



PF Formation

# Groundwater Report Hitchcock Road Site, Maroota, NSW. Annual Groundwater Management Plan 2017 - 2018

Report E2W-0224 R004 (v2)

30 October 2018



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Pty Ltd  
Environmental & Groundwater Consulting

**Client: PF Formation**

**Project: Groundwater Report  
Hitchcock Road Site, Maroota  
2017-2018 Annual Groundwater Management Plan**

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Report: 30 October 2018  
Ref: E2W-224 R004 (V2)



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## 1 INTRODUCTION

Earth2Water Pty Ltd (E2W) was engaged by PF Formation (PFF) to provide the Groundwater Report (2017-2018 Annual Groundwater Management Plan) for Hitchcock Road Site, Maroota (Figure 1). The groundwater sampling<sup>1</sup> and downloading of loggers (7) was conducted in consultation with Melissa Mass (South East Environmental Pty Ltd) and Joshua Graham (PFF) during August 2018. URS Australia Pty Ltd (URS) was previously (up to 2013) retained by PFF to prepare the groundwater component of the report.

PF Formation (PFF) is required under the Development Approval conditions set for the Maroota Hitchcock Road property area (Figure 2) to prepare an annual Water Management Plan (WMP) report to the *Department of Planning and Environment* (DPE). The WMP is part of the overall Environmental Management Plan and addresses the surface water and groundwater aspects of the sand extraction operations at the site. E2W provided an updated WMP (8 January 2018) which included a detailed assessment of the hydrogeology, site survey, pit depths and installation of additional wells and loggers (4).

The WMP for the past year also includes the monitoring data collected from 1996 to 14 August 2018 for the Hitchcock Road site, and also for Portion 198. Additional monitoring data was obtained for the 2017-2018 and included water testing and data logger results from the clean water dam, Por 167 Dam, and two new deep wells (PF167MW3D, PF167MW4D). Monthly water levels<sup>2</sup> was undertaken at available monitoring wells at Hitchcock Road and Lot 198 (Figure 2, Table 3-9, & Appendix G).

## 2 GROUNDWATER MONITORING NETWORK AND SAMPLING

During May 2017, six additional monitoring wells were installed to improve the site characterisation of the Hawkesbury Sandstone (i.e. PF166MW-2D, PF167MW-3D, PF167MW-4D, PF167MW-5D) and Maroota Sand Aquifers (PF167MW-2s, PF167MW-4s, refer to Appendix E, Figure-1). The 6 monitoring wells were drilled by TerraTest Pty Ltd under E2W (Dino Parisotto) supervision and utilised to update the groundwater depths and guide the pit extraction depths (Tables 3A & 3B).

The existing wells (PF214MW-1, PFL2HitchMW-1, PF167MW-1 and PF166MW-1) and new wells (PF166MW-2D, PF167MW-3D, PF167MW-4D, PF167MW-5D, PF167MW-2s, PF166MW-4s) were surveyed by Landair Survey Pty Ltd (May 2017, Appendix E). The aerial survey provided an updated aerial photographic plan showing current pit excavation works and site topographic contours (Figure 1). The new and existing monitoring wells were surveyed by a registered surveyor (Mathew Freeburn Pty Ltd) on 29 May 2017 to enable groundwater levels to be reduced to Australian Height Datum (mAHD, Table 2).

<sup>1</sup> Sampling locations (13) include: PF214MW-1, PFL2HitchMW-1, PF167MW-1, PF166MW-1 (dry), Lot198PB-1 & PB-2, and new locations: PF166MW-2D, PF167MW-2s, PF167MW-3D, PF167MW4D, PF167MW4s, and two dams (CWD & Por167).

<sup>2</sup> Measured by Melissa Mass of South East Environmental Pty Ltd

At the Hitchcock Road site, groundwater was monitored at six existing and six new locations on 14 August 2018. The details of the existing and new wells are presented in Tables 3A and 3B.

### ***Existing Wells (Sampling 14 August 2018)***

1. Monitoring bore PF167MW1, located in Portion 167 (data logger available),
2. Monitoring bore PF166MW1, located in Portion 166 (dry well- no sample),
3. Monitoring bore PFL2HitchMW1, located in Lot 2 (data logger available),
4. Monitoring bore PFP214MW1, located in Portion 214 (data logger available); and
5. Production Bores PF198PB1 and PF198PB2, located in Portion 198.

The pumping records are available from the two water supply dams (clean water dam and PF167DAM in Portion 167) for 2017-2018.

### ***New Wells (Sampling 14 August 2018)***

6. Monitoring bore PF166MW2D, located in Portion 166,
7. Monitoring bore PF166MW2S, located in Portion 166,
8. Monitoring bore PF167MW3D, located in Portion 167 (data logger available),
9. Monitoring bore PF167MW4D, located in Portion 167 (data logger available),
10. Monitoring bore PF167MW4S, located in Portion 167,
11. Monitoring bore PF167MW5D, located in Portion 167 (decommissioned in 2017).

*Groundwater sample collection was undertaken at the new and existing wells on 7 August 2018 by Melissa Mass of South East Environmental Pty Ltd. Additional monitoring was conducted by Earth2Water on 14 August 2018 at all wells to check water levels, field chemistry (PH,EC,DO, T, Eh), and to down load the data loggers (7).*

The additional new wells (6) installed in May 2017 improves the definition of the groundwater flow regime at the central and north portion of the site (i.e. PF166MW-2D & PF167MW-3D). The groundwater data and site topography indicates the presence of a groundwater divide near the highest part of the site which separates the flows to the north and south (RL ~240 mAHD at trig station, Figures 1 & 4).

Groundwater pumping and chemical analyses were also collected from the two water supply bores in Portion 198 (i.e. PF198PB1 & PF198PB2). The bore PB2 was previously treated with iron-floc chemicals due to clogging. The chemical treatment ceased at PB2 in December 2016.

Groundwater monitoring has been carried out at the sites since 1996. Initially, water levels in bores PF166MW1 and PF167MW1 were measured manually at weekly intervals together with chemical field parameters such as pH and Electrical Conductivity (EC). The manual measurements continued until December 1998. In January 1999, the two bores were equipped with Dataflow Systems automatic data loggers (i.e. PF166MW-1; the data logger was removed in 2017).

Data loggers have been downloaded quarterly between January 1999 and June 2000. Since June 2000, the dataloggers have been downloaded biannually. In January 2006, the old style Dataflow dataloggers were replaced with Solinst Levellogger 3001 units, capable of storing 40,000 readings in the memory, with a battery life span of around 10 years. The Solinst dataloggers allow the data for annual downloading, a monitoring interval (once daily) started on July 2006. E2W downloaded the aged data loggers on 17 July 2017, however the data was

only recorded from one (PF167MW1) out of the four loggers (*note*. No data was not able to be downloaded from loggers at PFL2HitchMW1, PFP214MW1, PF166MW1 in the 2016 to 2017 period. Loggers are >10 yrs old).

Data logger information was retrieved from PF167MW-1 for the 2017 to 2018 period, including the two loggers (PFL2HitchMW1, PFP214MW1). The logger from well (PF166MW1) was not able to be programmed and decommissioned.

Groundwater level information at all available wells was also collected using an acoustic water level probe on a monthly basis (August 2017 to 2018) by Melissa Mass of South East Environmental Pty Ltd. The monthly water level measurements (& annual sampling) are conducted at new and existing wells by South East Environmental, whilst annual gauging and sampling is conducted by E2W.

New Solinst data loggers (4) were installed at four locations (Por 167 dam, clean water dam, PF167MW3D, PF167MW4D) on 9 August 2017 to assist with the groundwater management and guiding of pit extraction depths. The four loggers were downloaded on 14 August 2018 as part of the annual report.

Field chemistry (EC, PH, T, DO, Redox) was measured using a calibrated field meter (TPS 90 FLMV) at the 5 bores (PF167MW1, PFL2HitchMW1, PFP214MW1, PF167MW4D, PF167MW4s) and 2 dams (CWD, Por167 Dam) on 14 August 2018.

Groundwater samples were collected by South East Environmental Pty Ltd and E2W (Dino Parisotto) in consultation with PFF (Joshua Graham) on 7 and 14 August 2018, respectively. All water samples were submitted for chemical analyses under Chain of Custody procedures to Australian Laboratory Services Pty Ltd (ALS-Sydney).

Samples were collected from a total of 10 bores and 2 dams;

- Existing Wells: PFL2HitchMW1, PFP214MW1, PF167MW1, PF166MW1 (dry), Lot198PB-1 & Lot198PB-2,
- New Wells: PF167MW3D, PF167MW4D, PF167MW4s, PF167MW2D, PF167MW2s; and
- Artificial water storages (CWD & Por167 dam).

*Note: Two bores were not sampled (i.e. PF166MW1 a dry well and PF167MW5D-decommissioned). Water samples were collected from the production bores PF198PB1 & PB2 (14 August 2018) are from water supply/pumping bores. The recent 2017 survey and monthly water level measurements have been used to adjust the data logger results (i.e. adjusted RL of logger).*

The laboratory reports are presented in Appendix B. The analytical results have been plotted on individual graphs that are updated annually to assess trends over time (Graphs 1 to 6 and Appendix C).

The analytical list for all bores, which was discussed and agreed upon with the DLWC (now the NSW Office of Water) has included:

- pH, Electrical Conductivity and Total Dissolved Solids;
- Calcium, Magnesium, Sodium and Potassium;

- Chloride, Sulphate, Bicarbonate; and
- Oil & Grease.

## **2.1 Monitoring Bore PF167MW1**

Groundwater monitoring at bore PF167MW1 commenced in March 1996. The data between March 1996 and December 1998 (manual collection) have been plotted in the graph of Figure 2, together with EC and rainfall records collected by PFF (Appendix C). An automated weather station has been installed by PFF in 2010 and also in early 2017 (including barometric pressure).

The Figure HG-2 (2013-2018) presents the combined Solinst datalogger records for bore PF167MW1 (previous records are presented in Appendix C). The monthly water level gauging graphs is presented in Figure HG-8, and Appendix G.

Previous minor data gaps exist and a slight difference between the manual data and the start of the automatic recording is evident in the previous data, which are due to the time intervening between the end of the manual and start of the automatic recording methods (Appendix C, URS, 2013).

## **2.2 Monitoring Bore PF166MW1**

Groundwater monitoring at bore PF166MW1 (Figure HG-3 shows 2013 to 2016 monitoring data) commenced in March 1998 in the same manner as for bore PF167MW1. The data between March 1998 and December 1998 (manual collection) have been plotted in the graph of Figure 4 (Appendix C), together with EC and rainfall records collected by PFF.

Refer to Table 2 for water level gauging results. Logger data is not available for 2016-2017 (logger now decommissioned due to age >10 yrs). The monthly water level gauging graph is presented in Figure HG-8 (2017 to 2018), and Appendix G.

The well is currently dry and no samples were collected.

## **2.3 Monitoring Bore PFP214MW1**

Bore PFP214MW1 was installed in March 2009 as part of an extended groundwater monitoring network following the Development Approval for Portion 214, located at the southern boundary of the Hitchcock Road site.

A datalogger was installed in the bore in early April 2009 (Solinst Levellogger Gold 3001, serial no. 51040540). Refer to Table 2 for water level gauging results.

Bore PFP214MW1 hydrograph is presented in Figure HG-4 (showing 2013 to 2018 monitoring data). Logger data is not available for 2016-2017 due to technical issues with the aged logger. The monthly water level gauging graph is presented in Figure HG-4.

The monthly water level gauging graph is presented in Figure HG-8 (2017 to 2018), and Appendix G.

## 2.4 Monitoring Bore PFL2HitchMW1

Bore PFL2HitchMW1 was also installed in March 2009. This bore is located midway along the eastern boundary of the Hitchcock Site and monitors the full sequence of the Maroota Sand. A datalogger was installed in the bore in early April 2009 (Solinst Levellogger Gold 3001, serial no. 510405840). Refer to Table 2 for water level gauging results.

Bore PFL2HitchMW1 hydrograph is presented in Figures HG-5, HG-8 (2017 to 2018), and Appendix G.

## 2.5 New Monitoring Bores (2017)

Seven new monitoring wells (PF167MW-3D, PF167MW-4D, PF167MW-4s, PF167MW-2D, PF167MW-2s, PF167MW-5D<sup>4</sup>) were installed at the site in 2017 to assist with the assessment of the sandstone and Maroota Sands aquifers.

Data loggers were installed in August 2017 at two deep wells (PF167MW-4D, PF167MW-3D, refer to Figure HG-6 and HG-7) to assist with the pit extraction depths. Results for the new wells are in presented in Table 3-9, Figure HG-8, and Appendix G.

The four existing wells (PFL2HitchMW1, PFP214MW1, PF167MW1, PF166MW1<sup>5</sup>) were sampled in August 2018 to assist with the groundwater study at the site.

## 2.6 Portion 167 Dam

At the early stages of the site development, an excavation (PF167DAM) was carried out to the top of the Hawkesbury Sandstone to an approximate level of 178m AHD. The excavation collects groundwater and surface water run-off and was eventually licensed by the DLWC (No.10BL157308) as part of the water supply of the operation. Water levels measured against surveyed pegs have been collected at the dam since September 1996 and pumpage records kept since January 1997.

Water quality in the dam is generally not monitored because the dam collects incident rainfall, run-off and groundwater and, as a result, water quality would vary according to the proportion of each component at the time of measurement.

Due to high rainfall in 2014-2015 (1321.5 mm) no monitoring or pumping was required from the Portion 167 Dam. Pumping was undertaken by PFF from Portion 167 Dam during the 2017-2018 (drought period) and summarised in Table 3-7 (Total of 48.953 ML).

The pumpage was due to the lower rainfall (473 mm for 2017-2018) and high volume of sand extraction (note: water level monitoring is not required for the licence).

Water level monitoring is not required in the new license conditions, however a data logger was installed in August 2017 to assist with the site water balance and assessment. Water samples and field chemistry were collected on 14 August 2018 for the site water balance and assessment (Figure HG-10 and Table 3-9). The data logger readings are provided as raw data in Figure HG-10 (*note: logger data requires adjustment with barometric pressure, evaporation and pumping influences. To be provided in separate documentation*).

<sup>4</sup> PF167MW5D was decommissioned in ealry 2018 during the construction of the tailings dam.

<sup>5</sup> PF166MW-1 is currently a dry well.



## 2.7 Clean Water Dam (Portion 167)

Water quality in the dam is not previously monitored because the dam collects incident rainfall, run-off and recycled water from the wash plant and tailings.

Water level monitoring is not required in the new license conditions, however a data logger was installed in August 2017 to assist with the site water balance. Water samples and field chemistry were collected on 14 August 2018 to assist with the site water balance and assessment (Figure HG-9 and Table 3-9). The data logger readings are provided as raw data in Figure HG-9 (*note: logger data requires adjustment with barometric pressure, evaporation and pumping influences. To be provided in separate documentation*).

## 2.8 Portion 198 Water Supply Bores

The two water supply bores in Portion 198 (PF198PB1 and PF198PB2) have been monitored manually since their installation in March 1998. Groundwater samples have been collected quarterly for the last four quarters to March 2000, biannually up to July 2006 and annually since then. Pumpage records are collected and totalised weekly. (*Note: Pump in bore PF198PB1 was out of service for most of 2012-2013*).

Water quality data have been plotted for selected parameters and the graphs (5 & 6) and the laboratory reports in Appendix B. Monthly water levels were measured during the 2017 -2018 period by South East Environmental (Melissa Mass, Figure HG-1).

The bores were operational and sampling from PF198PB1 & PF198PB2 discharge outlet occurred on 14 August 2018. A water sample was collected from PF198PB1 & 2 for the chemical assessment and field chemistry by E2W (Tables 3-5 & 3-6).

*Note: Chemical treatment for clogging (Fe-floc) at PB-2 ceased in December 2016.*

# 3 GROUNDWATER DATA ASSESSMENT

The groundwater assessment for the site has been conducted by E2W in collaboration with PFF (Josh Graham) and Melissa Mass (South East Environmental Pty Ltd- SEE). The analytical reports by ALS Environmental are presented in Appendix B, whilst the monthly water level measurements by SEE are included in Appendix G.

Additional monitoring locations are included in the 2017 to 2018 operating period due to the installation of six new wells (May 2017) and assessment of the clean water dam (CWD) and Por 167 dam. The additional testing locations relate to the revised water management plan established for the site in late 2017.

## 3.1 New Monitoring Wells

During May 2017, six additional monitoring wells were installed to improve site coverage and better assess water levels in the Hawkesbury Sandstone (PF166MW-2D, PF167MW-3D, PF167MW-4D, PF167MW-5D) and Maroota Sand Aquifers (PF166MW-2s, PF167MW-4s Figures 1 & 2, Tables 2, 3A & 3B). The 6 monitoring wells were drilled by TerraTest Pty Ltd under E2W (Dino Parisotto) supervision and testing (Table 3B).

The inferred hydrogeological cross sections for the site are presented in Figures 3 & 4. The new monitoring wells (6) and also recent survey (aerial and well RL details) were used to better assess the pit extraction depths and the groundwater buffer zone (2m requirement).

The previous water level contour map provided by URS (June 2011) is presented in Appendix D. E2W note that the URS water contour map is based on a limited well network comprising three monitoring wells over a 100 ha site. The additional new wells (6) installed at the site in May 2017 provide a better depiction of the groundwater flow regime, particularly in the north (e.g. area of PF166MW-2D).

The groundwater data and site topography indicates the presence of a groundwater divide at the highest point of the site (RL ~240 mAHD at trig station located near PF166MW-3D and PFL2HitchMW-1). Refer to Figures 1 to 4.

A decline in groundwater levels is evident across the site due to the prevailing drought conditions (i.e. rainfall = 473 mm during 2017-2018).

### **3.2 Groundwater Levels**

Groundwater levels in the Hawkesbury Sandstone and Maroota Sand aquifers indicate the presence of perched and regional water tables (Tables; 2, 3A, 3B).

The plots of bore PF167MW1, which taps the full saturated thickness of the Maroota Sand, and bore PF166MW1, which taps an unconfined aquifer (Maroota Sand) perched at a higher elevation, indicate a general rapid response to periods of sustained rainfall (Appendix C). Records for the two new monitoring bores, PFP214MW1 and PFL2HitchMW1, indicate a subdued and moderate response to rainfall.

The yearly rainfall for the year 2010 (1015.1mm), for the year 2011 (1115.4 mm) and for the year 2012 (984 mm) have been considerably above the long term average of 910.3 mm (to June 2013). Rainfall for the year July 2013- June 2014 has been just 595.5 mm, indicating that the rainfall for year is below the yearly long term average (Note: These rainfall data are reported from the BOM weather station No. 67014 located on Old Telegraph Road).

Rainfall for July 2014 to June 2015 was 1321.5 mm and above the annual average. The above average rainfall for 2014-2015 and high monthly rainfall during April 2015 (422 mm) has stabilised water levels associated with the previous year of low rainfall and subsequently caused a rising of the water table in all bores. Rainfall for July 2015 to June 2016 was 1176 mm and above the annual average.

The average rainfall for July 2016 to June 2017 was 957.4 mm, with a substantial 276.8 mm occurring in the month of March 2017. The groundwater table rose approximately 1m in the sandstone aquifer (PF167MW-1) following March 2017.

The rainfall for July 2017 to June 2018 was only 473 mm, which is substantially below the annual average and indicative of drought conditions. All deep wells and shallow wells show a general decline in the groundwater levels reflecting the lower rainfall.

### 3.3 Bore PF167MW1

After a significant rain event in June 2007, the water level rose by 4.5 m to a level similar to the highest recorded value in mid-2000 (Figure HG-2, and Appendix C).

Since June 2011 to 2014, after a period of variable and a slow decline, the water level in this bore has been rising steadily following the above average rainfall up to 2013 (2014 is below annual average). The level from rainfall in 2014-2015 is similar in the year 2000. Water levels were stable in 2014 and then rose sharply (approximately 1.5 m, 183.8 mAHD) after the high recharge event of April 2015 (rainfall 422 mm, Figure HG-2).

Following the April 2015 rainfall event other recharge events occurred in early and mid 2016 causing groundwater levels to rise and vary between 183 and 184 mAHD (June 2016 ~ 183.4 mAHD).

Water levels were approximately 183.5 AHD during July 2017, and ranged from ~182.5 to 184 mAHD during 2016-2017. Spikes in water levels relate to storm events, such as the high rainfall in March 2017 (Figure HG-2). The groundwater table rose approximately 1m in the sandstone aquifer (PF167MW-1) following March 2017 rainfall.

The water levels manually measured from August 2016 to August 2018 ranged from 183.12 mAHD to 181.1 mAHD (August 2018), whilst the water levels declined from approximately 183.2 (June 2016) to 181 mAHD (August 2018). Refer to Table 2, Figures HG-8 & HG-2.

### 3.4 Bore PF166MW1

Since March 2011, the water level in this bore has been rising steadily, although it shows a slight fall during a low rainfall period in the second half of 2012, followed by a rise as a result of the high rainfall at the beginning of 2013. Bore PF166MW1 taps a perched aquifer with variable responses to major and sustained rainfall events and periods (Figure 3, Appendix C).

The water level declines during 2014 and then rises steadily in 2015 due to the above average rainfall and high April 2015 rainfall (422 mm, Figure 3). Following the April 2015 rainfall event other recharge events occurred in early 2016 causing groundwater levels to rise and peak at approximately 200.8 mAHD in April 2016 (Figure 2).

The water levels manually measured from August 2016 to August 2018 ranged from 199.55 mAHD to below 199 mAHD in May 2018 (Figure HG-8, Table 2). The well has been dry for past few months. The water levels in the Maroota Sand are perched above the sandstone aquifer and have declined to its lowest elevation due to the prevailing drought.

### 3.5 Bore PFP214MW1

Bore PFP214MW1 taps the full thickness of the Maroota Sand at the southern edge of the quarry area. Since its installation in March 2009, the water level has shown a slow declining trend up to end of February 2011. Since that time the water level has risen in response to the above average rainfall (Figure 4, Appendix C).

Water levels fluctuated slightly (<1m) during 2014 (181.6 m to 180.3 AHD) and then rises slightly and stabilises (180.3 to 181.2 mAHD) with minor fluctuations during 2015 and 2016.

Water levels also showed minor fluctuation during 2017 to 2018 with an overall decline. Water levels ranged from approximately 180.2 to 179.5 mAHD (August 2018, Figure HG-4)

The water levels manually measured from August 2016 to August 2018, ranged from 179.41 mAHD to 179.54 mAHD (August 2018). Refer to Table 2 and Figure HG-8. The recent water levels (depth below ground) are similar to the previous 2017 levels.

PFF conducted a survey of new and existing wells (Freeburn Surveying Pty Ltd) in May 2017 as part of updating the well network. An adjustment (1.16m elevation) of the well casing RL at PF214MW-1 was required and presented in Table 2, Appendix E.

### **3.6 Bore PFL2HitchMW1**

Bore PFL2HitchMW1 is the deepest bore in the Hitchcock Road site, as it is located in the vicinity of the former trigonometric station, which is the highest elevation on the site and taps the full thickness of the Maroota Sand aquifer.

The hydrograph shows that after an initial settlement period after drilling, the water level stabilised at an RL level of 189.6 m AHD without any significant response to the rainfall events until September 2012, after which time it shows a steady rise in response to the above average rainfall (Figure HG-5, Appendix C).

Since 2013, the water level shows a slight consistent decline to approximately December 2014, followed by a stable to gently rising water table after April 2015 to mid 2016 where it stabilises at approximately 189.95 mAHD (Figure HG-5). The water levels decline gently from August 2017 to August 2018, ranging from approximately 189.7 to 189.4 mAHD, respectively.

The water levels manually measured from August 2016 to August 2018 and ranged from 189.6 mAHD to 189.85 mAHD (Table 2, Figure HG-8). The recent water levels show a relatively stable and decreasing water level reflecting the dry season.

### **3.7 Portion 167 Dam**

Records of pump operation have been kept from PF167DAM since January 1997. The Figure 7 (in Appendix C) shows the monthly summary of the pumpage from the dam. Due to the above average rainfall over previous years (2011-2013 and 2014-2015) no pumping has been necessary from this source, however below average rainfall has occurred in early 2014, and 2017-2018, with some pumping necessary. No pumping occurred from July 2014 to June 2015.

Pumpage occurred (46.829 ML) from Portion 167 Dam during 2015 to 2016. Pumpage occurred (38.407 ML) from Portion 167 Dam during 2016 to 2017, and **48.953 ML** for 2017-2018. The licensed limit for the Portion 167 dam is 50 ML/year which are not exceeded for 2018. Pumping records are provided in Table 3-7.

The rainfall recorded at the BOM station since 2010 has been above the long term annual average of 910.3 mm. No water levels have been recorded at this site during the 2011 - 2013, 2014 - 2015 years, as the dam and the pump have been under water for most of the recording period due to the above average rainfall and resulting run-off experienced in the Maroota area during the 2001-2013 and, in particular, during the period May-June 2013 when the water level peaked briefly at 189 m AHD, returning to 180 m AHD at the end of June 2013.

The water level in the dam reduced by approximately 2m (184.5 m to 182.5 mAHd) during the past year (2017-2018) due to the low rainfall and high pumpage (**48.953 ML/yr**). The water levels in the dam also appear to be affected by significant evaporation losses during summer and combined contributions from rainfall and groundwater recharge (Figure HG-10). The dam is hydraulically connected to the Maroota Sands aquifer and aquifer recharge patterns closely linked to climate.

The quarry area is internally draining and, therefore, the dam collects all incident rainfall on the site.

Although water is pumped from the dam for a variety of purposes, such as dust suppression and irrigation of rehabilitated areas and, more recently, for sand slurring, records show that water levels return rapidly to the average values indicated above, even after higher levels are experienced after heavy rainfall and consequential run-off.

The data logger was installed in the dam during a period of high water levels in August 2017. Due to the low rainfall and declining water levels, the logger was shifted to a deeper part of the dam by 2.295m on 12 April 2018. The logger data indicates a lowered water table due to the drought conditions. Previous records suggest that the Maroota Sand aquifer at the site is capable of sustaining the required pumpage even under the lower rainfall recharge conditions.

### **3.8 Clean Water Dam (CWD in Portion 167)**

Water quality in the dam (1 Ha ~1.5m maximum depth) was not previously monitored because the dam collects incident rainfall, run-off and recycled water from the wash plant and tailings. The data logger was installed in the dam during a period of high water levels in August 2017 (187.635 mAHd). The water levels have decreased by approximately 1m from 2017 to 2018 (186.5 mAHd) due to a lack of rainfall, summer evaporation losses and through operational activities (Figure HG-9).

Water level monitoring is not required in the new license conditions, however a data logger was installed in August 2017 to assist with the site water balance. Water samples and field chemistry were collected on 14 August 2018 to assist with the site water balance and assessment (Figure HG-9 and Table 3-9).

### **3.9 Water Supply Bores (PB1 & PB2; Portion 198)**

Pumping records for the two water supply bores in Portion 198 for the year July 2017 to June 2018 are tabulated in Table 3-8. In previous years, during 2014-2015 pumpage was 21.8 ML, whilst during 2013-2014 the total pumpage was 33.6 ML and still significantly below the combined annual allocation of 60 ML. This lower consumption rate is due to the non-operational status of bore PF198PB1 for part of the year 2013, and overall improved efficiency of the plant (including in 2014).

During 2015 to 2016 and given the above average rainfall the available pumping records (PB1 & 2) indicate a usage of 16.841 ML. Pumpage during 2016 to 2017 from PB1 & 2 indicate a combined usage of 16.507 ML. Pumpage during 2017 to 2018 from PB1 & 2 indicate a combined usage of 13.622 ML.

Groundwater usage is below the combined annual allocation of 60 ML (Table 3-8).



### 3.10 Water Quality

The water quality obtained from the existing (4), new wells (5) and dams (2) are presented in hydrochemical diagrams (Piper and Durov, Appendix H) and time series graphs (1-6).

Water quality in bores PF167MW1 and PF166MW1 has been monitored for pH and EC since monitoring started. Since June 1999 groundwater quality has been analysed for a range of analytical parameters and for Oil and Grease to obtain background data.

Since July 2009, groundwater quality data have also become available from the newly installed monitoring bores, PFP214MW1 and PFL2HitchMW1. Historical and recent analytical results for the other samples from the monitoring sites are summarised in Tables 3-1 to 3-6, and have been plotted in the graphs (1-6). The laboratory reports are presented in Appendix B.

The graphs (1&2) show EC time series trends with water levels and rainfall for the initial monitoring period (March 1996 to January 1999 for bore PF167MW1 and March 1998 to January 1999 for bore PF166MW1), before the installation of the dataloggers (refer to Appendix C for previous graphs presented in URS 2013). The EC graphs show a sympathetic variation with rainfall, indicating the effects of dilution generated by recharge (decrease in EC) and by lower water table. In the latter case, the improved EC is interpreted as the effect of aquifer recharge by fresher water.

The graphs (1 to 6) confirm the dependence of the aquifer upon rainfall to maintain storage and supply. No analysis has been carried out of the water from the Portion 167 Dam because extraneous influences, such as direct rainfall and run-off, make the water in the dam not representative of the groundwater at that site.

Groundwater quality has also been monitored at bores PF198PB1 (Graph-5) and PF198PB2 (Graph-6), the two processing plant water supply bores. The water in these bores is derived from the Hawkesbury Sandstone aquifer. Water quality records are summarised in Tables 3-5 and 3-6 and have been graphed (Refer to Graphs 1 to 6, and also in Appendix C, URS 2013). The groundwater levels in the production bores (PF198PB1 & PB2) are presented in Table 3-8.

The waters in the Maroota Sand aquifer monitoring bores are similar and have a characteristic rain composition, with low pH (acidic), low TDS and a Sodium-Chloride water type. The samples were also analysed for Oil and Grease to monitor the possible effect of the sand extraction operations. Concentrations of Oil & Grease were not detected in all bores for the August 2018, and previous four monitoring events (2017, 2016, 2015, 2014).

The deep Hawkesbury Sandstone pumping bores groundwater display a slightly different character from that in the shallow Maroota Sand aquifer in the Hitchcock Road area and from the shallow Hawkesbury Sandstone aquifer in other areas of Maroota. The deeper groundwater has a slightly higher TDS, pH and Bicarbonate content (PF198PB1 & 2) than the shallower Maroota Sand groundwater; however, its overall low salinity content and sodium-chloride rain composition indicate a dynamic groundwater regime with regular and rapid rainfall recharge.

An increasing EC/TDS trend is evident in two bores (PFL2HitchMW1, PF214MW1) from 2013 to 2017, and inferred to relate to variable aquifer characteristics and rainfall recharge patterns. The EC/TDS at the two bores is interpreted to have stabilised in the past year (2017-2018).

The water quality of the deep new bores (MW-3D, MW-4D, MW-2D) within the sandstone are similar to the existing bores. The water quality in the dams (CWD and Por 167 spring) is similar to the shallow bores (MW-4S) situated within the Maroota Sands. The deeper bores (MW-4D) are similar in major ion composition (Na-Cl rich) to shallower bores and dams, however has slightly higher TDS (Appendix H, Piper 1 & 2).

Overall, all the site monitoring bores in both the Hawkesbury Sandstone and in the Maroota Sand show a marginal decrease in Total Dissolved Solids over time, the deeper bores showing a more constant character. The general groundwater flow regime with the sandstone is shown in Figures 1 to 4, and also in Appendix D (URS, groundwater regime in 2011).

### **3.11 Quality Control**

The laboratory quality control samples (ALS laboratory duplicates, procedure blanks and control spikes) returned results within the required limits and acceptance criteria. The quality control data generated by the laboratory are presented with the laboratory certificates in Appendix B.

Based on the evaluation of the data, it is assessed that the accuracy and precision of the analytical data generated in the sampling round, as reported by the analytical laboratory, are acceptable as a basis for interpretation.

## 4 CONCLUSIONS

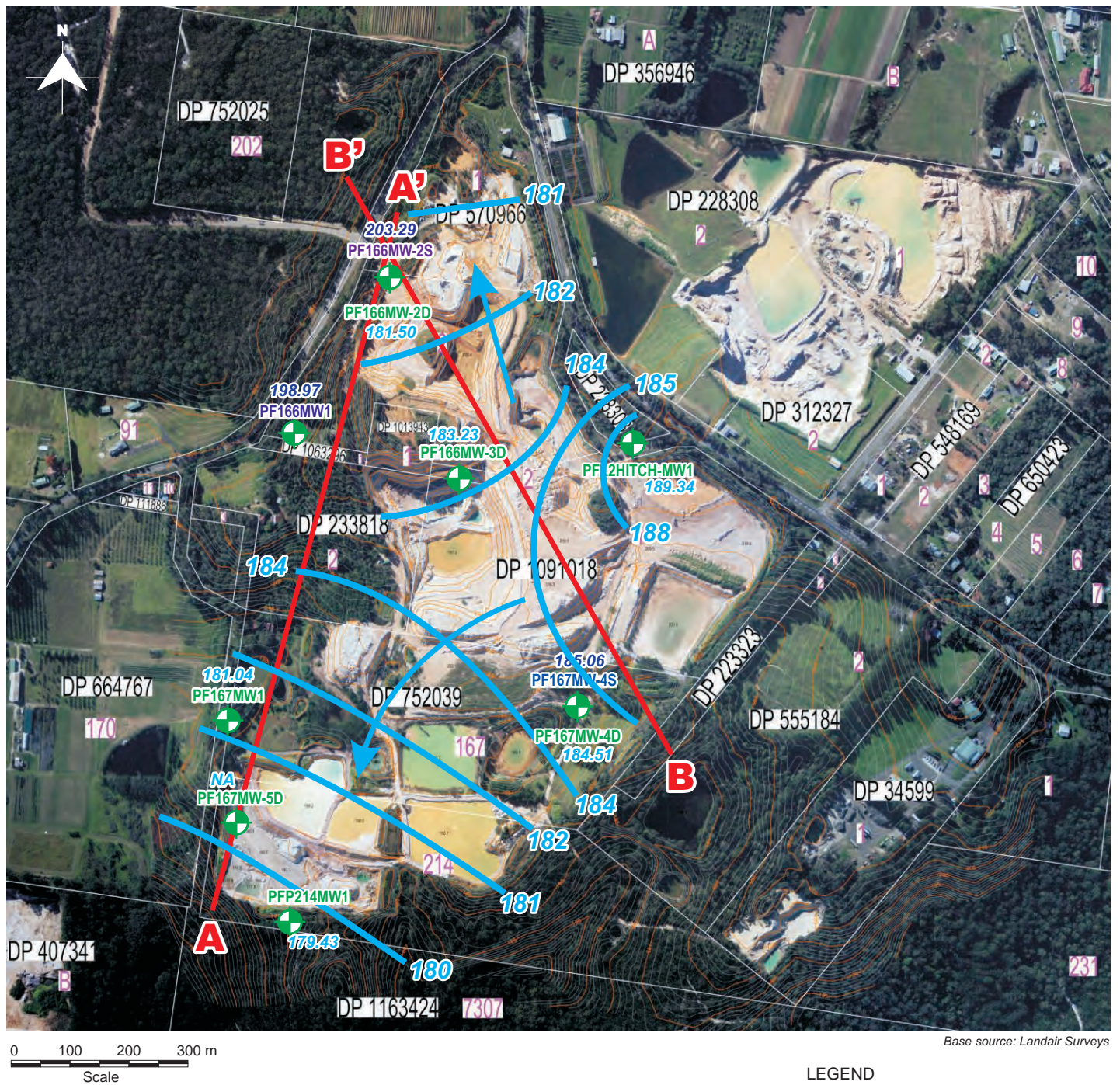
The assessment of the data collected on the groundwater levels and quality in the Maroota Hitchcock Road site, some of which represent the oldest data available to the groundwater study carried out by the DLWC (now Office of Water) in the area, indicate that:

- Water levels in the Maroota Sand aquifer generally respond to the rainfall pattern. The rainfall during 2017/2018 of 473 mm was substantially below the annual average.
- Water quality in the Maroota Sand aquifer varies with rainfall recharge (slight increasing EC/TDS trends are visible in two deep bores (PFL2HitchMW1, PF214MW1) due to variations in aquifer characteristics and rainfall from 2013 to 2017. The recent 2018 sampling indicates a stabilisation of EC/TDS trends in the two bores.
- Water was pumped from the dam in Portion 167 (48.953 ML) and below the PFF allocation (50 ML).
- Groundwater pumpage occurred from the two deep water supply bores in Portion 198 (16.841 ML in 2015-2016, 21.8 ML in 2014-2015, 21.8 ML in 2014-2015, 2016-2017 was 16.507 ML). Pumpage records for the two production bores (PF198PB1=12.027 ML, and PF198PB2=1.595 ML) in 2017-2018 was 13.622 ML and below the allocation (combined 60 ML/yr).
- The chemical composition of the groundwater in the deep aquifer of the Hawkesbury Sandstone (water supply bores in Portion 198) has an overall character that indicates that rainfall recharge occurs readily.
- The new monitoring wells (6) installed in May 2017 and recent survey (aerial and well RL details) were used to better assess groundwater levels, flow regime, groundwater divide and pit extraction depths. E2W understand that two previous pit extraction areas (locations near PF167MW-3D and PF167MW-5D) were backfilled in 2017 to meet the required groundwater buffer zone (i.e. >2m above the high water table).
- The current sand extraction operations in the Hitchcock Road area operate in a manner that does not appear to have an adverse impact upon the groundwater sustainability, and meet the DA Approval Conditions.

The data collected during the year are available to the NSW Office of Water for their continued study in the area.

## FIGURES





Perched Water Table ( Maroota Sand):  
PFMW-2s, PFMW-4s, PF166MW1

## Site Plan & Inferred Groundwater Flow Regime (14 Aug 2018)

Date: Aug 2018

Reference: E2W\_224\_15.cdr

MAROOTA - HITCHCOCK ROAD SITE

Figure 1





LEGEND

- Site Boundary
- Groundwater Monitoring Location

0 254.4  
metres

Source: URS

Date: Oct 2018

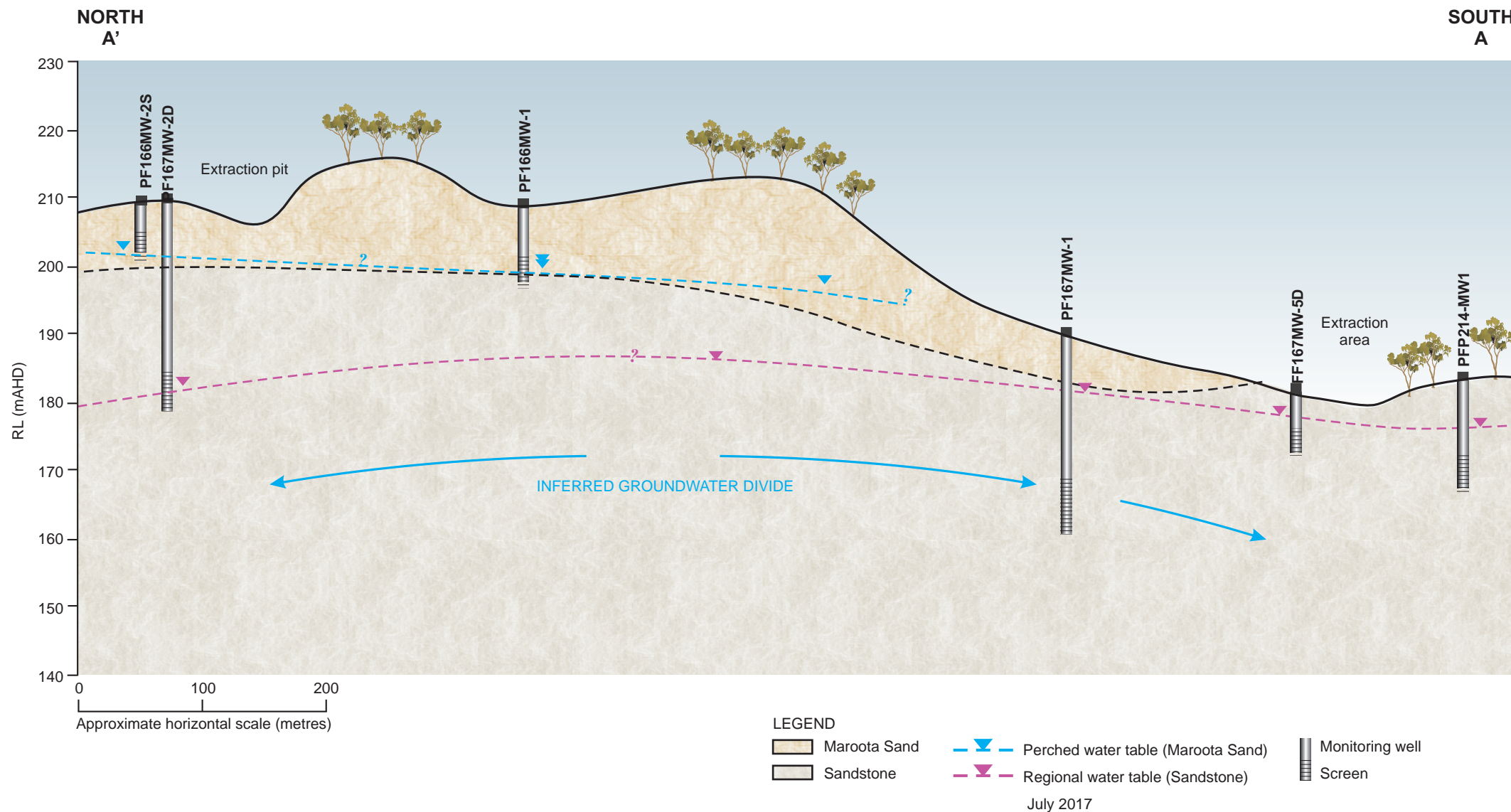
Reference: E2W\_224\_07.cdr

**SITE LOCATION- Hitchcock Rd & Lot 198 (August 2018)**

PF FORMATION - Hitchcock Road, Maroota

**Figure 2**





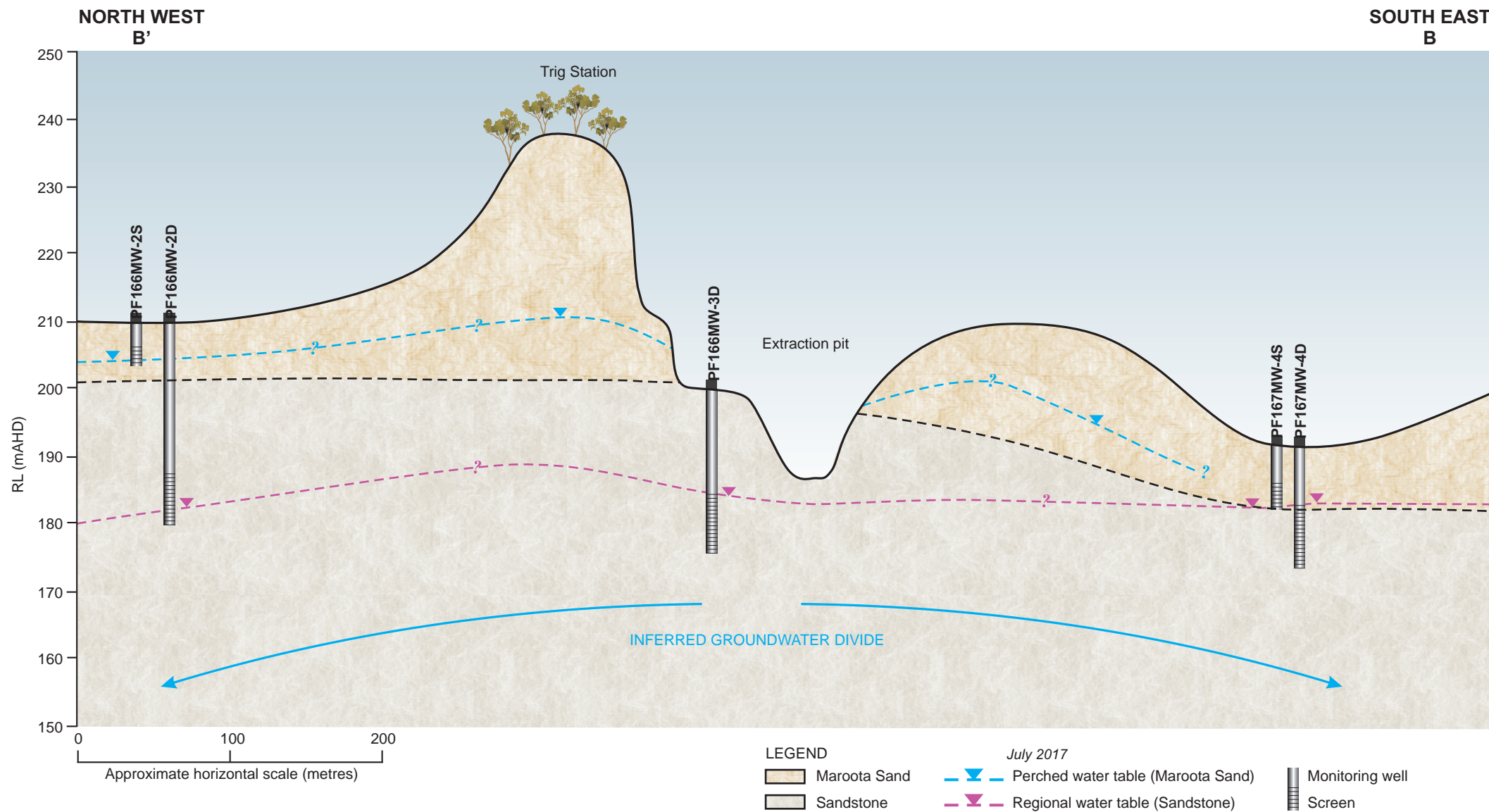
## INFERRED HYDROGEOLOGICAL SECTION (N-S)

**Date:** Oct 2018

**Reference:** E2W\_224\_17.cdr

MARootA - HITCHCOCK ROAD SITE

**Figure 3**



## INFERRED HYDROGEOLOGICAL SECTION (NW-SE)

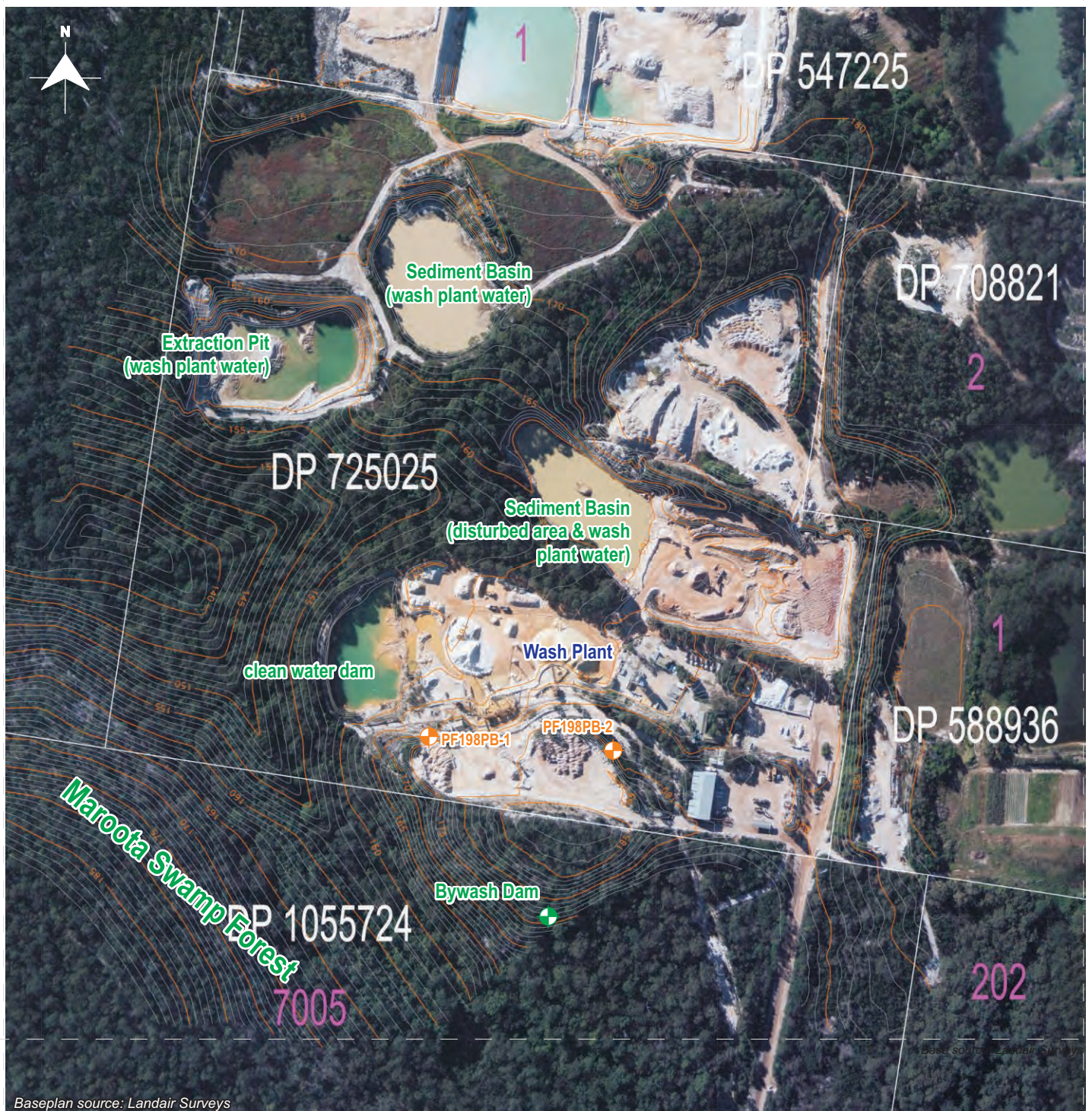
**Date:** Oct 2018

**Reference:** E2W\_224\_16.cdr

**MAROOTA - HITCHCOCK ROAD SITE**

**Figure 4**





0 30 60 90 120 150  
Scale (metres)

**LEGEND**

PF198PB-1  Production Bore (sandstone aquifer)

**Site Layout for Lot 198 (August 2018)**

Date: 29 August 2018

Reference: E2W\_224\_22.cdr

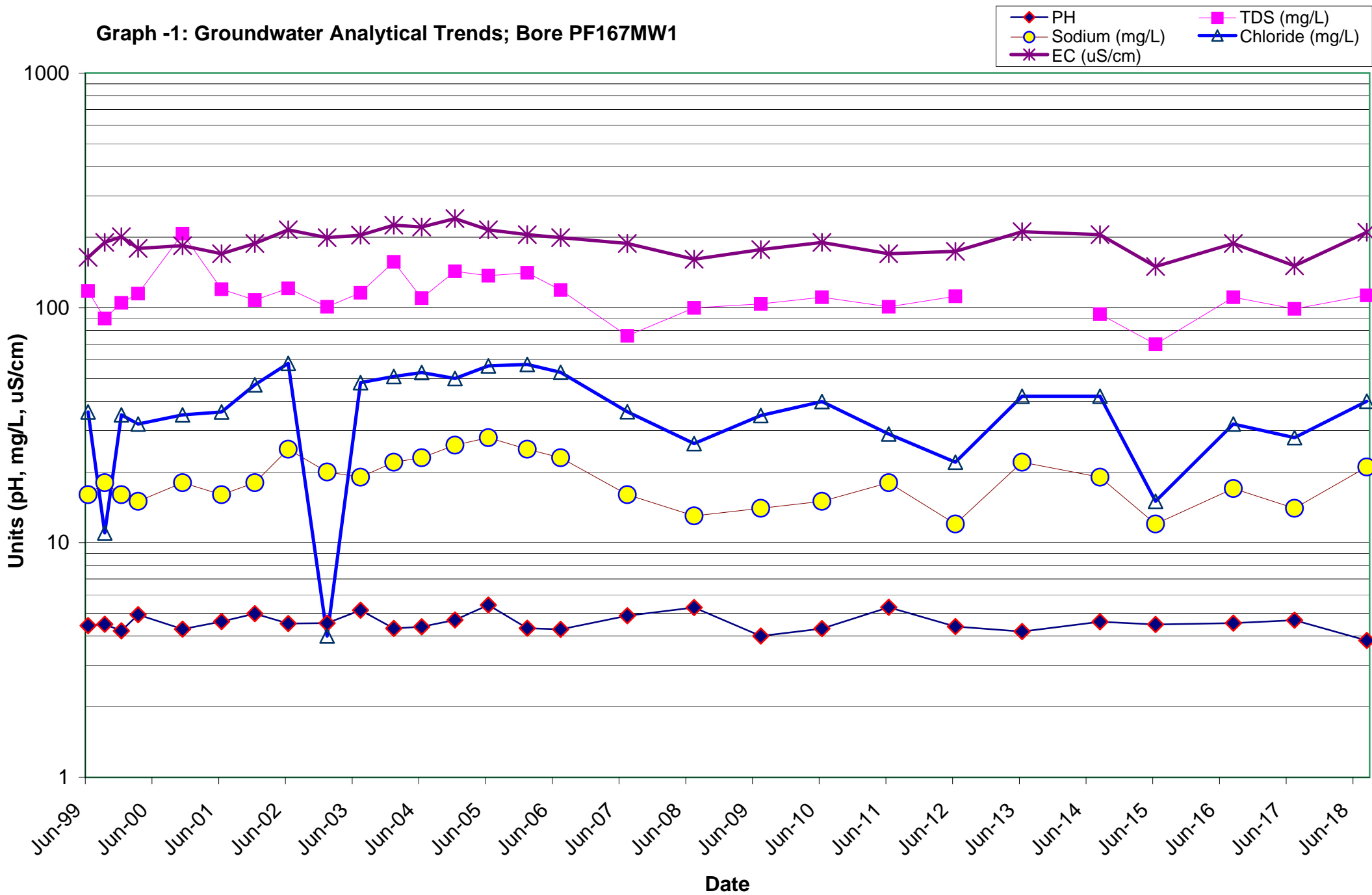
PF Formation: Maroota -Lot 198 Site

**Figure 5**

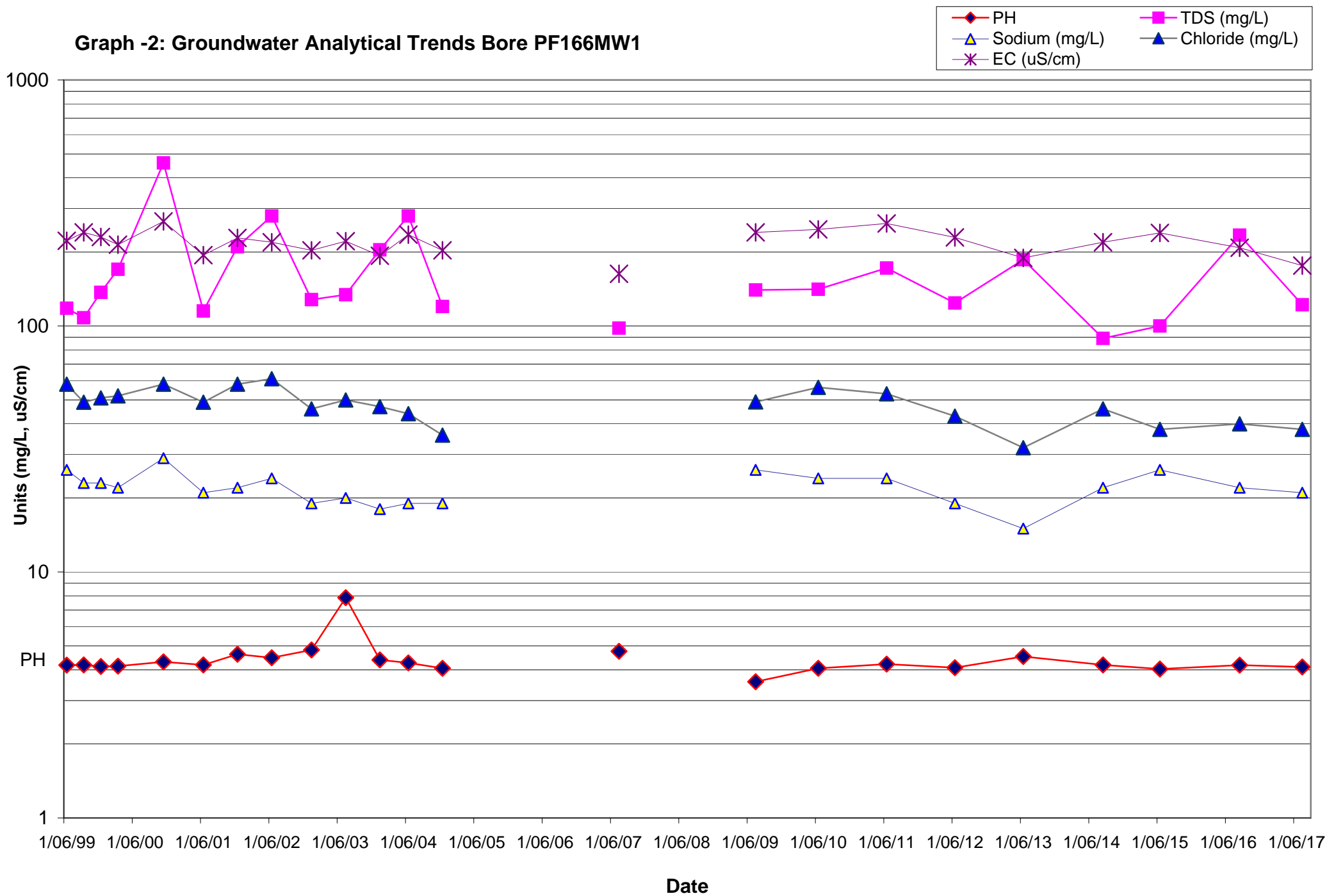
## GRAPHS



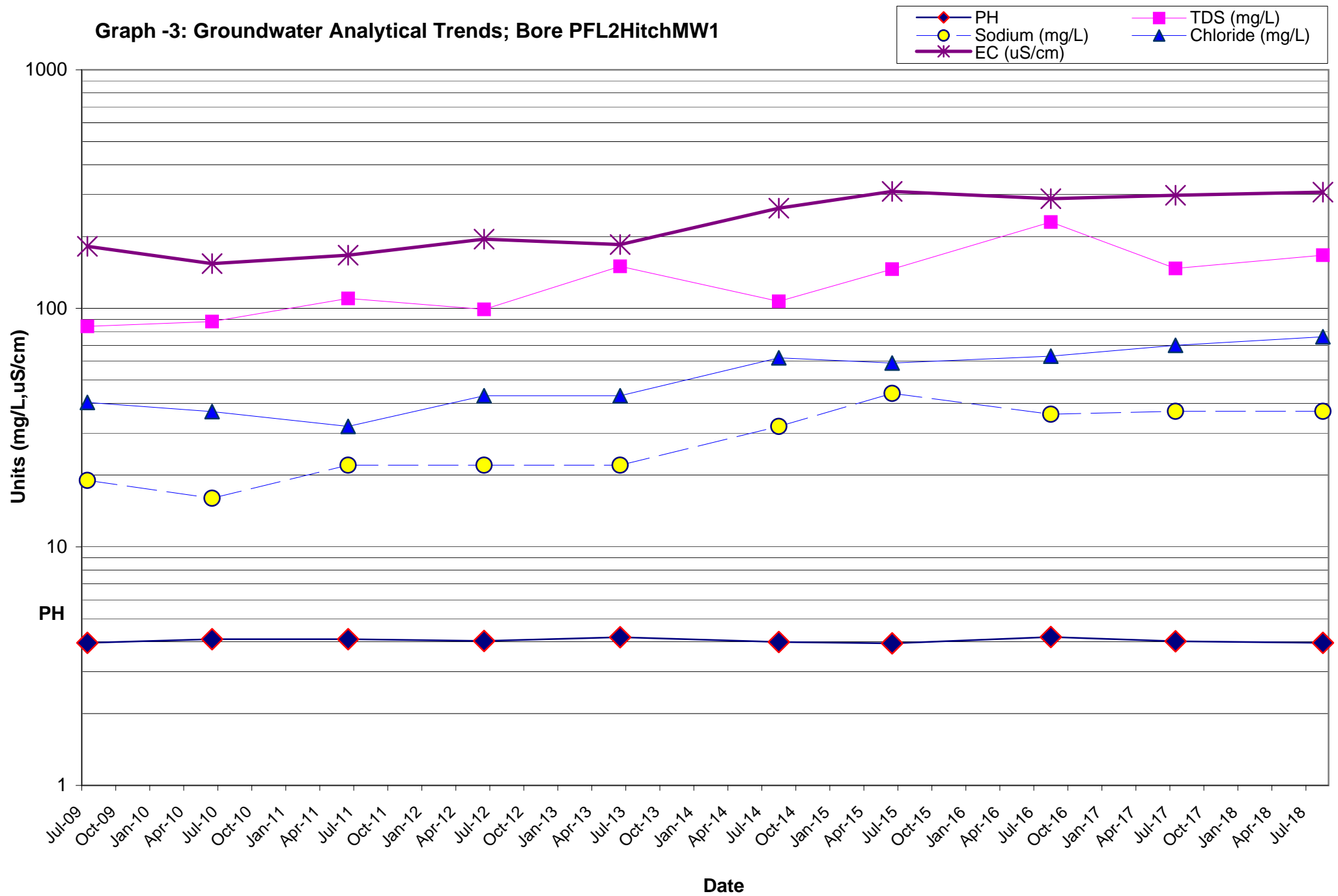
Graph -1: Groundwater Analytical Trends; Bore PF167MW1



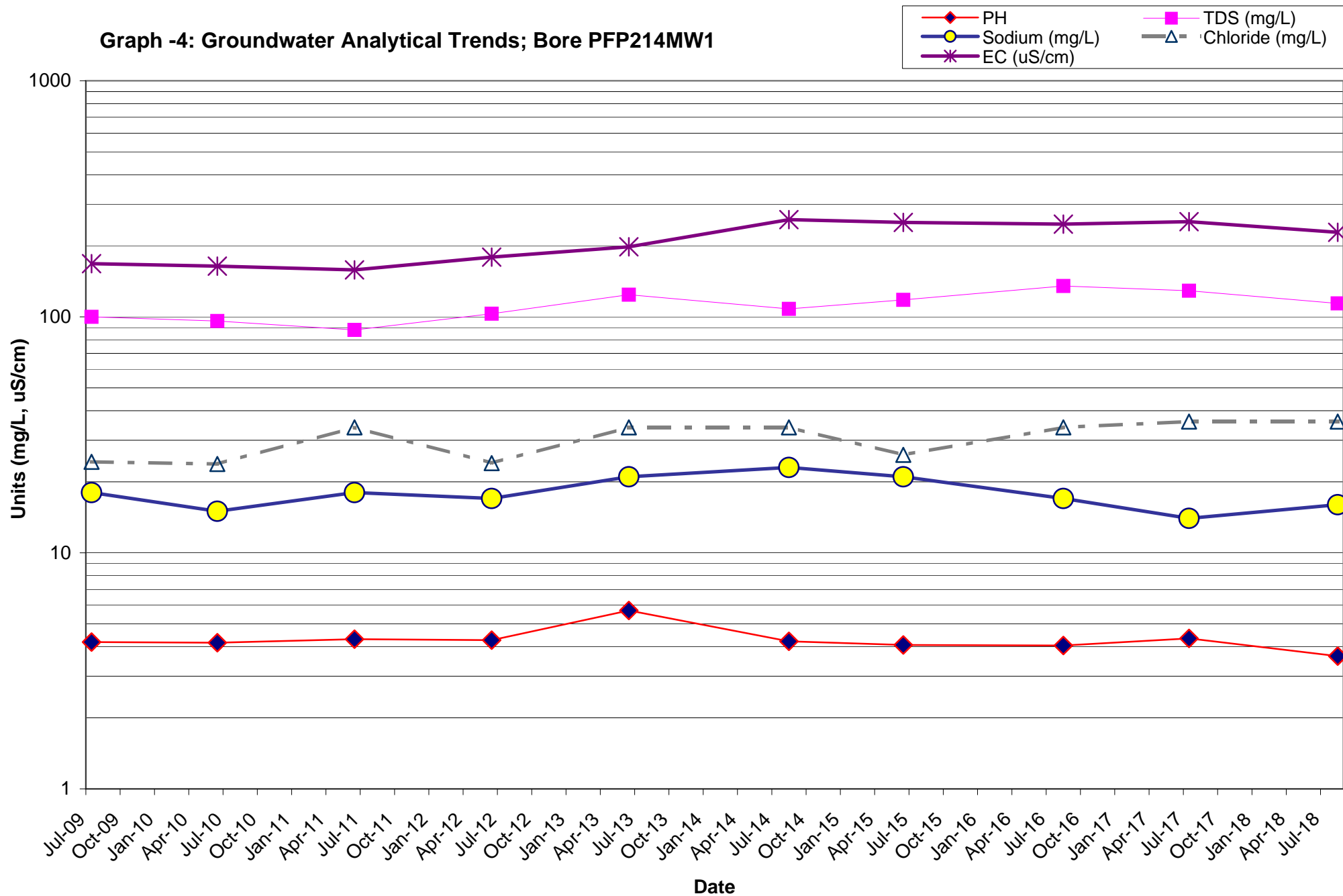
**Graph -2: Groundwater Analytical Trends Bore PF166MW1**



Graph -3: Groundwater Analytical Trends; Bore PFL2HitchMW1

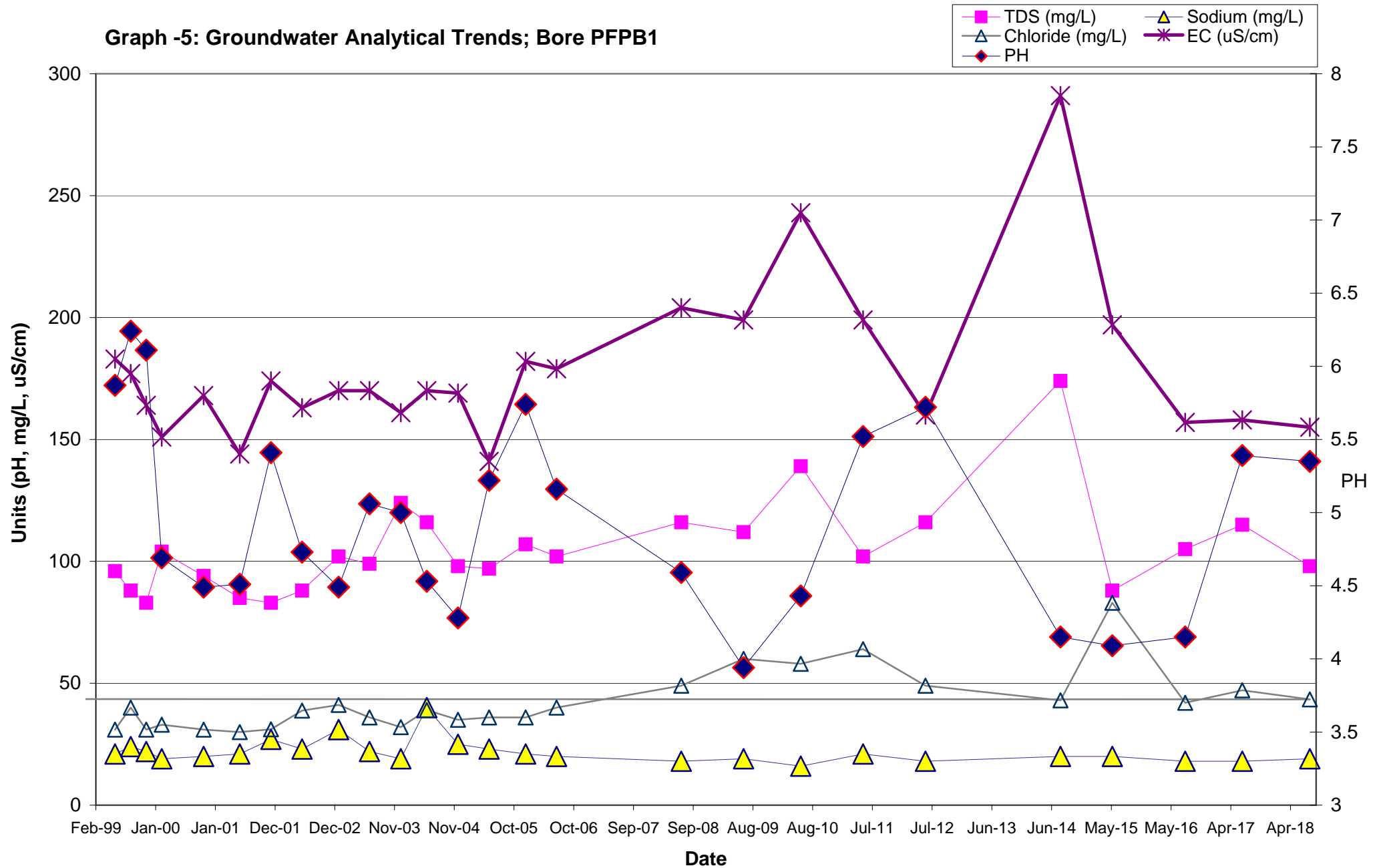


**Graph -4: Groundwater Analytical Trends; Bore PFP214MW1**





**Graph -5: Groundwater Analytical Trends; Bore PFPB1**



Graph-6: Groundwater Analytical Trends; Bore PFPB2

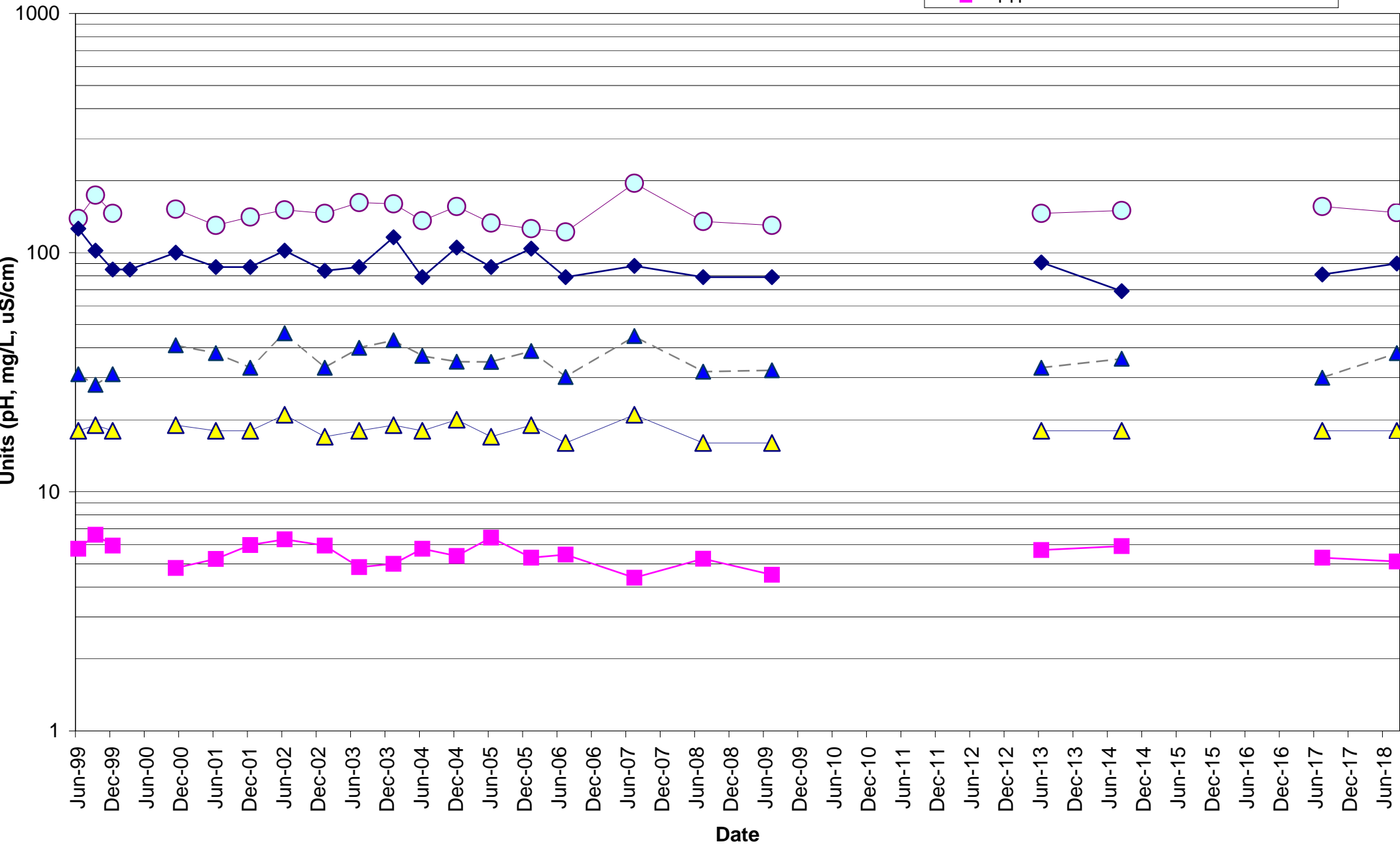


Figure HG-1: Lot 198 Wells (PB1 & PB2); Groundwater Level Measurements (2017 to 2018)

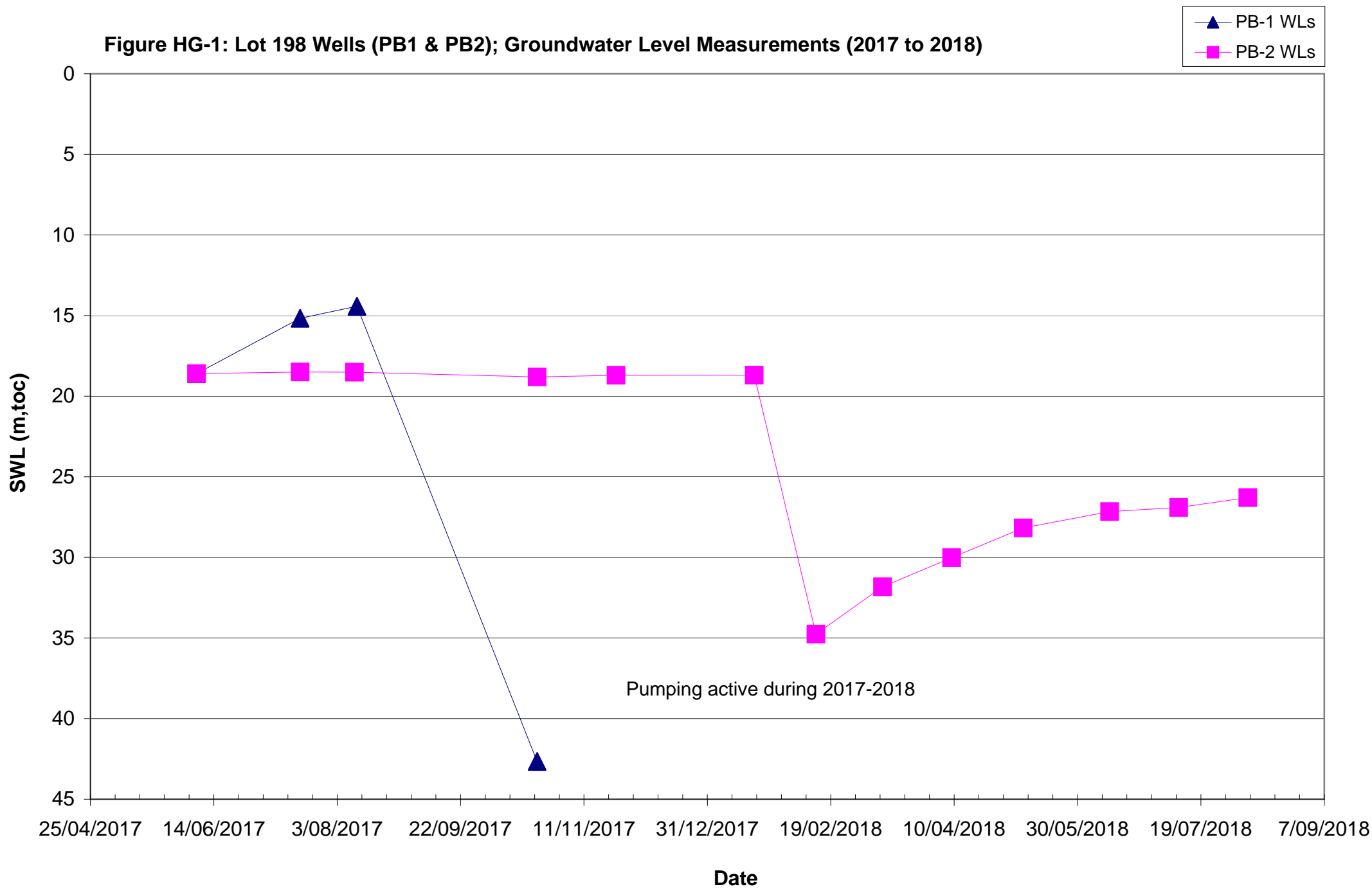


Figure HG-2: Monitoring Data at Bore PF167MW1 (2013-2018)

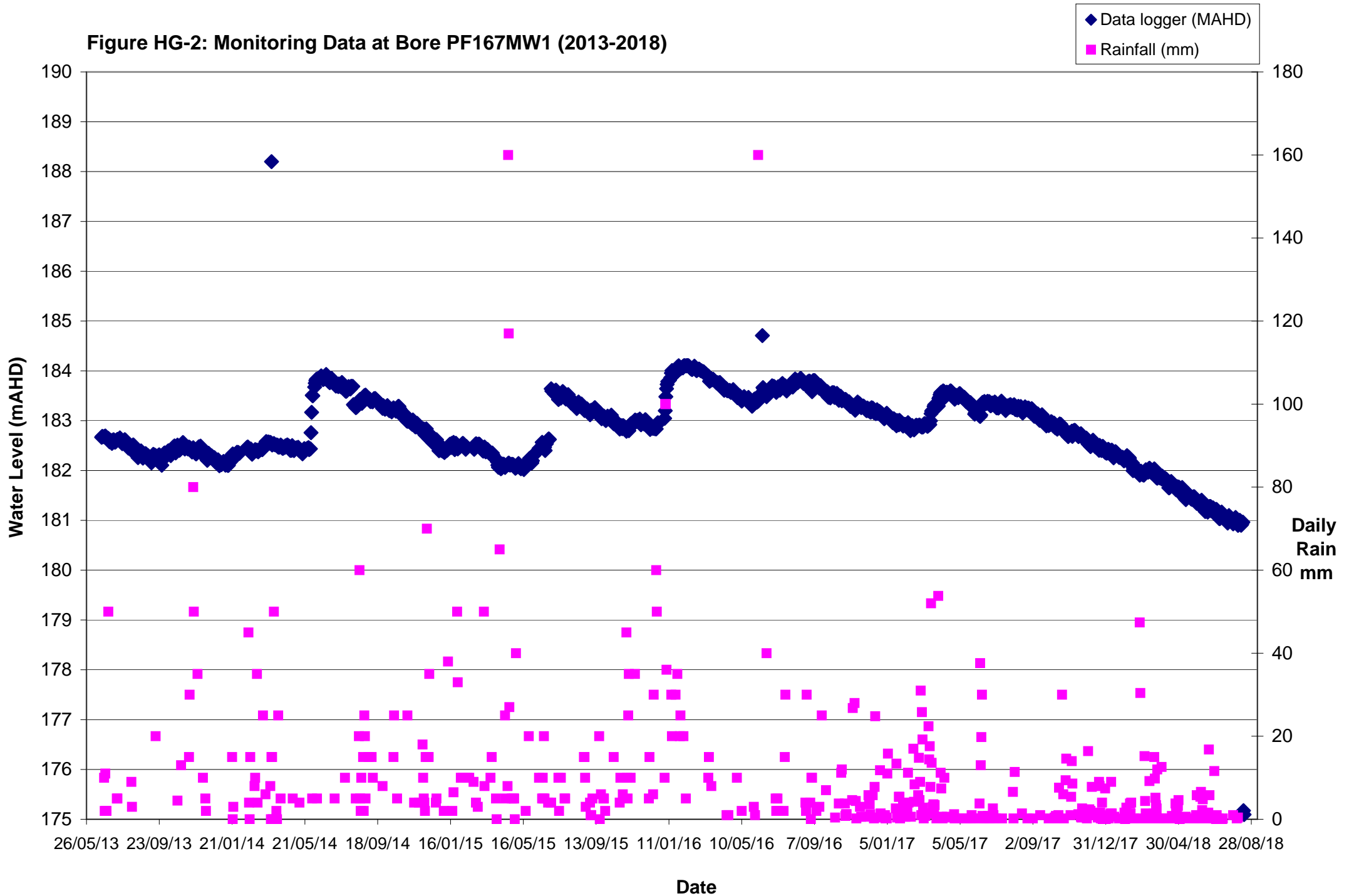
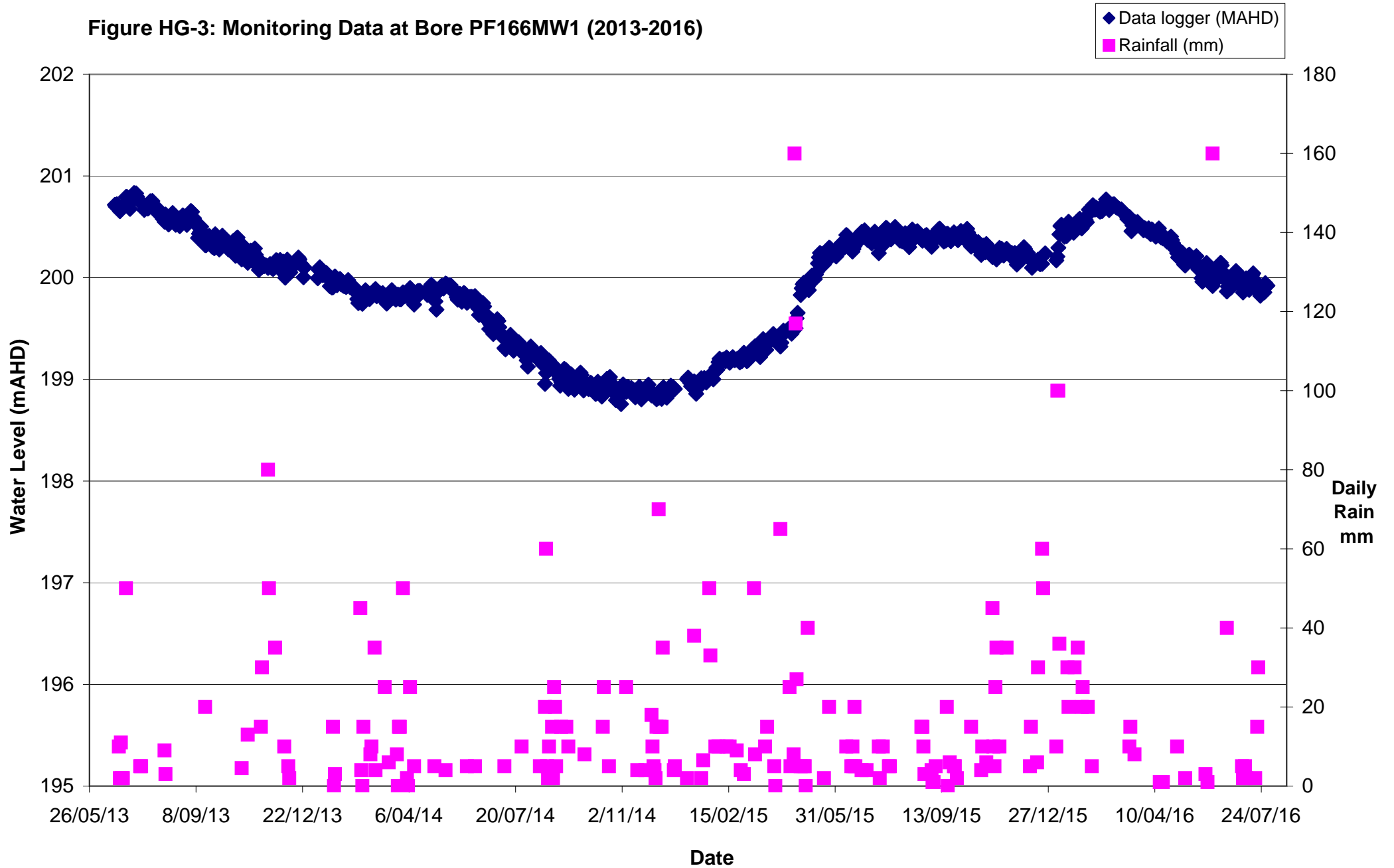




Figure HG-3: Monitoring Data at Bore PF166MW1 (2013-2016)



**Figure HG-4: Monitoring Data at Bore PF214MW1 (2013-2018)**

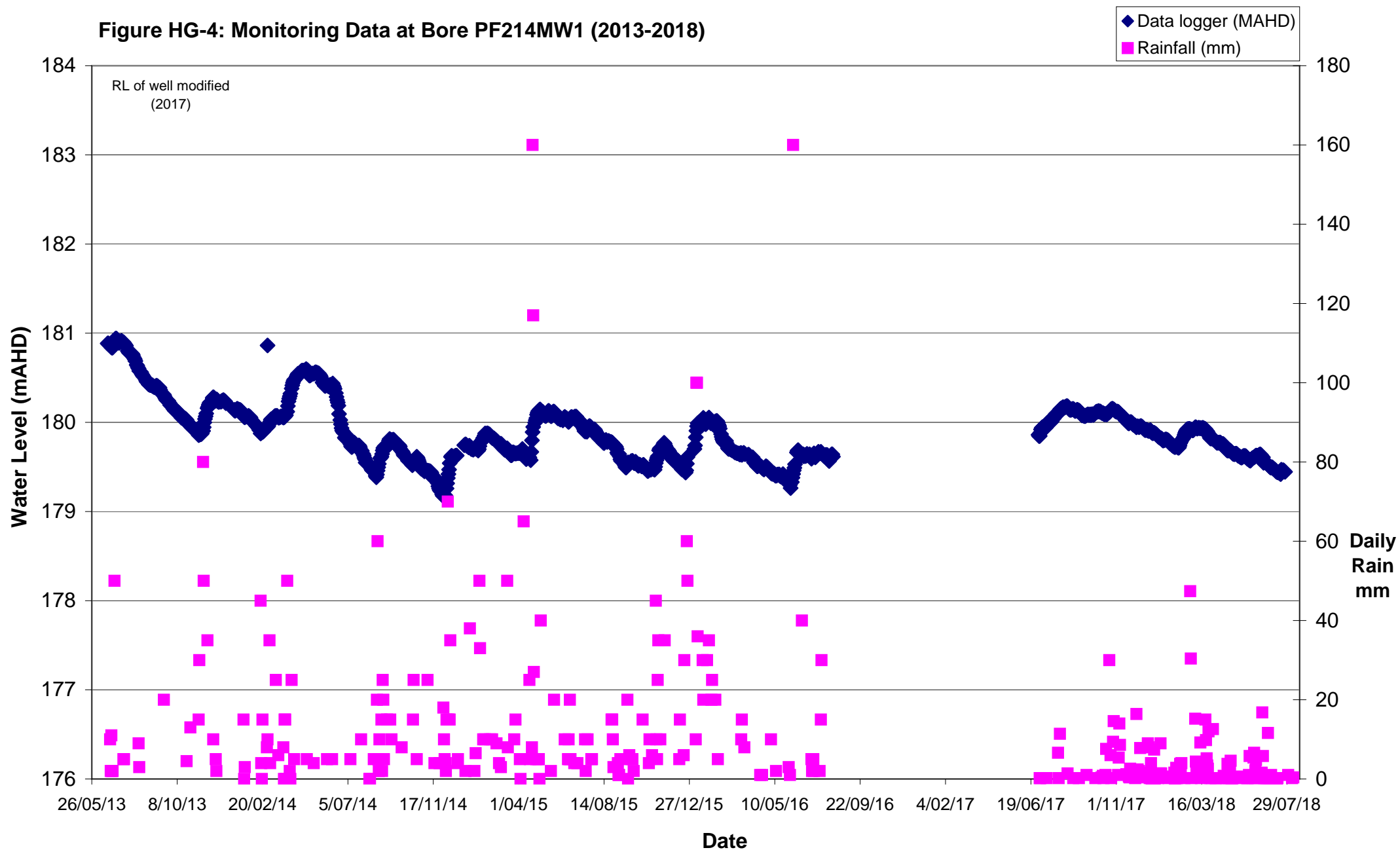


Figure HG-5: Monitoring Data Bore PFL2HitchMW1 (2013-2018)

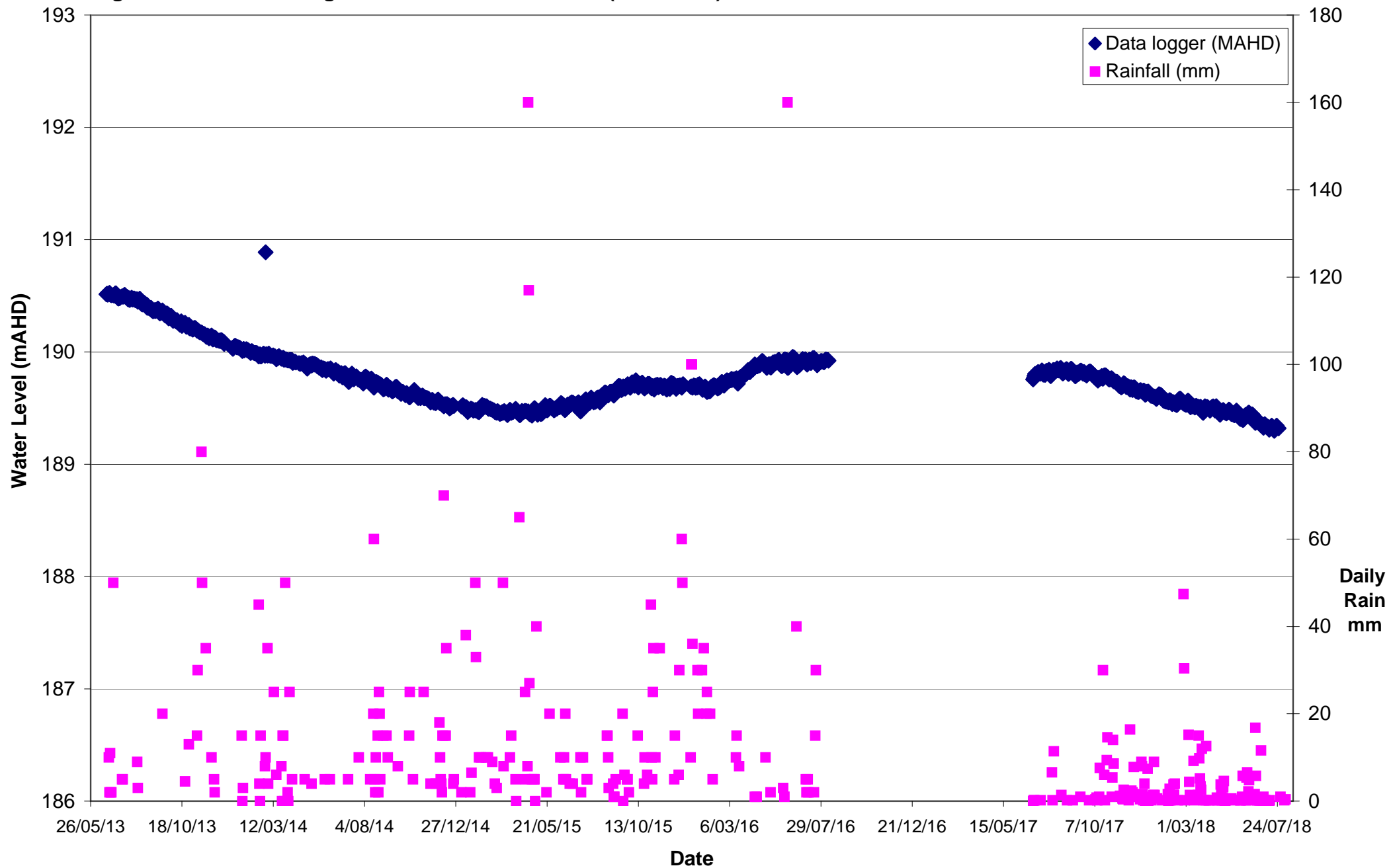


Figure HG-6: Monitoring Data Bore PF167MW3D (2017-2018, New bore)

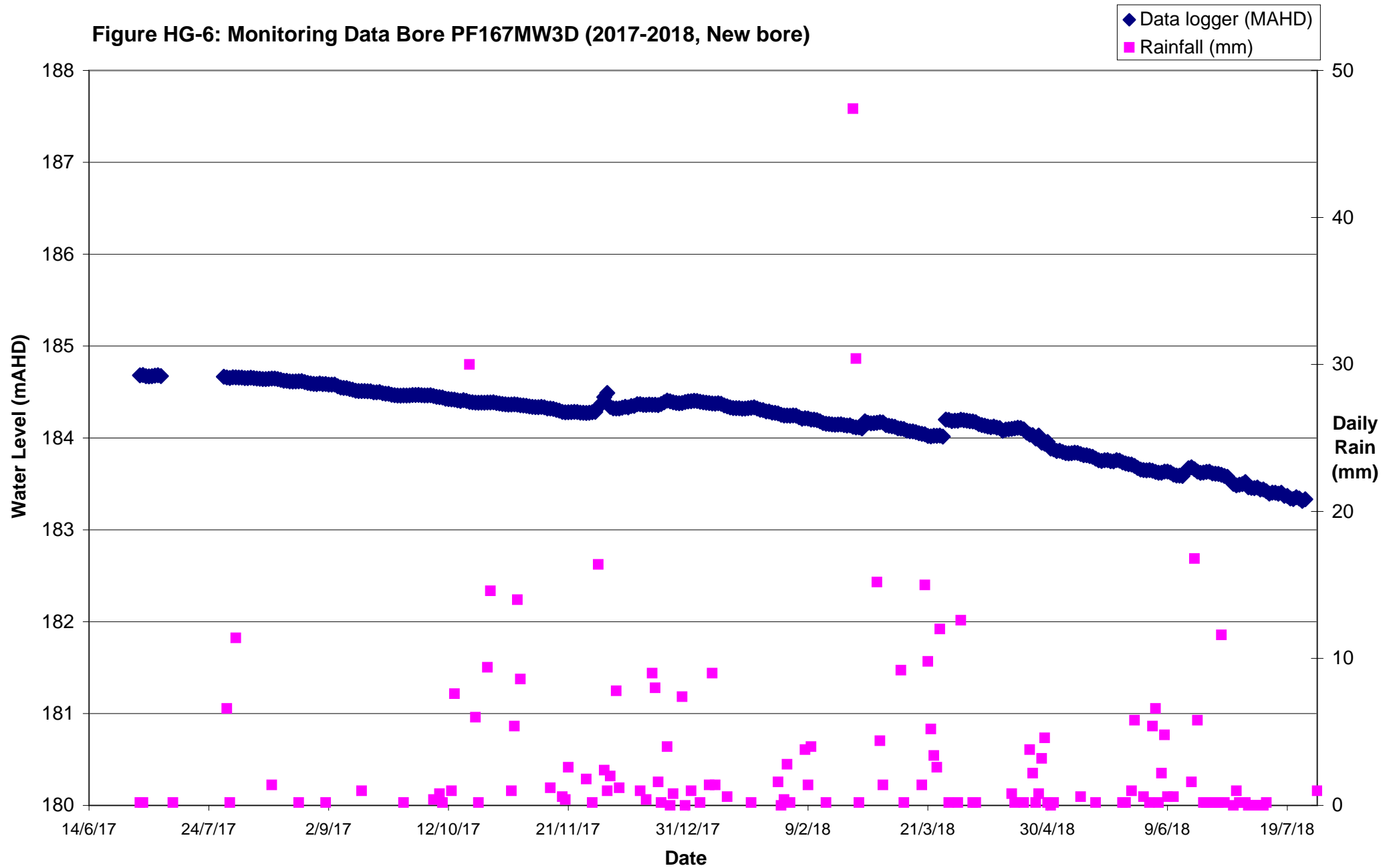
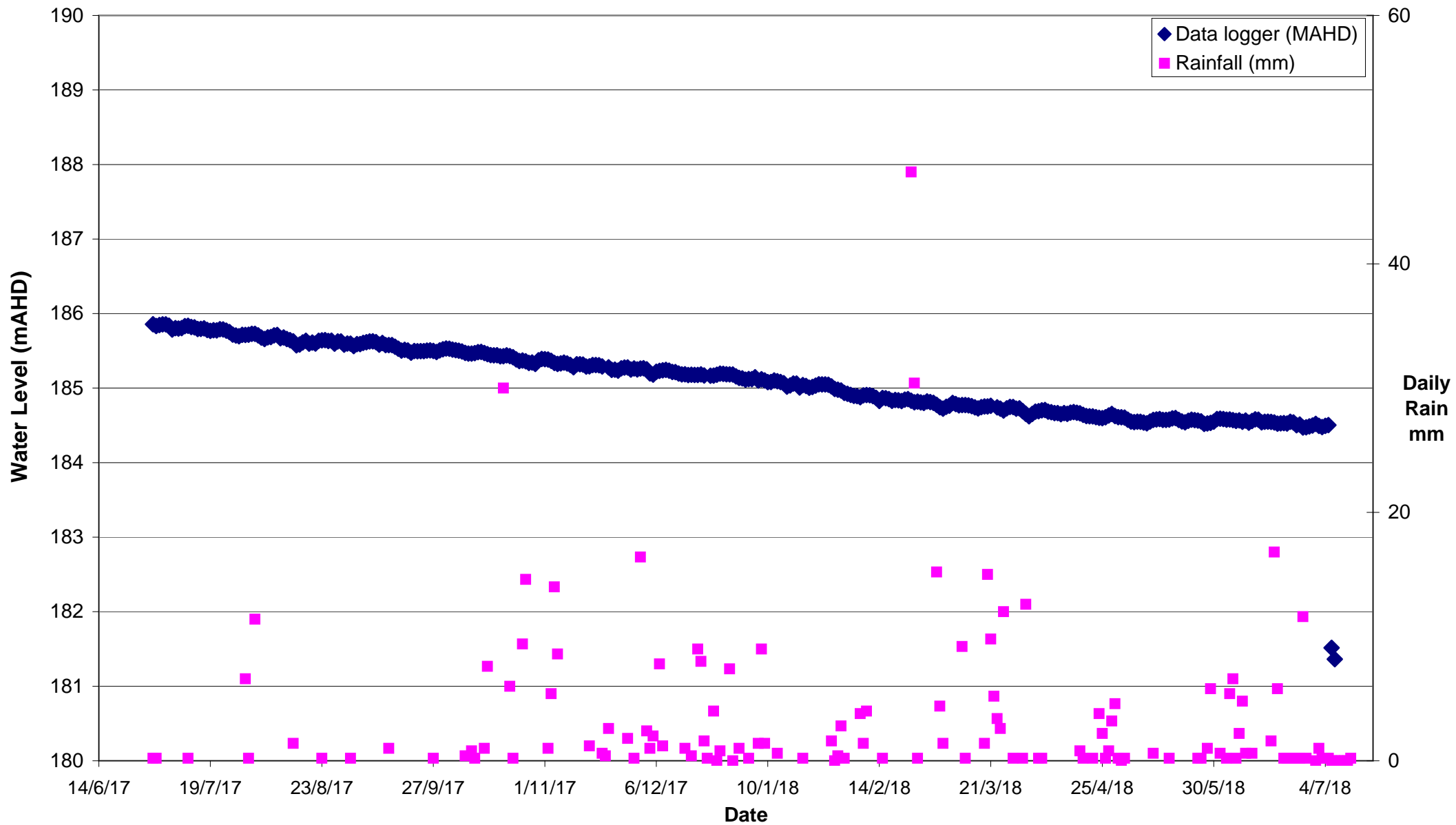
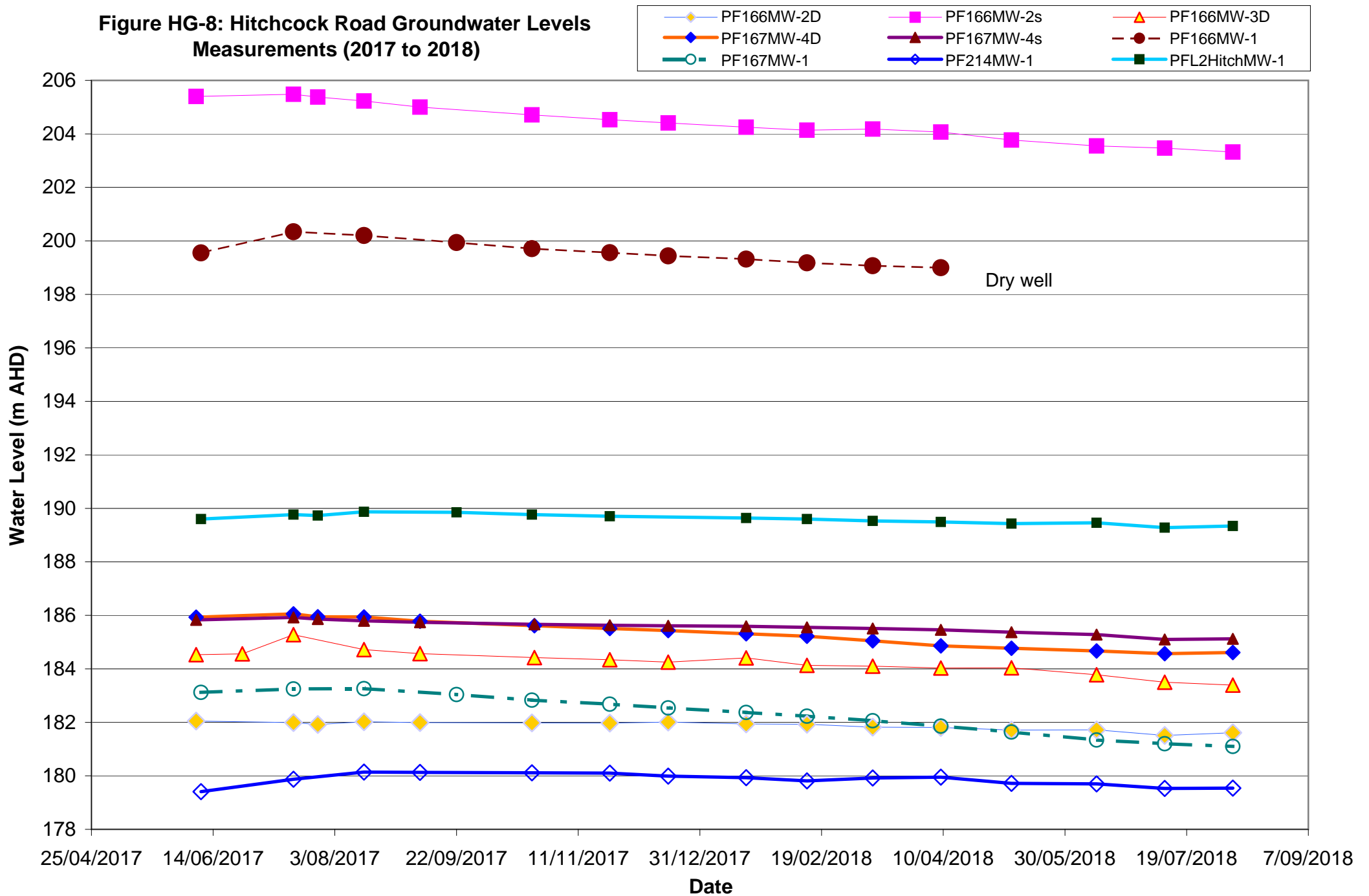




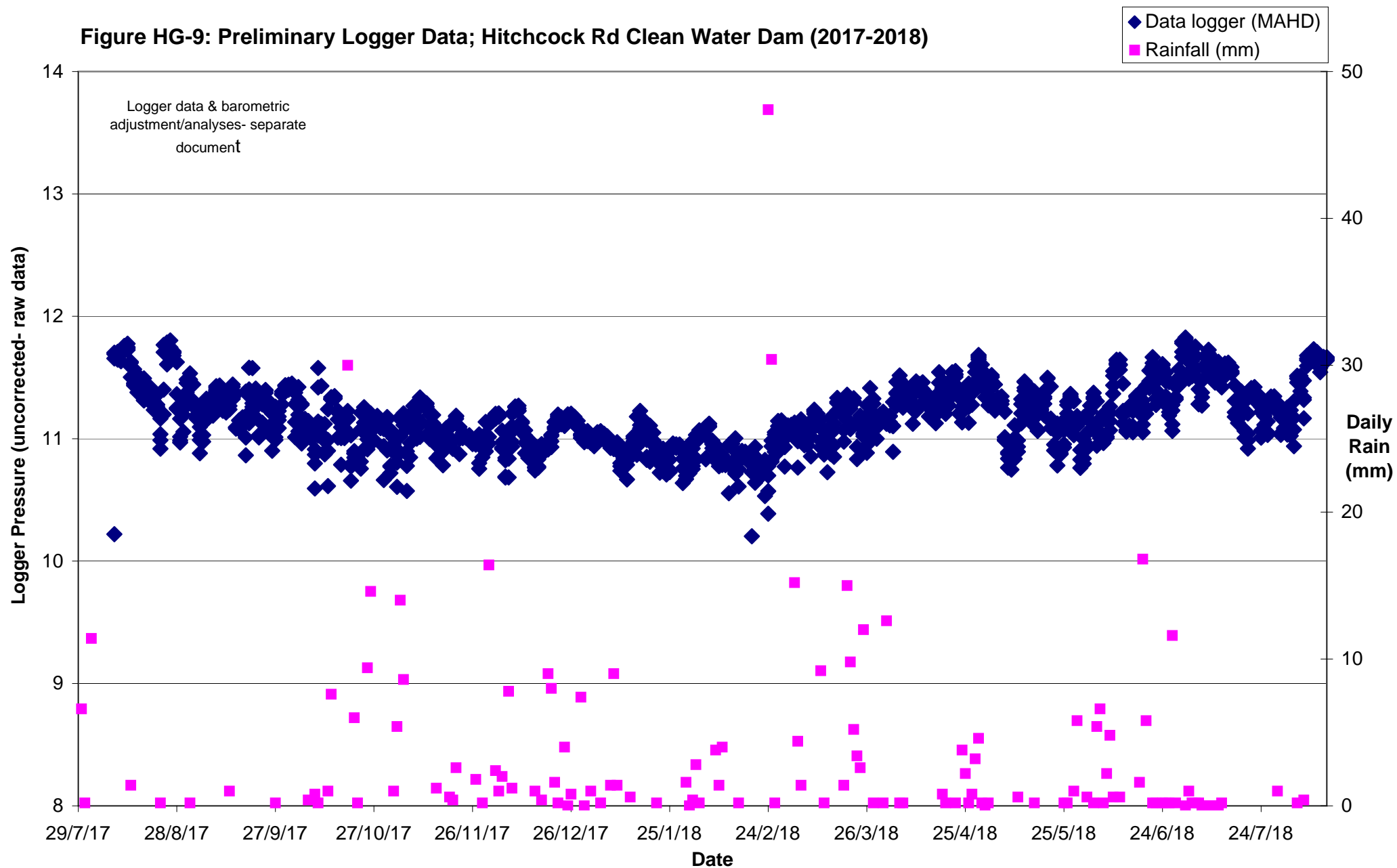
Figure HG-7: Monitoring Data Bore PF167MW4D (2017-2018, New bore)



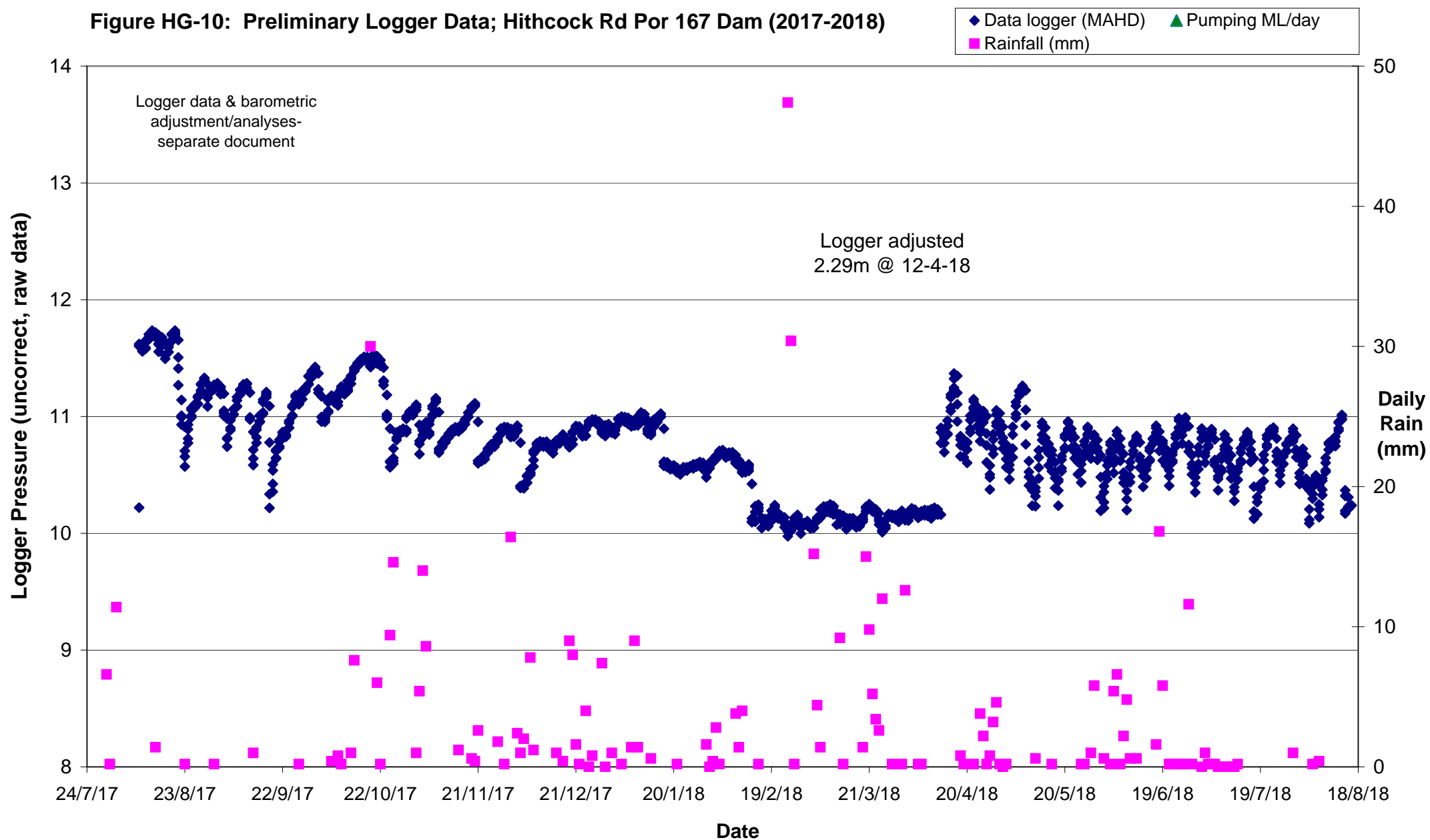
**Figure HG-8: Hitchcock Road Groundwater Levels Measurements (2017 to 2018)**



**Figure HG-9: Preliminary Logger Data; Hitchcock Rd Clean Water Dam (2017-2018)**



**Figure HG-10: Preliminary Logger Data; Hithcock Rd Por 167 Dam (2017-2018)**



## TABLES

**Table 1: Maroota Climate Summary (2017-2018)**

Date	Monthly Rainfall (mm)
July (2017)	7.2
August	13.2
September	1.4
October	70.2
November	35.8
December	63.2
January (2018)	15.4
February	90.8
March	80
April	29.2
May	8.4
June (2018)	58.2
<b>Total (mm/yr)</b>	<b>473</b>

Note: drought





**Table 2: Monitoring Well Details and Water Table Gauging (August 2018)**  
**Maroota - Hitchcock Road**

Sample ID	SWL (m btoc) 14-8-2018	SWL (toc) 7- 6-2017	PVC Stickup *	BOH (mbgl)	Co-ordinates	Ground RL	RL (TOC) *	Reduced SWL (mAHD) 14-8-2018	Aquifer	pH	EC (mS/cm)	DO (%)	DO (mg/L)	Redox (mV)	Temp (°C)	Comments
<b>Existing Groundwater Monitoring Wells</b>																
PF214MW-1	5.84	5.85	0.8	18	313286.41 & 6294508.34	184.45	185.26	179.43	deep sandstone	3.77	0.213	63	6	160	18.7	clear water
PF167MW-1	6.91	4.83	0.3	23.8	313190.79 & 6294816.05	187.85	187.95	181.04	deep sandstone	3.82	0.169	26	2	145	17.4	clear water
PF166MW-1	11.38	10.8	0.55	11.45	313293.61 & 6295256.65	209.78	210.35	198.97	maroota sand							dry well- insufficient sample
PFL2HitchMW-1	36.53	36.27	0.55	43.5	313810.71 & 6295241.46	225.13	225.87	189.34	deep sandstone	3.27	0.307	65	6	167	19.3	clear water
<b>New Groundwater Monitoring Wells (2016/2017)</b>																
PF167 MW-2D	28.40	27.85	0.6	29.4	313438.92 & 6295492.65	209.28	209.9	181.50	deep sandstone	6.47	0.303	80	7.5	73	19.9	Cloudy brown
PF167 MW-2s	6.71	4.60	0.7	5.1	313439.64 & 6295494.49	209.3	210	203.29	maroota sand	4.15	0.255	80	35	3.2	20.8	Cloudy brown
PF167 MW-3D	15.44	14.40	0.75	23	313545.67 & 6295186.86	197.93	198.67	183.23	deep sandstone	3.8	0.332	70	6.5	126	15.2	clear water
PF166 MW-4D	8.88	7.46	0.5	15.5	313727.56 & 6294836.89	192.93	193.39	184.51	deep sandstone	5.61	0.2	42	4	109	15.7	clear water
PF166 MW-4s	8.38	7.61	0.5	8	313725.86 & 6294836.93	192.93	193.44	185.06	maroota sand	4.80	0.09	65	6	115	14.8	clear water
PF167 MW-5D	removed	1.76	0.5	9.5	313203.61 & 6294658.95	180.85	181.54	NA	deep sandstone							well removed - bund wall

## Notes:

NA= not available

SWL= standing water level

BOH= bottom of well

\* Survey conducted in May 2017 by Freeborn Surveyors

Water level at PFL2HitchMW-1 measured on 7-8-18 by Melissa Mass

**Table 3A: Summary of Existing Monitoring Wells (Hitchcock Road, Maroota)**

PF Formation at Maroota



	PF167MW1	PF166MW1	PFL2HitchMW1	PFP214MW1	Lot 198PB1	Lot 198PB2	Por 167 Spring
Ground Elevation (mAHD)	187.64	209.94	226	186.5			184
Lot & DP	Lot 167 DP 752039	Lot 2 DP570933	Lot 1 DP109 1018	Lot 167 DP 752039	Lot 198 DP 752025	Lot 198 DP 752025	Lot 167 DP 752039
License No	GW100649	GW104410	GW110746	GW110747	10AL109354	10WAL1093550	GW104614
Alocation (ML/yr)					Combined 60 ML /yr		50 ML/year
Approval Number					GW101528	GW101527	10WA114809
Groundwater Resource	Sydney Central Sandstone	Maroota Tertiary Sand	Sydney Central Sandstone	Sydney Central Sandstone	Sydney Central Sandstone	Sydney Central Sandstone	Maroota Tertiary Sand
Date Installed	1996	1998	2009	2009	1998	1998	1995
Drilled Depth (m bgl)	23.8	11.8	43.5	18	150	138	4
Well Screen Interval (mbgl)	20-23 ?	4.9-10.9	31- 43	11.5- 17.5	23.4 - 140	35.5-140	
Aquifer Permeability (K m/day)	0.1 L/sec	NA	0.1 L/sec	0.1 L/sec	0.5 L/sec	2.6 L/sec	10 L/sec
Water Levels (mbgl)	4	10.57	36	5.6	20.58	35.36	(~4 m) 180 MAHD
Water Type	Na-Cl	Na-SO4	Na-Cl	Na-Cl	Na-Cl	Na-Cl	
PH	4.5	4	4	4.1	4.1	5	
Total Dissolved Solids, TDS	100	100	140	120	100	150	
Data Logger	Yes	Yes	Yes	Yes	No	No	No
Water Bearing Zones (mbgl)	6 to 8m	Na	Na-Cl	11.5-12	15.5-18.5m , 26-27m, 108 -114.5m, 188.5-121m	56.5-57.2m, 74-75.55m	
Geology	0-2m Sand 2-10m Wet gravel 10-23.8 m Weathered Sandstone	0- 0.7m Sand 0.7-6.5m Sandy Clay 6.5- 11.5m Sand 11.5 -11.8m weathered sandstone	0- 18.5m Clay Sandy 18.5- 24.5m qtz gravel 24- 34m Clay & gravel 34 -43.5m weathered sandstone & clay	0- 0.5m Sandy 0.5- 18m sandstone - soft with clay	0-150 m Sandstone. Some interbedded Shale; 44-45m, 51-53.5m, 114.5-188.5m, 134.4-135m	0-138 m Sandstone. Some interbedded Ironstone; 48.5-49m, Shale; 49-50.5m, 58.5-60m	Inferred sand/gravels (Maroota)
Comments	located on south west boundary	located on west boundary	located on east boundary	located on south boundary	Allocation is Under utilised. Pumping bore and supply to sand wash plant	Pumping bore and supply to sand wash plant. Treated for Fe floc- not sampled for some yrs (2018 sampled)	Allocation is under utilised. Former agricultural use-spring & unlined dam. Previous data logging (URS, 1996-2012) of pond levels

**Table 3B: Summary of New Monitoring Wells (Hitchcock Road; August 2018)**

PF Formation at Maroota



	PF166MW-2S	PF166MW-2D	PF166MW-3D	PF167MW-4D	PF167MW-4S	PF167MW-5D #
Ground Elevation (mAHD)	210	210.09	198.67	193.39	193.44	181.54
Lot & DP	Lot 1 DP 570966	Lot 1 DP 570966	Lot 1 DP1013943	Lot 167 DP 752039	Lot 167 DP 752039	Lot 214 DP 752039
Groundwater Resource	Maroota Tertiary Sand	Sydney Central Sandstone	Sydney Central Sandstone	Sydney Central Sandstone	Maroota Tertiary Sand	Sydney Central Sandstone
Date Installed	May-17	May-17	May-17	May-17	May-17	1/05/2017 (#Feb 2018)
Drilled Depth (m bgl)	8.5 m	29.4 m	23 m	15.5 m	8 m	9.5 m
Well Screen Interval (mbgl)	4.9 -7.9 m	26.4 -29.4 m	20 -23 m	11.5 -15.5 m	5 -8 m	6.4 -9.4 m
Aquifer Permeability (K m/day)	6.9 * E-01 m/sec	Na	4.57 * E-02 m/sec	1.6 * E-01 m/sec	7.18 * E-02 m/sec	4.95 * E-02 m/sec
Water Levels (mbgl)	4	25	14	8.5	7	2
Water Type	Na-Cl	Na-Cl	Na-Cl	Na-Cl	Ca-SO4	K-Cl
PH	5.39	6.99	5.63	5.85	5.85	5.82
Total Dissolved Solids, TDS	384	549	346	2170	736	1140
Water Bearing Zones (mbgl)	4 to 5.5m	4 to 5.5m	Na	7 to 8 m	7 to 8 m	Na
Geology	0-4m: Sandy Clay 4- 5.5m: Sand 5.5 -8.5m: Sandy Clay	0-4m: Sandy Clay 4-5.5m: Sand 5.5 -8.5m: Sandy Clay 8.5 -29.4m: Sandstone	0-23m: Sandstone	0- 7.1m: Sandy Silt & Clay 7.1 -15.5m: Sandstone	0- 7.1m: Sandy Silt & Clay 7.1 -8m: Sandstone	0 -9.5m: Sandstone
Comments	located on site entrance	located on site entrance	located next to extraction pit	located near Por 167 Dam	located near Por 167 Dam	located on southern extraction area

## Tables 3.1 to 3.2: Maroota Hitchcock Road- Water Analyses (1999 to 2018)



Table 3-1 Bore PF167MW1 Chemical Analyses Summary

Date		2.6.99	8.9.99	21.12.99	9.3.00	28.11.00	21.6.01	19.12.01	26.6.02	23.1.03	9.7.03	30.1.04	29.6.04	15.12.04
pH		4.43	4.49	4.21	4.93	4.28	4.61	4.98	4.52	4.54	5.15	4.31	4.38	4.68
Electrical Conductivity, EC	uS/cm	164	190	201	179	184	170	188	215	199	204	225	221	240
Total Dissolved Solids, TDS	mg/L	118	90	105	115	207	120	108	121	101	116	157	110	143
Calcium, Ca	mg/L	3	3	5	6	3	6	6	5	3	4	4	5	5
Magnesium, Mg	mg/l.	5	4	4	4	4	4	5	4	4	3	4	4	4
Sodium, Na	mg/L	16	18	16	15	18	16	18	25	20	19	22	23	26
Potassium, K	mg/L	2	2	3	3	3	5	4	5	2	2	2	3	3
Bicarbonate, HCO <sub>3</sub>	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1
Sulphate, SO <sub>4</sub>	mg/L	9	11	35	32	16	15	15	14	9	13	12	10	13
Chloride, Cl	mg/L	36	11	35	32	35	36	47	58	4	48	51	53	50
Oil and Grease	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

Table 3-1 (Con't) Bore PF167MW1 Chemical Analyses Summary

Date		22.6.05	19.1.06	6.7.06	5.7.07	3.7.08	3.7.09	16.6.10	22.6.11	20.6.12	19.6.13	8.8.14	30.6.15	10.8.2016	17.7.2017	14.8.2018
pH		5.42	4.32	4.27	4.88	5.29	4	4.3	5.3	4.39	4.18	4.6	4.48	4.54	4.67	3.83
Electrical Conductivity, EC	uS/cm	215	205	199	188	161	177	190	170	174	211	205	150	188	151	210
Total Dissolved Solids, TDS	mg/L	137	141	119	76	100	104	111	101	112		94	70	111	99	113
Calcium, Ca	mg/L	5	4	4	2	6	5	3	4	7	<1	5	5	5	4	4
Magnesium, Mg	mg/l.	4	4	4	3	5	4	3	4	4	4	4	3	4	4	4
Sodium, Na	mg/L	28	25	23	16	13	14	15	18	12	22	19	12	17	14	21
Potassium, K	mg/L	3	3	3	2	4	4	2	4	4	2	3	2	3	3	4
Bicarbonate, HCO <sub>3</sub>	mg/L	2	1	<1	<1	<1	<1	2	2.4	<1	<1	<1	<1	<1	<1	<1
Sulphate, SO <sub>4</sub>	mg/L	13	10	6	10	30	22.6	17.1	18	28	1	19	30	22	24	17
Chloride, Cl	mg/L	56.6	57.4	53.1	36.1	26.4	34.8	39.9	29	22	42	42	15	32	28	40
Oil and Grease	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

Table 3-2 Bore PF166MW1 Chemical Analyses Summary

Date		1.6.99	8.9.99	21.12.99	9.3.00	29.11.00	21.6.01	19.12.01	26.6.02	23.1.03	9.7.03	30.1.04	29.6.04	15.12.04
pH		4.18	4.19	4.13	4.14	4.31	4.19	4.63	4.48	4.82	7.86	4.39	4.27	4.06
Electrical Conductivity, EC	uS/cm	222	240	230	214	266	194	228	219	203	221	193	235	203
Total Dissolved Solids, TDS	mg/L	118	108	137	170	460	115	210	280	128	134	204	280	120
Calcium, Ca	mg/L	1	1	1	1	1	1	1	2	1	1	<1	1	1
Magnesium, Mg	mg/L	6	6	6	5	6	5	6	6	5	4	5	5	4
Sodium, Na	mg/L	26	23	23	22	29	21	22	24	19	20	18	19	19
Potassium, K	mg/L	<1	<1	1	1	1	1	2	1	<1	<1	<1	1	1
Bicarbonate, HCO <sub>3</sub>	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1
Sulphate, SO <sub>4</sub>	mg/L	1	7	1	1	16	2	1	2	<1	<1	2	<1	2
Chloride, Cl	mg/L	58	49	51	52	58	49	58	61	46	50	47	44	36
Oil and Grease	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	5	<5

Table 3-2 (con't) Bore PF166MW1 Chemical Analyses Summary

Date		22.6.05	19.1.06	6.7.06	5.7.07	3.7.08	3.7.09	16.6.10	22.6.11	20.6.12	19.6.13	8.8.14	30.6.15	10.8.2016	17.7.2017	14.8.2018
pH					4.76		3.58	4.06	4.22	4.08	4.53	4.19	4.03	4.18	4.11	dry
Electrical Conductivity, EC	uS/cm	DRY	DRY	DRY	163	NA	240	247	261	229	189	219	239	208	176	
Total Dissolved Solids, TDS	mg/L				98		140	141	172	124	186	89	100	234	122	
Calcium, Ca	mg/L						<1	<1	1	1	6	1	<1	1	<1	
Magnesium, Mg	mg/L						4	4	6	5	4	5	6	5	5	
Sodium, Na	mg/L						26	24	24	19	15	22	26	22	21	
Potassium, K	mg/L						2	2	3	3	4	1	1	2	2	
Bicarbonate, HCO <sub>3</sub>	mg/L						<1	<1	<1	<1	<1	<1	<1	<1	<1	
Sulphate, SO <sub>4</sub>	mg/L						2.21	1.77	1	1	21	2	1	2	2	
Chloride, Cl	mg/L						49.1	56.3	53	43	32	46	38	40	38	
Oil and Grease	mg/L						<5	<5	<5	<5	<5	<5	<5	<5	<5	



### Tables 3.3 to 3.4: Maroota Hitchcock Road- Water Analyses (1999 to 2018)

**Table 3-3 Bore PFL2HitchMW1 Chemical Analyses Summary**

Date		3.7.2009	16.6.2010	22.6.2011	20.6.2012	20.6.2012	19.6.2013	8.08.2014	30.06.2015	10.8.2016	17.7.2017	14.8.2018
pH		3.96	4.1	4.1	4.03	4.03	4.18	3.99	3.94	4.19	4.02	3.96
Electrical Conductivity, EC	uS/cm	182	154	167	195	195	185	263	309	288	298	307
Total Dissolved Solids, TDS	mg/L	84	88	110	99	99	150	107	146	230	147	167
Calcium, Ca	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Magnesium, Mg	mg/L	2	2	2	2	2	2	3	3	3	4	4
Sodium, Na	mg/L	19	16	22	22	22	22	32	44	36	37	37
Potassium, K	mg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate, HCO <sub>3</sub>	mg/L	<1	<	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sulphate, SO <sub>4</sub>	mg/L	7.88	4.06	5	1	1	4	6	6	6	5	6
Chloride, Cl	mg/L	40.3	36.9	32	43	43	43	62	59	63	70	76
Oil and Grease	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

**Table 3-4 Bore PFP214MW1 Chemical Analyses Summary**

Date		3.7.2009	16.6.2010	22.6.2011	20.6.2012	19.6.2013	8.08.2014	30.06.2015	10.8.2016	17.7.2017	14.8.2018
pH		4.19	4.16	4.31	4.27	5.7	4.22	4.07	4.05	4.34	3.65
Electrical Conductivity, EC	uS/cm	168	164	158	179	198	258	251	247	253	228
Total Dissolved Solids, TDS	mg/L	100	96	88	103	124	108	118	135	129	114
Calcium, Ca	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Magnesium, Mg	mg/L	6	5	4	6	7	10	11	10	8	9
Sodium, Na	mg/L	18	15	18	17	21	23	21	17	14	16
Potassium, K	mg/L	1	<1	1	<1	2	<1	<1	1	1	2
Bicarbonate, HCO <sub>3</sub>	mg/L	<1	<1	<1	<1	2	<1	<1	<1	<1	<1
Sulphate, SO <sub>4</sub>	mg/L	1.9	<0.5	<1	<1	<1	<1	<1	<1	<1	<1
Chloride, Cl	mg/L	24.3	23.8	34	24	34	34	26	34	36	36
Oil and Grease	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

Tables 3.1 to 3.6: Maroota Hitchcock Road- Water Analyses (1999 to 2018)



Table 3-5 Bore 198PB1 Chemical Analyses Summary (1999-2018)

Date		1.6.99	8.9.99	21.12.99	9.3.00	28.11.00	21.6.01	19.12.01	26.6.02	23.1.03	9.7.03	30.1.04	29.6.04	15.12.04	22.6.05	19.1.06	6.7.06	5.7.07	3.7.08	3.7.09	16.6.10	22.6.11	20.6.12	19.6.13	8.08.14	30.06.15	10.08.16	17.7.2017	14.8.2018
pH		5.87	6.24	6.11	4.69	4.49	4.51	5.41	4.73	4.49	5.06	5	4.53	4.28	5.22	5.74	5.16	NA	4.59	3.94	4.43	5.52	5.72	NA	4.15	4.09	4.15	5.39	5.35
E Conductivity, EC	uS/cm	161	170	169	141	182	179	204	199	243	199	160	291	197	157	158	155		144	174	163	170	170		183	177	164	151	168
Total Dissolved Solids, TDS	mg/l	124	116	98	97	107	102	116	112	139	102	116	174	88	105	115	98		85	83	88	102	99		96	88	83	104	94
Calcium, Ca	mg/L	1	<1	1	1	3	2	2	4	3	2	2	4	1	1	2	1		<1	1	<1	2	2		1	1	1	2	2
Magnesium, Mg	mg/L	4	6	5	3	3	4	4	4	4	3	2	5	2	2	4	3		2	2	2	4	3		2	2	2	3	3
Sodium, Na	mg/L	21	24	22	19	20	21	27	23	31	22	19	40	25	23	21	20		18	19	16	21	18		20	20	18	18	19
Potassium, K	mg/L	1	<1	1	1	2	5	5	3	3	2	2	3	2	2	2	2		1	2	1	2	2		2	1	2	2	1
Bicarbonate, HCO <sub>3</sub>	mg/l	13	29	22	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	12	5		<1	<1	<1	3.7	9.8		<1	<1	<1	3	7
Sulphate, SO <sub>4</sub>	mg/L	4	4	4	2	8	8	3	7	4	8	6	9	8	8	6	2		10	9.31	6.89	6	6		9	7	8	6	9
Chloride, Cl	mg/l	39	35	36	36	40	49	60	58	64	49	43	83	42	47.1	43.4	43.8		31.1	38.8	41.1	36	32		40	31	33	31	30
Oil and Grease	mg/l	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5	<5	<5	5	<5		<5	<5	<5	<5	<5		<5	<5	<5	<5	<5

Table 3-6 Bore198PB2 Chemical Analyses Summary (1999-2018)

Date		1.6.99	8.9.99	21.12.99	9.3.00	29.11.00	21.6.01	19.12.01	26.6.02	23.1.03	9.7.03	30.1.04	29.6.04	15.12.04	22.6.05	19.1.06	6.7.06	5.7.07	3.7.08	3.7.09	16.6.10	22.6.11	20.6.12	19.6.13	8.08.14	30.06.15	10.08.16	17.7.2017	14.8.2018
pH		5.78	6.61	5.96	NA	4.8	5.24	5.99	6.33	5.96	4.84	5	5.78	5.39	6.43	5.3	5.46	4.37	5.25	4.5	NA	NA	NA	5.71	5.93	no sample	no sample	5.3	5.11
E Conductivity, EC	uS/cm	139	174	146	NA	152	130	141	151	146	162	160	136	156	133	126	122	195	135	130				146	150	(note 1)	(note 1)	156	147
Total Dissolved Solids, TDS	mg/L	126	102	85	NA	100	87	87	102	84	87	116	79	105	87	104	79	88	79	79				91	69			81	90
Calcium, Ca	mg/L	1	2	2	NA	<1	<1	<1	1	<1	<1	2	1	1	<1	<1	1	<1	1	<1				<1	<1			<1	<1
Magnesium, Mg	mg/L	5	5	5	NA	4	3	4	4	4	2	2	4	2	4	3	4	3	5	3				3	4			3	3
Sodium, Na	mg/L	18	19	18	NA	19	18	18	21	17	18	19	18	20	17	19	16	21	16	16				18	18			18	18
Potassium, K	mg/L	2	2	2	NA	1	1	2	2	1	<1	2	1	2	2	1	2	1	2	2				2	2			1	1
Bicarbonate, HCO <sub>3</sub>	mg/L	23	33	19	NA	4	3	13	8	16	<1	<1	9	2	14	7	24	<1	24.4	9.2				9	10			6	6
Sulphate, SO <sub>4</sub>	mg/L	3	3	2	NA	1	1	3	2	<1	<1	6	1	4	4	1	1	4	2	2.78				2	4			6	3
Chloride, Cl	mg/l	31	28	31	NA	41	38	33	46	33	40	43	37	35	34.9	38.8	30.2	44.8	31.8	32.2				33	36			30	38
Oil and Grease	mg/L	<5	<5	<5	-	NA	<5	<5	11	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5				<5	<5			<5	<5

Note 1= Bore clogging (Iron floc) and chemicals added to unclog (unrepresentative water)



**Table 3-7: Portion 167 Dam Annual Pumpage Records**  
1997 to 2018



YEAR	TOTAL, ML
1997	24.56
1998	24.24
1999 to May	16.84
1 June 1999 - 30 June 2000	66.3
1 July 2000 - 5 September 2000	31.4
5 September 2000 - 25 June 2001	Not used
25 June 2001 - 30 June 2001	1
1 July 2001 - 8 February 2002	59.2
8 February 2002 - 30 June 2002	Not used
30 June 2002 - 29 August 2002	Not used
29 August 2002 - 30 June 2003	65.2
1 July 2003 - 29 June 2004	73.1
1 July 2004 - 3 May 2005	57.5
7 October 2005 - 30 June 2006	25.4
1 July 2006 - 30 June 2007	21.3
1 July 2007 - 30 June 2008	21.5
1 July 2008 - 30 June 2009	42.2
1 July 2009 - 30 June 2010	56.2
1 July 2010 - 30 June 2011	48.9
1 July 2011 - 30 June 2012	No pumpage
1 July 2012 - 30 June 2013	42.8
1 July 2013 - 30 June 2014	30.395
1 July 2014 - 30 June 2015	No pumpage
1 July 2015 - 30 June 2016	46.829
1 July 2016 - 30 June 2017	38.407
1 July 2017 - 30 June 2018	<b>48.953</b>

**Table 3-8: Water Supply Bores, Annual Pumping Records (PB1 &2)**  
2000 to 2018

Year	Bore	Total, ML
1 July 1999 - 30 June 2000	Bore PF1 98PB1	21.1
	PF198PB2	35.6
1 July 2000 - 30 June 2001	Bore PF198PB1	20.3
	Bore PF198PB2	29
1 July 2001 - 30 June 2002	Bore PF198PB1	25.1
	Bore PF198PB2	36
1 July 2002 - 30 June 2003	Bore PF198PB1	24.8
	Bore PF198PB2	47.8
1 July 2003 - 29 June 2004	Bore PF198PB1	22.9
	Bore PF198PB2	49.3
1 July 2004 - 29 June 2005	Bore PF1 98PB1	4.2
	Bore PF198PB2	18.7
5 July 2005 - 23 June 2006*	Bore PF198PB1	14.8
	Bore PF198PB2	8.9
24 June 2006 - 30 June 2007*	Bore PF198PB1	7.8
	Bore PF198PB2	19.9
1 July 2007 - 30 June 2008*	Bore PF198PB1	1.6
	Bore PF198PB2	22.9
1 July 2008 - 30 June 2009*	Bore PF198PB1	25.6
	Bore PF198PB2	16
1 July 2009 - 30 June 2010*	Bore PF198PB1	9.5
	Bore PF198PB2	8.1
1 July 2010 - 30 June 2011*	Bore PF198PB1	11.8
	Bore PF198PB2	NA
1 July 2011 - 30 June 2012*	Bore PF198PB1	9.8
	Bore PF198PB2	13.2
1 July 2012 - 30 June 2013	Bore PF198PB1	NA
	Bore PF198PB2	10.9
1 July 2013 - 30 June 2014	Bore PF198PB1	3.6
	Bore PF198PB2	30
1 July 2014 - 30 June 2015	Bore PF198PB1	6.1
	Bore PF198PB2	15.7
1 July 2015 - 30 June 2016	Bore PF198PB1	5.73
	Bore PF198PB2	11.111
1 July 2016 - 30 June 2017	Bore PF198PB1	8.951
	Bore PF198PB2	7.556
1 July 2017 - 30 June 2018	Bore PF198PB1	<b>12.027</b>
	Bore PF198PB2	<b>1.595</b>
	Combined PB1&2 per yr	<b>13.622</b>

Note:

\* Due to modifications carried out at the wash plant, these bores are no longer required for continuous water supply

**Table 3-9: Maroota Hitchcock Road- Water Analyses for New Wells & Dams (May 2017 & August 2018)**



		MW-2S	MW-2S	MW-2S	MW-2D	MW-2D	MW-3D	MW-3D	MW-4S	MW-4S	MW-4D	MW-4D	MWW-5D	CWD	Por167 Dam
Date		17/07/2017	18/05/2017	14/08/2018	18/05/2017	14/08/2018	18/05/2017	1/08/2018	18/05/2017	14/08/2018	18/05/2017	14/08/2018	18/05/2017	14/08/2018	14/08/2018
pH		4.58	5.39	5.5	6.99	5.5	5.63	4.02	6.03	4.48	5.85	5.47	5.82	4.62	4.15
Electrical Conductivity, EC	uS/cm	166	211	128	307	128	278	306	129	76	274	158	190	222	201
Total Dissolved Solids (ALS)	mg/L	114	<b>384</b>	<b>84</b>	<b>549</b>	<b>84</b>	<b>346</b>	<b>159</b>	<b>169</b>	----	<b>736</b>	<b>95</b>	<b>1140</b>	<b>125</b>	<b>108</b>
Calcium, Ca	mg/L	3	5	2	9	2	2	1	7	1	3	2	<1	5	2
Magnesium, Mg	mg/L	4	3	2	3	2	1	7	3	1	1	2	<1	3	3
Sodium, Na	mg/L	18	20	15	40	15	32	36	8	11	37	22	13	25	22
Potassium, K	mg/L	2	2	1	3	1	11	<1	3	1	8	<1	26	3	2
Bicarbonate, HCO <sub>3</sub>	mg/L	<1	2	8	35	8	2	<1	12	<1	8	13	3	<1	<1
Sulphate, SO <sub>4</sub>	mg/L	6	8	3	12	3	3	2	20	4	32	7	<1	5	7
Chloride, Cl	mg/L	38	37	30	40	30	56	68	12	17	34	18	36	45	38
Oil & Grease		<5						<5		<5		<5		<5	<5

Note: Analyses by ALS

Re-analyses conducted on TDS- filtering of samples conducted due to TDS values exceeding EC (turbidity & silica issues)

**bold-** TDS results are considered anomalous (re-analyses conducted after filtering samples, i.e. TDS higher than EC, possibly silica in water)

---- (no TDS available- matrix interference)

## APPENDIX A

### LIMITATIONS

Earth2Water Pty Ltd has prepared this report for the use of PF Formation in accordance with the standard terms and conditions of the consulting profession. This report is prepared in accordance with the scope of work and for the purpose outlined in the proposal. The methodology adopted and sources of information used by E2W are outlined in this report. Some technical issues arose from the downloading of the Solinst data loggers (2008/2009) and considered to reflect logger age).

This report was prepared from August to October 2018 and is based on the information reviewed at the time of preparation. This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of conditions as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented in this report, and our experience.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, E2W should be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

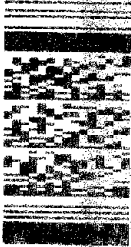
## APPENDIX B



21/8/18

HT

## CHAIN OF CUSTODY DOCUMENTATION- EARTH2WATER PTY LTD

CLIENT: Earth2Water Pty Ltd		LABORATORY BATCH NO.:		ALS Environmental	
POSTAL ADDRESS: 175 Fern St, Gerringong NSW		SAMPLERS: Dino Parisotto/Ellen Swanson		Smithfield	
SEND REPORT TO: D Parisotto		PHONE: 0422 334102 FAX: 4236 1824 E-MAIL: dino@earth2water.com.au		BULLETIN BOARD: <input type="checkbox"/> E-MAIL: YES	
DATA NEEDED BY: 5 day turnaround		REPORT NEEDED BY: 4 day turnaround (important)		DISK: <input type="checkbox"/> FAX: YES	
Site: Maroota		QUOTE NO.:		QC LEVEL: <input type="checkbox"/> QCS1: <input type="checkbox"/> QCS2: <input type="checkbox"/> QCS3: Yes <input type="checkbox"/> QCS4: <input type="checkbox"/>	
P.O. NO.: E2W-224A		COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:			
INVOICE to: Earth2Water		Retain samples for 3 weeks prior to disposal			
SAMPLE DATA			ALS Containers		
SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.
1 PF 167 MW-1	water	14/08/2018		2 bottles	
2 PF 166 MW1	water	14/08/2018		NA	
3 PF L2 Hicth MW1	water	14/08/2018		2 bottles	
4 PF P2 14 MW1	water	14/08/2018			
5 PF 198 PB2	water	14/08/2018			
6 PF 198 PB1	water	14/08/2018			
7 MW4D	water	14-8-18			
8 MW3D	water	14-8-18			
9 CWD	water	14-8-18			
10 For 167 Dam	water	14-8-18			
<div style="display: flex; justify-content: space-between;"> <div> <p>Environmental Division Sydney Work Order Reference <b>ES1823974</b></p>  <p>Telephone: +61-2-8794 8555</p> </div> <div> <p><b>Laboratory Analyses</b></p> <p>1 Oil &amp; Grease</p> <p>2 Ph, EC, TDS,</p> <p>2 Ca, Mg, Na, K, Cl, HCO3, SO4</p> <p>water sample not filtered</p> </div> </div>					
RELINQUISHED BY:		15/8/18		RECEIVED BY:	
NAME: Dino Parisotto		DATE: Aug 2018		NAME: Scott Heyes	
OF: Earth2Water		TIME:		TIME: 1400	
NAME:		DATE:		DATE:	
OF:		TIME:		TIME:	

## CERTIFICATE OF ANALYSIS

**Work Order** : **ES1823974**  
**Client** : **EARTH2WATER PTY LTD**  
**Contact** : **MR DINO PARISOTTO**  
**Address** : **175 FERN ST**  
**GERRINGONG NSW 2534**  
**Telephone** : **+61 4236 1334**  
**Project** : **----**  
**Order number** : **E2W-224A**  
**C-O-C number** : **----**  
**Sampler** : **DINO PARISOTTO, ELLEN SWANSON**  
**Site** : **Maroota**  
**Quote number** : **EN/222/17 - MOD**  
**No. of samples received** : **9**  
**No. of samples analysed** : **9**

**Page** : 1 of 4  
**Laboratory** : Environmental Division Sydney  
**Contact** : Customer Services ES  
**Address** : 277-289 Woodpark Road Smithfield NSW Australia 2164  
**Telephone** : +61-2-8784 8555  
**Date Samples Received** : 15-Aug-2018 14:00  
**Date Analysis Commenced** : 15-Aug-2018  
**Issue Date** : 20-Aug-2018 21:24



This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

**Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.**

### Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW



## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	PF 167 MW-1	PF L2 Hicth MW1	PF P2 14 MW1	PF 198 PB2	PF 198 PB1
Client sampling date / time					14-Aug-2018 00:00	14-Aug-2018 00:00	14-Aug-2018 00:00	14-Aug-2018 00:00	14-Aug-2018 00:00
Compound	CAS Number	LOR	Unit		ES1823974-001	ES1823974-002	ES1823974-003	ES1823974-004	ES1823974-005
					Result	Result	Result	Result	Result
<b>EA005P: pH by PC Titrator</b>									
pH Value	----	0.01	pH Unit		----	3.96	----	5.11	5.35
<b>EA010P: Conductivity by PC Titrator</b>									
Electrical Conductivity @ 25°C	----	1	µS/cm		----	307	----	147	168
<b>EA015: Total Dissolved Solids dried at 180 ± 5 °C</b>									
Total Dissolved Solids @180°C	----	10	mg/L		----	167	----	90	94
<b>ED037P: Alkalinity by PC Titrator</b>									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		----	<1	----	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		----	<1	----	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		----	<1	----	6	7
Total Alkalinity as CaCO3	----	1	mg/L		----	<1	----	6	7
<b>ED041G: Sulfate (Turbidimetric) as SO4 2- by DA</b>									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		----	6	----	3	9
<b>ED045G: Chloride by Discrete Analyser</b>									
Chloride	16887-00-6	1	mg/L		----	76	----	38	30
<b>ED093F: Dissolved Major Cations</b>									
Calcium	7440-70-2	1	mg/L		----	<1	----	<1	2
Magnesium	7439-95-4	1	mg/L		----	4	----	3	3
Sodium	7440-23-5	1	mg/L		----	37	----	18	19
Potassium	7440-09-7	1	mg/L		----	<1	----	1	1
<b>EN055: Ionic Balance</b>									
Total Anions	----	0.01	meq/L		----	2.27	----	1.25	1.17
Total Cations	----	0.01	meq/L		----	1.94	----	1.06	1.20
<b>EP020: Oil and Grease (O&amp;G)</b>									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW4D	MW3D	CWD	Por 167 Dam	----
Client sampling date / time					14-Aug-2018 00:00	14-Aug-2018 00:00	14-Aug-2018 00:00	14-Aug-2018 00:00	----
Compound	CAS Number	LOR	Unit		ES1823974-006	ES1823974-007	ES1823974-008	ES1823974-009	-----
					Result	Result	Result	Result	----
<b>EA005P: pH by PC Titrator</b>									
pH Value	----	0.01	pH Unit		----	----	4.62	4.15	----
<b>EA010P: Conductivity by PC Titrator</b>									
Electrical Conductivity @ 25°C	----	1	µS/cm		----	----	222	201	----
<b>EA015: Total Dissolved Solids dried at 180 ± 5 °C</b>									
Total Dissolved Solids @180°C	----	10	mg/L		----	----	125	108	----
<b>ED037P: Alkalinity by PC Titrator</b>									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		----	----	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		----	----	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		----	----	<1	<1	----
Total Alkalinity as CaCO3	----	1	mg/L		----	----	<1	<1	----
<b>ED041G: Sulfate (Turbidimetric) as SO4 2- by DA</b>									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		----	----	5	7	----
<b>ED045G: Chloride by Discrete Analyser</b>									
Chloride	16887-00-6	1	mg/L		----	----	45	38	----
<b>ED093F: Dissolved Major Cations</b>									
Calcium	7440-70-2	1	mg/L		----	----	5	2	----
Magnesium	7439-95-4	1	mg/L		----	----	3	3	----
Sodium	7440-23-5	1	mg/L		----	----	25	22	----
Potassium	7440-09-7	1	mg/L		----	----	3	2	----
<b>EN055: Ionic Balance</b>									
Total Anions	----	0.01	meq/L		----	----	1.37	1.22	----
Total Cations	----	0.01	meq/L		----	----	1.66	1.35	----
<b>EP020: Oil and Grease (O&amp;G)</b>									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	----



Environmental Division  
Sydney  
Work Order Reference  
**ES1823206**



Telephone : + 61-2-6784 8555



MARRIOTT  
SYDNEY HARBOUR  
CIRCULAR QUAY

South East Environmental.  
Water samples.

Please check for

PH

EC

TDS

Major cations

Major Anions

Anything further best to contact  
Dino at Earth 2 Water. He  
knows what is needed.

Thanks.

Melissa Mass.

30 PITT STREET, SYDNEY NSW AUSTRALIA • PO BOX R656 ROYAL EXCHANGE, SYDNEY NSW 1225  
T: (61 2) 9259 7000 • F: (61 2) 9251 1122  
www.marriott.com

REC: Sydney  
08/18/18 1520  
127



# CHAIN OF CUSTODY

ALS Laboratory  
please tick ✓

23/6/17 10:17 AM  
Ph: 07 3300 9900 E: [enquiries@als.com.au](mailto:enquiries@als.com.au)  
C/O: 23/6/17 10:17 AM  
Ph: 07 3300 9900 E: [enquiries@als.com.au](mailto:enquiries@als.com.au)  
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Ph: 07 3300 9900 E: [enquiries@als.com.au](mailto:enquiries@als.com.au)

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C/O: 23/6/17 10:17 AM  
Ph: 07 3300 9900 E: [enquiries@als.com.au](mailto:enquiries@als.com.au)  
C/O: 23/6/17 10:17 AM  
Ph: 07 3300 9900 E: [enquiries@als.com.au](mailto:enquiries@als.com.au)

CLIENT: Earth 2 Water

OFFICE:

PROJECT:

ORDER NUMBER:

PROJECT MANAGER:

SAMPLER:

COC emailed to ALS? (YES / NO)

Email Reports to (will default to PM if no other addresses are listed):

Email invoices to (will default to PM if no other addresses are listed):

COMMENT/SPECIAL HANDLING/STORAGE OR DISPOSAL:

TURNAROUND REQUIREMENTS:  
(Standard TAT may be longer for some tests  
e.g. Ultra Trace Organics)

☐ Standard TAT (list due date):  
☐ Non Standard or urgent TAT (list due date):

COC SEQUENCE NUMBER (circle)

FOR LABORATORY USE ONLY (Circle)

Yes No N/A

RECEIVED BY:

RECEIVED BY:

Yes No N/A

DATE/TIME:

DATE/TIME:

Yes No N/A

DATE/TIME:

DATE/TIME:

Yes No N/A

DATE/TIME:

DATE/TIME:

Yes No N/A

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Yes No N/A

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Yes No N/A

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved Plastic; AP = Airtight Unpreserved Plastic; V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulfate Preserved; VS = VOA Vial Sulfuric Unpreserved Vial SO = Sulfuric Preserved Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Solids; R = Unpreserved Bag.

## CERTIFICATE OF ANALYSIS

**Work Order** : **ES1823206**  
**Client** : **EARTH2WATER PTY LTD**  
**Contact** : **MR DINO PARISOTTO**  
**Address** : **175 FERN ST**  
**GERRINGONG NSW 2534**  
**Telephone** : **+61 4236 1334**  
**Project** : **----**  
**Order number** : **----**  
**C-O-C number** : **----**  
**Sampler** : **----**  
**Site** : **----**  
**Quote number** : **EN/222/17 - MOD**  
**No. of samples received** : **12**  
**No. of samples analysed** : **12**

**Page** : 1 of 5  
**Laboratory** : Environmental Division Sydney  
**Contact** : Customer Services ES  
**Address** : 277-289 Woodpark Road Smithfield NSW Australia 2164  
**Telephone** : +61-2-8784 8555  
**Date Samples Received** : 08-Aug-2018 15:20  
**Date Analysis Commenced** : 08-Aug-2018  
**Issue Date** : 13-Aug-2018 15:13



This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

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- Analytical Results

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### Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW



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Where moisture determination has been performed, results are reported on a dry weight basis.

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Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- TDS by method EA-015 may bias high for various samples due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH_02S	BH_04	BH_06D	PFP214 MW1	PF167 MW1
Client sampling date / time					07-Aug-2018 12:05	07-Aug-2018 11:27	07-Aug-2018 12:15	07-Aug-2018 09:01	07-Aug-2018 09:59
Compound	CAS Number	LOR	Unit		ES1823206-001	ES1823206-002	ES1823206-003	ES1823206-004	ES1823206-005
					Result	Result	Result	Result	Result
<b>EA005P: pH by PC Titrator</b>									
pH Value	----	0.01	pH Unit		3.62	3.76	4.67	3.65	3.83
<b>EA010P: Conductivity by PC Titrator</b>									
Electrical Conductivity @ 25°C	----	1	µS/cm		237	134	1690	228	210
<b>EA015: Total Dissolved Solids dried at 180 ± 5 °C</b>									
Total Dissolved Solids @180°C	----	10	mg/L		242	168	848	114	113
<b>ED037P: Alkalinity by PC Titrator</b>									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		<1	<1	<1	<1	<1
Total Alkalinity as CaCO3	----	1	mg/L		<1	<1	<1	<1	<1
<b>ED041G: Sulfate (Turbidimetric) as SO4 2- by DA</b>									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		33	6	44	<1	17
<b>ED045G: Chloride by Discrete Analyser</b>									
Chloride	16887-00-6	1	mg/L		34	28	508	36	40
<b>ED093F: Dissolved Major Cations</b>									
Calcium	7440-70-2	1	mg/L		<1	<1	10	<1	4
Magnesium	7439-95-4	1	mg/L		2	2	33	9	4
Sodium	7440-23-5	1	mg/L		32	16	248	16	21
Potassium	7440-09-7	1	mg/L		<1	<1	1	2	4
<b>EN055: Ionic Balance</b>									
Total Anions	----	0.01	meq/L		1.65	0.91	15.2	1.02	1.48
Total Cations	----	0.01	meq/L		1.56	0.86	14.0	1.49	1.54
Ionic Balance	----	0.01	%		----	----	4.16	----	----



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	PFPI4-MW1	PFL3MW-2	PFPI4-WM2	PFPI4-WM3	PF166MW-3D
Client sampling date / time					07-Aug-2018 10:45	07-Aug-2018 10:15	07-Aug-2018 11:04	07-Aug-2018 11:12	07-Aug-2018 09:28
Compound	CAS Number	LOR	Unit		ES1823206-006	ES1823206-007	ES1823206-008	ES1823206-009	ES1823206-010
					Result	Result	Result	Result	Result
<b>EA005P: pH by PC Titrator</b>									
pH Value	----	0.01	pH Unit		3.68	3.54	3.45	3.50	4.02
<b>EA010P: Conductivity by PC Titrator</b>									
Electrical Conductivity @ 25°C	----	1	µS/cm		152	222	295	169	306
<b>EA015: Total Dissolved Solids dried at 180 ± 5 °C</b>									
Total Dissolved Solids @180°C	----	10	mg/L		77	112	152	89	159
<b>ED037P: Alkalinity by PC Titrator</b>									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		<1	<1	<1	<1	<1
Total Alkalinity as CaCO3	----	1	mg/L		<1	<1	<1	<1	<1
<b>ED041G: Sulfate (Turbidimetric) as SO4 2- by DA</b>									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		2	3	3	2	2
<b>ED045G: Chloride by Discrete Analyser</b>									
Chloride	16887-00-6	1	mg/L		34	48	62	37	68
<b>ED093F: Dissolved Major Cations</b>									
Calcium	7440-70-2	1	mg/L		<1	<1	<1	<1	1
Magnesium	7439-95-4	1	mg/L		2	3	5	2	7
Sodium	7440-23-5	1	mg/L		17	23	31	19	36
Potassium	7440-09-7	1	mg/L		2	1	1	<1	<1
<b>EN055: Ionic Balance</b>									
Total Anions	----	0.01	meq/L		1.00	1.42	1.81	1.08	1.96
Total Cations	----	0.01	meq/L		0.96	1.27	1.78	0.99	2.19



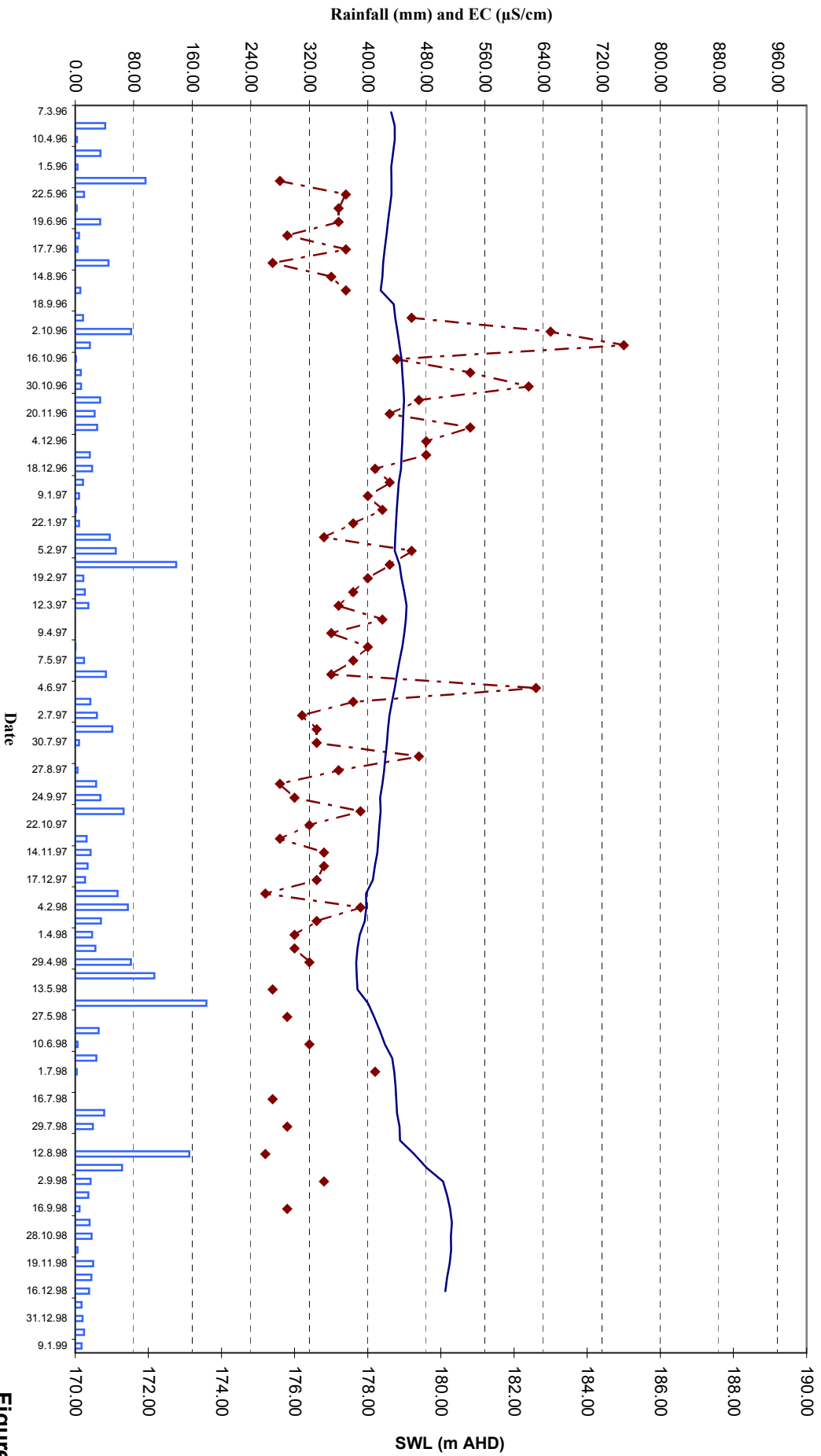


## Analytical Results

Sub-Matrix: <b>WATER</b> (Matrix: <b>WATER</b> )				Client sample ID	PF167MW-4D	PF167MW-4S	----	----	----
Client sampling date / time					07-Aug-2018 09:17	07-Aug-2018 09:20	----	----	----
Compound	CAS Number	LOR	Unit		ES1823206-011	ES1823206-012	-----	-----	-----
					Result	Result	----	----	----
<b>EA005P: pH by PC Titrator</b>									
pH Value	----	0.01	pH Unit		5.47	4.48	----	----	----
<b>EA010P: Conductivity by PC Titrator</b>									
Electrical Conductivity @ 25°C	----	1	µS/cm		158	76	----	----	----
<b>EA015: Total Dissolved Solids dried at 180 ± 5 °C</b>									
Total Dissolved Solids @180°C	----	10	mg/L		95	----	----	----	----
<b>ED037P: Alkalinity by PC Titrator</b>									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		13	<1	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		13	<1	----	----	----
<b>ED041G: Sulfate (Turbidimetric) as SO4 2- by DA</b>									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		7	4	----	----	----
<b>ED045G: Chloride by Discrete Analyser</b>									
Chloride	16887-00-6	1	mg/L		18	17	----	----	----
<b>ED093F: Dissolved Major Cations</b>									
Calcium	7440-70-2	1	mg/L		2	1	----	----	----
Magnesium	7439-95-4	1	mg/L		2	1	----	----	----
Sodium	7440-23-5	1	mg/L		22	11	----	----	----
Potassium	7440-09-7	1	mg/L		<1	1	----	----	----
<b>EN055: Ionic Balance</b>									
Total Anions	----	0.01	meq/L		0.91	0.56	----	----	----
Total Cations	----	0.01	meq/L		1.22	0.64	----	----	----

## APPENDIX C

**P.F.FORMATION**  
**Bore PF167MW1 Groundwater Monitoring Data**



**Figure 2**



**PF FORMATION**  
**Bore PF167MW1 Groundwater Monitoring Data**

— Rainfall, mm  
— Water level m AHD

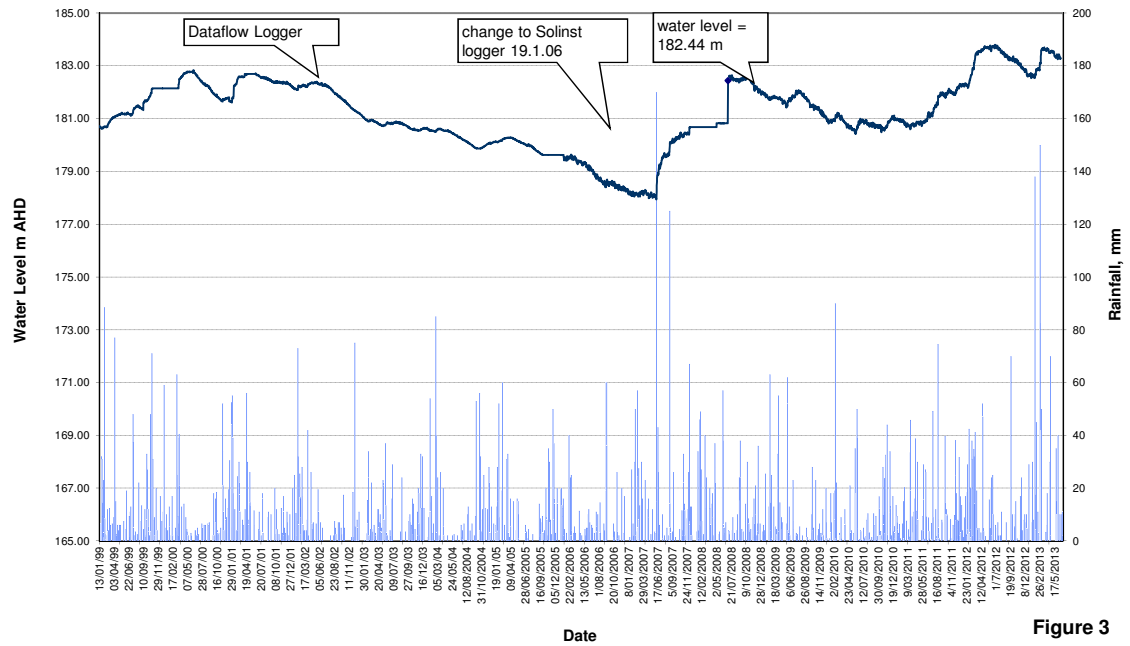


Figure 3

# PF FORMATION PF166MW1 Groundwater Monitoring Data

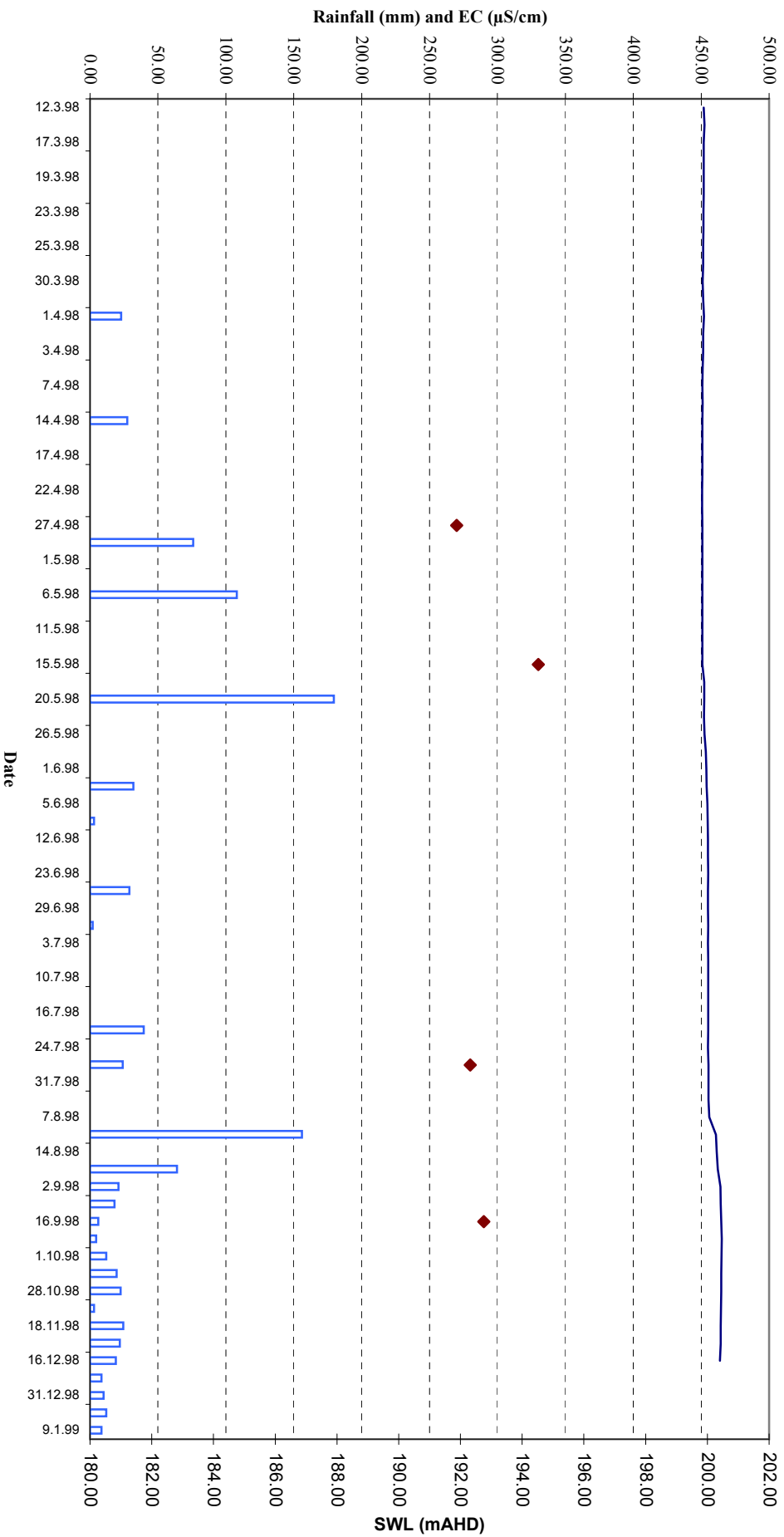
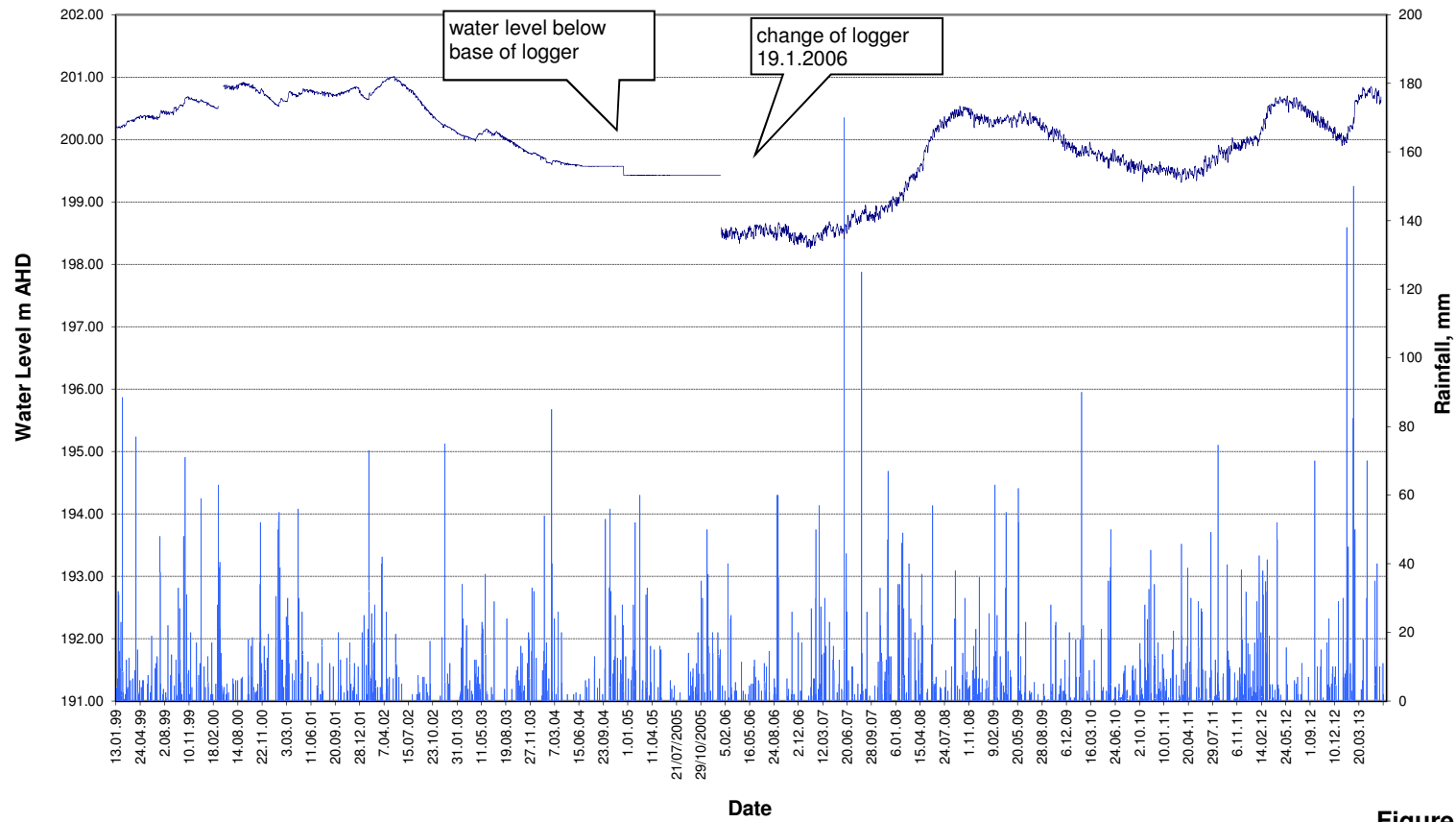


Figure 4



**PF FORMATION**  
**Bore PF166MW1 Groundwater Monitoring Data**

— Rainfall, mm  
— Water Level m AHD



**Figure 5**



# PF FORMATION Bore PFP214MW1 Groundwater Monitoring Data

— Rainfall, mm  
— Water Level, m AHD

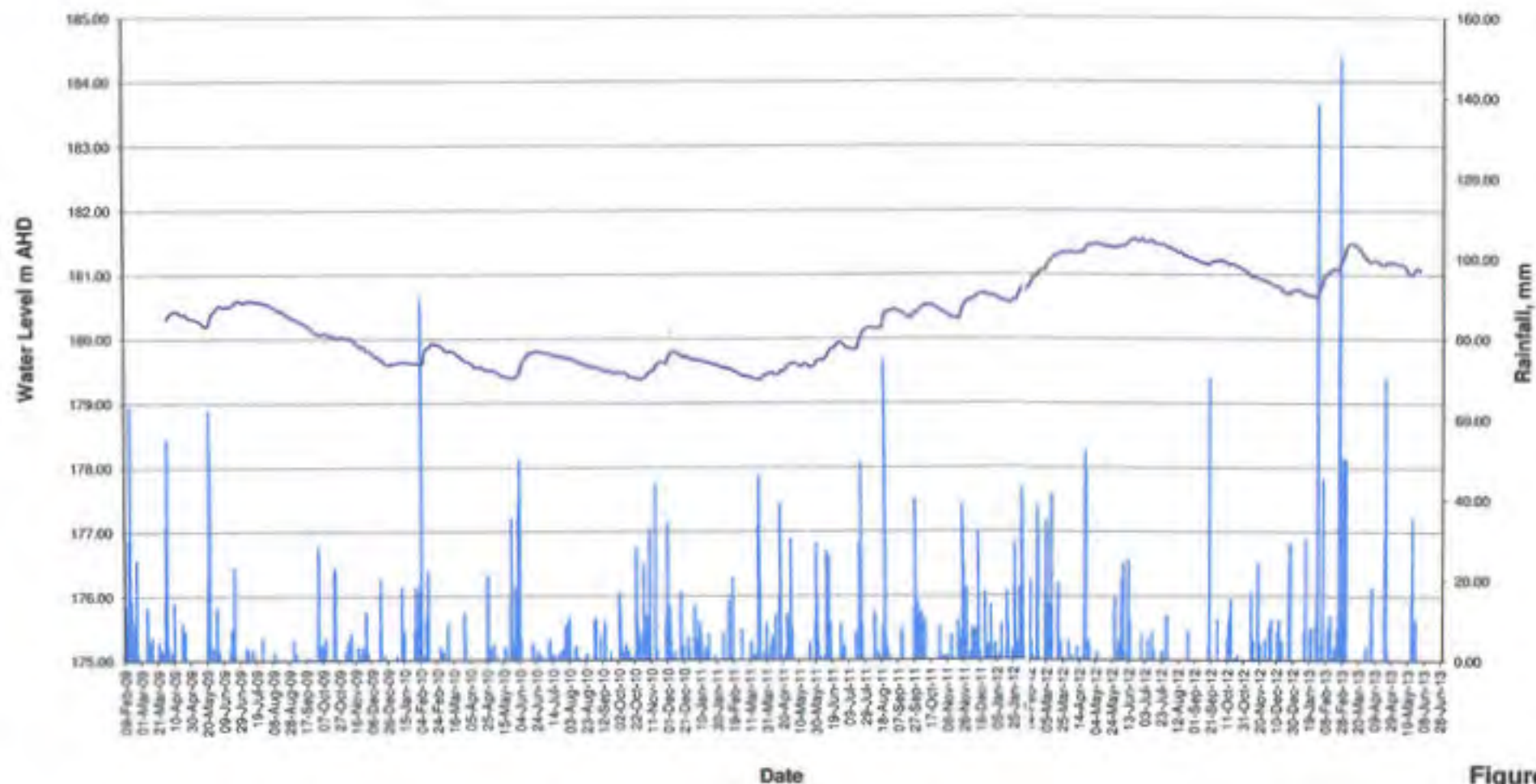
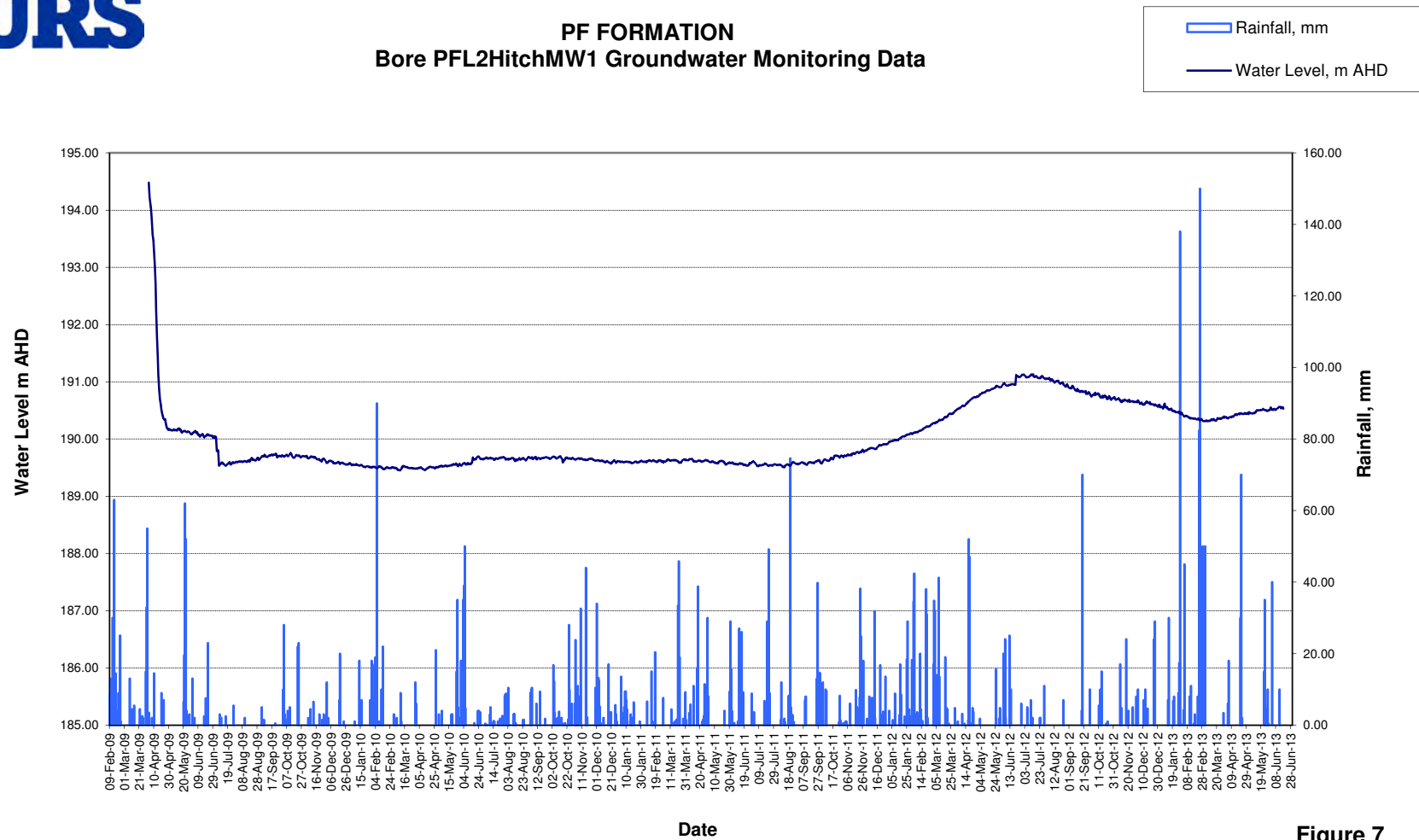


Figure 6



**PF FORMATION**  
**Bore PFL2HitchMW1 Groundwater Monitoring Data**



**Figure 7**



PF FORMATION  
PF167DAM, Licence No. 10BL157308, Groundwater Monitoring Data

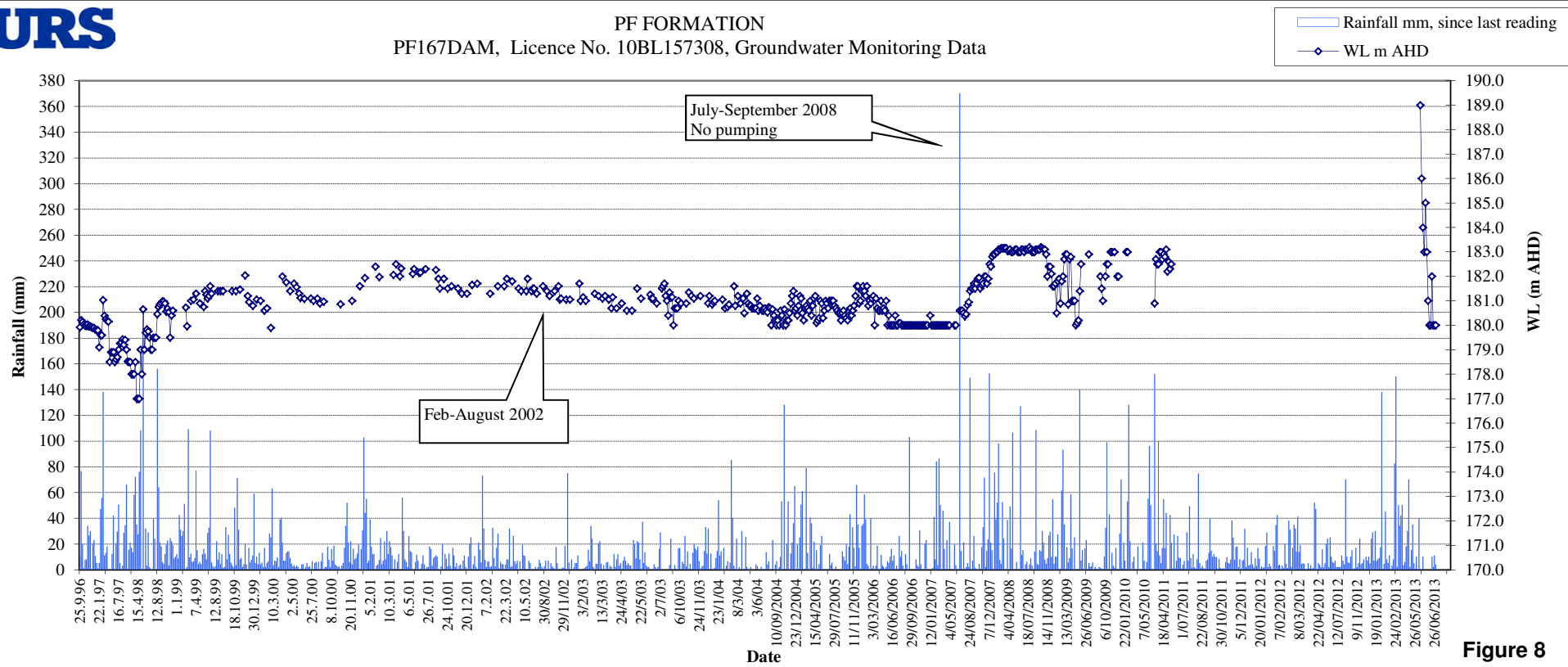


Figure 8



# PF FORMATION PF167DAM Monthly Pumpage Records

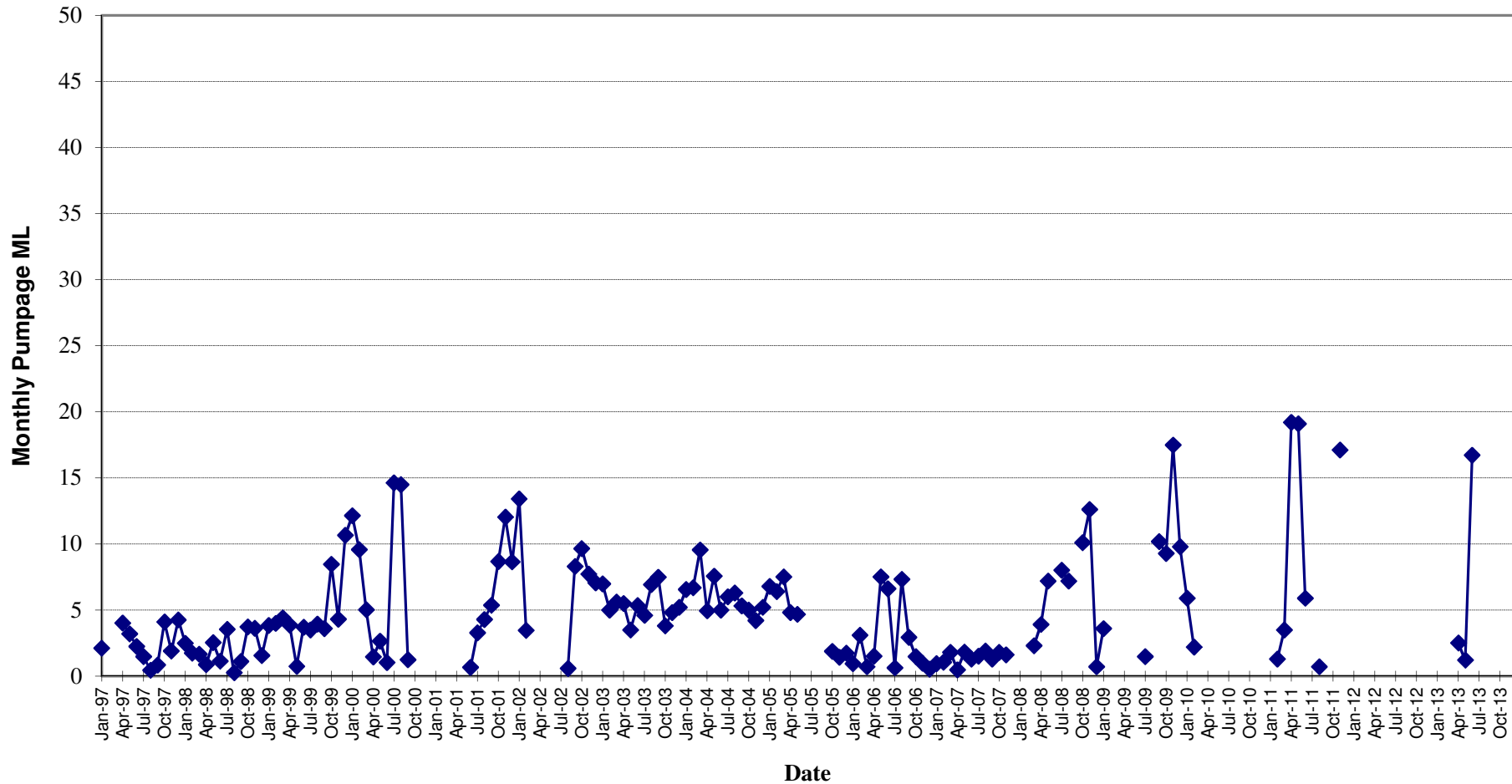


Figure 9

## APPENDIX D

## GROUNDWATER MONITORING WELL

<b>PROJECT :</b> Maroota- Hitchcock Rd		<b>JOB NO:</b> E2W-0238 Earth2Water Pty Ltd	
<b>LOCATION:</b> PF166MW-2s		<b>DATE STARTED:</b> 16/05/2017	
<b>SUPERVISOR:</b> Dino Parisotto (Lic DL1977)		<b>DATE COMPLETED:</b> 16/05/2017	
Contractor: TerraTest Pty Ltd		Method: SFA 125 mm diam	
Rig: Hydrapower Scout		Depth: 8.5 m	R.L. Ground (m):
Datum: Ground level		Water Level: approx 4 mbgl	R.L. WL (m):
<b>Well ID: MW-2s</b>			
Lithological Log	Comments	Depth (m)	Bore Construction Details
<div style="display: flex; justify-content: space-between;"> <div style="width: 40%;"> <p>Maroota Sands Outcrop- rehab area</p> <p>0 - 4 m Sandy Clay (fill): medium brown firm, moist, slightly plastic some quartz pebbles</p> <p>4- 5.5 m Sand: light grey, some silt &amp; granules, loose, saturated/wet (palaeochannel)</p> <p>5.5- 8.5m Sandy Clay: med brown, stiff plastic, moist</p> <p>8.5 m End of Borehole (target depth- sandy clay)</p> </div> <div style="width: 10%; text-align: center;"> <p>ingress</p> </div> <div style="width: 40%;"> <p>Monument- steel PVC/50mm stick-up (+0.65m)</p> <p>cement plug around PVC sleeve</p> <p>drill cuttings &amp; bentonite</p> <p>50mm PVC class 18 Casing ('+0.65m to 4.9m)</p> <p>Bentonite seal (2- 4.2m)</p> <p>4.2 - 8 m Gravel pack (2mm)</p> <p>4.9- 7.9m, 50mm PVC cl 18 screen 0.45mm aperture, screw coupling</p> <p>PVC end cap at 7.9 m</p> </div> </div>			
		0	
		1.0	
		2.0	
		3.0	
		4.0	
		5.0	
		6.0	
		7.0	
		8.0	
		9.0	
		10.0	
		11.0	



# GROUNDWATER MONITORING WELL


<b>PROJECT :</b>	Maroota- Hitchcock Rd	<b>JOB NO:</b>	E2W-0238 Earth2Water Pty Ltd
<b>LOCATION:</b>	PF166MW-2D	<b>DATE STARTED:</b>	16/05/2017
<b>SUPERVISOR:</b>	Dino Parisotto (Lic DL1977)	<b>DATE COMPLETED:</b>	17/05/2017
Contractor: TerraTest Pty Ltd	Method:	SFA 125 mm diam to 11m , RAB from 11-30m (100mm diam)	
Rig: Hydrapower Scout	Depth:	29.4 m	R.L. Ground (m):
Datum: Ground level	Water Level: approx 25 mbgl		R.L. WL (m):

**Well ID: MW-2D**

Lithological Log	Comments	Depth (m)	Bore Construction Details
Maroota Sands Outcrop- rehab area			Monument- steel PVC/50mm stick-up (+0.6m)
0 - 4 m Sandy Clay (fill): medium brown firm, moist, slightly plastic some quartz pebbles		0	cement plug around PVC sleeve
3.5- 5.7m Sand: light brown, some silt & granules, loose, saturated/wet (palaeochannel)	ingress	2.5	drill cuttings & bentonite
5.7-6.3 m Hard band (iron stone)		5.0	50mm PVC class 18 Casing ('+0.6m to 26.4m)
6.3- 9.5m Sandy Clay: med brown, stiff plastic, moist		7.5	
9.5-29.4m Sandstone/Siltstone (soft); light grey fine grained, clay matrix, moist weathered	11m RAB	10.0	
dusty drill cuttings- light grey		12.5	
moderately hard siltstone/sandstone		15.0	
		17.5	
moderately hard siltstone/sandstone		20.0	
light grey, clay matrix		22.5	Bentonite seal (23- 29.4m)
	minor ingress <0.01 L/sec	25.0	25 -29.4m Gravel pack (2mm)
		27.5	26.4- 29.4m, 50mm PVC cl 18 screen 0.45mm aperture, screw coupling
29.4 m End of Borehole (target depth- hard sandstone/siltstone)		30.0	PVC end cap at 29.4m



## GROUNDWATER MONITORING WELL

<b>PROJECT :</b> Maroota- Hitchcock Rd		<b>JOB NO:</b> E2W-0238 Earth2Water Pty Ltd	
<b>LOCATION:</b> PF167MW-3D		<b>DATE STARTED:</b> 17/05/2017	
<b>SUPERVISOR:</b> Dino Parisotto (Lic DL1977)		<b>DATE COMPLETED:</b> 17/05/2017	
Contractor: TerraTest Pty Ltd	Method:	SFA 125 mm diam to 3m , RAB from 3-23m (100mm diam)	
Rig: Hydrapower Scout	Depth:	23 m	R.L. Ground (m):
Datum: Ground level	Water Level: approx 14 mbgl		R.L. WL (m):
<b>Well ID: MW-3D</b>			
Lithological Log	Comments	Depth (m)	Bore Construction Details
Maroota Sands & Sandstone (extraction pit) 0 to 23m Sandstone/Siltstone (soft): light grey fine grained, weathered, clay matrix slight moisture  hard light grey sandstone- dry  dusty drill cuttings- light grey        moderately hard siltstone/sandstone        dusty drill cuttings- light grey  moderately hard siltstone/sandstone        dusty drill cuttings- light grey	SFA	0	 Monument- steel PVC/50mm stick-up (+0.75m)
		1.5	
	3m RAB	3.0	cement plug around PVC sleeve
		4.5	drill cuttings & bentonite
		6.0	50mm PVC class 18 Casing (+0.75m to 20m)
		7.5	
		9.0	
		10.5	
		12.0	
		13.5	
		15.0	
		16.5	Bentonite seal (16- 18.6m)
		18.0	
		19.5	
		21.0	20 - 23 m, 50mm PVC cl 18 screen 0.45mm aperture, screw coupling
		22.5	18.6- 23m Gravel pack (2mm)
		24.0	PVC end cap at 23 m
		25.5	
23 m End of Borehole (target depth- moderate hard sandstone)	dry		

# GROUNDWATER MONITORING WELL

<b>PROJECT :</b>	Maroota- Hitchcock Rd	<b>JOB NO:</b>	E2W-0238 Earth2Water Pty Ltd
<b>LOCATION:</b>	PF167MW-4s	<b>DATE STARTED:</b>	18/05/2017
<b>SUPERVISOR:</b>	Dino Parisotto (Lic DL1977)	<b>DATE COMPLETED:</b>	18/05/2017
Contractor: TerraTest Pty Ltd	Method:	SFA 125 mm diam	
Rig: Hydrapower Scout	Depth:	8 m	R.L. Ground (m):
Datum: Ground level	Water Level: approx 7 mbgl		R.L. WL (m):

**Well ID: MW-4s**

Lithological Log	Comments	Depth (m)	Bore Construction Details
Maroota Sands Outcrop- near Por167 Dam			Monument- steel PVC/50mm stick-up (+0.5m)
0 - 2 m Sandy Silty Clay: medium brown firm, moist, uniform, slightly plastic		0	cement plug around PVC sleeve
		1.0	drill cuttings & bentonite
2- 3.5 m Sandy Clay: med brown/red brown firm-stiff, moist, uniform, slightly plastic		2.0	50mm PVC class 18 Casing ('+0.5m to 6.4m)
		3.0	
3.5-7.1m Sandy Silt: med brown, some clay (10%) & minor pebbles, firm, moist.		4.0	Bentonite seal (2- 4m)
		5.0	
		6.0	4 - 8 m Gravel pack (2mm)
	minor ingress	7.0	5 - 8 m, 50mm PVC cl 18 screen 0.45mm aperture, screw coupling
7.1- 8 m Sandstone/Siltstone (soft); light grey fine grained, clay matrix, moist weathered		8.0	PVC end cap at 8 m
8 m End of Borehole (target depth- moderate hard sandstone)		9.0	
		10.0	
		11.0	



## GROUNDWATER MONITORING WELL

<b>PROJECT :</b> Maroota- Hitchcock Rd		<b>JOB NO:</b> E2W-0238 Earth2Water Pty Ltd	
<b>LOCATION:</b> PF167MW-4D		<b>DATE STARTED:</b> 18/05/2017	
<b>SUPERVISOR:</b> Dino Parisotto (Lic DL1977)		<b>DATE COMPLETED:</b> 18/05/2017	
Contractor: TerraTest Pty Ltd		Method: SFA 125 mm diam	
Rig: Hydrapower Scout		Depth: 15.5 m	
Datum: Ground level		R.L. Ground (m):	
		Water Level: approx 8.5 mbgl	
		R.L. WL (m):	
<b>Well ID: MW-4D</b>			
<b>Lithological Log</b>	<b>Comments</b>	<b>Depth (m)</b>	<b>Bore Construction Details</b>
<div><div><div>Maroota Sands Outcrop- near Por167 Dam</div><div>0 - 2 m Sandy Silty Clay: medium brown firm, moist, uniform, slightly plastic</div><div>2- 3.5 m Sandy Clay: med brown/red brown firm-stiff, moist, uniform, slightly plastic</div><div>3.5-7.1m Sandy Silt: med brown, some clay (10%) &amp; minor pebbles, firm, moist.</div><div>7.1-15.5 m Sandstone/Siltstone (soft); light grey fine grained, clay matrix, moist weathered</div><div>muddy drill cutting returns</div><div>15.5 m End of Borehole (target depth- moderate hard sandstone)</div></div><div>minor ingress</div><div><div><div>Monument- steel PVC/50mm stick-up (+0.5m)</div><div>cement plug around PVC sleeve</div><div>drill cuttings &amp; bentonite</div><div>50mm PVC class 18 Casing ('+0.5m to 12.5m)</div><div>Bentonite seal (9.4- 11.4m)</div><div>12.5 - 15.5m, 50mm PVC cl 18 screen 0.45mm aperture, screw coupling</div><div>11.4-15.5m Gravel pack (2mm)</div><div>PVC end cap at 15.5 m</div></div></div></div>			

# GROUNDWATER MONITORING WELL

<b>PROJECT :</b> Maroota- Hitchcock Rd		<b>JOB NO:</b> E2W-0238 Earth2Water Pty Ltd	
<b>LOCATION:</b> PF166MW-5D		<b>DATE STARTED:</b> 18/05/2017	
<b>SUPERVISOR:</b> Dino Parisotto (Lic DL1977)		<b>DATE COMPLETED:</b> 18/05/2017	
Contractor: TerraTest Pty Ltd		Method: SFA 125 mm diam	
Rig: Hydrapower Scout		Depth: 9.5 m	
Datum: Ground level		R.L. Ground (m):	
		Water Level: approx 3 mbgl	
		R.L. WL (m):	
<b>Well ID: MW-5D</b>			
<b>Lithological Log</b>	<b>Comments</b>	<b>Depth (m)</b>	<b>Bore Construction Details</b>
Sandstone Outcrop- near Silt Pond 0 to 9.5m Sandstone/Siltstone (soft): light grey fine grained, weathered, clay matrix moist  becoming very moist  hardness increasing  moderately hard siltstone/sandstone light grey, clay matrix muddy drill cutting returns	minor ingress	0	Monument- steel PVC/50mm stick-up (+0.5m) cement plug around PVC sleeve
		1.0	
		2.0	50mm PVC class 18 Casing (+0.5m to 6.4m)
		3.0	drill cuttings & bentonite
		4.0	Bentonite seal (3.5- 5.5m)
		5.0	
		6.0	
		7.0	6.4 - 9.4 m, 50mm PVC cl 18 screen 0.45mm aperture, screw coupling
		8.0	5.5-9.4 m Gravel pack (2mm)
		9.0	
9.5m End of Borehole (target depth- moderate hard sandstone)		10.0	PVC end cap at 9.4 m
		11.0	



## APPENDIX E

### Mathew Freeburn Pty Ltd (survey information)

**From:** Clint [mailto:clint@freeburnsurveyors.com]  
**Sent:** Monday, 29 May 2017 3:50 PM  
**To:** 'Josh Graham' <josh@pfformation.com.au>  
**Subject:** Extraction Levels and Wells.

Hi Josh,

Below are the Coordinates and levels taken on concrete base, top of pipe and top of metal lid for new and existing monitoring wells.

(PFP214 MW1) E =313286.41 N = 6294508.34 RL 184.450 Concrete - RL 185.26 Pipe - RL 185.34 Lid  
(PF167MW-5D) E =313203.61 N = 6294658.95 RL 180.850 Concrete - RL 181.54 Pipe - RL 181.65 Lid  
(PF167 MW1) E =313190.79 N = 6294816.05 RL 187.850 Concrete - RL 187.95 Pipe  
(PF167MW-4S) E =313725.86 N =6294836.93 RL 192.930 Concrete - RL 193.44 Pipe - RL 193.57 Lid  
(PF167MW-4D) E =313727.56 N = 6294836.89 RL 192.930 Concrete - RL 193.39 Pipe - RL 193.193.52 Lid  
(PF166MW-3D) E =313545.67 N = 6295186.86 RL 197.930 Concrete - RL 198.67 Pipe - RL 198.81 Lid  
(PF166 MW1) E =313293.61 N = 6295256.65 RL 209.780 Concrete - RL 210.35 Pipe - RL 210.55 Lid  
(PF166MW-2D) E =313438.92 N = 6295492.65 RL 209.280 Concrete - RL 209.90 Pipe - RL 210.09 Lid  
(PF166MW-2S) E =313439.64 N = 6295494.49 RL 209.300 Concrete - RL 210.00 Pipe - RL 210.10 Lid  
(PFL2HITCH MW1) E =313810.71 N = 6295241.46 RL 225.130 Concrete - RL 225.87 Pipe - RL 226.01 Lid

Please also see attached PDF's showing levels taken at bottom of extraction.

I think this all you need for tomorrow if you need anything else please let me know.

Regards

Clint Donnelly.  
0433121668

**FREEBURN SURVEYING**

PHONE: (02) 4721 2289 FAX: (02) 4721 5646  
SUITE 2, FIRST FLOOR "SURVEYOR HOUSE"  
2 CASTLEREAGH STREET, PENRITH NSW 2750



## APPENDIX F



## APPENDIX G

Bore Water Monitoring				
Hitchcocks Road & 198				
<b>Lot 198 PB01 - Washplant</b>				
Date	Time	SWL (m,toc)	P/NP	Notes
7/06/2017	1510	18.6	P	
19/07/2017	1135	15.17	P	
11/08/2017	1324	14.42	NP	
23/10/2017	1320	42.66	P	

Monitoring conducted by Melissa Mass (SE Environmental P/L)

Bore Water Monitoring					
Hitchcocks Road & 198					
Lot 198 PB02 - Workshop					
Date	Time	SWL (m,toc)	P/NP	SWL,m (AHD)	Notes
7/06/2017		18.6	NP		
19/07/2017	1130	18.5	NP		
10/08/2017	645	18.51	NP		
23/10/2017	1516	18.805	NP		
24/11/2017	1550	18.705	NP		
19/01/2018	919	18.7	NP		
13/02/2018	1000	34.76	NP		
12/03/2018	958	31.82	NP		Rainfall in past month <150mm
9/04/2018	1108	30.02	NP		
8/05/2018	1138	28.17	NP		
12/06/2018	1028	27.16	NP		Rainfall in past month <20mm
10/07/2018	953	26.9	NP		Rainfall in past month <35mm
7/08/2018	1307	26.29	NP		

Monitoring conducted by Melissa Mass (SE Environmental P/L)

Bore Water Monitoring				
Hitchcocks Road & 198				
PF166MW - 2D				
Date	Time	SWL (m,toc)	SWL,m (AHD)	Notes
7/06/2017	1525	27.85	182.05	
17/07/2017		27.91	181.99	
27/07/2017	1100	27.98	181.92	
15/08/2017	1220	27.88	182.02	
7/09/2017	1600	27.91	181.99	
23/10/2017	1500	27.92	181.98	
24/11/2017	800	27.93	181.97	
18/12/2017	1414	27.89	182.01	
19/01/2018	1209	27.96	181.94	
13/02/2018	1205	27.97	181.93	
12/03/2018	1244	28.08	181.82	Rainfall in past month <150mm
9/04/2018	1339	28.09	181.81	
8/05/2018	1418	28.19	181.71	
12/06/2018	1313	28.18	181.72	Rainfall in past month <20mm
10/07/2018	1226	28.39	181.51	Rainfall in past month <35mm
7/08/2018	944	28.29	181.61	

Monitoring conducted by Melissa Mass (SE Environmental P/L)

Bore Water Monitoring				
Hitchcocks Road & 198				
PF166MW - 2S				
Date	Time	SWL (m,toc)	SWL,m (AHD)	Notes
7/06/2017	1525	4.6	205.4	
17/07/2017		4.52	205.48	
27/07/2017	1100	4.625	205.375	
15/08/2017	1210	4.77	205.23	
7/09/2017	1600	5	205	
23/10/2017	1500	5.29	204.71	
24/11/2017	800	5.47	204.53	
18/12/2017	1414	5.59	204.41	
19/01/2018	1208	5.75	204.25	
13/02/2018	1205	5.86	204.14	
12/03/2018	1243	5.82	204.18	Rainfall in past month <150mm
9/04/2018	1338	5.93	204.07	
8/05/2018	1417	6.23	203.77	
12/06/2018	1312	6.45	203.55	Rainfall in past month <20mm
10/07/2018	1225	6.53	203.47	Rainfall in past month <35mm
7/08/2018	943	6.68	203.32	Muddy

Monitoring conducted by Melissa Mass (SE Environmental P/L)

Bore Water Monitoring				
Hitchcocks Road & 198				
PF166MW - 3D				
Date	Time	SWL (m, to	SWL, m (A	Notes
7/06/2017		14.14	184.53	
26/06/2017		14.11	184.56	
17/07/2017		13.395	185.275	
15/08/2017	12.38	13.95	184.72	
7/09/2017	15.3	14.1	184.57	
24/10/2017	1020	14.25	184.42	
24/11/2017	1015	14.33	184.34	
18/12/2017	715	14.42	184.25	
19/01/2018	1241	14.26	184.41	
13/02/2018	1220	14.54	184.13	
12/03/2018	1237	14.57	184.1	Rainfall in past month <150mm
9/04/2018	1332	14.64	184.03	
8/05/2018	1410	14.63	184.04	
12/06/2018	1306	14.89	183.78	Rainfall in past month <20mm
10/07/2018	1216	15.17	183.5	Rainfall in past month <35mm
7/08/2018	928	15.28	183.39	

Monitoring conducted by Melissa Mass (SE Environmental P/L)



Bore Water Monitoring				
Hitchcocks Road & 198				
PF167MW - 4D				
Date	Time	SWL (m,toc)	SWL,m (AHD)	Notes
7/06/2017		7.46	185.93	
17/07/2017		7.335	186.055	
27/07/2017	1110	7.445	185.945	
15/08/2017	1230	7.45	185.94	
7/09/2017	1540	7.61	185.78	
24/10/2017	1030	7.775	185.615	
24/11/2017	1030	7.88	185.51	
18/12/2017	726	7.96	185.43	
19/01/2018	1235	8.08	185.31	
13/02/2018	1229	8.17	185.22	
12/03/2018	1231	8.34	185.05	Rainfall in past month <150mm
9/04/2018	1325	8.53	184.86	
8/05/2018	1405	8.62	184.77	
12/06/2018	1258	8.72	184.67	Rainfall in past month <20mm
10/07/2018	1212	8.82	184.57	Rainfall in past month <35mm
7/08/2018	915	8.78	184.61	

Monitoring conducted by Melissa Mass (SE Environmental P/L)

Bore Water Monitoring				
Hitchcocks Road & 198				
PF167MW - 4S				
Date	Time	SWL (m,toc)	SWL,m (AHD)	Notes
7/06/2017		7.61	185.83	
17/07/2017		7.515	185.925	
27/07/2017	1110	7.58	185.86	
15/08/2017	1230	7.645	185.795	
7/09/2017	1540	7.7	185.74	
24/10/2017	1030	7.775	185.665	
24/11/2017	1030	7.81	185.63	
18/12/2017	726	7.83	185.61	
19/01/2018	12.36	7.85	185.59	
13/02/2018	1227	7.89	185.55	
12/03/2018	1232	7.93	185.51	Rainfall in past month <150mm
9/04/2018	1326	7.98	185.46	
8/05/2018	1406	8.07	185.37	
12/06/2018	1300	8.16	185.28	Rainfall in past month <20mm
10/07/2018	1212	8.34	185.1	Rainfall in past month <35mm
7/08/2018	920	8.32	185.12	

Monitoring conducted by Melissa Mass (SE Environmental P/L)

Bore Water Monitoring				
Hitchcocks Road & 198				
PF166 MW1				
Date	Time	SWL (m,toc)	SWL,m (AHD)	Notes
9/06/2017		10.8	199.55	
17/07/2017		10.01	200.34	
15/08/2017	1345	10.15	200.2	
22/09/2017	1450	10.41	199.94	
23/10/2017	910	10.64	199.71	
24/11/2017	810	10.79	199.56	
18/12/2017	710	10.91	199.44	
19/01/2018	1216	11.03	199.32	
13/02/2018	1155	11.17	199.18	
12/03/2018	1215	11.28	199.07	Rainfall in past month <150mm
9/04/2018	1313	11.35	199	
8/05/2018	1339	Dry		
12/06/2018	1245	Dry		Rainfall in past month <20mm
10/07/2018	1157	Dry		Rainfall in past month <35mm
7/08/2018	848	Dry		

Monitoring conducted by Melissa Mass (SE Environmental P/L)

Bore Water Monitoring				
Hitchcocks Road & 198				
PF167 MW1				
Date	Time	SWL (m,toc)	SWL,m (AHD)	Notes
9/06/2017		4.83	183.12	
17/07/2017		4.7	183.25	
15/08/2017	1200	4.69	183.26	
22/09/2017	1442	4.91	183.04	
23/10/2017	916	5.12	182.83	
24/11/2017	740	5.27	182.68	
18/12/2017	700	5.41	182.54	
19/01/2018	1204	5.58	182.37	
13/02/2018	1200	5.72	182.23	
12/03/2018	9.47	5.89	182.06	Rainfall in past month <150mm
9/04/2018	1057	6.09	181.86	
8/05/2018	1430	6.31	181.64	
12/06/2018	1013	6.61	181.34	Rainfall in past month <20mm
10/07/2018	1236	6.75	181.2	Rainfall in past month <35mm
7/08/2018	959	6.85	181.1	

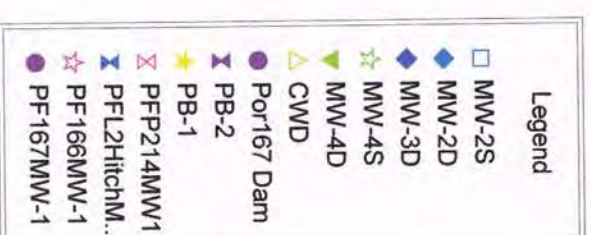
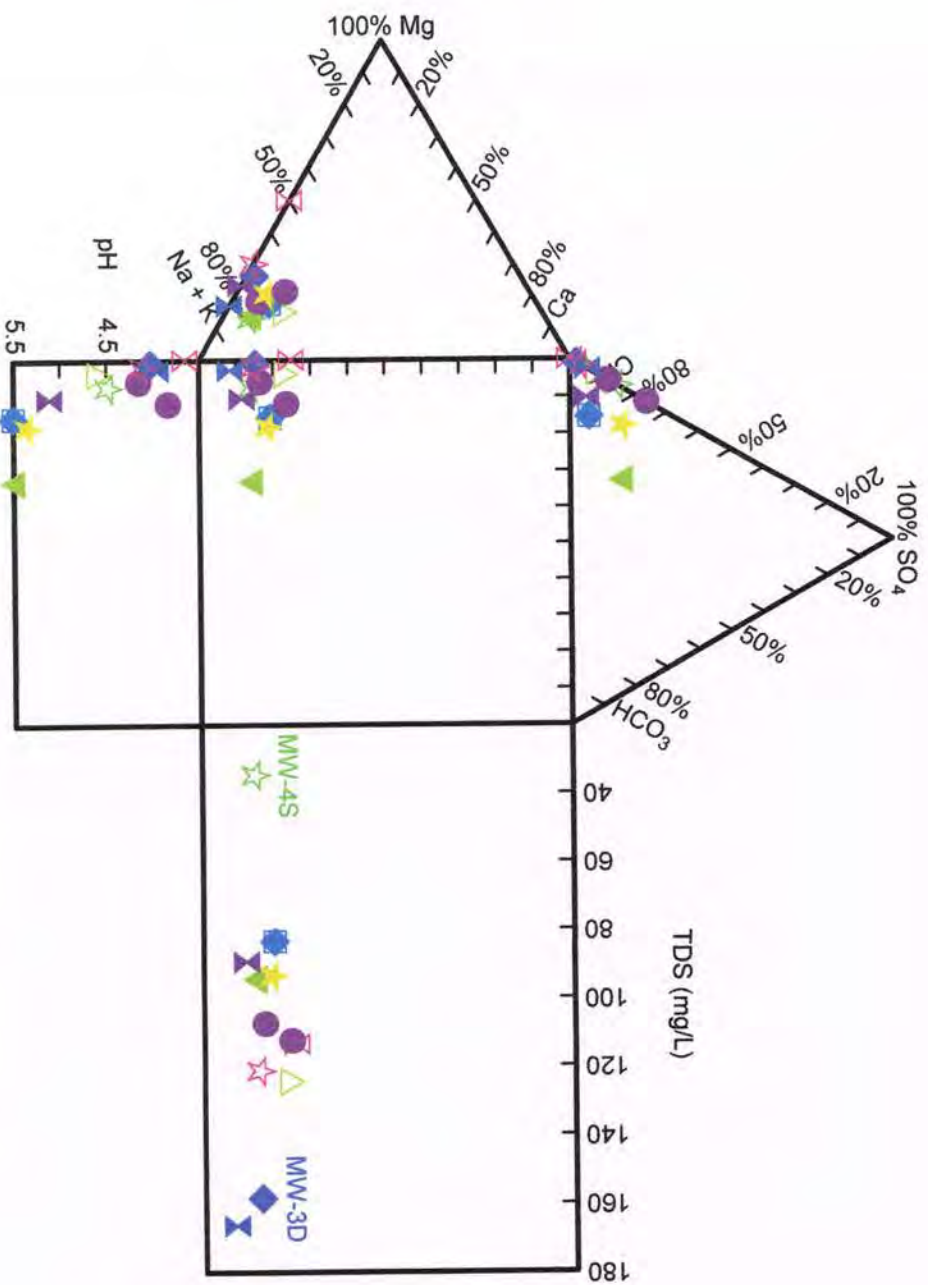
Monitoring conducted by Melissa Mass (SE Environmental P/L)

Bore Water Monitoring				
Hitchcocks Road & 198				
PF214 MW1				
Date	Time	SWL (m,toc)	SWL,m (AHD)	Notes
9/06/2017		5.85	179.41	
17/07/2017		5.385	179.875	
15/08/2017	1215	5.12	180.14	
7/09/2017	1410	5.13	180.13	
23/10/2017	940	5.146	180.114	
24/11/2017	1045	5.16	180.1	
18/12/2017	800	5.27	179.99	
19/01/2018	1222	5.33	179.93	
13/02/2018	1215	5.45	179.81	
12/03/2018	1223	5.34	179.92	Rainfall in past month <150mm
9/04/2018	1318	5.31	179.95	
8/05/2018	1354	5.54	179.72	
12/06/2018	1252	5.56	179.7	Rainfall in past month <20mm
10/07/2018	1204	5.73	179.53	Rainfall in past month <35mm
7/08/2018	901	5.72	179.54	

Monitoring conducted by Melissa Mass (SE Environmental P/L)

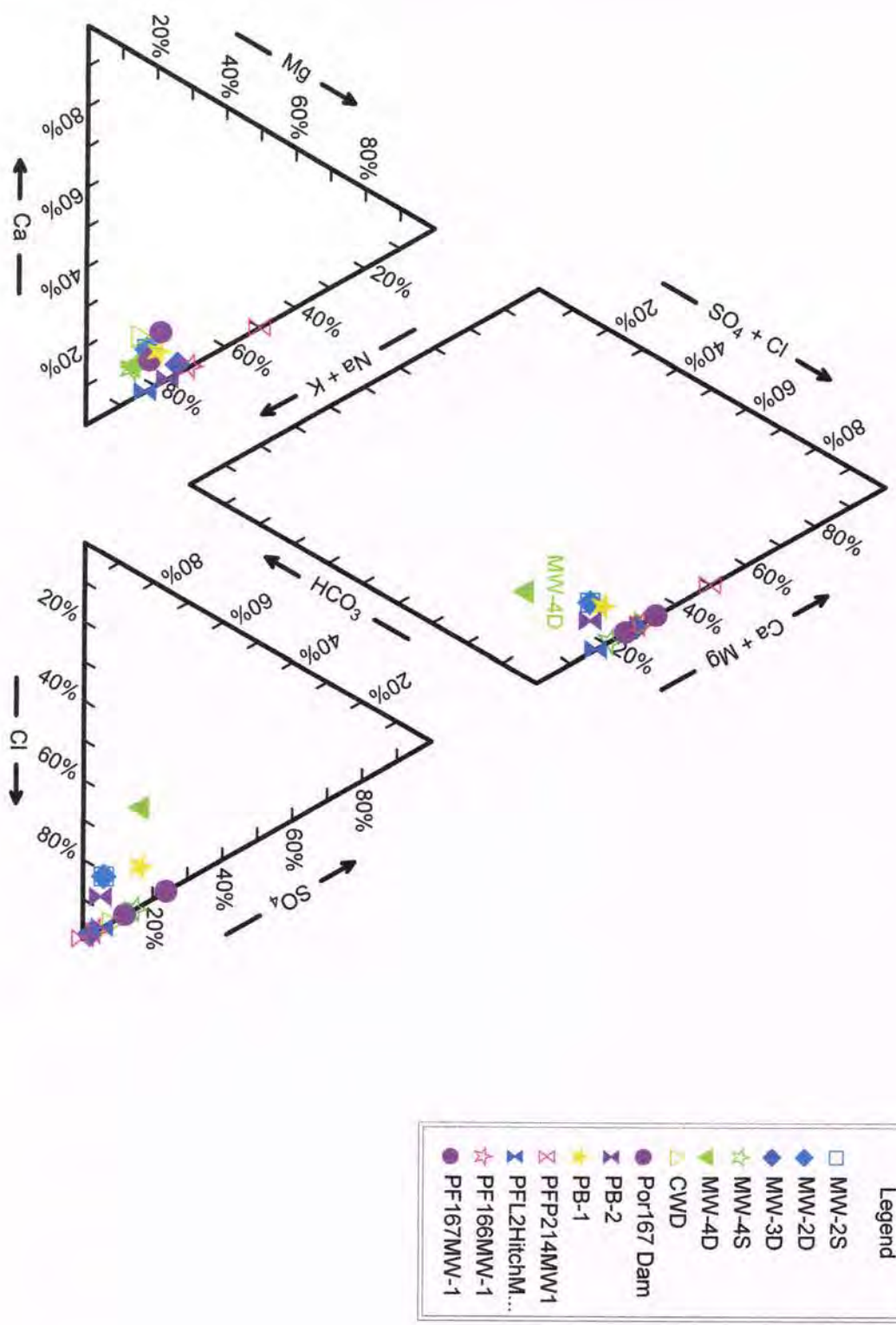
## APPENDIX H

# Durov1 Maroota Water Aug 2018





Piper1; Marroota Water Aug 2018



LAST PAGE OF REPORT



*Thank you for the opportunity to work with  
PF Formation.*

Feedback is Welcomed at Earth2Water  
([dino@earth2water.com.au](mailto:dino@earth2water.com.au))

