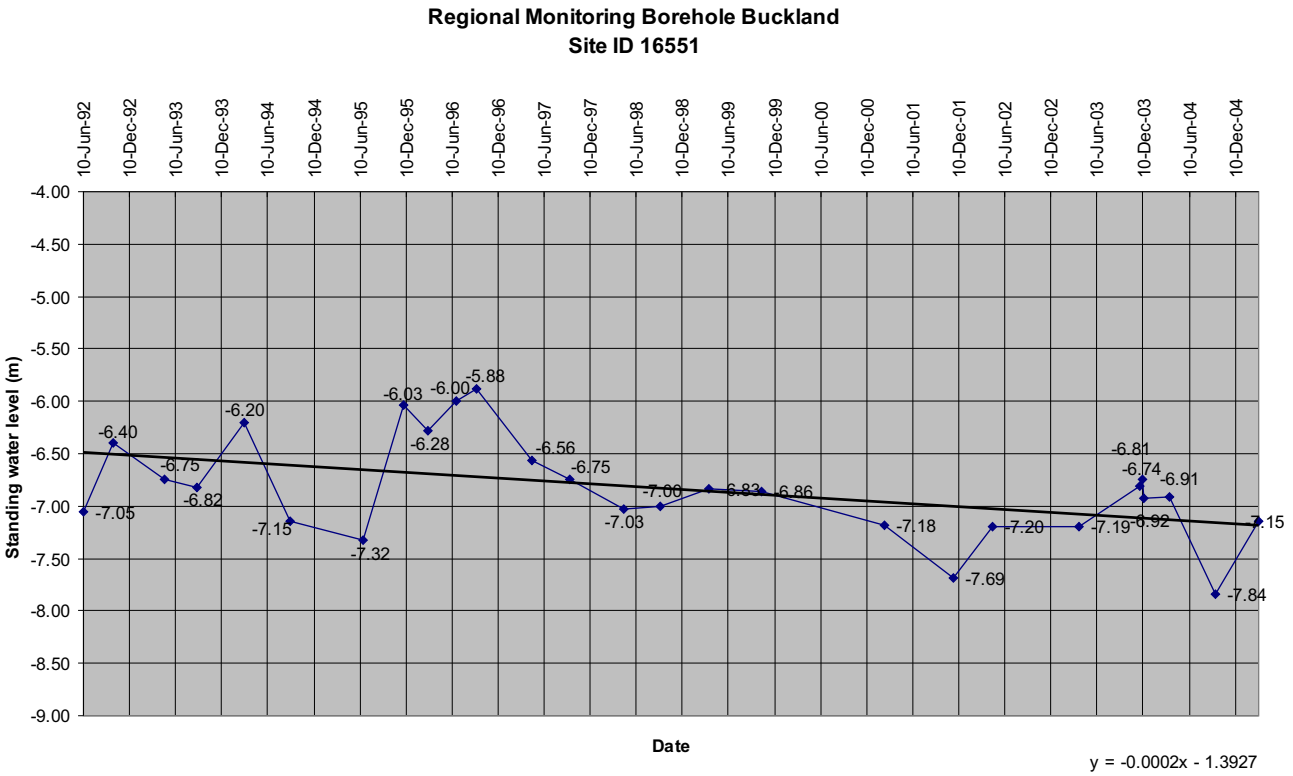
Burnie Tip No. 2



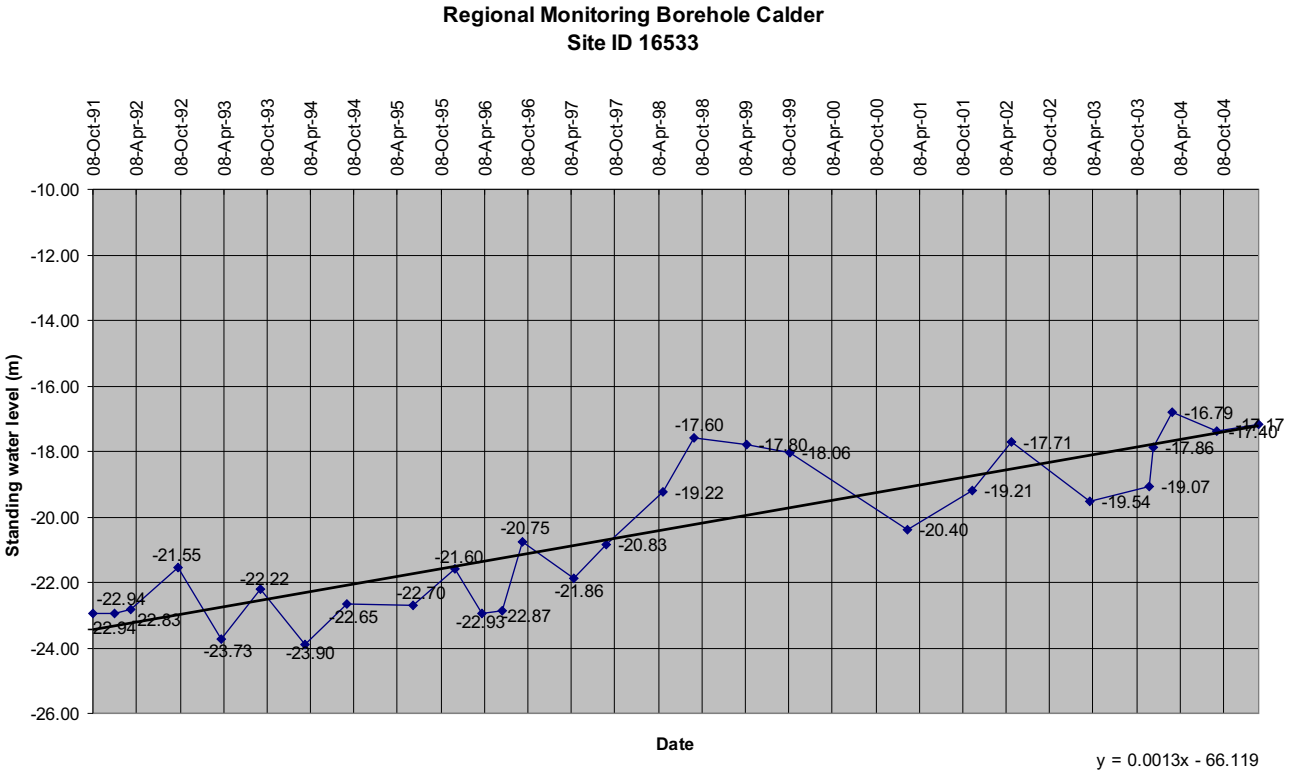
Burnie Tip No. 4



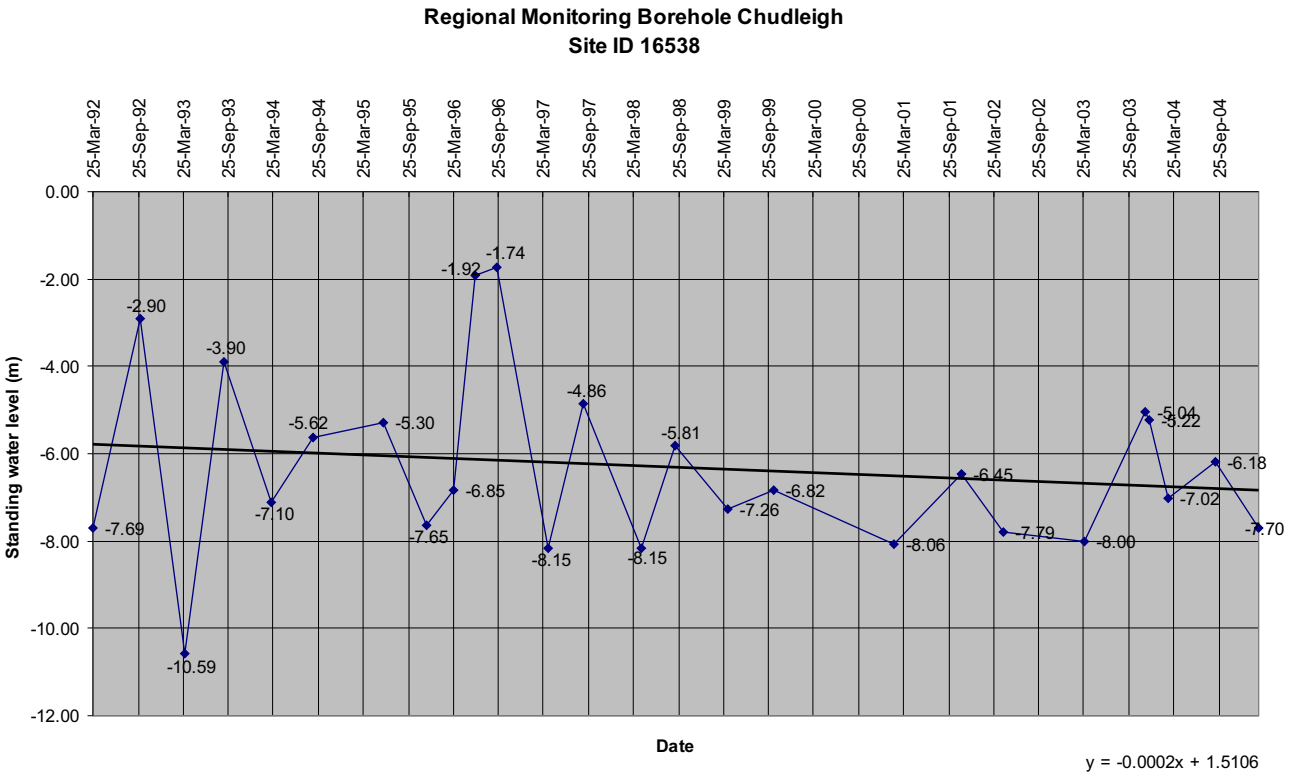
Buckland



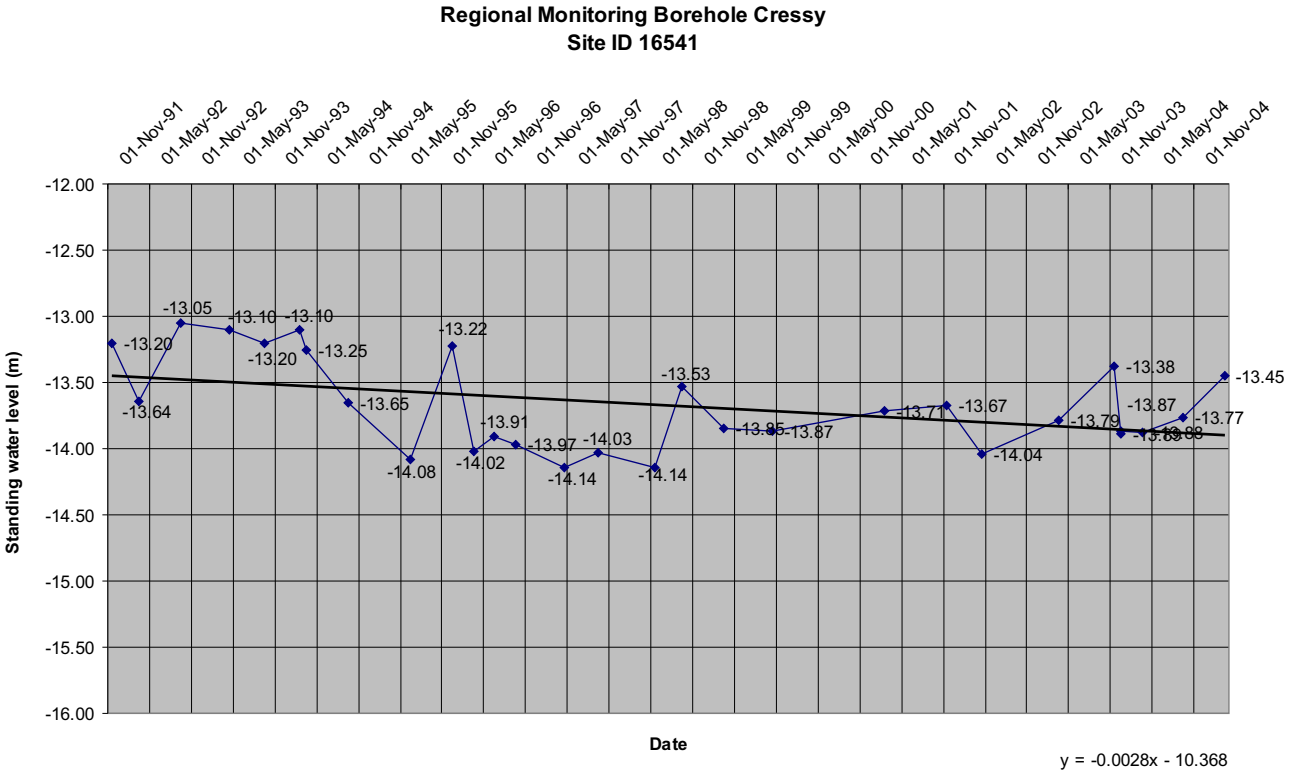
Calder



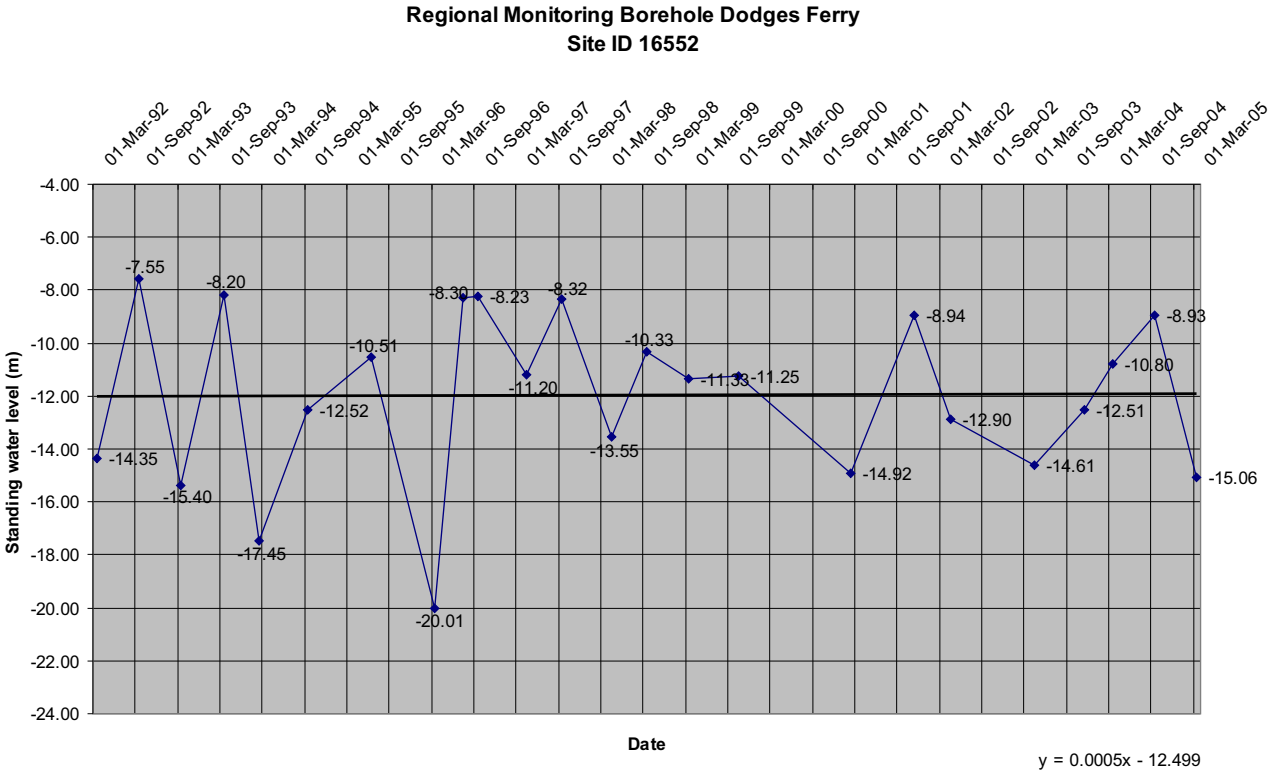
Chudleigh



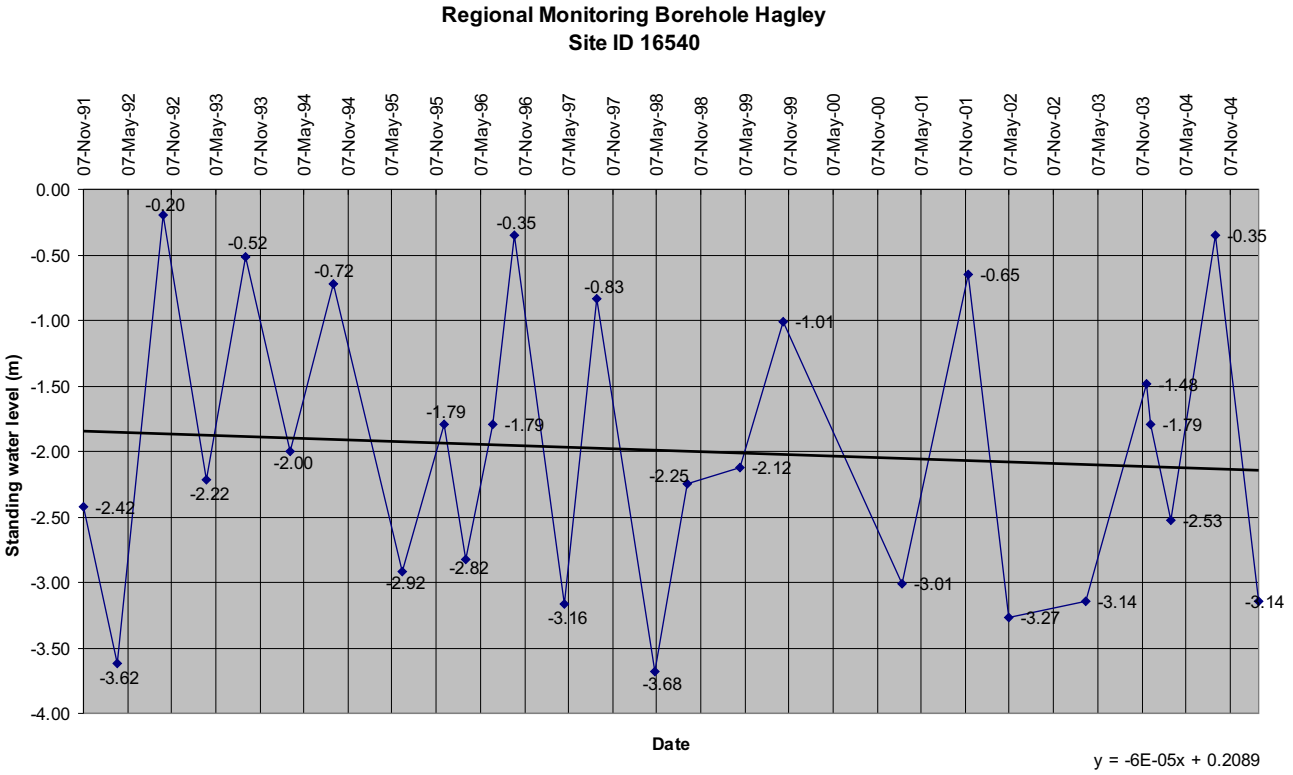
Cressy



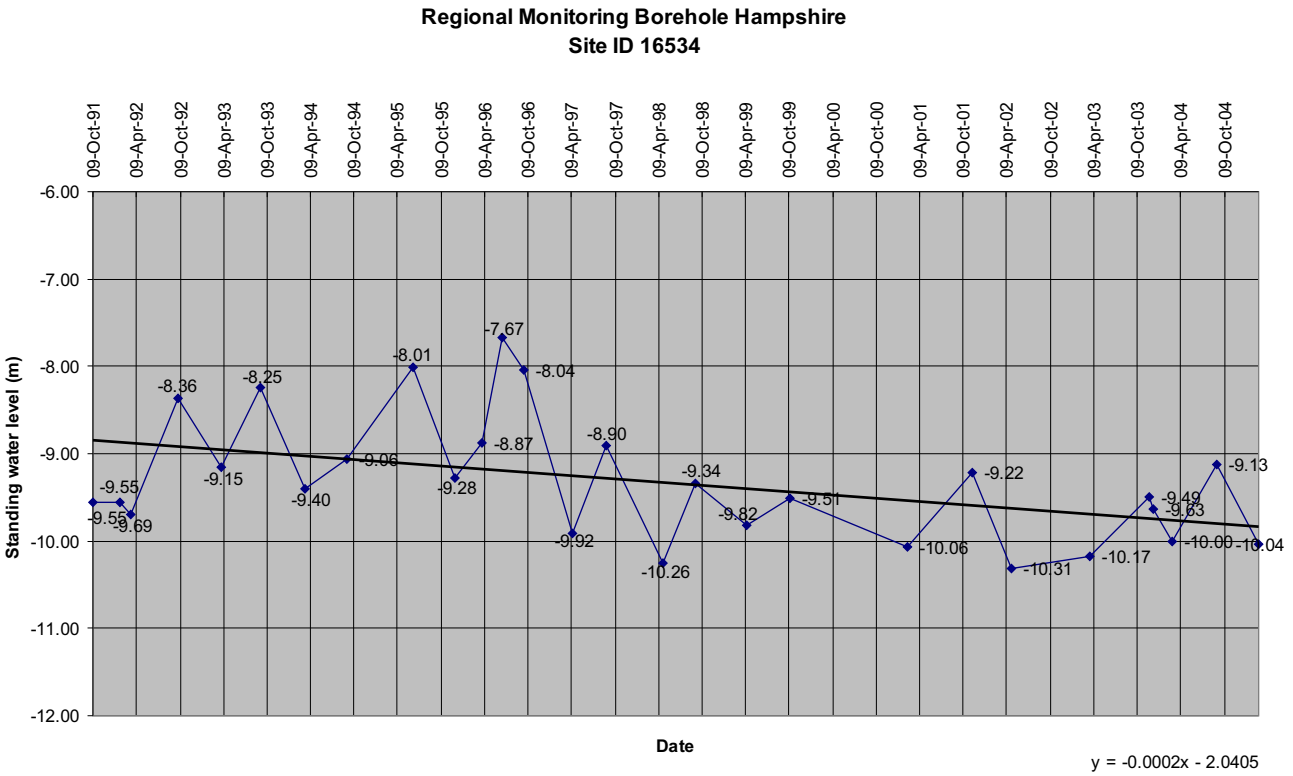
Dodges Ferry



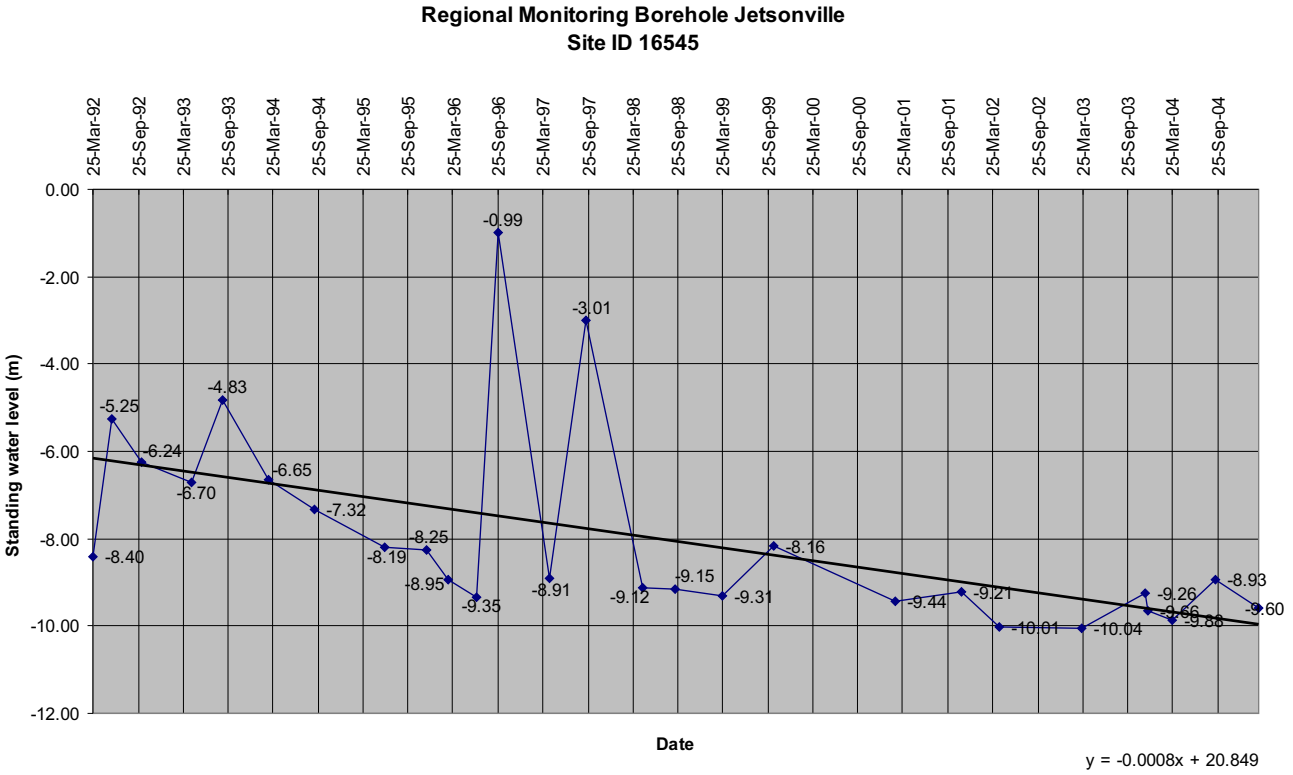
Hagley



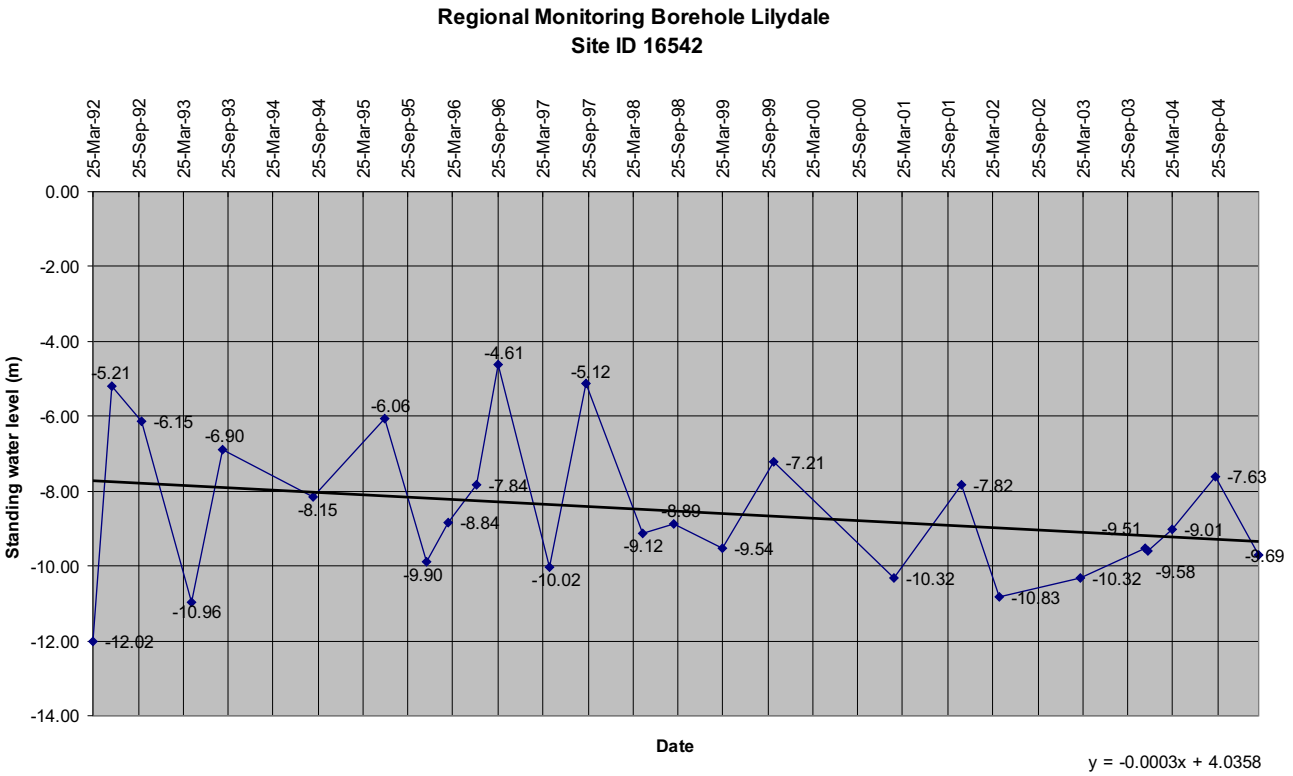
Hampshire



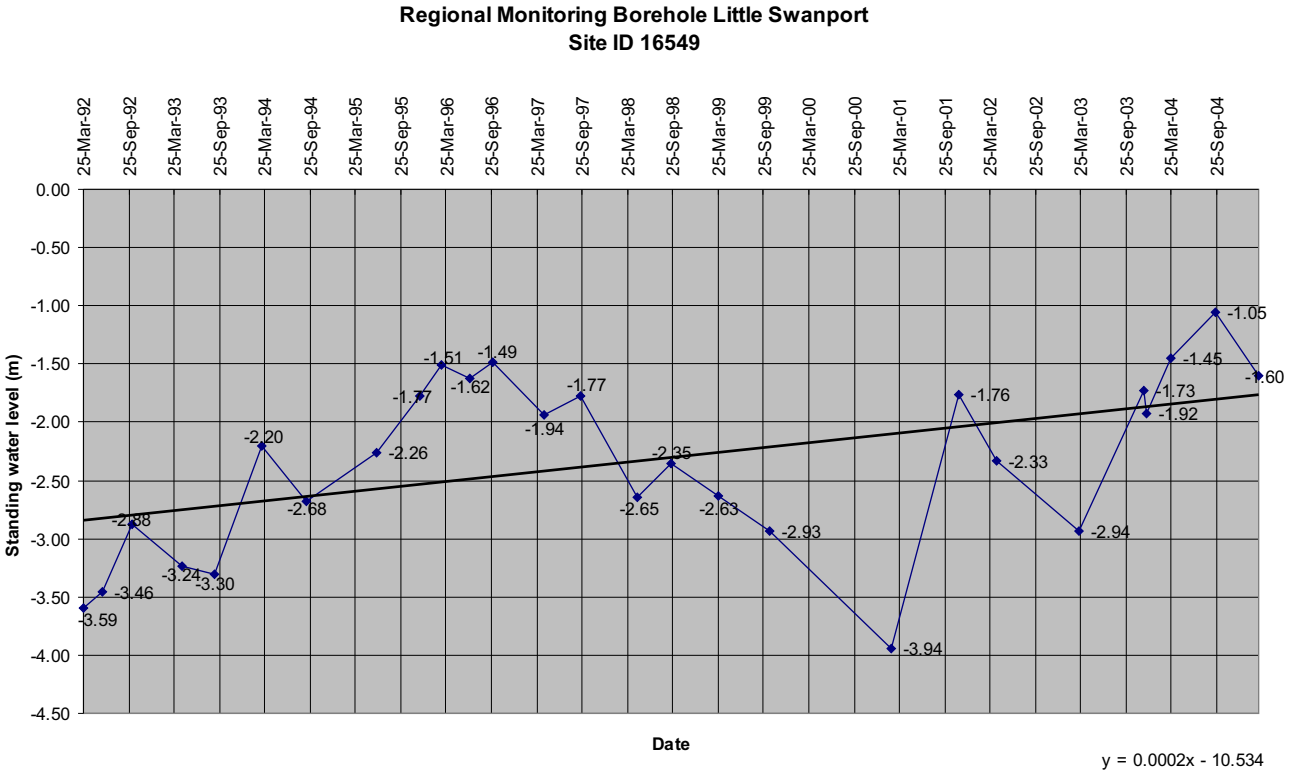
Jetsonville



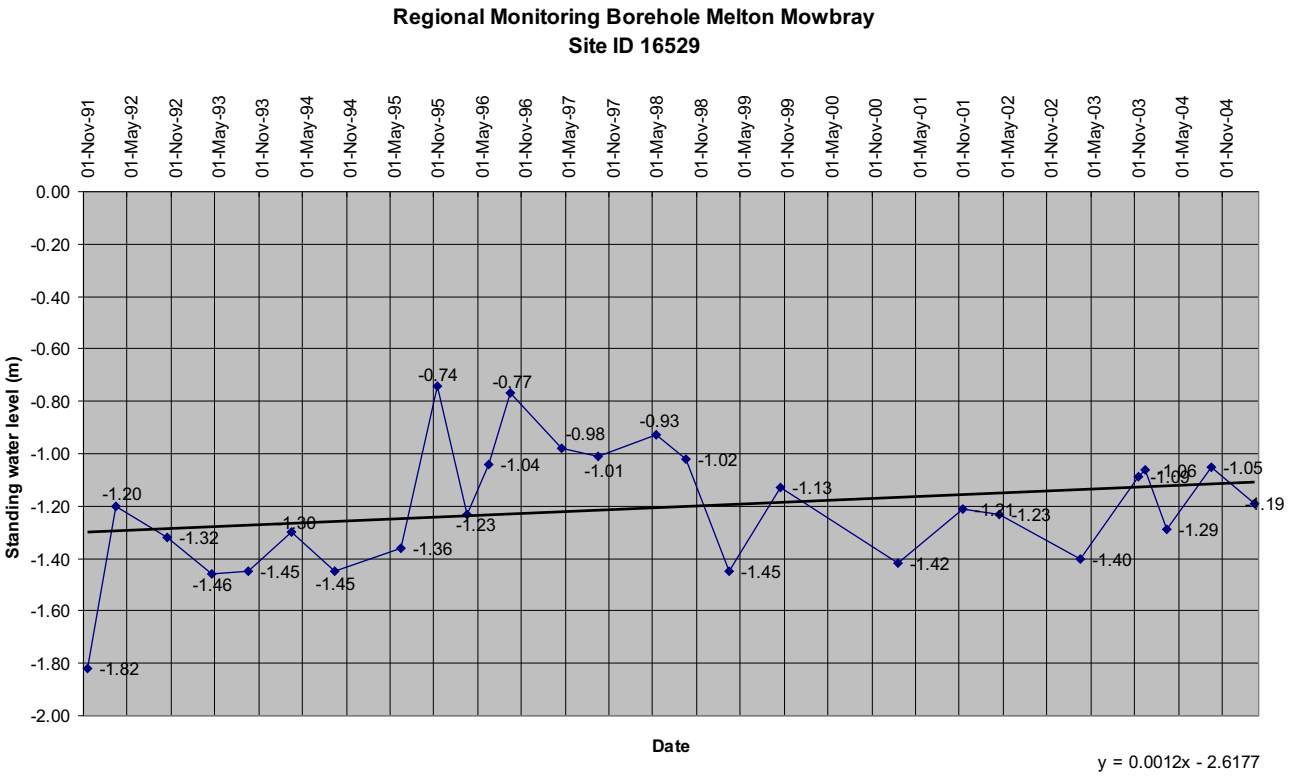
Lilydale



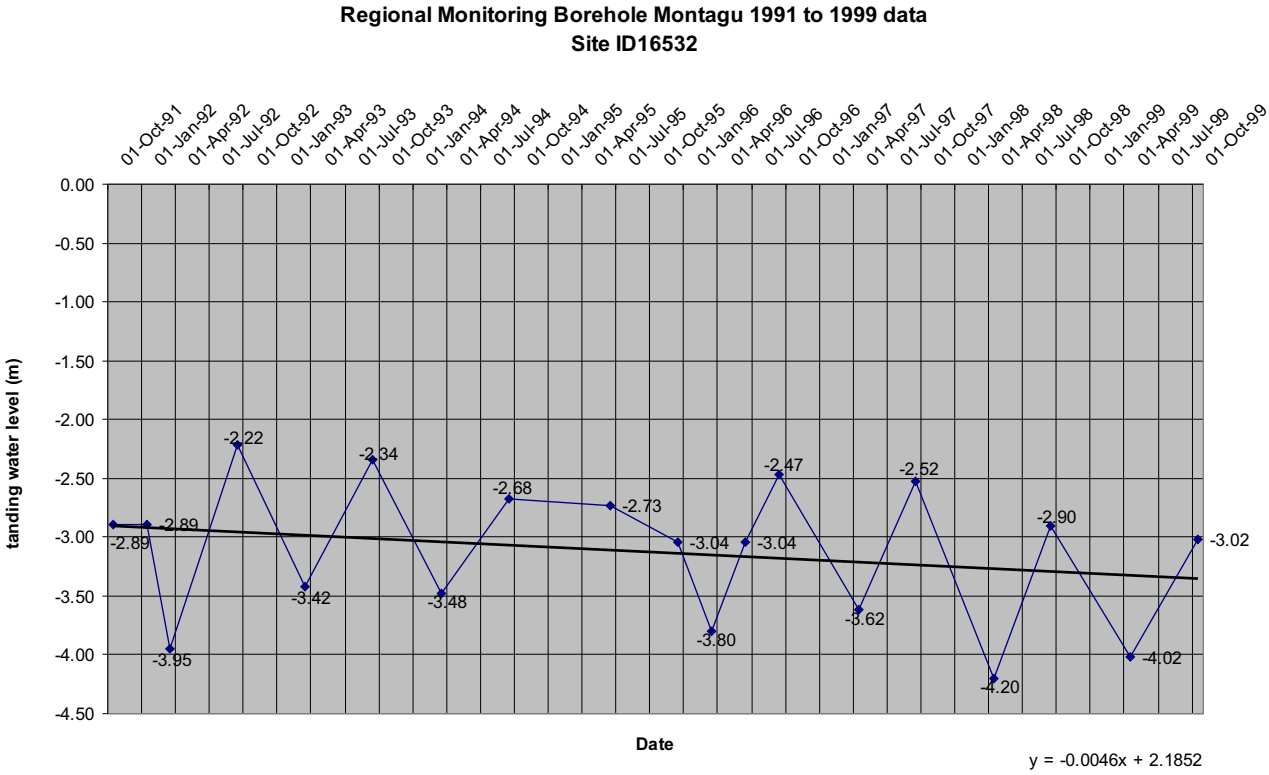
Little Swanport



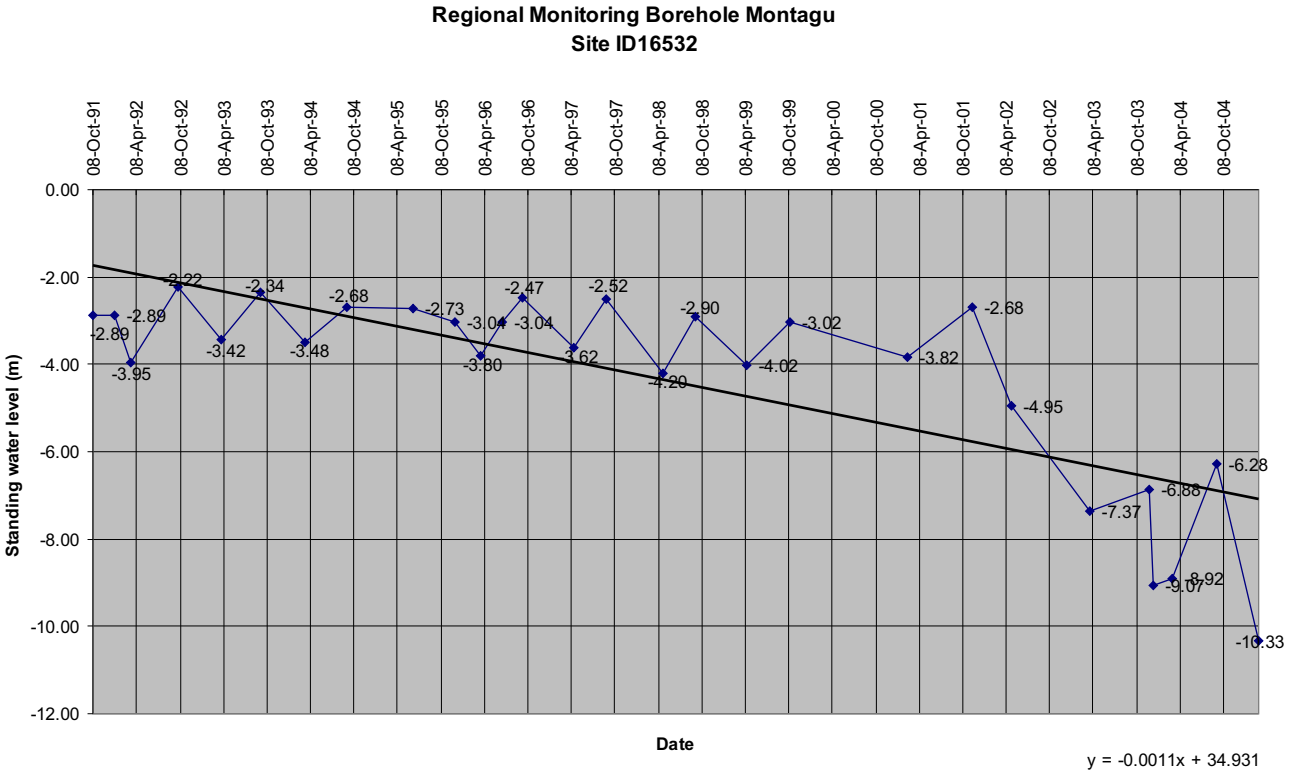
Melton Mowbray



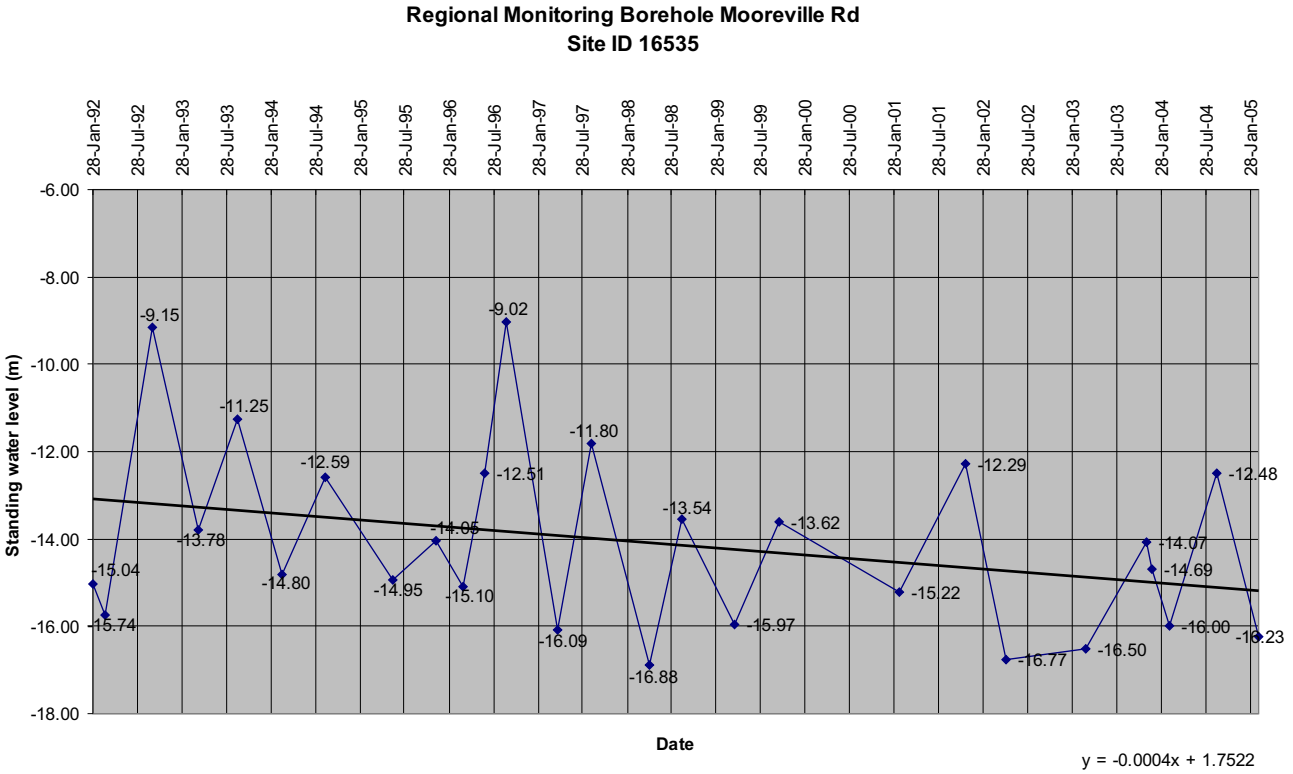
Montagu (to 1999)



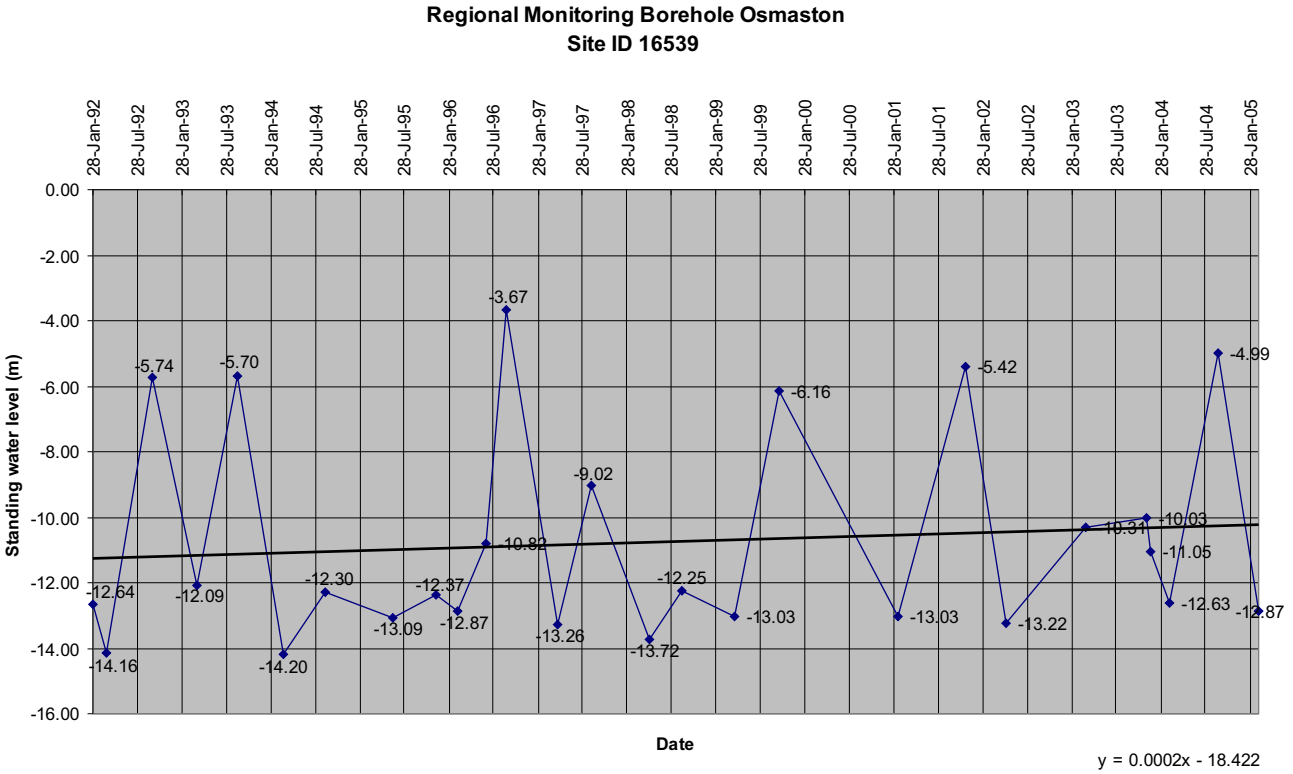
Montagu



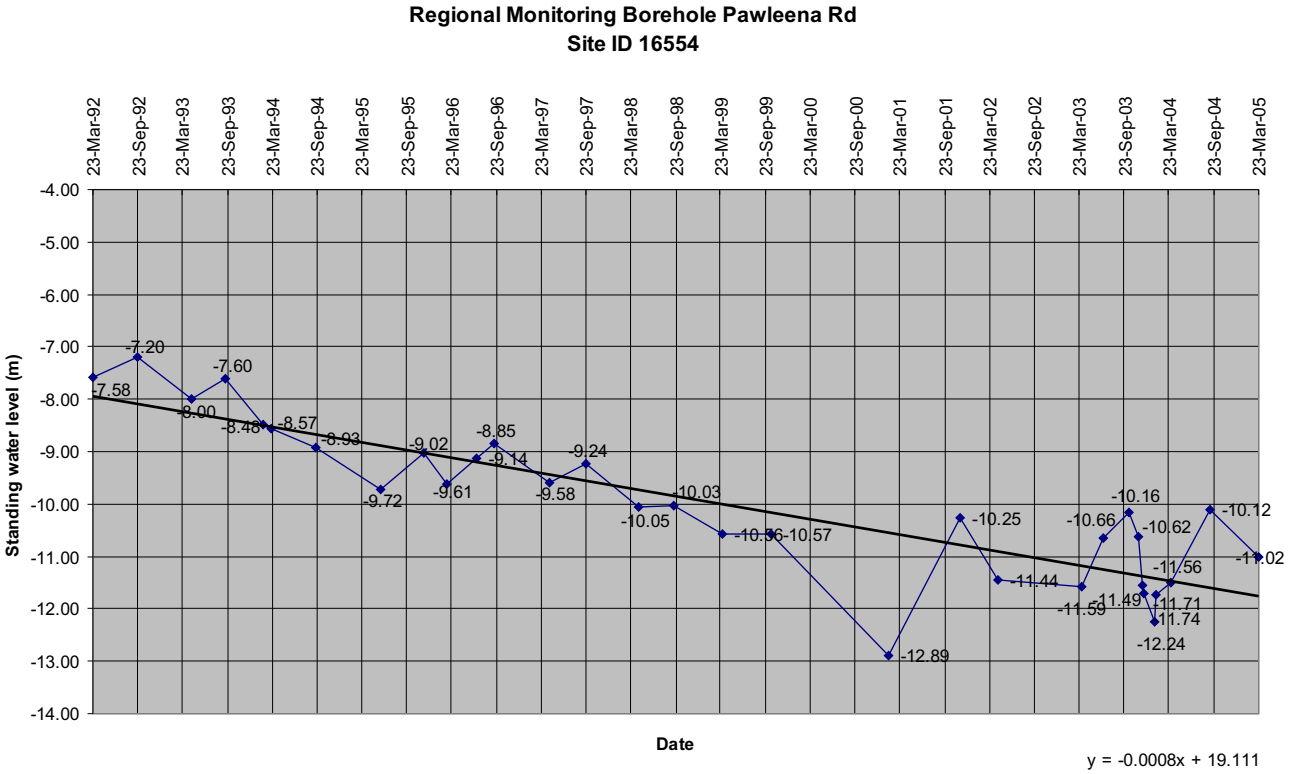
Mooreville Road



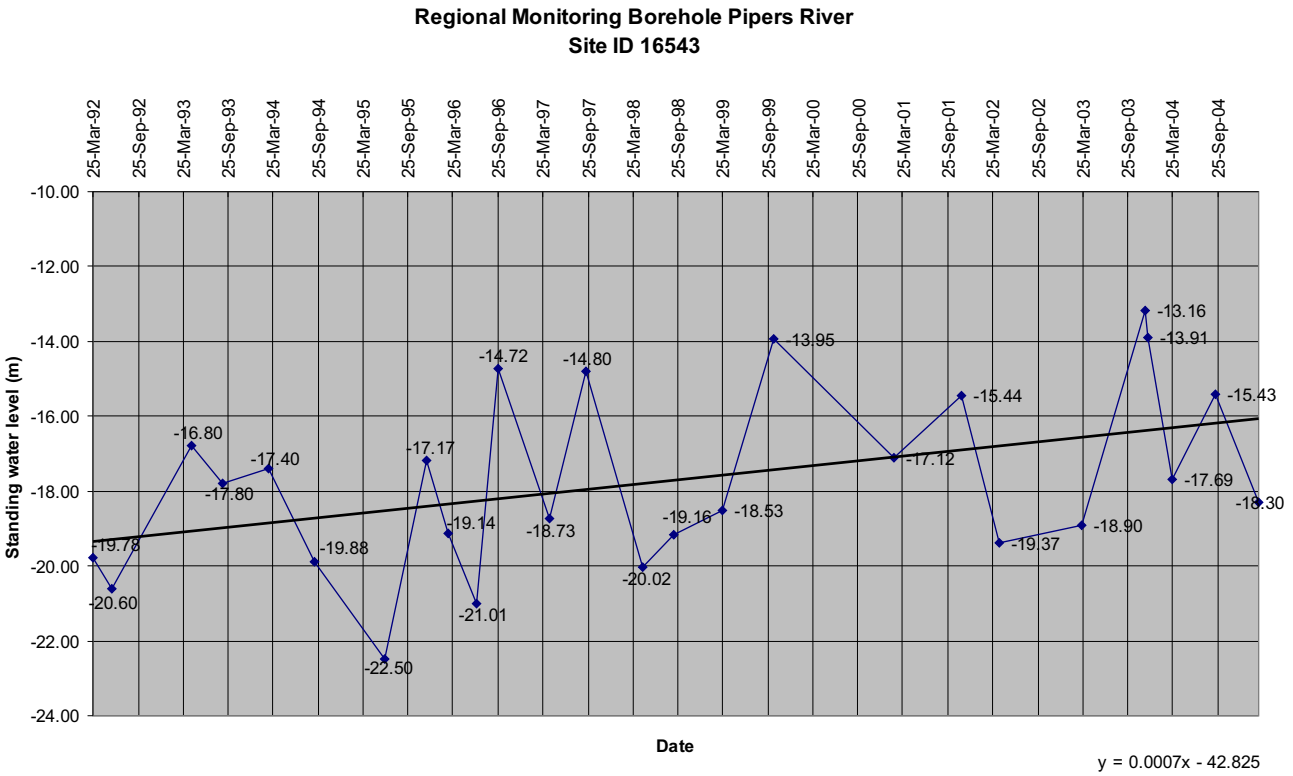
Osmaston



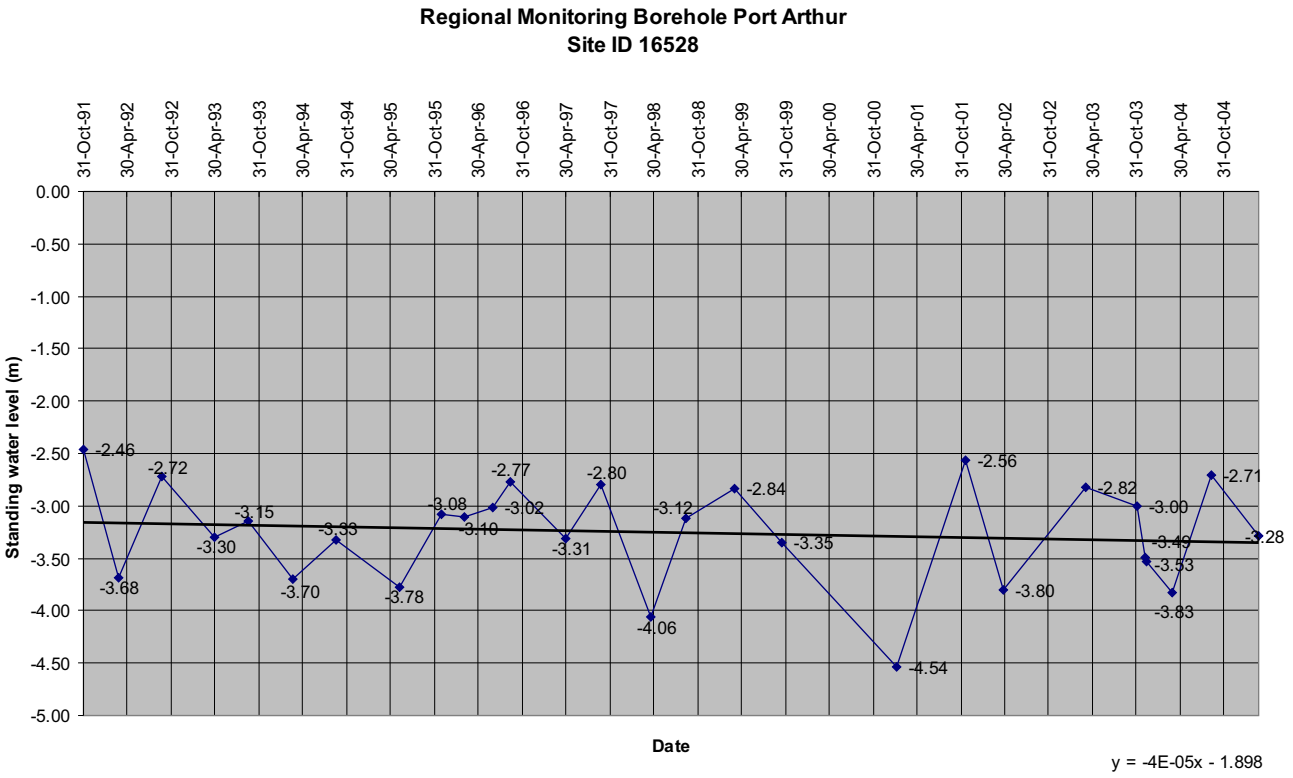
Pawleena Road



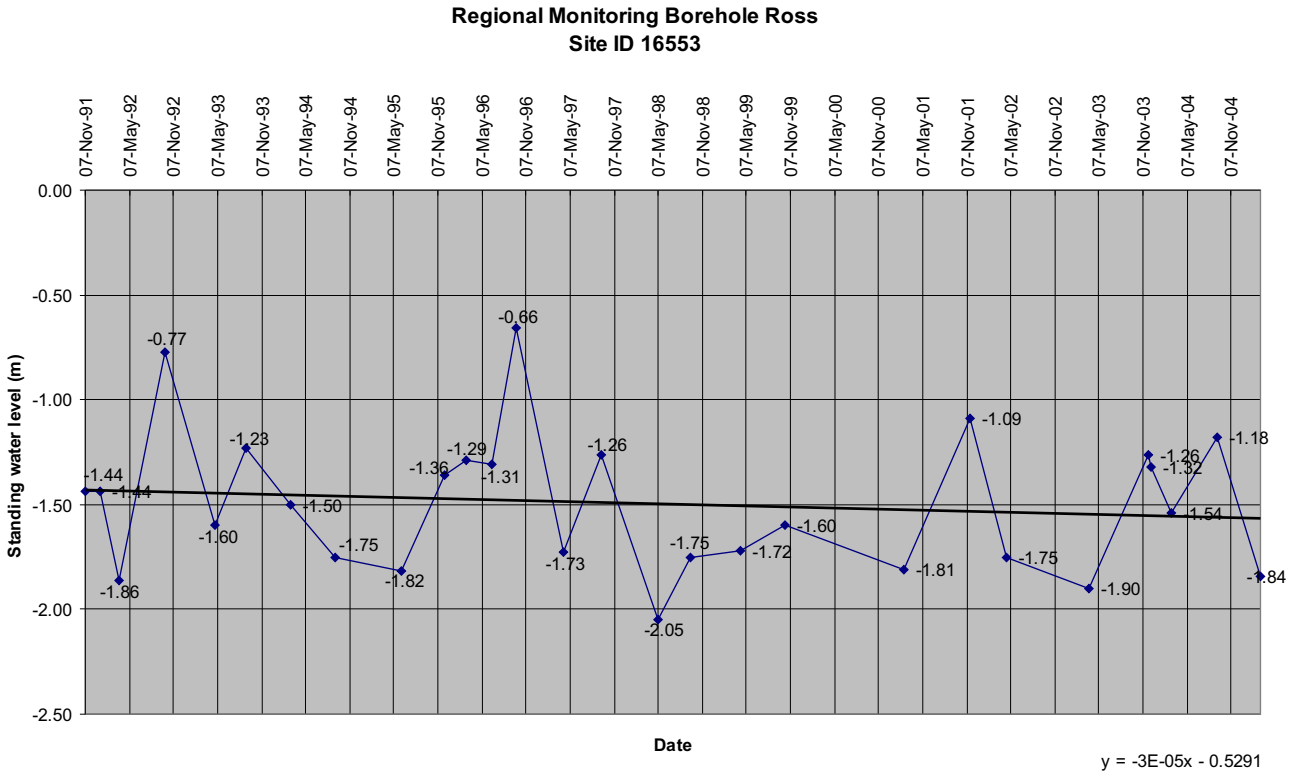
Pipers River



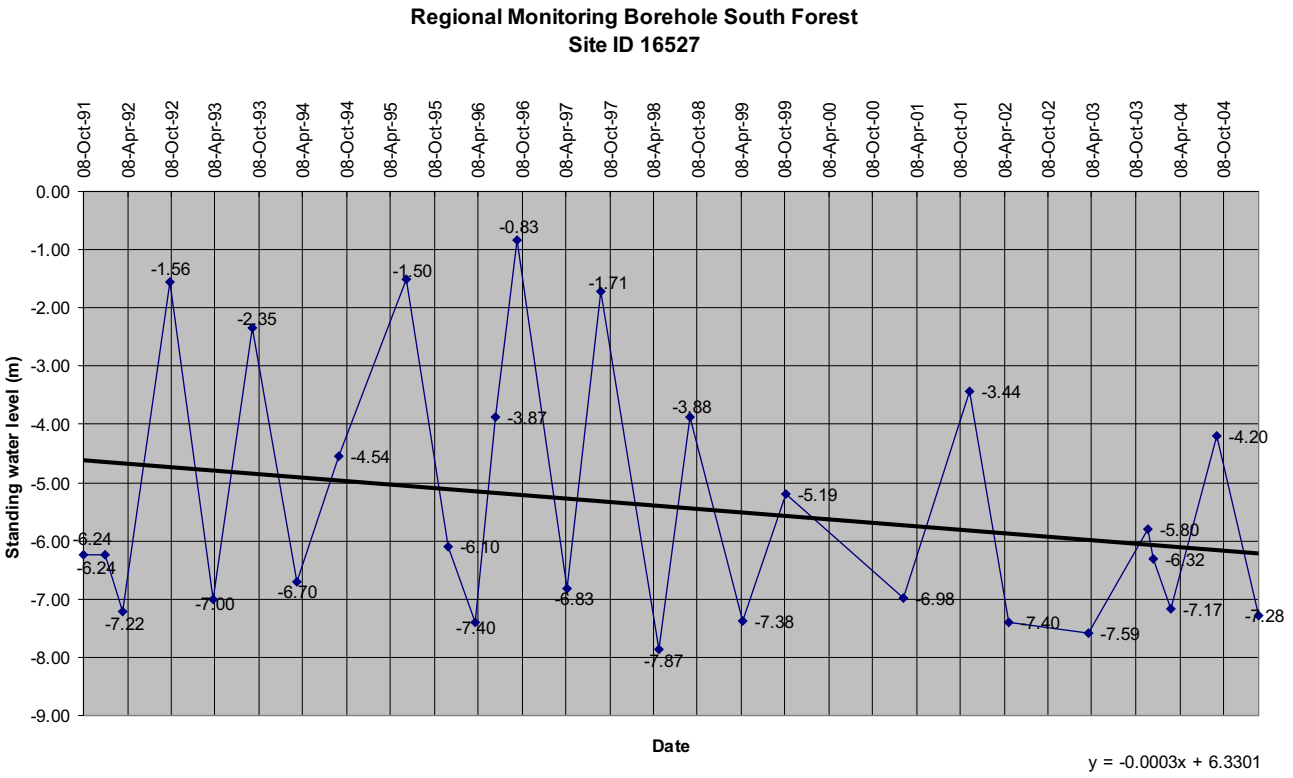
Port Arthur



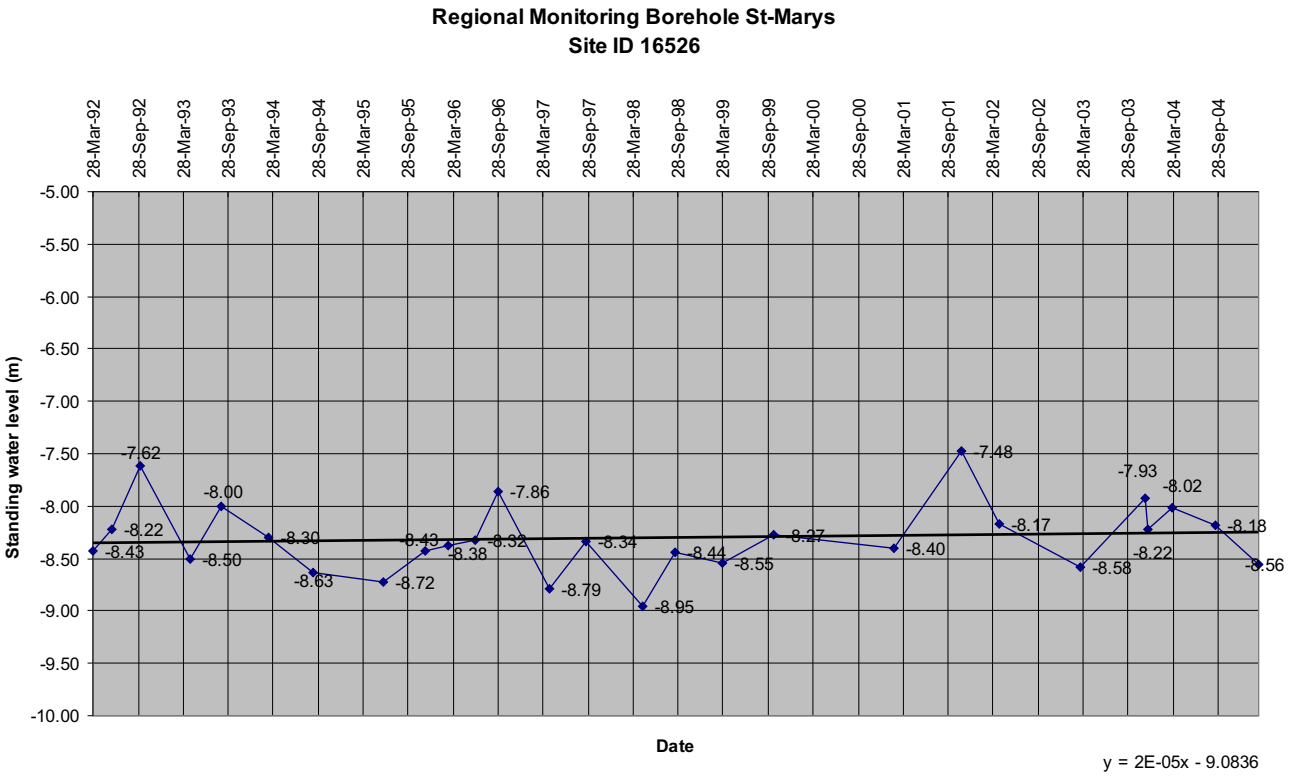
Ross



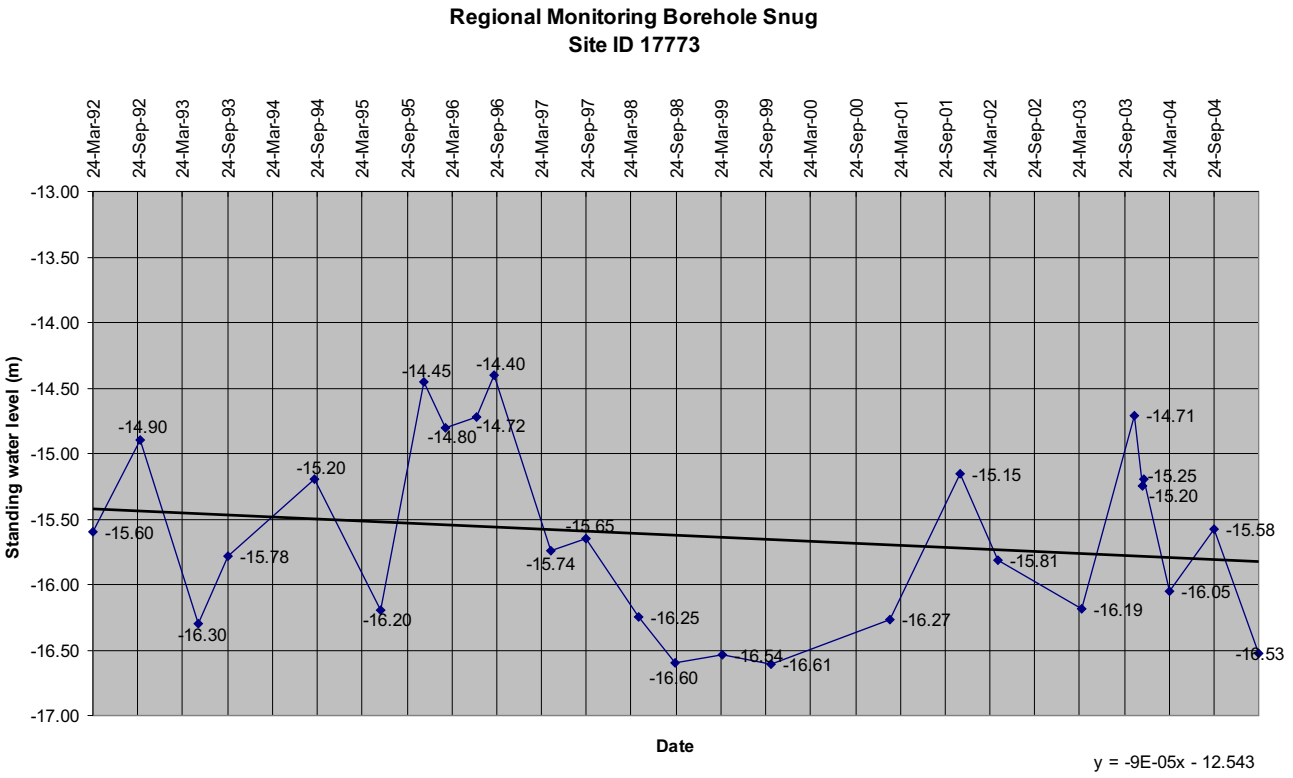
South Forest



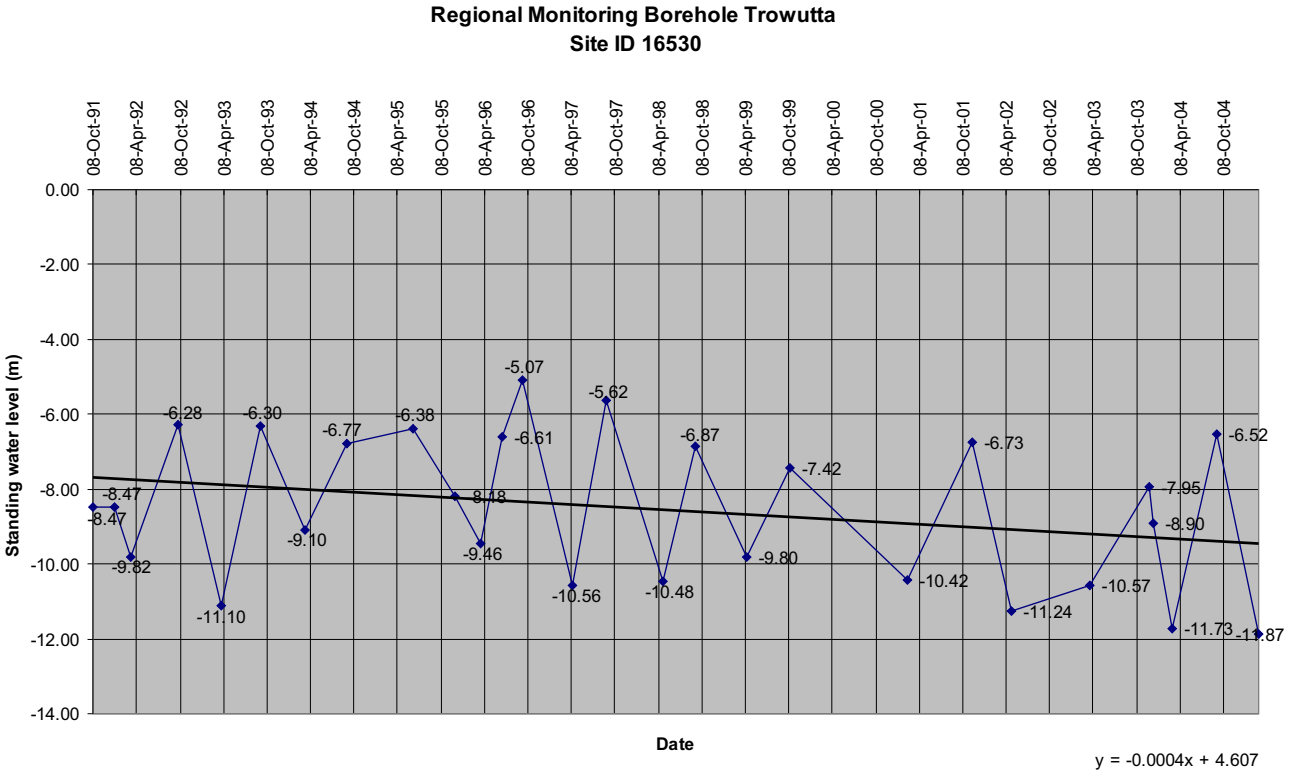
St Marys



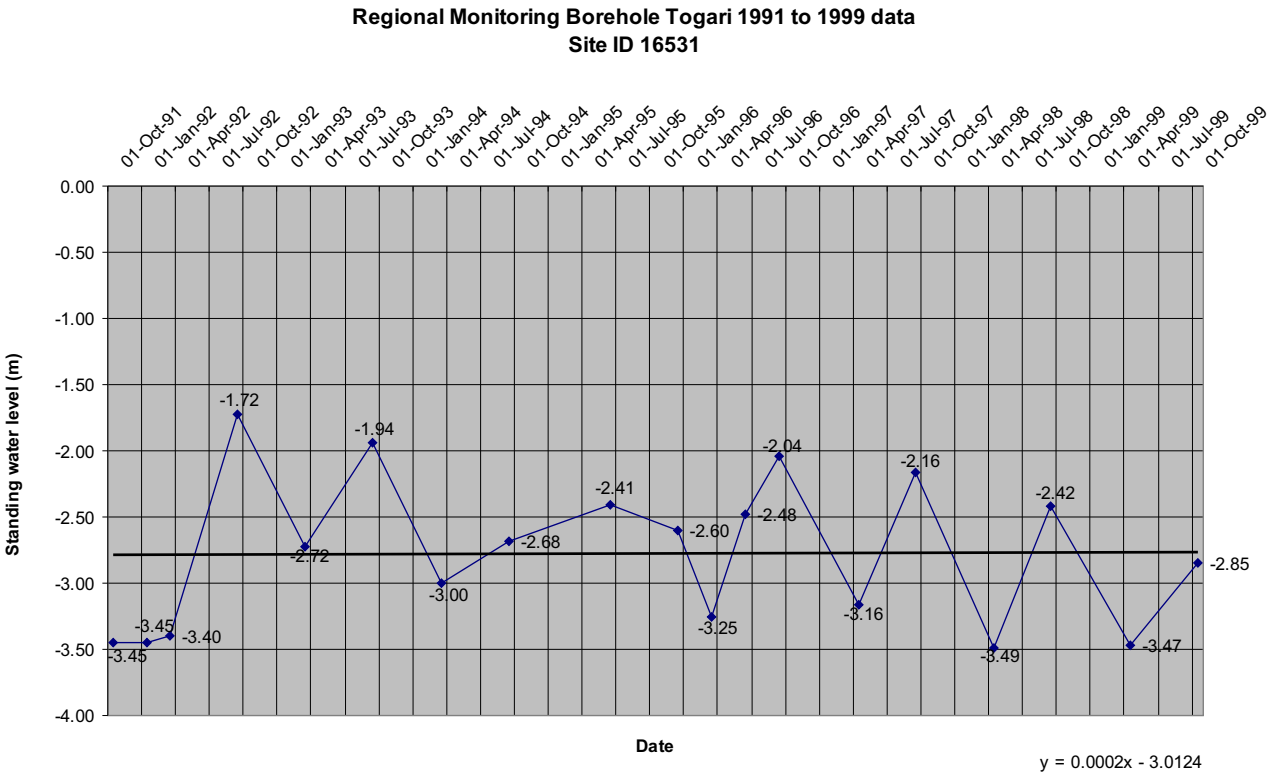
Snug



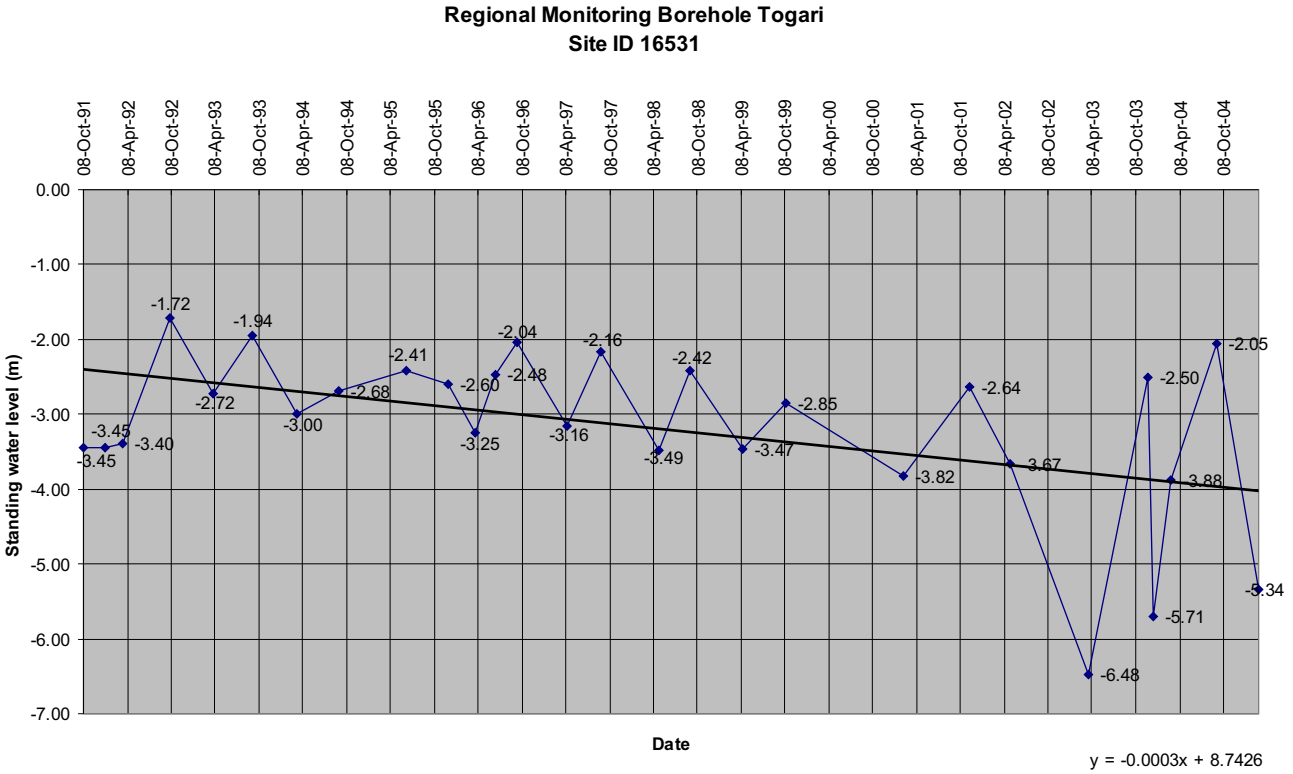
Trowutta



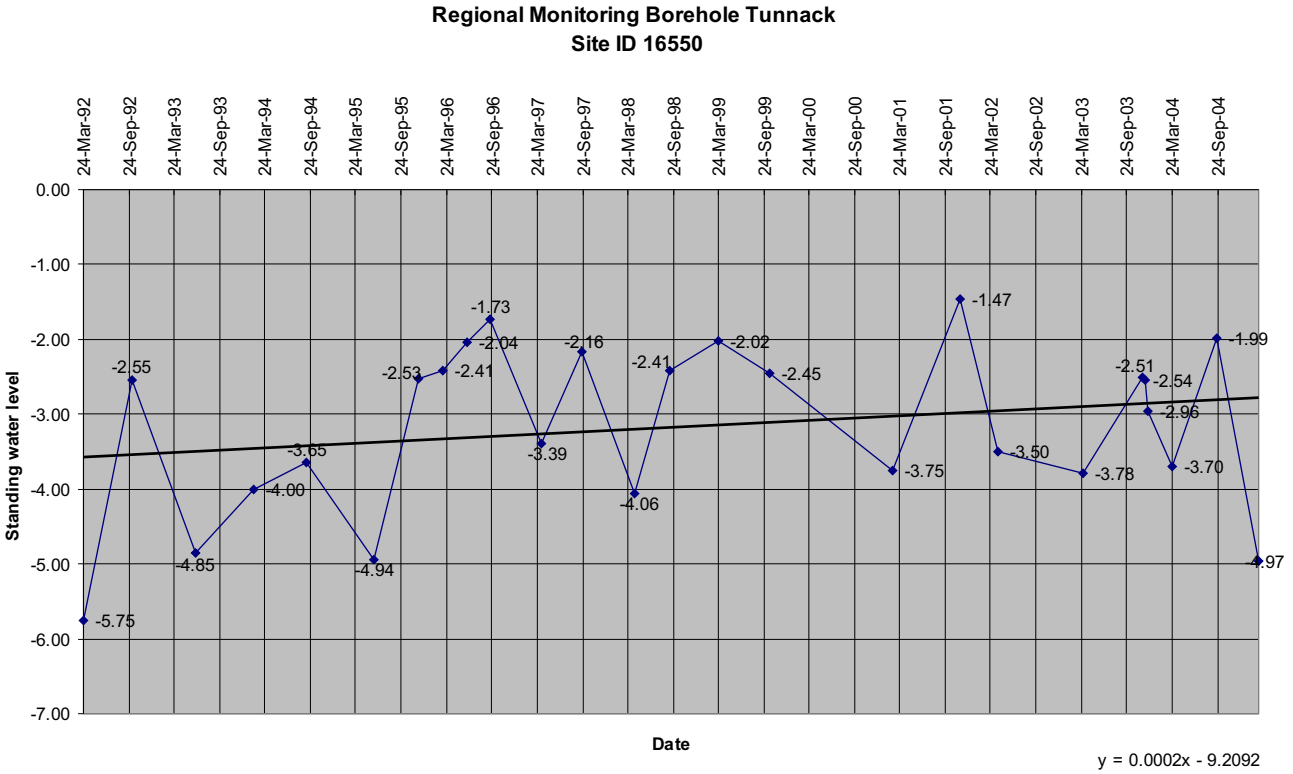
Togari (to 1999)



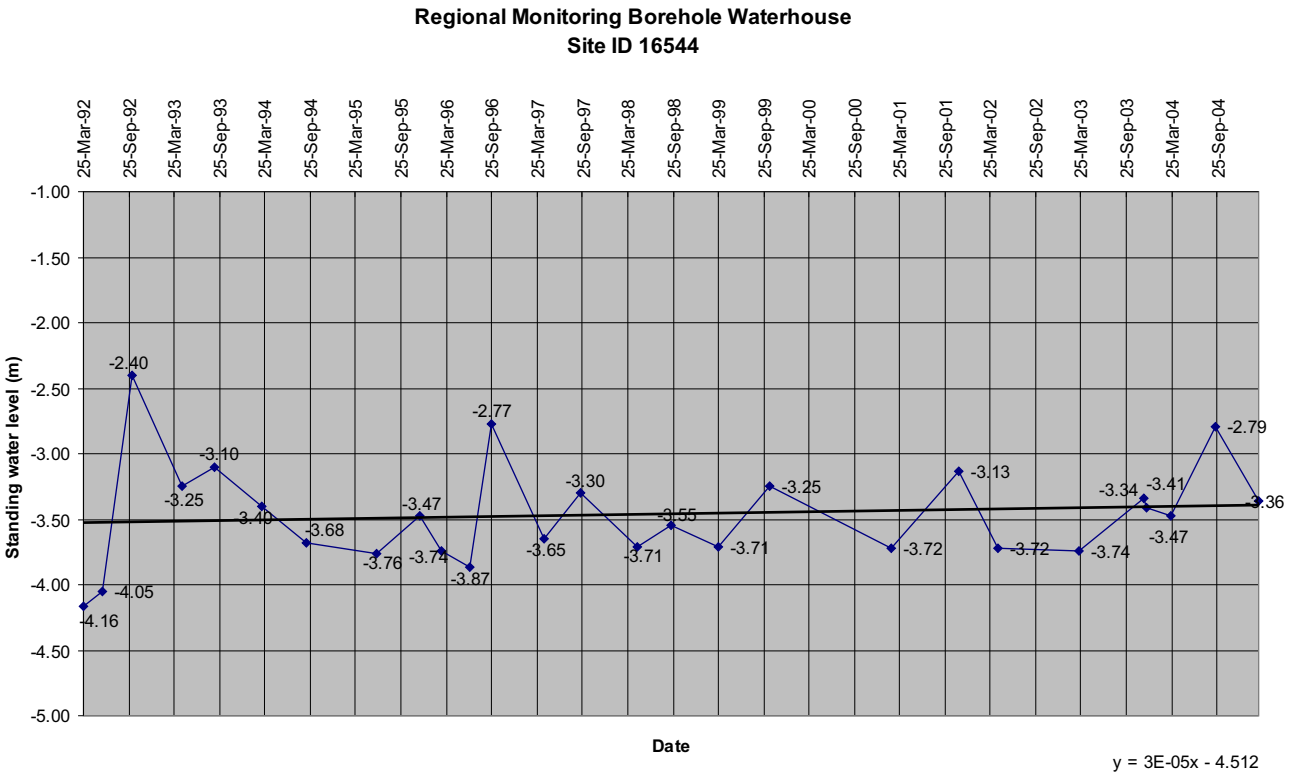
Togari



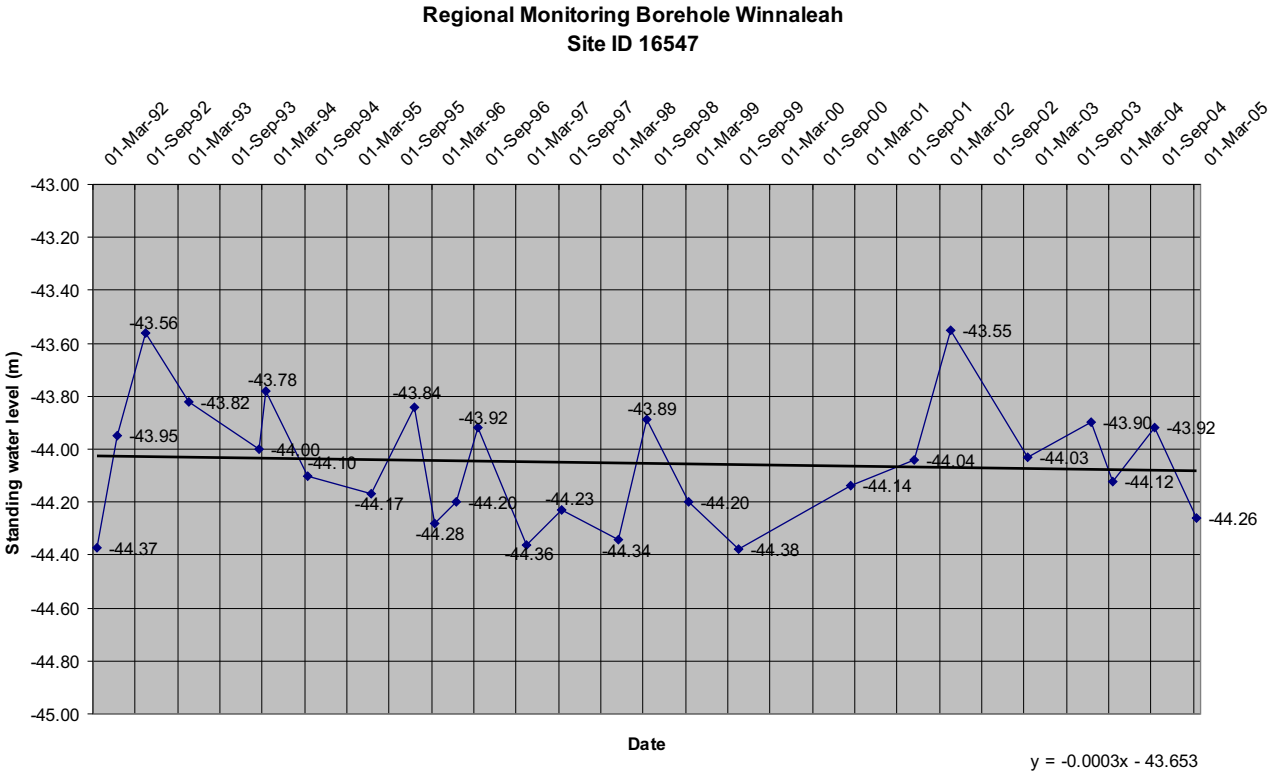
Tunnack



Waterhouse



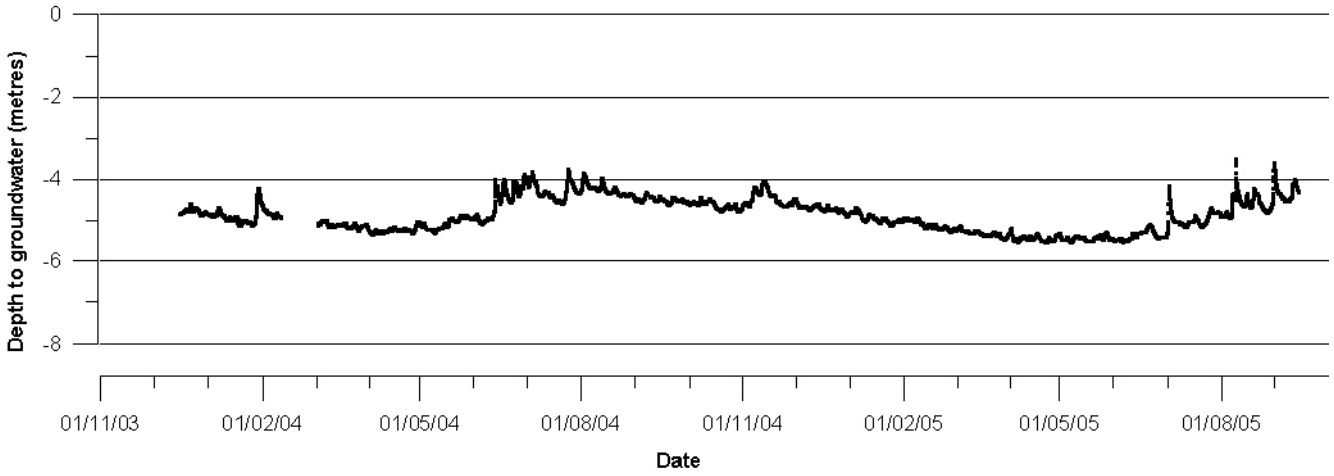
Winnaleah


Regional Monitoring Borehole Winnaleah
Site ID 16547
Standing water level (m)
Date
y = -0.0003x - 43.653
-43.00
-43.20
-43.40
-43.60
-43.80
-44.00
-44.20
-44.40
-44.60
-44.80
-45.00
01-Mar-92
01-Sep-92
01-Mar-93
01-Sep-93
01-Mar-94
01-Sep-94
01-Mar-95
01-Sep-95
01-Mar-96
01-Sep-96
01-Mar-97
01-Sep-97
01-Mar-98
01-Sep-98
01-Mar-99
01-Sep-99
01-Mar-00
01-Sep-00
01-Mar-01
01-Sep-01
01-Mar-02
01-Sep-02
01-Mar-03
01-Sep-03
01-Mar-04
01-Sep-04
01-Mar-05
-44.37
-43.56
-43.95
-43.82
-43.78
-44.00
-44.10
-44.17
-43.84
-44.28
-44.20
-43.92
-44.36
-44.23
-44.34
-43.89
-44.20
-44.38
-44.14
-44.04
-43.55
-44.03
-43.90
-44.12
-43.92
-44.26

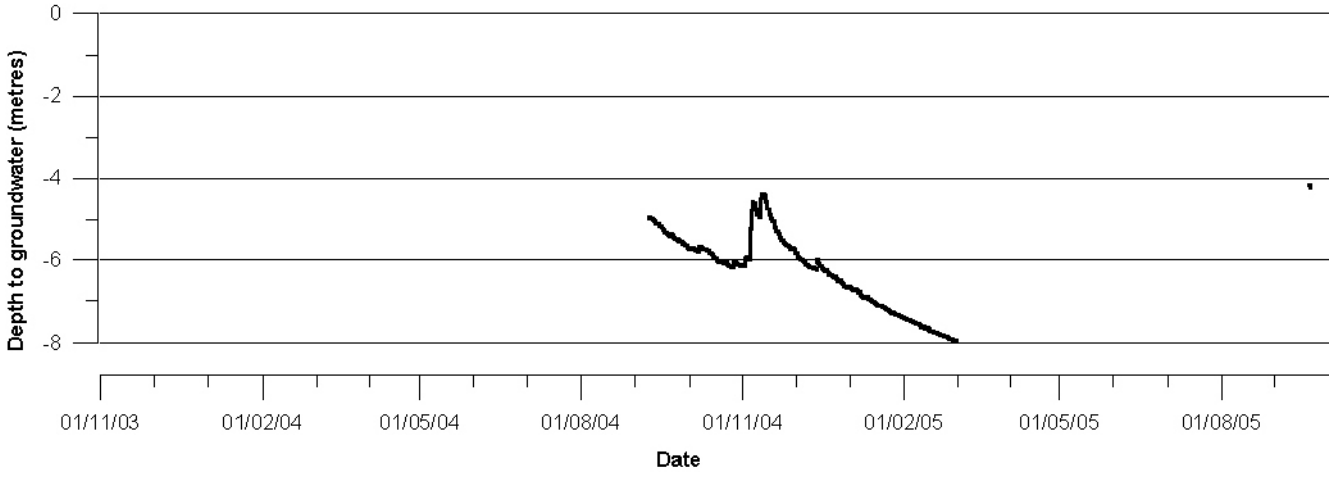
APPENDIX 3

Odyssey water level hydrographs — December 2003 to September 2005

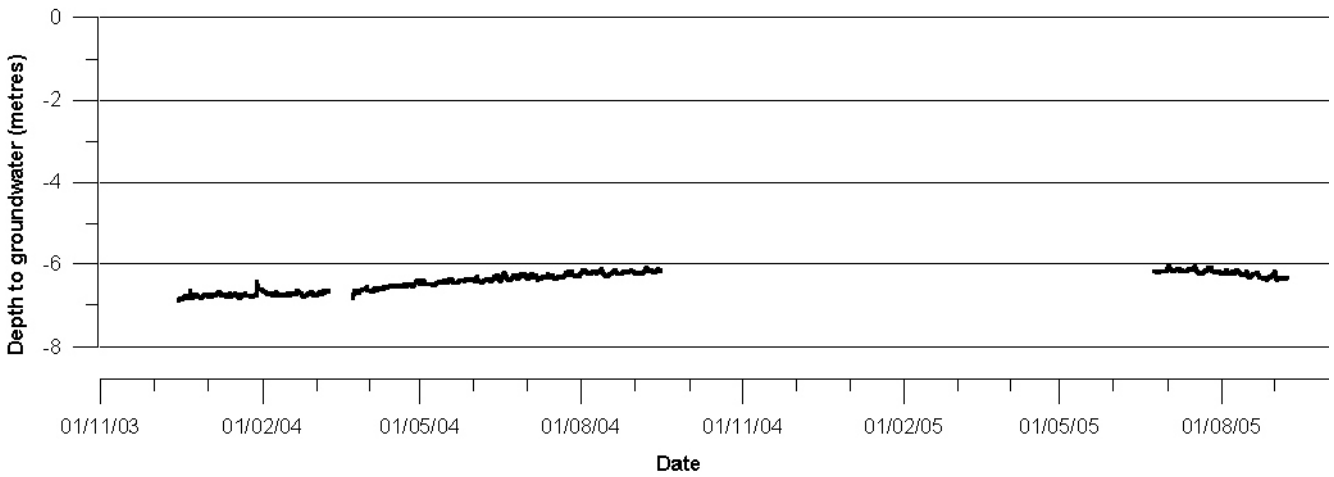
Barrington groundwater hydrograph



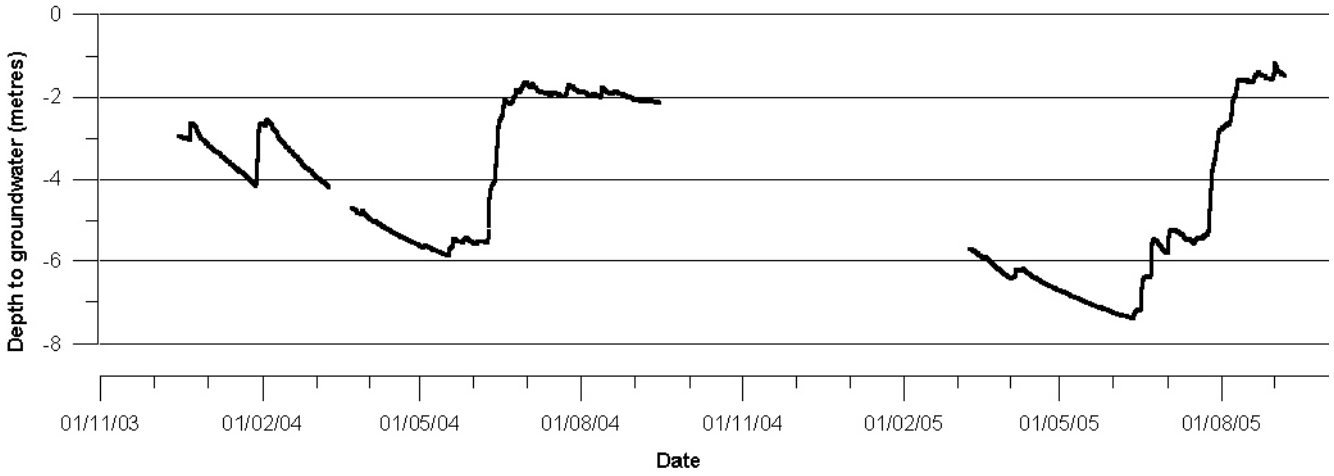
Beulah groundwater hydrograph



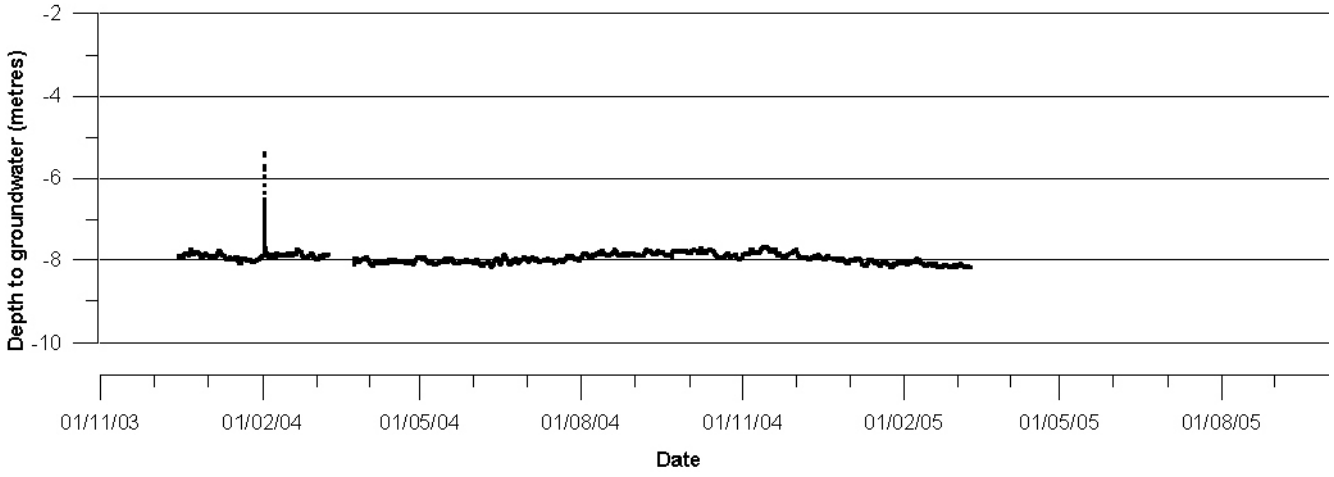
Bicheno groundwater hydrograph



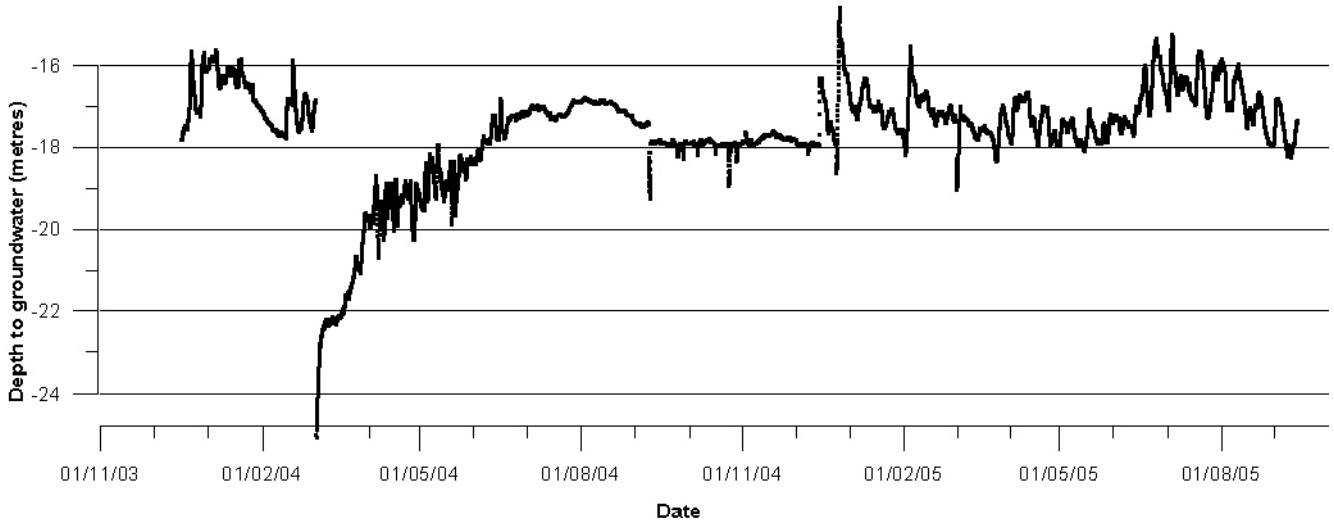
Branxholm groundwater hydrograph



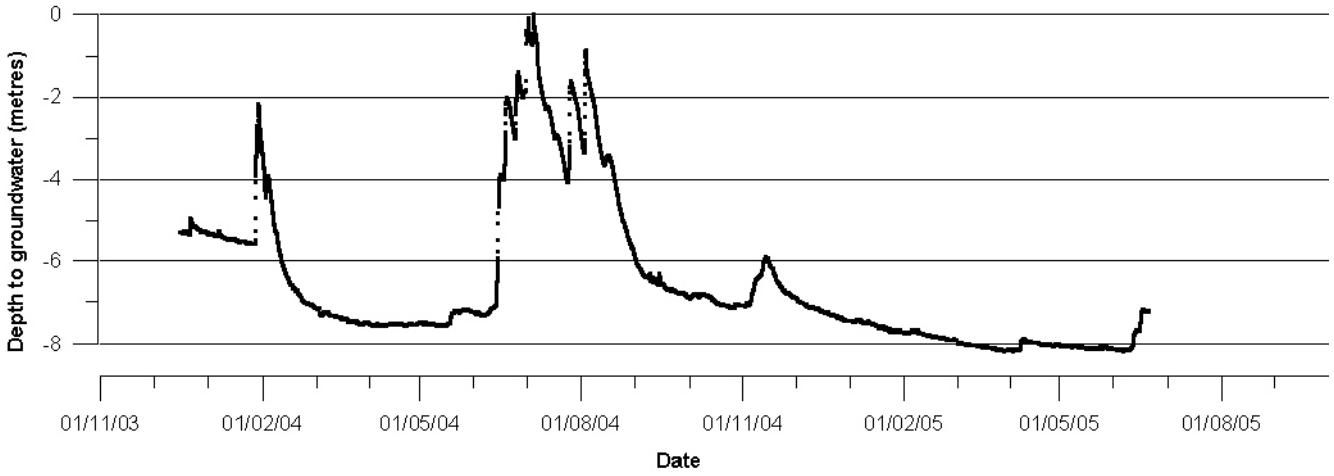
Buckland groundwater hydrograph



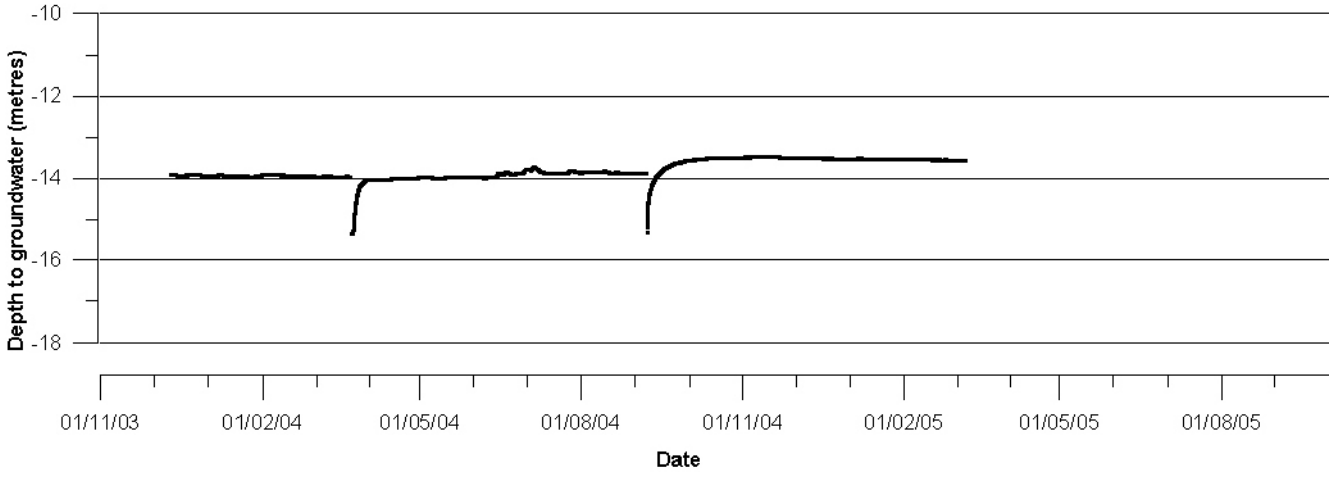
Calder groundwater hydrograph



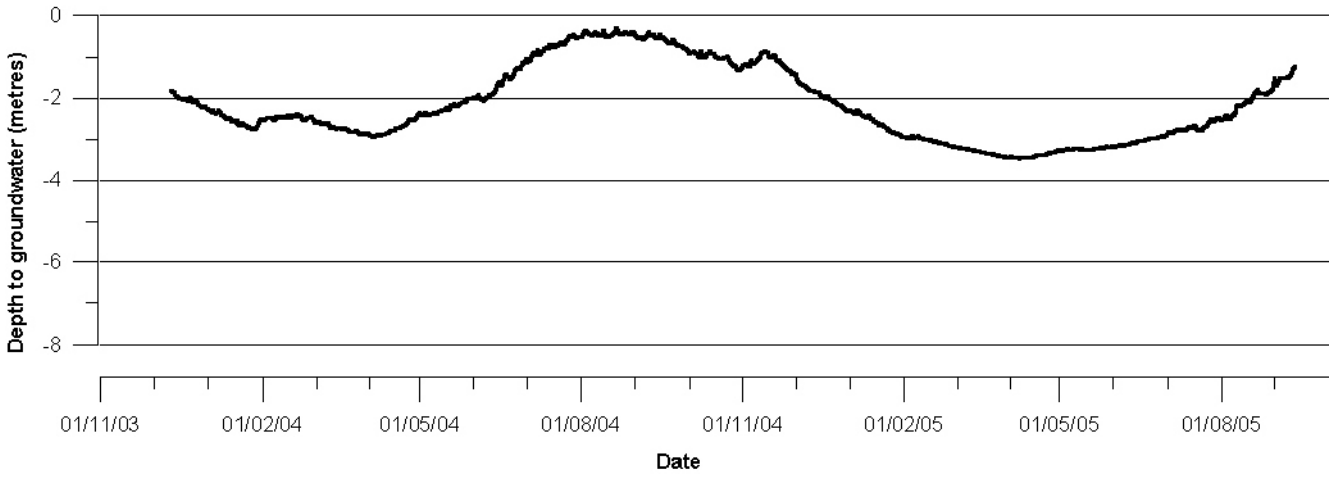
Chudleigh groundwater hydrograph



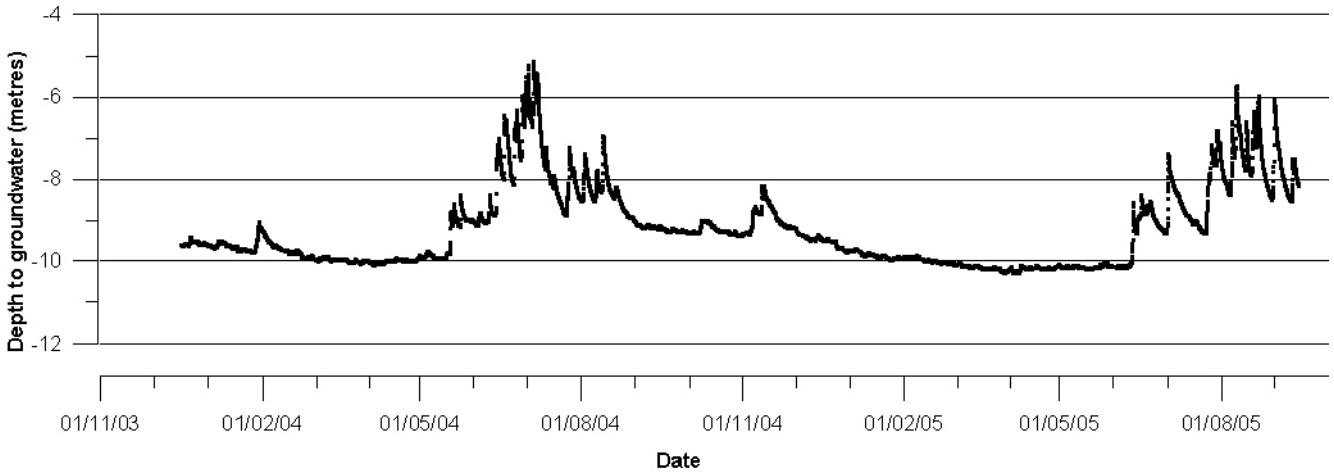
Cressy groundwater hydrograph



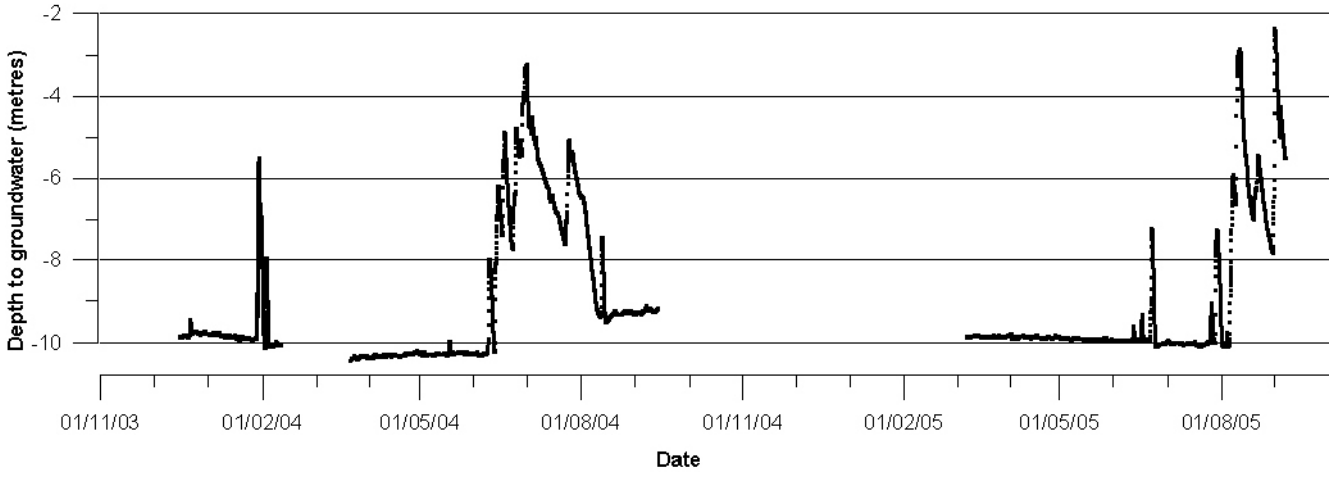
Hagley groundwater hydrograph



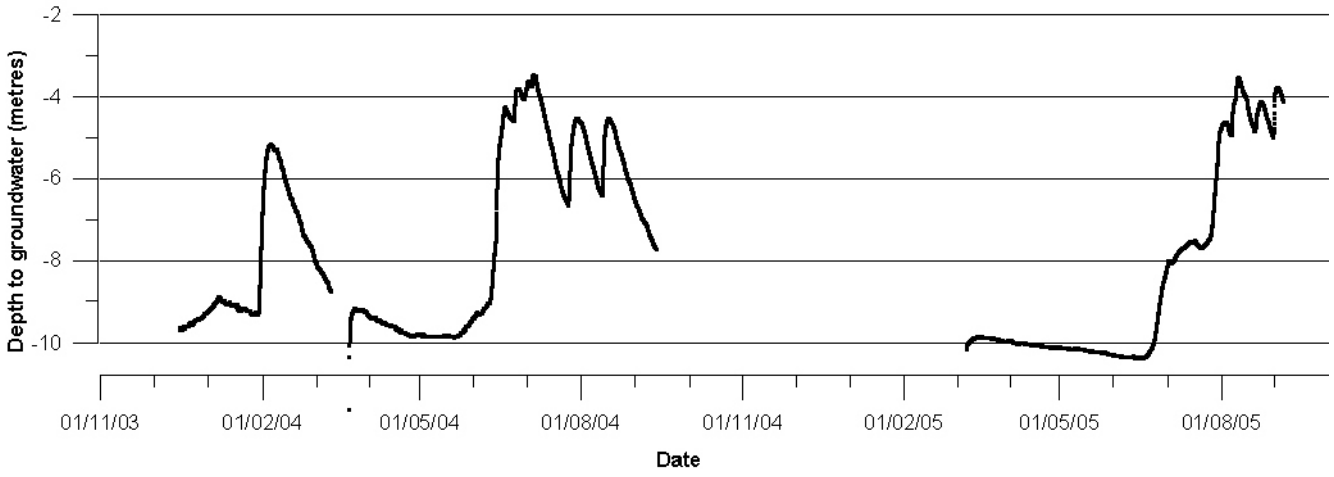
Hampshire groundwater hydrograph



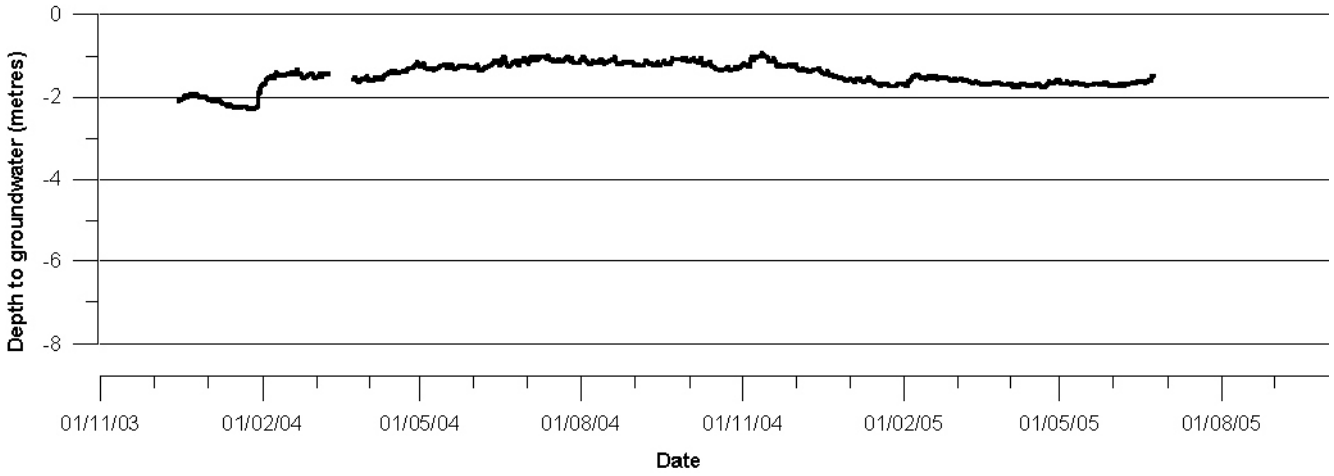
Jetsonville groundwater hydrograph



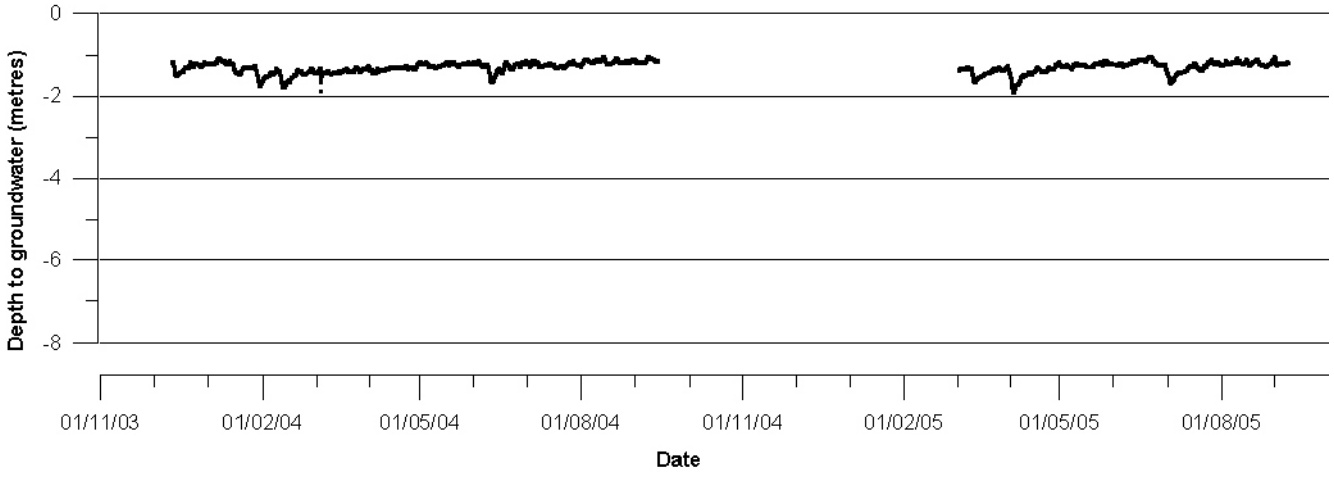
Lilydale groundwater hydrograph



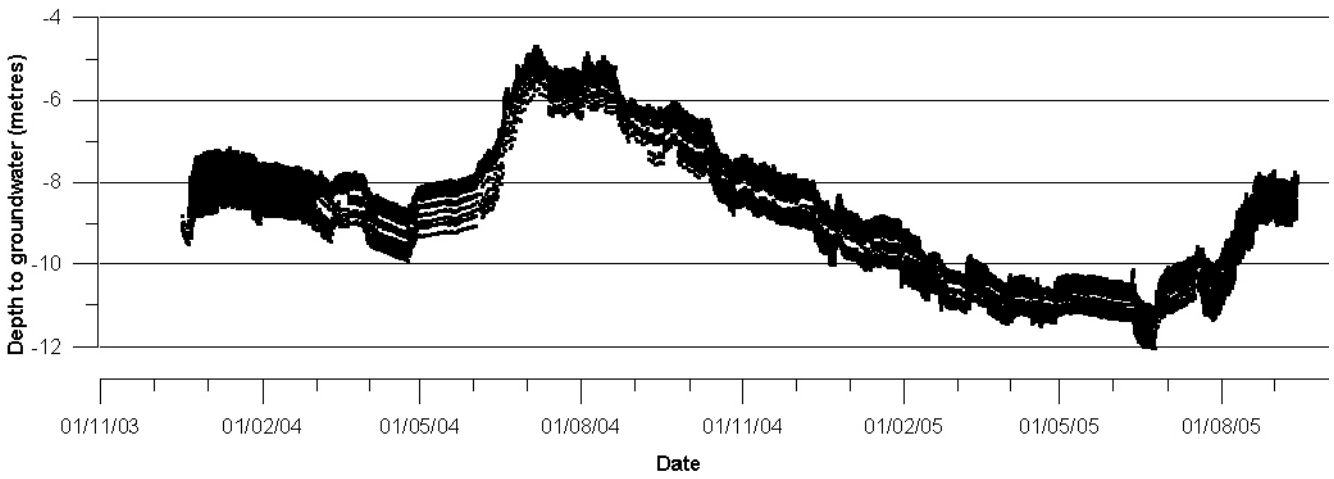
Little Swanport groundwater hydrograph



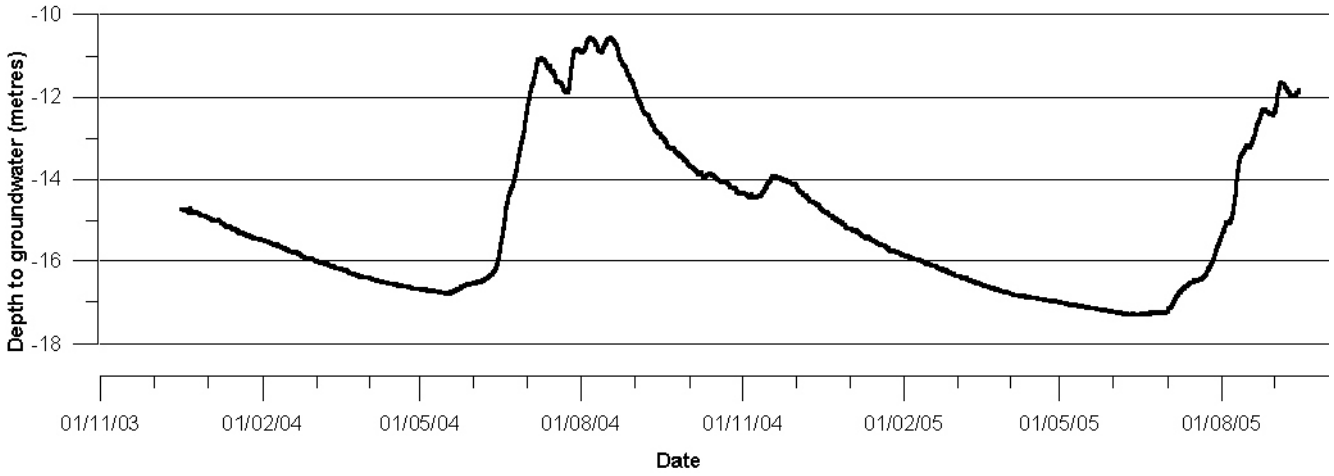
Melton Mowbray groundwater hydrograph



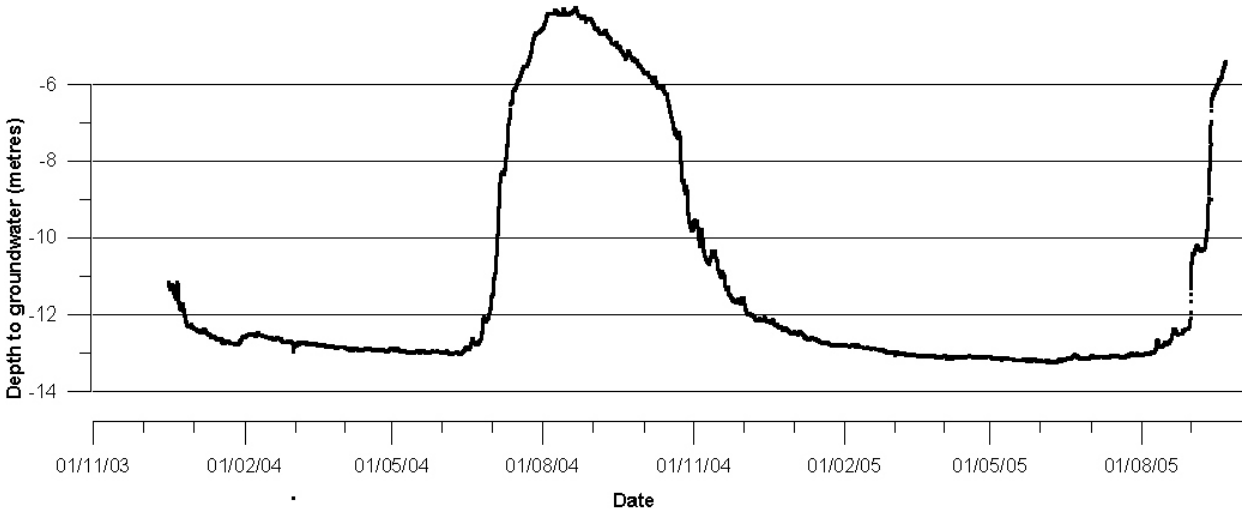
Montagu groundwater hydrograph



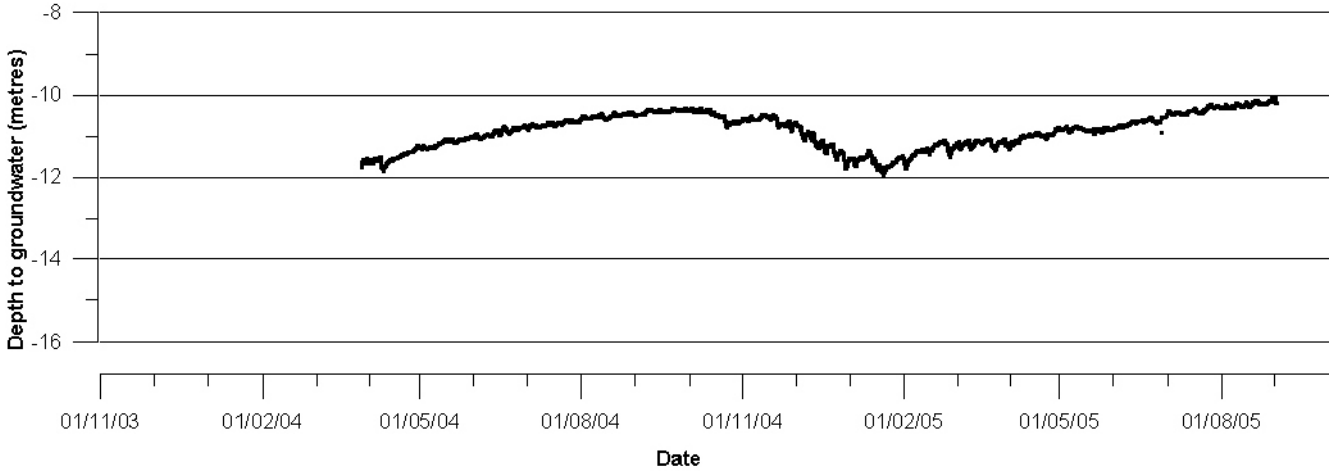
Mooreville Road groundwater hydrograph



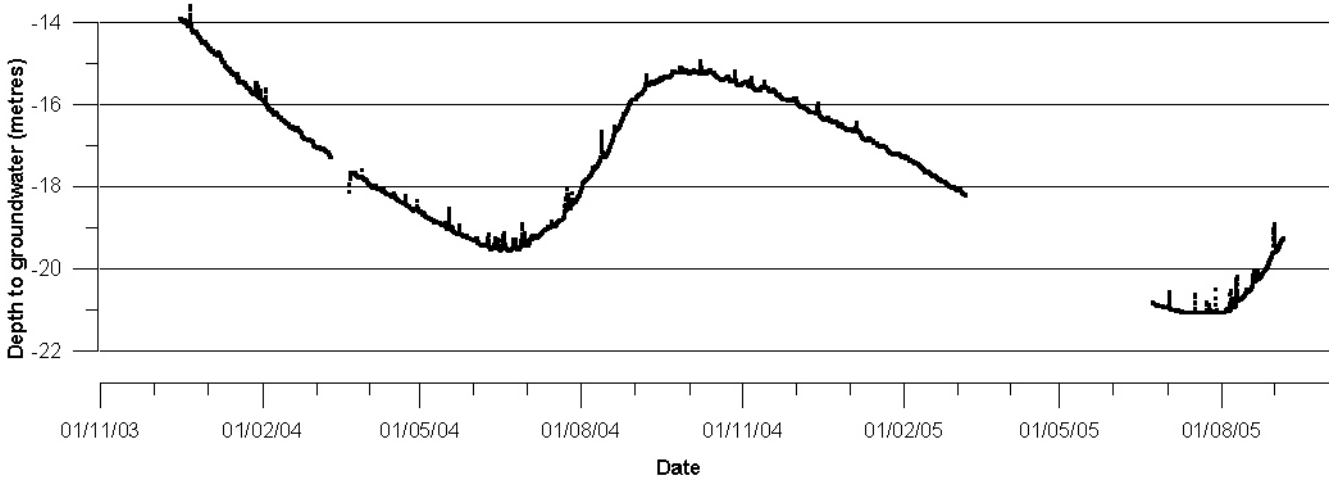
Osmaston groundwater hydrograph



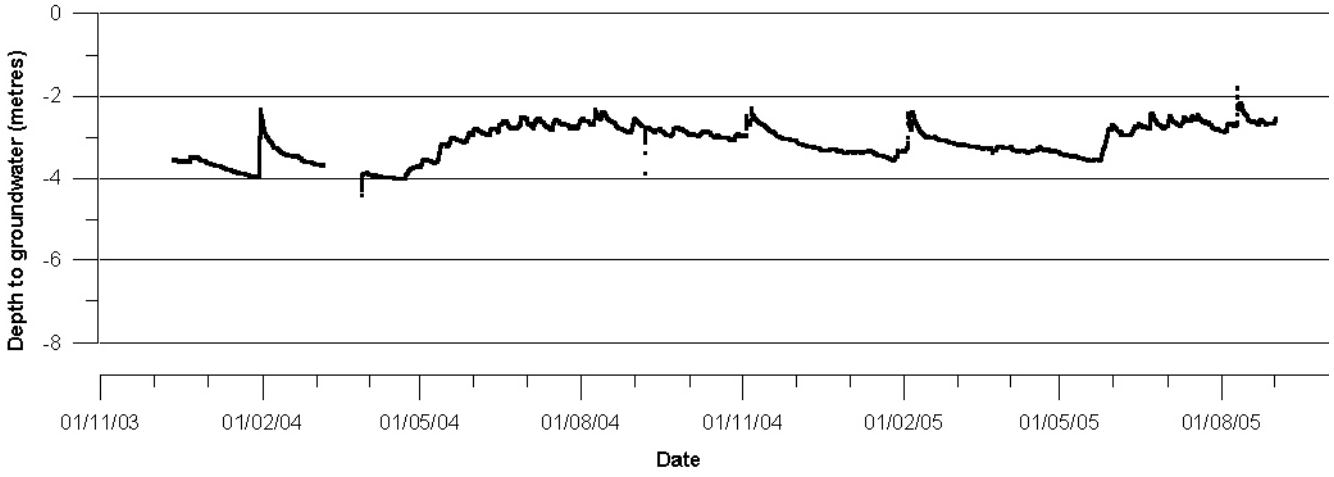
Pawleena Road groundwater hydrograph



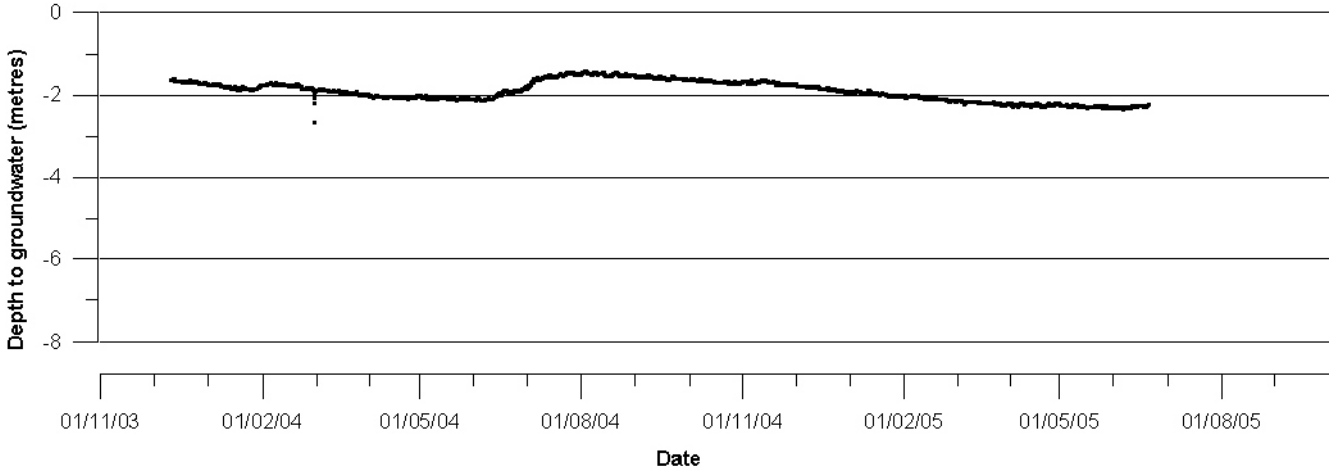
Pipers River groundwater hydrograph



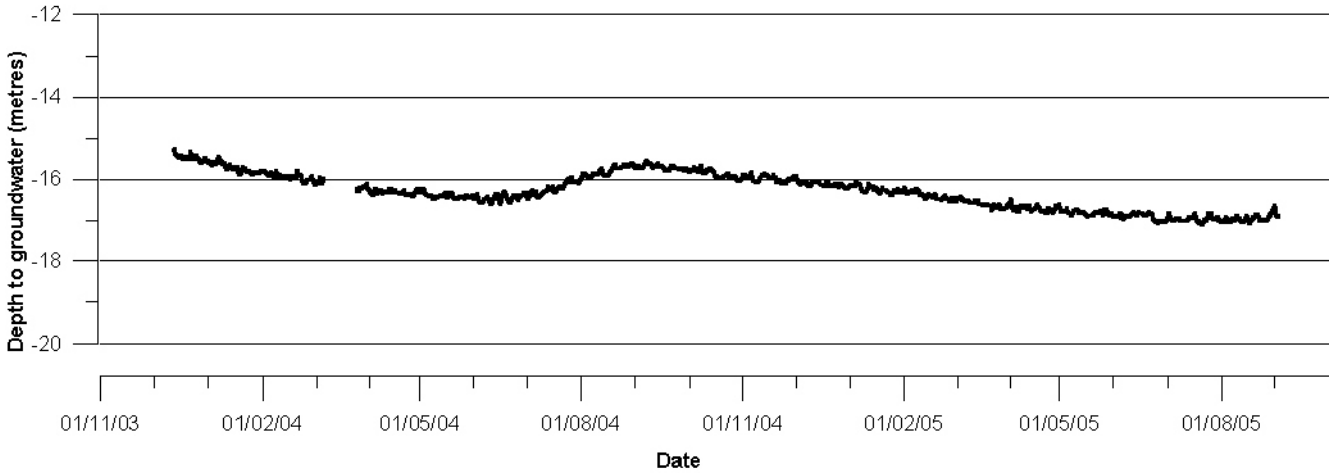
Port Arthur groundwater hydrograph



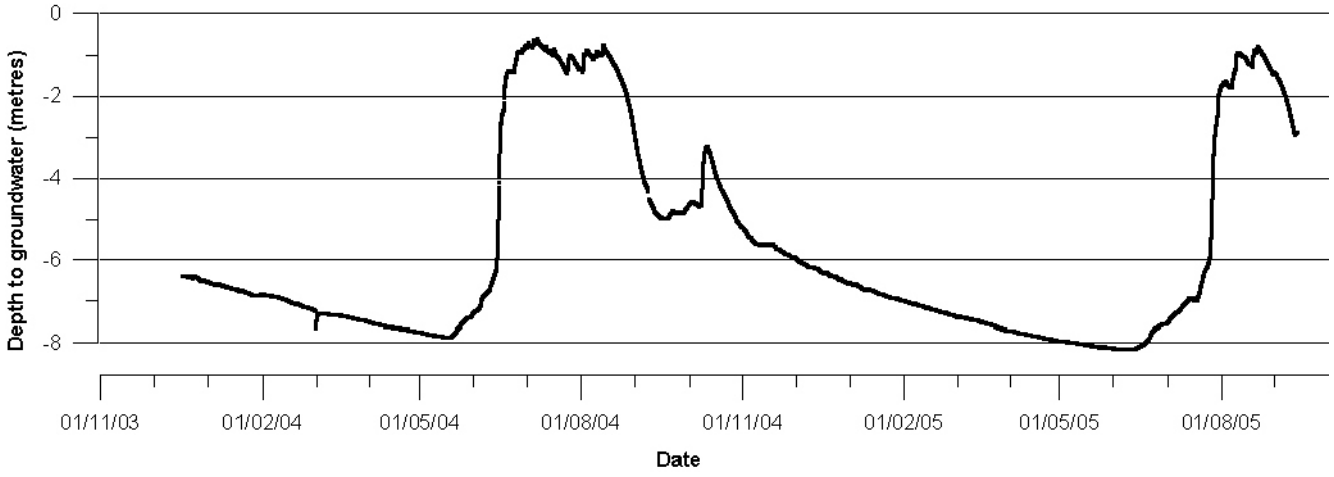
Ross groundwater hydrograph



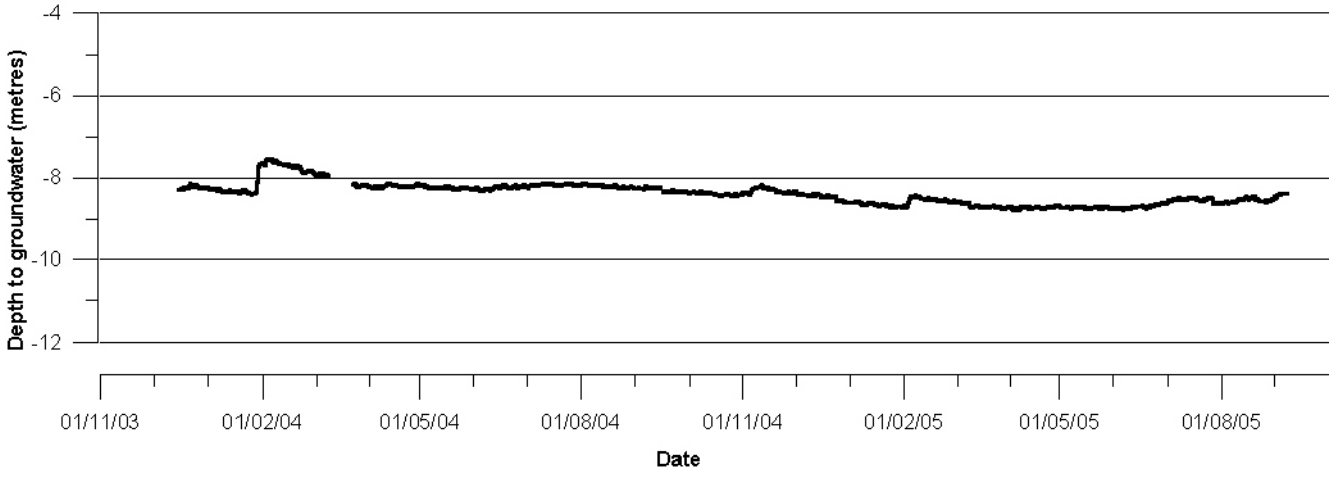
Snug groundwater hydrograph



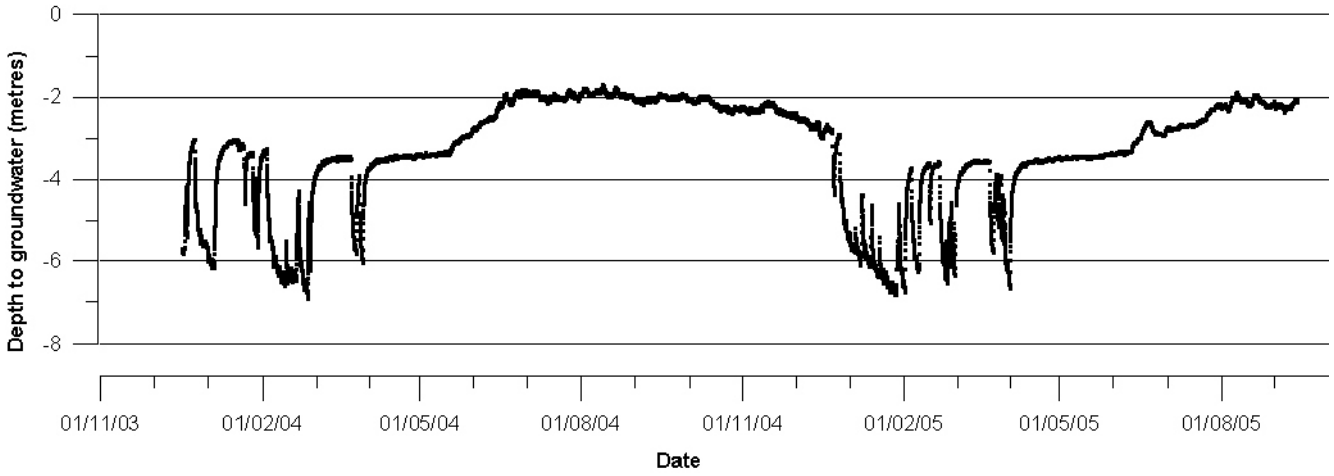
South Forest groundwater hydrograph



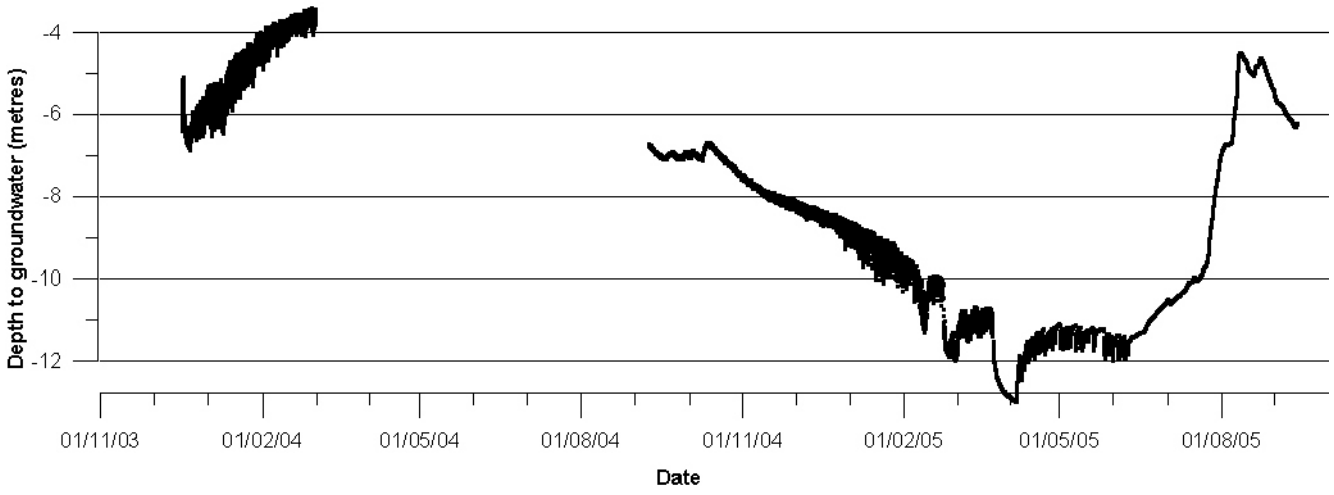
St Marys groundwater hydrograph



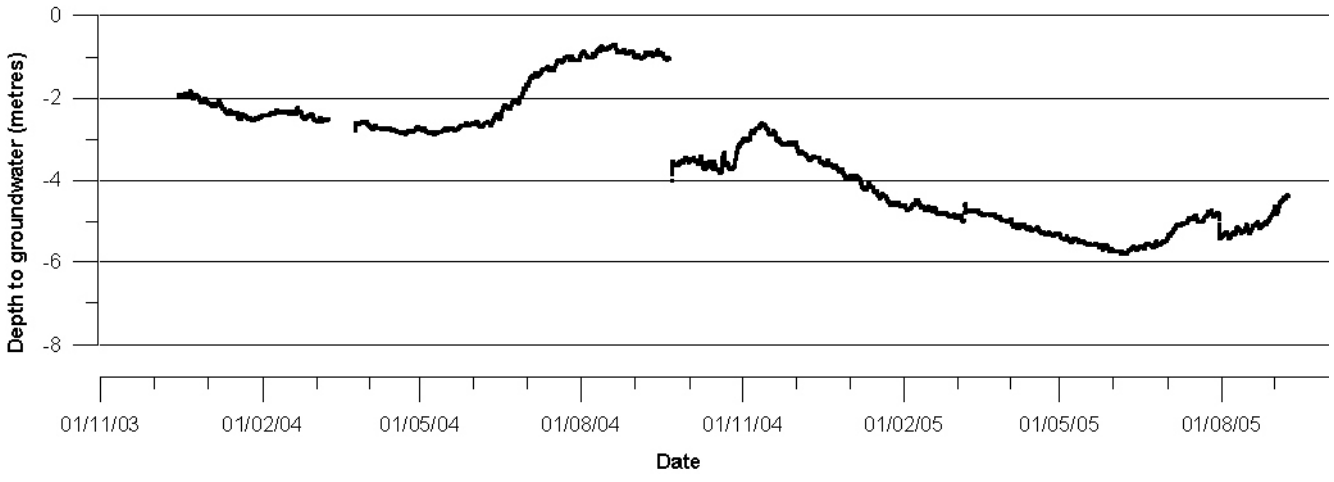
Togari groundwater hydrograph



Trowutta groundwater hydrograph



Tunnack groundwater hydrograph



Waterhouse groundwater hydrograph