Memorandum

Ground Floor, Suite 01, 20 Chandos Street
St Leonards, NSW, 2065
PO Box 21
St Leonards, NSW, 1590

T +61 2 9493 9500
F +61 2 9493 9599
E info@emmconsulting.com.au

www.emmconsulting.com.au

22 May 2019

To Aaron Clifton
From James Duggleby

Subject Camden Gas Project- FY18/19 Six-monthly monitoring update – April 2019

Dear Aaron,

This memo presents the updated hydrographs for the Menangle Park and Glenlee groundwater monitoring bores to April 2019 in Figures A.1 – A.5, and the water quality results for the April 2019 sampling event in Table A.1, including the Nepean River. Results are presented for samples taken on 9 April 2018.

Key observations for this monitoring period (October 2018 to April 2019) are:

- Groundwater levels at the Menangle Park monitoring bores remain within the historic range with no increasing or decreasing overall trend identified. Bores MPMB01, MPMB02, and MPMB03 showed a short-term response to the rainfall events in late March 2019.
- Groundwater level at the Glenlee monitoring bore GLMB03 remains stable with a slight decreasing trend observed since July 2016.
- As noted in the October 2018 monitoring update memo (EMM 2018), the vibrating wire piezometer (VWP) sensors at GLMB01 and GLMB02 stabilised at lower piezometric pressure head levels compared with pressures observed from the former standpipe monitoring bores prior to conversion to VWPs. This data is not considered representative of formation pressures, potentially due to interference from the gravel pack surrounding the piezometers. Although the absolute pressure values post-VWP installation are not representative of formation pressures, the trends in the data are and are therefore still useful.

The groundwater quality results will be analysed and discussed in the next annual monitoring report.

The results are included in the following attached figures and table:

- Figures A.1 – A.4: Individual hydrographs for the Menangle Park and Glenlee sites;
- Figures A.5: Nested hydrographs for the Menangle Park and Glenlee sites;
- Table A.1: Water quality results for April 2019.

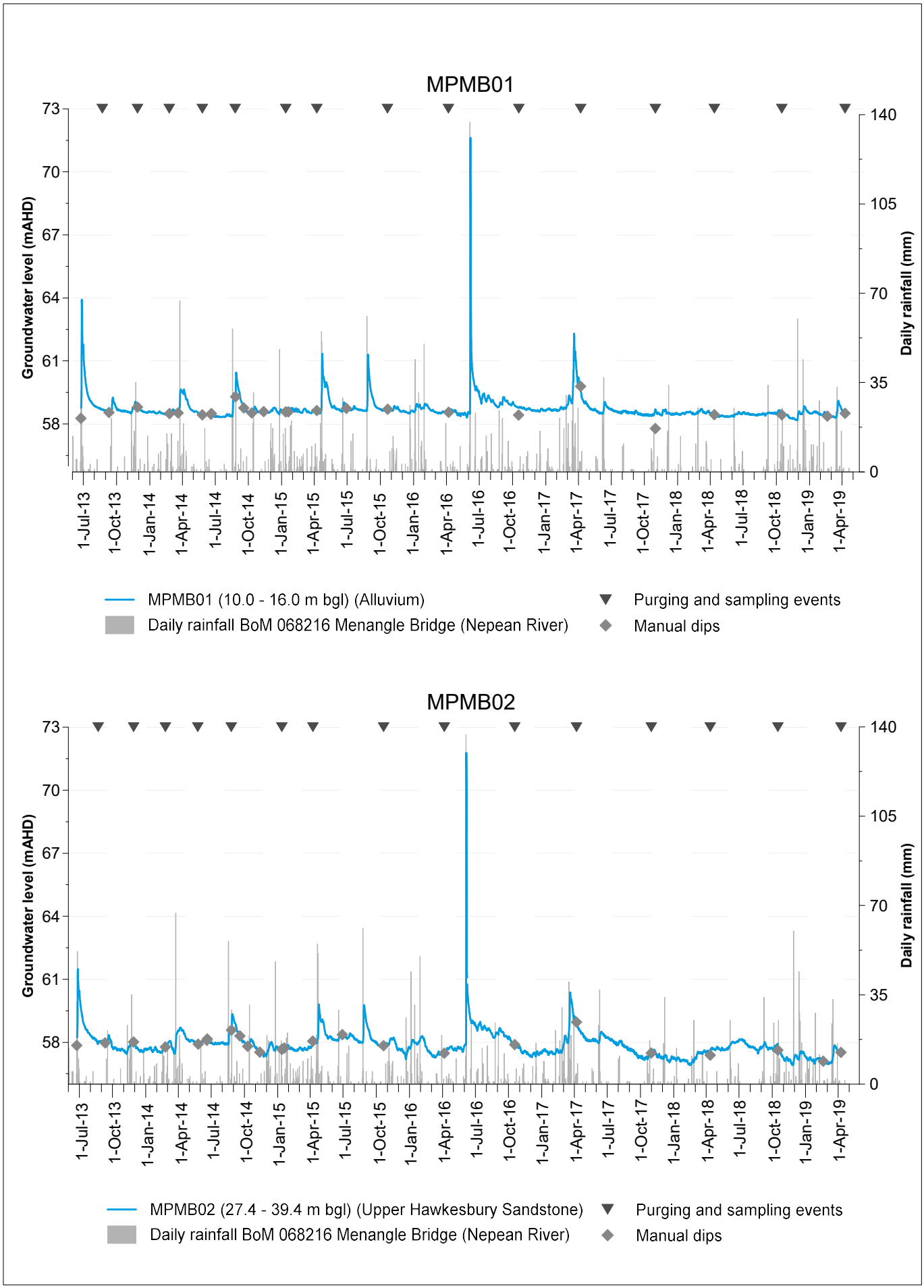
Yours sincerely

James Duggleby
Principal Hydrogeologist

gjimenez@emmconsulting.com.au
Reviewed: SR

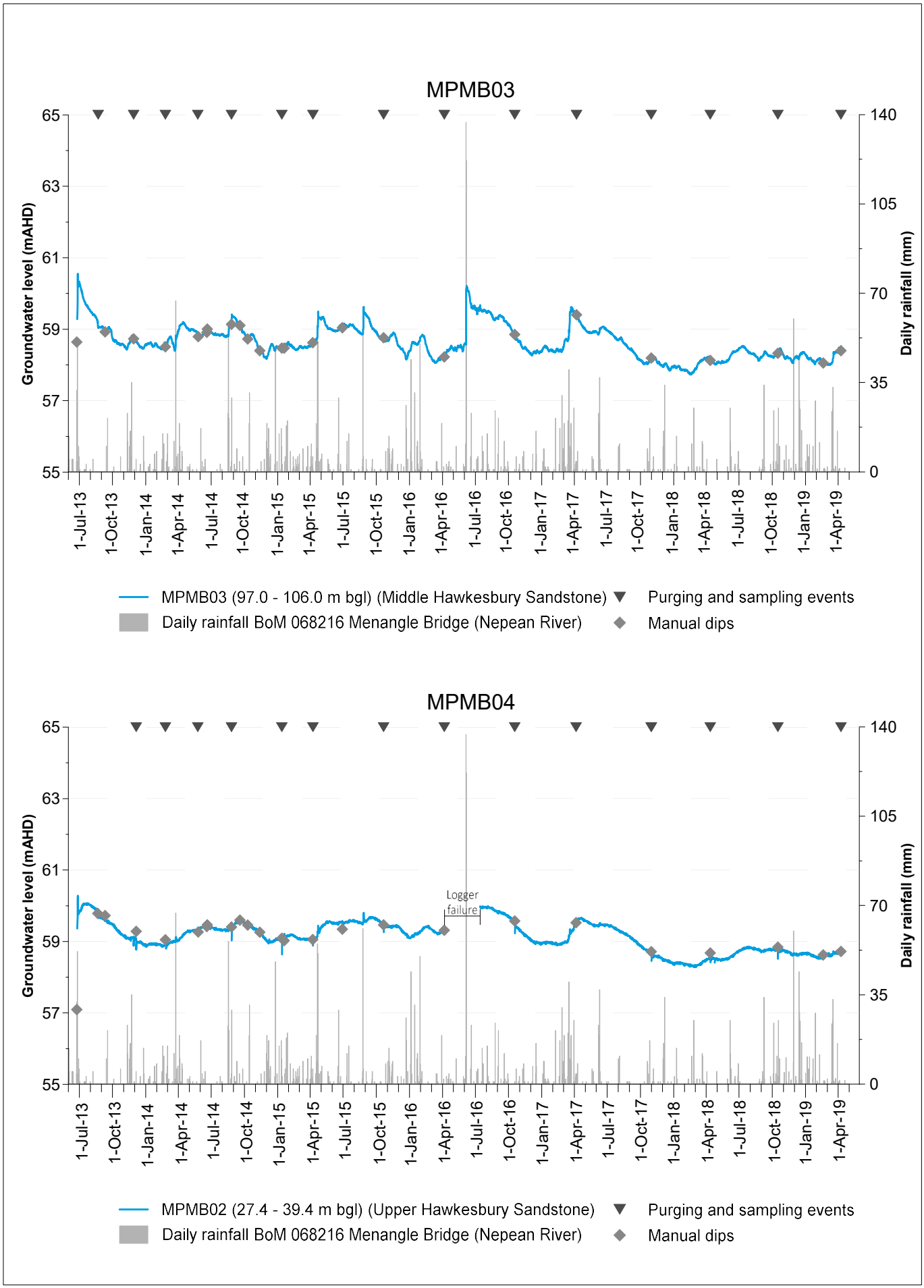
Reference

EMM Consulting (EMM) 2018, *Camden Gas Project – FY17/18 Six-monthly monitoring update – October 2018,* prepared for AGL Energy Pty Ltd.



MPMB01 and MPMB02 hydrographs

Camden Gas Project
Six-monthly Monitoring Event - April 2019
Figure A.1

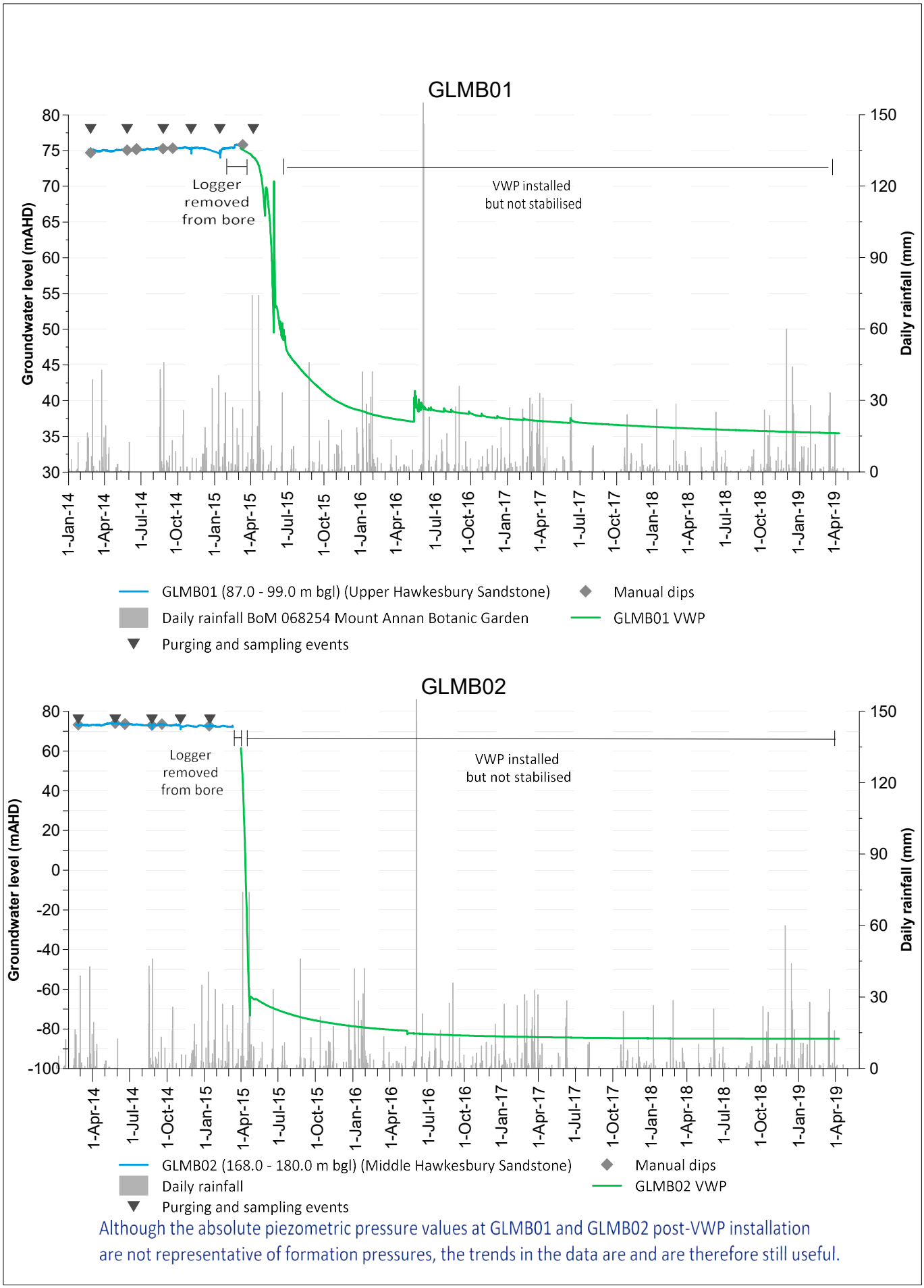


MPMB03 and MPMB04 hydrographs

Camden Gas Project

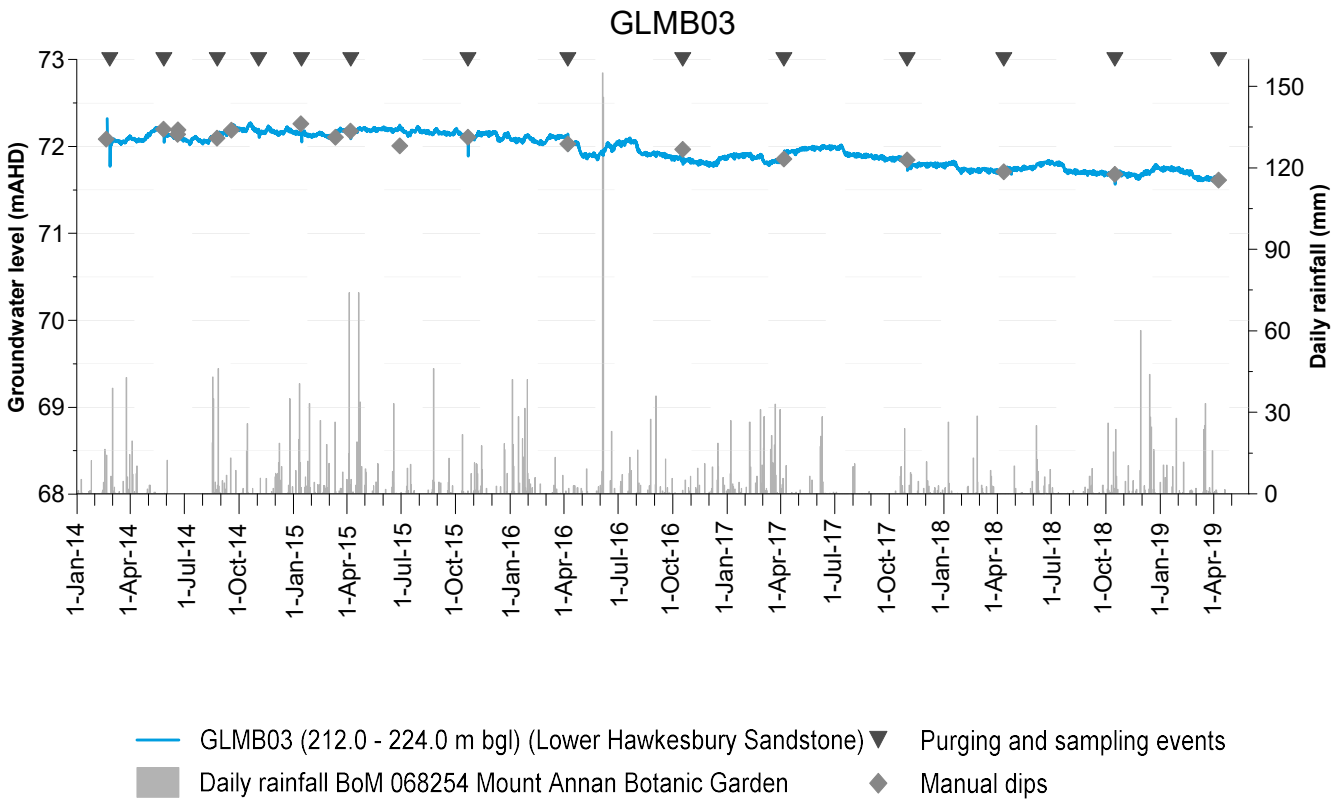
Six-monthly Monitoring Event - April 2019

Figure A.2



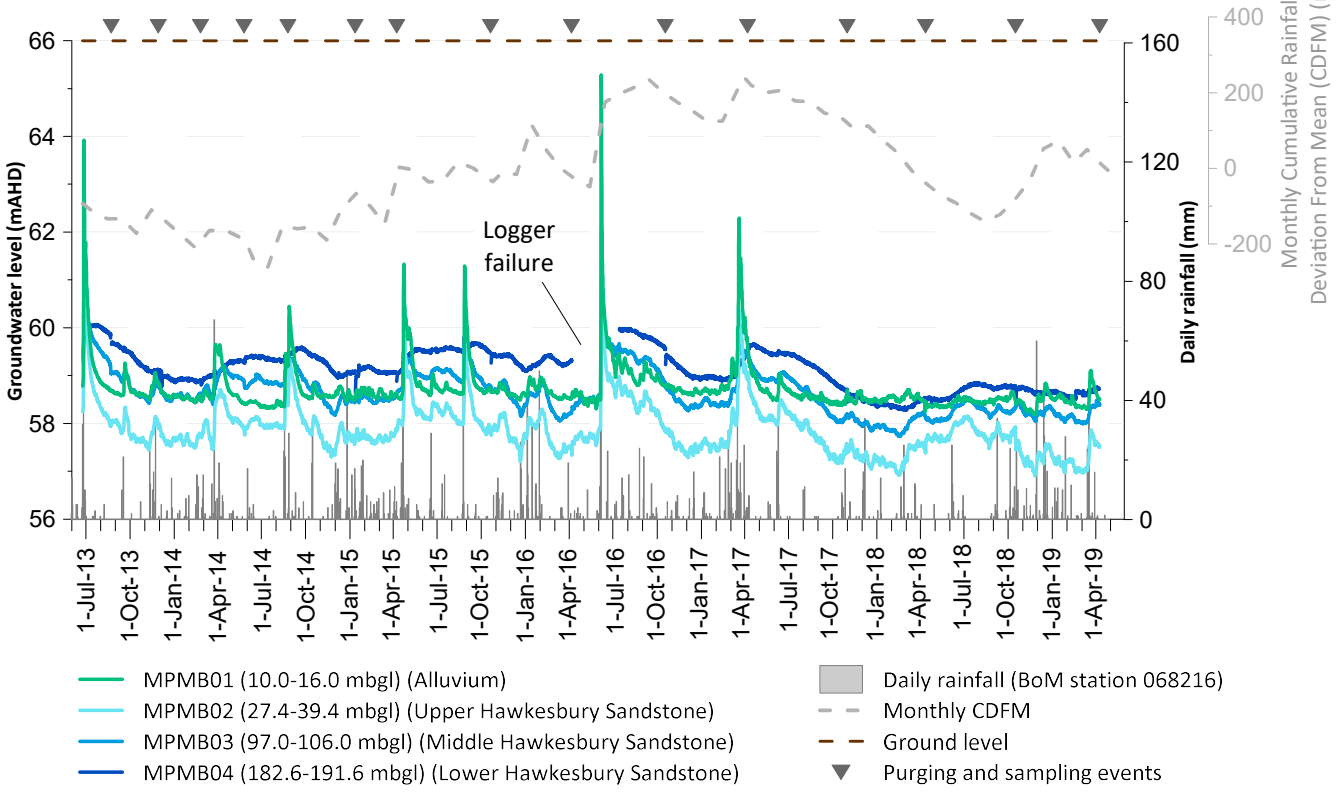
GLMB01 and GLMB02 hydrographs

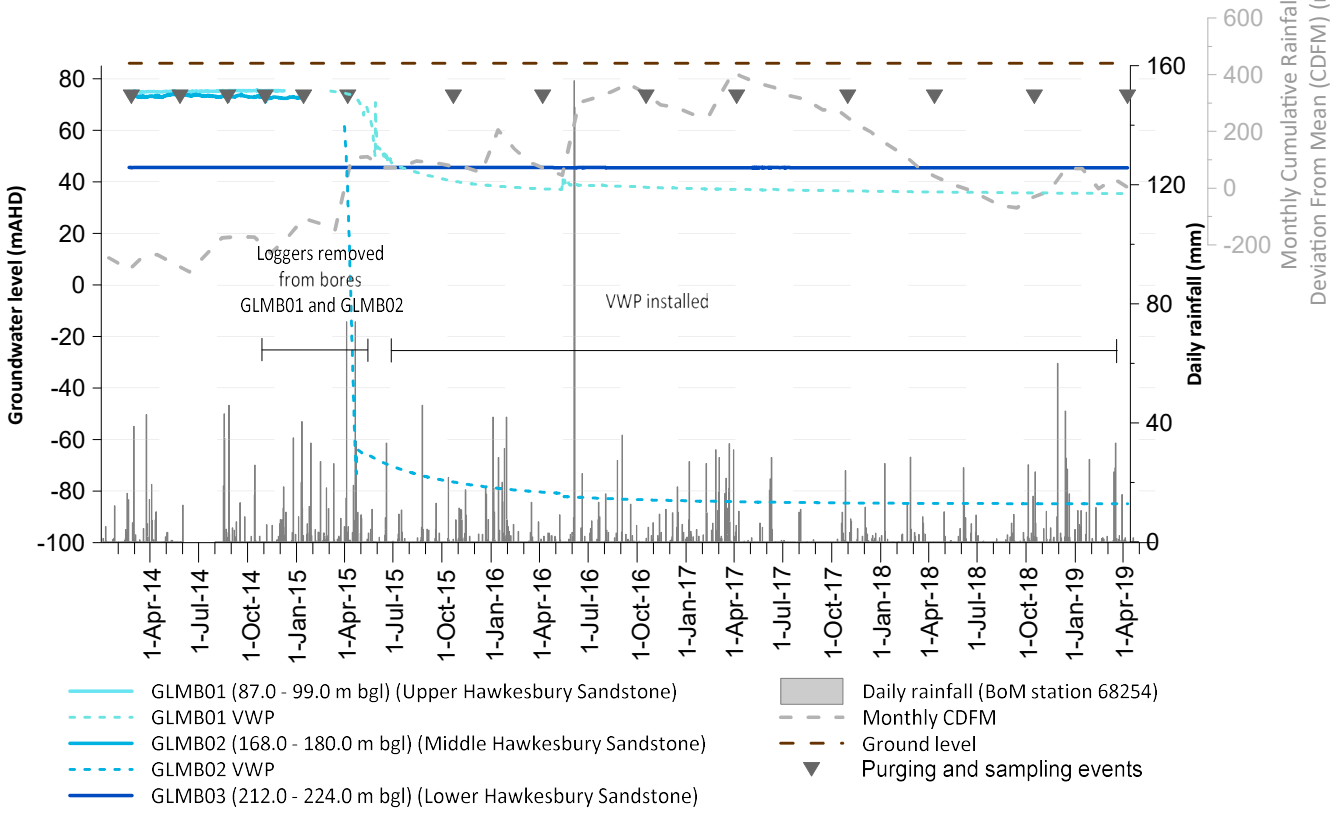
Camden Gas Project
Six-monthly Monitoring Event - April 2019
Figure A.3



GLMB03 hydrograph

Camden Gas Project
Six-monthly Monitoring Event - April 2019
Figure A.4





Although the absolute piezometric pressure values at GLMB01 and GLMB02 post-VWP installation are not representative of formation pressures, the trends in the data are and are therefore still useful.

MPMB and GLMB hydrographs

Camden Gas Project

Six-monthly Monitoring Event - April 2019

Figure A.5

Table A.1 Water quality results six-monthly monitoring event - April 2019

		Field ID	GLMB03	MPMB01	MPMB02	MPMB03	MPMB04	Nepean River
		Date	9/04/2019	9/04/2019	9/04/2019	9/04/2019	9/04/2019	9/04/2019
		Water level (mbgl)	14.823	8.695	9.530	8.575	8.195	N/A
	Units	EQL						
Field parameters								
Dissolved Oxygen	mg/L		2.19	1.03	1.14	1.49	1.12	6.07
pH (field)	pH units		8.31	5.21	6.45	7.09	9.65	7.24
Electrical conductivity (field)	uS/cm		5201	784	870	1088	487	154.5
Electrical conductivity (lab)	µS/cm	1	5470	776	837	1060	430	115
Temp (Field)	°C		24	19.9	22	20	21.5	22.2
Dissolved oxygen (field)	%		27	11.5	13.3	16.9	12.9	71.1
Total dissolved solids (field)	mg/L		3380	507	565.5	706.5	316.6	100.8
Total dissolved solids (lab)	mg/L	10	2990	509	436	570	306	86
Suspended solids	mg/L	5	8	18	21	16	<5	<5
Redox (field)	mV		-112.7	169.8	-57.6	-65.2	-102.4	75.8
Laboratory analytes								
pH (Lab)	pH_Units	0.01	8.09	6.31	7.23	7.76	9.26	7.35
Alkalinity (Hydroxide) as CaCO3	mg/L	1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity-mg CaCO3/L	mg/L	1	<1	<1	<1	<1	25	<1
Bicarbonate Alkalinity-mg CaCO3/L	mg/L	1	1780	16	166	421	113	17
Alkalinity (total) as CaCO3	mg/L	1	1780	16	166	421	138	17
Sulfate as SO4 - Turbidimetric	mg/L	1	<5	6	7	2	2	8
Chloride	mg/L	1	607	264	189	70	46	30
Calcium	mg/L	1	155	11	33	87	4	3
Magnesium	mg/L	1	118	20	29	22	2	3
Sodium	mg/L	1	957	104	87	108	88	17
Potassium	mg/L	1	37	1	4	12	7	2
Reactive Silica	mg/L	0.05	19.4	18.2	12.2	9.65	3.87	2.7
Fluoride	mg/L	0.1	<0.1	<0.1	0.2	0.2	0.3	<0.1
Bromide	mg/L	0.01	1.17	0.394	0.255	0.103	0.072	0.052
Cyanide Total	mg/L	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Dissolved metals								
Aluminium	mg/L	0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.02
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	0.026	<0.001	0.003	0.002	<0.001	<0.001
Barium	mg/L	0.001	26.6	0.639	0.505	3.12	0.557	0.062
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05
Bromine	mg/L	0.1	1.6	0.5	0.3	0.1	<0.1	<0.1
Cadmium	mg/L	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
Cobalt	mg/L	0.001	<0.001	0.039	<0.001	0.001	<0.001	<0.001
Copper	mg/L	0.001	0.002	0.005	<0.001	<0.001	0.002	0.003
Iron	mg/L	0.05	0.52	<0.05	3.95	1.44	<0.05	0.13
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.016	0.414	0.166	0.034	<0.001	0.014
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Nickel	mg/L	0.001	<0.001	0.017	0.001	<0.001	<0.001	<0.001
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	0.001	6.32	0.138	0.43	0.881	0.136	0.034
Uranium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	0.061	0.052	0.006	0.007	0.014	0.007
Nutrients								
Ammonia (as N)	mg/L	0.01	2.97	<0.01	0.09	0.94	0.37	0.02
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (as N)	mg/L	0.01	<0.01	0.41	<0.01	<0.01	<0.01	0.2
Nitrite + Nitrate as N	mg/L	0.01	<0.01	0.41	<0.01	<0.01	<0.01	0.2
Total phosphorus	mg/L	0.01	0.02	0.02	-	0.03	0.02	0.04
Reactive phosphorus (as P)	mg/L	0.01	0.09	<0.01	<0.01	<0.01	<0.01	<0.01
Total organic carbon	mg/L	1	12	1	2	3	16	6
Dissolved gases								
Methane	mg/L	0.01	12.7	0.019	0.978	24.8	31.3	0.014
Ethane	mg/L	0.01	0.072	<0.01	<0.01	<0.01	<0.01	<0.01
Ethene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Propane	mg/L	0.01	0.022	<0.01	<0.01	<0.01	<0.01	<0.01
Propene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Butene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Butane	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenolic compounds								
Phenol	µg/L	1	<1	<1	<1	<1	<1	<1
2-chlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1
2-methylphenol	µg/L	1	<1	<1	<1	<1	<1	<1
3-&4-methylphenol	µg/L	2	<2	<2	<2	<2	<2	<2
2-nitrophenol	µg/L	1	<1	<1	<1	<1	<1	<1
2,4-dimethylphenol	µg/L	1	<1	<1	<1	<1	<1	<1
2,4-dichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1
2,6-dichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1
4-chloro-3-methylphenol	µg/L	1	<1	<1	<1	<1	<1	<1
2,4,6-trichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1
2,4,5-trichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1
Pentachlorophenol	µg/L	2	<2	<2	<2	<2	<2	<2
Polycyclic aromatic hydrocarb								
Acenaphthene	µg/L	1	<1	<1	<1	<1	<1	<1
Acenaphthylene	µg/L	1	<1	<1	<1	<1	<1	<1
Fluorene	µg/L	1	<1	<1	<1	<1	<1	<1
Phenanthrene	µg/L	1	<1	<1	<1	<1	<1	<1
Anthracene	µg/L	1	<1	<1	<1	<1	<1	<1
Fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1
Pyrene	µg/L	1	<1	<1	<1	<1	<1	<1
Benz(a)anthracene	µg/L	1	<1	<1	<1	<1	<1	<1
Chrysene	µg/L	1	<1	<1	<1	<1	<1	<1
Benzo(k)fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1
Benzo(b&j)fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1
Benzo(a) pyrene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc (Zero)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1,2,3-c,d)pyrene	µg/L	1	<1	<1	<1	<1	<1	<1
Dibenz(a,h)anthracene	µg/L	1	<1	<1	<1	<1	<1	<1
Benzo(g,h,i)perylene	µg/L	1	<1	<1	<1	<1	<1	<1
PAHs (Sum of total)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total petroleum hydrocarbons								
C 6 - C 9 Fraction	µg/L	20	150	<20	<20	<20	60	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50	<50	<50
TPH+C10 - C36 (Sum of total)	µg/L	50	<50	<50	<50	<50	<50	<50
Total recoverable hydrocarbons								
C6-C10 fraction	µg/L	20	150	<20	<20	<20	60	<20
C6 - C10 fraction minus BTEX	µg/L	20	60	<20	<20	<20	30	<20
C10 - C16 fraction	µg/L	100	<100	<100	<100	<100	<100	<100
TRH >C10-C16 less Naphthalene (F2)	µg/L	100	<100	<100	<100	<100	<100	<100
C16 - C34 fraction	µg/L	100	<100	<100	<100	<100	<100	<100
C34 - C40 fraction	µg/L	100	<100	<100	<100	<100	<100	<100
C10 - C40 fraction (Sum)	µg/L	100	<100	<100	<100	<100	<100	<100
Aromatic hydrocarbons								
Benzene	µg/L	1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2	92	<2	<2	<2	31	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2	<2	<2
Xylene (m & p)	µg/L	2	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	2	<2	<2	<2	<2	<2	<2
Xylene Total	µg/L	2	<2	<2	<2	<2	<2	<2
Total BTEX	µg/L	1	92	<1	<1	<1	31	<1
Naphthalene	µg/L	1	<1	<1	<1	<1	<1	<1

Note: mbgl - metres below ground level; EQL - laboratory estimated quantitation limit