AGL Upstream Investments Pty Ltd

Camden Gas Project

FY14 Q4 Groundwater Monitoring Update – June 2014

13 June 2014

PARSONS BRINCKERHOFF

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1. Introduction

AGL Upstream Investments Pty Ltd (AGL) owns and operates the Camden Gas Project (CGP) located in the Macarthur region, 65 km southwest of Sydney, NSW (Figure 1.1). The CGP has been producing natural gas from coal seams for the Sydney region since 2001 and currently consists of 144 gas wells (of which, approximately 97 were operational in June 2014) within Stage 1 and Stage 2 area. The target coal seams are the Bulli and Balgownie coal seams within the Illawarra Coal Measures at depths of approximately 600–700 m below ground level (mbgl).

Parsons Brinckerhoff was engaged to investigate the hydrogeological environment to:

- characterise the groundwater systems within the region
- assess the degree of connectivity (if any) between the shallow beneficial aquifers and the Permian coal seams
- monitor trends within the shallow groundwater systems with respect to the operating gas project.

This report details activities undertaken for the three months to June 2014 and forms the fourth quarterly status summary of groundwater monitoring for the CGP for FY2014. Full analysis and discussion of these monitoring results will be presented in the comprehensive 2014 Annual Report which will detail all groundwater level and quality results from the 2013-14 monitoring period (to be finalised in September 2014).

1.1 Groundwater assessment Phase 1

The Phase 1 Groundwater Assessment and Conceptual Hydrogeological Model for the Northern Expansion of the Camden Gas Project (Parsons Brinckerhoff, 2011), was a desktop study summarising information from a number of sources including the NSW Office of Water (NOW) groundwater database, the Digital Imaging Geological Systems (DIGS) database, and previous reports and detailed drill logs supplied by AGL.
The main conclusions from the Phase 1 investigation are:

- Groundwater is rarely used for consumptive uses across the area given the urbanisation and the availability of reticulated water supplies from Sydney Water.
- Available hydrogeological data for the region suggest that groundwater occurs within:
  - unconfined Quaternary and Tertiary alluvium/sediment aquifers
  - late Triassic Wianamatta Group rocks (a confining unit with localised perched aquifers)
  - Triassic Hawkesbury Sandstone
  - Triassic Narrabeen Group sandstone
  - permeable zones within the Permian Illawarra Coal Measures.
- The Hawkesbury Sandstone is the main aquifer across the expansion area, with minor aquifers in the Narrabeen Group sandstones. The coal seams are low permeability water bearing zones and are not useful aquifers for supply purposes.
- Available water quality data suggests distinct differences in water chemistry and isolation of each of these aquifer zones. The groundwater quality in aquifer systems in the study area is highly variable, ranging from fresh (below 300 mg/L total dissolved solids (TDS)) to slightly salty (up to 7,500 mg/L TDS). Groundwater quality is generally brackish to saline in the shallow Wianamatta Group shales, while the most saline groundwater generally occurs in the deeper Permian coal seams.

- Groundwater resources are characterised by low yields from the Hawkesbury Sandstone and alluvial aquifers. Negligible yields characterise the Ashfield Shale and coal measures.
- It is anticipated that the presence of extensive and thick claystone formations in the stratigraphic sequence that overlies the Illawarra Coal Measures in the project area will impede the vertical flow of groundwater such that overlying aquifer zones will be hydraulically isolated, experiencing little, if any drawdown impact related to depressurisation of the coal measures. However the possibility cannot be ruled out that major fault zones could provide a hydraulic pathway through claystone horizons and that some shallow groundwater impacts may be observed close to those structures.

1.2 Groundwater assessment Phase 2

The Phase 2 Groundwater Investigations comprised the installation of a groundwater monitoring network of three nested sites (a combined total of 11 monitoring bores), and subsequent groundwater quality and level monitoring at AGL's Denham Court (four bores), Menangle Park (four bores) and Glenlee (three bores) sites (Figure 1.1). The objective of the drilling was to establish dedicated monitoring bores in the shallow unconsolidated material, the surface alluvium, the shallow Ashfield Shale aquifer, and the main water supply aquifer (Hawkesbury Sandstone) so as to obtain baseline water level and water quality prior to any coal seam gas development in the vicinity.

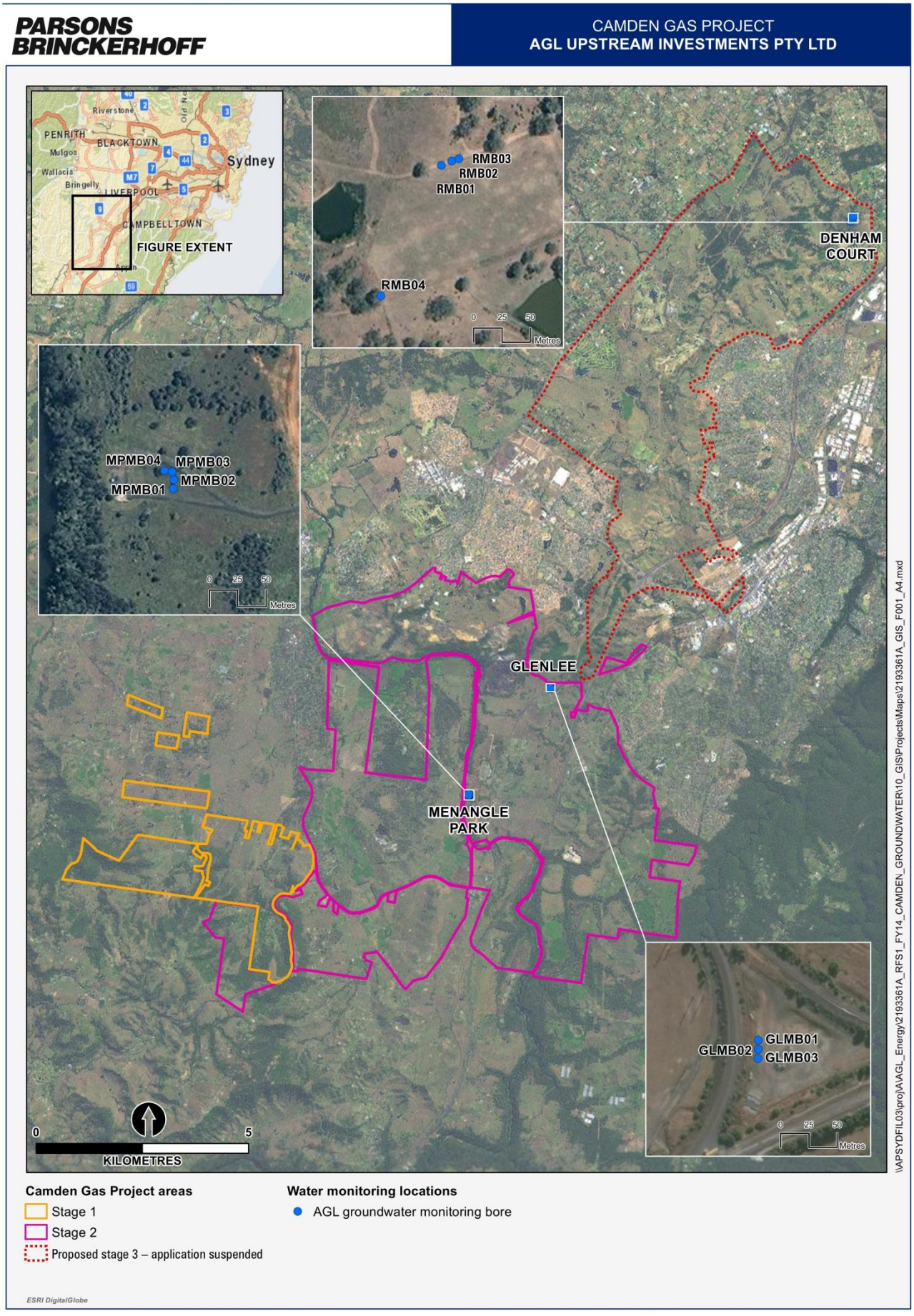

Figure 1.1 Denham Court, Menangle Park and Glenlee site locations

2. Monitoring network

2.1 Bore completions

The groundwater monitoring bore installation program at the Denham Court site was undertaken between 4 October and 19 October 2011. The bore installation program at the Menangle Park site, together with one additional bore at the Denham Court site (RMB04), was undertaken between 21 May and 14 June 2013. The bore installation program at the Glenlee site was undertaken between 20 January and 4 February 2014.

The drilling of the bores was undertaken by Highland Drilling using an air rotary drilling rig supervised by Parsons Brinckerhoff hydrogeologists. The drilling and construction of the groundwater monitoring bores was carried out in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (ARMCANZ, 2003). Table 2.1 and Figure 2.1 summarise the construction details.

Table 2.1 Groundwater monitoring bore construction details

Monitoring bore	Location	Total depth (m)	Screened interval (mbgl)	Lithology	Casing material	Screened Formation
RMB01	Denham Court	84.0	69.0–81.0 (12 m)	Siltstone	50 mm, class 18 uPVC, screwed casing	Wianamatta Group, Ashfield Shale
RMB02	Denham Court	150.0	135.0–147.0 (12 m)	Sandstone	50 mm, class 18 uPVC, screwed casing	Upper Hawkesbury Sandstone
RMB03	Denham Court	300.0	290.0–299.0 (9 m)	Sandstone	50 mm, galvanised/ stainless steel, screwed casing	Lower Hawkesbury Sandstone
RMB04	Denham Court	8.5	4.5–7.5 (3 m)	Clay/ siltstone	50 mm, class 18 uPVC, screwed casing	Wianamatta Group, Ashfield Shale
MPMB01	Menangle Park	18.5	10.0–16.0 (6 m)	Clay	50 mm, class 18 uPVC, screwed casing	Alluvium
MPMB02	Menangle Park	42.0	27.4–39.4 (12 m)	Sandstone	50 mm, class 18 uPVC, screwed casing	Upper Hawkesbury Sandstone
MPMB03	Menangle Park	108.5	97.0–106.0 (9 m)	Sandstone	50 mm, class 18 uPVC, screwed casing	Middle Hawkesbury Sandstone
MPMB04	Menangle Park	192.6	182.6–191.6 (9 m)	Sandstone	50 mm, galvanised/ stainless steel, screwed casing	Lower Hawkesbury Sandstone
GLMB01	Glenlee	102.2	87.0–99.0 (12 m)	Sandstone	50 mm, class 18 uPVC, screwed casing	Upper Hawkesbury Sandstone
GLMB02	Glenlee	190.3	168.0–180.0 (12 m)	Sandstone	50 mm, galvanised/ stainless steel, screwed casing	Middle Hawkesbury Sandstone
GLMB03	Glenlee	228.3	212.0–224.0 (12 m)	Sandstone	50 mm, galvanised/ stainless steel, screwed casing	Lower Hawkesbury Sandstone

The groundwater monitoring bores were drilled through the following Triassic formations within the Sydney Basin: Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone. Some shale lenses, up to 7 m thick, were observed in the Hawkesbury Sandstone. It was noted that the Ashfield Shale was of minimal

thickness or absent at the Menangle Park Site. In addition, Tertiary alluvium was present at the Menangle Park site.

At the Denham Court site minor seeps were encountered in the Ashfield Shale at depth. Groundwater was encountered in the Hawkesbury Sandstone at approximately 108–114 mbgl and minimal flows were recorded throughout (a maximum value of 0.9 L/s when airlifting RMB03). At the Menangle Park site minimal flows we recorded within the alluvium (a maximum of 0.7 L/s when airlifting). Groundwater was encountered in the Hawkesbury Sandstone at approximately 42–60 mbgl and flows were up to 14.3 L/s when airlifting (MPMB04 at approximately 100 mbgl).

At the Glenlee site minimal inflows were encountered within the Ashfield Shale (a maximum of 0. 5 L/s at 66 mbgl). Groundwater was encountered in the Hawkesbury Sandstone at approximately 78 mbgl and flows were up to 2.9 L/s (GLMB03 at approximately 210 mbgl).

No fractures were encountered during drilling and therefore groundwater flow is assumed to be via primary permeability. There do not appear to be any major fault zones within the stratigraphy encountered at all monitoring sites.

2.2 Survey

The groundwater monitoring bore locations were surveyed by registered surveyors (SMEC Pty Ltd) to Map Grid of Australia (MGA), a UTM grid coordinate system based on the Geocentric Datum of Australia 1994. The bores were also surveyed for surface elevation to Australian Height Datum (AHD). The survey results are detailed in Table 2.2.

Table 2.2 Monitoring bore coordinates and elevations

Monitoring bore	Survey date	Easting*	Northing*	Ground level (mAHD)	Top of casing (mAHD)
RMB01	09/03/2012	300465.860	6237305.080	72.420	72.940
RMB02	09/03/2012	300474.930	6237308.700	72.800	73.340
RMB03	09/03/2012	300481.290	6237310.920	73.000	73.540
RMB04	12/07/2013	300412.627	6237189.692	61.926	62.463
MPMB01	12/07/2013	291426.371	6223648.178	66.672	67.196
MPMB02	12/07/2013	291426.853	6223656.095	66.626	67.129
MPMB03	12/07/2013	291425.335	6223662.800	66.418	66.971
MPMB04	12/07/2013	291418.472	6223664.149	66.203	66.912
GLMB01	11/05/2014	293339.716	6226185.480	86.143	86.628
GLMB02	11/05/2014	293339.606	6226177.342	86.603	86.051
GLMB03	11/05/2014	293339.428	6226169.251	85.887	86.435

Note:

* Grid system MGA56

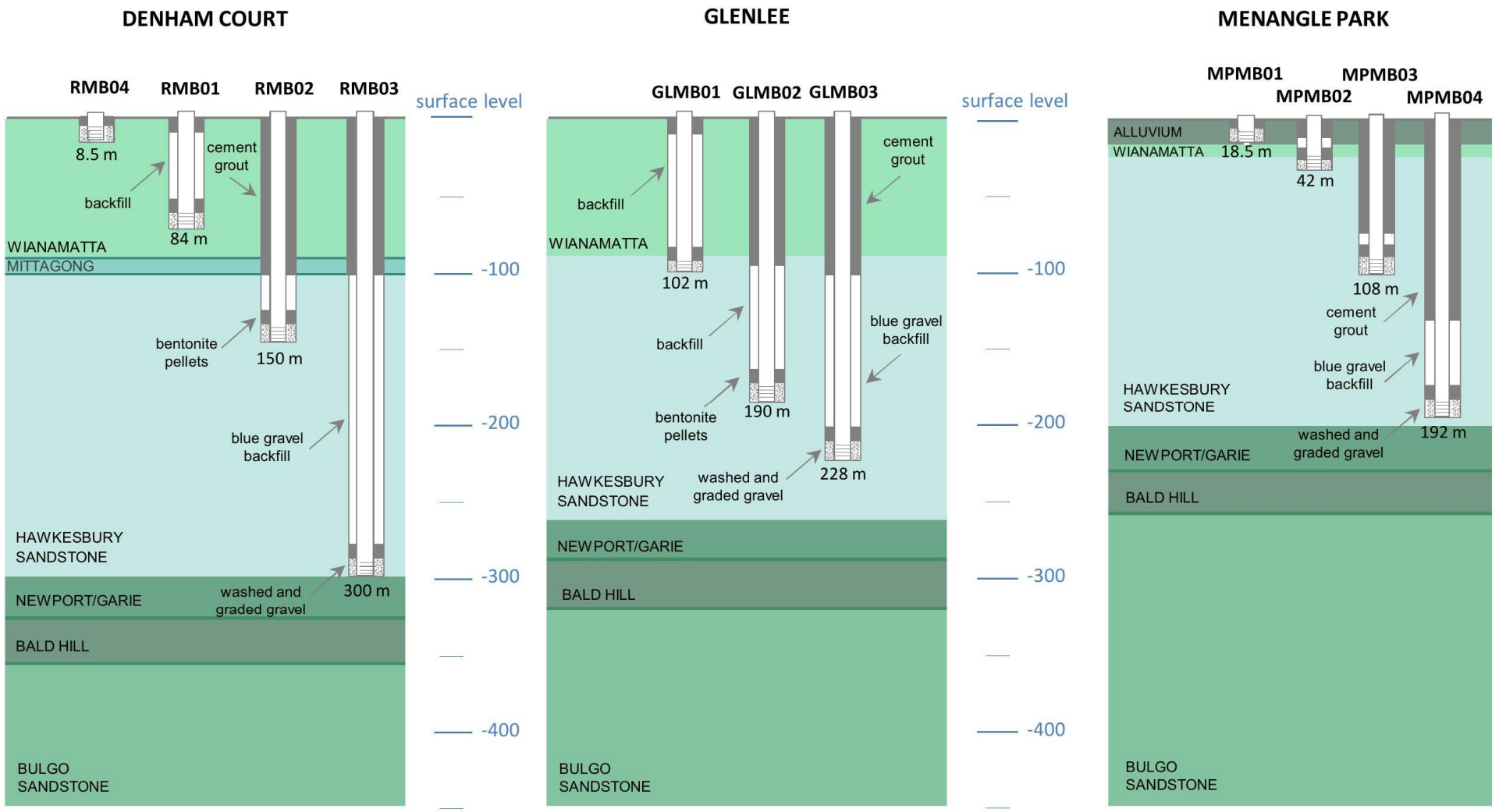

Figure 2.1 Nested groundwater monitoring bores at Denham Court, Glenlee and Menangle Park

3. Groundwater levels

Solinst Levelogger (M30) dataloggers are installed in each monitoring bore, and programmed to record water levels at 6-hourly intervals. Groundwater level hydrographs for each groundwater monitoring site are plotted with daily rainfall recorded by the nearest Bureau of Meteorology (BoM) rain gauge for each site.

A hydrograph showing fluctuations in groundwater level from November 2011 to May 2014 within each bore at the Denham Court site is shown in Figure 3.1, with the exception of RMB04, which has been dry since its installation in June 2013. Individual hydrographs are attached in Figures A.1 to A.3 in Appendix A. The Denham Court hydrographs are plotted with daily rainfall recorded by the Ingleburn rain gauge (BoM site: 066190).

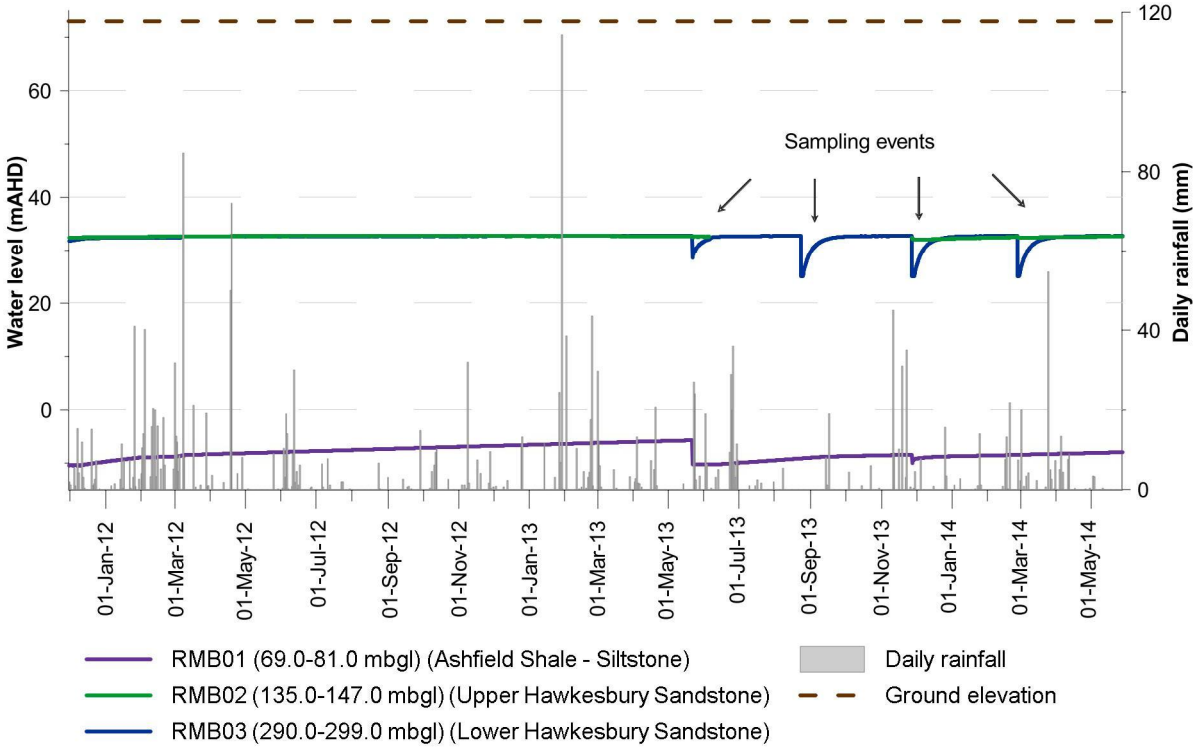

Figure 3.1 Groundwater levels in the Denham Court monitoring bores

A hydrograph showing fluctuations in groundwater level from June 2013 to May 2014 within each bore at the Menangle Park site is shown in Figure 3.2. Individual hydrographs are attached in Figures A.4 to A.7 in Appendix A. The Menangle Park hydrographs are plotted with daily rainfall recorded by the Menangle Bridge rain gauge (BoM site: 068216).

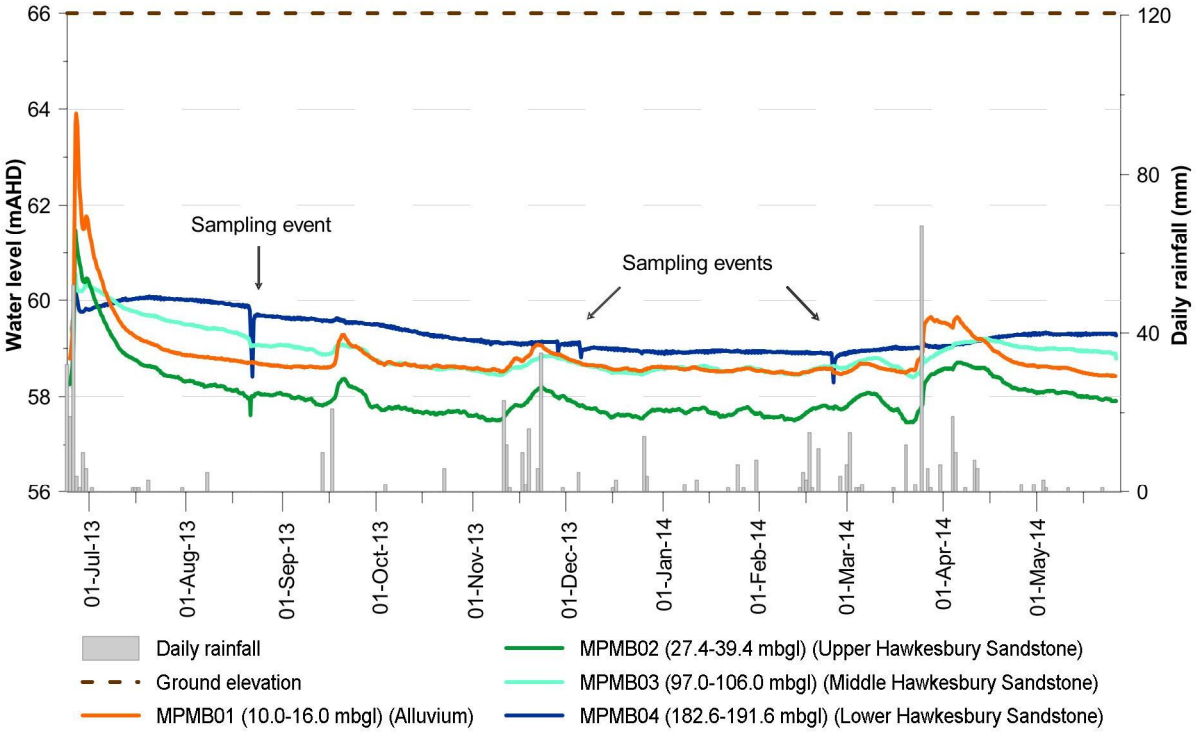

Figure 3.2 Groundwater levels in the Menangle Park monitoring bores

A hydrograph showing fluctuations in groundwater level from February 2014 to May 2014 within each bore at the Glenlee site is shown in Figure 3.3. Individual hydrographs are attached in Figures A.8 to A.10 in Appendix A. The Glenlee hydrographs are plotted with daily rainfall recorded by the Mount Annan Botanic Garden rain gauge (BoM site: 068254).

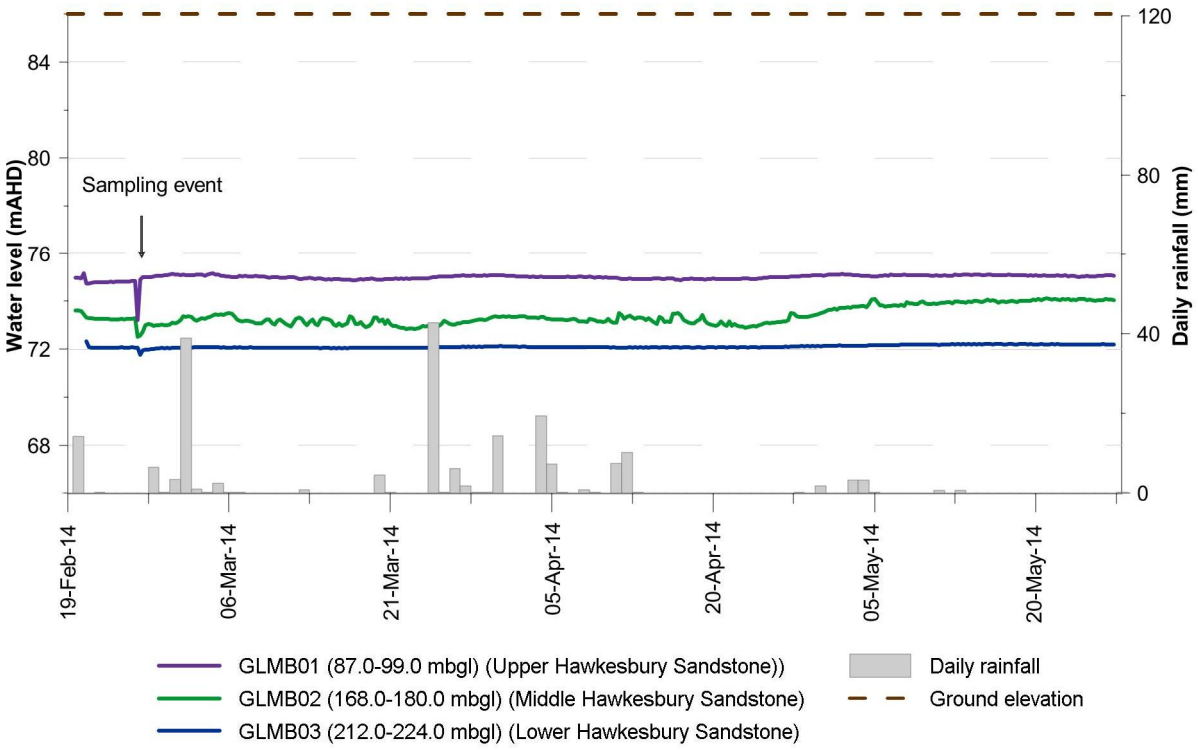

Figure 3.3 Groundwater levels in the Gleenle monitoring bores

Full analysis of these data will be presented in the 2013-14 annual groundwater monitoring status report (to be finalised in September 2014). However, trends from the groundwater level monitoring to-date can be summarised as follows:

- Denham Court site: Groundwater levels are deep (at least 40 mbgl) and there is currently no apparent influence from rainfall.
- Menangle Park site: Groundwater levels are shallow (less than 10 mbgl) and all bores show a response to rainfall (decreasing with depth) in the period of monitoring data (12 months). There is an apparent upward hydraulic gradient at this site except during high rainfall recharge events.
- Glenlee site: Groundwater levels are shallow (less than 15 mbgl) and there is currently no apparent influence from rainfall over the short monitoring period (three months). There is an apparent downward hydraulic gradient at this site.

4. Groundwater quality

Monitoring bores were sampled between 26 and 28 May 2014. (Note that RMB01 and RMB04 were not sampled as there was insufficient groundwater in the bores to obtain a representative sample).

A micro-purge™ low-flow sampling system was deployed allowing a representative groundwater sample to be drawn into the pump intake directly from the screened portion of the aquifer. Groundwater levels and water quality parameters were monitored during the low flow sampling to ensure that representative groundwater samples were collected. Samples were sent to Australian Laboratory Service (ALS) Environmental Pty Ltd for laboratory testing. ALS is certified by the National Association of Testing Authorities (NATA) for all analytes tested.

Table 4.1 lists the analytical results from the groundwater quality sampling event. All results are compared against the ANZECC (2000) guidelines for freshwater ecosystems (southeast Australia – lowland rivers) because the rivers are the ultimate receiving waters for both surface water runoff and groundwater discharge. However, these water guidelines are often naturally exceeded in catchments with rocks deposited in marine environments, hence they should be considered for reference only and not as a water quality objective or threshold.

Table 4.1 Groundwater quality summary – May 2014

Parameters	Units	ANZECC (2000) guidelines[a]	RMB02	RMB03	MPMB01	MPMB02	MPMB03	MPMB04	GLMB01	GLMB02	GLMB03
General parameters											
pH (field)	pH units	6.5–8.0[b]	6.78	**9.70**	**5.54**	**6.44**	7.04	**9.84**	6.77	7.03	8.17
pH (lab)			7.21	**9.52**	**5.45**	6.81	7.44	**9.45**	7.32	7.46	**8.29**
EC (field)	µS/cm	125–2,200[b]	**10,636**	**7,746**	902	885	1,020	1,031	**9,075**	**6,655**	**5,453**
EC (lab)			**10,400**	**7,970**	924	890	1,070	1,050	**9,330**	**6,840**	**5,570**
Temperature	°C	–	19.53	20.51	21.46	25.70	18.95	19.39	19.90	20.98	20.13
Dissolved oxygen	% sat	80–110[b]	**8.3**	**10.2**	**7.5**	**12.3**	**1.6**	**0.8**	**2.1**	**10.3**	**4.1**
TDS (field)	mg/L	–	6,917	5,034	586	575	663	670	5,904	4,326	3,544
TDS (lab)			6,560	4,470	518	413	550	541	5,650	4,000	2,820
Suspended Solids	mg/L	–	<5	<5	114	80	<5	86	5	25	<5
Redox	mV	–	-98.4	-203.0	153.7	-124.5	-215.4	-215.5	-218.3	-213.3	-232.0
Water type[c]			Na-Cl	Na-Cl	Na-Mg-Cl	Na-Mg-Cl-HCO_3	Na-Ca-HCO_3	Na-Cl-HCO_3-CO_3	Na-Cl	Na-Cl-HCO_3	Na-Cl-HCO_3
Laboratory analytes											
Hydroxide alkalinity as $CaCO_3$	mg/L	–	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate alkalinity as $CaCO_3$	mg/L	–	<1	240	<1	<1	<1	126	<1	<1	<1
Bicarbonate alkalinity as $CaCO_3$	mg/L	–	829	234	16	200	493	167	574	829	816
Total alkalinity as $CaCO_3$	mg/L	–	829	474	16	200	493	293	574	829	816
Sulphate	mg/L	–	<1	<1	3	7	<1	<1	138	<1	<1
Chloride	mg/L	–	3,020	2,340	283	177	78	172	2,880	1,600	1,240

Parameters	Units	ANZECC (2000) guidelines[a]	RMB02	RMB03	MPMB01	MPMB02	MPMB03	MPMB04	GLMB01	GLMB02	GLMB03
Calcium	mg/L	–	192	2	14	28	85	6	197	210	49
Magnesium	mg/L	–	79	12	25	27	22	5	223	92	78
Sodium	mg/L	–	1,690	1,560	119	101	107	181	1,390	979	910
Potassium	mg/L	–	39	20	1	4	14	18	28	26	30
Silica	mg/L	–	10.80	6.49	19.70	13.30	9.25	3.97	11.70	22.90	12.10
Total cyanide	mg/L	0.007	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Fluoride	mg/L	–	0.2	0.4	<0.1	0.2	0.2	0.5	0.2	0.2	0.2
Dissolved metals											
Aluminium	mg/L	0.055	<0.01	<0.01	0.01	0.03	<0.01	0.02	<0.01	<0.01	<0.01
Antimony	mg/L	–	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.013	<0.001	<0.001	<0.001	0.004	**0.035**	0.003	0.004	0.012	0.037
Barium	mg/L	–	48.00	5.41	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium	mg/L	ID	<0.001	<0.001	0.716	0.510	3.350	0.891	0.351	8.540	5.670
Cadmium	mg/L	0.37	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	ID	<0.001	<0.001	0.042	0.002	0.004	<0.001	0.002	<0.001	0.002
Copper	mg/L	0.0014	<0.001	<0.001	**0.015**	0.001	<0.001	**0.002**	<0.001	<0.001	<0.001
Lead	mg/L	0.0034	<0.001	<0.001	**0.009**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	1.9	0.027	<0.001	0.504	0.148	0.047	0.020	0.442	0.897	0.024
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	ID	<0.001	0.004	<0.001	<0.001	<0.001	0.007	<0.001	<0.001	0.004
Nickel	mg/L	0.011	<0.001	<0.001	**0.016**	0.001	0.004	<0.001	0.002	<0.001	0.003

Parameters	Units	ANZECC (2000) guidelines[a]	RMB02	RMB03	MPMB01	MPMB02	MPMB03	MPMB04	GLMB01	GLMB02	GLMB03
Selenium	mg/L	0.011	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	–	10.100	2.280	0.154	0.361	1.080	0.265	5.340	4.430	3.320
Uranium	mg/L	ID	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
Vanadium	mg/L	ID	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.008	**0.015**	<0.005	**0.070**	**0.009**	0.006	**0.039**	**0.018**	0.006	**0.075**
Boron	mg/L	0.37	<0.05	0.17	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Iron	mg/L	ID	5.22	<0.05	<0.05	3.96	0.83	<0.05	2.20	1.45	0.44
Bromine	mg/L	ID	6.6	5.1	0.8	0.4	0.2	0.4	7.5	4.6	3.6
Nutrients											
Ammonia as N	mg/L	0.02[b]	**4.36**	**3.42**	0.01	**0.09**	**0.93**	**0.99**	**2.39**	**1.74**	**2.24**
Nitrite as N	mg/L	0.02[b]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.7	0.02	<0.01	0.15	0.02	0.02	0.02	0.01	0.01	0.02
Total phosphorus	mg/L	0.05[b]	<0.05	0.01	**0.10**	0.04	0.02	0.03	0.05	**0.15**	0.03
Reactive phosphorus	mg/L	0.02[b]	**0.08**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.06**	0.01
Total organic carbon	mg/L	–	<1	28	5	3	<1	15	<1	<1	<1
Dissolved gases											
Methane	µg/L	–	37,600	42,000	<10	53	35,900	27,300	35,600	16,200	33,500
Ethene	µg/L	–	<10	<10	<10	<10	<10	<10	<10	<10	<10
Ethane	µg/L	–	14	10	<10	<10	<10	<10	1,950	816	371
Propene	µg/L	–	<10	<10	<10	<10	<10	<10	<10	<10	<10
Propane	µg/L	–	<10	<10	<10	<10	<10	<10	544	190	69
Butene	µg/L	–	<10	<10	<10	<10	<10	<10	<10	<10	<10

Parameters	Units	ANZECC (2000) guidelines[a]	RMB02	RMB03	MPMB01	MPMB02	MPMB03	MPMB04	GLMB01	GLMB02	GLMB03
Butane	µg/L	–	<10	<10	<10	<10	<10	<10	115	36	<10
Phenolic compounds											
Phenol	µg/L	–	<1.0	<1.0	<1.0	<1.0	<1.0	10.2	<1.0	<1.0	1.8
Polycyclic aromatic compounds											
Naphthalene	µg/L	16	<1.0	<1.0	11	5.7	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	µg/L	–	<1.0	<1.0	12.3	7.8	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	µg/L	–	<1.0	<1.0	9.7	6.4	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	µg/L	ID	<1.0	<1.0	15.3	10.2	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	µg/L	ID	<1.0	<1.0	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	µg/L	ID	<1.0	<1.0	1.6	1.1	<1.0	<1.0	<1.0	<1.0	<1.0
Benzene	µg/L	950	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	ID	<2	35	<2	<2	<2	84	<2	19	109
Ethylbenzene	µg/L	ID	<2	<2	<2	<2	<2	<2	<2	<2	<2
Meta- & para-Xylene	µg/L	ID	<2	<2	<2	<2	<2	<2	<2	2	2
Ortho-Xylenes	µg/L	350	<2	<2	<2	<2	<2	<2	<2	<2	<2
C_6–C_9	µg/L	–	<20	60	<20	<20	<20	130	110	100	160
C_{10}–C_{14}	µg/L	–	<50	50	520	250	<50	60	<50	<50	<50
C_{15}–C_{28}	µg/L	–	<100	120	190	<100	<100	190	<100	<100	<100
C_{29}–C_{36}	µg/L	–	<50	<50	<50	<50	<50	60	<50	<50	<50

Notes:

a) ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems: 95% protection levels (trigger values).

b) ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems: trigger values for lowland rivers in south-east Australia.

c) Calculated using AQUACHEM.

ID – insufficient data to derive a reliable trigger value.

Bold indicates exceedance of guideline value.

Full analysis of these data will be presented in the 2013-2014 annual groundwater monitoring status report. However, the results to-date can be summarised as follows:

- Groundwater at Denham Court (within the Hawkesbury Sandstone) is characterised as moderately saline, with sodium and chloride the dominant ions. Groundwater pH conditions range from neutral to alkaline. Dissolved metal concentrations are generally low and do not exceed ANZECC (2000) criteria with the exception of zinc. Ammonia (as N) concentrations exceed the ANZECC (2000) guideline criteria and reactive phosphorous exceeds the guidelines at RMB02 only. Dissolved methane and ethane were detected at both monitoring bores. Toluene was detected at RMB03. No Polycyclic Aromatic Hydrocarbons (PAHs) were detected. Total petroleum hydrocarbons (TPH) were detected at RMB03.
- Groundwater at Menangle Park (within the alluvium and Hawkesbury Sandstone) is characterised as fresh, with sodium, chloride and bicarbonate the overall dominant ions. Groundwater pH range from acidic to alkaline. Dissolved metal concentrations are generally low and do not exceed ANZECC (2000) criteria with the exception of arsenic, copper, lead, nickel and zinc in at least one monitoring bore. Ammonia (as N) concentrations exceeded the ANZECC (2000) guideline criteria at most bores. Total phosphorous was detected at all monitoring bores, and concentrations exceed the ANZECC (2000) guideline criteria at MPMB01 only. Methane was detected in all monitoring bores except at MPMB01, with relatively low concentrations at MPMB02. No PAHs were detected with the exception of naphthalene, which was detected at concentrations below the ANZECC (2000) guidelines at MPMB01 and MPMB02. Phenolic compounds, TPH C_6–C_9 and toluene were detected at MPMB04.
- Groundwater at Glenlee (within the Hawkesbury Sandstone) is characterised as slightly saline, with sodium and chloride the dominant ions, together with bicarbonate at GLMB03. Groundwater pH conditions range from neutral to slightly alkaline. Dissolved metal concentrations are generally low and do not exceed ANZECC (2000) guideline criteria with the exception of zinc. Ammonia (as N) concentrations exceed the ANZECC (2000) guideline criteria at all bores. Total phosphorous and reactive phosphorous concentrations exceed the ANZECC (2000) guideline criteria at GLMB02 only. Dissolved methane, propane and ethene were detected in all bores. Phenol was detected at GLMB03. Toluene, xylenes and TPH C_6–C_{10} fraction were detected at most bores. PAHs were not detected.

5. Summary

The preliminary results of the CGP groundwater investigation are consistent with the conceptual model presented in the Phase 1 report (Parsons Brinckerhoff, 2011) and the results presented in the 2012-2013 *Annual Groundwater Monitoring Status Report* (Parsons Brinckerhoff, 2013) and in the FY2014 Quarter 3 sampling update (Parsons Brinckerhoff, 2014). In brief summary:

Denham Court site

- Groundwater levels are deep (at least 40 mbgl) and there is currently no apparent influence from rainfall.
- Groundwater quality in the Hawkesbury Sandstone is poor (moderately saline) and of limited beneficial use due to its elevated salinity.

Menangle Park site

- Groundwater levels are shallow (less than 10 mbgl) and all bores show a response to rainfall (decreasing with depth) in the period of monitoring (12 months).
- Groundwater quality in all aquifers and water bearing zones is reasonably fresh and suitable for livestock based on the analysed parameters.

Glenlee site

- Groundwater levels are shallow (less than 15 mbgl) and there is currently no apparent influence from rainfall in the short period of monitoring (three months).
- Groundwater quality in the Hawkesbury Sandstone is poor (slightly saline) and of limited beneficial use due to its elevated salinity.

The field investigation program is ongoing, consisting of quarterly sampling and automated groundwater level monitoring.

6. Statement of limitations

6.1 Scope of services

This report has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and Parsons Brinckerhoff (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

6.2 Reliance on data

In preparing the report, Parsons Brinckerhoff has relied upon data, surveys, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, Parsons Brinckerhoff has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Parsons Brinckerhoff will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Parsons Brinckerhoff.

6.3 Environmental conclusions

In accordance with the scope of services, Parsons Brinckerhoff has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

6.4 Report for benefit of client

The report has been prepared for the benefit of the client (and no other party). Parsons Brinckerhoff assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of Parsons Brinckerhoff or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Parties other than the client should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

6.5 Other limitations

Parsons Brinckerhoff will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

7. References

- ANZECC, 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality Volumes 3 and 4.* Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
- Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ), 2003. *Minimum Construction Requirements for Water Bores in Australia*.
- Parsons Brinckerhoff, 2011. *Phase 1 Groundwater Assessment and Conceptual Hydrogeological Model for the Northern Expansion of the Camden Gas Project*. February 2011, 2114759A PR_5375 RevF.
- Parsons Brinckerhoff, 2013. Camden Gas Project – 2012–2013 Annual Groundwater Monitoring Status Report. October 2013, 2114759B-WAT-RPT-7568 RevC.
- Parsons Brinckerhoff, 2014. Camden Gas project – FY14 Q3 Groundwater Monitoring Update – March 2014. April 2014, 2193361A-WAT-RPT-7720 RevB.

Appendix A

Groundwater hydrographs

Figure A.1 Groundwater levels and rainfall RMB01

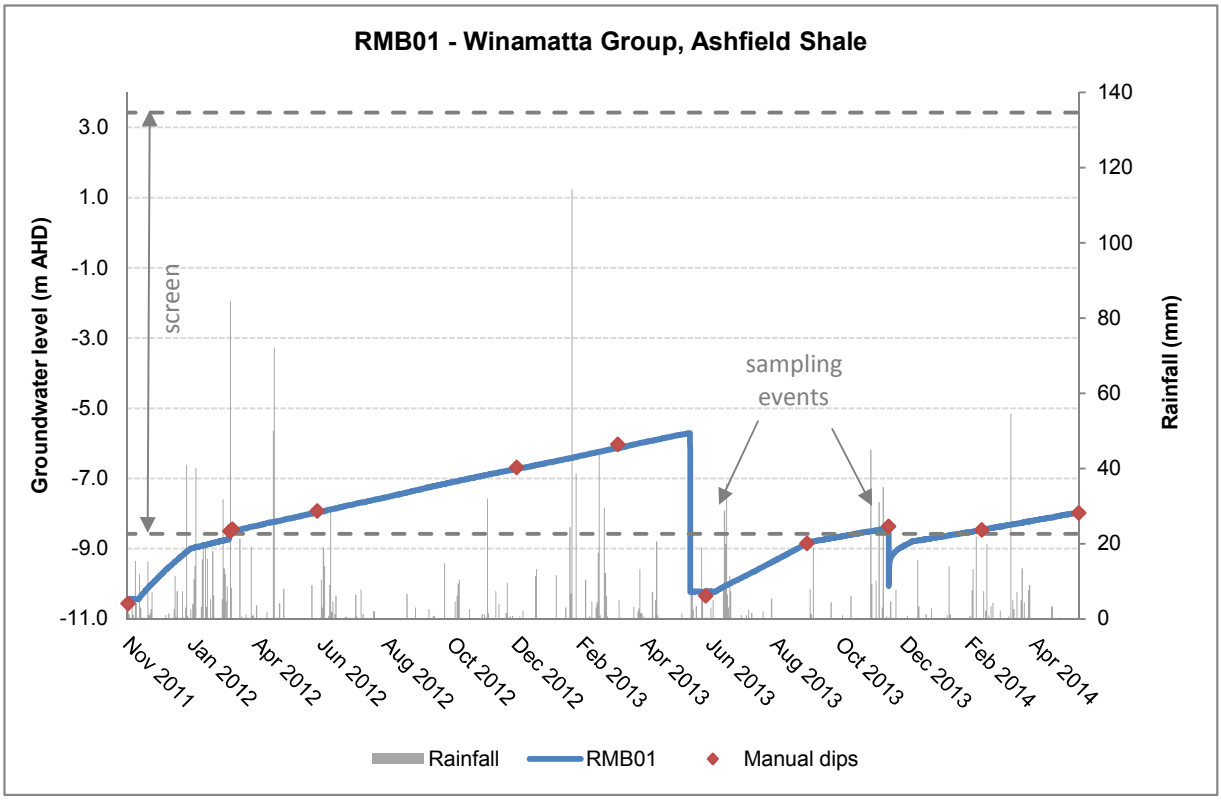

Figure A.2 Groundwater levels and rainfall RMB02

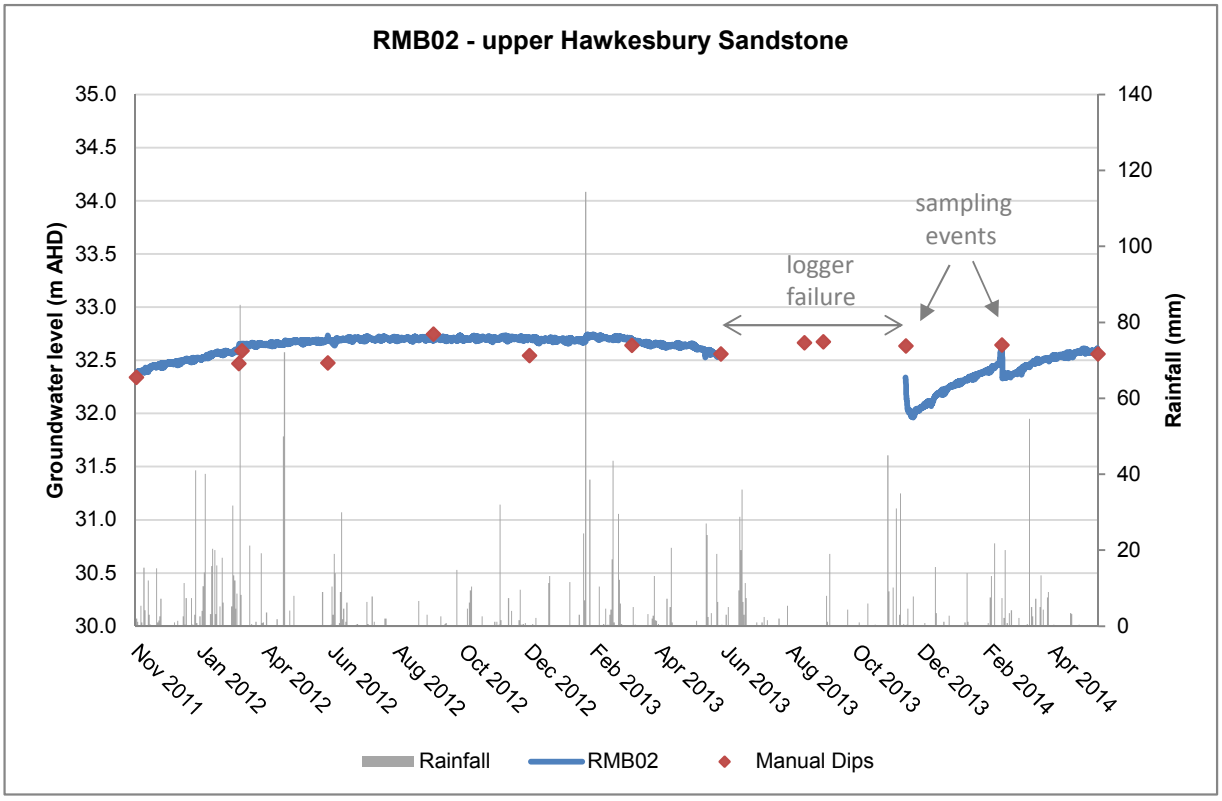

Figure A.3 Groundwater levels and rainfall RMB03

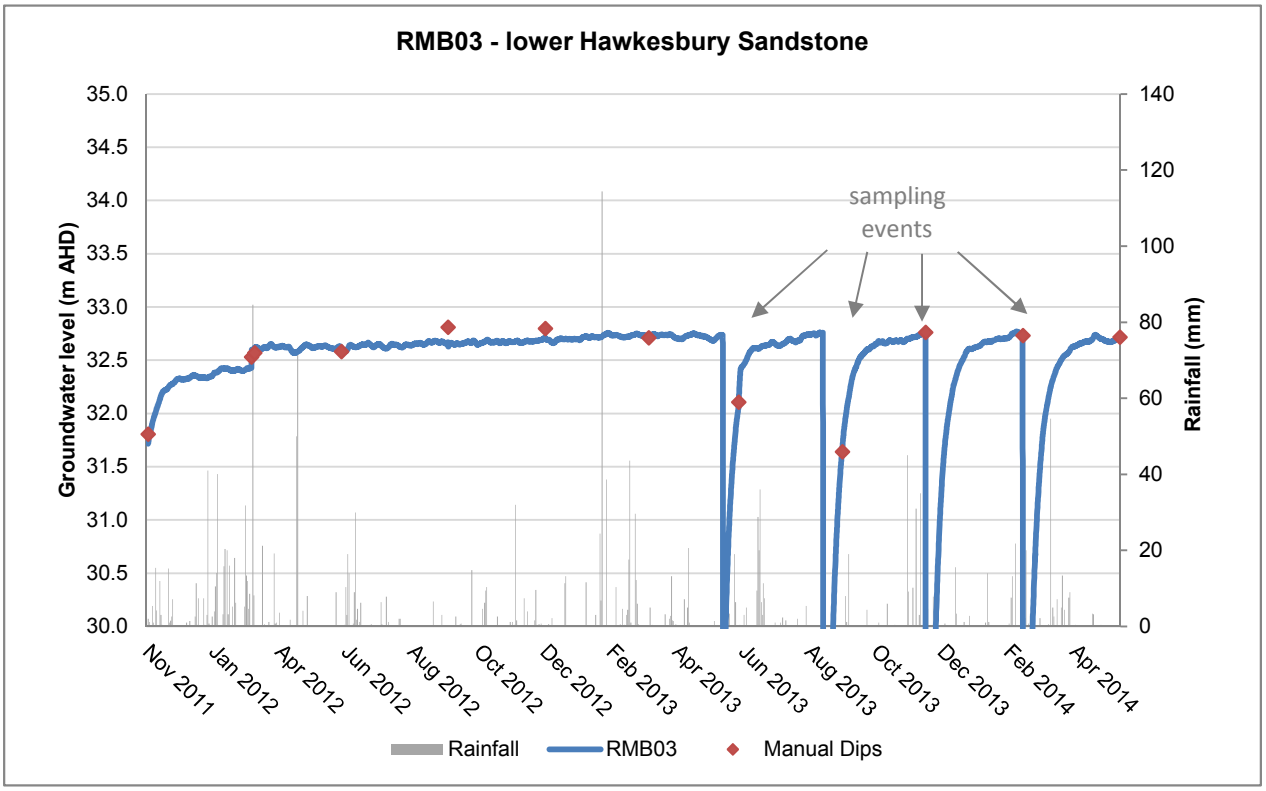

Figure A.4 Groundwater levels and rainfall MPMB01

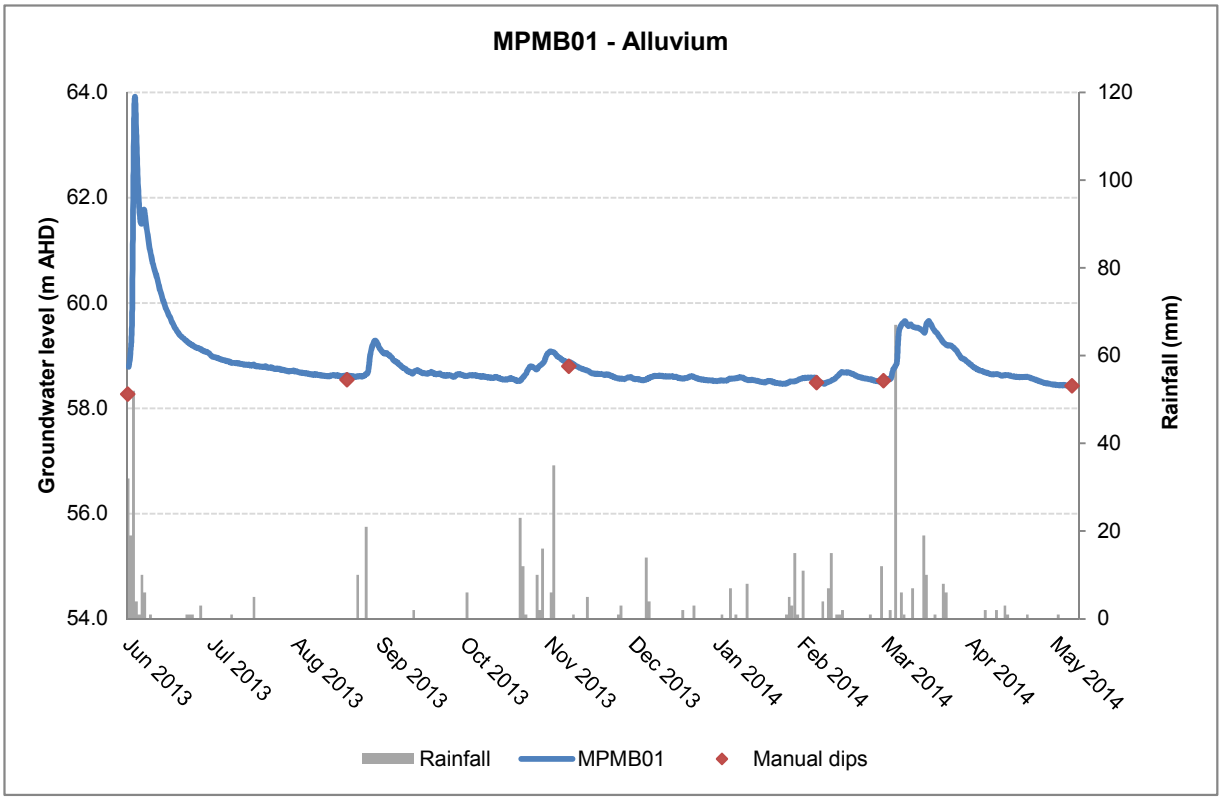

Figure A.5 Groundwater levels and rainfall MPMB02

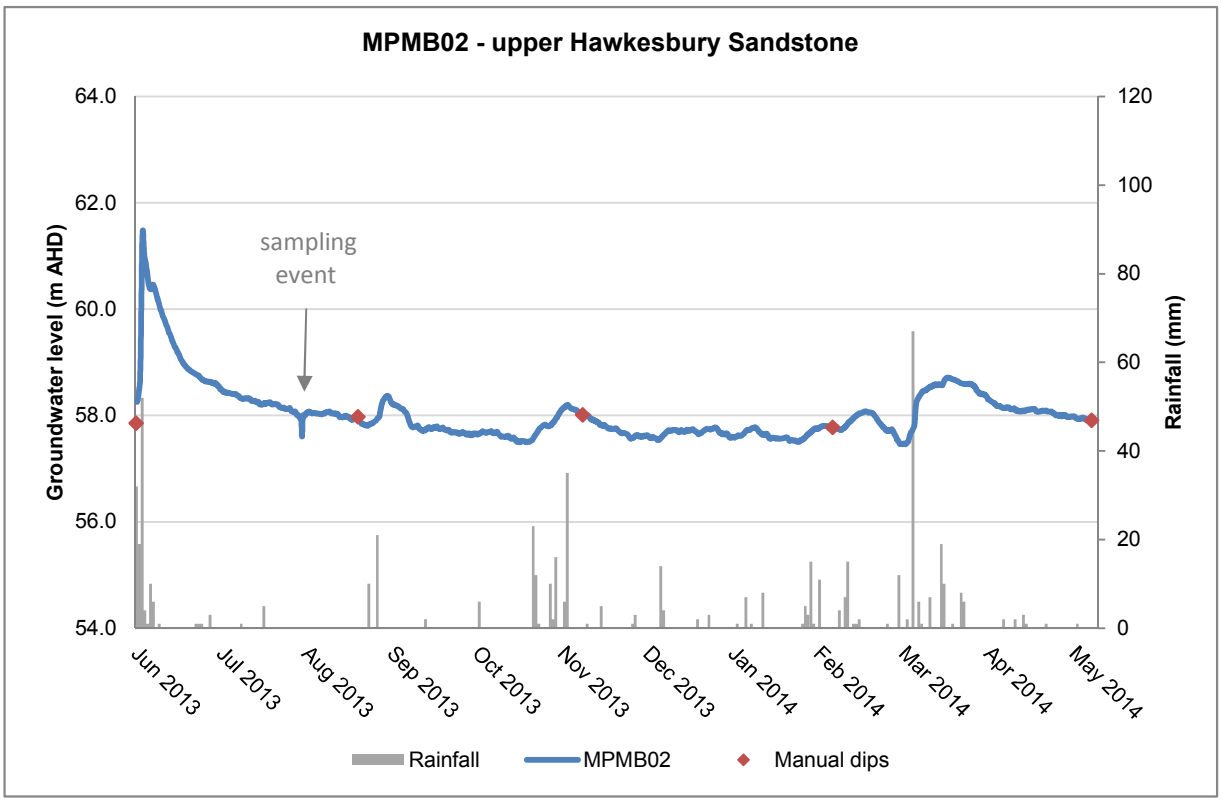

Figure A.6 Groundwater levels and rainfall MPMB03

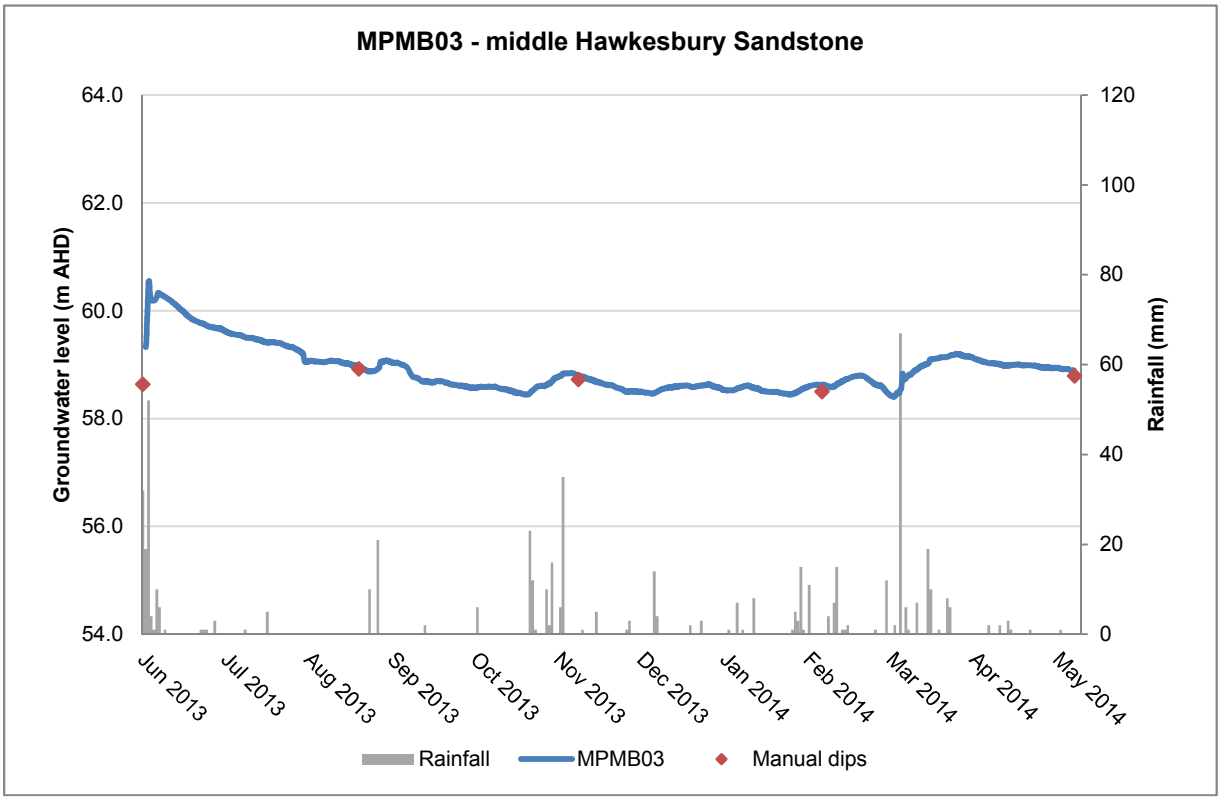

Figure A.7 Groundwater levels and rainfall MPMB04

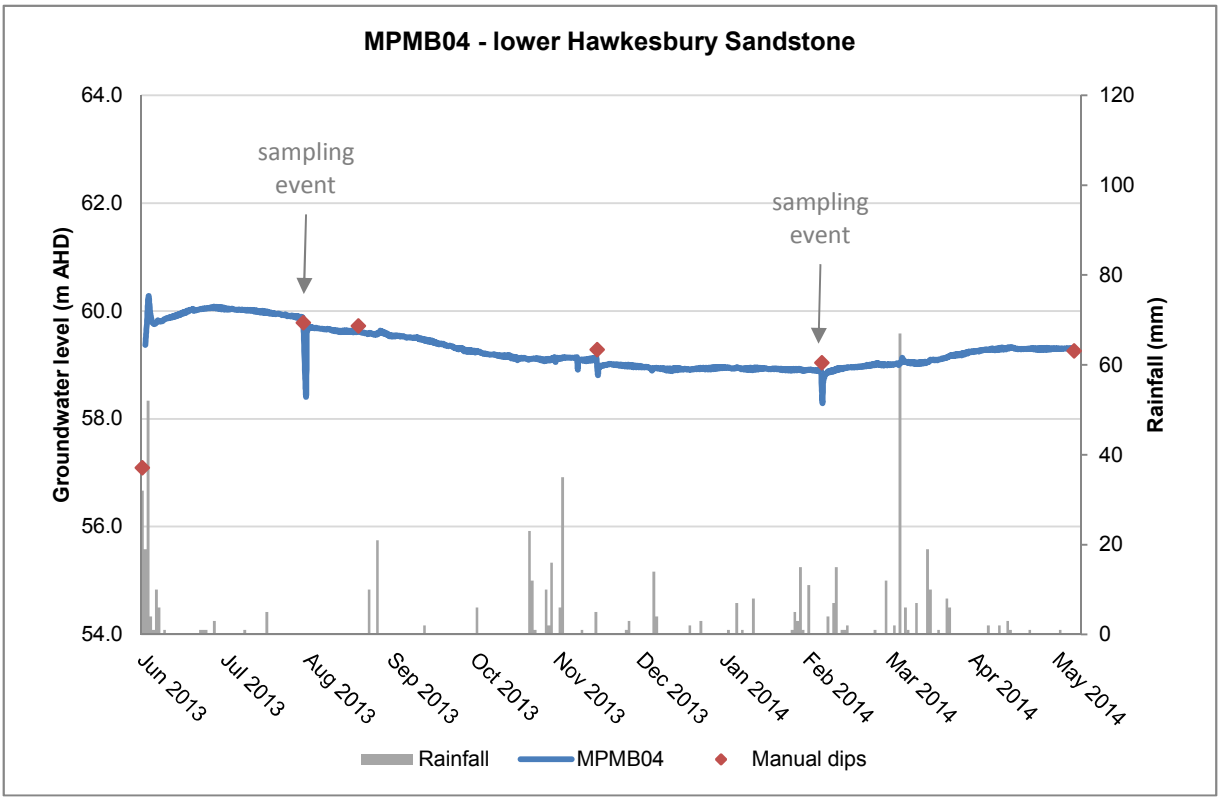

Figure A.8 Groundwater levels and rainfall GLMB01

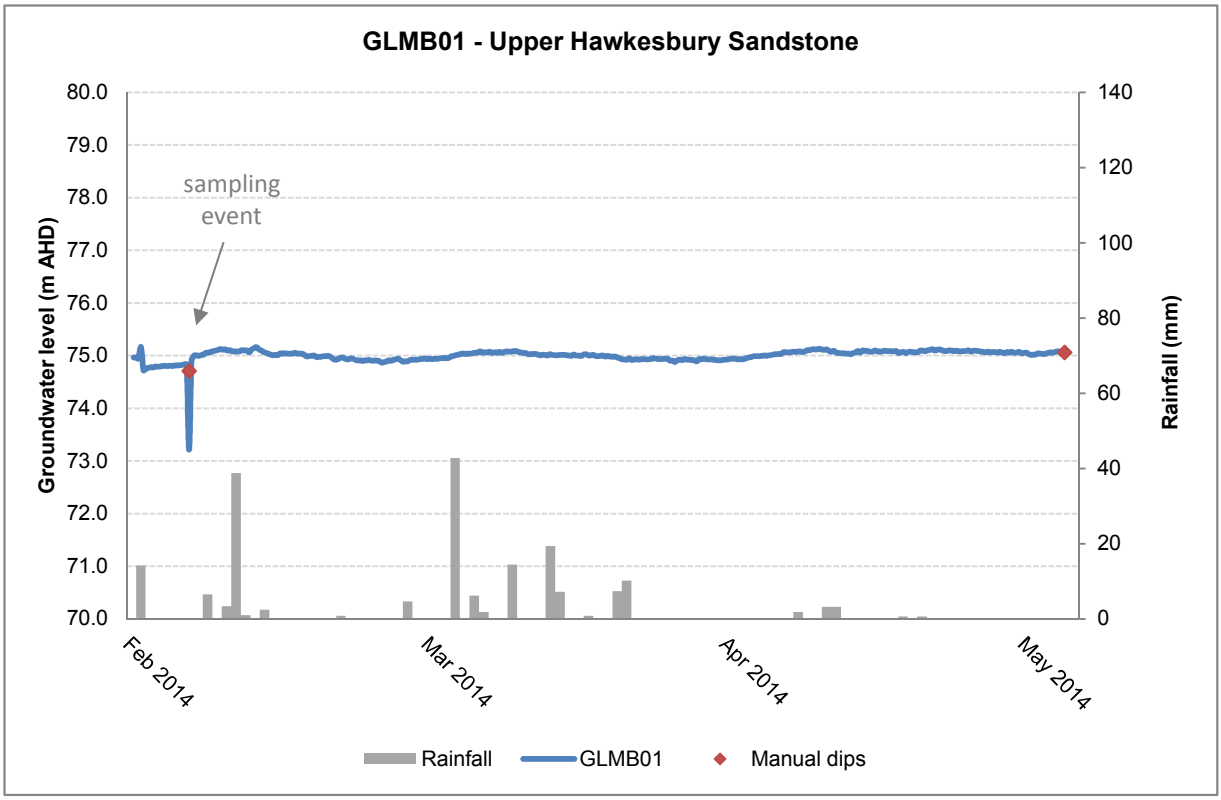

Figure A.9 Groundwater levels and rainfall GLMB02

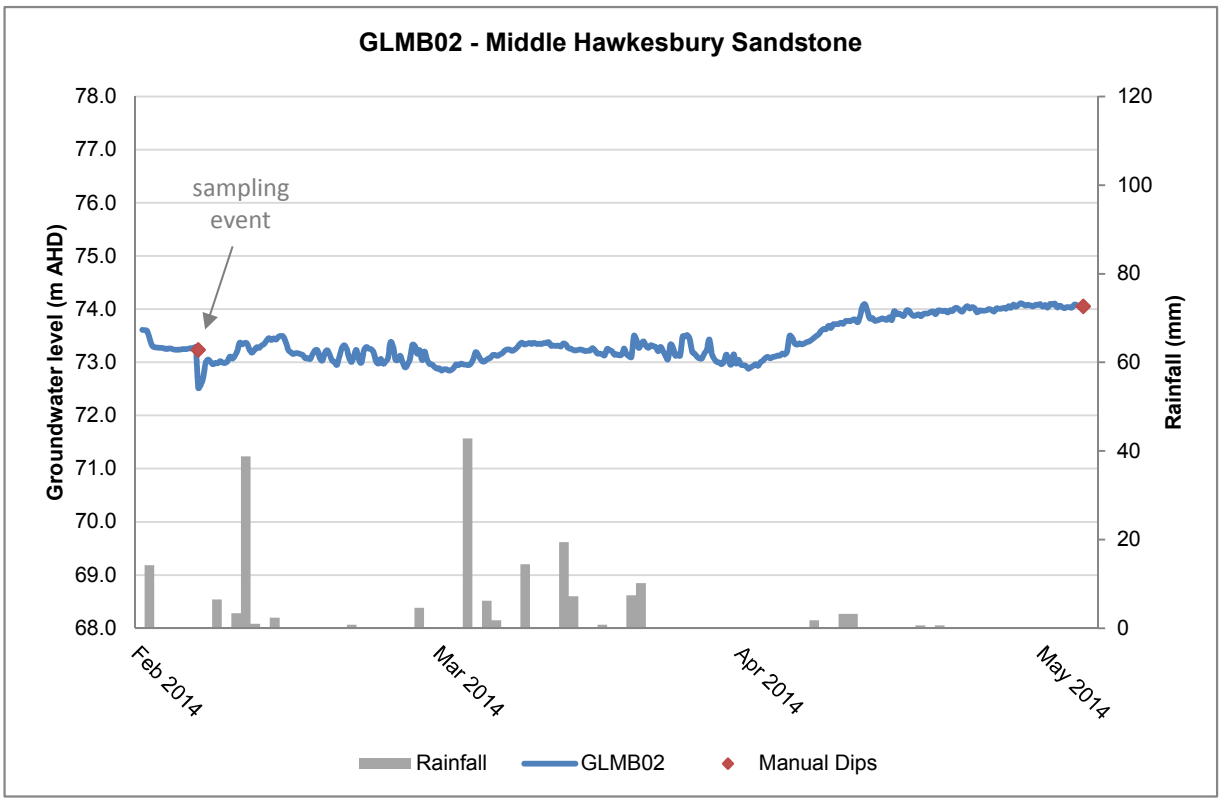

Figure A.10 Groundwater levels and rainfall GLMB03