

Memorandum



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10 November 2017

To Aaron Clifton
From Susan Macolino

Subject Camden Gas Project- FY17/18 Six-monthly monitoring update – October 2017

Dear Aaron,

This memo presents the updated hydrographs for the Menangle Park and Glenlee groundwater monitoring bores to October 2017, and the water quality results for the October 2017 sampling event.

Key observations for this monitoring period (April to October 2017) are as follows:

- water levels at the Menangle Park monitoring bores show a slight response to the rainfall events in June 2017; this response decreases with depth;
- water levels at the Glenlee monitoring bore GLMB03 remain relatively stable; and
- the VWP sensors at GLMB01 and GLMB02, have not stabilised during this monitoring period. As such, the data has not been presented in this report as it is considered unreliable.

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

Figures A.1 – A.4: Individual hydrographs for the Menangle Park and Glenlee sites

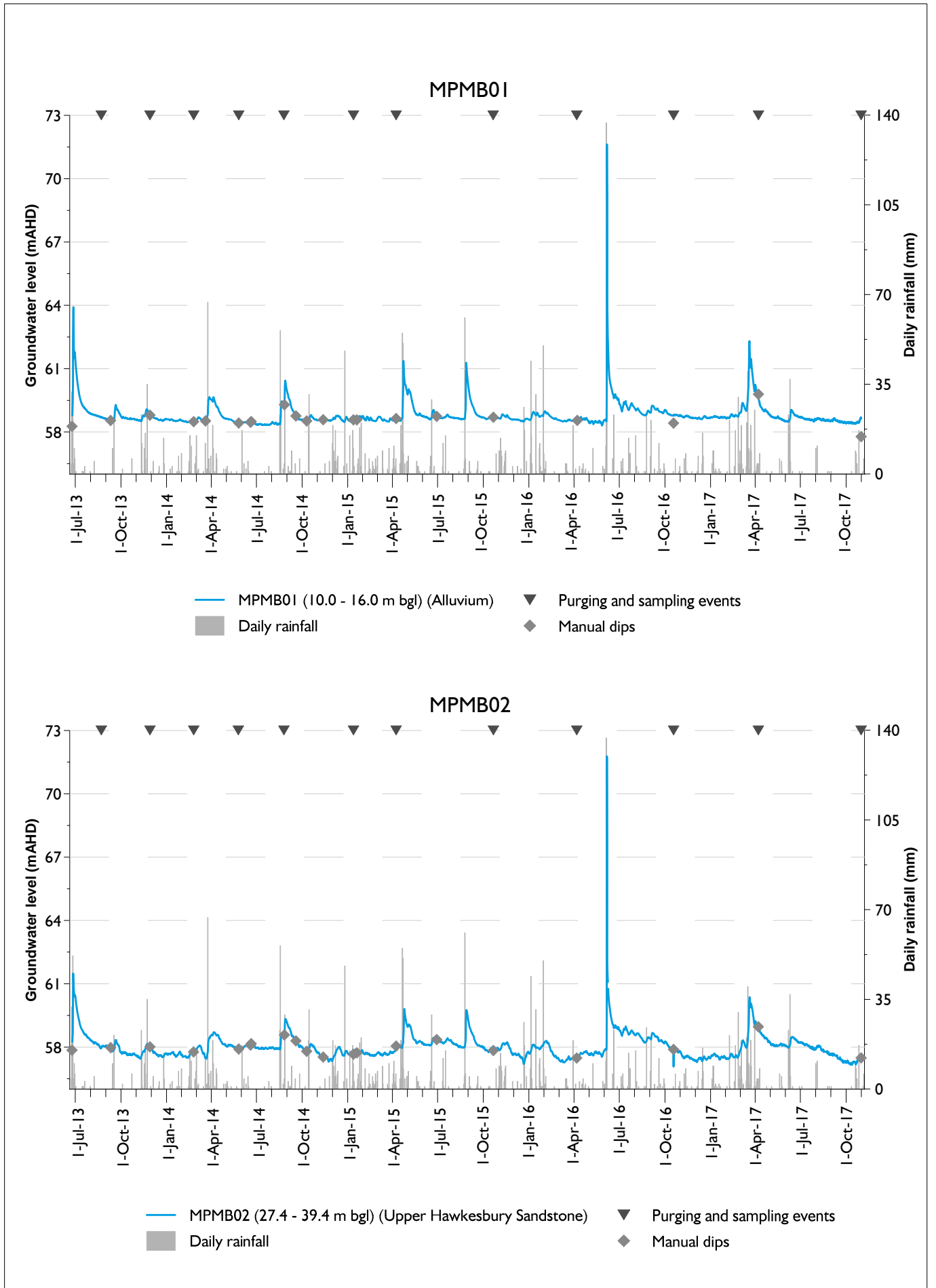
Figures A.5: Nested hydrographs for the Menangle Park and Glenlee sites

Table A.1: Water quality results for October 2017

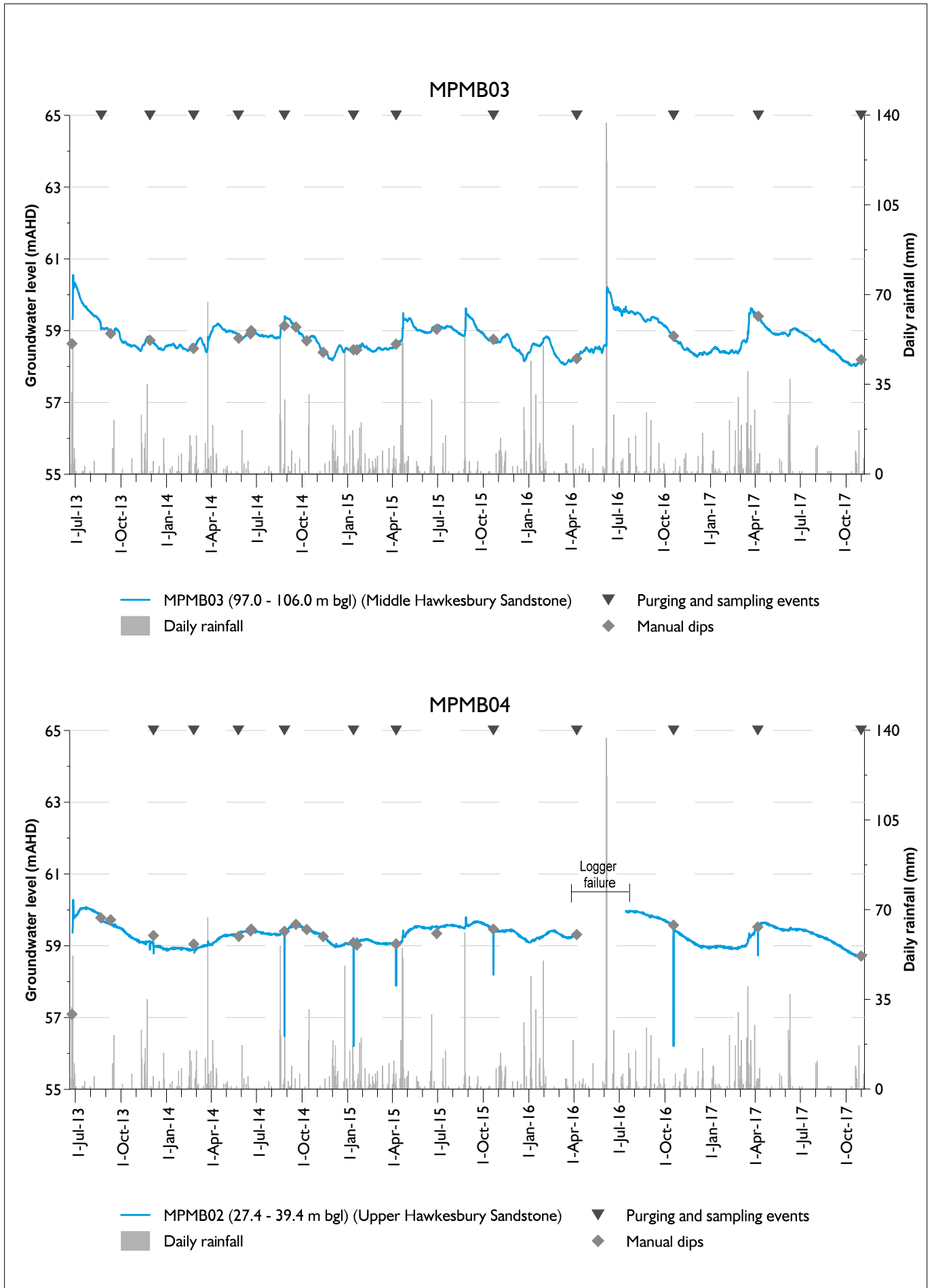
Yours sincerely

A handwritten signature in black ink that reads 'S. Macolino'.

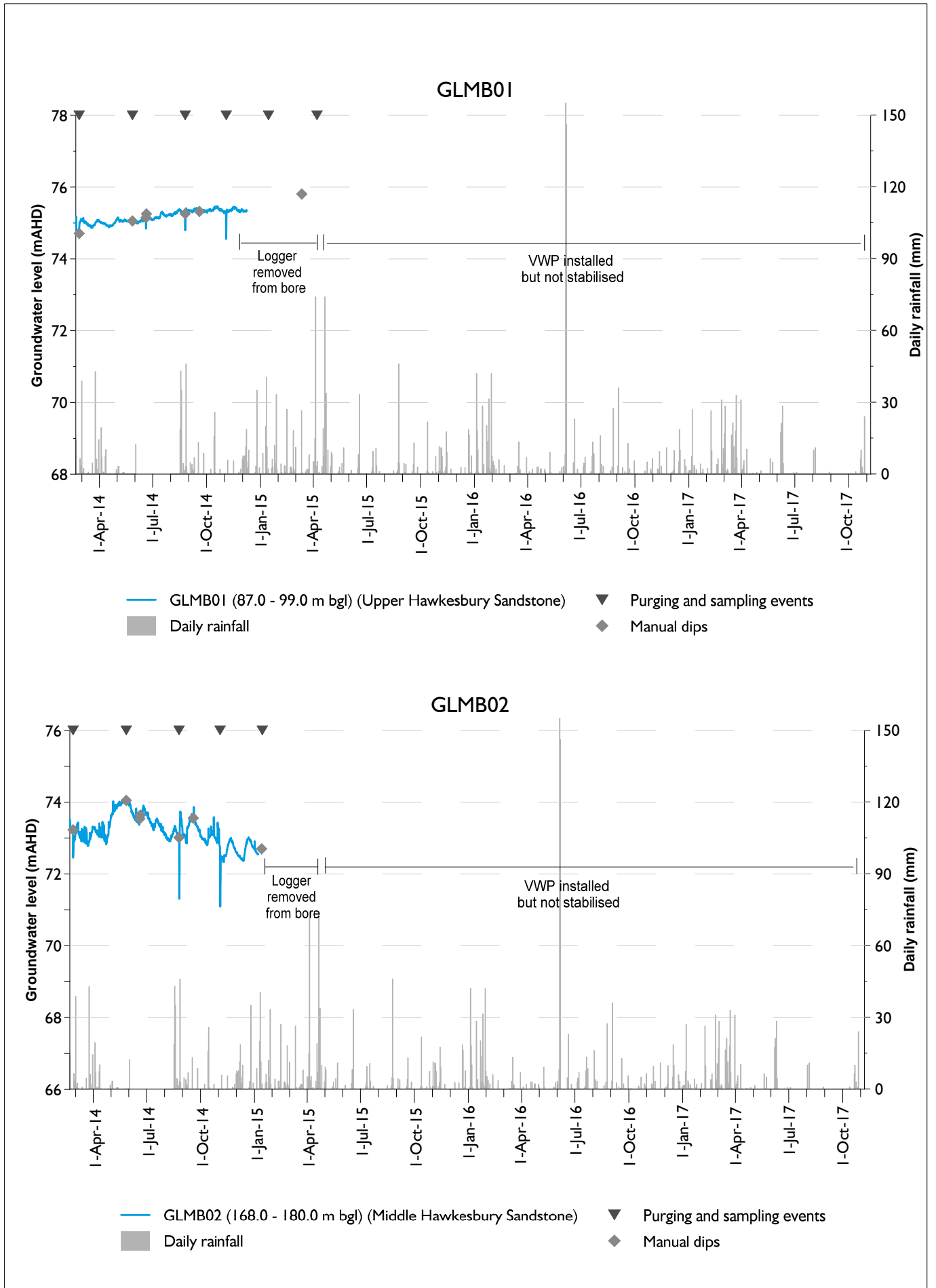
Susan Macolino
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Reviewed: JD



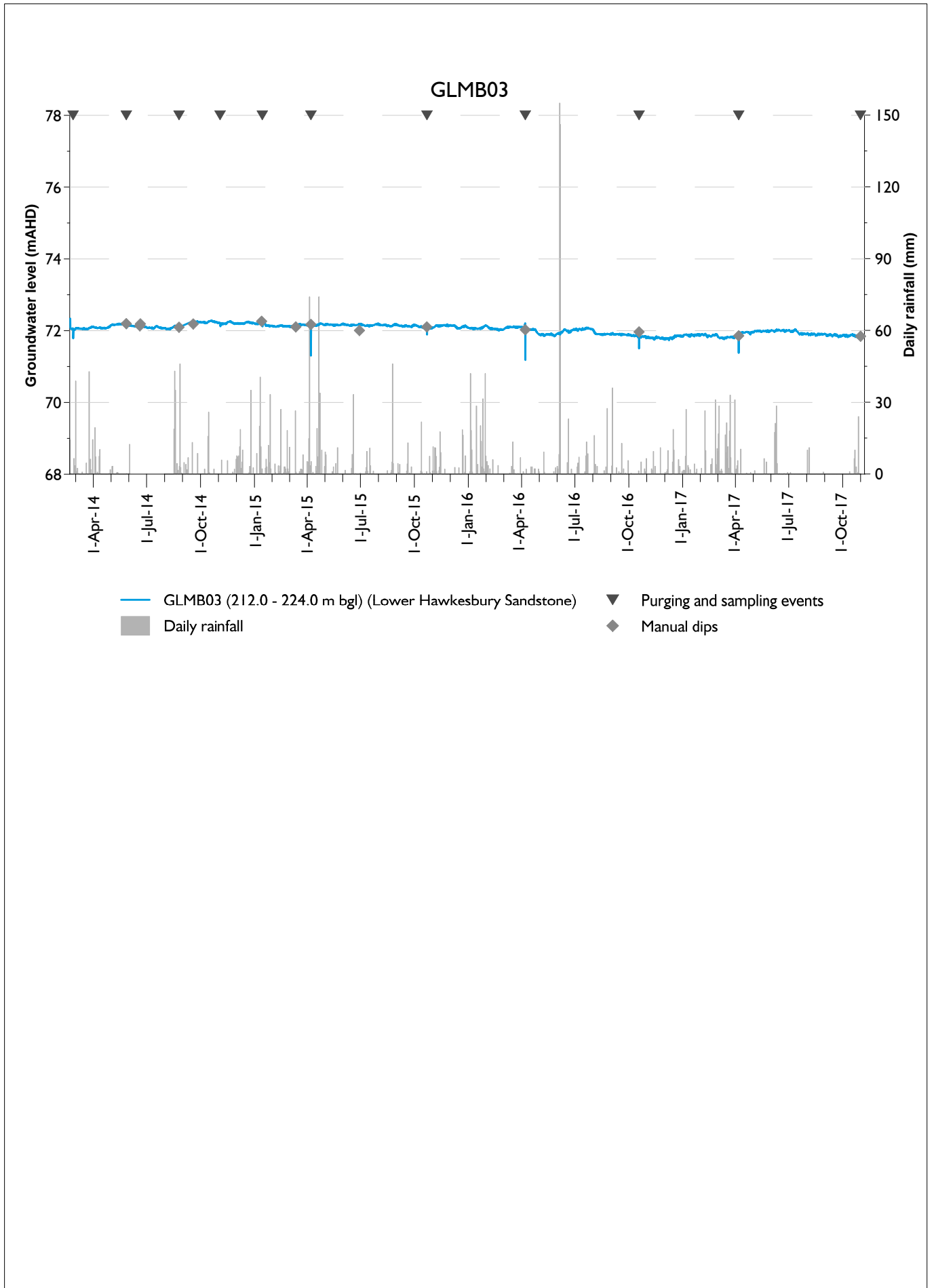
MPMB01 and MPMB02 hydrographs
 Camden Gas Project
 Six-monthly Monitoring Update - October 2017
 Figure A.1

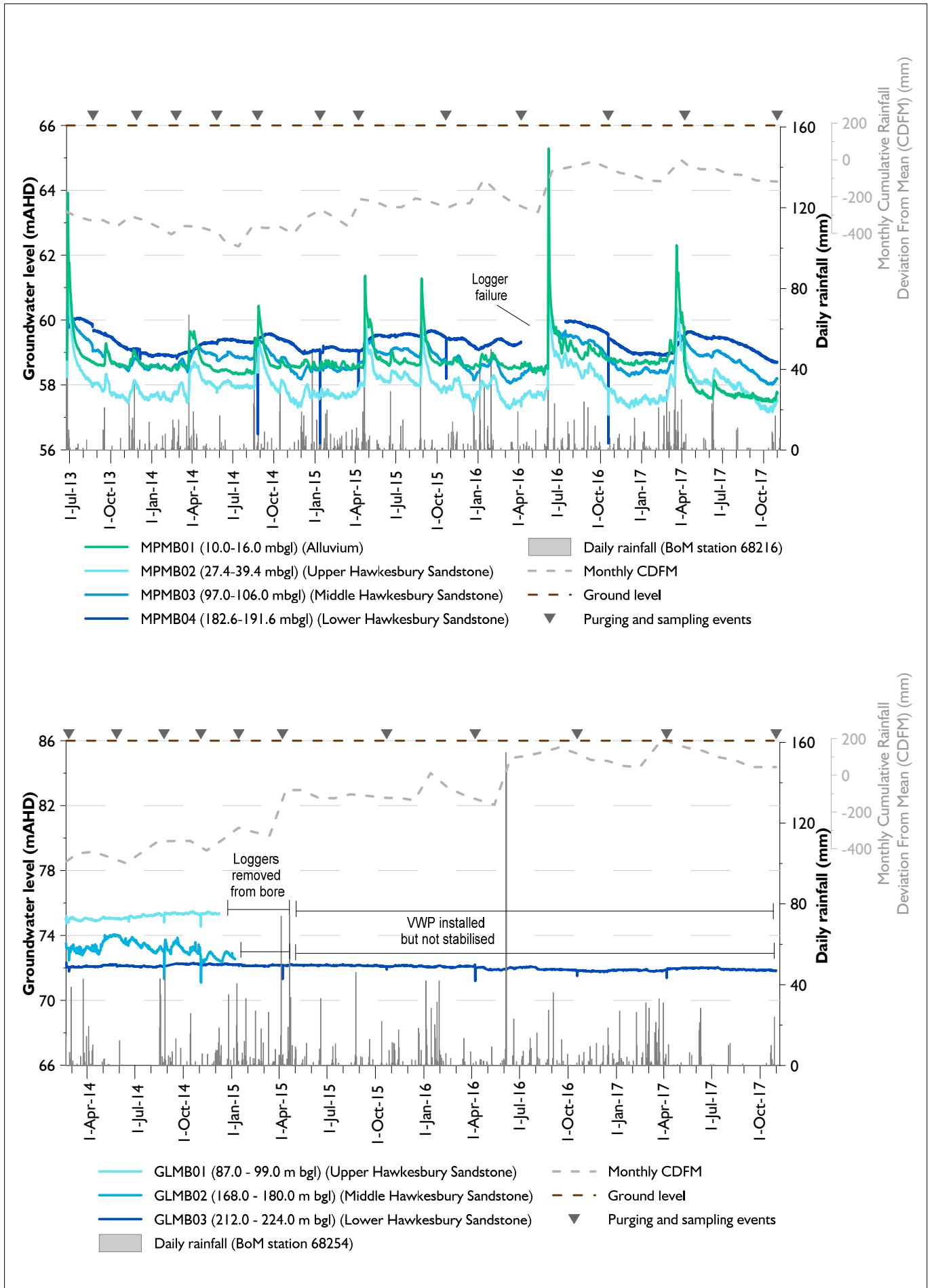


MPMB03 and MPMB04 hydrographs
 Camden Gas Project
 Six-monthly Monitoring Update - October 2017
 Figure A.2



GLMB01 and GLMB02 hydrographs





MPMB and GLMB hydrographs

Table A.1 Water quality results October 2017

| Field ID | GLMB03 | MPMB01 | MPMB02 | MPMB03 | MPMB04 | Date | |
|---------------------------------------|----------|--------|---------|---------|---------|------------|------------|
| | | | | | | 31/10/2017 | 31/10/2017 |
| Water level (mbgl) | 14.59 | 9.42 | 9.64 | 8.78 | 8.2 | | |
| Units | EQL | | | | | | |
| Field parameters | | | | | | | |
| Dissolved Oxygen | mg/L | 1.52 | 0.38 | 0.53 | 1.06 | 0.39 | |
| pH (Field) | pH units | 10.24 | 5.04 | 6.49 | 7.55 | 10.22 | |
| Electrical conductivity (field) | µS/cm | 2,577 | 720 | 852 | 1,110 | 499 | |
| Electrical conductivity (lab) | µS/cm | 1 | 4,550 | 804 | 809 | 1,080 | 569 |
| Temp (Field) | °C | 21.3 | 20.3 | 19.1 | 19.5 | 19.8 | |
| Dissolved oxygen (field) | % | 17.3 | 4.4 | 5.8 | 11.8 | 4.4 | |
| Total dissolved solids (field) | mg/L | 1,677 | 468 | 553 | 722 | 324 | |
| Total dissolved solids (lab) | mg/L | 10 | 2,730 | 436 | 406 | 568 | 256 |
| Suspended solids | mg/L | 5 | <5 | 450 | 1,090 | 66 | <5 |
| Redox (Field) | mV | -366.2 | 111 | -95.9 | -213.2 | -371.8 | |
| Laboratory analytes | | | | | | | |
| Alkalinity (Hydroxide) as CaCO3 | mg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Carbonate Alkalinity-mg CaCO3/L | mg/L | 1 | 766 | <1 | <1 | <1 | 91 |
| Bicarbonate Alkalinity-mg CaCO3/L | mg/L | 1 | 881 | 14 | 186 | 519 | 65 |
| Alkalinity (total) as CaCO3 | mg/L | 1 | 1,650 | 14 | 186 | 519 | 157 |
| Sulfate as SO4 - Turbidimetric | mg/L | 1 | <10 | 2 | 4 | <10 | <10 |
| Chloride | mg/L | 1 | 708 | 251 | 159 | 65 | 72 |
| Calcium | mg/L | 1 | 30 | 10 | 35 | 92 | 2 |
| Magnesium | mg/L | 1 | 57 | 20 | 27 | 23 | <1 |
| Sodium | mg/L | 1 | 994 | 105 | 82 | 113 | 107 |
| Potassium | mg/L | 1 | 37 | 1 | 3 | 13 | 6 |
| Reactive Silica | mg/L | 0.05 | 6.23 | 18.3 | 11.6 | 9.16 | 7.52 |
| Fluoride | mg/L | 0.1 | <0.1 | 0.2 | 0.2 | 0.2 | 0.6 |
| Bromide | mg/L | 0.01 | 1.3 | 0.458 | 0.275 | 0.121 | 0.153 |
| Cyanide Total | mg/L | 0.004 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 |
| Dissolved metals | | | | | | | |
| Aluminium | mg/L | 0.01 | <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 |
| Arsenic | mg/L | 0.001 | 0.005 | <0.001 | 0.008 | 0.006 | 0.002 |
| Barium | mg/L | 0.001 | 3.92 | 0.666 | 0.541 | 3.51 | 0.399 |
| Beryllium | mg/L | 0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Boron | mg/L | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Bromine | mg/L | 0.1 | 1.6 | 0.5 | 0.3 | 0.1 | 0.2 |
| Cadmium | mg/L | 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 |
| Cobalt | mg/L | 0.001 | <0.001 | 0.044 | 0.002 | 0.001 | <0.001 |
| Copper | mg/L | 0.001 | 0.003 | 0.002 | <0.001 | <0.001 | 0.002 |
| Iron | mg/L | 0.05 | <0.05 | 0.45 | 3.3 | 2.27 | <0.05 |
| Lead | mg/L | 0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Manganese | mg/L | 0.001 | 0.003 | 0.447 | 0.2 | 0.061 | <0.001 |
| Mercury | mg/L | 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 | 0.008 |
| Nickel | mg/L | 0.001 | <0.001 | 0.016 | 0.006 | <0.001 | <0.001 |
| Selenium | mg/L | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Strontium | mg/L | 0.001 | 2.36 | 0.127 | 0.506 | 0.941 | 0.09 |
| Uranium | mg/L | 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 |
| Zinc | mg/L | 0.005 | 0.031 | 0.046 | 0.01 | <0.005 | 0.026 |
| Nutrients | | | | | | | |
| Ammonia (as N) | mg/L | 0.01 | 2.65 | 0.04 | 0.09 | 0.98 | 0.76 |
| Nitrite (as N) | mg/L | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Nitrate (as N) | mg/L | 0.01 | <0.01 | 0.29 | <0.01 | <0.01 | <0.01 |
| Nitrite + Nitrate as N | mg/L | 0.01 | <0.01 | 0.29 | <0.01 | <0.01 | <0.01 |
| Total phosphorus | mg/L | 0.01 | <0.01 | 0.22 | 0.18 | 0.05 | 0.01 |
| Reactive phosphorus (as P) | mg/L | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 |
| Total organic carbon | mg/L | 1 | 53 | 2 | 1 | <1 | 5 |
| Dissolved gases | | | | | | | |
| Methane | mg/L | 0.01 | 27.2 | 0.072 | 1.07 | 32.5 | 44.2 |
| Ethane | mg/L | 0.01 | 0.194 | <0.01 | <0.01 | <0.01 | <0.01 |
| Ethene | mg/L | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Propane | mg/L | 0.01 | 0.047 | <0.01 | <0.01 | <0.01 | <0.01 |
| Propene | mg/L | 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 |
| Butane | mg/L | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Phenolic compounds | | | | | | | |
| Phenol | µg/L | 1 | 2.6 | <1 | <1 | <1 | 1.1 |
| 2-chlorophenol | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| 2-methylphenol | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| 3,4-dimethylphenol | µg/L | 2 | <2 | <2 | <2 | <2 | <2 |
| 2-nitrophenol | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| 2,4-dimethylphenol | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| 2,4-dichlorophenol | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| 2,6-dichlorophenol | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| 4-chloro-3-methylphenol | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| 2,4,6-trichlorophenol | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| 2,4,5-trichlorophenol | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Pentachlorophenol | µg/L | 2 | <2 | <2 | <2 | <2 | <2 |
| Polycyclic aromatic hydrocarb | | | | | | | |
| Acenaphthene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Acenaphthylene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Fluorene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Phenanthrene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Anthracene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Fluoranthene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Pyrene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Benzo(a)anthracene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Chrysenes | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Benzo(k)fluoranthene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Benzo(b)fluoranthene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Benzo(a)pyrene | µg/L | 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 |
| Indeno(1,2,3-c,d)pyrene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Dibenz(a,h)anthracene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Benzo(g,h,i)perylene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| PAHs (Sum of total) | µg/L | 0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Total petroleum hydrocarbons | | | | | | | |
| C6 - C9 Fraction | µg/L | 20 | 130 | <20 | <20 | <20 | 40 |
| C10 - C14 Fraction | µg/L | 50 | <50 | <50 | <50 | <50 | <50 |
| C15 - C28 Fraction | µg/L | 100 | <100 | <100 | <100 | <100 | <100 |
| C29 - C36 Fraction | µg/L | 50 | <50 | <50 | <50 | <50 | <50 |
| TPH+C10 - C36 (Sum of total) | µg/L | 50 | <50 | <50 | <50 | <50 | <50 |
| Total recoverable hydrocarbons | | | | | | | |
| C6 - C10 fraction | µg/L | 20 | 130 | <20 | <20 | <20 | 40 |
| C6 - C10 fraction minus BTEX | µg/L | 20 | <20 | <20 | <20 | <20 | <20 |
| C10 - C16 fraction | µg/L | 100 | <100 | <100 | <100 | <100 | <100 |
| TPH+C10-C16 less Naphthalene (F2) | µg/L | 100 | <100 | <100 | <100 | <100 | <100 |
| C16 - C24 fraction | µg/L | 100 | <100 | <100 | <100 | <100 | <100 |
| C24 - C40 fraction | µg/L | 100 | <100 | <100 | <100 | <100 | <100 |
| C10 - C40 fraction (Sum) | µg/L | 100 | <100 | <100 | <100 | <100 | <100 |
| Aromatic hydrocarbons | | | | | | | |
| Benzene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Toluene | µg/L | 2 | 113 | <2 | <2 | <2 | 32 |
| Ethylbenzene | µg/L | 2 | <2 | <2 | <2 | <2 | <2 |
| Xylene (m & p) | µg/L | 2 | <2 | <2 | <2 | <2 | <2 |
| Xylene (o) | µg/L | 2 | <2 | <2 | <2 | <2 | <2 |
| Xylene Total | µg/L | 2 | <2 | <2 | <2 | <2 | <2 |
| Total BTEX | µg/L | 1 | 113 | <1 | <1 | <1 | 32 |
| Naphthalene | µg/L | 1 | <1 | <1 | <1 | <1 | <1 |
| Additional analytes | | | | | | | |
| Ionic Balance | % | 0.01 | 2.48 | 4.7 | 4.23 | 1.97 | 2.58 |
| Cations Total | meq/L | 0.01 | 50.4 | 6.74 | 7.61 | 11.7 | 4.91 |
| pH (Lab) | pH Units | 0.01 | 9.35 | 5.69 | 6.99 | 7.58 | 9.64 |
| Anions Total | meq/L | 0.01 | 52.9 | 7.4 | 8.28 | 12.2 | 5.17 |

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